East Grand Rapids Public Schools

K-12 SCIENCE CURRICULUM

K-12 CURRICULUM ADOPTED — APRIL 2009

6-12 COMMON CORE STATE STANDARDS INTEGRATED — MAY 2012

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K-12 Science Curriculum
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PHILOSOPHY

Science students continually observe, question, problem solve, collect and analyze data, collaborate, make real-world connections, and communicate effectively.

MISSION

Educating and inspiring each student to navigate successfully in a global community

RATIONALE

We began working together as a K-12 committee on February 28, 2008, with the purpose of researching and studying science curriculum. During the time of research, a great deal of discussion was held and realignment was accomplished based on the new state requirements, the K-8 Grade Level Content Expectations and the High School Content Expectations (HSCE), in addition to the national science standards.

We understand that there is a growing sense of urgency among educators, parents, policymakers, and business people to provide students with skills that will enable them to compete with their international peers. These skills extend beyond the basics to new knowledge and skills that prepare them for *their* world of work.

As we prepared the curriculum and selected support resources, we considered the students' need to be able to accomplish the following:

- Think critically
- Apply knowledge to new situations
- Analyze information
- Understand new ideas
- Communicate effectively
- Collaborate
- Solve problems
- Make decisions

PROFESSIONAL LEARNING PLAN

HIGH SCHOOL

We will continue with a K-12 implementation team (Professional Learning Community) for the 2009-2010 school year with an emphasis on:

- Examining and reflecting the newly aligned curriculum
- Aligning common assessments for the required core classes
- Ensuring that the content expectations are articulated for personal curriculums
- Developing collaboratively professional learning opportunities for the department

MIDDLE SCHOOL

We will continue with a K-12 implementation team (Professional Learning Community) for the 2009-2010 school year with an emphasis on:

- Examining and reflecting the newly aligned curriculum
- Aligning common assessments for the required core classes
- Ensuring that the content expectations are articulated for personal curriculums
- Developing collaboratively professional learning opportunities for the department

ELEMENTARY

We will continue with an elementary implementation team for the 2009-2010 school year.
Professional learning opportunities will include:

- Administrative training of the “inquiry based” science learning philosophy and a commitment to the ongoing needs of the program
- During the 2009-2010 school year, teachers will be trained in the inquiry-based science learning philosophy, as well as units assigned to their grade level.
- During professional development days, we will bring in trainers to further enhance our staff learning of the program
- Training will be provided in years to come for new teachers and teachers who switch grade levels.

RECOMMENDATIONS and BUDGET

HIGH SCHOOL

Anatomy & Physiology
Essentials of Anatomy & Physiology, Pearson/Prentice Hall
80 books x $86.97 ..... $6,957.60

Physics (New 9th Grade Class)
Physics, Pearson/Prentice Hall
110 books x $73.97 ..... $8,136.70

Physics (Honors)
Physics: Principles and Problems, Glencoe
120 books x $73.50 ..... $8,820.00

Biology
Miller & Levine Biology, Pearson/Prentice Hall
110 books x $75.97 ..... $8,356.70

Biology (Honors)
Glencoe Science Biology, National Geographic, Glencoe
140 books x 74.40 ..... $10,416.00

Total for High School $42,687.00

MIDDLE SCHOOL

Materials were purchased in 2002. MS received Earth Science materials
from the HS in March 2009. Budget allowance **$3000.00**

ELEMENTARY SCHOOLS .....

Grade Levels K-5 x 3 buildings, approximately **$65,800.00**

Subtotal

- High School $42,687.00
- Middle School 3,000.00
- Elementary 65,800.00

TOTAL BUDGET $111,487.00

FUTURE CONSIDERATIONS

I. Proposed High School Courses

Environmental Science

Environmental science is a topic of study that includes several disciplines including geology, chemistry, biology, and ecology, but it also crosses into several social sciences. The course being proposed for inclusion in the EGR science curriculum hopes to incorporate all of these in a year-long class that stresses the importance of science in society and the process of science itself.

The foundation of the course is an understanding of the earth and its many components – energy, water, air, soil, and organisms, especially humans. While knowledge of these components is important, it is their interrelatedness that will be stressed. Students will use their understanding of the world in which they live to serve as a learning tool. Time will be spent studying not only ways in which humans have influenced the world around them, but also ways that humans can lessen their impact on the earth through sustainable energy sources, air/water/land consumption, and alternative food sources.

Environmental science at EGRHS is intended for students that are curious about the world around them and what they can do to help it. Self-directed, hands-on activities will play major role in the learning process where students can identify problems and work to develop solutions. Reflection and collaboration, vital components of real-world science, will be abundant in this course as students gain more knowledge as the year progresses.

Science Olympiad

Science Olympiad is designed as a third or fourth year science course and can be taken concurrently with other science requirements for students who are competition or project oriented. The purpose of this course is to engage students who are eager to take a hands-on, self-directed approach to explore an area in science in depth. It will be designed so that the students will choose several different events that they would like to specialize in, such as geology, astronomy, physics, chemistry, ecology, biology, anatomy, design, technology, and scientific investigation.

This course will allow students to specialize in an area of science that is of particular interest to them. Through research, projects, demonstrations, laboratory work, and discussion, students will prepare to compete in the regional Science Olympiad competition.

II. Recommendation for Textbooks and Support Resources

- Textbook and support resource rotation desired every seven years
- Needed for the 2012-2013 school year:
  - Senior Physics will be dropped
  - Advanced Physics needs both books and resources
  - Chemistry and Honors Chemistry needs both books and resources

III. Proposed Resources (replacement every 5-10 years)

Biology/Honors Biology/AP Biology

Material	Michigan Content Expectation	Number	Cost
Microscopes	Bacteria and Cells	36 (2 class sets)	27,000
Dissecting microscope	Cells/Osmosis and Diffusion/Living organism exploration	36 (2 class sets)	11,500
Hot Plates/Stirrer	Biochemistry/Enzymes Thermal Chemistry	36 (2 class sets)	16,200
Incubator	Biochemistry/Microbiology Genetics	1	500
Autoclave	Biochemistry/Microbiology Genetics	1	1,500
Refrigerator	All perishable lab materials	1	Find used
Electrophoresis equipment, chambers, and power supplies	DNA/Genetics/Restriction Enzymes/Plasmids	Classroom set	3,375

Chemistry/Honors Chemistry

Material	Michigan Content Expectation	Number	Cost
*Microgram Balance	Measurement	4	8,800
Milligram Balance	Measurement	6/yr	3,000
pH meters and supplies	Acid/Bases	14	5,600-11,200
Still	Solutions	1	500
*Spectrophotometers	Equilibrium/Molarity/Rates Photosynthesis (AP Bio)	Replace as needed; None at this time	1,400
Electrolysis	Electrochemistry/Stoichiometry	14	2,100
Electrical chem.. cells	Electrochemistry/Stoichiometry	1-8	100-800
*Gas tank/regulator/ Dry ice maker	Gas Laws/Phase Changes	3	2,100 530
*Vacuum pump 2 stage	Gas Law/Phase Changes	1	250
Barometer (Hg Free)	Gas Laws	1	250
Dewar flask	Thermochemistry	1	300

*10-20 year purchase

Physics/Honors Physics/Advanced Physics/AP Physics

Material	Michigan Content Expectation	Number	Cost
Multi-meters	Electric Current	10	800
Electroscopes	Electric Forces	18	30
Electrostatic Supplies	Electric Forces		
Van de Graaff Generator	Electric Forces	1	530
Wimshurst Machine	Electric Forces	1	590
Power Supplies	Electricity and Magnetism	6	300
Soldering Stations	Electricity and Magnetism	18	30
Radiation Sources	Energy and Society, Energy Transformations	3	190
Nuclear Filters/Absorbers	Energy and Society, Energy Transformations	3	170
Specific Heat Masses	Energy Transformations	18	180
Power Supply (Gas Tubes)	Energy Transformations	1	200
Gas Tubes	Energy Transformations	8	40
Photo-electric Apparatus	Energy Transformations, AP Curriculum	1	1,970
High Resolution Force Sensor	Forces	10	1,390
Black Board Mechanics	Forces	18	1,030
Light Sensor	Light	18	2,400
Ultraviolet Light sensor	Light	1	170
Transmission Gratings (slide mount)	Light and Optics	36	TBD
Polaroid Filters	Light and Optics	3	TBD
Optics Bench	Light and Optics	18	530
Laser	Light and Optics	1	300
Concave/Convex Mirror	Light and Optics	1	250
Blackboard Optic System	Light and Optics	1	1,300
Light Ray Box	Light and Optics	18	2,800
Calipers	Measurement	18	TBD
Chlandi Plates Kit	Mechanical Waves	1	90
Economy Wave Driver	Mechanical Waves	18	900
Waver Driver Post	Mechanical Waves	3	270
Wave Table	Mechanical Waves	1	1,000
Pasco Motion Sensor	Motion	18	1,450

Physics/Honors Physics/Advanced Physics/AP Physics *(continued)*

Material	Michigan Content Expectation	Number	Cost
Time of Flight Sensor	Motion	1	80
Laser Switch	Motion	3	250
Freefall Accessory	Motion	1	130
Drop Shoot Accessory	Motion	1	60
Projectile Launcher	Motion	3	1,100
Bicycle Wheel Gyroscope	Motion	1	340
Rotational Inertia Set	Motion	2	270
Spark Timers	Motion	18	TBD
Air Track Accessories	Motion, Forces	3	170
Accessory Photogate	Motion Momentum	36	2,400
Supper Pulley	Motion Momentum	36	850
Pasco Digital Adapter	Motion Momentum	18	1,100
Stobe Box	Motion and Waves	1	200
Stroscope	Motion and Waves	1	550

IV. Building/Safety Needs

Acid Cabinet, 2 @ 950 ..... $1,900
Flammable Cabinet $1,750
Properly maintained ventilated storage and installation ..... TBD
Greenhouse (See two previous bond proposals) ..... TBD
Fume hood, plus installation $1,200

V. Annual Consumable Materials (Building/Department Budgets)

Physics/Honors Physics/AP Physics

- Plastic balls
- rocket engines
- electronic supplies
- balloons
- glue
- tape
- alpha source
- Van der Graff Belts
- Bar magnets
- electrostatic supplies $550

Biology/Honors Biology

- Living Organisms: Daphnia, Planaria, Bacteria, Plants $400
- Preserved: Pigs $1,000

Annual Consumable Materials (Building/Department Budgets) *continued*

AP Biology

- Dialysis tubing
- Clinistix
- plastic cups
- live plants
- slides
- catalase
- DPIP
- disposable syringes

AP Biology (Annual Consumable Materials *continued*)

- pipette tips for micropipettes
- labeling pens and markers
- microorganisms (*Sordaria perithecia*- wild and tan mutant types, *E. coli*)
- chromatography paper
- parafilm
- pea seeds
- sterile Eppendorf tips and tubes,1% agarose
- TBE buffer
- electrophoresis buffer
- restriction buffer
- ECo*RI* digested DNA
- *HIND III* DN *Drosophila melonogaster* (wild type, 2-4 experimental types)
- pill bugs
- chemicals (not stocked for chemistry)
- grocery store items.....$1,850

Anatomy/Physiology (Preserved)

- Cats $2,000
- Hearts, Brains, Eyes.....$300

Chemistry

- Chemicals.....$1,500
- Chemical hardware $1,000

VI. Equipment currently purchased by EGR Schools Foundation and EGRHS PTSA

- Pasco 750 Interface
- Numerous Pasco Sensors from multiple grants
- Physics Cinema Classics demonstration videos
- Wave Table
- Wave Generator
- Gieger Mueller Tube
- Circular Motion Apparatus
- Pasco Gas Law Apparatus
- Nuclear Isotope Generator
- 15 digital stop watches Robic
- A set of 18 Pasco Explorer Data loggers with temperature and voltage probes

Equipment currently purchased by EGR Schools Foundation and EGRHS PTSA (*continued*)

- A demonstration set of probes (1 each)
- A set of 8 Force meters for Pasco Probes
- 30 Electronic Kits
- Set of electrophoresis equipment
- Six Spectrophotometers
- Manual Autoclave (sterilizer)
- Incubators
- Microbiology lab supplies
- Microscopes, Balances
- Hot Plates/Stirrer
- Scientific American Frontiers DVD set
- PASPORT Biology Intermediate Bundle
- Population Genetics Studies and Chi Square Analysis
- Supplies for lab on Tragedy of the Commons
- Antibiotic Resistance Lab Supplies
- Energy in the Ecosytems—photosynthesis lab
- Microscopes—15
- Dissecting Microscopes—15
- Microscopes for Bacteria---4
- Graphing Calculator
- Digital Camera and IPOD
- Explorer GLX: Hand-held Data Storage Unit
- Water Testing Kits—(now sent to the middle school)
- Star Board for Computer
- Microscope Slides
- Forensic Science Books
- CSI:EGR—Money to buy supplies for the new Forensic Science class
- Spec 20 Sptectroscope
- Tandems
- Auto Levels, Tripods, Rods
- Micrometers
- Centragram Balances
- Darkroom enlargers
- Lab timers
- Audio generators
- Volt ohm meters
- Block tronics/Thermisters

East Grand Rapids Public Schools

ELEMENTARY SCIENCE CURRICULUM

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Kindergarten Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)

1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)

1 Statement (3)

Standard: Reflection and Social Implications (RS)

1 Statement (1)

Discipline 2: Physical Science (P)

Standard: Force and Motion (FM)

Position (2)

Gravity (1)

Force (4)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)

Life Requirements (2)

Discipline 4: Earth Science (E)

Standard: Solid Earth (SE)

Earth Materials (1)

Kindergarten Science Standards, Statements, and Expectations

SCIENCE PROCESSES	*1. TLW demonstrate an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems by using their five senses to explore the natural world.* **Essential Questions** • How does science help us answer questions about the world around us? • What does it mean to question? • Why do scientists conduct investigations? **Key Concepts** • Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations. • Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation. **Inquiry Process** S.IP.00.11 Make purposeful observation of the natural world using the appropriate senses. S.IP.00.12 Generate questions based on observations. S.IP.00.13 Plan and conduct simple investigations. S.IP.00.14 Manipulate simple tools (for example: hand lens, pencils, balances, non-standard objects for measurement) that aid observation and data collection. S.IP.00.15 Make accurate measurements with appropriate (non-standard) units for the measurement tool. S.IP.00.16 Construct simple charts from data and observations. **Inquiry Analysis and Communication** S.IA.00.12 Share ideas about science through purposeful conversation. S.IA.00.13 Communicate and present findings of observations. S.IA.00.14 Develop strategies for information gathering (ask an expert, use a book, make observations, conduct simple investigations, search the Internet, and watch a video). **Reflection and Social Implications** S.RS.00.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
PHYSICAL SCIENCE	*2. TLW compare the position and motion of an object in relation to other objects.* **Essential Questions** • What happens when you drop an object? **Key Concepts** • All objects fall toward Earth because of the force of gravity. • An object's position may be described by locating the object relative to the position of other objects. • The perception of the motion of an object depends on one's viewpoint. *3. TLW explain that a force is a push or pull and demonstrate those forces on objects.* **Essential Questions** • What affects the movement of an object? • What is a force?

	Key Concepts • Objects at rest only start moving when a push or pull is applied to them. • Pushes or pulls can change the speed or direction of moving objects. • The shape, size, and weight of an object can affect its motion. **Force and Motion** P.FM.00.11 Compare the position of an object (for example: above, below, in front of, behind, on) in relation to other objects around it. P.FM.00.12 Describe the motion of an object (for example: away from or closer to) from different observers' views. P.FM.00.21 Observe how objects fall toward the earth. P.FM.00.31 Demonstrate pushes and pulls. P.FM.00.32 Observe that objects initially at rest will move in the direction of the push or pull. P.FM.00.33 Observe how pushes and pulls can change the speed or direction of moving objects. P.FM.00.34 Observe how shape (for example: cone, cylinder, sphere), size, and weight of an object can affect motion
LIFE SCIENCE	*4. TLW compare living and nonliving things and identify the basic requirements for life.* **Essential Questions** • How do we know if something is alive? • What do living things need? • What materials from the earth does a plant need to grow? **Key Concepts** • Air, water, and soil are earth materials that plants use to grow. • Living things have the basic needs of food, water, air, and space. Some living things need light. • Objects on earth can be classified as living or non-living. **Organization of Living Things** L.OL.00.11 Identify that living things have basic needs. L.OL.00.12 Identify and compare living and nonliving things.
EARTH SCIENCE	*5. TLW develop an understanding of the properties of earth materials and how those properties make materials useful. Understand gradual and rapid changes in earth materials and features of the surface of earth. Understand magnetic properties of earth.* **Solid Earth** E.SE.00.11 Identify earth materials (air, water, soil) that are used to grow plants.

Science Vocabulary as first introduced in Kindergarten

above	away	behind
below	between	bitter
closer	color (and common color words)	cone
cylinder	data	direction
ear	eye	fall
gravity	hard	hearing
in front	inside	investigation
motion	moving objects	nose
object	objects at rest	observe odor
on	pleasant	position

predict	pull	pulling
push	pushing	question
rough texture	salty	senses
shape	sight	size
skin	smell	smooth texture
soft	sound	sour
sphere	sweet	taste
texture	tongue	touch
under	unpleasant	weight

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First Grade Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)

1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)

1 Statement (3)

Standard: Reflection and Social Implications (RS)

1 Statement (2)

Discipline 2: Physical Science (P)

Standard: Properties of Matter (PM)

Physical Properties (1)

States of Matter (2)

Magnets (2)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)

Life Requirements (1)
Life Cycles (1)

Standard: Heredity (HE)

Observable Characteristics (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)

Solar Energy (2)
Weather (4)
Weather Measurement (2)

Standard: Solid Earth (SE)

Earth Materials (1)

First Grade Science Standards, Statements, and Expectations

SCIENCE PROCESSES	*1. TLW demonstrate an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems by using measurement tools to investigate the natural world.* **Essential Questions** • How does science help us answer questions about the world around us? • What does it mean to question? • Why do scientists conduct investigations? **Key Concepts** • Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations. • Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation. **Inquiry Process** S.IP.01.11 Make purposeful observation of the natural world using the appropriate senses. S.IP.01.12 Generate questions based on observations. S.IP.01.13 Plan and conduct simple investigations. S.IP.01.14 Manipulate simple tools (for example: hand lens, pencils, rulers, thermometers, rain gauges, balances, non-standard objects for measurement) that aid observation and data collection. S.IP.01.15 Make accurate measurements with appropriate (non-standard) units for the measurement tool. S.IP.01.16 Construct simple charts from data and observations. **Inquiry Analysis and Communication** S.IA.01.12 Share ideas about science through purposeful conversation. S.IA.01.13 Communicate and present findings of observations. S.IA.01.14 Develop strategies for information gathering (ask an expert, use a book, make observations, conduct simple investigations, and watch a video). **Reflection and Social Implications** S.RS.01.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities. S.RS.01.12 Recognize that science investigations are done more than one time.
PHYSICAL SCIENCE	*2. TLW classify objects by observable attributes and explain that objects have physical properties and may exist in different states.* **Essential Questions** • What are the states of water? • What properties do common objects have? • Why does a liquid take the shape of its container? • Why does a solid keep its own shape? **Key Concepts** • A solid keeps its own shape, while a liquid takes the shape of its container. • All objects and substances have physical properties that can be measured. • Water exists as a solid (ice) and as a liquid (water). **Properties of Matter** P.PM.01.11 Demonstrate the ability to sort objects according to observable attributes such as color, shape, size, sinking or floating. P.PM.01.21 Demonstrate that water as a solid keeps its own shape (ice).

	P.PM.01.22 Demonstrate that water as a liquid takes on the shape of various containers. P.PM.01.31 Identify materials that are attracted by magnets. P.PM.01.32 Observe that like poles of a magnet repel and unlike poles of a magnet attract.
LIFE SCIENCE	*3. TLW identify the needs and life cycles of animals.* **Organization of Living Things** L.OL.01.13 Identify the needs of animals. L.OL.01.21 Describe the life cycle of animals including the following stages: egg, young, adult; egg, larva, pupa, adult. *4. TLW identify characteristics of animals that are passed from parents to young animals.* **Essential Questions** • How can you tell which kind of adult animals are the parents of a young animal? **Key Concepts** • Many characteristics are passed from parent to young. • Young animals share many characteristics of their parents. **Heredity** L.HE.01.11 Identify characteristics (for example: body coverings, beak shape, number of legs, body parts) that are passed on from parents to young. L.HE.01.12 Classify young animals based on characteristics that are passed on from parents (for example: dogs/puppies, cats/kittens, cows/calves; chickens/chicks)
EARTH SCIENCE	*5. TLW describe weather conditions and identify the role of the sun as it affects our weather.* **Essential Questions** • How do people stay safe during severe weather? • How does weather change? • What causes our weather? **Key Concepts** • In Michigan, the seasons are summer, autumn, winter, and spring. • Severe weather can be dangerous and precautions must be taken to stay safe. • The sun warms the land, air, and water, affecting the weather. • Weather changes daily and seasonally. • Weather is described by determining temperature, cloud cover, precipitation, and wind. **Earth Systems** E.ES.01.11 Identify the sun as the most important source of heat which warms the land, air, and water of the earth. E.ES.01.12 Demonstrate the importance of sunlight and warmth in plant growth. E.ES.01.21 Compare daily changes in the weather related to temperature (cold, hot, warm, cool); cloud cover (cloudy, partly cloudy, foggy); precipitation (rain, snow, hail, freezing rain); wind (breezy, windy, calm). E.ES.01.22 Describe and compare weather related to the four seasons in terms of temperature, cloud cover, precipitation, and wind. E.ES.01.23 Describe severe weather events. E.ES.01.24 Describe precautions that should be taken for human safety during severe weather conditions (thunderstorms, lightning, tornadoes, high winds, blizzards, hurricanes). E.ES.01.31 Identify the tools that might be used to measure temperature, precipitation, cloud cover, and wind. E.ES.01.32 Observe and collect data of weather conditions over a period of time.

	Solid Earth E.SE.01.12 Describe how earth materials contribute to the growth of plant and animal life.

Science Vocabulary as first introduced in 1st Grade

adult	air	amphibian
attract	autumn	backbone
balance	beak shape	big/ bigger
bird	blizzard	blow
body covering	breakable/unbreakable	breezy
calm	capacity	cat/kitten
change	chicken/chick	classify
cloud	cloud cover	cloudy
cold/colder	cool/cooler	compare
confirm	container	cow/calf
cup	daily	dew
differences	distance	dog/puppy
egg	equal	estimate
feather	fish	flexible/firm
fog	foggy	force
freezing rain	fur	graph
growth	hail	hair
hard/harder	hardness	heat
heavier than	heavy/heavier	height
high winds	hot/hotter	warm/warmer
human	hurricane	ice
insect	large/larger	larva
leg	length	life cycle
light	lighter	lighter than
lightning	limb	live birth
long	long/longer	longest
magnet	magnetic	magnetic force
mammal	measure	measurement
melting	movement	nearest
non-magnetic	non-standard unit	observe
parent	partly cloudy	precipitation
predict	prediction	pupa
rain	repel	reptile
safety	seasonal weather patterns	seasons
severe weather	shelter	short/shorter
shortest	similarities	sink/float
sky	small/smaller	snow
soft/ softer	spring	summer
sun	sunny	tall/taller
tallest	temperature	thermometer
thunderstorm	tornado	tree
unit	volume	warmth
water	weather	weather conditions
weather patterns	weigh	width
wind	windy	winter
young		

ELEMENTARY SCIENCE CURRICULUM

Second Grade Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)
1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)
1 Statement (3)

Standard: Reflection and Social Implications (RS)
1 Statement (4)

Discipline 2: Physical Science (P)

Standard: Properties of Matter (PM)
Physical Properties (4)
Material Composition

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (1)
Life Cycles (1)

Standard: Heredity (HE)
Observable Characteristics (2)

Discipline 4: Earth Science (E)

Standard: Solid Earth (SE)
Surface Changes (1)

Standard: Fluid Earth (FE)
Water (4)
Water Movement (2)

Second Grade Science Standards, Statements, and Expectations

SCIENCE PROCESSES	*1. TLW demonstrate an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems by using measurement tools to investigate the natural world.* **Essential Questions** • How does science help us answer questions about the world around us? • What does it mean to question? • Why do scientists conduct investigations? **Key Concepts** • Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations. • Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation. **Inquiry Process** S.IP.02.11 Make purposeful observation of the natural world using the appropriate senses. S.IP.02.12 Generate questions based on observations. S.IP.02.13 Plan and conduct simple investigations. S.IP.02.14 Manipulate simple tools (ruler, meter stick, measuring cups, hand lens, thermometer, balance) that aid observation and data collection. S.IP.02.15 Make accurate measurements with appropriate units (meter, centimeter) for the measurement tool. S.IP.02.16 Construct simple charts and graphs from data and observations. **Inquiry Analysis and Communication** S.IA.02.12 Share ideas about science through purposeful conversation. S.IA.02.13 Communicate and present findings of observations. S.IA.02.14 Develop strategies and skills for information gathering and problem solving (books, internet, ask an expert, observation, investigation, technology tools). **Reflection and Social Implications** S.RS.02.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities. S.RS.02.13 Recognize that when a science investigation is done the way it was done before, similar results are expected. S.RS.02.15 Use evidence when communicating scientific ideas. S.RS.02.16 Identify technology used in everyday life.
PHYSICAL SCIENCE	*2. TLW classify objects by observable attributes and measure length, volume, and weight of objects.* **Essential Questions** • What properties do common objects have? **Key Concepts** • All objects and substances have physical properties that can be measured. *3. TLW classify objects as single substances or mixtures.* **Essential Questions** • How are solutions and suspensions alike and different? • What is a mixture?

	Key Concepts • Substances may be classified as single substances or mixtures. **Properties of Matter** P.PM.02.12 Describe objects and substances according to their properties (color, size, shape, texture, hardness, liquid or solid, sinking, or floating). P.PM.02.13 Measure the length of objects using rulers (centimeters) and meter sticks (meters). P.PM.02.14 Measure the volume of liquids using common measuring tools (measuring cups, measuring spoons). P.PM.02.15 Compare the weight of objects using balances.
LIFE SCIENCE	*4. TLW identify the needs of plants, describe the life cycle of flowering plants, and identify characteristics of plants that are passed from parents to young.* **Essential Questions** • What are the basic needs of plants? • What are the stages in the life cycles of flowering plants? **Key Concepts** • Plants need air, water, soil and light to grow and live. • The life stages of flowering plants are seed, plant, flower, and fruit. **Organization of Living Things** L.OL.02.14 Identify the needs of plants. L.OL.02.22 Describe the life cycle of familiar flowering plants including the following stages: seed, plant, flower, and fruit **Heredity** L.HE.02.13 Identify characteristics of plants (for example: leaf shape, flower type, color, size) that are passed on from parents to young.
EARTH SCIENCE	*5. TLW describe the major landforms and bodies of water of the surface of the earth.* **Essential Questions** • What are the characteristics of earth's bodies of water? • What are the characteristics of earth's landforms? **Key Concepts** • Different landforms have different characteristics. • Different types of bodies of water have different characteristics. • The earth has many types of bodies of water. • The earth has many types of landforms. **Solid Earth** **E.SE.02.21** Describe the major landforms of the surface of the earth (mountains, plains, plateaus, valleys, hills). *6. TLW identify sources, uses, properties, and movement of water.* **Essential Questions** • What are the states of water? • Why does a liquid take the shape of its container? • Why does a solid keep its own shape? **Key Concepts** • A solid keeps its own shape, while a liquid takes the shape of its container. • Water exists as a solid (ice) and as a liquid (water).

	Fluid Earth E.FE.02.11 Identify water sources (wells, springs, lakes, rivers, oceans). E.FE.02.12 Identify household uses of water (drinking, cleaning, food preparation). E.FE.02.13 Describe the properties (visible, flowing, melting, dew) of water as a liquid (lakes, rivers, streams, oceans). E.FE.02.14 Describe the properties (hard, visible, freezing, ice) of water as a solid (ice, snow, iceberg, sleet, hail). E.FE.02.21 Describe how rain collects on the surface of the earth and flows downhill into bodies of water (streams, rivers, lakes, oceans) or into the ground. E.FE.02.22 Describe the major bodies of water on the earth's surface (lakes, ponds, oceans, rivers, streams).

Science Vocabulary as first introduced in 2nd Grade

attribute	body of water	centimeter (cm)
changes in matter	dissolve	evaporate
flower	flowering plant	flowing
freeze/freezing	fruit	function
Great Lakes	hill	iceberg
lake	landform	leaf
leaf shape	light/lighter	liquid
mass	matter	measuring cup
measuring spoon	melt/melting	meter (m)
mixture	mountain	ocean
physical property	plain	plateau
pond	river	root
seed	seed plant	seedling
sleet	snow	solid
sort	spring	states of matter
stem	stream	substance
surface	valley	visible
volume	water source	waterfall
well		

ELEMENTARY SCIENCE CURRICULUM

Third Grade Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)
1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)
1 Statement (5)

Standard: Reflection and Social Implications (RS)
1 Statement (7)

Discipline 2: Physical Science (P)

Standard: Force and Motion (FM)
Gravity (1)
Force (4)
Speed (3)

Standard: Energy (EN)
Forms of Energy (1)
Light Properties (2)
Sound (2)

Standard: Properties of Matter (PM)
Conductive and Reflective Properties (2)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Structures and Functions (2)
Classification (2)

Standard: Evolution (EV)
Environmental Adaptation (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)
Natural Resources (4)
Human Impact (2)

Standard: Solid Earth (SE)
Earth Materials (2)
Surface Changes (1)
Using Earth Materials (2)

SCIENCE PROCESSES	1. *TLW demonstrate an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems by investigating gravity.* **Essential Questions** • How does science help us answer questions about the world around us? • What does it mean to question? • What is gravity? • Why do scientists conduct investigations? **Key Concepts** • Gravity is the force that pulls objects toward the earth. • Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations. • Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation. **Inquiry Process** S.IP.03.11 Make purposeful observation of the natural world using the appropriate senses. S.IP.03.12 Generate questions based on observations. S.IP.03.13 Plan and conduct simple and fair investigations. S.IP.03.14 Manipulate simple tools that aid observation and data collection (for example: hand lens, balance, ruler, meter stick, measuring cup, thermometer, spring scale, stop watch/timer). S.IP.03.15 Make accurate measurements with appropriate units (centimeters, meters, Celsius, grams, seconds, minutes) for the measurement tool. S.IP.03.16 Construct simple charts and graphs from data and observations. **Inquiry Analysis and Communication** S.IA.03.11 Summarize information from charts and graphs to answer scientific questions. S.IA.03.12 Share ideas about science through purposeful conversation in collaborative groups. S.IA.03.13 Communicate and present findings of observations and investigations. S.IA.03.14 Develop research strategies and skills for information gathering and problem solving. S.IA.03.15 Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences. **Reflection and Social Implications** S.RS.03.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities. S.RS.03.14 Use data/samples as evidence to separate fact from opinion. S.RS.03.15 Use evidence when communicating scientific ideas. S.RS.03.16 Identify technology used in everyday life. S.RS.03.17 Identify current problems that may be solved through the use of technology. S.RS.03.18 Describe the effect humans and other organisms have on the balance of the natural world. S.RS.03.19 Describe how people have contributed to science throughout history and across cultures.

PHYSICAL SCIENCE	*2. TLW compare and contrast the motion of objects in terms of speed, direction, and the forces exerted on the object.* **Essential Questions** • What affects the movement of an object? • What is a force? **Key Concepts** • A force is a push or pull. • Pushes or pulls can change the speed or direction of moving objects. • The shape, size, and weight of an object can affect its motion. **Force and Motion** P.FM.03.22 Identify the force that pulls objects towards the earth. P.FM.03.35 Describe how a push or a pull is a force. P.FM.03.36 Relate a change in motion of an object to the force that caused the change of motion. P.FM.03.37 Demonstrate how the change in motion of an object is related to the strength of the force acting upon the object and to the mass of the object. P.FM.03.38 Demonstrate when an object does not move in response to a force, it is because another force is acting on it. P.FM.03.41 Compare and contrast the motion of objects in terms of direction. P.FM.03.42 Identify changes in motion (change direction, speeding up, slowing down). P.FM.03.43 Calculate the speed of an object based on the distance it travels divided by the amount of time it took to travel that distance. *3. TLW explain the properties of light and sound and how people perceive these forms of energy.* **Essential Questions** • How do sound and light interact with objects? • How do sound and light travel? • How do we perceive light and sound? • What are sound and light? **Key Concepts** • Light and sound are forms of energy. • Light enables us to see. • Light travels in a straight line and interacts in different ways with matter. • Sound waves enable us to hear. • Sound waves travel in all directions and have different properties. • Vibrating objects produce sound. **Energy** P.EN.03.11 Identify light and sound as forms of energy. P.EN.03.21 Demonstrate that light travels in a straight line and that shadows are made by placing an object in a path of light. P.EN.03.22 Demonstrate what happens to light when it travels from water to air. (a straw half in water looks bent). P.EN.03.31 Relate sounds to their sources of vibrations (for example: a musical note produced by a vibrating guitar string, the sounds of a drum made by the vibrating drum head). P.EN.03.32 Distinguish the effect of fast or slow vibrations as pitch.

	Properties of Matter P.PM.03.51 Demonstrate how some materials are heated more than others by light that shines on them. P.PM.03.52 Explain how we need light to see objects: light from a source reflects off objects and enters our eyes.
LIFE SCIENCE	*4. TLW classify plants and relate characteristics and functions of observable parts that allow them to live in their environment.* **Essential Questions** • How can plants be classified? • What are the functions of flowers, stems, roots, and leaves in plants? **Key Concepts** • Organisms can be classified on the basis of observable characteristics. • Organisms have different structures that serve different functions in growth, survival, and reproduction. **Organization of Living Things** L.OL.03.31 Describe the function of the following plant parts: flower, stem, root, and leaf. L.OL.03.41 Classify plants on the basis of observable physical characteristics (roots, leaves, stems, and flowers). *5. TLW classify animals and relate characteristics and functions of observable structures that allow them to live in their environment.* **Essential Questions** • How can animals be classified? • What are the functions of the structures of animals? **Key Concepts** • Organisms can be classified on the basis of observable characteristics. • Organisms have different structures that serve different functions in growth, survival, and reproduction. **Organization of Living Things** L.OL.03.32 Identify and compare structures in animals used for controlling body temperature, support, movement, food-getting, and protection (for example: fur, wings, teeth, claws). L.OL.03.42 Classify animals on the basis of observable physical characteristics (backbone, skin, shell, limbs, scales). *6. TLW relate characteristics and functions of observable structures of plants and animals that allow them to live in their environment.* **Essential Questions** • How do plants and animals adapt to their environment? **Key Concepts** • Different kinds of organisms have characteristics that help them to live in different environments. **Evolution** L.EV.03.11 Relate characteristics and functions of observable parts in a variety of plants that allow them to live in their environment (for example: leaf shape, thorns, odor, color). L.EV.03.12 Relate characteristics and functions of observable body parts to the ability of animals to live in their environment (for example: sharp teeth, claws, color, body covers).

EARTH SCIENCE	*7. TLW identify and describe different types of materials from the earth and their uses.* **Essential Questions** • How do people use earth materials? • What are some useful earth materials? **Key Concepts** • Earth materials include rocks, minerals, soil, water, and air. • Rocks are made up of minerals. • The earth is made of many minerals that are useful to people. • Types of earth materials include minerals, rocks, clay, boulders, gravel, sand, and soil. **Earth Systems** E.ES.03.41 Identify natural resources (metals, fuels, fresh water, farmland, and forests). E.ES.03.51 Describe ways humans are dependent on the natural environment (forests, water, clean air, earth materials) and constructed environments (homes, neighborhoods, shopping malls, factories, and industry). **Solid Earth** E.SE.03.13 Recognize and describe different types of earth materials (mineral, rock, clay, boulder, gravel, sand, soil). E.SE.03.14 Recognize that rocks are made up of minerals. E.SE.03.31 Identify earth materials used to construct some common objects (for example: bricks, buildings, roads, glass). E.SE.03.32 Describe how materials taken from the earth can be used as fuels for heating and transportation. *8. TLW identify and describe natural causes of change in the earth's surface.* **Essential Questions** • How does earth's surface change over time? **Key Concepts** • Some forces (volcanoes and earthquakes) build up the earth's surface (constructive) and other forces (weathering and erosion) tear down or wear away the earth's surface (destructive). • The surface of earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes. **Solid Earth** E.SE.03.22 Identify and describe natural causes of change in the earth's surface (erosion, glaciers, volcanoes, landslides, and earthquakes). *9. TLW identify and classify renewable and nonrenewable natural resources and describe the human impact on the environment.* **Essential Questions** • How can people extend the use of limited natural resources and why should they do so? • In what ways do people affect their environment?

	Key Concepts • Human change the environment in ways that are helpful and also in ways that are harmful for themselves and other organisms. • Humans can extend the limited supply of many natural resources by recycling, reuse, and renewal. • Humans depend on their natural and constructed environment. **Earth Systems** E.ES.03.42 Classify renewable (fresh water, farmland, forests) and non-renewable (fuels, metals) resources. E.ES.03.43 Describe ways humans are protecting, extending, and restoring resources (recycle, reuse, reduce, renewal). E.ES.03.44 Recognize that paper, metal, glass, and some plastics can be recycled. E.ES.03.52 Describe helpful or harmful effects of humans on the environment (garbage, habitat destruction, land management, renewable and non-renewable resources).

Science Vocabulary as first introduced in 3rd Grade

absorb	adaptation	analyze
attribute	bone	boulder
brick	bright/brighter	building
cause and effect	characteristic	classification system
classify	claw	clay
climate	coal	cold-blooded
colored filters	colored lights	compost
cone	confirm	constructed environment
destruction	dim	earthquake
energy	environment	environmental change
erosion	extend resources	fern
forest	forms of energy	fresh water
friction	fuel	garbage
gasoline	glacier	glass
gravel	groundwater	habitat
hand lens	harmful effects	heating
helpful effects	horn	land management
landfill	landslide	large
lava	light source	low)
magnification	magnifier	magnify
measurement tool	metal	mineral
moss	natural environment	natural gas
natural resource	Newton	non-woody plant
nonrenewable resource	oil	ore
organism	particle	path of light (in straight lines)
pebble	photosynthesis	pitch (high
plastic	pollution	properties of light
properties of sound	protect resources	recreation
recycle	reduce	reflection
renew	renewable resource	reproduction
restore resources	reuse	road

rock	sand	scales
shadow	shell	shrub
skeleton	slow	small)
soil	sound source	speed
spring scale	Sun’s energy	surface water
survive	technology	teeth
transmit	transportation	trash
vibrations (fast	volcanic eruption	volcano
volume (sound)	warm-blooded	weathered rock
weathering	white light	wing
woody plant	work	

ELEMENTARY SCIENCE CURRICULUM

Fourth Grade Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)
1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)
1 Statement (5)

Standard: Reflection and Social Implications (RS)
1 Statement (7)

Discipline 2: Physical Science (P)

Standard: Energy (EN)
Forms of Energy (1)
Energy and Temperature (3)
Electrical Circuits (2)

Standard: Properties of Matter (PM)
Physical Properties (3)
States of Matter (1)
Magnets (2)
Conductive and Reflective Properties (1)

Standard: Changes in Matter (CM)
Changes in State (1)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (2)

Standard: Evolution (EV)
Survival (2)

Standard: Ecosystems (EC)
Interactions (1)
Changed Environment Effects (1)

Discipline 4: Earth Science (E)

Standard: Earth in Space and Time (ST)
Characteristics of Objects in the Sky (2)
Patterns of Objects in the Sky (5)
Fossils (3)
Geological Time (2)

SCIENCE PROCESSES	1. *TLW demonstrate an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems by estimating and measuring weight, mass, and volume.* **Essential Questions** • How does science help us answer questions about the world around us? • What does it mean to question? • What does measuring an object or substance tell us about the natural world and why is that important? • Why do scientists conduct investigations? **Key Concepts** • All objects and substances have physical properties that can be measured. • Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations. • Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation. **Inquiry Process** S.IP.04.11 Make purposeful observation of the natural world using the appropriate senses. S.IP.04.12 Generate questions based on observations. S.IP.04.13 Plan and conduct simple and fair investigations. S.IP.04.14 Manipulate simple tools that aid observation and data collection (for example: hand lens, balance, ruler, meter stick, measuring cup, thermometer, spring scale, stop watch/timer, graduated cylinder/beaker). S.IP.04.15 Make accurate measurements with appropriate units (millimeters centimeters, meters, milliliters, liters, Celsius, grams, seconds, minutes) for the measurement tool. S.IP.04.16 Construct simple charts and graphs from data and observations. **Inquiry Analysis and Communication** S.IA.04.11 Summarize information from charts and graphs to answer scientific questions. S.IA.04.12 Share ideas about science through purposeful conversation in collaborative groups. S.IA.04.13 Communicate and present findings of observations and investigations. S.IA.04.14 Develop research strategies and skills for information gathering and problem solving. S.IA.04.15 Compare and contrast sets of data from multiple trials of a science investigation and explain reasons for differences. **Reflection and Social Implications** S.RS.04.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities. S.RS.04.14 Use data/samples as evidence to separate fact from opinion. S.RS.04.15 Use evidence when communicating scientific ideas. S.RS.04.16 Identify technology used in everyday life. S.RS.04.17 Identify current problems that may be solved through the use of technology. S.RS.04.18 Describe the effect humans and other organisms have on the balance of the natural world. S.RS.04.19 Describe how people have contributed to science throughout history and across cultures.
PHYSICAL SCIENCE	**Energy** 2. *TLW compare different forms of energy and describe how temperature relates to energy.*

	Essential Questions • How can the temperature of a substance be increased? • How does temperature relate to energy? • What are heat and electricity? **Key Concepts** • Heat and electricity are forms of energy. • Increasing the temperature of any substance requires the addition of energy. **Forms of Energy/Energy and Temperature** P.EN.04.12 Identify heat and electricity as forms of energy. P.EN.04.41 Demonstrate how temperature can be increased in a substance by adding energy. P.EN.04.42 Describe heat as the energy produced when substances burn, certain kinds of materials rub against each other, and when electricity flows through wire. P.EN.04.43 Describe how heat is produced through electricity, rubbing, and burning. *3. TLW design and create simple circuits and an electromagnet, and classify objects as good or poor conductors of heat and electricity.* **Essential Questions** • In an electromagnet, what is the relationship between magnetism and electricity? • What is an electromagnet? • What materials are good conductors and what materials are poor conductors? **Key Concepts** • Electrical circuits transfer electrical energy and produce magnetic fields. • Objects vary in the extent to which they conduct electricity. **Electrical Circuits** P.EN.04.51 Explain how electrical energy is transferred and changed through the use of a simple circuit. P.EN.04.52 Create a simple working electromagnet and explain the conditions necessary to make the electromagnet. P.PM.04.53 Identify objects that are good conductors or poor conductors of heat and electricity. **Properties of Matter** *4. TLW compare and contrast states of matter and explain how matter can change from one state to another.* **Essential Question** Matter can be changed from one state to another through heating and cooling. **Key Concepts** • Each state of matter has unique physical properties. Gases are easily compressed, but liquids and solids do not compress easily. Solids have their own particular shapes. Liquids and gases take the shape of the container. • Matter can be changed from one state to another through heating and cooling • Matter exists in different states: solids, liquids, and gases. **Physical Properties** P.PM.04.16 Measure the weight (spring scale) and mass (balances in grams or kilograms) of objects. P.PM.04.17 Measure volumes of liquids and capacities of containers in milliliters and liters. P.PM.04.18 Demonstrate the use of centimeter cubes poured into a container to estimate the container's capacity.

	P.PM.04.23 Compare and contrast the states (solids, liquids, gases) of matter. P.CM.04.11 Explain how matter can change from one state (liquid, solid, gas) to another by heating and cooling. *5. TLW demonstrate magnetic field and explain how objects are affected by the strength of the magnet and the distance from the magnet.* **Essential Questions** • How do magnets work? • How is magnetic attraction affected by the distance between a magnet and an object? • What is a magnetic field? **Key Concepts** • A force is a push or pull. • Magnets can repel or attract other magnets. Magnets can also attract certain non-magnetic objects at a distance. **Magnets** P.PM.04.33 Demonstrate magnetic field by observing the patterns formed with iron filings using a variety of magnets. P.PM.04.34 Demonstrate that magnetic objects are affected by the strength of the magnet and the distance away from the magnet.
LIFE SCIENCE	**Life Requirements** *6. TLW explain how variations in physical characteristics can give organisms an advantage and how environmental changes can produce changes in food webs.* **Essential Questions** • How do changes in the environment impact food chains and food webs and why? • How do organisms interact with one another in ways that are harmful or helpful? • What are the basic needs of plants and animals? • What impact do individual differences in various organisms of the same kind have? **Key Concepts** • Changes in the environment can produce changes in food webs. • Organisms have basic needs for air, water, and food. Plants also need light. • Organisms interact to provide food and shelter to one another. • Organisms of the same kind have individual differences and some variations in physical characteristics give an advantage for survival and reproduction. **Life Requirements** L.OL.04.15 Determine that plants require air, water, light, and a source of energy and building material for growth and repair. L.OL.04.16 Determine that animals require air, water, and a source of energy and building material for growth and repair. **Ecosystems** **Essential Question** • How do organisms interact with one another in ways that are harmful or helpful? **Key Concept:** • Organisms interact to provide food and shelter to one another. **Interactions/Changed Environment Effects** L.EC.04.11 Identify organisms as part of a food chain or food web. L.EC.04.21 Explain how environmental changes can produce a change in the food web.

	Evolution **Essential Question** • How do changes in the environment impact food chains and food webs and why **Key Concept** • Organisms of the same kind have individual differences and some variations in physical characteristics give an advantage for survival and reproduction. **Survival** L.EV.04.21 Identify individual differences (for example: color, leg length, size, wing size) in organisms of the same kind. L.EV.04.22 Identify how variations in physical characteristics of individual organisms give them an advantage for survival and reproduction.
EARTH SCIENCE	**Earth in Space and Time** *7. TLW compare and contrast characteristics and predictable patterns of movement of the sun, moon, and earth.* **Essential Questions** • What are the apparent movements of the sun, moon, and earth? • Why does the moon appear to be the same size as the sun? • Why does the moon change shape during the course of a month? **Key Concepts** • The moon appears to be the same size as the sun because it is closer to the earth. • The sun, moon, and earth have observable characteristics and predictable patterns of movement. **Characteristics of Objects in the Sky** E.ST.04.11 Identify common objects in the sky, such as the sun and the moon. E.ST.04.12 Compare and contrast the characteristics of the sun, moon and earth, including relative distances and abilities to support life. E.ST.04.21 Describe the orbit of the earth around the sun as it defines a year. E.ST.04.22 Explain that the spin of the earth creates day and night. E.ST.04.23 Describe the motion of the moon around the earth. E.ST.04.24 Explain how the visible shape of the moon follows a predictable cycle which takes approximately one month. E.ST.04.25 Describe the apparent movement of the sun and moon across the sky through day/night and the seasons. **Geological Time** *8. TLW explain how fossils provide important evidence of how life and environmental conditions have changed in a given location.* *9. TLW understand how the earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.* **Essential Questions** • How do fossils provide evidence about the history of the earth? **Key Concepts** • Fossils provide evidence about the history of the earth. E.ST.04.31 Explain how fossils provide evidence of the history of the earth. E.ST.04.32 Compare and contrast life forms found in fossils and organisms that exist today.

	E.ST.06.31	Explain how rocks and fossils are used to understand the age and geological history of the earth (timelines and relative dating, rock layers).
	E.ST.06.41	Explain how earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.
	E.ST.06.42	Describe how fossils provide important evidence of how life and environmental conditions have changed.

Science Vocabulary as first introduced in 4th Grade

ability to support life	advantage	ancient life form
apparent movement of the moon	apparent movement of the sun	appropriate
battery flow of electrical energy	battery	calendar (year)
camouflage	century	closed circuit
community	condensation	conductor
consumer	convert	day
death	decade	decomposer
development	diameter	dinosaur
earth's orbit	ecosystem	electrical charge
electrical circuit	electrical current	electrical energy
electricity	electromagnet	energy transformation
extinct	food chain	food web
fossil	gas	good conductor
individual differences	inherit	iron filings
kilometer (km)	leg length	life form
like poles	magnetic attraction	magnetic field
magnetic force	magnetic poles	magnetic repulsion
mammoth	metric ton	migration
mile (m)	milligram (mg)	millimeter (mm)
modern life form	month	moon
moon's orbit	negative charge	night
north pole	open circuit	opposite poles
orbit	outer space	phase change
physical change	planet	pole
poor conductor	positive charge	precaution
precise	precision	predator
prehistoric animals	prey	producer
relative distance	relative position	response (to environment)
rock layer	Solar System	source of energy
south pole	spin	structure
survival	ton (t)	wing size
year	era	

Geological Times:

New Vocabulary

brachiopod	geologic history	mountain building	theory
deposition	geologic time	relative dating	timeline
earth processes	geological events	rock layers	trilobite
geologic age	glacier movement	strata	Law of Superposition

ELEMENTARY SCIENCE CURRICULUM

Fifth Grade Science Standards, Statements, and Expectations

(NOTE: The number in parentheses represents the number of expectations.)

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)
1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)
1 Statement (5)

Standard: Reflection and Social Implications (RS)
1 Statement (7)

Discipline 2: Physical Science (P)

Standard: Energy (EN)
Waves and Energy (3)
Solar Energy (1)
Energy Transfer (1)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Animal Systems (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)
Solar Energy Effects (3)
Weather and Climate (4)
Water Cycle (2)

Standard: Solid Earth (SE)
Soil (2)
Rock Formation (1)
Plate Tectonics (3)
Magnetic Field of the Earth (2)

Standard: Fluid Earth (FE)
Atmosphere (2)

Standard: Earth in Space and Time (ST)
Fossils (1)
Geological Time (2)

SCIENCE PROCESSES

Inquiry Process

1. S.IP.M.1 Inquiry

Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

Essential Questions

- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is science inquiry?
- Why do scientists conduct investigations?

1. S.IP.05.11 Generate scientific questions based on observations, investigations, and research.
2. S.IP.05.12 Design and conduct scientific questions based on observations, investigations, and research.
3. S.IP.05.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens) appropriate to scientific investigations.
4. S.IP.05.14 Use metric measurement devices in an investigation.
5. S.IP.05.15 Construct charts and graphs from data and observations
6. S.IP.05.16 Identify patterns in data.

New Vocabulary

area	data presentation	logical reasoning	results
control group	displacement	measurement error	scientific equipment
control of variables	empirical evidence	method of investigation	scientific method
controlled experiment	grams/cubic centimeter	multiple trials	skepticism
convection	grams/mL	peer review	
data analysis	law	replicable experiment	
data interpretation	logical argument	research	

Enrichment Vocabulary

dependent variable	displacement method	inference
dimension	independent variable	qualitative measurement
direct observation	indirect observation	quantitative measurement

Inquiry Analysis and Communication

2. S.IA.M.1 Inquiry

Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

Essential Questions

- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

1. S.IA.05.11 Analyze information from data tables and graphs to answer scientific questions.
2. S.IA.05.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.
3. S.IA.05.13 Communicate and defend findings of observations and investigations using evidence.
4. S.IA.05.14 Draw conclusions from sets of data from multiple trials of a scientific investigation.
5. S.IA.05.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

New Vocabulary

area	data presentation	logical reasoning	results
control group	displacement	measurement error	scientific equipment
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controlled experiment	grams/cubic centimeter	multiple trials	skepticism
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Enrichment Vocabulary

dependent variable	displacement method	inference
dimension	independent variable	qualitative measurement
direct observation	indirect observation	quantitative measurement

Reflection and Social Implications

3. S.RS.M.1 Reflecting on Knowledge

Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.

1. S.RS.05.11 Evaluate the strengths and weaknesses of claims, arguments, and data.
2. S.RS.05.12 Describe limitations in personal and scientific knowledge.
3. S.RS.05.13 Identify the need for evidence in making scientific decisions.
4. S.RS.05.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
5. S.RS.05.16 Design solutions to problems using technology.
6. S.RS.05.17 Describe the effect humans and other organisms have on the balance in the natural world.
7. S.RS.05.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

New Vocabulary

area	data presentation	logical reasoning	results
control group	displacement	measurement error	scientific equipment
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Enrichment Vocabulary

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PHYSICAL SCIENCE

Energy

4. P.EN.M.3 ***Waves and Energy***

Waves have energy and transfer energy when they interact with matter. Examples of waves include sound waves, seismic waves, waves on water, and light waves.

Essential Questions

-

Key Concepts

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1. P.EN.07.31 Identify examples of waves, including sound waves, seismic waves, and waves on water.
2. P.EN.07.32 Describe how waves are produced by vibrations in matter.
3. P.EN.07.33 Demonstrate how waves transfer energy when they interact with matter (for example: tuning fork in water, waves hitting a beach, earthquake knocking over buildings)

New Vocabulary

energy transfer	matter	seismic wave	

Enrichment Vocabulary

5. P.EN.M.6 ***Solar Energy***

Nuclear reactions take place in the sun producing heat and light. Only a tiny fraction of the light energy from the sun reaches earth, providing energy to heat the earth.

Essential Questions

- How does the sun produce energy and how is the earth affected?

Key Concepts

- Nuclear reactions take place on the sun, producing heat and light, but only a fraction of the light energy is transformed to heat energy on the earth.

1. P.EN.07.61 Identify that nuclear reactions take place in the sun, producing heat and light.

New Vocabulary

chemical energy	heat energy	solar energy	
energy distribution	nuclear reaction		

Enrichment Vocabulary

helium	hydrogen	nuclear fusion	

6. P.EN.M.4 ***Energy Transfer***

Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

Essential Questions

- What are three ways that heat energy is transferred?
- What happens to the energy when heat is transferred?
- What happens when energy is transformed from one form to another?

Key Concepts

- convection
- conduction
- Energy can be transformed from one form to another.
- Energy is not lost or gained when it is transferred.
- Heat energy is transferred from one object to another by radiation
- Nuclear reactions take place on the sun, producing heat and light, but only a fraction of the light energy is transformed to heat energy on the earth.

1. P.EN.07.62 Explain how only a tiny fraction of light energy from the sun is transformed to heat energy on earth.

New Vocabulary

conduction	energy distribution	energy transformation	radiation
convection	energy transfer	heat transfer	

Enrichment Vocabulary

Law of Conservation of Energy			

LIFE SCIENCE

Organization of Living Things

7. L.OL.M.4 ***Animal Systems***

Multicellular organisms may have specialized systems that perform functions which serve the needs of the organism.

Essential Questions

- How are the needs of multicellular organisms met by specialized systems?
- How do body systems work together?

Key Concepts

- Animal systems (including body systems of humans) work together to perform selected activities.
- Multicellular organisms may have specialized systems that perform functions that serve the needs of the organism.

1. L.OL.05.41 Identify the general purpose of selected animal systems (digestive, nervous, excretory, and reproductive).
2. L.OL.05.42 Explain how animal systems (digestive, nervous, excretory, and reproductive) work together to perform selected activities

New Vocabulary

animal system	digestive system	multi-cellular organism	tissue
body system	energy	nervous system	
brain	excretory system	organ	
cell	health	reproductive system	

Enrichment Vocabulary

absorption	epiglottis	oviducts	stomach
autonomic	esophagus	pancreas	sympathetic nervous system
axon	excretion	parasympathetic nervous system	testes
bile	excretory system	penis	tongue
bladder	feces	peripheral nervous system	transport
cell body	gall bladder	rectum	ureter
central nervous system	impulse	repair	urethra
cerebellum	kidneys	response (to a stimulus)	urine
cerebrum	large intestine	saliva	uterus
chemical digestion	liver	salivary gland	vagina
dendrite	medulla	sensory nerves	vas deferens
digestion	metabolism	small intestine	voluntary
egg	motor nerves	somatic	
elimination	mouth	sperm	
endocrine system	neuron	spinal cord	
enzyme	ovaries (ovum)	stimulus	

EARTH SCIENCE

Earth Systems

8. E.ES.M.1 ***Solar Energy Effects***

The sun is the major source of energy for phenomena on the surface of the Earth.

1. E.ES.07.11 Demonstrate, using a model or drawing, the relationship between the warming by the sun of the earth and the water cycle as it applies to the atmosphere (evaporation, water vapor, warm air rising, cooling, condensation, clouds).
2. E.ES.07.12 Describe the relationship between the warming of the atmosphere of the earth by the sun and convection within the atmosphere and oceans.
3. E.ES.07.13 Describe how the warming of the earth by the sun produces winds and ocean currents.

New Vocabulary

atmosphere	cooling	evaporation	water vapor
cloud formation	dew	fog	wind
condensation	dew point	ocean current	

9. E.ES.M.7 ***Weather and Climate***

Global patterns of atmospheric and oceanic movement influence weather and climate.

Essential Questions

- How do the oceans affect climate and weather?
- How does climate compare to weather?

- How would earth be different if it didn't rotate?
- What causes different weather conditions?
- What causes ocean currents?
- What would earth be like with no oceans?

Key Concepts

- Climate is a long-term average of weather which is affected by the oceans.
- Oceans redistribute matter and energy around the earth.
- The earth's rotation generates currents that influence global and regional climates.

1. E.ES.07.71 Compare and contrast the difference and relationship between climate and weather.
2. E.ES.07.72 Describe how different weather occurs due tot he constant motion of the atmosphere from the energy of the sun reaching the surface of the earth.
3. E.ES.07.73 Explain how the temperature of the oceans affects the different climates on earth because water in the oceans holds a large amount of heat.
4. E.ES.07.74 Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.

New Vocabulary

air mass	convergence	jet stream	regional climate
air pressure	Coriolis effect	lake effect snow	relative humidity
barometer	deep water oceanic currents	landmass	satellite weather image
barometric pressure	dew point	low pressure	stationary front
boundary	drought	occluded front	surface oceanic currents
climate	El Nino	ocean currents	warm front
climatic zones	flood	ocean layers	weather
cold front	frontal boundaries	oceanic circulation	weather map
convection current	high pressure	prevailing winds	

10. E.ES.M.8 Water Cycle

Water circulates through the four spheres of the earth in what is known as the "water cycle."

Essential Questions

- How does fresh water move?
- How is water related to earth systems?
- What are the components and processes of the water cycle?
- What are the components of a watershed and how does a watershed relate to the water cycle?
- What is the source of energy for the water cycle?

Key Concepts

- A watershed is the land area drained by a stream system.
- Groundwater is a dynamic feature on the earth.
- On a world-wide basis, groundwater is the most significant source of water to sustain life.
- The sun is the source of energy for the water cycle and causes multiple changes of state as water moves through the water cycle.
- Water circulates through the four earth systems in a process known as the water cycle.

- Water flows through the various components of a watershed including surface features and groundwater.

1. E.ES.07.81 Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff, ground water, and absorption occur within the cycle.
2. E.ES.07.82 Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater

New Vocabulary

absorption	lakes	snow	transpiration
elevations	precipitation	streams	water cycle
groundwater	rain	sublimation	water vapor
hail	rivers	surface features	watershed
hydrosphere	salt water	surface mining	wetlands
infiltration	sleet	surface run-off	wetlands

Solid Earth

11. E.SE.M.1 Soil

Soils consist of weathered rocks and decomposed organic materials from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture.

Essential Questions

- How are earth materials classified?
- How do we use earth materials each day?
- What are the origins of the different types of materials?
- What is soil and how is it formed?
- What types of materials make up the earth?

Key Concepts

- Describe how soil is a mixture of different particle sizes and textures, made up of weather-eroded rock and decomposed organic material.
- Physical and chemical weathering lead to erosion and the formation of soils and sediments.

1. E.SE.06.11 Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.
2. E.SE.06.12 Explain how waves, wind, water, and glacier movement, shape and reshape the land surface of the earth by eroding rock in some areas and depositing sediments in other areas.

New Vocabulary

abrasion	dust particle	mechanical weathering	salinity
chemical composition	erosion	mixture	sand
chemical weathering	glacier movement	nitrogen	sediments
chemical weathering	grain	organic material	silt
clay	humidity	oxygen	soil
composition of soil	humus	particle size	soil texture
decomposed	hydrogen	physical weathering	texture
deposition	loam	rock cycle	weather-eroded

Enrichment Vocabulary

methane			

12. E.SE.M.4 Rock Formation

Rocks and rock formations bear evidence of the minerals, materials, temperature/pressure conditions, and forces that created them.

Essential Questions

- How does the rock cycle explain the formation of rock types and the changes they undergo?
- If mountains are constantly eroding, why isn't the surface of the earth completely flat?
- Why do rocks change over time?

Key Concepts

- Rocks are composed of one or more minerals.
- Rocks change over time, due to processes such as cooling, erosion, weathering, heat, and pressure.
- The rock cycle model explains the formation of igneous, metamorphic, and sedimentary rocks and that rocks are constantly forming and changing.
- The surface of earth is not flat because earthquakes and volcanoes build up the earth's surface even as wind, water, and ice erode it.
- Waves, wind, water, and glacier movement shape and reshape the land surface of the earth by eroding rock in some areas and depositing sediments in other areas.

1. E.SE.06.41 Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.

New Vocabulary

aesthenosphere	glacier movement	metamorphism	rocks
cementing	igneous rock	minerals	sediment
chemical weathering	lava	molten rock	sedimentary rock
compacting	lithosphere	plate tectonics	thermal contraction
convecting mantel	magma	pressure	thermal expansion
core	mantle	rock breakage	upper mantle
crust	mechanical weathering	rock composition	volcano
crystallization	mesosphere	rock cycle	weathering
deposition	metallic core	rock sequence	
freezing and thawing (weathering)	metamorphic rock	rock types	

13. E.SE.M.5 Plate Tectonics

The lithospheric plates of the earth constantly move, resulting in major geological events, such as earthquakes, volcanic eruptions, and mountain building.

Essential Questions

- How much do tectonic plates move each year?
- What are the layers of the earth?
- What evidence makes scientists believe the continents are moving?
- Why do earthquakes and volcanoes occur in some parts of the world and not in others?

Key Concepts

- Earthquakes and volcanoes are most common along plate boundaries and at hot spots.
- Plate boundaries are areas where plates are moving away from each other, crashing into each other, or sliding past each other.
- Plate movements result in potentially catastrophic events such as earthquakes and volcanic eruptions, which may create tsunamis, trenches, mountains, or islands.
- Plate tectonics theory is the central organizing theory of geology and is part of the explanation of every phenomenon and process that is observable in the geosphere and interconnects with the other earth systems.
- Tectonic plates of the earth constantly move centimeters every year.
- The earth consists of layers.

1. E.SE.06.51 Explain plate tectonic movement and how the lithospheric plates move centimeters each year.
2. E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.
3. E.SE.06.53 Describe layers of the earth as a lithosphere (crust and upper mantle), convecting mantle, and dense metallic core.

New Vocabulary

dense metallic core	magnetic field	mountain building	seismic waves
earthquakes	magnetic properties of the earth	natural magnet	volcanic eruptions
fault	magnetite	navigation	
lithospheric plates	magnitude	plate tectonic	
magnetic compass	man-made magnet	poles	

14. E.SE.M.6 Magnetic Field of Earth

Earth as a whole has a magnetic field that is detectable at the surface with a compass

Essential Questions

- How does a magnetic compass work?
- How does the earth compare to a magnet?

Key Concepts

- Earth as a whole has a magnetic field that is detectable at the surface with a magnetic compass.
- Magnets can repel or attract other magnets. Magnets can also attract certain non-magnetic objects at a distance.

1. E.SE.06.61 Describe the earth as a magnet and compare the magnetic properties of the earth to that of a natural or man-made magnet.
2. E.SE.06.62 Explain how a compass works using the magnetic field of the earth, and how a compass is used for navigation on land and sea.

New Vocabulary

lodestone			

Fluid Earth

15. E.FE.M.1 Atmosphere

The atmosphere is a mixture of nitrogen, oxygen and trace gases that include water vapor. The atmosphere has different physical and chemical composition at different elevations.

Essential Questions

- What is the composition of the atmosphere?

Key Concepts

- The atmosphere is a mixture of gases that have different weather conditions associated with frontal boundaries.
- The atmosphere is in constant motion, with different weather conditions associated with frontal boundaries.

1. E.FE.07.11 Describe the atmosphere as a mixture of gases.
2. E.FE.07.12 Compare and contrast the composition of the atmosphere at different elevations.

New Vocabulary

air density	altitude	density	ozone layer
air pressure	atmospheric composition	elevation	

Earth in Space and Time

16. M.3 Fossils

Fossils provide important evidence of how life and environmental conditions have changed in a given location.

Essential Questions

- How do fossils provide evidence of how life and environmental conditions have changed?

Key Concepts

- Fossils provide evidence of how life and environmental conditions have changed.

1. E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the earth (timelines and relative dating, rock layers).

New Vocabulary

fossil	Petoskey stone		

Enrichment Vocabulary

index fossil			

17. E.ST.M.4 Geological Time

Earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.

Essential Questions

- How do rocks and fossils provide evidence about the history of the earth?

Key Concepts

- Rocks and fossils provide evidence about the history of the earth.

1. E.ST.06.41 Explain how earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.
2. E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

New Vocabulary

brachiopod	geologic history	mountain building	theory
deposition	geologic time	relative dating	timeline
earth processes	geological events	rock layers	trilobite
geologic age	glacier movement	strata	

Enrichment Vocabulary

era	Law of Superposition		

East Grand Rapids Public Schools

MIDDLE SCHOOL SCIENCE CURRICULUM

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MIDDLE SCHOOL SCIENCE CURRICULUM

Grade 6

KEY FOR COMMON CORE STATE STANDARDS

RST Reading Standards for Literacy in Science and Technical Subjects

WHST Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

SCIENCE PROCESSES

Inquiry Process

1. S.IP.M.1 ***Inquiry***

Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to the new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

RST.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*

RST.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic. 6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

RST.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RST.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Research to Build and Present Knowledge

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.9 Draw evidence from informational texts to support analysis reflection, and research.

Range of Writing

WHST.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

1. S.IP.06.11 Generate scientific questions based on observations, investigations, and research.
2. S.IP.06.12 Design and conduct scientific investigations.
3. S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes) appropriate to scientific investigations.
4. S.IP.06.14 Use metric measurement devices in an investigation.
5. S.IP.06.15 Construct charts and graphs from data and observations.
6. S.IP.06.16 Identify patterns in data

New Vocabulary

area	data presentation	logical argument	research
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control group	empirical evidence	measurement error	scientific equipment
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controlled experiment	grams/cubic centimeter	multiple trials	skepticism
data analysis	grams/mL	peer review	variable
data interpretation	law	replicable experiment	

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

Key Ideas and Details

RST.1 Cite specific textual evidence to support analysis of science and technical texts.

Inquiry Analysis and Communication

2. S.IA.M.1 *Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.*

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
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- The foundation of scientific theory is replicable investigations.
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Key Ideas and Details

RST.1 Cite specific textual evidence to support analysis of science and technical texts.

RST.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the ext distinct froml prior knowledge or opinions.

Text Types and Purposes

WHST.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
e. Establish and maintain a formal style and objective tone.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

WHST.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

1. S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions.
2. S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.
3. S.IA.06.13 Communicate and defend findings of observations and investigations using evidence.
4. S.IA.06.14 Draw conclusions from sets of data from multiple trials of a scientific investigation.
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Reflection and Social Implications

3. S.RS.M.1 *Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.*

Essential Questions

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2. S.RS.06.12 Describe limitations in personal and scientific knowledge.
3. S.RS.06.13 Identify the need for evidence in making scientific decisions.
4. S.RS.06.14 Evaluate scientific explanations based on current evidence and scientific principles.
5. S.RS.06.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
6. S.RS.06.16 Design solutions to problems using technology.
7. S.RS.06.17 Describe the effect humans and other organisms have on the balance of the natural world.
8. S.SR.06.18 Describe what science and technology can and cannot reasonably contribute to society.
9. S.RS.06.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

New Vocabulary

area	data presentation	logical argument	research
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PHYSICAL SCIENCE

Energy

4. P.EN.M.1 Kinetic and Potential Energy

Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.

Properties of Matter

5. P.PM.M.1 Chemical Properties of Matter

Chemical Properties of Matter has chemical properties. The understanding of chemical properties helps to explain how new substances are formed.

Key Concepts

- Substances may be classified by their physical and/or chemical properties.

1. P.PM.07.11 Classify substances by their chemical properties (flammability, pH, acid-base indicators, reactivity).

New Vocabulary

acid-base indicator	gas formation	less reactive metal	precipitate
chemical property	highly reactive metal	melting point	reactive rate
flammability	highly reactive nonmetal	pH	reactivity

6. P.PM.M.2 Elements and Compounds

Elements are composed of a single kind of atom that are grouped into families with similar properties on the periodic table. Compounds are composed of two or more different elements. Each element and compound has a unique set of physical and chemical properties such as boiling point, density, color, conductivity, and reactivity.

Essential Questions

- How are elements organized on the periodic table?
- What are the differences among elements, compounds, and mixtures?
- What are the differences between atoms and molecules?

Key Concepts

- Atoms and molecules are respectively the smallest components of elements and compounds.
- Chemical changes occur when matter reacts and produces new substances but physical changes yield different forms of the same substance rather than a new substance.
- Elements and compounds have different physical and chemical properties.
- Elements are organized into families on the periodic table by similar properties.
- Elements are pure substances, compounds are chemically combined, and mixtures can be separated into their component parts.
- Evidence of chemical change includes color change, gas formation, solid formation, and temperature change.

1. P.PM.07.21 Identify the smallest component that makes up an element.
2. P.PM.07.22 Describe how the elements within the Periodic Table are organized by similar properties into families (highly reactive metals, less reactive metals, highly reactive nonmetals, and some almost completely non-reactive gases).
3. P.PM.07.23 Illustrate the structure of molecules using models or drawing (water, carbon dioxide, salt).
4. P.PM.07.24 List examples of physical and chemical properties of elements and compounds (bioling point, density, color, conductivity, reactivity).

New Vocabulary

bond	element stability	products	reaction rate
compound	non-reactive gas	reactants	reactivity
element	periodic table		

Changes in Matter

7. P.CM.M.1 Changes in State

Matter changing from state to state can be explained by using models which show that matter is composed of tiny particles in motion. When changes of state occur, the atoms and/or molecules are not changed in structure. When the changes in state occur, mass is conserved because matter is not created or destroyed.

1. P.CM.06.11 Describe and illustrate changes in state, in terms of the arrangement and relative motion of the atoms or molecules.
2. P.CM.06.12 Explain how mass is conserved as it changes from state to state in a closed system

New Vocabulary

boiling point	electron	nucleus	solid formation
density	neutron	proton	

Enrichment Vocabulary

atomic theory			

8. P.CM.M.2 ***Chemical Changes***

Chemical changes occur when two elements and/or compounds react and produce new substances. These new substances have different physical and chemical properties than the original elements and/or compounds. During the chemical change, the number and kind of atoms in the reactants are the same as the number and kind of atoms in the products. Mass is conserved during chemical changes. The mass of the reactants is the same as the mass of the products.

Essential Questions

- What are characteristics of a physical change?
- What happens to substances during a chemical change?
- What is evidence of a chemical change?

1. P.CM.07.21 Identify evidence of chemical change through color, gas formation, solid formation, and temperature change.
2. P.CM.07.22 Compare and contrast the chemical properties of a new substance with the original after a chemical change.
3. P.CM.07.23 Describe the physical properties and chemical properties of the products and reactants in a chemical change.

New Vocabulary

chemical change	chemical reaction	compound	solution
chemical formula	chemical symbol	rusting	suspension
chemical property			

EARTH SCIENCE

The Earth in Space and Time

9. E5.p1 ***Sky Observations (prerequisite)***

Common sky observations (such as lunar phases) can be explained by the motion of solar system objects in regular and predictable patterns. Our galaxy, observable as the Milky Way, is composed of billions of stars, some of which have planetary systems. Seasons are a result of the tilt of the rotation axis of the earth. The motions of the moon and sun affect the phases of the moon and ocean tides. (prerequisite)

1. E5.p1A Describe the motions of various celestial bodies and some effects of those motions. (prerequisite).
2. E5.p1B Explain the primary cause of seasons. (prerequisite)
3. E5.p1C Explain how a light year can be used as a distance unit. (prerequisite
4. E5.p1D Describe the position and motion of out solar system in our galaxy. (prerequisite)

New Vocabulary

Apparent movement of the stars	Copernicus	Moon	Speed of light
Astronomy	Light year	Moon phase	Spiral of structure
Celestial body	Milky Way	Ocean	Tide
Copernican revolution			

Enrichment Vocabulary

Composition of the universe	Computer modeling	Planetarium	Space exploration
Computer imaging	Observatory		

10. E5.1 ***The Earth in Space***

Scientific evidence indicates the universe is orderly in structure, finite, and contains all matter and energy. Information from the entire light spectrum tells us about the composition and motion of objects in the universe. Early in the history of the universe, matter clumped together by gravitational attraction to

form stars and galaxies. According to the Big Bang theory, the universe has been continually expanding at an increasing rate since its formation about 13.7 billion years ago.

Essential Questions

- How do scientists estimate the age of the universe?
- How does the universe change over time?

Key Concepts

- The universe is dynamic and contains all the matter and energy that exists.

1. E5.1A Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.
2. E5.1b Describe how the Big Bang theory accounts for the formation for the universe.
3. E5.1c Explain how observations of the cosmic microwave background have helped determine the age of the universe.
4. E5.1d Differentiate between the cosmological and Doppler red shift.

New Vocabulary

age of the universe	cosmic microwave background	Doppler Red Shift	Ga (billion years ago)
astronomical distance	cosmological red shift	evidence for the expansion of the universe	history of the universe
Big Bang theory	Doppler effect	evidence of the Big Bang Theory	solar system formation

Enrichment Vocabulary

extraterrestrial life			

11. E5.2 ***The Sun***

Stars, including the sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. Solar energy is responsible for life processes and weather as well as phenomena on earth. These and other processes in stars have led to the formation of all the other chemical elements.

Essential Questions

- How does the sun generate energy?
- What is the sun and how does it relate to other objects in the solar system?

Key Concepts

- Solar energy is responsible for life processes, weather, and other phenomena on earth.
- The sun creates energy by the transformation of matter into energy using nuclear fusion.
- The sun is a star that is the largest body in our solar system, which includes other planets, their moons, and smaller objects such as asteroids and comets. Earth is the third planet from the sun.

1. E5.2A Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).
2. E5.2B Relate events on the sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.
3. E5.2C Describe how nuclear fusion produces energy in the sun.
4. E5.2D Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.

New Vocabulary

Aurora	Solar flare	Sun’s radiation	Sunspot cycle
Nuclear fusion	Solar wind	Sunspot	

Enrichment Vocabulary

Indirect ray	Radiant energy		

12. 5.2x ***Stellar Evolution Stars***

Stellar Evolution Stars, including the sun, transform matter into energy in nuclear reactions. When hydrogen nuclei fuse to form helium, a small amount of matter is converted to energy. These and other processes in stars have led to the formation of all the other chemical elements. There is a wide range of stellar objects of different sizes and temperatures. Stars have varying life histories based on these parameters.

1. E5.2e Explain how the Hertzsprung - Russell (H-R) diagram can be used to deduce other parameters (distance).
2. E5.2f Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.
3. E5.2g Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).
4. E5.2h Compare the evolution paths of low-moderate-, and high-mass stars using the H-R diagram.
5. E5.3A Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way galaxy about 4.6 Ga (billion years ago).

Enrichment Vocabulary

absolute brightness	double star	light spectrum (electromagnetic spectrum)	spectral class
absolute magnitude	dwarf star	magnitude	spectroscope
apparent magnitude	giant star	neutron star	star cluster
binary star	heavy elements	nova	supergiant star
Black Hole	light elements	relative magnitude	supernova

LIFE SCIENCE

Organization of Living Things

13. L.OL.M.2 ***Cell Functions***

All organisms are composed of cells, from one cell to many cells. In multicellular organisms, specialized cells perform specialized functions. Organ and organ systems are composed of cells, and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.

Essential Questions

- How do cells become specialized?
- How do organisms grow and develop?

Key Concepts

- All organisms are composed of cells, and cells function in a similar way in all organisms.
- Cells comprise different body tissues, organs, and organ system.
- Organisms grow and develop through an increase in cell number and/or cell size.
- Through cell division, cells can become specialized for specific functions.

1. L.OL.07.21 Recognize that all organisms are composed of cells (single cell organisms, multicellular organisms).
2. L.OL.07.22 Explain how cells make up different body tissues, organs, and organ systems.
3. L.OL.07.23 Describe how cells in all multicellular organisms are specialized to take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or organism needs.
4. L.OL.07.24 - Recognize that cells function in a similar way in all organisms.

New Vocabulary

Amoeba	cperm cell	microscope	red blood cell
bone cell	cytoplasm	mitochondria	ribosome
cell	digestion	muscle cell	root cell
cell division	elodea	nerve cell	specialized cell
cell growth	endoplasmic reticulum	nucleus	specialized organ
cell membrane	excretion	nutrient	specialized tissue

cell structure	fertilization	organelle	stem cell
cell wall	golgi complex	paramecium	vacuole
chioroplast	leaf cell	petal	white blood cell
chlorophyll	lysosome	pistil	

Enrichment Vocabulary

cellular respiration	chromosome	impulse	mitosis

14. L.OL.M.4 Animal Systems

Multicellular organisms may have specialized systems that perform functions which serve the needs of the organism.

1. L.OL.05.41 Identify the general purpose of selected animal systems (digestive, nervous, excretory, and reproductive) work together to perform selected activities.
2. L.OL.05.42 Explain how animal systems (digestive, nervous, excretory, and reproductive) work together to perform selected activities.

New Vocabulary

blood	heart	muscles	respiration
circulatory system	lung	muscular system	skeletal system
exercise	lymphatic system	organ system	

Enrichment Vocabulary

Artery	Gliding joint	Movable joint	Tendon
Ball and socket joints	Hinge joint	Pivot joint	Tissue
Breathing	Homeostasis	Protection	Trachea
Bronchus	Joint	Respiration	Unmovable joint
Cartilage	Ligament	Support	vein
Contract	Marrow		
Diaphragm			

Heredity

15. L.HE.M.1 Inherited and Acquired Traits

The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important; for other characteristics, interactions with the environment are more important.

Essential Questions

- How are characteristics of living things passed on sexually and asexually?
- What are advantages and disadvantages of sexual reproduction? Asexual reproduction?

Key Concepts

- Characteristics of living things are passed on sexually and asexually.
- Sexual and asexual reproduction have both advantages and disadvantages.

1. L.HE.M.11 Explain that the traits of an individual are influenced by both the environment and the genetics of the individual.
2. L.HE.05.12 Distinguish between inherited and acquired traits.

New Vocabulary

asexual reproduction	gene	nucleus	pollen
codominant gene	gene pair	offspring	sexual reproduction
dominant	genotype	ovary	sperm cell

embryo	germination	pistil	stamen
fertilization			

Enrichment Vocabulary

breeding	controlled selection	reproductive stress	reproductive success

Earth Systems

16. E.ES.M.6 Seasons

Seasons result from annual variations in the intensity of sunlight and length of day due to the tilt of the axis of the earth relative to the plane of its yearly orbit around the sun.

Key Concepts

- Seasons on the earth are the result of variations in the intensity of sunlight caused by the tilt of the earth on its axis and revolution around the sun.

1. E.ES.05.61 Demonstrate using a model, seasons as the result of variations in the intensity of sunlight caused by the tilt of the earth relative to the plane of its yearly orbit around the sun.
2. E.ES.05.62 Explain how the revolution of the earth around the sun defines a year.

New Vocabulary

axis	revolution	Southern Hemisphere	Tropic of Cancer
Northern Hemisphere	rotation	tilt	Tropic of Capricorn

Enrichment Vocabulary

Clockwise	Counter clockwise	Direct rays	

Earth in Space and Time

17. E.SE.M.1 Solar System

The sun is the central and largest body in our solar system. Earth is the third planet from the sun in a system that includes other planets and their moons, as well as smaller objects, such as asteroids and comets.

1. E.ST.05.11 Design a model that describes the position and relationship of the planets and other objects (comets and asteroids) to the sun.

New Vocabulary

asteroid movement pattern	nebula	star composition	star system
comet impact	nova	star destruction	star temperature
helium	space probes	star evolution	star types
Hertzsprung-Russell (H-R)	star age	star formation	stellar energy
life cycle of stars	star brightness	star size	

18. E.ST.M.2 Solar System Motion

Gravity is the force that keeps most objects in the solar system in regular and predictable motion.

Essential Questions

- How does gravity affect the orbit of objects in the solar system?
- What are the apparent movements of the sun, moon, and earth?
- What are tides and what causes them?
- Why do constellations seem to move across the nighttime sky?
- Why do constellations seem to move across the nighttime sky?
- Why does the moon appear to be the same size as the sun?
- Why does the moon appear to change shape during the course of a month?

Key Concepts

- A year is defined as the amount of time it takes for the earth to revolve around the sun.
- As the moon orbits the earth, it appears to have different phases because we see different amounts of the moon that is lighted by the sun.
- Constellations appear to move across the nighttime sky due to the rotation of the earth on its axis.
- Gravity is the force that keeps most objects in the solar system in regular and predictable orbits.
- The combined gravitational effect of the sun and the moon produce tides on the earth.

1. E.ST.05.21 Describe the motion of planets and moons in terms of rotation on axis and orbits due to gravity.
2. E.ST.05.22 Explain moon phases as they relate to the position of the moon in its orbit around the earth, resulting in the amount of observable reflected light.
3. E.ST.05.23 Recognize that nighttime objects (stars and constellations) and the sun appear to move because the earth rotates on its axis and orbits the sun.
4. E.ST.05.24 Explain lunar and solar eclipse based on the relative positions of the earth, moon, and sun, and the orbit of the moon.
5. E.ST.05.25 Explain the tides of the oceans as they relate to the gravitational pull and orbit of the moon.

New Vocabulary

apparent movement of the planets	Equator	moons	rotate
asteroid	first quarter moon	neap tide	rotation
astronomy	full moon	new moon	satellite
axis	galaxy	North Pole	solar
Big Dipper (Ursa Major)	gibbous	North Star	Solar System
binoculars	Halley's comet	Orion	spring tide
comet	inertia	phase	star
comet movement pattern	Little Dipper (Ursa Minor)	planet	sun's position
comet tail	lunar	Polaris	telescope
constellation	meteor	reflected light	third quarter moon
crescent moon	meteorite	revolution	waning
eclipse	Milky Way	revolve	waxing
emitted light	moon phases		

Enrichment Vocabulary

circumpolar	lunar exploration	planetary exploration	spacecraft
east (E)	mythology	south (S)	star chart
elliptical orbit	navigator	Southern Cross	west (W)
Leo	north(N)		

MIDDLE SCHOOL SCIENCE CURRICULUM
Grade 7

KEY FOR COMMON CORE STATE STANDARDS

RST Reading Standards for Literacy in Science and Technical Subjects

WHST Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

SCIENCE PROCESSES

Inquiry Process

1. S.IP.M.1 ***Inquiry***

Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

RST.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*

RST.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic. 6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

RST.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

RST.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RST.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Text Types and Purposes

WHST1. Write arguments focused on *discipline-specific content*.

a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.

b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
d. Establish and maintain a formal style.
e. Provide a concluding statement or section that follows from and supports the argument presented.

Research to Build and Present Knowledge

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.9 Draw evidence from informational texts to support analysis reflection, and research.

Range of Writing

WHST.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

1. S.IP.07.11 Generate scientific questions based on observations, investigations, and research.
2. S.IP.07.12 Design and conduct scientific investigations.
3. S.IP.04.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations.
4. S.IP.07.14 Use metric measurement devices in an investigation.
5. S.IP.07.15 Construct charts and graphs from data and observations.
6. S.IP.07.16 Identify patterns in data.

New Vocabulary

area	date interpretation	law	replicable experiment
conclusion	displacement	logical argument	research
control group	empirical evidence	logical reasoning	results
control of variables	Experimental control	measurement error	scientific equipment
controlled experiment	Experimental evidence	method of investigation	scientific method
data analysis	grams/cubic centimeter	multiple trials	skepticism
data presentation	grams/mL	peer review	variable

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

Analysis and Communication

2. S.IA.M.1 ***Inquiry Analysis and Communication***

Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST.1 Cite specific textual evidence to support analysis of science and technical texts.

RST.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the ext distinct from prior knowledge or opinions.

Text Types and Purposes

WJST.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
e. Establish and maintain a formal style and objective tone.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

WHST.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

1. S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions.
2. S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.
3. S.IA.07.13 Communicate and defend findings of observations and investigations.
4. S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions.
5. S.IA.07.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

New Vocabulary

area	date interpretation	law	replicable experiment
conclusion	displacement	logical argument	research
control group	empirical evidence	logical reasoning	results
control of variables	Experimental control	measurement error	scientific equipment
controlled experiment	Experimental evidence	method of investigation	scientific method
data analysis	grams/cubic centimeter	multiple trials	skepticism
data presentation	grams/mL	peer review	variable

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

Reflection and Social Implications

3. S.RS.M.1 ***Reflecting on Knowledge***

Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge required careful analysis of evidence that guides decision-making and the application of science throughout history and within society.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

RST.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*

RST.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

RST.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

RST.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RST.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

1. S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data.
2. S.RS.07.11 Describe limitations in personal and scientific knowledge.
3. S.RS.07.13 Identify the need for evidence in making scientific decisions.
4. S.RS.07.14 Evaluate scientific explanations based on current evidence and scientific principles.
5. S.RS.07.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
6. S.RS.07.16 Design solutions to problems using technology.
7. S.RS.07.17 Describe the effect humans and other organisms have on the balance of the natural world.
8. S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society.
9. S.RS.07.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

New Vocabulary

area	date interpretation	law	replicable experiment
conclusion	displacement	logical argument	research

control group	empirical evidence	logical reasoning	results
control of variables	Experimental control	measurement error	scientific equipment
controlled experiment	Experimental evidence	method of investigation	scientific method
data analysis	grams/cubic centimeter	multiple trials	skepticism
data presentation	grams/mL	peer review	variable

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

PHYSICAL SCIENCE

Energy

4. P.EN.M.1 ***Kinetic and Potential Energy***

Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.

Essential Questions

- How can potential energy be transformed into kinetic energy?
- What is kinetic energy and what are examples of kinetic energy?
- What is potential energy and what are examples of potential energy?

Key Concepts

- Gravitational, elastic, and chemical energy are all forms of potential energy.
- Objects and substances in motion have kinetic energy.
- Objects and substances may have potential energy (stored energy) due to their relative positions in a system.
- Potential energy can be transformed into kinetic energy in mechanical systems.

1. P.EN.06.11 Identify kinetic or potential energy in everyday situations (for example: stretched rubber band, objects in motion, ball on a hill, food energy).
2. P.EN.06.12 Demonstrate the transformation between potential and kinetic energy in simple mechanical systems (for example: roller coasters, pendulums).

New Vocabulary

chemical potential energy	food energy	kinetic energy	potential energy
elastic potential energy	gravitational potential energy	mechanical system	

5. P.EN.M.4 ***Energy Transfer***

Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

Essential Questions

- How can changes in one system affect another system?
- How does the Earth operate as a system?

Key Concepts

- Processes, events, and features on earth result from energy transfer and movement of matter through interconnected Earth systems. (Source: Michigan High School Companion Document for Earth Science, page 16, 2007)
- The Earth operates as a system and all components (geosphere, atmosphere, biosphere, and hydrosphere) interact with one another.

1. P.EN.06.42 Illustrate how energy can be transferred while no energy is lost or gained in the transfer**.**

New Vocabulary

biological processes	closed system	interaction	physical processes
biosphere	Earth system	movement of matter and energy	sustainability
chemical processes	geosphere		

Enrichment Vocabulary

stewardship			

LIFE SCIENCE

Organizations of Living Things

6. L.OL.M.5 ***Producers, Consumers, and Decomposers***

All animals, including humans, are consumers that meet their energy by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.

Essential Questions

- How are organisms classified based on their source of energy?
- What criteria are used for classifying living things?
- What is classification?

Key Concepts

- Changes in one population might affect other populations based on their relationships in food webs.
- Classification of living things is an artificial method of sorting organisms into groups based on anatomical structures and functions.
- Classification schemes have levels from general (kingdom) to more specific (species).
- Organisms can be classified based on their source of energy for growth and development.

1. L.OL.06.51 Classify organisms (producers, consumers, and decomposers) based on their source of energy for growth and development.
2. L.OL.06.52 Distinguish between the ways in which consumers and decomposers obtain energy.

New Vocabulary

anatomical structure	exoskeleton	kingdom	protista kingdom
animal kingdom	external structure	monera kingdom	relatedness
classification system	fungus kingdom	mutlicellular organism	single-cell organism
endoskeleton	internal structure	plant kingdom	unicellular organism

Enrichment Vocabulary

amoeba	control	organelle	species
bacteria	dichotomous key	paramecium	taxonomy
Carolus Linnaeus	non-flowering plant		

Ecosystems

7. L.EC.M.1 ***Interactions of Organisms***

Organisms of one species from a population. Populations of different organisms interact and form communities. Living communities and nonliving factors that interact with them form ecosystems.

Essential Questions

- How can changes in one population affect other populations in a food web?

1. L.EC.06.11 List examples of populations, communities, and ecosystems including the Great Lakes region.

8. L.EC.M.2 ***Relationships of Organisms***

Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship. Some organisms may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

Essential Questions

- What are the patterns of relationships between and among populations in an ecosystem?

Key Concepts

- Common patterns of relationships exist between and among populations in an ecosystem.

1. L.EC.06.21 Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).
2. L.EC.06.22 Explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency.
3. L.EC.06.23 Predict how changes in one population might affect other populations based upon their relationships in the food web.

New Vocabulary

biodiversity	host	natural balance	population
commensalism	interdependence	natural balance	relationship
competitive relationship	introduction of non-native species	parasite	species reintroduction
dependence	mutualism	parasitic relationship	symbiosis
habitat destruction	mutually beneficial relationship	parasitism	symbiotic relationship

9. L.EC.M.3 ***Biotic and Abiotic Factors***

The number of organisms and populations an ecosystem can support depends on the biotic (living) resources available and abiotic (nonliving) factors, such as quality of light and water, range of temperatures and soil composition.

Essential Questions

- What are biotic and abiotic factors in an ecosystem?

Key Concepts

- Ecosystems have both biotic (living) and abiotic (non-living) components.

1. L.EC.06.31 Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.
2. L.EC.06.32 Identify the factors in an ecosystem that influence changes in population size.

10. L.EC.M.4 ***Environmental Impact of Organisms***

All organisms (including humans) cause change in the environment where they live. Some of the changes are harmful to the organisms or other organisms, whereas others are helpful.

Essential Questions

- How do humans alter the balance of ecosystems?
- What are possible consequences of overpopulation of organisms (including humans)?
- What can cause extinctions of plants and animals?
- What impact do behavioral and physical characteristics have on an organism's ability to survive in its environment?
- What is environmental change and what causes it?

Key Concepts

- Changes in the environment can lead to extinction of animals and plants.
- Fossils provide evidence of how living things and environmental conditions have changed.
- Humans are part of the Earth's ecosystem and can purposely or accidentally alter the balance of ecosystems.

- Organisms have physical and behavioral characteristics that enable them to survive in their environment.
- Possible consequences of overpopulation include species extinction, resource depletion, climate change, and pollution.

1. L.EC.06.41 Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.
2. L.EC.06.42 Predict possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution).

New Vocabulary

acid rain	disadvantage	irrigation	resource management
acquired trait	ecosystem	land development	sewage
agriculture	exhaust	land use	smog
asteroid impact	farming	learning	solid waste
atmosphere	flooding	manufactured	species
behavior	generate electricity	mining	species extinction
behavior characteristics	green space	natural balance	species reintroduction
biodiversity	habit	ozone	surface mining
carbon dioxide	habitat destruction	pesticide	toxic waste
catastrophic event	impact	pollutant	trait
climate change	industrial waste	population	treatment
construction	instinct	reforestation	tsunami
dam	interdependence	relationship	urban development
dependence	introduction of non-native species		

Enrichment Vocabulary

acid rain	exhaust	manufactured	resource management
agriculture	farming	mimicry	sewage
atmosphere	flooding	mining	smog
biodiversity	generate electricity	mutually beneficial relationship	solid waste
carbon dioxide	grassland	natural balance	species reintroduction
climate change	green space	ozone	surface mining
communication of danger	habitat destruction	parasitic relationship	taiga
construction	industrial waste	pesticide	temperate deciduous forest
countershading	interdependence	pollutant	temperate rainforest
dam	introduction of non-native species	population	toxic waste
dependence	irrigation	population	treatment
desert	land development	reforestation	tropical rainforest
ecological succession	land use	relationship	urban development
ecological succession			

EARTH SCIENCE

Solid Earth

11. E.SE.M.1 ***Soils***

Soils consist of weathered rocks and decomposed organic materials from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture.

Essential Questions

- How are earth materials classified?
- How do we use earth materials each day?
- What are the origins of the different types of materials?

- What is soil and how is it formed?
- What types of materials make up the earth?

Key Concepts

- Describe how soil is a mixture of different particle sizes and textures, made up of weather-eroded rock and decomposed organic material.
- Physical and chemical weathering lead to erosion and the formation of soils and sediments.

1. E.SE.06.13 Describe how soil is a mixture, made up of weather eroded rock and decomposed organic material.
2. E.SE.06.14 Compare different soil samples based on particle size and texture.

New Vocabulary

chemical weathering	humus	organic material	rock cycle
composition of soil	loam	particle size	sediments
decomposed	mechanical weathering	physical size	soil texture
deposition	mixture	physical weathering	texture
grain			

12. P.EN.M.4 ***Energy Transfer***

Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

Essential Questions

- How is water related to Earth systems?
- What are the components and processes of the water cycle?
- What are the components of a watershed and how does a watershed relate to the water cycle?
- What is the source of energy for the water cycle?

Key Concepts

- A watershed is the land area drained by a stream system.
- The Sun is the source of energy for the water cycle and causes multiple changes of state as water moves through the water cycle.
- Water circulates through the four Earth systems in a process know as the water cycle.
- Water flows through the various components of a watershed including surface features and groundwater.

1. P.EN.07.43 Explain how light energy is transferred to chemical energy through the process of photosynthesis.

New Vocabulary

hydrosphere	salt water	water cycle	watershed
infiltration	transpiration	water vapor	wetlands
run-off			

Enrichment Vocabulary

agricultural run-off	continental glacier	irrigation	polar cap

PHYSICAL SCIENCE

Properties of Matter

13. P.PM.M.1 ***Chemical Properties***

Matter has chemical properties. The understanding of chemical properties helps to explain how new substances are formed.

1. P.PM.07.11 Classify substances by their chemical properties (flammability, pH, acid-base indicators, reactivity).

14. L.OL.M.6 ***Photosynthesis***

Plants are producers; they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars along with minerals from the soil to form fats, proteins, and carbohydrates. These products can be used immediately, incorporated into the cells of a plant as the plant grows, or stored for later use.

Essential Questions

- What is photosynthesis and how does it help plants make, use, and store their own food?

Key Concepts

- Light energy from the Sun is transferred to chemical energy through the process of photosynthesis, allowing plants to use carbon dioxide and water to produce food (carbohydrates, proteins, and fats).
- Plants make, use, and store their food through the process of photosynthesis.

1. L.OL.07.61 Recognize the need for light to provide energy for the production of carbohydrates, proteins and fats.
2. L.OL.07.62 Explain that carbon dioxide and water are used to produce carbohydrates, proteins, and fats.
3. L.OL.07.63 Describe evidence that plants make, use and store food.

New Vocabulary

carbon dioxide (CO2)	process chloroplast	reactant	sugar (glucose)
chlorophyll	product	starch	water (H2O)
fat	protein	storage	word equation
oxygen (O2)			

Enrichment Vocabulary

Cellulose	Lipid	Respiration	

15. E.ES.M.4 ***Human Consequences***

Human activities have changed the land, oceans, and atmosphere of the earth resulting in the reduction of the number and variety of wild plants and animals sometimes causing extinction of species.

Essential Questions

- How do human activities change the surface of the Earth?
- How does pollution impact the environment and organisms?
- What are examples and sources of pollution?

Key Concepts

- Human activities change the surface of the Earth and affect the survival of organisms.
- Pollution impacts habitats, climate change, and the survival of organisms.
- There are many origins of pollution, including car exhaust, industrial emissions, acid rain, and natural sources.

1. E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.
2. E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

New Vocabulary

air pollution	dust particle	irritated eyes	radioactive decay
benefit	Earth system	limestone	recycling processes
biogeochemical cycles	Earth's external source of energy	manufacturing	refining
biomass energy	Earth's internal source of energy	mechanical energy	renewable energy
biosphere	ecology	metallic ores	reservoir

breathing difficulties	ethanol	nitrogen	risk
carbon cycle	fertilizer	nitrogen cycle	risk-benefit
carbon footprint	fossil fuels	nonrenewable energy	side effect
chemical	geosphere	nuclear (U-235) energy	solid waste
compound	geothermal energy	overpopulation	stratosphere
conservation	gravitational energy	Ozone action Day	sustainability
construction	herbicides	ozone depletion	thermal energy
coral reef destruction	human modification of ecosystems	ozone layer	urban development
deforestation	hydroelectric energy	product life cycle	waste disposal
detergent	industrial emissions	product production	waste product
disposal	insecticides		

Enrichment Vocabulary

aerosol	energy production	methane greenhouse gases	sick building syndrome
alternative perspective	environmental impact statement (EIS)	nitrate	smoke stacks
by-product	global warming	opportunity cost	Superfund waste site
carrying capacity	herbicide	pesticide	toxic rain
cost-benefit analysis	housing industry	phosphate	troposphere
economic impact	incinerator	refrigerant	water treatment

16. E2.4 ***Resources and Human Impacts on Earth Systems***

The Earth provides resources (including minerals) that are used to sustain human affairs. The supply of non-renewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.

Essential Questions

- How do elements move within and between Earth systems?
- In which forms does energy exist on Earth and how is energy transferred from one system to another?
- Processes, events, and features on Earth result from energy transfer and movement of matter through interconnected Earth systems.
- What are the advantages and disadvantages of different sources of energy?
- What is the impact of humans on Earth's ecosystem?

Key Concepts

- All sources of energy that humans use have advantages and disadvantages.
- Elements can exist in several different states and chemical forms and can move within and between Earth systems.
- Energy in Earth systems can exist in a number of forms, can be transferred from one form to another, and can move from one reservoir to another.
- Humans can have a positive or negative impact on earth's ecosystems.

1. E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.
2. E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.
3. E2.4d Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.

Force and Motion

17. P.FM.M.2 ***Force Interactions***

Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force, and gravitational force.

Essential Questions

- What are contact and non-contact forces and how do they move objects?

Key Concepts

- Both contact forces and non-contact forces can move objects.

1. P.FM.05.21 Distinguish between contact forces and non-contact forces.
2. P.FM.05.22 Demonstrate contact and non-contact forces to change the motion of an object.

New Vocabulary

change in direction	electrically charged object	inertia	non-contact force
contact force	gravitational pull	magnetism	

Enrichment Vocabulary

buoyancy	electron	static cling	theory
buoyant force			

18. P.FM.M.3 ***Force***

Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. a balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

Essential Questions

- What affects the movement of an object?
- What impact does a balanced force have on the motion of an object?
- What impact does an unbalanced force have on the motion of an object?
- What is a force?

Key Concepts

- A balanced force on an object does not change the motion of the object.
- A force is a push or pull?
- An unbalanced force on an object changes the motion of the object.
- Forces have a magnitude and direction.
- Pushes or pulls can change the speed or direction of moving objects.
- The shape, size, and weight of an object can affect its motion.

1. P.FM.05.31 Describe what happens when two forces act on an object in the same or opposing directions.
2. P.FM.05.32 Describe how constant motion is the result of balanced (zero net) forces.
3. P.FM.05.33 Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.
4. P.FM.05.34 Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

New Vocabulary

analyze	First Law of Motion	net force	speed
balanced forces	friction	Newton	Third Law of Motion
change in motion related to force	gravitational pull	Newton's Laws of Motion	unbalanced forces
change in speed	inertia	Second Law of Motion	work
deceleration			

Enrichment Vocabulary

block and tackle	inclined plane	Newtons	simple machine
complex machine	lever	pulley	wedge
fulcrum	newton (N)	screw	wheel and axle

19. P.FM.M.4 ***Speed***

Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

Essential Questions

- How can motion be described?
- How can motion be represented on a graph?

Key Concepts

- Motion can be described by a change in position relative to its point of reference.
- Motion can be measured and represented on a graph.
- The motion of an object can be described by its speed and the direction in which it is moving.

1. P.FM.05.41 Explain the motion of an object relative to its point of reference.
2. P.FM.05.42 Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.
3. P.FM.05.43 Illustrate how motion can be measured and represented on a graph.

New Vocabulary

acceleration	deceleration	direction of motion	point of reference
constant speed			

LIFE SCIENCE

Evolution

20. L.EV.M.1 ***Species Adaption and Survival***

Species with certain traits are more likely than others to survive and have offspring in particular environments. When an environment changes, the advantage or disadvantage of the species' characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.

1. L.EV.05.11 Explain how behavioral characteristics (adaption, instinct, learning, habit)) of animals help them to survive in their environment.
2. L.EV.05.12 Describe the physical characteristics (traits) of organisms that help them survive in their environment.
3. L.EV.05.13 Describe how fossils provide evidence about how living things and environmental conditions have changed.
4. L.EV.05.14 Analyze the relationship of environmental change and catastrophic events (for example: volcanic eruption, floods, asteroid impacts, tsunami) to species extinction

21. L.EV.M.2 ***Relationships among Organisms***

Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.

1. L.EV.05.21 Relate degree of similarity in anatomical features to the classification of contemporary organisms.

KEY FOR COMMON CORE STATE STANDARDS

RST Reading Standards for Literacy in Science and Technical Subjects

WHST Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

INQUIRY

Inquiry, Reflection, and Social Implications

1. E.1 ***Scientific Inquiry***

Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.

Essential Questions

- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure

RST.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*

RST.5 Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic. 6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

RST.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas

RST.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RST.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Text Types and Purposes

WHST1. Write arguments focused on *discipline-specific content*.

a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
d. Establish and maintain a formal style.
e. Provide a concluding statement or section that follows from and supports the argument presented.

Research to Build and Present Knowledge

WHST.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.9 Draw evidence from informational texts to support analysis reflection, and research.

1. E1.1A Generate new questions that can be investigated in the laboratory or field
2. E1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
3. E1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity - length, volume, weight, time interval, temperature- with the appropriate level of precision).
4. E1.1D Identify patterns in data and relate them to theoretical models.
5. E1.1E Describe a reason for a given conclusion using evidence from an investigation.
6. E1.1F Predict what would happen if the variables, methods, or timing of an investigation were changed.
7. E1.1G Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.
8. E1.1H Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.
9. E1.1i Distinguish between scientific explanations that are regarded as a current scientific consensus and the emerging questions that active researchers investigate.

New Vocabulary

area	data presentation	logical argument	replicable experiment
control group	displacement	logical reasoning	research
control of variables	empirical evidence	measurement error	results
controlled experiment	grams/cubic centimeter	method of investigation	scientific equipment
data analysis	grams/mL	multiple trials	scientific method
data interpretation	law	peer review	skepticism

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

2. E1.2 ***Scientific Reflection and Social Implications***

The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a

personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

Essential Questions

- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Key Ideas and Details

RST1. Cite specific textual evidence to support analysis of science and technical texts.

RST.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the ext distinct from prior knowledge or opinions.

Range of Reading and Level of Text Complexity

RST.10 By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Text Types and Purposes

WHST.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.
e. Establish and maintain a formal style and objective tone.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

Production and Distribution of Writing

WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.5 With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

WHST.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

Range of Writing

WHST.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

1. E1.2A Critique whether or not specific questions can be answered through scientific investigations.
2. E1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.
3. E1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.
4. E1.2D Evaluate scientific explanations in a peer review process or discussion format.
5. E1.2E Evaluate the future career and occupational prospects of science fields.
6. E1.2F Critique solutions to problems, given criteria and scientific constraints.
7. E1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.
8. E1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.
9. E1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.
10. E1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.
11. E1.2k Analyze how science and society interact from an historical, political, economic, or social perspective.

New Vocabulary

area	data presentation	logical argument	replicable experiment
control group	displacement	logical reasoning	research
control of variables	empirical evidence	measurement error	results
controlled experiment	grams/cubic centimeter	method of investigation	scientific equipment
data analysis	grams/mL	multiple trials	scientific method
data interpretation	law	peer review	skepticism
area	data presentation	logical argument	replicable experiment

Enrichment Vocabulary

dependent variable	displacement method	indirect observation	qualitative measurement
dimension	independent variable	inference	quantitative measurement
direct observation			

PHYSICAL SCIENCE

Energy

3. P.EN.M.1 ***Kinetic and Potential Energy***

Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.

4. P.EN.M.4 ***Energy Transfer***

Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

Essential Questions

- What are three ways that heat energy is transferred?
- What happens to the energy when hear is transferred?
- What happens when energy is transformed from one form to another?

Key Concepts

- Energy can be transformed from one form to another.
- Energy is not lost or gained when it is transferred.
- Heat energy is transferred from one object to another by radiation, conduction, and convection.

1. P.EN.06.41 Explain how different forms of energy can be transferred from one place to another by radiation, conduction, or convection.
2. P.EN.06.42 Illustrate how energy can be transferred while no energy is lost or gained in the transfer.

New Vocabulary

chemical energy	energy transfer	heat transfer	radiation
convection	energy transformation	radiation	solar energy
energy distribution			

Changes in Matter

5. P.CM.M.1 ***Changes in State***

Matter changing from state to state can be explained by using models which show that matter is composed of tiny particles in motion. When changes of state occur, the atoms and/or molecules are not changed in structure. When the changes in state occur, mass is conserved because matter is not created or destroyed.

Essential Questions

- How can heating or cooling change an object?
- What happens to matter when it changes from state to state?

Key Concepts

- Each state of matter has unique physical properties. Gases are easily compressed, but liquids and solids do not compress easily. Solids have their own particular shapes. Liquids and gases take the shape of the container.
- Mass is conserved as matter changes from state to state in a closed system.
- Matter can be changed from one state to another through heating and cooling.
- Matter exists in different states: solids, liquids, and gases.

1. P.CM.06.11 Describe and illustrate changes in state, in terms of the arrangement and relative motion of the atoms or molecules.
2. P.CM.06.12 Explain how mass is conserved as it changes from state to state in a closed system.

New Vocabulary

atom	conservation of mass	heat source	molecule
closed system	deposition	invisible	sublimination
compression			

Properties of Matter

6. P.PM.M.1 ***Chemical Properties***

Matter has chemical properties. The understanding of chemical properties helps to explain how new substances are formed.

7. P.PM.M.2 ***Elements and Compounds***

Elements are composed of a single kind of atom that are grouped into families with similar properties on the periodic table. Compounds are composed of two or more different elements. Each element and compound has a unique set of physical and chemical properties such as boiling point, density, color, conductivity, and reactivity.

Essential Questions

- How are elements organized on the periodic table?
- What are the differences among elements, compounds, and mixtures?
- What are the differences between atoms and molecules?

Key Concepts

- Atoms and molecules are respectively the smallest components of elements and compounds.
- Elements and compounds have different physical and chemical properties.
- Elements are organized into families on the periodic table by similar properties.
- Elements are pure substances, compounds are chemically combined, and mixtures can be separated into their component parts.

1. P.PM.07.21 Identify the smallest component that makes up an element.

New Vocabulary

acid-base indicator	chemical symbol	element	less reactive metal
boiling point	compound	flammability	neutron
bond	density	highly reactive metal	non-reactive gas
chemical formula	electron	highly reactive nonmetal	nonmetal
chemical property			

Enrichment Vocabulary

atomic theory			

8. L.OL.M.3 ***Growth and Development***
Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissue of an embryo.

1. L.OL.07.31 Describe growth and development in terms of increase of cell number and/or cell size.
2. L.OL.07.32 Examine how through cell division, cells can become specialized for specific functions.

LIFE SCIENCE

Heredity

9. L.HE.M.2 ***Reproduction***
Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.

Essential Questions

- What effects do heredity and the environment have on an organism?

Key Concepts

- Characteristics of an organism are influenced by both heredity and the environment.

1. L.HE.M.07.21 Compare how characteristics of living things are passed on through generations, both asexually and sexually.
1. L.HE.M.07.22 Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

New Vocabulary

acquired trait	heredity	mutation	toxin
diversity of life	inheritance	Punnett square	trait
gene	inherited trait	ratio	variation in population
hereditary information			

Enrichment Vocabulary

breeding	dominant gene	identical twin studies	recessive gene
chromosome	genotype	identical twins	reproductive stress
controlled selection	hybrid	phenotype	

EARTH SYSTEMS

10. E2.1 ***Earth Systems Overview***
The Earth is a system consisting of four major interacting components: geosphere (crust, mantle, and core), atmosphere (air), hydrosphere (water), and biosphere (the living part of Earth). Physical, chemical, and biological processes act within and among the four components on a wide range of time scales to continuously change Earth's crust, oceans, atmosphere, and living organisms. Earth elements

move within and between the lithosphere, atmosphere, hydrosphere, and biosphere as part of geochemical cycles.

1. E2.1A Explain why the Earth is essentially a closed system in terms of matter.
2. E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.
3. E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.

11. E2.2 ***Energy in Earth Systems***

Energy in Earth systems can exist in a number of forms (e.g., thermal energy as heat in the Earth, chemical energy stored as fossil fuels, mechanical energy as delivered by tides) and can be transformed from one state to another and move from one reservoir to another. Movement of matter and its component elements, through and between Earth's systems, is driven by Earth's internal (radioactive decay and gravity) and external (Sun as primary) sources of energy. Thermal energy is transferred by radiation, convection, and conduction. Fossil fuels are derived from plants and animals of the past, are nonrenewable and, therefore, are limited in availability. All sources of energy for human consumption (e.g., solar, wind, nuclear, ethanol, hydrogen, geothermal, hydroelectric) have advantages and disadvantages.

1. E2.2A Describe the earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).
2. E2.2B Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.
3. E2.2C Describe natural processes in which heat transfer in the earth occurs by conduction, convection, and radiation.
4. E2.2D Identify the main sources of energy to the climate system.
5. E2.2e Explain how energy changes form through Earth systems.
6. E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.

12. E2.3 ***Biogeochemical Cycles***

The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Most elements can exist in several different states and chemical forms; they move within and between the geosphere, atmosphere, hydrosphere, and biosphere as part of the Earth system. The movements can be slow or rapid. Elements and compounds have significant impacts on the biosphere and have important impacts on human health.

1. E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbon acid (water), and animals (life) within Earth systems and how those forms can be beneficial or harmful to humans.
2. E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).
3. E2.3c Explain how the nitrogen cycle is part of the Earth system.
4. E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.

13. E2.4 ***Resources and Human Impacts on Earth Systems***

The Earth provides resources (including minerals) that are used to sustain human affairs. The supply of non-renewable natural resources is limited and their extraction and use can release elements and compounds into Earth systems. They affect air and water quality, ecosystems, landscapes, and may have effects on long-term climate. Plans for land use and long-term development must include an understanding of the interactions between Earth systems and human activities.

1. E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.

2. E2.4c Explain ozone depletion in the stratosphere and methods to slow human activities to reduce ozone depletion.

The Solid Earth

14. E3.p1 ***Landforms and Soils (prerequisite)***

Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruptions, and deposition of sediments transported in rivers, streams, and lakes through watersheds. Destructive forces include weathering and erosion. The weathering of rocks and decomposed organic matter result in the formation of soils. (prerequisite)

1. E3.p1A Explain the origin of Michigan landforms. Describe and identify surface features using maps and satellite images. (prerequisite)
2. E3.p1B Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments. (prerequisite)
3. E3.p1C Describe how coastal features are formed by wave erosion and deposition. (prerequisite)

15. E3.p2 ***Rocks and Minerals (prerequisite)***

Igneous, metamorphic, and sedimentary rocks are constantly forming and changing through various processes. As they do so, elements move through the geosphere. In addition to other geologic features, rocks and minerals are indicators of geologic and environmental conditions that existed in the past. (prerequisite)

Essential Questions

- How does the rock cycle explain the formation of rock types and the changes they undergo?
- If mountains are constantly eroding, why isn't the surface of the Earth completely flat?
- Why do rocks change over time?

Key Concepts

- Rocks are composed of one or more minerals.
- Rocks change over time, due to processes such as cooling, erosion, weathering, heat, and pressure.
- The rock cycle model explains the formation of igneous, metamorphic, and sedimentary rocks and that rocks are constantly forming and changing.
- The surface of Earth is not flat because earthquakes and volcanoes build up the Earth's surface even as wind, water, and ice erode it.
- Waves, wind, water, and glacier movement shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in others.

1. E3.p2A Identify common rock-forming minerals (quartz, feldspar, biotite, calcite, hornblende). (prerequisite)
2. E3.p2B Identify common igneous (granite, basalt, andesite, obsidian, pumice), metamorphic (schist, gneiss, marble, slate, quartzite), and sedimentary (sandstone, limestone, shale, conglomerate) rocks and describe the processes that change one kind of rock to another. (prerequisite)

New Vocabulary

cementing	foliation	magma	rock breakage
chemical weathering	freezing and thawing (weathering)	mechanical weathering	rock composition
contact metamorphism	geochemical cycle	metamorphic environment	rock cycle
crust	glacier movement	metamorphic rock	rock sequence
crystal	grain	metamorphism	rock types
crystal size	grain shape	molten rock	sediment
crystallization	grain size	nonfoliated texture	sedimentary rock
deposition	igneous rock	plate tectonics context	sedimentation
deposition environment	intrusive	pressure	silt
extrusive	lithification	regional metamorphism	

Enrichment Vocabulary

andesite	compaction	destructive force	obsidian
basalt	constructive force	directional structure	olivine
basin	constructive force	feldspar	pumice
biotite	crystallization	gneiss	quartz
calcite	decomposition	granite	Richter scale
cavern	delta	hornblende	schist
cementing	depsotional environment	marble	slate
compaction	destructive force	metamorphic environment	

16. E3.p3 ***Basic Plate Tectonics (prerequisite)***

Early evidence for the movement of continents was based on the similarities of coastlines, geology, faunal distributions, and paleoclimatelogical data across the Atlantic and Indian Oceans. In the 1960s, additional evidence from marine geophysical surveys, seismology, volcanology, and paleomagnetism resulted in the development of the theory of plate tectonics. (prerequisite)

Essential Questions

- What evidence makes scientists believe the continents are moving?

Key Concepts

- Earthquakes and volcanoes are most common along plate boundaries and at hot spots.
- Plate boundaries are areas where plates are moving away from each other, crashing into each other, or sliding past each other.
- Plate movements result in potentially catastrophic events such as earthquakes and volcanic eruptions, which may create tsunamis, trenches, mountains, or islands.
- Plate tectonics theory is the central organizing theory of geology and is part of the explanation of every phenomenon and process that is observable in the geosphere and interconnects with the other Earth systems. (Source: Michigan High School Companion Document for Earth Science)
- Tectonic plates of the Earth constantly move centimeters every year.

1. E3.p3A Describe geologic, paleontologic, and paleoclilmatalogic evidence that indicates Africa and South America were once part of a single continent.
2. E3.p3B Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g., continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).
3. E3.p3C Describe the three major types of volcanoes (shield volcano, stratovolcano, and cinder cones) and their relationship to the Ring of Fire.

New Vocabulary

asthenosphere	elastic rebound theory	magnetite	plate boundary
composition	explosivity	man-made magnet	plate collision
concentric layers	fault	mid-ocean ridge	plate tectonic movement
continental collision	geologic features	molten core	plate tectonics theory
continental crust	geologic force	molten rock	primary wave
continental plate	global positioning system (GPS)	mountain belt	Richter scale
continental rift	inner core	mountain building	Ring of Fire
convecting mantle	intensity	mountain range	S-wave
crustal deformation	lithosphere	natural magnet	sea floor spreading
crustal plate movement	lodestone	navigation	secondary wave
deep-sea trench	lower mantle	oceanic crust	seismology
dense metallic core	magma	oceanic plate	subduction zone
Earth's crust	magmatic activity	outer core	tectonic plates
Earth's internal source of energy	magnetic compass	outer core	thermal energy

Earth's layers	magnetic properties of the Earth	P-wave	upper mantle

Enrichment Vocabulary

basalt	guyot	Pangea	transform boundary
cinder cone volcano	iron	peridotite	transform fault
compression	island arc	shear wave	volcanic arc
convergent boundary	Mercalli Scale	shield volcano	Volcano Explosivity Index
divergent boundary	Moment Magnitude Scale	stratovolcano	volcanology
granite	nickel		

17. ***Advanced Rock Cycle***

Igneous, metamorphic, and sedimentary rocks are indicators of geologic and environmental conditions and processes that existed in the past. These include cooling and crystallization, weathering and erosion, sedimentation and lithification, and metamorphism. In some way, all of these processes are influenced by plate tectonics, and some are influenced by climate.

Essential Questions

- How does the rock cycle explain the formation of rock types and the changes they undergo?
- If mountains are constantly eroding, why isn't the surface of the Earth completely flat?
- Why do rocks change over time?

Key Concepts

- Rocks are composed of one or more minerals.
- Rocks change over time, due to processes such as cooling, erosion, weathering, heat, and pressure.
- The rock cycle model explains the formation of igneous, metamorphic, and sedimentary rocks and that rocks are constantly forming and changing.
- The surface of Earth is not flat because earthquakes and volcanoes build up the Earth's surface even as wind, water, and ice erode it.
- Waves, wind, water, and glacier movement shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in others.

1. E3.1A Discriminate between igneous, metamorphic, and sedimentary rocks and describe the processes that change one kind of rock into another.
2. E3.1B Explain the relationship between the rock cycle and plate tectonics theory in regard to the origins of igneous, sedimentary, and metamorphic rocks.
3. E3.1c Explain how the size and shape of grains in sedimentary rock indicate the environment of formation (including climate) and deposition.
4. E3.1e Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.
5. E3.1e Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.

New Vocabulary

cementing	foliation	magma	rock breakage
chemical weathering	freezing and thawing (weathering)	mechanical weathering	rock composition
contact metamorphism	geochemical cycle	metamorphic environment	rock cycle
crust	glacier movement	metamorphic rock	rock sequence
crystal	grain	metamorphism	rock types
crystal size	grain shape	molten rock	sediment
crystallization	grain size	nonfoliated texture	sedimentary rock
deposition	igneous rock	plate tectonics context	sedimentation
deposition environment	intrusive	pressure	silt

extrusive	lithification	regional metamorphism	

Enrichment Vocabulary

andesite	compaction	destructive force	obsidian
basalt	constructive force	directional structure	olivine
basin	constructive force	feldspar	pumice
biotite	crystallization	gneiss	quartz
calcite	decomposition	granite	Richter scale
cavern	delta	hornblende	rock cycle
cementing	depositional environment	marble	schist
compaction	destructive force	metamorphic environment	slate

18. E3.2 ***Interior of the Earth***

The Earth can also be subdivided into concentric layers based on their physical characteristics: (lithosphere, asthenosphere, lower mantle, outer core, and inner core). The crust and upper mantle compose the rigid lithosphere (plates) that moves over a "softer" asthenosphere (part of the upper mantle).The magnetic field of the Earth is generated in the outer core. The interior of the Earth cannot be directly samples and must be modeled using data from seismology.

Key Concepts

- Earth as a whole has a magnetic field that is detectable at the surface with a magnetic compass.
- Magnets can repel or attract other magnets. Magnets can also attract certain non-magnetic objects at a distance.
- The earth consists of layers.

1. E3.2A Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.
2. E3.2B Explain how scientists infer that the Earth has interior layers with discernable properties using patterns of primary (P) and secondary (S) seismic wave arrivals.
3. E3.2C Describe the differences between oceanic and continental crust (including density, age, composition).
4. E3.2d Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.

New Vocabulary

asthenosphere	elastic rebound theory	magnetite	plate boundary
composition	explosivity	man-made magnet	plate collision
concentric layers	fault	Mid-ocean ridge	plate tectonic movement
continental collision	geologic features	molten core	plate tectonics theory
continental crust	geologic force	molten rock	primary wave
continental plate	global positioning system (GPS)	mountain belt	Richter scale
continental rift	inner core	mountain building	Ring of Fire
convecting mantle	intensity	mountain range	S-wave
crustal deformation	lithosphere	natural magnet	sea floor spreading
crustal plate movement	lodestone	navigation	secondary wave
deep-sea trench	lower mantle	oceanic crust	seismology
dense metallic core	magma	oceanic plate	subduction zone
Earth's crust	magmatic activity	outer core	tectonic plates
Earth's internal source of energy	magnetic compass	outer core	thermal energy
Earth's layers	magnetic properties of the earth	P-wave	upper mantle

Enrichment Vocabulary

basalt	guyot	Pangea	transform boundary
cinder cone volcano	iron	peridotite	transform fault

compression	island arc	shear wave	volcanic arc
convergent boundary	Mercalli Scale	shield volcano	Volcano Explosivity Index
divergent boundary	Moment Magnitude Scale	stratovolcano	volcanology
granite	nickel		

19. E3.3 ***Plate Tectonics Theory***

The Earth's crust and upper mantle make up the lithosphere, which is broken into large mobile pieces called tectonic plates. The plates move at velocities in units of centimeters per year as measured using the global positioning system (GPS). Motion histories are determined with calculations that relate rate, time, and distance of offset geologic features. Oceanic plates are created at mid-ocean ridges by magmatic activity and cooled until they sink back into the Earth at subduction zones. At some localities, plates slide by each other. Mountain belts are formed both by continental collision and as a result of subduction. The outward flow of heat from Earth's interior provides the driving energy for plate tectonics.

Essential Questions

- What evidence makes scientists believe the continents are moving?

Key Concepts

- Earthquakes and volcanoes are most common along plate boundaries and at hot spots.
- Plate boundaries are areas where plates are moving away from each other, crashing into each other, or sliding past each other.
- Plate movements result in potentially catastrophic events such as earthquakes and volcanic eruptions, which may create tsunamis, trenches, mountains, or islands.
- Plate tectonics theory is the central organizing theory of geology and is part of the explanation of every phenomenon and process that is observable in the geosphere and interconnects with the other Earth systems. (Source: Michigan High School Companion Document for Earth Science)

1. E3.3A Explain how plate tectonics accounts for the features and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.
2. E3.3B Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that result from their increased density.
3. E3.3C Describe the motion history of geologic features (e.g., plates, Hawaii) using equations relating rate, time, and distance.
4. E3.3d Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.
5. E3.r3e Predict the temperature distribution in the lithosphere as a function of distance from the mid-ocean ridge and how it relates to ocean depth. (recommended)
6. E3.r3f Describe how the direction and rate of movement for the north American plate has affected the local climate over the last 600 million years. (recommended)

New Vocabulary

asthenosphere	elastic rebound theory	magnetite	plate boundary
composition	explosivity	man-made magnet	plate collision
concentric layers	fault	mid-ocean ridge	plate tectonic movement
continental collision	geologic features	molten core	plate tectonics theory
continental crust	geologic force	molten rock	primary wave
continental plate	global positioning system (GPS)	mountain belt	Richter scale
continental rift	inner core	mountain building	Ring of Fire
convecting mantle	intensity	mountain range	S-wave
crustal deformation	lithosphere	natural magnet	sea floor spreading
crustal plate movement	lodestone	navigation	secondary wave
deep-sea trench	lower mantle	oceanic crust	seismology

dense metallic core	magma	oceanic plate	subduction zone
Earth's crust	magmatic activity	outer core	tectonic plates
Earth's internal source of energy	magnetic compass	outer core	thermal energy
Earth's layers	magnetic properties of the earth	P-wave	upper mantle

Enrichment Vocabulary

basalt	guyot	Pangea	transform boundary
cinder cone volcano	iron	peridotite	transform fault
compression	island arc	shear wave	volcanic arc
convergent boundary	Mercalli Scale	shield volcano	Volcano Explosivity Index
divergent boundary	Moment Magnitude Scale	stratovolcano	volcanology
granite	nickel		

20. E3.4 ***Earthquakes and Volcanoes***

Plate motions result in potentially catastrophic events (earthquakes, volcanoes, tsunamis, mass wasting) that affect humanity. The intensity of volcanic eruptions is controlled by the chemistry and properties of the magma. Earthquakes are the result of abrupt movements of the Earth. They generate energy in the form of body and surface waves.

Essential Questions

- Why do earthquakes and volcanoes occur in some parts of the world and not in others?

Key Concepts

- Tectonic plates of the Earth constantly move centimeters every year.

1. E3.4A Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.
2. E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.
3. E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.
4. E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.
5. E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.
6. E3.4f Explain why fences are offset after an earthquake, using the elastic rebound theory.

New Vocabulary

asthenosphere	elastic rebound theory	molten core	plate tectonics theory
composition	explosivity	molten rock	primary wave
concentric layers	fault	mountain belt	Richter scale
continental collision	geologic features	mountain range	Ring of Fire
continental crust	geologic force	oceanic crust	S-wave
continental plate	global positioning system (GPS)	oceanic plate	sea floor spreading
continental rift	intensity	outer core	secondary wave
crustal deformation	lower mantle	P-wave	seismology
crustal plate movement	magma	plate boundary	subduction zone
deep-sea trench	magmatic activity	plate collision	thermal energy
Earth's internal source of energy	Mid-ocean ridge		

Enrichment Vocabulary

basalt	guyot	Pangea	transform boundary
cinder cone volcano	iron	peridotite	transform fault
compression	island arc	shear wave	volcanic arc
convergent boundary	Mercalli Scale	shield volcano	Volcano Explosivity Index
divergent boundary	Moment Magnitude Scale	stratovolcano	volcanology

granite	nickel		

The Fluid Earth

21. E4.p1 ***Water Cycle (prerequisite)***

Water circulates through the crust and atmosphere and in oceans, rivers, glaciers, and ice caps and connects all of the Earth systems. Groundwater is a significant reservoir and source of freshwater on Earth. The recharge and movement of groundwater depends on porosity, permeability, and the shape of the water table. The movement of groundwater occurs over a long period time. Groundwater and surface water are often interconnected. (prerequisite)

Essential Questions

- How do land use decisions by communities impact water quality and water supply for both groundwater and surface water?
- How does fresh water move?
- How is water related to Earth systems?
- What are the components and processes of the water cycle?
- What are the components of a watershed and how does a watershed relate to the water cycle?
- What is the source of energy for the water cycle?

Key Concepts

- A watershed is the land area drained by a stream system.
- Groundwater is a dynamic feature on the Earth.
- Land use decisions affect water quality and water supply.
- On a world-wide basis, groundwater is the most significant source of water to sustain life.
- The Sun is the source of energy for the water cycle and causes multiple changes of state as water moves through the water cycle.
- Water circulates through the four Earth systems in a process known as the water cycle.
- Water flows through the various components of a watershed including surface features and groundwater.

1. E4.p1A Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption. (prerequisite)
2. E4.p1B Analyze the flow of water between the elements of a watershed, including surface features lakes, streams, rivers, wetlands) and groundwater. (prerequisite)
3. E4.p1C Describe the river and stream types, features, and process including cycles of flooding, erosion, and deposition, as they occur naturally and as they are impacted by land use decisions. (prerequisite)
4. E4.p1D Explain the types, process, and beneficial functions of wetlands.

New Vocabulary

aquifer	landscape	residence time	water cycle
hydrogeology	outputs	run-off	water table
hydrosphere	permeability	salt water	water vapor
infiltration	porosity	sustainability	watershed
infiltration	recharge	transpiration	wetlands
inputs	reservoir	water budget	

Enrichment Vocabulary

agriculture run-off	continental glacier	ice sheet	polar cap
artesian aquifer	discharge	irrigation	rebound
cloud formation	ice cap	percolate	unconfined aquifer
confined aquifer			

22. E4.p2 ***Weather and the Atmosphere (prerequisite)***

The atmosphere is divided into layers defined by temperature. Clouds are indicators of weather. (prerequisite)

Essential Questions

- How does climate compare to weather?
- What causes different weather conditions?
- What is the composition of the atmosphere?

Key Concepts

- The atmosphere is a mixture of gases that have different compositions at different altitudes.
- The atmosphere is in constant motion, with different weather conditions associated with frontal boundaries.

1. E4.p2A Describe the composition and layers of the atmosphere. (prerequisite)
2. E4.p2B Describe the differences between weather and climate. (prerequisite)
3. E4.p2C Explain the differences between fog and dew formation and cloud formation. (prerequisite)
4. E4.p2D Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depend on the temperature. (prerequisite)
5. E3.p2E Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded). (prerequisite)
6. E4.p2F Describe the characteristics and movement across North America of the major air masses and the jet stream. (prerequisite)
7. E4.p2G Interpret a weather map and describe present weather conditions and predict changes in weather over 24 hours. (prerequisite)
8. E4.p2I Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and that their vertical components control the global distribution of rainforests and deserts. (prerequisite)

New Vocabulary

adiabatic cooling	cold front	frontal boundaries	occluded front
adiabatic temperature changes	convergence	frontal wedging	oxygen
adiabatic warming	density	high pressure	relative humidity
air density	dew point	humidity	satellite weather image
air mass	downburst (wind shear	hydrogen	stationary front
air pressure	drought	jet stream	trace gases
altitude	drylines	layers of the atmosphere	warm front
atmospheric composition	dust particle	low pressure	water vapor
atmospheric pressure	elevation	nitrogen	weather map
cloud formation	flood		

Enrichment Vocabulary

altitude	lake effect snow	methane	weather bulletin
argon			

23. E4.p3 ***Glaciers (prerequisite)***

Glaciers are large bodies of ice that move under the influence of gravity. They form part of both the rock and water cycles. Glaciers and ice sheets have shaped the landscape of the Great Lakes region. Areas that have been occupies by ice sheets are depressed. When the ice sheet is removed, the region rebounds (see also climate change). (prerequisite)

1. E4.p3A Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy. (prerequisite)
2. E4.p3B Explain what happens to the lithosphere when an ice sheet is removed. (prerequisite)
3. E4.p3C Explain the formation of the Great Lakes. (prerequisite)

24. E4.1 ***Hydrogeology***

Fresh water moves over time between the atmosphere, hydrosphere (surface water, wetlands, rivers, and glaciers), and geosphere (groundwater). Water resources are both critical to and greatly impacted by humans. Changes in water systems will impact quality, quantity, and movement of water. Natural surface water processes shape the landscape everywhere and are affected by human land use decisions.

Essential Questions

- How do land use decisions by communities impact water quality and water supply for both groundwater and surface water?
- How does fresh water move?
- How is water related to Earth systems?
- What are the components and processes of the water cycle?
- What are the components of a watershed and how does a watershed relate to the water cycle?
- What is the source of energy for the water cycle?

Key Concepts

- A watershed is the land area drained by a stream system.
- Groundwater is a dynamic feature on the Earth.
- Land use decisions affect water quality and water supply.
- On a world-wide basis, groundwater is the most significant source of water to sustain life.
- The Sun is the source of energy for the water cycle and causes multiple changes of state as water moves through the water cycle.
- Water circulates through the four Earth systems in a process known as the water cycle.
- Water flows through the various components of a watershed including surface features and groundwater.

1. E4.1A Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative sizes as Earth's freshwater reservoirs and the dynamics of water movement (inputs and outputs, residence times, sustainability).
2. E4.1B Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g., the past 100 years) qualitatively using the concepts of recharge, residence time, inputs, and outputs.
3. E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.

New Vocabulary

aquifer	landscape	residence time	water cycle
hydrogeology	outputs	run-off	water table
hydrosphere	permeability	salt water	water vapor
infiltration	porosity	sustainability	watershed
infiltration	recharge	transpiration	wetlands
inputs	reservoir	water budget	

Enrichment Vocabulary

agriculture run-off	continental glacier	ice sheet	polar cap
artesian aquifer	discharge	irrigation	rebound
cloud formation	ice cap	percolate	unconfined aquifer
confined aquifer			

25. E4.2 ***Oceans and Climate***

Energy from the Sun and the rotation of the Earth control global atmospheric circulation. Oceans redistribute matter and energy around the Earth through currents, waves, and interaction with other Earth systems. Ocean currents are controlled by prevailing winds, changes in water density, ocean topography, and the shape and location of landmasses. Oceans and large lakes (e.g., Great Lakes) have a major effect on climate and weather because they are a source of moisture and a large reservoir of hear. Interactions between oceanic circulation and the atmosphere can affect regional climates throughout the world.

Essential Questions

- How are winds and ocean currents produced?
- How do the oceans affect climate and weather?
- How would Earth be different if it didn't rotate?
- What causes ocean currents?
- What would Earth be like with no oceans?

Key Concepts

- Oceans redistribute matter and energy around the Earth.
- The Earth's rotation generates currents that influence global and regional climates.
- The warming of the Earth by the Sun causes convection within the atmosphere and oceans, producing winds and ocean currents.

1. E4.2A Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the earth, changes in water temperature and salinity in high latitudes, and basin shape.
2. E4.2B Explain how interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climate zones, and the ocean as a major CO2 reservoir.
3. E4.2c Explain the dynamics (including ocean-atmosphere interactions) of the El nini-Southern Oscillation (ENSO) and its effect on continental climates.
4. E4.2d Identify factors affecting seawater density and salinity and describe how density affects oceanic currents.
5. E4.2e Explain the differences between maritime and continental climates with regard to oceanic currents.
6. E4.2f Explain how the Coriolis effect controls oceanic circulation.
7. E4.r2g Explain how El Nino affects economies (e.g., in South America).

New Vocabulary

boundary	deep water oceanic currents	ocean layers prevailing winds	surface oceanic currents
carbon dioxide reservoir	El Nino	oceanic circulation	thermohaline circulation
climatic zones	El Nino-Southern Oscillation (ENSO)	prevailing winds	topography
continental climate	heat reservoir	regional climate	transportation of energy
convection current	landmass	salinity	transportation of matter
Coriolis effect	maritime climate	seawater density and salinity	unequal heating of air, land masses, and oceans
currents	ocean current		

Enrichment Vocabulary

gyre			

26. E4.3 ***Severe Weather***

Tornadoes, hurricanes, blizzards, and thunderstorms are severe weather phenomena that impact society and ecosystems. Hazards include downbursts (wind shear), strong winds, hail, lightning, heavy rain, and flooding. The movement of air in the atmosphere is due to differences in air density resulting from variations in temperature. Many weather conditions can be explained by fronts that occur when air masses meet.

1. E4.3A Describe the various conditions of formation associated with severe weather (thunderstorms, tornadoes, hurricanes, floods, waves, and drought).
2. E4.3B Describe the damage resulting from and the social impact of thunderstorms, tornadoes, hurricanes, and floods.
3. E4.3C Describe severe weather and flood safety and mitigation.
4. E4.3D Describe the seasonal variations in severe weather.
5. E4.3E Describe conditions associated with frontal boundaries that result in severe weather (thunderstorms,

tornadoes, and hurricanes).

6. E4.3F Describe how mountains, frontal wedging (including dry lines), convection, and convergence form clouds and precipitation.
7. E4.3g Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.

27. E5.3 ***Earth History and Geologic Time***

The solar system formed from a nebular cloud of dust and gas 4.6 Ga (billion years ago). The Earth has changed through time and has been affected by both catastrophic (e.g., earthquakes, meteorite impacts, volcanoes) and gradual geologic events (e.g., plate movements, mountain building) as well as the effects of biological evolution (formation of an oxygen atmosphere). Geologic time can be determined through both relative and absolute dating.

Essential Questions

- How do fossils provide evidence of how life and environmental conditions have changed?
- How do rocks and fossils provide evidence about the history of the Earth?
- How do scientists determine the age of rocks and layers of the Earth?
- How has the Earth changed over time?

Key Concepts

- Fossils provide evidence of how life and environmental conditions have changed.
- Rocks and fossils provide evidence about the history of the Earth.
- The Earth has changed over time as land, oceans, and atmosphere formed and life began, as evidenced by the fossil record.
- Usually, the older layers of rock in the Earth's crust are located below the younger layers. (Principle of Superposition)

1. E5.3B Describe the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.
2. E5.3C Relate major events in the history of the Earth to the geologic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous- Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.
3. E5.3D Describe how index fossils can be used to determine time sequence.

New Vocabulary

absolute dating	era	metamorphic rock	relative dating
ancestry	Ga (billion years ago)	mountain building	relative-age dating
brachiopod	geologic age	parent substance	rock cycle
carbon-14 (C-14)	geologic history	period	sedimentary rock
catastrophic geologic event	geologic time	Permian extinction	strata
Cretaceous-Tertiary (K-T) extinction	geological time scale	Petoskey stone	strata
daughter substance	geology	Pleistocene ice age	superposition
decay rate	glacier movement	radioactive decay	theory
deposition	gradual geologic event	radioactive element	timeline
Earth processes	half-life	radioactive isotope	trilobite
environmental condition	igneous rock	radioactive substance	unconformity. uranium-lead (U-Pb)
eon	index fossil	radiometric dating	uniformitarianism
epoch	law of superposition		

Enrichment Vocabulary

era	index fossil	Law of Superposition	unconformities
extrusion	intrusion	superposition	uniformitarianism

fault			

28. E5.2x ***Geologic Dating***

Early methods of determining geologic time, such as the use of index fossils and stratigraphic principles, allowed for the relative dating of geological events. However, absolute dating was impossible until the discovery that certain radioactive isotopes in rocks have known decay rates, making it possible to determine how many years ago a given mineral or rock formed. Different kinds of radiometric dating techniques exist. Technique selection depends on the composition of the material to be dated, the age of the material, and the type of geologic event that affected the material.

Essential Questions

- How do fossils provide evidence of how life and environmental conditions have changed?
- How do rocks and fossils provide evidence about the history of the Earth?
- How do scientists determine the age of rocks and layers of the Earth?
- How has the Earth changed over time?

Key Concepts

- Fossils provide evidence of how life and environmental conditions have changed.
- Rocks and fossils provide evidence about the history of the Earth.
- The Earth has changed over time as land, oceans, and atmosphere formed and life began, as evidenced by the fossil record.
- Usually, the older layers of rock in the Earth's crust are located below the younger layers. (Principle of Superposition)

1. E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ration of daughter to parent substances present in the sample.
2. E5.3f Explain why C-14 can be used to date a 40,000 year old tree but U-Pb connot.
3. E5.3g Identify a sequence of geologic events using relative age dating principles.

New Vocabulary

absolute dating	era	metamorphic rock	relative dating
ancestry	Ga (billion years ago)	mountain building	relative-age dating
brachiopod	geologic age	parent substance	rock cycle
carbon-14 (C-14)	geologic history	period	sedimentary rock
catastrophic geologic event	geologic time	Permian extinction	strata
Cretaceous-Tertiary (K-T) extinction	geological time scale	Petoskey stone	strata
daughter substance	geology	Pleistocene ice age	superposition
decay rate	glacier movement	radioactive decay	theory
deposition	gradual geologic event	radioactive element	timeline
Earth processes	half-life	radioactive isotope	trilobite
environmental condition	igneous rock	radioactive substance	unconformity. uranium-lead (U-Pb)
eon	index fossil	radiometric dating	uniformitarianism
epoch	law of superposition		

Enrichment Vocabulary

eon	extrusion	Law of Superposition	unconformities
epoch	fault	period	uniformitarianism
era	index fossil	strata	
era	intrusion	superposition	

29. E5.4 ***Climate Control***

Atmospheric gases trap solar energy that has been reradiated from the earth's surface (the greenhouse effect). The earth's climate has changed both gradually and catastrophically over geological and historical time frames due to complex interactions between many natural variables and events. The concentration of greenhouse gases (especially carbon dioxide) has increased due to human industrialization which has contributed to a rise in average global atmospheric temperatures and changes in the biosphere, atmosphere, and hydrosphere. Climates of the past are researched, usually using indirect indicators, to better understand and predict climate change.

Essential Questions

- How do scientists learn about the changing climate of Earth?
- How does Earth's climate change over time?
- How does the Sun produce energy and how is the Earth affected?
- What is the greenhouse effect and how does it have implications for society and ecosystems?

Key Concepts

- Climate is a long-term average of weather which is affected by the oceans.
- Climates of the past are researched, usually using indirect indicators, to better understand and predict climate change.
- Earth's climate has changed over time due to complex interactions between many natural variables and events.
- Industrialization has caused an increase in carbon dioxide, which has contributed to a rise in atmospheric temperatures and changes in the biosphere, atmosphere, and hydrosphere (the greenhouse effect).
- Nuclear reactions take place on the Sun, producing heat and light, but only a fraction of the light energy is transformed to heat energy on the Earth.

1. E5.4A Explain the natural mechanism of the greenhouse effect including comparisons of the major greenhouse gases (water vapor, carbon dioxide, oxide, and ozone).
2. E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the earth, meteorite impacts).
3. E5.3C Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels and the average global temperature over the past 150 years.
4. E5.4D Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (including the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).
5. E5.4e Based on evidence from historical climate research (e.g., fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system.
6. E5.4f Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils.
7. E5.4g Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat trapping capacity.
8. E5.r4h Use oxygen isotope data to estimate paleotemperature. (recommended)
9. E5.r4i Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. (recommended)
10. E5.r4j Predict the global temperature increase by 2100, given data on the annual trends of CO2 concentration increase. (recommended)

New Vocabulary

air density	coral bleaching	ice core data	ozone layer
algae growth	deep water oceanic currents	infrared radiation	polar ice caps
altitude	fluorocarbons	meteorite impact	salinity
biosphere	geologic record	methane	seawater density
boundary currents	geomorphology	nitrous oxide	striations

carbon dioxide	greenhouse effect	nuclear reaction	surface oceanic currents
climate change models	greenhouse gases	ocean topography	varve
climatic zones	heat trapping mechanisms		

Enrichment Vocabulary

nuclear fusion	oxygen isotope data	paleotemperature	

East Grand Rapids Public Schools

HIGH SCHOOL SCIENCE CURRICULUM

2915 Hall Street SE · Grand Rapids MI 49506-3111 · 616.235.3535

CURRICULUM SCOPE AND SEQUENCE

	8th Grade	9th Grade	10th Grade	11th Grade	12th Grade
College Prep Path	8th Grade Science	Physics	Biology	Chemistry	Elective in Life or Physical Science
Honors Path	8th Grade Science	Honors Physics	Honors Biology	Honors Chemistry	Elective in Life or Physical Science
Advanced Students Path	Test out of 8th Grade Science. Take Honors Physics at high school	Honors Biology	Honors Chemistry	Elective in Life or Physical Science	Elective in Life or Physical Science

KEY FOR COMMON CORE STATE STANDARDS

RST Reading Standards for Literacy in Science and Technical Subjects

WHST Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects

Inquiry, Reflection, and Social Implications

1. *TLW understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations of force and motion.*

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

WHST 9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

WHST 9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

WHST 9-10.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Inquiry and Introduction to Physics

Essential Questions

- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Prerequisite Vocabulary

analyze	balance	cause
centimeter	conclusion	control of variables
controlled experiment	data	effect
experimental control	force	friction
gram	graph	gravity
hypothesis	mass	measurement error
measurement tool	meter	metric measurement system
Newton	observation	scientific investigation
scientific law	scientific method	scientific question
spring scale	temperature	theory
thermometer	variable	weight

New Vocabulary

control	control group	conversion
dependent variable	empirical evidence	experimental group

experimental research	field research	independent variable
inference	logical reasoning	peer review process
pulley	results	sample
scientific experiment	scientific notation	significant figures
validity		

Motion of Objects

2. TLW measure, calculate, graph, and analyze the motion of an object (position, speed, velocity, and acceleration) as a function of time.

Unit/Lesson

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

One-Dimensional Motion of Objects

Essential Questions

- How can an object's position (distance) and velocity be determined as a function of time?
- What is the relationship between a moving object's position (distance), displacement, speed, velocity, and acceleration?

Key Concepts

- An object's velocity can be calculated and graphed.
- An object's motion can be described by its position, displacement, speed, velocity, and acceleration.
- An object's position (distance) can be measured, calculated, and graphed as a function of time.

Prerequisite Vocabulary

acceleration (a)	change	change in direction
change in motion related to force	change in speed	constant speed
direction	direction of motion	distance (d)
function	graph	motion
point of reference	position	relative distance
relative position	second (s)	speed
time(t)		

New Vocabulary

control	control group	conversion
dependent variable	empirical evidence	experimental group
experimental research	field research	independent variable
inference	logical reasoning	peer review process
pulley	results	sample

scientific experiment	scientific notation	significant figures
validity		

Two-Dimensional Motion of Objects

3. TLW measure, calculate, graph, and analyze the motion of an object in two dimensions.

Unit/Lesson

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
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WHST 9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

WHST 9-10.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Essential Questions

- How are the horizontal and vertical motions of a projectile related?
- What are vectors?
- What is two-dimensional motion?
- Why does an object accelerate if it is traveling in circular motion at a constant speed?
- Why is the flight path of a projectile curved?

Key Concepts

- As an object changes position in a circle, the direction of velocity changes and the object accelerates.
- Motion in a plane can be classified as one-dimensional, two-dimensional, circular, or periodic.
- The flight path of a projectile is curved due to gravity.
- The horizontal and vertical motions of a projectile are independent.
- Vectors are quantities that have both magnitude and direction (such as velocity and acceleration) and can be represented as arrows on motion diagrams.

Prerequisite Vocabulary

acceleration (a)	change in direction	change in motion related to force
change in speed	constant speed	direction
distance (d)	mass	motion
net force	position	relative distance
relative position	second (s)	speed
time (t)		

New Vocabulary

acceleration due to gravity	average acceleration	average speed
ballistic pendulum	circular motion	component
constant acceleration	curved path	displacement
frame of reference	horizontal velocity	inversely proportional
launch angle	magnitude	motion diagram
periodic motion	proportional	range
relative motion	resultant	scalar
two-dimensional motion	two-dimensional projectile motion	vector
velocity (v)	vertical velocity	

Enrichment Vocabulary

kinematics	negative acceleration	positive acceleration

Forces and Motion

4 TLW apply Newton's Laws to predict and calculate the change in the motion of an object when acted upon by forces.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Essential Questions

- What impact does a balanced force have on the motion of an object?
- What impact does an unbalanced force have on the motion of an object?
- What is an action-reaction force?
- What is F = ma?
- What is inertia?
- What is net force and how is net force determined?

Key Concepts

- A balanced force on an object does not change the motion of the object.
- A body continues in its state of rest or in its state of motion in a straight line at constant speed unless it is acted upon by a net force. (Newton's First Law of Motion)
- Forces have a magnitude and direction.
- Forces that act in the same direction combine; forces that act in opposite directions cancel each other out. Net force is the sum of all forces acting on an object.
- The change of speed and/or direction (acceleration) of an object is proportional to the net force and inversely proportional to the mass of the object. The acceleration and net force are always in the same direction. (F = ma) (Newton's Second Law of Motion)
- Unbalanced forces on an object result in a non-zero net force and the object will accelerate.
- Whenever one object exerts a force on another object, a force equal in magnitude and opposite in direction is exerted back on the first object. (action-reaction) (Newton's Third Law of Motion)

Prerequisite Vocabulary

acceleration	atom	balanced forces
buoyancy	buoyant force	change in direction
change in motion related to force	change in speed	compression
constant speed	contact force	direction
force	friction	gravitational pull
gravity	inertia	interaction
magnetism	mass	molecule
motion	net force	Newton
newton (N)	Newton's First Law of Motion	Newton's Second Law of Motion
Newton's Third Law of Motion	Newton's Laws of Motion	non-contact force

nuclear energy	pull	push
scientific law	scientific theory	speed
unbalanced forces	weight	

New Vocabulary

action/reaction forces	air resistance	direct contact
direction of a force	electrical force	electromagnetic force
equal and opposite force	forces at a distance	free-body diagram
frictional force	gravitational force	inverse square law
inversely proportional	linear motion	magnitude of a force
normal force	nuclear force	proportional
scalar	strong nuclear force	tension force
vector	velocity (v)	weal nuclear force

Enrichment Vocabulary

attractive force	bending	repulsive force	shear

Momentum

5. *TLW describe how force, mass, and velocity affect the momentum of an object, calculate impulse, and solve simple collision problems.*

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

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RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST 9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Essential Questions

- How do interactions between objects affect the total momentum of the objects?
- What is necessary to change an object's momentum?
- What motions can be predicted by interactions between objects of varying mass and velocity?

Key Concepts

- A net external force is required to change an object's momentum.
- In interactions between objects, the total momentum of the objects does not change.
- Interaction between objects produces predictable motion.

Prerequisite Vocabulary

acceleration	mass	net force
Newton's Laws of Motion	Newton's Second Law	Newton's Third Law

New Vocabulary

average velocity	change in momentum	change in velocity
collision	external force	F = ma

force if impact	impulse	internal force
inversely proportional	Law of Conservation of Momentum	momentum (p)
projectile	proportional	vector
velocity (V)		

Enrichment Vocabulary

elastic	inelastic	

Circular Motion and Gravity

6. TLW measure, calculate, graph, and analyze uniform circular motion and explain gravitational interactions using the Law of Universal Gravitation.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

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RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST 9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST 9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Essential Questions

- How does gravity affect all objects in the universe and what is the relationship between the force of gravity, mass, and the distance between objects?
- What is circular motion?
- What is periodic motion?
- Why and how does an object travel in a curved path and what type of acceleration does it undergo?

Prerequisite Vocabulary

acceleration	direction	force	gravity	mass
motion	net force	position	revolution	rotation
speed	time	weight		

New Vocabulary

acceleration due to gravity	action/reaction forces	average acceleration
average speed	center of gravity	centripetal force

circular motion	component	earth-moon interaction
elliptical orbit	gravitation	gravitational force
inverse square law	inversely proportional	Law of Universal Gravitation
magnitude	orbital motion	period
periodic motion	proportional	radius
tide	uniform circular motion	universal gravitational constant (G)
vector	velocity (v)	

Forms of Energy and Energy Transformations

7. TLW identify and explain forms of energy in mechanical systems and measure and calculate work and changes in kinetic and potential energy.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

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a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
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Forms of Energy and Mechanical Energy

Key Concepts

- Energy exists in many forms: mechanical energy, friction, magnetic energy, chemical energy, gravitational energy, light energy, heat energy, electrical energy, sound energy, and nuclear energy.
- Moving objects have kinetic energy; objects experiencing a force may have potential energy due to their relative locations.
- Work is the product of a force moving an object and the distance the object is moved.

Essential Questions

- What are the forms of energy and how and why are they classified?
- What is the difference between potential energy and kinetic energy and how are they related?
- What is work and how is the amount of work calculated, given force and distance?

Prerequisite Vocabulary

change in direction	change in motion related to force	change in speed
chemical energy	distance	electrical energy
energy distribution	energy of motion	energy transfer
energy transformation	force (F)	form of energy
friction	gravity	heat energy
kinetic energy (KE)	light energy	magnetic energy
mass (m)	mechanical system	net force
Newton's First Law of Motion	nuclear energy	pendulum
potential energy (PE)	solar energy	sound energy
source of energy	speed	wave
work (w)		

New Vocabulary

air resistance	direction of a force	drag
gravitational energy	gravitational potential energy (GPE)	impact speed
initial vertical velocity	joule (J)	kilowatt (kW)
Kilowatt hour (kWh)	Law of Conservation of Energy	magnitude of a force
maximum	minimum	newton (N)
Newtonian mechanics	power	rate
velocity (v)	watt (W)	

Enrichment Vocabulary

efficiency	force advantage	gear
input	mechanical advantage	output
speed advantage		

Mechanical Waves

8. TLW explain the properties of mechanical waves; calculate wave velocity, wavelength, and frequency; and predict the behavior of mechanical waves when interacting with various media.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

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Essential Questions

- How do mechanical waves move through a medium?
- How do mechanical waves transfer energy without transferring mass?
- What are the characteristics of waves that describe their motion?

Key Concepts

- Mechanical waves are vibrations in a medium that move from source to receiver, conveying energy.
- Waves are described by their wavelength, amplitude, frequency, and speed.
- Waves transfer energy from one place to another without transferring mass.

Prerequisite Vocabulary

absorb/absorption	acoustics	amplitude
compression	convex	crest
echo	electromagnetic wage	energy
frequency	gas	interaction
liquid	longitudinal wave	matter
mechanical wave	medium	meter (m)
molecule	pendulum	period
pitch (high/low)	reflection	refract/refraction
seismic wave	solid	SONAR
sound	sound source	sound wave
transmission	transmit	transverse wave
trough	tuning fork	vacuum
vibration	vocal cords	volume
wave	wave velocity	wavelength

New Vocabulary

compression waves	decibel (dB)	Doppler effect
emission	intensity	interference
Law of Superposition	meters per second	micrometers
origin	P wave	rarefaction
S wave	scattering	shock wave
sonic boom	ultrasound	velocity
water wave	wave propagation	

Enrichment Vocabulary

constructive interference	destructive interference	dolphin communication
natural frequency	oscillate	real image
resonance	virtual image	visible spectrum
wave of oscillation	wave of translation	

Light

9. *TLW explain the nature of light and how it interacts with matter and apply Snell's Law to calculate the path of a light ray.*

Unit/Lesson

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Essential Questions

- How does light interact with matter?
- How is the angle of incidence related to the angle of reflection and what are the practical applications?
- What are examples of constructive and destructive interference with light and what are practical applications of this interference?

Key Concepts

- Light interacts with matter by reflection, refraction, absorption, or transmission.
- The angle of incidence equals the angle of reflection.
- Waves can superimpose on each other (interference) in constructive or destructive ways.

Prerequisite Vocabulary

absorb/absorption	amplitude	bright/brighter
compression	convex	crest
electromagnetic wave	emitted light	energy
frequency	gas	infrared radiation
interaction	light	light source
light wave	light year	liquid
longitudinal wave	matter	mechanical wave
medium	meter (m)	molecule
path of light	period	rarefaction
reflection	refract/refraction	solid
transmission	transmit	transverse wave
trough	vacuum	vibration
visible	wave velocity	wavelength

New Vocabulary

angle of incidence	angle of reflection	angle of refraction
colors of the spectrum	concave	converging
diffraction	diffraction grating	direct ray
diverging	emission	focal length
focal point	hertz (Hz)	incident wave
index of refraction (n)	indirect ray	interference
Law of Reflection	lens	meters per second
micrometers	nanometer (nm)	opaque
origin	prism	ray diagram

real image	reflected wave	refracted wave
scattering	Snell's Law	spectrum
speed of light	translucent	transparent
velocity	virtual image	visible light
white light		

Enrichment Vocabulary

center bright spot	constructive interference	critical angle
destructive interference	first order bright spot	LASER
photometry	principal axis	

Electromagnetic Waves and Quantum Theory

10. TLW explain the properties of electromagnetic waves, predict their behavior when interacting with various media, and explain the relationships among electromagnetic waves, communication, and quantum theory.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

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a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Essential Questions

- How are different types of electromagnetic waves used for communication and to transfer information from one place to another?
- How are electromagnetic waves produced?
- What is the electromagnetic spectrum?

Key Concepts

- Electromagnetic waves are produced by changing motion in a magnetic field. This allows them to travel through empty space without the need of a medium.
- Modulated electromagnetic waves are used for communication devices to transfer information from one place to another.
- The electromagnetic spectrum exists as a continuum of waves of varying energies: radio waves, microwaves, infrared waves, visible light, ultraviolet light, x- rays, gamma rays.

Prerequisite Vocabulary

absorb/absorption	acceleration	amplitude
crest	electromagnetic wave	energy
frequency	infrared radiation	interaction
kinetic energy	light	magnetic field
matter	medium	particle
period	reflected light	reflection
refraction	transmission	transmit
transverse wave	trough	vacuum
visible	wave	wave velocity
wavelength		

New Vocabulary

analog	angle of incidence	angle of reflection
angle of refraction	antenna	colors of the spectrum
diffraction	digital	electric field
electromagnetic radiation	electromagnetic spectrum	emission
gamma rays	hertz (Hz)	incident wave
infrared wave	interference	microwave
modulation	nanometer (nm)	radiant heat
radio waves	rate	reception
reflected wave	refracted wave	scattering
spectrum	speed of light	television signals
ultraviolet light	ultraviolet radiation	velocity
visible light	wave properties	x-ray

Enrichment Vocabulary

atomic (bright line)	coherent light	electromagnetic energy
incident light	LASER	natural frequency
particle theory	photoelectric	photon
Planck's constant	quantum theory	quantum/quanta
resonance	visible spectrum	wave theory

Electric Force

11. TLW use Coulomb's Law to predict how electric force between charged objects varies with distance and explain how objects become charged by induction.

Unit/Lesson

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a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

Essential Questions

- How can an object acquire an electric charge?
- How does electric force compare to gravitational force?
- How does the distance between objects affect the strength of a charge?

Key Concepts

- Electric force is vastly greater than gravitational force.
- Electrons can be transferred from one object to another, creating a static charge.
- Like charges repel, opposite charges attract, and the force between charged objects decreases as the distance increases.
- Most observable forces may be traced to electric forces acting between atoms and molecules.

Prerequisite Vocabulary

atom	attract	contact force
distance	electric charge	electrical attraction
electrical current	electrical energy	electrical repulsion
electrically charged object	electricity	electron
force	form of energy	friction
magnet	molecule	negative charge
net force	positive charge	precaution
proton	repel	source of energy
static electrical charge		

New Vocabulary

charged object	coulomb (C)	Coulomb's Law
current electricity	direction of a force	Distribution of electric charge
electric force	electric potential	electric shock
electrically neutral	electrocution	electromagnetic force
force at a distance	gravitational force	induction
inverse square law	inversely proportional	like charge
magnitude of a charge	magnitude of a force	moving electrical charge
neutral	opposite charge	proportional

strong nuclear force	Van de Graaff generator	weak nuclear force

Enrichment Vocabulary

grounding		

Electric Current

12. TLW identify types of electrical circuits, use Ohm's Law to explain and calculate the relationships in current electricity, and explain everyday applications of electric current.

Unit/Lesson

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Essential Questions

- In electric circuits, how are flow, potential, and resistance related?
- What are the components, parameters, and conditions of a functioning electric circuit?
- What are the possible dangers of a short circuit and how can they be prevented?

Key Concepts

- A circuit allows the flow of electricity when it is complete (closed) and prevents the flow when it is open.
- A short circuit has a bypass of resistance lower than the original circuit in the flow of electricity that can cause a variety of problems such as fire or shock.
- Electric current is used to transfer energy to do work.
- Within an electric circuit, current (flow) has a potential (voltage), which can be slowed by resistance.

Prerequisite Vocabulary

battery	chemical energy	closed circuit
conduction	conductivity	distance
electric energy	electrical attraction	electrical charge
electrical circuit	electrical current	electrical repulsion
electricity	electromagnet	electron
energy transformation	flow of electrical energy	form of energy
good conductor	heat	light
magnet	magnetic field	magnetic force
negative charge	open circuit	poor conductor
positive charge	precaution	repel
shock	source of energy	

New Vocabulary

ammeter	amperage	amperes (I)
charge	circuit breaker	complete circuit
coulomb (C)	Coulomb's Law	current flow
electric company	electric generator	electric motor
electric power	electrical switch	electron flow model
flow	fuse	grounding
incomplete circuit	insulator	kilowatt (kWh)
load	moving electric charge	moving magnet
Ohm	Ohm's Law	parallel circuit
potential difference	power	power source
resistance	resistance force	series circuit
simple circuit	volt (V)	volt meter
voltage	watt (W)	work (w)

Energy Transformations

13. TLW explain transformations from one form of energy to another and calculate thermal energy transfer.

Unit/Lesson

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Essential Questions

- During energy transformations, how is the total amount of energy affected?
- How is energy transformed from one form to another?
- Why is heat usually a non-recoverable part of energy transformation?

Key Concepts

- During energy transformations, the total amount of energy remains constant.
- Energy is constantly transformed from one form to another.
- In energy transformations, one main by-product is heat, which is usually not recoverable as a useful form of energy.
- Moving objects transfer energy from one location to another and to other objects.
- The amount of energy before a transformation is equal to the amount of energy after the transformation. (Energy is neither lost nor gained during a transformation.)

Prerequisite Vocabulary

chemical energy	electrical energy	energy
energy of motion	energy transfer	energy transformation
form of energy	heat energy	kinetic energy (KE)
light energy	magnetic energy	mechanical energy
nuclear energy	potential energy (PE)	solar energy
sound energy	source of energy	system
temperature		

New Vocabulary

efficiency	energy transfer diagram	gravitational energy
input	Law of Conservation of Energy	output
thermal energy	thermal equilibrium	

Nuclear Energy

14. TLW explain nuclear processes of fission, fusion, and radioactive decay and the positive and negative effects of nuclear energy.

Unit/Lesson

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RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

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RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

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c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

WHST 9-10.7 Conduct sort as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 9-10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

WHST 9-10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How are humans affected by radioactive decay?
- How does fusion compare to fission?
- How does the amount of energy compare before and after a nuclear reaction?
- What is the Law of Conservation of Matter and Energy and what are its implications?

Key Concepts

- Changes in atomic nuclei can occur through fission, fusion, and/or radioactive decay.
- Matter must be included as a form of energy in nuclear energy transformations.
- The Law of Conservation of Matter and Energy states that the total quantity of matter and energy available in the universe is fixed and never changes.

Prerequisite Vocabulary

atom	benefit	earth's crust
electron	energy distribution	energy transformation
form of energy	heat	light
matter	neutron	nuclear energy
nuclear reaction	potential energy	pressure
proton	renewable resource	risk
safety	solar energy	source of energy
temperature	wave	

New Vocabulary

atomic bonding principles	atomic configuration	atomic energy
atomic mass	atomic nucleus	atomic number
atomic reaction	atomic weight	by-product
chemical bond	earth's external energy source	earth's internal energy source
electromagnetic radiation	electromagnetic spectrum	half-life
infrared light	Law of Conservation of Matter and Energy	mass to energy conversion
microwave	nonrenewable energy	nuclear decay rate
nuclear fission	nuclear force	nuclear fusion
nuclear mass	nuclear stability	radioactive decay
radioactive isotope	release of energy	renewable energy
speed of light	spontaneous nuclear reaction	star composition
stellar energy	stored energy	subatomic particle
technological application	thermal energy	ultraviolet light
ultraviolet radiation	useful energy output	visible light
x-ray		

Enrichment Vocabulary

alpha radiation	beta radiation	gamma radiation	radon

Honors Physics

Honors Physics is intended to not only give students an understanding of the core physics concepts, but also prepare students for advanced work in physics and chemistry. As many scientists have noted, the language of science is mathematics. In addition to giving students an excellent introduction to the core physics concepts, Honors students will learn to use basic mathematics to understand and describe the natural world. This course is specifically intended to prepare students for Advanced or AP Physics. Honors Physics will be an essential prerequisite for these more advanced courses. State of Michigan requires successful completion of a course in physic or chemistry to receive a high school diploma. This course fulfills that requirement.

Mechanics

A Physics Toolkit
Measurement
Graphing Data
Mathematics and Physics
Representing Motion
Velocity and Position
Position-Time Graphs
Accelerated Motion
Accelerated Motion
Free Fall
Acceleration due to gravity

Forces in One Dimension
Force and Motion
Newton's Laws

Forces in Two Dimensions
Vectors
Friction
Force and Motion in Two Dimensions

Motion in Two Dimensions
Projectile Motion
Circular Motion
Relative Velocity
Gravitation
The Law of Universal Gravitation
Planetary Motion and Gravitation

Momentum and its Conservation
Impulse and Momentum
Conservation of Momentum

Energy, Work, and Simple Machines
Energy and Work
Machines
Energy and its Conservation
Conservation of Energy

Thermodynamics

Thermal Energy
Temperature and thermal energy
Changes of state

Waves, Sound and Light

Vibrations and Waves
Periodic Motion
Wave Properties
Wave Behavior

Sound
Properties of Sound
Physics of Music

Fundamentals of Light
Illumination
Wave Nature of Light

Inference and Diffraction
Interference
Diffraction

Electricity and Magnetism

Static Electricity
Electric Charge
Electric Force

Current Electricity
Currents and Circuits
Electrical Energy

Series and Parallel Circuits
Simple Circuits
Applications of Circuits

Magnetic Fields
Permanent Magnets
Electromagnets
Forces Caused by Magnetic Fields
Electric Motors and Generators

Quantum Theory
A Particle Models of Waves (E = hf)
Matter Waves

Modern Physics
The Atom
The Bohr Model of the Atom
Quantum Models of the Atom

Nuclear Physics
The Nucleus
Nuclear Decay and Reactions

Senior Physics

Senior Physics is a conceptual based physics course taught at a senior high school level. This course is largely conceptual in nature utilizing concrete experiences from students' daily lives. Students will utilize algebra to solve real-world science applications. This course is designed to prepare students for continuing study in college science courses especially, biology, and chemistry, and physics. The State of Michigan requires the successful completion of a course in Physics or Chemistry to receive a high school diploma. This course fulfills that requirement.

Mechanics

Linear Motion
Projectile Motion
Forces and Newton's Laws
Impulse and Momentum
Work and Energy
Circular Motion
Rotational Motion
Universal Gravity

Sound and Light

Vibrations and Waves
Sound, Light and Color

Electricity and Magnetism

Electrostatics
Electric Current and Circuits
Magnetism Fields and Forces

Atomic and Nuclear Physics

The Atom and the Quantum
The Atomic Nucleus and Radioactivity
Nuclear Fission and Fusion

Advanced Physics

This is 2nd year physics course will cover extended topics in physics at an advanced mathematical level. Students will utilize advanced algebra and trigonometry to solve real-world physics and engineering applications. This course is designed to prepare students for continuing study in college science courses especially, chemistry, physics, and engineering. This course is a 2nd year physics course with Physics or Honors Physics being a prerequisite.

Mechanics

Kinematics in 1-D and 2-D
Forces and Newton's Laws
Dynamics and Uniform Circular Motion
Work, Energy and Torque
Momentum and Rotational Kinematics
Elasticity and Simple Harmonic Motion
Fluids

Electromagnetism

Electric Forces and Fields
Electric Potential, Currents and Circuits
Magnetic Fields and Forces
Electromagnetic Induction
Alternating Current

Waves

Waves and Sound
Electromagnetic Waves
Reflection and Refraction
Interference and Diffraction
Optics
Relativity and Quantum Physics

Inquiry, Reflection, and Social Implications

1. TLW understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, implementation, and evaluation of scientific investigations.

Unit/Lesson

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Essential Questions

- How do organisms react to a change in the environment?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- Every experiment provides useful results, whether or not the results match the hypothesis.
- Organisms react to changes in the environment.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Organization and Development of Living Systems

2. TLW explain the structure and function of organic molecules, including carbohydrates, lipids, proteins, and nucleic acids which contain many bonds that store energy.

Unit/Lesson

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Essential Questions

- How does the structure of each complex organic molecule serve its function?
- How is food use in organisms related to food storage?
- What are organic molecules and why are they important to life?
- What is the chemical nature of living organisms?
- Where is the energy in biological organic macromolecules?

Key Concepts

- Living organisms are composed primarily of water and four types of biological macromolecules.
- The bonds between carbon and hydrogen (two fundamental elements of macromolecules) store chemical energy.
- The four biological macromolecules include carbohydrates, lipids, proteins, and nucleic acids, which serve a variety of functions based on their chemical nature.

3. TLW demonstrate the relationship of cell structures, functions, and specialization to life processes.

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WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Essential Questions

- How do materials move in and out of cells?
- How does cell structure serve its function?
- What are the differences between prokaryotic and eukaryotic cells and how do these differences relate to an organism's complexity?

Key Concepts

- Cells are the basic units of life and contain organelles with different functions.
- Cells have become more complex over time.
- Eukaryotic cells are complex and can serve many functions.

- Prokaryotes are the simplest cells.
- The cell membrane regulates the movement of materials in and out of cells.

4. *TLW describe the processes of photosynthesis and cellular respiration (aerobic and anaerobic) and the role of ATP as it relates to these processes.*

Unit/Lesson

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Essential Questions

- How are photosynthesis and respiration related?
- How does ATP provide energy for cells?
- What are the differences and similarities between aerobic and anaerobic respiration?

Key Concepts

- ATP is a macromolecule whose function is the storage of cellular energy.
- Photosynthesis and cellular respiration are reverse reactions.
- The type of cellular respiration is dependent on the presence or absence of oxygen.

5. *TLW explain the complex processes and interactions of cells, tissues, and organ systems that allow organisms to maintain a stable internal environment necessary for life.*

Unit/Lesson

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

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Essential Questions

- How do living organisms maintain homeostasis?

Key Concepts

- Different structures within an organism perform different functions.
- Many organs and systems work together to maintain homeostasis.
- The internal environment of living things must remain relatively stable.

Interdependence of Living Systems and the Environment

6. TLW analyze the dependence of organisms on environmental resources and how matter and energy are transferred throughout ecosystems.

Unit/Lesson

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Essential Questions

- How do living organisms obtain the energy they need?
- What is the relationship between matter and energy?

Key Concepts

- All organisms obtain the energy the need, either directly or indirectly from the sun.
- Biogeochemical cycles (water, carbon, and nitrogen) are essential to the recycling of matter and energy through ecosystems.
- Chemical energy is passed from one consumer to the next through food chains and webs.
- Decomposers continue the process of energy transformation while returning nutrients to the ecosystem.
- The radiant energy captured from the sun by plants (who are called producers) is converted to chemical energy by photosynthesis.

7. TLW explain factors that influence population dynamics, evaluate situations that disrupt ecosystems, and analyze the impact of humans on the environment.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including

relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST 9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST 9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Essential Questions

- Can factors that affect the stability of ecosystems be controlled and how?
- How can humans limit their negative impact on ecosystems?
- What factors affect ecosystem stability?

- What happens to an ecosystem after a disaster?

Key Concepts

- Humans affect ecosystems.
- New ecosystems can develop and existing ecosystems can change over time.
- The stability of ecosystems depends upon many factors.

Genetics

8. TLW compare/contrast how genetic material is passed from cell to cell by the processes of mitosis and meiosis and explain how these processes relate to asexual and/or sexual reproduction.

Unit/Lesson

RST 9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
RST 9-10.2	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.
RST 9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
RST 9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
RST 9-10.5	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
RST 9-10.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
RST 9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
WHST 9-10.1	Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
WHST 9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
WHST 9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHST 9-10.6	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Essential Questions

- How do offspring obtain characteristics both similar to and different from their parents?
- What are the advantages and disadvantages of various reproductive strategies?
- What happens to cells as a given organism grows?
- Why is it necessary for cells to become specialized?

Key Concepts

- As cells grow, they reach a size that requires them to divide. Mitosis, cell division, ensures that the two daughter cells have genetic information that is identical to the original.
- Different parts of the organism fill different roles. The cells are differentiated in function, despite having the identical genetic information.
- Sexual reproduction allows for greater variability in offspring; asexual reproduction, such as vegetative propagation, grafting, cloning and spore formation, produces an identical copy of the parent.
- Sexually produced organisms obtain part of each parent's genetic information.

9. *TLW analyze the processes of replication and protein synthesis (transcription and translation) as it relates to DNA/RNA and explain how mutations and genetic engineering of DNA result in phenotypic changes in the organism or its offspring.*

		Unit/Lesson
RST 9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	
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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

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b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

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WHST 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

Essential Questions

- How does the structure of DNA allow for replication?
- How does the structure of DNA determine an organism's traits and by what process does this occur?
- What is a gene?

Key Concepts

- Changes in DNA can be harmful, helpful, or silent.
- DNA forms the blueprint for all life.
- DNA is inherited…passed from parent to offspring.

10. TLW predict patterns of inheritance using laws of heredity and analyze these patterns to explain variation.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

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Essential Questions

- What causes different traits throughout different generations of an organism?
- What causes variation within a population?

Key Concepts

- Chromosomes contain genes in which heredity information is stored.
- Genetic variation is essential to biodiversity and the stability of a population.
- Genetic variation is the result of the law of segregation and the law of independent assortment.
- One or more genes can determine an inherited trait of an individual and a single gene can influence more than one trait.
- Random mutations in DNA may be caused by the environment and are another source of genetic variation.

Evolution and Biodiversity

11. TLW explain evolution as the result of genetic changes within a population that occur in changing environments over time and that modern evolution includes the concepts of common descent, natural selection, and biodiversity.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

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f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Essential Questions

- How do new species arise?
- How does natural selection affect a population?
- What accounts for the diversity in the world around you?
- What is an adaptation?

Key Concepts

- Evolutionary evidence (embryonic, DNA biochemical) explains similarities among organisms.
- Natural selection and the changing environment are mechanism of evolution.
- Organisms change over time.

Science Vocabulary as first introduced in Biology

abiotic	accuracy	acidity
activation energy	active transport	ADP (adenosine diphospate)
aerobic	allele	amino acid
amino acid sequence	amino acids	anaerobic
analogous structure	anatomical characteristic	animal behavior
archaea kingdom	ATP	ATP (adenosine triphospate)
bacteria	behavioral response	bias
biochemical characteristic	biogeochemical cycle	biological adaptation
biological molecule	biology	biotechnology
breakdown of food molecules	cancer	carbohydrate

carbon cycle	carbon-hydrogen (covalent bonds)	carcinogen
carrying capacity	cataclysmic change	catalyst
cell differentiation	cell division	cell function
cell growth	cell organelle	cell theory
cellular communication	cellular differentiation	cellular energy conversion
cellular regulation	cellular respiration	cellular response
cellular waste disposal	chemical bond	cholesterol
chromosome	chromosome pair	circulation
codominance	codominant trait	codon
common descent	comparative anatomy	complementary sequence
concentration gradient	control group	crossing over
cytokinesis	daughter cell	degree of kinship
dehydration	deletion	dependent variable
diffusion	digestion	digestive system
dihybrid cross	diploid	disease agents
DNA	DNA (deoxyribonucleic acid)	DNA molecule
DNA replication	DNA sequence	DNA subunit
dominance	dominant	dominant trait
double helix	duplication of genes	ecology
ecosystem stability	embryo formation	embryonic stages of development
empirical evidence	endocytosis	energy requirements of living systems
environmental influence	enzyme	equilibrium
equilibrium of ecosystems	eubacteria kingdom	eukaryote
evaluate	evolution	exotcytosis
experimental design	experimental error	experimental group
exponential growth (J curve)	external stimuli	flow of energy
flow of matter	fossil record	gamete
gene encoding	gene expression	gene location
gene pool	genetic code	genetic continuity
genetic diversity	genetic drift	genetic mutation
genetic variation	geographic isolation	global warming
Golgi apparatus	greenhouse effect	haploid
hemoglobin	heterozygous	high energy bonds
homeostasis	homologous chromosome pair	homologous structure
homozygous	hormone	human genetics
human modification of the ecosystem	hybrid	hydrolysis
hypertonic	hypotonic	immune response
immunity	impermeable	incomplete dominance
independent assortment	independent variable	inference
inquiry	insertion	integumentary system
isotonic	jumping genes	karyotype
law of independent assortment	law of segregation	lipid
locus	lymphatic/immune system	macromolecule
measurement error	meiosis	Mendelian genetics
messenger RNA	mitochondrion	mitosis
molecular energy	molecular genetics	molecular synthesis
monohybrid cross	morphological similarities	morphology
natural selection	neuron	neurotransmitter
new gene combinations	nitrogen cycle	nitrogenous waste

non-disjunction	nucleic acid	organic compound
organic molecule	osmosis	parent cell
passive transport	pedigree	peptide bonds
permeable	phenotype	photosynthesis
phylogenetics	physiological change	polygenic trait
polymer	population dynamics	population sampling
potential energy	product	progeny
prokaryote	protection from disease	protein structure
protein synthesis	Punnett square	qualitative data
quantitative data	reactant	recessive trait
recessiveness	recombination	recombination of genetic material
regulatory response	replication of data/results	respiration
ribosomal RNA	RNA (ribonucleic acid)	sample
sample size	scientific consensus	scientific law
sex cell	sex chromosome	sex chromosomes
sex-linked trait	shared characteristic	speciation
species variation	specimen	stable internal environment
storage of genetic information	structural specialization	subpopulation
substitution	substrate	succession
synthesis	transcription	transfer RNA
transformation of energy	transformation of matter	translation
transplantation	transport of cell materials	transport of energy
trophic level	validity	vestigial structure
zygote		

Honors Biology

The honors biology curriculum goes into more depth and a faster pace than the regular level biology. The honors biology student is expected to do more at home reading and course work. The lab experiments are done in class and students are required to do the lab write-ups and analysis questions at home. Students will complete labs with less teacher direction.

Here are some specific examples of extensions done in the Honors class:

1.	Ecology	Population Calculations and Energy Pyramid
2.	Eco Jar	Long term population studies project
3.	Microbiology	Antibiotic Resistance and Gene Expression Labs
4.	Science Process Skills	Photosynthesis, Cellular Respiration and Protein Synthesis—all of these are taught at a much deeper level.
5.	Cell Cycle	Cyclins and Kinases are added to enhance the understanding at the honors level.
6.	Genetics	Dihybrid Crosses, Hardy-Weinberg Population Studied, Population Genetics
7.	Biochemistry	Thermodynamics, Enzyme (Catalase Labs), and Macromolecules (adding unknown)

HIGH SCHOOL SCIENCE CURRICULUM

Chemistry

1-8 First Semester 9-14 Second Sem	**New 2012 Sequence**	**(former Instructional Sequence)**
Inquiry, Reflection, and Social Implications	**1**	1. TLW design and conduct valid experiments, draw conclusions, and evaluate all aspects of the process. (Instructional Sequence 1)
Forms of Energy	**3**	2. TLW describe the energy of electrons according to quantum theory and express the organization of the electron using electron configuration and kernel structures. (Instructional Sequence 3)
	14	3. TLW explain nuclear changes, their relationship to dating and conservation of matter and energy, and analyze concepts of nuclear chemistry as related to risk/benefit issues of industry, the environment, and society. (Instructional Sequence 4)
Energy Transfer and Conservation	**5**	4. TLW predict products, write balanced equations, and describe energy changes during chemical reactions. (Instructional Sequence 6)
	6	5. TLW measure, calculate, and diagram energy transfer for chemical reactions and relate entropy and enthalpy to determine the spontaneity of reactions. (Instructional Sequence 12)
Properties of Matter	**2**	6. TLW categorize elements of the periodic table and explain how elements, ions, and isotopes differ in atomic structure. (Instructional Sequence 2)
	4	7. TLW predict bonding between two atoms of different elements, name the binary compound and write its formula, classify bonds as ionic, covalent, or polar covalent; and explain intermolecular forces. (Instructional Sequence 5)
	7	8. TLW use stoichiometric methods to determine the relationships between atoms and molecules in elements, compounds and chemical reactions. (Instructional Sequence 7)
	8	9. TLW describe physical and chemical properties of matter and explain phase changes according to kinetic molecular theory. (Instructional Sequence 8)
	9	10. TLW use kinetic molecular theory to describe the behavior of gases. (Instructional Sequence 9)
Changes in Matter	**10**	11. TLW make and test solutions of various concentrations; determine the factors that affect solubility, reaction rates, and colligative properties; determine equilibrium; and apply LeChetelier's Principle to chemical systems. (Instructional Sequence 10)
	11	12. Using acid-base theory, TLW write equations for various acid-base reactions and determine the pH and concentration of various samples. (Instructional Sequence 11)
	12	13. TLW explain oxidation and reduction and identify examples and uses of oxidation-reduction reactions. (Instructional Sequence 13)
	13	14. TLW draw structural formulas and isomers for simple hydrocarbon chains and recognize biological polymers. (Instructional Sequence 14)

Inquiry, Reflection, and Social Implications

1. TLW design and conduct valid experiments, draw conclusions, and evaluate all aspects of the process.

Unit/Lesson

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What happens to substances during a chemical change?
- What is evidence of a chemical change?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- A chemical change does not always occur when substances are combined.
- Chemical changes occur when matter reacts and produces new substances; physical changes yield different forms of the same substance rather than a new substance.
- Every experiment provides useful results, whether or not the results match the hypothesis.
- Evidence of chemical change includes color change, gas formation, solid formation, and temperature change.
- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- Substances may be classified by their physical and/or chemical properties.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Forms of Energy

2. *TLW describe the energy of electrons according to quantum theory and express the organization of the electron using electron configuration and kernel structures.*

Unit/Lesson

RST 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts,

processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST 11-12.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Essential Questions

- How can an emission spectrum be used to identify an element?
- What accounts for a specific energy emission or absorption within atoms?

Key Concepts

- Individual elements have an emission spectrum that is always the same and that can be used to identify the element.
- The specific energy emission or absorption within atoms can be accounted for by electron transition within energy levels.

3. *TLW explain nuclear changes, their relationship to dating and conservation of matter and energy, and analyze concepts of nuclear chemistry as related to risk/benefit issues of industry, the environment, and society.*

Unit/Lesson

RST 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST 11-12.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

RST 11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

RST 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST 11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any

one source and following a standard format for citation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- What holds the nucleus together in atoms?
- Why is matter conserved in chemical reactions and not in nuclear reactions?

Key Concepts

- In all atoms, the nucleus is held together by a strong force.
- In nuclear reactions, matter is not conserved but stabilizes through the process of radioactive decay.

Energy Transfer and Conservation

4. TLW predict products, write balanced equations, and describe energy changes during chemical reactions.

Unit/Lesson

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How is matter conserved during a chemical reaction?
- What is the role of energy in chemical reactions?

Key Concepts

- Chemical reactions will either absorb or produce energy.
- Matter is not created nor destroyed in a chemical reaction.
- Matter undergoes physical and chemical changes; chemical changes produce new products, while physical changes do not produce new products.

5. *TLW measure, calculate, and diagram energy transfer for chemical reactions and relate entropy and enthalpy to determine the spontaneity of reactions.*

Unit/Lesson

RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
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WHST 11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How is energy involved in chemical reactions?

Key Concepts

- Heat is released or absorbed in chemical reactions and is proportional to the amounts of reactants consumed.

- Some chemical reactions are reversible and involve the same amount of energy regardless of the direction of the reaction.

Properties of Matter

6. TLW categorize elements of the periodic table and explain how elements, ions, and isotopes differ in atomic structure.

Unit/Lesson

RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
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Essential Questions

- What are elements and how does the structure of atoms determine the classification and reactions of elements?
- What is the relationship between atoms, ions, and isotopes?
- Why is matter conserved in chemical reactions and not in nuclear reactions?

Key Concepts

- An element is determined by the number of protons in its nucleus.
- Elements consist of atoms, which may occur in other forms called ions and isotopes.
- In nuclear reaction, mater is not conserved but stabilizes through the process of radioactive decay.

- Ions have an unequal number of protons and electrons, while the isotopes of a given element have different numbers of neutrons.
- The periodic table categorizes elements based on their atomic structure.

7. *TLW predict bonding between two atoms of different elements, name the binary compound and write its formula, classify bonds as ionic, covalent, or polar covalent; and explain intermolecular forces.*

Unit/Lesson

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How are compounds named?
- What are the differences between elements, mixtures, and compounds?
- What are the differences between ionic and covalent bonds?

Key Concepts

- Atoms and molecules are respectively the smallest components of elements and compounds.
- Compounds are named according to the elements of which they are comprised.
- Elements are pure substances, compounds are chemically combined, and mixtures can be separated into their component parts.
- When two elements combine, the bonds between the atoms are ionic or covalent.

8. TLW use stoichiometric methods to determine the relationships between atoms and molecules in elements, compounds and chemical reactions.

Unit/Lesson

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	WHST 11-12.4

Essential Questions

- Given the mass of the reactant(s), how can the mass of the product(s) be determined?
- How can the amount of a substance be changed from moles to grams or to representative particles?
- How is the percent composition of an unknown substance determined?

Key Concepts

- The composition of an unknown substance can be determined.
- The mass of the reactants in a chemical reaction can be used to determine the mass of the products.
- The quantity of a substance in a reaction can be used to determine the quantity of another substance in the reaction.

9. *TLW describe physical and chemical properties of matter and explain phase changes according to kinetic molecular theory.*

Unit/Lesson

RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
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WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How is heat energy transferred from one substance to another?
- What happens to energy as a substance changes from one phase to another?
- What happens to the molecules of a substance as the substance is heated?
- What is the difference between boiling and evaporation?
- What is the difference between heat and temperature?

Key Concepts

- Boiling and evaporation are not the same.
- Energy is absorbed or released as a substance changes from one phase to another.
- Energy may be transferred from one object to another.
- Heat and temperature are not the same.
- Heating is the transfer of energy from one substance to another. As temperature increases, average kinetic energy increases.
- Molecules that comprise matter are constantly in motion.

10. TLW use kinetic molecular theory to describe the behavior of gases.

Unit/Lesson

RST 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

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c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
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e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

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b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as

well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Essential Questions

- How can pressure, volume, and temperature relationships be illustrated?

Key Concepts

- Pressure, volume, and temperature relationships can be predicted by models, mathematical equations, and graphs.

Changes in Matter

11. TLW make and test solutions of various concentrations; determine the factors that affect solubility, reaction rates, and colligative properties; determine equilibrium; and apply LeChetelier's Principle to chemical systems.

Unit/Lesson

RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
RST 11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST 11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.
RST 11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information
RST 11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST 11-12.1	Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between

claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How do changing conditions affect the equilibrium of a chemical system?
- How does the concentration of a solution affect the rate of chemical reactions?

Key Concepts

- Changing conditions will cause shifts in the equilibrium of a chemical system.
- In a closed system, many reactions reach equilibrium.
- The concentration of a solution affects the reaction rate of chemical reactions.

12. Using acid-base theory, TLW write equations for various acid-base reactions and determine the pH and concentration of various samples.

Unit/Lesson

RST 9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions

defined in the text.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

RST 9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST 9-10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
WHST 9-10.6	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
WHST 11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
WHST 11-12.9	Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How can acids be distinguished from bases?

Key Concepts

- Chemical reactions that occur in nature and through human activity impact the environment.
- Matter can be classified by its properties as acid, base, or neutral.
- What are the economic and aesthetic impacts of acid rain?

13. TLW explain oxidation and reduction and identify examples and uses of oxidation-reduction reactions.

Unit/Lesson

RST 9-10.2	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.
RST 9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
RST 9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
RST 9-10.5	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
RST 9-10.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
RST 11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information
WHST 9-10.1	Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Essential Questions

- How do humans use the release of energy in redox reactions?

Key Concepts

- Humans use redox reactions in industry and to supply energy.
- Many oxidation-reduction reactions are a source of energy.

14. TLW draw structural formulas and isomers for simple hydrocarbon chains and recognize biological polymers.

Unit/Lesson

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

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c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

Essential Questions

- What are examples of groups of organic compounds?
- What are the uses of organic compounds?
- Why are organic compounds important? How do organic compounds vary?
- Why is organic chemistry important?

Key Concepts

- Carbon atoms can bond to one another and to other key elements in chains, rings, and branching networks to make a variety of structures, making the most numerous compounds in the world.
- Organic chemicals are essential for human existence.
- Organic compounds are important because they are the basis for life.

Science Vocabulary as first introduced in Chemistry

absorption spectrum	acid	acid-base reaction
acidic	activation energy	actual yield
alkali metal	alkaline	alkaline-earth metal
alkane	alkene	alkyne
ampde	aqueous (aq)	atmosphere (atm)
atomic mass	atomic mass unit (amu)	atomic motion
atomic number	atomic radius	atomic structure
atomic theory	atomic weight	Avogadro's hypothesis
Avogadro's number	Avogadro's Principle	balanced equation
base	basic	binary compound
Bohr	bond energy	branching network of carbon atoms
bright-line spectrum	Bronsted-Lowry	calorie
carbon	carbon bonds	carbon chain
carbon chemistry	carbon ring	carboxyl group
cathode	charged object	chemical bond
coefficient	colligative properties	combustion
concentration	covalent bond	crystalline solid
decay rate	decomposition reaction	delta (change)
dependent variable	dissolving mechanism	distillation
double bond	double displacement reaction	ductile
electrically neutral	electrochemical cell	electromagnetic field
electromagnetic wave	electron cloud	electron configuration
electron sharing	electron transfer	electronegativity
elementary particle	emission spectrum	empirical formula
endothermic reaction	energy level	enthalpy
entropy	equilibrium	excess reagent
excited state	exothermic reaction	factor-label method
family (group) of elements	first ionization energy	fission
flame test	formula	formula unit
gas law	Gibb's Free Energy	ground state
half-life	halogen	heat of solution
Hess's Law	hydrion paper	hydrocarbon
hydrogen ion	hydronium ion	hydroxide
Ideal Gas Law	independent variable	inert gas
intermolecular	ion	ionic bond
ionic motion	ionization	isomer
isotope	joule	Kelvin temperature scale
kernel	kernel structure	kilopascal (kPa)
kinetic molecular theory	Law of Conservation of Mass	Le Chatelier's Principle
Lewis dot structure	limiting reagent	malleable
mass number	mass-mass	Mendeleev
metalloid	molar mass	molar volume
molar volume at STP	molarity	mole

mole concept	mole ratio	mole-mass
mole-mole	molecular formula	monomer
Mosely	neutral	neutralization
neutralize	neutron mass to energy conversion	noble gas
nuclar (U-235 energy	nuclear chemistry	nuclear equation
orbital	organic compound	oxidation
oxidation number	oxidation-reduction reaction	p orbital
percent composition	percent yield	periodicity
pH	phase	polarity
polyatomic	polymer	probability
quantum energy	quantum mechanics	quantum numbers
quantum theory	radioactive dating	radioactive decay
radioactive element	radioactive isotope	radioactive substance
reaction rate	reagent	reduction
relative abundance	relative energy	release of energy
representative particle	rotational motion	s orbital
salt	saturation	scientific experiment
scientific method	semiconductor	shell (of an atom)
single displacement reaction	solubility	solvent
specific heat	stable isotope	standard temperature and pressure (STP)
stoichiometry	structural formula	subatomic particle
sublevel	subscript	symbol
synthesis reaction	synthetic polymer	theorectical yield
thermal contraction	thermal expansion	titration
translational motion	unreactive	unsaturated
unstable isotope	valence	valence electron
vapor pressure	vaporization	vibrational motion
wave amplitude		

Inquiry, Reflection, and Social Implications

1. TLW design and conduct valid experiments, draw conclusions, and evaluate all aspects of the process.

Unit/Lesson

C1.1B	Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
C1.1C	Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
C1.2B	Identify and critique arguments about personal or societal issues based on scientific evidence.
C1.2j	Apply science principles or scientific data to anticipate effects of technological design decisions.
C1.2k	Analyze how science and society interact from a historical, political, economic, or social perspective.
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
RST 11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
WHST 11-12.1	Write arguments focused on *discipline-specific content.* a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
WHST 11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 11-12.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How can substances be classified?
- How does science help us answer questions about the world around us?
- What does it mean to question?
- What happens to substances during a chemical change?
- What is evidence of a chemical change?
- What is scientific inquiry?
- Why do scientists conduct investigations?

Key Concepts

- A chemical change does not always occur when substances are combined.
- Chemical changes occur when matter reacts and produces new substances; physical changes yield different forms of the same substance rather than a new substance.
- Every experiment provides useful results, whether or not the results match the hypothesis.
- Evidence of chemical change includes color change, gas formation, solid formation, and temperature change.

- Scientific investigations follow processes that require systematic and logical development, observation, and careful analysis.
- Scientific investigations generally lead to new questions.
- Substances may be classified by their physical and/or chemical properties.
- The foundation of scientific theory is replicable investigations.
- Through repeated inquiry, patterns emerge and theories are proposed.

Forms of Energy

2. *TLW describe the energy of electrons according to quantum theory and express the organization of the electron using electron configuration and kernel structures.*

Unit/Lesson

C4.8i	Describe the fact that the electron location cannot be exactly determined at any given time.
C1.1D	Identify patterns in data and relate them to theoretical models.
C4.9c	Predict general trends in atomic radius, first ionization energy, and electonegativity of the elements using the periodic table.
RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
RST 11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST 11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
RST 11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information
WHST 11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Essential Questions

- How can an emission spectrum be used to identify an element?
- What accounts for a specific energy emission or absorption within atoms?

Key Concepts

- Individual elements have an emission spectrum that is always the same and that can be used to identify the element.
- The specific energy emission or absorption within atoms can be accounted for by electron transition within energy levels.

3. *TLW explain nuclear changes, their relationship to dating and conservation of matter and energy, and analyze concepts of nuclear chemistry as related to risk/benefit issues of industry, the environment, and society.*

		Unit/Lesson
C3.5a	Explain why matter is not conserved in nuclear reactions.	
C2.r5c	Describe the potential energy changes as two protons approach each other. (recommended)	
RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.	
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.	
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.	
RST 11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.	
RST 11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.	
RST 11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.	
RST 11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information	
RST 11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.	
WHST 11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.	

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

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WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- What holds the nucleus together in atoms?
- Why is matter conserved in chemical reactions and not in nuclear reactions?

Key Concepts

- In all atoms, the nucleus is held together by a strong force.
- In nuclear reactions, matter is not conserved but stabilizes through the process of radioactive decay.

Energy Transfer and Conservation

4. TLW predict products, write balanced equations, and describe energy changes during chemical reactions.

Unit/Lesson

C5.2A Balance simple chemical equations applying the conservation of matter.

C5.6b Predict single replacement reactions.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create

an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How is matter conserved during a chemical reaction?
- What is the role of energy in chemical reactions?

Key Concepts

- Chemical reactions will either absorb or produce energy.
- Matter is not created nor destroyed in a chemical reaction.
- Matter undergoes physical and chemical changes; chemical changes produce new products, while physical changes do not produce new products.

5. *TLW measure, calculate, and diagram energy transfer for chemical reactions and relate entropy and enthalpy to determine the spontaneity of reactions.*

Unit/Lesson

C3.4e Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$ (Note: mathematical computation of ΔG is not required.)

C3.4f Explain why some endothermic reactions are spontaneous at room temperature.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations)

into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How is energy involved in chemical reactions?

Key Concepts

- Heat is released or absorbed in chemical reactions and is proportional to the amounts of reactants consumed.
- Some chemical reactions are reversible and involve the same amount of energy regardless of the direction of the reaction.

Properties of Matter

6. TLW categorize elements of the periodic table and explain how elements, ions, and isotopes differ in atomic structure.

Unit/Lesson

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

RST 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
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c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

Essential Questions

- What are elements and how does the structure of atoms determine the classification and reactions of elements?
- What is the relationship between atoms, ions, and isotopes?
- Why is matter conserved in chemical reactions and not in nuclear reactions?

Key Concepts

- An element is determined by the number of protons in its nucleus.
- Elements consist of atoms, which may occur in other forms called ions and isotopes.
- In nuclear reaction, mater is not conserved but stabilizes through the process of radioactive decay.
- Ions have an unequal number of protons and electrons, while the isotopes of a given element have different numbers of neutrons.
- The periodic table categorizes elements based on their atomic structure.

7. *TLW predict bonding between two atoms of different elements, name the binary compound and write its formula, classify bonds as ionic, covalent, or polar covalent; and explain intermolecular forces.*

Unit/Lesson

C4.3h Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding.

C4.3d Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)

C4.3f Identify the elements necessary for hydrogen bonding (N, O, F).

C4.3g Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).

C4.4b Identify if a molecule is polar or nonpolar given a structural formula for the compound.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on

explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.5 Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST 11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.

RST 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry

when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How are compounds named?
- What are the differences between elements, mixtures, and compounds?
- What are the differences between ionic and covalent bonds?

Key Concepts

- Atoms and molecules are respectively the smallest components of elements and compounds.
- Compounds are named according to the elements of which they are comprised.
- Elements are pure substances, compounds are chemically combined, and mixtures can be separated into their component parts.
- When two elements combine, the bonds between the atoms are ionic or covalent.

8. *TLW use stoichiometric methods to determine the relationships between atoms and molecules in elements, compounds and chemical reactions.*

Unit/Lesson

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Essential Questions

- Given the mass of the reactant(s), how can the mass of the product(s) be determined?
- How can the amount of a substance be changed from moles to grams or to representative particles?
- How is the percent composition of an unknown substance determined?

Key Concepts

- The composition of an unknown substance can be determined.
- The mass of the reactants in a chemical reaction can be used to determine the mass of the products.
- The quantity of a substance in a reaction can be used to determine the quantity of another substance in the reaction.

9. *TLW describe physical and chemical properties of matter and explain phase changes according to kinetic molecular theory.*

Unit/Lesson

C5.4B	Measure, plot, and interpret the graph of the temperature versus time of an ice-water mixture, under slow heating, through melting and boiling.
RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.
RST 11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
RST 11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
WHST 11-12.1	Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How is heat energy transferred from one substance to another?
- What happens to energy as a substance changes from one phase to another?
- What happens to the molecules of a substance as the substance is heated?
- What is the difference between boiling and evaporation?
- What is the difference between heat and temperature?

Key Concepts

- Boiling and evaporation are not the same.
- Energy is absorbed or released as a substance changes from one phase to another.
- Energy may be transferred from one object to another.
- Heat and temperature are not the same.
- Heating is the transfer of energy from one substance to another. As temperature increases, average kinetic energy increases.
- Molecules that comprise matter are constantly in motion.

10. TLW use kinetic molecular theory to describe the behavior of gases.

Unit/Lesson

C4.5a Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.

C4.5b Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.

C4.5c Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.

RST 11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.

RST 11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

RST 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.

RST 11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

WHST 11-12.1 Write arguments focused on *discipline-specific content.*

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
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d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as

well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Essential Questions

- How can pressure, volume, and temperature relationships be illustrated?

Key Concepts

- Pressure, volume, and temperature relationships can be predicted by models, mathematical equations, and graphs.

Changes in Matter

11. TLW make and test solutions of various concentrations; determine the factors that affect solubility, reaction rates, and colligative properties; determine equilibrium; and apply LeChetelier's Principle to chemical systems.

		Unit/Lesson
C4.7a	Investigate the difference in the boiling point or freezing point of pure water and a salt solution.	
C5.r1a	Predict how the rate of a chemical reaction will be influenced by changes in concentration, temperature, and pressure. (recommended)	
C5.r1b	Explain how the rate of a reaction will depend on concentration, temperature, pressure, and, nature of reactant. *(recommended)*	
RST 11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and t any gaps or inconsistencies in the account.	
RST 11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	
RST 11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.	
RST 11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.	
RST 11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.	
RST 11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative date, video, multimedia) in order to address a question or solve a problem.	
RST 11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information	
RST 11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.	
WHST 11-12.1	Write arguments focused on *discipline-specific content.* a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.	

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 11-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.

e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST 11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Essential Questions

- How do changing conditions affect the equilibrium of a chemical system?
- How does the concentration of a solution affect the rate of chemical reactions?

Key Concepts

- Changing conditions will cause shifts in the equilibrium of a chemical system.
- In a closed system, many reactions reach equilibrium.
- The concentration of a solution affects the reaction rate of chemical reactions.

12. Using acid-base theory, TLW write equations for various acid-base reactions and determine the pH and concentration of various samples.

Unit/Lesson

C5.7g	Calculate the pH from the hydronium ion or hydroxide ion concentration.
C5.r7i	Identify the Bronsted-Lowry conjugate acid-base pairs in an equation. (recommended)
RST 9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
RST 9-10.2	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.
RST 9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
RST 9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.
RST 9-10.5	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
RST 9-10.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
RST 9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST 9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
WHST 9-10.1	Write arguments focused on *discipline-specific content*. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
WHST 9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples

appropriate to the audience's knowledge of the topic.

c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.

d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST 9-10.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST 9-10.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

WHST 11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST 11-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

Essential Questions

- How can acids be distinguished from bases?

Key Concepts

- Chemical reactions that occur in nature and through human activity impact the environment.
- Matter can be classified by its properties as acid, base, or neutral.
- What are the economic and aesthetic impacts of acid rain?

13. TLW explain oxidation and reduction and identify examples and uses of oxidation-reduction reactions.

Unit/Lesson

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

RST 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics*.

RST 9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).

RST 9-10.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

RST 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information

WHST 9-10.1 Write arguments focused on *discipline-specific content*.

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e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST 9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Essential Questions

- How do humans use the release of energy in redox reactions?

Key Concepts

- Humans use redox reactions in industry and to supply energy.
- Many oxidation-reduction reactions are a source of energy.

14. TLW draw structural formulas and isomers for simple hydrocarbon chains and recognize biological polymers.

Unit/Lesson

C5.8C Recognize that proteins, starches, and other large biological molecules are polymers.

RST 9-10.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the ext.

RST 9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

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d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from or supports the argument presented.

Essential Questions

- What are examples of groups of organic compounds?
- What are the uses of organic compounds?
- Why are organic compounds important? How do organic compounds vary?
- Why is organic chemistry important?

Key Concepts

- Carbon atoms can bond to one another and to other key elements in chains, rings, and branching networks to make a variety of structures, making the most numerous compounds in the world.
- Organic chemicals are essential for human existence.
- Organic compounds are important because they are the basis for life.

Science Vocabulary as first introduced in Chemistry

absorption spectrum	acid	acid-base reaction
acidic	activation energy	actual yield
alkali metal	alkaline	alkaline-earth metal
alkane	alkene	alkyne
ampde	aqueous (aq)	atmosphere (atm)
atomic mass	atomic mass unit (amu)	atomic motion
atomic number	atomic radius	atomic structure
atomic theory	atomic weight	Avogadro's hypothesis
Avogadro's number	Avogadro's Principle	balanced equation
base	basic	binary compound
Bohr	bond energy	branching network of carbon atoms
bright-line spectrum	Bronsted-Lowry	calorie
carbon	carbon bonds	carbon chain
carbon chemistry	carbon ring	carboxyl group
cathode	charged object	chemical bond
coefficient	colligative properties	combustion
concentration	covalent bond	crystalline solid
decay rate	decomposition reaction	delta (change)
dependent variable	dissolving mechanism	distillation
double bond	double displacement reaction	ductile
electrically neutral	electrochemical cell	electromagnetic field
electromagnetic wave	electron cloud	electron configuration
electron sharing	electron transfer	electronegativity
elementary particle	emission spectrum	empirical formula
endothermic reaction	energy level	enthalpy
entropy	equilibrium	excess reagent
excited state	exothermic reaction	factor-label method
family (group) of elements	first ionization energy	fission
flame test	formula	formula unit

gas law	Gibb's Free Energy	ground state
half-life	halogen	heat of solution
Hess's Law	hydrion paper	hydrocarbon
hydrogen ion	hydronium ion	hydroxide
Ideal Gas Law	independent variable	inert gas
intermolecular	ion	ionic bond
ionic motion	ionization	isomer
isotope	joule	Kelvin temperature scale
kernel	kernel structure	kilopascal (kPa)
kinetic molecular theory	Law of Conservation of Mass	Le Chatelier's Principle
Lewis dot structure	limiting reagent	malleable
mass number	mass-mass	Mendeleev
metalloid	molar mass	molar volume
molar volume at STP	molarity	mole
mole concept	mole ratio	mole-mass
mole-mole	molecular formula	monomer
Mosely	neutral	neutralization
neutralize	neutron mass to energy conversion	noble gas
nuclar (U-235 energy	nuclear chemistry	nuclear equation
orbital	organic compound	oxidation
oxidation number	oxidation-reduction reaction	p orbital
percent composition	percent yield	periodicity
pH	phase	polarity
polyatomic	polymer	probability
quantum energy	quantum mechanics	quantum numbers
quantum theory	radioactive dating	radioactive decay
radioactive element	radioactive isotope	radioactive substance
reaction rate	reagent	reduction
relative abundance	relative energy	release of energy
representative particle	rotational motion	s orbital
salt	saturation	scientific experiment
scientific method	semiconductor	shell (of an atom)
single displacement reaction	solubility	solvent
specific heat	stable isotope	standard temperature and pressure (STP)
stoichiometry	structural formula	subatomic particle
sublevel	subscript	symbol
synthesis reaction	synthetic polymer	theorectical yield
thermal contraction	thermal expansion	titration
translational motion	unreactive	unsaturated
unstable isotope	valence	valence electron
vapor pressure	vaporization	vibrational motion
wave amplitude		

HIGH SCHOOL SCIENCE CURRICULUM

Anatomy & Physiology

Body Plan & Organization

1. TLW understand anatomical position as it pertains to directional terms, planes, and sections.
2. TLW be able to identify the body cavities and regions of the human body.
3. TLW understand how the human body is organized leading to a survey of the body systems.

Homeostasis

4. TLW understand the general types of homeostatic mechanisms and know example of each.
5. TLW will be able to predict changes that will occur in order to maintain homeostasis of various systems.

Chemistry & Biology Review

6. TLW have a basic understanding of the composition of matter as it pertains to atoms and how they are put together.
7. TLW will have knowledge of the four basic organic macromolecules including how they are structured and used.
8. TLW review the structure and function of various organelles especially those that pertain to protein synthesis and cellular respiration.
9. TLW know the structure of the cell membrane and understand the various ways in which cells transport materials through it.
10. TLW know the differences between mitosis and meiosis as well as understand why those differences exist.

Histology

11. TLW know the types of epithelial tissue, how they are classified, and the functions of each.
12. TLW the types of connective tissue and how the different types are classified based on structure and function.
13. TLW know the three types of muscle tissue, the structure of each, and how their functions varying according to structure.
14. TLW identify the structurally differences of nervous tissue as it pertains to function of message conduction.
15. TLW compare the structure and function of various membranes located throughout the body.
16. TLW will understand the differences in structure and function of exocrine and endocrine glands, and be able to recognize examples as being one of the two types.

Integumentary System

17. TLW understand how the epidermis is structured in accordance with its function specifically as it relates to skin color and protection.
18. TLW understand how the structure of these layers relates to their function, and know how they work in conjunction with the epidermis.
19. TLW identify the accessory structures of the skin and understand how they contribute to the overall functions of the integumentary system.
20. TLW understand how the structures of the integumentary system coordinate with each other as well as other systems in order to maintain homeostasis.

Skeletal System

21. TLW understand the overlying functions of the skeletal system as well as how individual bones contribute.
22. TLW know gross and microscopic anatomy of bones as it relates to their function including the different shapes (long, short, flat, irregular) and types (compact and spongy).
23. TLW be able to compare and contrast the types of bone growth in terms how and when they occur.
24. TLW know how the skeletal system is divided (axial and appendicular) and the names of the bones.
25. TLW know how articulations are classified both structurally and functionally.
26. TLW be able to identify both the structures and functions of the various synovial joints.

Muscular System

27. TLW understand the general functions of the muscular system as well as specific functions of cardiac, skeletal, and smooth muscle.
28. TLW know the detailed structure of skeletal muscle cells as it relates to the function of contraction.

29. TLW identify the microscopic structures responsible for muscle contraction and understand how they interact in order to shorten the muscle.
30. TLW know the sources of energy for muscle contraction and how changes in conditions can affect the contraction cycle.
31. TLW understand the different types of muscle contraction as it relates to the varying function and performance of skeletal muscles.
32. TLW know the general structure of skeletal muscles and understand how different skeletal muscles are named.
33. TLW be able to identify muscles according to their location and movement produced.

Nervous System

34. TLW understand the general functions of the nervous system and its importance in overall body function.
35. TLW know the different branches of the nervous system and what the responsibility is of each.
36. TLW identify the different types of nervous tissue (neurons and neuroglial) and how they are structurally and functionally different.
37. TLW understand resting membrane potential and how it allows the propagation of an action potential in myelinated and unmyelinated axons.
38. TLW understand the role of various neurotransmitters in communicating between neurons across a synaptic cleft.
39. TLW know the structure and function of the various anatomy protecting the brain and spinal cord.
40. TLW know the anatomy of the spinal cord and how it relates to its function in movement and reflexes.
41. TLW know the divisions and functions of component parts of the brain.

Special Senses

42. TLW know the types, locations, and functions of the sensory receptors in the human body.
43. TLW will know the gross and microscopic structures of the human eye.
44. TLW understand the role of specific tissues in the eye and how changes in these tissues affect vision.
45. TLW will be able to compare and contrast the reception of scent and taste based on structural and functional differences.
46. TLW be able to identify the gross and microscopic hearing/accessory structures of the ear.
47. TLW be able connect structural components of the ear with the functional roles in both hearing and maintaining equilibrium.

Endocrine System

48. TLW will understand the general functions of the endocrine system especially in maintaining homeostasis.
49. TLW know the identity, source, secretory control, functional roles, and chemical classification of the major hormones produced by the body.
50. TLW understand the role of the hypothalamus and pituitary gland in control of hormonal secretion.

Cardiovascular System

51. TLW identify and understand the major functions of the cardivascular system.
52. TLW know the identity, microscopic anatomy, quantity, source, and functional role of the various blood components (plasma and formed elements).
53. TLW know the physiology of ABO and Rh blood typing and its importance in medicine.
54. TLW know the gross and microscopic anatomy of the human heart and how it develops.
55. TLW know the mechanism of cardiac muscle contraction and be able to compare it to the mechanism of skeletal muscle contraction
56. TLW be able to trace the pattern of blood flow through chambers of the heart as well as throughout the body, including systemic, pulmonary, coronary, hepatic portal, & fetal circulations.
57. TLW be able to compare/contrast the structure and function of different types of blood vessels.
58. TLW understand blood pressure and its functional interrelationships with cardiac output, peripheral resistance, & hemodynamics.

Digestive System

59. TLW know and understand the general functions of the digestive system.
60. TLW know the gross and microscopic anatomy of the GI tract and accessory structures of digestion.
61. TLW know the different mechanical and chemical processes of digestion and how these processes vary depending on the type of food.

62. TLW know how digestion is regulated both hormonally and neurally.
63. TLW understand the process of cellular respiration and how it relates to the catabolism/anabolism of carbohydrates, proteins, and lipids.
64. TLW understand the interrelatedness of cellular metabolism, energy balance, nutrition as it pertains to specific anatomy including the liver, adipose tissue, and skeletal muscle.

Urinary System

65. TLW understand the general functions of the urinary system as well as its interrelatedness with other systems.
66. TLW know both gross and microscopic anatomy of the urinary system including detailed histology of the nephon.
67. TLW understand the functional processes of urine formation, including filtration, reabsorption, secretion, & excretion as well as factors regulating urine volume and composition.
68. TLW understand the innervation and control of the urinary bladder.

Respiratory System

69. TLW understand the general functions of the respiratory system and its interrelatedness to other systems.
70. TLW will identify the structure and function of gross & microscopic anatomy of the respiratory tract & related organs.
71. TLW know the mechanisms of pulmonary ventilation and how they are controlled.
72. TLW understand the mechanisms of gas exchange in both the lungs and tissues as well as the mechanisms of transport in blood between the two.

HIGH SCHOOL SCIENCE CURRICULUM

Forensic Science & Genetics

Criminalistics and Crime Scene

1. TLW define the scope of forensic science.
2. TLW detail the history and development of forensic science.
3. TLW discuss the organizations of a crime laboratory and explain the functions it serves.
4. TLW list and discuss the ways in which a forensic scientist processes a crime scene.
5. TLW identify the legal considerations which must be considered at a crime scene.

Physical Evidence and Properties

6. TLW list, explain and give examples of the most common types of physical evidence.
7. TLW discuss the importance of glass fragments and fractures in a criminal investigation.
8. TLW explain the forensic characteristics of soil and how it can be applied to a criminal case.
9. TLW discuss the proper means for collecting and preserving soil evidence.

Glass and Soil

10. TLW explain how a forensic scientist determines the densities of small glass fragments by floatation.
11. TLW detail the forensic characteristics of soil and how it can be applied to a criminal case.

Organic and Inorganic Analysis

12. TLW list and discuss the generalized characteristics of elements and compounds.
13. TLW outline a process for selecting an analytical technique for identifying elements and compounds on evidence left at a crime scene.
14. TLW classify and use the limitations of chromatography, spectrophotometry, and X-ray diffraction.
15. TLW explain what electrophoresis is and what kind of evidence it can test.

Hair, Fibers, and Paint

16. TLW list and discuss the general morphology of hair.
17. TLW identify and compare hair fibers of animal and plant sources.
18. TLW outline a systematic procedure for collection and identification OF hair evidence.
19. TLW list the major types of fibers and key characteristics of each.
20. TLW identify and compare the major types of man-made fibers.
21. TLW discuss how to examine paint using microscopy and chemical analysis.
22. TLW list how to collect and preserve paint evidence.

Fingerprints

23. TLW outline the history of fingerprinting in criminal investigations.
24. TLW discuss the fundamental principles of fingerprinting.
25. TLW explain how to classify the four types of fingerprints, using the basic characteristics of each.
26. TLW discuss how to preserve developed prints.

Firearms, Tool Marks, and Impressions

27. TLW classify cartridge cases, gunpowder residues, and bullets.
28. TLW discuss key characteristics of tool marks and give a brief description what they would look like.
29. TLW classify other marks often found at the scene of a crime.

Document Examination

30. TLW list and discuss the criteria used for handwriting comparisons.
31. TLW collect various exemplary of handwriting.
32. TLW discuss the differences noted in typewriting comparisons.
33. TLW identify alterations, erasures, and obliterations to documents.
34. TLW identify document-processing problems, which occur frequently.

Forensic Toxicology

35. TLW identify the role of a toxicologist.
36. TLW describe the techniques a toxicologist would use to identify drugs.
37. TLW discuss how to preserve drug evidence.
38. TLW describe the structure and function of DNA.
39. TLW explain the process of DNA typing and how splicing and cutting DNA enhances this process.

Genetic History

40. TLW understand the history behind the different branches of genetics.
41. TLW discuss the basic Mendalian inheritance principles.
42. TLW learn how to solve a problem using a chi square analysis.
43. TLW research a genetic disease and include the karyotypes, pedigrees, and societal implications.
44. TLW explore the bioethics of cloning and genetics.

HIGH SCHOOL SCIENCE CURRICULUM

Advanced Placement Physics

I. Newtonian Mechanics

A. Measurement, Uncertainty and Experimental Error

B. Kinematics

1. Motion in one dimension and falling bodies
2. Motion in two dimensions:
   a. Vectors
   b. Projectile Motion

C. Newton's Laws of Motion

1. One dimensional dynamics
2. Two dimensional dynamics

D. Circular Motion; Gravitation

1. Uniform circular motion
2. Torque and rotational statics
3. Law of universal gravitation
4. Circular orbits

E. Work, Energy & Power

1. Work and the work-energy theorem
2. Forces and potential energy
3. Conservative and non-conservative forces; Energy conservation
4. Power
5. Mechanical equivalent of heat; Transfer of heat

F. Linear Momentum

1. Momentum and forces
2. Conservation of momentum
3. Elastic and inelastic collisions
4. Center of mass

G. Waves, Oscillations and Simple Harmonic Motion ("SHM")

1. The unit circle, period, and the sinusoidal nature of SHM
2. Energy and SHM
3. Dynamics of SHM

H. Waves

1. Types of waves
2. Properties of waves: interference, reflection, refraction, and diffraction
3. Doppler effect
4. Pitch, color, and sound quality

II. Thermal Physics and Fluids

A. Fluid Mechanics

1. Pressure in fluids
2. Buoyancy
3. Continuity and Bernoulli's equation
4. Applications of Bernoulli's Principle and Torricelli

B. Kinetic Theory and Thermodynamics

1. Ideal gasses
2. First law of thermodynamics
3. pV diagrams
4. Second law and heat engines

III. Electricity and Magnetism

A. **Electric Charge and Electric Field**

1. Static electricity and charge
2. Coulomb's law

3. Solving Coulomb's law problems using vectors
4. The electric field
5. Electric field lines

B. The Electric Potential

1. Electric potential and potential energy
2. Equipotential lines
3. Capacitance and capacitors
4. Dielectrics
5. The electron volt

C. Electric Circuits

1. Batteries
2. Current, resistance, power
3. AC and DC current

D. DC Circuits

1. EMF and terminal voltage
2. Resistors in series and parallel
3. Kirchoff's Rules
4. Circuits with capacitors

E. Magnetism

1. Magnets, domains, Curie Temperature
2. Forces on moving charges and current carrying wires
3. Fields of long straight wires
4. Solving magnetic field problems with vectors
5. The Mass Spectrometer

F. Electromagnetism

1. Faraday's Law of Induction
2. Lenz's Law
3. Transformers and transmission of power

IV. Waves and Optics

A. Physical Optics

1. Wave nature of light: waves versus particles
2. Interference of light
3. Diffraction and double slit experiments
4. Diffraction by a single slit
5. Diffraction gratings
6. Thin films
7. Polarization

B. Geometric Optics

1. Plane and spherical mirrors
2. Index of refraction
3. Snell's Law and total internal refraction
4. Thin lenses
5. Lens maker's equation and magnification

V. Modern Physics

A. Atomic Physics and Quantum Effects

1. Planck's quantum hypothesis & black body radiation
2. Photon theory of light and the Photoelectric effect
3. Photon interactions; Pair production
4. Wave particle duality & wave nature of matter
5. The Bohr Model and atomic spectra
6. Wave function and the double slit experiments

B. Nuclear Physics and Nuclear Reactions

1. Common nuclear reactions: Alpha, beta, and gamma decay
2. Fission and fusion

3. Mass defect and energy
4. Binding energy
5. Half-lives

C. Special Relativity

1. Time dilation
2. Mass and energy
3. Momentum
4. Relativistic addition of velocities

LAB LIST

Lab Title	Content Area	Objective or Description
Measurement of length	General Lab	The objective is to use different tools to measure length, to convert between systems of measurement and reconcile experimental errors.
Velocity and Acceleration	Mechanics	The objective is to measure the acceleration and final velocity of an object on an air track.
Measurement of g	Mechanics	The objective of is to design and conduct an experiment to measure g.
Projectiles	Mechanics	Using initial velocity and angle, students predict and measure the distance, time of flight and final velocity of a projectile.
Newton's Second Law	Mechanics	The objective is to design an experiment and test F = ma using an air track.
Potential and kinetic energy	Mechanics	The objective is to investigate the relationship between PE and KE
Coefficient of Friction	Mechanics	The objective is to measure the coefficient of friction between a car tire and road.
Inertial Balance	Mechanics	The objective is to use an inertial balance to determine the mass of an unknown object.
Pendulum	Mechanics	The objective is to investigate the behavior of pendulums.
Hooke's law	Mechanics	The objective is to design and conduct an experiment to determine the spring constant of an unknown spring.
Measurement of Static Charge	Electricity and Magnetism	The objective is to design and conduct an experiment to determine the charge deposited on two identical pith balls suspended from a thread.
RC Circuits	Electricity and Magnetism	The objective is to predict and measure the time constant of an RC circuit.
Kirchoff's Rules / Complex Circuits	Electricity and Magnetism	The objective is to construct complex circuits, predict and test the current flowing through various resistors in the circuit.
Tangent Galvanometer	Electricity and Magnetism	The objective is to use the tangent galvanometer to measure the strength of the earth's magnetic field.
Refraction	Waves and Optics	The objective is to measure the index of refraction of lucite and investigate the refraction of light in a prism.
Wave Properties: Diffraction	Waves and Optics	The objective is to investigate diffraction using a ripple tank, laser and speakers.
Wavelength of Light	Waves and Optics	The objective is to use a laser and diffraction grating to measure the wavelength of light produced by the laser.
Half Life of an Isotope	Modern Physics	The objective is to measure the half life of a radioactive isotope and to compare the decay curve of the isotope to the curve predicted by a classroom simulation.

HIGH SCHOOL SCIENCE CURRICULUM

Advanced Placement Biology

Concepts and Topics	Labs and Activities* (Descriptions in addendum)
Biology Themes and Chemistry of Life • Atoms • Bonding • Functional groups • Carbon compounds • Enzymes, levels of structure • Water, hydrogen bonding • Macromolecules • Lipids • Carbohydrates • Proteins • Nucleic Acids	1. Morgan Lab 1 – Scientific Investigations 2. Properties of Water Investigations 3. AP Lab 2 – Enzyme lab 4. Models of organic molecules
Plant and Animal cells • Cell organelles – structure and function • Nucleus • Ribosomes • Endomembrane System– Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Vacuoles, Vesicles • Mitochondria and Chloroplasts • Structure and function of cell membranes	5. AP Lab 1 - Diffusion and Osmosis 6. Cell Modeling – compare and contrast plant and animal cells 7. Diffusion and Osmosis lab assessment
Metabolism and Cellular Respiration • ATP • Glycolysis • Krebs Cycle • Electron Transport Chain	8. AP Lab 5 – Cellular Respiration 9. Respiration Modeling
Photosynthesis • Light reactions • Calvin cycle • PS I and PS II • Chlorophyll and wavelengths of light • C3, C4, CAM plants • Chloroplasts and parts of leaves	10. AP Lab 4 - Photosynthesis
Mitosis and Meiosis • Cell cycle and cell division • Regulation of cell division • Tumors • Asexual reproduction • Reduction division • Production of haploid gametes • Sexual reproduction • Crossing over • Independent Assortment • Mitosis compared to meiosis	11. AP Lab 3 – Mitosis and Meiosis

Genetics and Evolution	
Genetics • Mendelian genetics - history • Laws of segregation and Independent assortment • Monohybrid and Dihybrid crosses • Dominance, co-dominance, incomplete dominance, pleiotropy • Pedigree • Morgan and Drosophila genetics • Human genetic disorders	12. AP Lab 7 – Genetics of Organisms 13. M&M Chi-Square Activity
DNA • History of discovery • Structure – bonding and base pairs • Replication process – leading and lagging strands • DNA electrophoresis using restriction enzymes	14. DNA replication model 15. Restriction enzyme activity 16. AP Lab 6 DNA electrophoresis – Day long Saturday lab
Transcription and Translation • Structure of RNA • Transcription in prokaryotes vs. eukaryotes • Translation – codons/anti-codons, process of protein synthesis	17. Transcription and translation diagram
Genetics of Viruses and Bacteria • Viral and bacterial reproduction • HIV and its impact on world health • Bacterial transformation • Lac operon • Plasmids and current genetic research and discussion of future possibilities • Bacterial contributions to environment and ecosystems	18. Morgan Lab – Bacteria (growth, types, gram staining, etc.) 19. AP Lab 6 – Bacterial Transformation
Evolution • Historical perspective of Evolution theories • Darwin • Observations and data leading to Evolution Theory • Recent DNA data supporting Evolution • Population genetics • Genetic drift • Hardy-Weinberg • Patterns and modes of speciation • Micro and macro evolution • Phylogenics	20. Portions of PBS film series on Evolution 21. AP Lab 8 – Population Genetics and Evolution

Organisms and Populations	
Diversity of Life • Origin and evolution of earth and living things • Evolution of organic molecules, to single cell organisms to multicellular organisms, etc • Protists and Fungi • Evolution of plants and animals from sea to land dwelling • Classification schemes • Metabolic development in protists • Evolution of Red and Green Algae to first land plants	22. Morgan Lab 14 – Protists and Fungi 23. Student designed inquiry labs utilizing slime mold
Plants • Mosses, bryophytes and ferns • Life cycle of ferns • Alternation of generations • Evolution of gymnosperms • Evolution of angiosperms • Plant structure and growth • Transport in plants • Plant nutrition • Plant reproduction • Plant hormones and control systems • Plant anatomy	24. Morgan Lab 15 - Plant Diversity 25. Fern life cycle lab 26. Morgan Lab 16 - Gymnosperms and Angiosperms 27. AP Lab 9 – Transpiration in Plants
Animals • Review evolution of animal diversity • Vertebrates and Invertebrates focusing on development of systems and increasing complexity through dissection and examination of comparative anatomy set, including protists, sponges, hydra, planaria, mussels, earthworms, round worms, crayfish, grasshoppers, starfish, perch, and frogs • Evolution of Invertebrates to Vertebrates including chordates	28. Morgan Lab 17 and 18 – Animal Diversity I and II
Animal Physiology • Basic Principles of Animal Form and Function • Animal Nutrition • Circulation and Gas Exchange • The Immune System • Osmoregulation and Excretion • Hormones and the Endocrine System • Animal Reproduction • Animal Development • Nervous Systems • Sensory and Motor Mechanisms	29. AP Lab 10 - Physiology of the Circulatory System 30. Lab - Frog Dissection and systems analysis 31. Compare and contrast power point assignment 32. AP Lab 11 – Animal Behavior

Ecology • Review of material students covered during the past summer • Current topics: global warming, pollution, erosion of biomes, human threat to environment • Ecology and the Biosphere • Behavioral Ecology • Population Ecology • Community Ecology • Ecosystems	33. AP Lab 12 – Dissolved oxygen and primary productivity
Review and Putting it All Together • Each of the eight themes are related once again to the material that the students have learned as a review for the AP Test • science as process • evolution • energy transfer • continuity and change • structure and function • regulation • interdependence • science, technology, and nature	34. Student chosen presentation media for Putting it all Together
Ethical Issues in Biology Topics that have come up during the year are researched and discussed. These topics are student driven and in the past have included: • Stem cell research • Animal rights in research and testing • Organ donation • The role of politicians and the government in determining the content of science education and in making scientific research decisions • Who should make ethical decisions regarding the use of science and technology? Individuals, politicians, religious leaders, physicians, etc.?	

Lab and Activities

1. **Morgan Lab 1 – Scientific Investigations**
   Students design their own investigation and then practice using scientific processes such as determining variables, data vs. inferences, graphing, etc.
2. **Properties of Water Investigations**
   Students investigate the adhesive and cohesive properties of water through 8-10 different activities.
3. **AP Lab 2 – Enzyme lab**
   Students perform a hands-on lab from the AP lab manual. Students answer the questions in the lab manual. Modifications are made to assure the effectiveness of catalase.

4. **Models of organic molecules**
   Models are used to create and view the active sites of molecules and to build macromolecules.

5. **AP Lab 1 - Diffusion and Osmosis**
   Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual. An inquiry investigation is used as an assessment of this concept.

6. **Cell Modeling – compare and contrast plant and animal cells**
   Hands-on models are created of plant and animal cells, and students highlight the similarities and the differences between the two types of cells.

7. **Diffusion and Osmosis lab assessment – see # 5**
   Jars are put out of varying concentrations of sugar and students determine the concentrations utilizing the skills learned in AP Lab 1.

8. **AP Lab 5 – Cellular Respiration**
   Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

9. **Cellular Respiration Modeling**
   White boards are used to diagram and follow the process of cellular respiration.

10. **AP Lab 4 – Photosynthesis**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual. The data obtained from the calorimeter has fluctuated.

11. **AP Lab 3 – Mitosis and Meiosis**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

12. **AP Lab 7 – Genetics of Organisms**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual. Different Drosophila mutants are used for variety.

13. **M&M Chi-Square Activity**
    M&Ms are used to determine the validity of the published ratio of colors in a bag of candy using Chi-square analysis.

14. **DNA replication model**
    Students create working models displaying the mode of action for DNA replication.

15. **Restriction enzyme activity**
    Paper, pencils, and scissors are used to simulate the action of a restriction enzyme.

16. **AP Lab 6 DNA electrophoresis** – Day long Saturday lab
    Lab is performed according to the AP lab manual protocol. Students commit to a Saturday so that the entire lab can be completed at once. The gels are teacher-stained with ethidium bromide and pictures are taken of the gels for the students to work with. Students answer the questions in the lab manual.

17. **Transcription and translation diagram**
    White boards are used to diagram transcription and translation and the areas in the cell where the processes take place.

18. **Morgan Lab – Bacteria (growth, types, gram staining, etc.)**
    Prior to performing the Bacterial Transformation lab, the students work in the lab with various types of bacteria to learn about aseptic technique, bacterial growth, staining techniques, and the appearance of different types of bacteria.

19. **AP Lab 6 – Bacterial Transformation**
    Lab is performed according to the AP lab manual protocol utilizing a kit from Wards, Carolina, or BioRad. Students answer the questions in the lab manual.

20. **Portions of PBS film series on Evolution**
    Good dramatization of much of Darwin's discoveries and his concerns about his place in the scientific community.

21. **AP Lab 8 – Population Genetics and Evolution**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

22. **Morgan Lab 14 – Protists and Fungi**
    A variety of protists and fungi are investigated through observation.

23. **Student designed inquiry labs utilizing slime mold**
    Physarum polycephalum is used for a student-designed lab. Students determine what variable to study and set up the protocol. They share results with the other students and write a formal lab report covering their study.

24. **Morgan Lab 15 - Plant Diversity**
    A variety of plants are observed for similarities and differences. The evolutionary trends are identified.

25. **Fern life cycle lab**
    Fern spores are germinated and the gametes are observed. The life cycle is watched and the plants are potted in soil for the students to take home.

26. **Morgan Lab 16 - Gymnosperms and Angiosperms**
    Gymnosperm and angiosperm life cycles are examined at the microscopic and macroscopic levels. Seeds and Flowers are dissected.

27. **AP Lab 9 – Transpiration in Plants**
    Lab has been performed using the Carolina Biological kit. Students answer the questions in the lab manual that come with the Carolina kit.

28. **Morgan Lab 17 and 18 – Animal Diversity I and II**
    Preserved specimens of approximately ten to twelve animal organisms are dissected and compared and contrasted.

30. **AP Lab 10 - Physiology of the Circulatory System**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

31. **Lab - Frog Dissection and systems analysis**
    As the various systems are studied, frogs and other organisms are dissected and the systems analyzed. The students dissect a fetal pig in their tenth grade biology class.

32. **Compare and contrast power point assignment:**
    Students compare and contrast the following systems in an invertebrate, a vertebrate, and a human:
    1. Nutrition and the Digestive System
    2. Circulation and Gas Exchange
    3. Osmoregulation and Excretory System
    4. Reproductive System
    5. Nervous System
    6. Sensory and Motor Mechanism

    The evolutionary significance of each of the systems must be clearly described and integrated into the presentation.

33. **AP Lab 11 – Animal Behavior**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

34. **AP Lab 12 – Dissolved oxygen and primary productivity**
    Lab is performed according to the AP lab manual protocol. Students answer the questions in the lab manual.

35. **Student chosen presentation media for "Putting it all Together"**
    Students are assigned one of the eight themes: science as process; evolution; energy transfer; continuity and change; structure and function; regulation; interdependence; and science, technology, and nature. They then take the major concepts learned and relate them to the themes. These presentations are then shared with the other members of the class.

Curriculum Review Worksheets

Contents

This booklet provides worksheets to guide you in examining the match between your school's curriculum and the knowledge and skills assessed in EXPLORE®, PLAN®, and the ACT®:

ACT®

IC 0402WW070

Introduction

This booklet provides four sets of worksheets to guide you in the process of examining the match between the content and skills deemed important by your school and the knowledge and skills assessed in the four tests included in EXPLORE®, PLAN®, and the ACT®—English, Mathematics, Reading, and Science. College Readiness Standards are provided for six score ranges along a score scale that is common to EXPLORE (1–25), PLAN (1–32), and the ACT (1–36). These three testing programs are components of ACT's Educational Planning and Assessment System (EPAS™).

This booklet also provides a set of worksheets for the Writing Standards associated with the ACT Writing Test, an optional component of the ACT. The Standards for Writing are provided for five score ranges along the ACT Writing Test score range: 3–4, 5–6, 7–8, 9–10, and 11–12.

To use each worksheet, you should review each skill; consider whether the skill, knowledge, or process is included in the school, district, and state curricular frameworks; and answer the following three questions:

- Is this skill, knowledge, or process **included** in your [content area] curriculum?
- At what grade level (or in what course) are students **first introduced** to the skill, knowledge, or process?
- At what grade level (or in what course) are students **expected to demonstrate proficiency** in the skill, knowledge, or process?

Engaging in this activity will help you focus on the skills and concepts that are emphasized in your courses, to identify instructional needs, to consider the many ways in which teachers teach and students learn, and to reflect on how your course goals fit into and work toward the school's educational goals. This activity allows educators to discuss and compare their perspectives related to curriculum expectations. There is much evidence that student achievement can be raised when teachers and other school personnel address the academic content that teachers teach and the amount of practice that is provided to students in particular areas.

TABLE 4: Science College Readiness Standards for Score Range 13–15

Science Standards	For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables; a food web diagram)			
Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels)			

Science College Readiness Standards are measured in the context of science topics students encounter in science courses. These topics may include:

• Animal behavior • Animal development and growth • Body systems • Cell structure and processes • Ecology • Evolution • Genetics • Homeostasis • Life cycles • Molecular basis of heredity • Origin of life • Photosynthesis • Plant development, growth, structure • Populations • Taxonomy	. Atomic structure . Chemical bonding, equations, nomenclature, reactions . Electrical circuits . Elements, compounds, mixtures . Force and motions . Gravitation . Heat and work . Kinetic and potential energy . Magnetism . Momentum . The Periodic Table . Properties of solutions . Sound and light · States, classes, and properties of matter • Waves	• Earthquakes and volcanoes • Earth's atmosphere • Earth's resources • Fossils and geological time • Geochemical cycles • Groundwater • Lakes, rivers, oceans • Mass movements • Plate tectonics • Rocks, minerals • Solar system • Stars, galaxies, and the universe • Water cycle • Weather and climate • Weathering and erosion

TABLE 4 (continued): Science College Science Standards	**Readiness Standards for Score Range 16–19** For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Select two or more pieces of data from a simple data presentation	Yes	Elem	MS
Understand basic scientific terminology	Yes	Elem	MS
Find basic information in a brief body of text	Yes	Elem	MS
Determine how the value of one variable changes as the value of another variable changes in a simple data presentation	Yes	Elem	MS
Understand the methods and tools used in a simple experiment	Yes	MS	9th—Physics

TABLE 4 (continued): Science College Science Standards	Readiness Standards for Score Range 20–23 For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Select data from a complex data presentation (e.g., a table or graph with more than three variables; a phase diagram)	Yes	MS	11th—Chemistry
Compare or combine data from a simple data presentation (e.g., order or sum data from a table)	Yes	Elem	MS
Translate information into a table, graph, or diagram	Yes	Elem	MS
Understand the methods and tools used in a moderately complex experiment	Yes	MS	9th—Physics
Understand a simple experimental design	Yes	Elem	MS
Identify a control in an experiment	Yes	Elem	MS
Identify similarities and differences between experiments	Yes	Elem	MS
Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model	Yes	MS	9th—Physics
Identify key issues or assumptions in a model	Yes	MS	9th—Physics

TABLE 4 (continued): Science College Science Standards	Readiness Standards for Score Range 24–27 For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table)	Yes	Middle School	9th Physics
Compare or combine data from a complex data presentation	Yes	Middle School	9th Physics
Interpolate between data points in a table or graph	Yes	Middle School	9th Physics
Determine how the value of one variable changes as the value of another variable changes in a complex data presentation	Yes	Middle School	9th Physics
Identify and/or use a simple (e.g., linear) mathematical relationship between data	Yes	Middle School	9th Physics
Analyze given information when presented with new, simple information	Yes	Middle School	9th Physics
Understand the methods and tools used in a complex experiment	Yes	9th Physics	11th Chemistry/12th Physics
Understand a complex experimental design	Yes	9th Physics	11th Chemistry/12th Physics
Predict the results of an additional trial or measurement in an experiment	Yes	Middle School	9th Physics
Determine the experimental conditions that would produce specified results	Yes	Middle School	9th Physics
Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	No		
Determine whether given information supports or contradicts a simple hypothesis or conclusion, and why	Yes	Middle School	9th Physics
Identify strengths and weaknesses in one or more models	Yes	9th Physics	11th Chemistry/12 Physics
Identify similarities and differences between models	Yes	MS Earth Science	11th Ghemistry/12th Physics
Determine which model(s) is(are) supported or weakened by new information	Yes	MS Earth Science	10th Biology
Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion	Yes	Middle School	10th Biology

TABLE 4 (continued): Science College **Science Standards** (PLAN and ACT only)	**Readiness Standards for Score Range 28–32** For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Compare or combine data from a simple data presentation with data from a complex data presentation	Yes	9th Physics	11th Chemistry
Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data	Yes	9th Physics	11th Chemistry
Extrapolate from data points in a table or graph	Yes	9th Physics	11th Chemistry
Determine the hypothesis for an experiment	Yes	K-8	10th Biology
Identify an alternate method for testing a hypothesis	Yes	K-8	12th Elective Science Course
Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model	Yes	K-8	12th Elective Science Course
Determine whether new information supports or weakens a model, and why	Yes	K-8	10th Biology
Use new information to make a prediction based on a model	Yes	K-8	9th Physics

TABLE 4 (continued): Science College **Science Standards** (ACT only)	**Readiness Standards for Score Range 33–36** For each skill, knowledge, or process:		
	Is it **included** in your science curriculum?	At what grade level (or in which course) are students **first introduced** to it?	At what grade level (or in which course) are students **expected to demonstrate proficiency**?
Compare or combine data from two or more complex data presentations	Yes	9th Physics	12th Elective Science Course
Analyze given information when presented with new, complex information	Yes	9th Physics	9th Physics
Understand precision and accuracy issues	Yes	9th Physics	9th Physics
Predict how modifying the design or methods of an experiment will affect results	Yes	Pre 9th	11th Chemistry
Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results	Yes	K-8	12th Elective Science Course
Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models	Yes	K-8	12th Elective Science Course
Determine whether given information supports or contradicts a complex hypothesis or conclusion, and why	Yes	K-8	10th Biology