



Science Curriculum K – 12

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Science teachers at every level have shown a willingness to investigate new models and to try out new materials. They remain dedicated to the improvement of science instruction for all students.

Science Curriculum Philosophy North Kingstown School Department

The Mission Statement of the North Kingstown School Department states the belief that *all students are capable of learning and becoming self-directed learners*, and that they *have a desire to learn*. Effective instruction and a program that provides many opportunities for exploration and experimentation reflects that belief and demonstrates the understanding that students learn most effectively when they are active participants in their learning. The North Kingstown School Department science curriculum is designed to foster student's development of content knowledge as well as understanding and appreciation of scientific tools and processes. Even more importantly, our hands-on, inquiry-based science curriculum will help to develop higher level thinking skills such as problem solving, prediction, deductive and inductive reasoning, and cause and effect.

We believe a good elementary science curriculum:

- Engages children in the wonder and study of the natural world;
- Makes links to technology, the ways human beings have solved problems and adapted to the living world;
- Gives children opportunities to explore how things work first hand through activities and experiences with a wide variety of materials;
- Stimulates them to wonder, to be good observers, to make predictions, and to offer explanations;
- Helps them construct their own knowledge of scientific principles and concepts, making these part of the way they see the world and make decisions about their lives.

We believe a good middle school and high school curriculum;

- Continues the practices of the elementary model;
- Increases the expectations for student responsibility;
- Challenges student perceptions while heightening their scientific content knowledge;
- Motivates and supports students to explore and select career possibilities in many scientific fields.

We believe that science must be an active endeavor. It requires that teachers guide investigations and encourage questioning; that students accept responsibility for their own learning and push themselves for greater understandings; that administrators provide continuous support for teachers in terms of on-going professional development, and for students in the form of necessary materials and current text books; and that the community contribute through internships and other opportunities for students to use their scientific knowledge.

NK Science Curriculum K-12

Grade	Life Science	Earth/Space Science	Physical Science	Technology
Kindergarten		<i>Weather and Seasons</i>	<i>Balls and Ramps</i>	
1 st Grade	<i>New Plants</i>	<i>Pebbles, Sand and Silt</i>	<i>Balance and Motion</i>	
2 nd Grade	<i>Insects</i>		<i>Solids and Liquids</i>	<i>Simple Machines</i>
3 rd Grade	<i>Plant Growth & Develop.</i>	<i>Water</i>	<i>Sound</i>	
4 th Grade		<i>Land and Water</i>	<i>Electric Circuits</i>	<i>Models and Designs</i>
5 th Grade	<i>Microworlds</i>		<i>Sinking and Floating</i>	<i>Pulleys & Levers</i>
6 th Grade	<i>Ecosystems</i>		<i>Magnets and Motors</i>	<i>Measuring Time</i>
7 th Grade	<i>Life Forms</i>	Weather and Climate		
8 th Grade			<i>Chemistry</i> Motion, Forces, &Energy	
9 th Grade		Earth Science*		Robotics Project Lead the Way (Engr.)
10 th Grade	Biology AP Biology	Environmental Science AP Environmental Science Floraculture/Greenhouse Management Landscaping	Physics AP Chamistry	Science & Technology of Boatbuilding Robotics Project Lead the Way (Engr.)
11 th Grade	AP Biology Human Anatomy and Physiology Comparative Anatomy	Environmental Science AP Environmental Science Narragansett Bay Studies Astronomy Floraculture/Greenhouse Management Landscaping	Physical Science Physics AP Physics Chemistry AP Chemistry	Science & Technology of Boatbuilding Robotics Project Lead the Way (Engineering)
12 th grade	AP Biology Human Anatomy and Physiology Comparative Anatomy	Environmental Science AP Environmental Science Narragansett Bay Studies Astronomy Floraculture/Greenhouse Management Landscaping	Physical Science Physics AP Physics Chemistry AP Chemistry	Science & Technology of Boatbuilding Robotics Project Lead the Way (Engineering)

Topics in *italics* are taught using science kits and science modules.

*In high school, Earth Science is required of all freshmen. Students must take at least two additional science courses to meet graduation requirements.

**GEMS-Net Common Science Curriculum
KINDERGARTEN**

Topic	New Standards Performance Standards	Science Content	The Student will:	Unifying Concepts
<p>Earth and Space: Seasons and Weather</p>	<p>S1a S2a, S2b S3a, S3b, S3c S4a, S4c, S4d S5a, S5b, S5c, S5d, S5f S6a, S6b, S6c S7a, S7b, S7c S8b</p>	<p>In this module, kindergarten students keep a classroom weather chart. This experience helps children learn to observe the environment with their senses. Using objective scales to inform and support their observations introduces students to scientific data collection.</p> <p>Critical to connecting the daily weather chart with a larger investigation of patterns in weather is keeping good records of the data collected to revisit and compare over time. The task of collecting daily weather data and recording information on the weather chart becomes in itself a provocation for further explorations as children become more aware of weather as a natural phenomenon and begin to ask questions to increase their understanding.</p> <p>Each separate element documented on the chart can give rise to many interesting and appropriate investigations in the classroom.</p>	<ul style="list-style-type: none"> • Make detailed observations of cloud cover, temperature, precipitation, and wind velocity. • Communicate, describing weather (verbally) using appropriate language and scientific/quantitative terms; documenting/representing observations, ideas, understanding with picture and words. • Compare and contrast different types of weather, accumulate data on measurements of each element. • Measure using simple tools to quantify observations: <ul style="list-style-type: none"> -a thermometer measures temperature: when mercury is high, temperature is hot, when mercury is low, temperature is low. -a wind scale (rubric) describes/quantifies wind velocity: no wind – very windy. -a rain gauge measures rainfall. -a yardstick or ruler measures snowfall. -a sky scale (rubric) describes/quantifies cloud cover. • Plan and conduct investigations around predicting 	<ul style="list-style-type: none"> • Some events in nature have a repeating pattern. The weather changes from day to day, but things such as temperature and rain (or snow) tend to be high, low, or medium in the same months every year. • Elements of weather that we can observe and describe are: <ul style="list-style-type: none"> - Cloud cover - Temperature - Precipitation - Wind velocity. • There are different types of clouds. Observing clouds can help us to predict weather. • Some aspects of weather are causes which affect other aspects of weather or nature, i.e., temperature affects precipitation, bodies of water, ground).

Topic	New Standards Performance Standards	Science Content	The Student will:	Unifying Concepts
Physical Science: Balls and Ramps	S1b S4a, S4b S5a, S5b, S5c, S5f S6b, S6c S7a, S7b S8a, S8b, S8c	<p>The Balls and Ramps module has two connecting themes that run throughout a series of inquiry-based learning experiences. The first theme is the properties and characteristics of balls. The kindergarten students observe, use and compare different balls. The students compare the bounciness of different balls and they experiment with the different types of balls on the ramps. The kindergarten students also make balls, choosing from a wide variety of materials. Their task is to create a ball that will bounce and roll.</p> <p>The second theme is the things that affect the ways balls behave. The children explore how balls are affected by gravity, inertia, momentum and friction. The kindergarten students build roadways. They focus on some of the relationships between ramp steepness and the acceleration of the ball. This module provides opportunities for children to explore and observe closely some of the underlying concepts of physics</p>	<p>weather and changes in weather.</p> <p>The Student will:</p> <ul style="list-style-type: none"> • Use a variety of science process skills. • Engage in exploration, discovery and problem solving. • Explore and observe closely. • Work in groups to share experiences and to clarify ideas. • Organize and share their observations, discoveries and ideas through illustrations, charts and graphs. • Make predictions and experiment. • Attempt to connect ideas and apply their knowledge. • Formulate questions. • Work out problems themselves. • Share their experiences with balls and what they know about balls. • Focus on some of the differences among balls as they explore and record their findings. • Compare the size and weights of different balls and see how well they bounce and roll. • Use a variety of different balls to relate movement and bounciness to physical characteristics. • Measure the bounciness of different balls and develop a graph. 	<p>Unifying Concepts</p> <ul style="list-style-type: none"> • Balls have basic similarities but they do have differences. We can identify properties and characteristics of balls. • Weight, size materials and structure of the ball affect how it moves. When releasing a ball down a ramp, the force of gravity pulls it downward. • The steepness of the ramp influences how rapidly a ball accelerates. The steeper the incline of the ramp, the faster the ball travels down it. • The sizes or the weights of balls do not affect how fast they reach the bottoms of ramps of equal height and steepness. • A heavy ball and light ball that have similar surfaces and are rolled down the same ramp will roll the same distance. <p>SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES The module extends students natural fascination with the world. The explorations and experiences help to shape their understanding of some of the underlying concepts of physics. It allows the students to have fun as they further develop their scientific</p>

			<ul style="list-style-type: none"> • Make their own balls out of different materials and share about how and why the balls move as they do. • Explore what balls do on inclined planes. • Focus on the effect on the size and weight of balls and how fast it reaches the bottom of the ramps. • Work together to build ramp systems using all their prior experiences to inform their work. 	<p>thinking. The students will begin to use ways to record their observations and thinking and communicate their questions and ideas with others.</p> <p>HISTORY AND NATURE OF SCIENCE</p> <p>The ball is a toy that has delighted and fascinated children for generations. Students bring what they already know and apply it to new situations. They recognize ways to communicate and record their findings and connect that to scientific study.</p>
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**GEMS-Net Common Science Curriculum
FIRST GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Earth and Space: Pebbles, Sand and Silt (FOSS)	S3a, S3c S4a, S4b, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6c S7a, S7b, S7c S8a, S8b, S8c	<p>The Pebbles, Sand and Silt Module introduces students to several kinds of rocks.</p> <p>Throughout the activities in the module, students sort, wash, compare and seriate rocks. They separate mixtures of rocks with screens, and investigate clay and soil.</p> <p>After students have had many experiences with these earth materials, they participate in projects that demonstrate how people use earth materials in their daily lives.</p>	<ul style="list-style-type: none"> • Assemble, explore, interpret and construct a variety of experiments. • Collect data and use for decision making. • Predict, compare and research rocks, classifying collections. • Apply information to analyze structure, change and interaction. 	<ul style="list-style-type: none"> • People, alone or in groups, are always inventing new ways to solve problems and get work done. The tools and ways of doing things that people have invented affect all aspects of life. • Chunks of rocks come in many sizes and shapes, from boulders to grains of sand and even smaller. • Rocks are the solid portions of the earth. • Rocks can be sorted into groups by properties including color, shape, size and texture. • Rocks can be broken into smaller pieces. • Rocks change appearance when wet. • Silt and clay have different properties. • Earth materials can be used in a variety of constructions. • Soil is composed of a combination of materials and differs from one location to another.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Balance and Motion (FOSS)	S1a, S1b S4a, S4b, S4d S5a, S5b, S5c, S5d, S5e, S5f S6c S7b, S7c, S7d	The Balance and Motion module has students balance cardboard shapes and pencils, and make mobiles to explore balance, counter-balance, and	<ul style="list-style-type: none"> • Investigate materials constructively during free exploration and in a guided discovery mode. • Solve problems trial and 	<ul style="list-style-type: none"> • Things move or can be made to move along straight, curved, circular, back-and-forth and jagged paths. • The way to change how

	S8c	<p>stability.</p> <p>Students investigate spinning motion with tops, zoomers, and whirlers and rolling motion with wheel-and-axle systems, rolling cups and marble sin runways.</p>	<p>error.</p> <ul style="list-style-type: none"> • Explore concepts of balance, counterweight, and stability. • Observe systems that are unstable and modify them to reach equilibrium. • Discover different ways to produce rotational motion. • Construct and observe toys that spin. • Explore and describe some of the variables that influence the spinning of objects. • Observe and compare rolling systems with different-sized wheels. • Explore and describe the motion of rolling spheres. • Acquire the vocabulary associated with balance and motion. • Gain early experiences that will contribute to their understanding of several pervasive themes that relate one scientific idea to another: change and interaction. 	<p>something is moving is to give it a push or a pull.</p> <ul style="list-style-type: none"> • We live in a dynamic world where everything is in motion, or so it seems. But not everything is moving the same way. Some things move from one place to another. Other things go around and around in a rotational motion. Still other things are stationary, stable for a time, balanced on a thin line between stop and go.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Life Science: New Plants (FOSS)	S2a, S2b S4a S5a, S5b, S5c, S5d, S5f S7a, S7b S8a, S8b	The New Plants module helps students appreciate the diversity of life in the plant kingdom. They become familiar with the structures of flowering plants and discover ways to propagate new plants from mature plants. Students grow plants from seed using rapid-cycling brassica, (Wisconsin Fast Plants™)	<ul style="list-style-type: none"> • Conduct, record and organize daily observations. • Make and test predictions, classify collections, apply previously applied information to analyze, structure and change. • Collect data and use it for decision making. • Do science involving critical thinking and problem solving. • Use communications as a tool in science. 	<ul style="list-style-type: none"> • Most food comes from farms either directly as crops or as the animals that eat the crops. To grow well, plants need enough warmth, light, and water. Crops must also be protected from weeds and pests that can harm them. • A lot can be learned about plants and animals by observing them closely, but care must be taken to know the needs of living things and how to provide for them in the classroom.

**GEMS-Net Common Science Curriculum
SECOND GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Technology: Simple Machines (Lego Dacta™)	S1a S4a, S4b, S4d S5a, S5b, S5c, S5e, S5f S6c S7b S8a, S8c	In the Simple Machines module (DACTA), students examine various types of simple machines, including levers, wheels and axles, pulleys, and gears, by building working models of each. Students develop, through hand-on experiences, a technical vocabulary which includes: force, friction, work, fulcrum, gear, train, spur gear, crown gear, and worm gear.	<ul style="list-style-type: none"> • Investigate characteristics of simple machines and the physical interaction of the objects. • Investigate motion and forces. • Work in a group to develop plans and construct devices/ models of their own design. 	<ul style="list-style-type: none"> • Identifying simple machines and their characteristics. • Comparison of simple machines and their characteristics.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Solids and Liquids (FOSS)	S1a, S1b S4a, S4b S5a, S5b, S5c, S5e S7a, S7b S8a, S8b, S8c	The Solids and Liquids module introduces students to characteristics of two states of matter. After describing properties of solid objects, students use them in construction projects. They investigate the properties of particular solids (cornmeal, beans, rice) and liquids (water, corn syrup, oil) and compare their behaviors. After observing solid/liquid and liquid/liquid interactions, students investigate toothpaste to determine if it is solid or liquid.	<ul style="list-style-type: none"> • Investigate properties of particular solids and liquids. • Investigate toothpaste to determine whether it is solid or liquid. 	<ul style="list-style-type: none"> • Water can be a liquid or a solid and can be made to go back and forth into ice and then the ice allowed to melt. The amount of water is the same as it was before freezing. • Water left in an open container disappears, but water in a closed container does not disappear. • Observing and identifying characteristics of solid/liquid (state of matter). • Investigating and comparing behaviors of solids/liquids.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts

<p>Life Science: Insects (FOSS)</p>	<p>S2a, S2b, S2c S4a, S4d S5a, S5b, S5c, S5d, S5f S6c S7a, S7b, S7c S8b</p>	<p>The Insects module introduces students to the life sequences of a number of insects. Darkling beetles, milkweed bugs, wax moths, sick moths, painted lady butterflies, crickets, and ants are a few of the organisms observed over time. Students observe and compare insect structures and behaviors in different stages of the life cycle. Students discuss and record findings and pose questions to be answered. Students experience complete and simple insect metamorphosis and are introduced to a sampling of the diversity in the animal kingdom.</p>	<ul style="list-style-type: none"> • Observe mealworm, larvae, pupae, and adults over time. • Describe and record changes in mealworm structure and behavior over time. • Observe waxworm larvae and compare them to mealworm larvae. • Describe and record changes over time. • Observe the sequence of changes insects go through as they mature into adults. • Observe, describe and communicate the structure, pattern and behavior of insects. • Observe and compare the structures of an insect larvae and adult. • Compare different insects' structures and behaviors. • Observe structure and behavior of a butterfly. • Compare the structure and behavior of the butterfly to other insects. • Observe crickets, ants and other insects in classroom habitats. • Compare the structures and lifestyles of insects. • Note that different plants and animals have external features that help them thrive in different kinds of places. • Note that some animals and plants are alike in the way they look and in the things they do, and others are different from one another. 	<ul style="list-style-type: none"> • Needs of insects include air, food, water, and space. • Insects have structures that allow them to function. • The life cycle of the beetle goes from egg to larva, to pupa, to adult, which produces eggs. • Insects have common structures and behaviors. • Some insects, such as moths, produce silk threads. • Insects hatch from eggs. • Insects have three body parts: head, thorax, and abdomen. • Some insects go through simple metamorphosis (eggs, nymphal stages, adult). • Insect larvae have structures in common. • Some adult insects need food. • Different insects have different habitat requirements. • Some insects spend part of their life cycle in water. • Living things are found almost everywhere in the world. There are somewhat different kinds in different places. • Different plants and animals have external features that help them thrive in different kinds of places.
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**GEMS-Net Common Science Curriculum
THIRD GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Earth and Space: Water (FOSS)	S1a S3a, S3c S4a, S4b, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c S7a, S7b, S7c, S7d S8a, S8c	The Water module plunges students into close contact with the most amazing material, water. They investigate surface tension, freezing, expansion, density, evaporation, and condensation in a number of everyday settings. Finally, they consider water quality and the processes by which water is recycled naturally.	<ul style="list-style-type: none"> • Measure and mix dry and liquid materials in prescribed amounts, exercising reasonable safety. • Use numerical data in describing and comparing objects and events. • Observe and explore liquids and solids. • Investigate evaporation and condensation. • Compare water quality with indicators. • Observe changes that occur in water that has flowed over limestone. • Record observations in an appropriate manner. 	<ul style="list-style-type: none"> • Properties of water surface tension with water. • Absorption properties of water. • Water cycle. • Condensation/evaporation/precipitation. • Water use and quality. • When liquid disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below the freezing point of water. • Clouds and fog are made of tiny droplets of water. • Heating and cooling cause changes in the properties of materials. Many kinds of changes occur faster under hotter conditions. • Things change in steady, repetitive or irregular ways – or sometimes in more than one way at the same time. Often the best way to tell which kinds of change are happening is to make a table or graph of measurements. • Recognize when comparisons might not be fair because some conditions are not kept the same. • Seek better reasons for believing something than “Everybody knows that”, or “I just know”, and discount such reasons when given by others. Keep records of their investigations and

				observations and not change the records later. Offer reasons for their findings and consider reasons suggested by others.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Sound (STC)	S1a, S1b S2a, S2c S4a, S4b, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c S7a, S7b, S7c, S7d S8a, S8c	In Sound, third graders use tuning forks, slide whistles, strings, and other sound-producing objects to investigate the characteristics of sound. Students learn that sound is caused by vibrations and explore how sound travels. They learn about the relationship of pitch and volume, the frequency of vibrations. They discover, for example, that they can alter pitch by varying the length or tension of a string. Constructing simple string instruments, they also discover how they can increase the volume of the sound produced by the strings. Students investigate the characteristics of another common sound-producing mechanism – the human larynx – and build model vocal cords from rubber bands. They also learn about the anatomy and functioning of the human ear. They apply what they learn in the unit by designing and building musical instruments or other sound-producing devices.	<ul style="list-style-type: none"> • Observe and describe results of investigations with sound. • Compare and discuss sounds produced. • Communicate results through writing and with graphs. • Use science materials to perform experiments with sound. • Use previous experiences producing sounds and results of changing length and tension to predict outcomes. • Reflect on experiences through writing and discussion. • Apply previously learned concepts and skills to design a new sound producing device. Read for more information about sound and hearing. 	<ul style="list-style-type: none"> • Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. • Sound is produced by vibrations of an object, which are back and forth motions. Pitch and volume are two characteristics of sound. Changing the way an object vibrates changes the sound produced. Length and tension affect an object's vibrations and therefore the pitch of the sound produced. Pitch is determined by the frequency of the vibrations; volume is determined by the amplitude of the vibrations. • A speaker uses a vibrating membrane to amplify the sound produced electronically. The human ear has a membrane which vibrates when sound reaches it. The brain translates the vibrations into sound heard.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Life Science: Plant Growth and Development (STC)	S2a, S2b, S2c, S2d S4a, S4d S5a, S5b, S5c, S5d, S5e, S5f	In Plant Growth and Development students have the opportunity to observe	<ul style="list-style-type: none"> • Plant and care for the Brassica rapa. • Observe, describe and record 	<ul style="list-style-type: none"> • Organisms interact with one another in various ways besides providing food. Many plants

	<p>S6a, S6b, S6c S7a, S7b, S7c, S7d S8b, S8c</p>	<p>each stage in the life cycle of a simple plant by working with Wisconsin Past Plants™ (Brassica rapa), which germinate, mature, and go to seed within 40 days. Students plant seeds and watch the seedlings emerge. Later, they thin and transplant seedlings. As they watch the plant grow, students learn that plants need nutrients from the soil as well as water and light to thrive. As the unit expands to focus on the interdependence of living things, students cross-pollinate the flowers with dried honeybees. Finally, they harvest mature seeds and determine seed yields. These experiences deepen students' understanding of the characteristics of living organisms and their relationship with and dependence on their environment.</p>	<p>changes in plants.</p> <ul style="list-style-type: none"> • Compare and discuss changes occurring in plants over time. • Measure and record the growth of plants. • Use graphs to display and compare growth patterns. • Predict future growth from observations and measurements. • Read to learn more about plants. • Communicate results and reflect on experiences through writing, drawing and discussions. 	<p>depend on animals for carrying their pollen to other plants for dispersing their seeds.</p> <ul style="list-style-type: none"> • Some plant varieties and animal breeds have more desirable characteristics than other do, but some may be more difficult or costly to grow. The kinds of crops that can grow in an area depend on the climate and the soil. Irrigation and fertilizers can help crops grow in places where there is too little water or the soil is poor. • Many plants follow a life cycle that begins with growth from a seed and proceeds through the production of seeds. Plants have distinct stages in their life cycles. • To live and grow, plants need light, water and nutrients from the soil. • Things change in steady, repetitive, or irregular ways – or sometimes in more than one way at the same time. Often the best way to tell which kinds of change are happening is to make a table or graph of measurements. • For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all. • Sometimes comparisons might not be fair because some conditions are not kept the same.
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**GEMS-Net Common Science Curriculum
FOURTH GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
<p>Earth and Space: Land and Water (STC)</p>	<p>S1a, S1b S2a, S2c S3a, S3c S4a, S4b, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c S7a, S7b, S7c, S7d S8a, S8c</p>	<p>In the LAND AND WATER KIT students are challenged to make comparisons on the basis of their own results and those of their classmates. They connect the models to real-world examples and apply concepts learned to photographs of land and water on earth. Students then complete a home study of land and water interactions in their own region. Through these applications, students are encouraged to observe land and water each day, search for evidence of land and water interaction in the world around them. Students investigate the interaction between land and water by analyzing cause-and-effect, using a stream table as a model. Students create hills, build dams, and grow vegetation. Miniature valleys, waterfalls, and canyons form the stream tables as water flows over the soil. Through observing the model, manipulating certain parts of it, and testing interactions under various conditions, students discover how water changes the shape of land and how land formations, in turn,</p>	<ul style="list-style-type: none"> • Model erosion, deposition, and the water cycle with a stream table. • Use stream table materials to investigate the interactions between water and land. • Analyze the materials that make up land and describe these materials on the basis of their properties. • Test the water retention and porosity of earth materials. • Compare the changes inland created by water flowing on soil in a stream table. • Relate stream table results to natural processes. • Communicate the results of an investigation through record sheets, written observations, and drawings. • Investigate the effects of slope, flow, and natural land formations on erosion and deposition. • Create and label aerial diagrams. • Design build, and test the effects of dams. • Make and validate predictions about the water cycle and settling of insoluble particles. • Design and build a landscape and make predictions about how the landscape will affect the 	<ul style="list-style-type: none"> • Water has an important role in shaping the land on earth. The wearing away of earth is erosion; the settling of eroded materials is deposition. Both the flow of water and the slope of the land affect erosion and deposition. • Soil is a composite of weathered materials and organic matter at the earth's surface. • Soil components include sand, silt, clay, gravel, and humus. • Each soil component has unique properties. • Water runs off land or travels through the ground into lakes, streams, rivers, and oceans. • Landforms, such as canyons and deltas, result from the action of flowing water. • Humans can alter erosion and deposition in various ways, including planting vegetation, and building dams. • Hills, rocks, and human-made obstructions may change the path of water. • The water cycle includes the processes of evaporation, condensation, precipitation, and the passage of water over and through land. These processes affect the shape of the land. • Aerial diagrams are views of land or other surfaces as seen from above. • Waves, wind, water, and ice

		affect the flow of water.	<p>flow of water.</p> <ul style="list-style-type: none"> • Implement a planned investigation and predictions with results. • Recognize types of resources. • Recognize the importance of models for investigating processes too large or complex to study firsthand. • Develop an interest in the interactions between land and water and recognize these interactions in the real world. • Accept that humans can attempt to control and affect the interactions land and water. • Appreciate the important role that plants play in curbing erosion and runoff. • Recognize the role humans play in planning and designing landscapes in conjunction with the natural interaction of land and water. 	<p>shape and reshape the earth's land surface by eroding rock and soil in some areas and depositing them in other areas, sometimes in seasonal layers.</p> <ul style="list-style-type: none"> • Rocks are composed of different combinations of minerals. Smaller rocks come from the breakage and weathering of bedrock and larger rocks. • Soil is made partly from weathered rock, partly from plant remains – and also contains many living organisms. •
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Electric Circuits (STC)	S1c S4a, S4b, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c S7a, S7b, S7c S8a, S8c, S8d	Electric Circuits opens the door to the world of electricity for students. In Lessons 1 through 6, students are introduced to the basic properties of electricity and learn about electric circuits and the parts of a light bulb. In Lessons 7 through 10, students learn about conductors and insulators and about the symbols used to represent the parts of a circuit	<ul style="list-style-type: none"> • Wire simple electric circuits. • Predict, observe, describe, and record results of experiments with electricity. • Draw conclusions about circuits from the results of experiments. • Build and use a simple circuit tester. • Use symbols to represent the different parts of an electric circuit. • Build a simple switch. 	<ul style="list-style-type: none"> • Make safe electrical connections with various plugs, sockets, and terminals. • Seeing how a model works after changes are made to it may suggest how the real thing would work if the same thing were done to it. • A complete electric circuit is required for electricity to light a bulb. • A complete circuit can be constructed in more than one way

		<p>in circuit diagrams. In the last half of the unit, students explore different kinds of circuits, learn about switches, construct a flashlight, and investigate the properties of diodes. The unit culminates with students wiring a cardboard box house.</p>	<ul style="list-style-type: none"> • Apply troubleshooting strategies to complete an incomplete circuit. • Apply information about electric circuits to design and build a flashlight. • Apply information about electric circuits to design and wire a house. • Read to learn more about electricity. • Communicate results and ideas through writing, drawing and discussion. • Collect data. • Appreciate the need for safety rules when working with electricity. • Develop an interest in electricity. • Develop confidence in being able to analyze and solve a problem. 	<p>using the same materials.</p> <ul style="list-style-type: none"> • Different types of electric circuits show different characteristics. • A switch can be used to complete or interrupt a circuit. • Some materials conduct electricity; these are called conductors. • Some materials do not conduct electricity; these are called insulators. • Electricity can produce light and heat. • A diode conducts electricity in one direction only.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Technology: Motion and Design (STC)	<p>S1a, S1b S4a, S4db, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c S7a, S7b, S7c, S7d S8b, S8c</p>	<p>This unit invites students to explore the physics of motion and to apply what they have learned to design technology. Using plastic construction materials, weights, rubber bands, and propellers, students design and build two vehicles, one powered by external force and one that is self-propelled. They test how fast the vehicles move and use their findings to redesign the vehicles so that they move more efficiently. Cost analysis</p>	<p>Gain experience in:</p> <ul style="list-style-type: none"> • Describing in words the speed of an object and how it may change as the object moves. • Measuring time to describe motion. • Collecting data and presenting it on a line plot. • Selecting a representative value from several repeated measurements. • Recording and comparing distances to describe motion. • Predicting the effects of force on how a vehicle 	<ul style="list-style-type: none"> • A force is any push or pull on an object. A force is needed to make resting objects move and to bring moving objects to rest. • A force can change the speed of an object. Larger forces can change the speed of an object more than smaller forces. • Friction is a force that occurs between two surfaces. Friction opposes motion. • If a force acts on lighter and heavier vehicles, the speed of the lighter vehicle changes more than the speed of the heavier vehicle. • Energy can be stored in a

		<p>is one of the students' design requirements. As students design their vehicles, they intuitively apply concepts such as friction and kinetic and potential energy. They also explore the effect of gravity on motion. The unit concludes by challenging students to solve a final design challenge and to present their findings to the class.</p>	<p>moves.</p> <ul style="list-style-type: none"> • Solving design problems using previously collected data. • Designing and implementing plans to meet a requirement. • Modeling the processes of design technology. • Making detailed drawings to record a design. • Communicating results of an investigation through record sheets, written observations, drawings, and class discussions. • Recognize the role design technology plays in daily problem solving and apply these processes. • Appreciate how science can solve practical problems. • Develop a respect for test results and for using those results to improve design. 	<p>stretched rubber band and released to make a vehicle move.</p> <ul style="list-style-type: none"> • The features of a vehicle depend on the vehicle's function. • Air friction is a force that can slow the speed of a moving vehicle. • A spinning propeller can exert a force that can move a vehicle. The more the propeller is wound, the greater the distance a propeller-driven vehicle can move. • Design requirements specify how an object must perform. Cost is often a requirement in designing a product. • An engineer modifies and improves a design to meet design requirements.
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**GEMS-Net Common Science Curriculum
FIFTH GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Life Science: Microworlds (STC)	S1c S2a, S2b, S2c, S2d, S2e S4a, S4b S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6d, S6e S7a, S7b, S7c, S7e S8a	<p>This unit is composed of sequential phases that build upon one another. In the first phase, students make close observations of common objects, a penny, fabrics, screen wire, and pencil shavings. In the second phase, students are introduced to different lenses – magnifying glasses, acrylic spheres, and water drops – and use them to discover that in order to magnify, an object must be transparent and curved. In the third phase, students use the microscope to view inanimate objects. Students also learn to prepare slides of different types to suit different specimens. In the last phase of this unit, students must use all of the expertise they have developed in order to successfully view their new specimens; living creatures including Volvox, lepharisma and vinegar eels.</p>	<ul style="list-style-type: none"> • Use magnifiers, including hand lenses and microscopes to observe living and non-living specimens. • Use appropriate equipment and techniques in preparing microscope slides for viewing. • Record Data. • Predict. • Classify. • Explore. • Observe. • Understand that scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. • Understand that investigations can focus on physical, biological, and social questions. • Develop interest in exploring microscopic specimens, recognizing that micro-organisms have many of the same needs as other living things. • Become aware of diversity of microbial life. • Become Aware of interaction between living things and environment. 	<ul style="list-style-type: none"> • Technology enables scientists and others to observe things that are too small or too far away to be seen without magnification and to study the motion of objects that are moving very rapidly or are hardly moving at all. • Some living things consist of a single cell. Like familiar organisms, they need food, water and air; a way to dispose of waste, and an environment they can live in. • Microscopes make it possible to see that living things are made mostly of cells. Some organisms are made of a collection of similar cells that benefit from cooperating. Some organisms' cells vary greatly in appearance and perform different roles in the organisms. • Materials may be composed of parts that are too small to be seen without magnification. • When a new material is made by combining two or more materials, it has properties that are different from the original materials. For that reason, a lot of different materials can be made from a small number of basic kinds of materials. • In order to magnify, a lens must be transparent and curved. • Some living things are too small

			<ul style="list-style-type: none"> • Understand that clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists and stay informed about scientific discoveries around the world. 	<p>to be seen without magnification.</p> <ul style="list-style-type: none"> • All living things are made of at least one cell. • When magnified, all cells have observable structures. • Like all organisms, microorganisms grow and reproduce.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Floating and Sinking (STC)	S1a, S1b S4a, S4b, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6c, S6e S7a, S7b, S7d S8a, S8c, S8d	In Sinking & Floating students investigate the phenomenon of buoyancy. They begin by making a spring scale with which they weigh various objects. They make clay boats, test the boats' buoyancy, and discover that altering the shape of the boats affects buoyancy. Students are then challenged to design a boat that has a certain loading capacity. These experiments convince them of several surprising phenomena; for example, some "floaters" are heavier than some sinkers, and large objects are not always heavier than small objects. Students then turn their attention to differences between objects placed in fresh water and in salt-water. They construct a hydrometer that compares the levels at which objects float in both types of water.	<ul style="list-style-type: none"> • Observe, record, and organize test results. • Apply previous experiences to make predictions. • Create and analyze graphs. • Calibrate a spring scale and use it to measure the magnitude of a force. • Read science materials for information. • Communicate results through writing and discussion. • Solve a problem that requires the application of previously learned concepts and skills. • Understand that results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated, sometimes because of unrealized differences in the methods used or in the circumstances in which the investigation is carried out, and sometimes just because of uncertainties 	<ul style="list-style-type: none"> • Several variables affect the buoyancy of an object. • Water pushes up on both floating and submerged objects with a buoyant force; objects push down on the water. • The buoyant force on large objects is greater than the buoyant force on smaller objects. • The amount of water an object displaces is directly related to the object's volume. • Because of buoyant force, objects appear to weigh less when they are submerged. • Objects that weigh more than the same volume of water sink; objects that weigh less than the same volume of water float. • Salt water weighs more than an equal amount of fresh water. • The buoyancy of an object varies with the density of the liquid.

			<p>in observations. It is not always easy to tell which.</p> <ul style="list-style-type: none"> • Develop interest in investigating floating, sinking and related phenomena. • Recognize the importance of repeating a test or measurement and comparing results. • Offer reasons for their findings and consider reasons suggested by others. • Understand the development of boats over time and the Story of Archimedes' Discovery. • Understand that scientific laws, engineering principles, properties of materials and construction techniques must be taken into account in designing engineering solutions to problems. Other factors, such as cost, safety, appearance, environmental impact, and what will happen if the solution fails also must be considered. • Understand that throughout all of history people everywhere have invented and used tools. Most tools today are different from those of the past but many are modifications of very ancient tools. • Understand that scientists do not pay much attention to claims about how something works unless the claims are backed up with evidence that can be confirmed in a logical manner. 	
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Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Technology: Levers and Pulleys (FOSS)	S1a, S1b, S1c S4a, S4db, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6b, S6d, S6e S7a, S7b, S7d, S7e	<p>Students are introduced to levers as devices that help us lift weight or overcome resistance. Students investigate the fulcrum, effort, and load of one kind of lever (class-1) and conduct experiments with a spring scale to discover the relationships between the parts of lever systems. Students draw and graph their results. Students investigate and diagram class-1, class-2, and class-3 lever systems. They investigate and diagram common tools to determine how the tools apply levers. Students are introduced to a second simple machine and discover how to set up single-fixed and single-movable pulleys to lift a load. They use a scale to quantify effort with single pulleys. They go on to set up and diagram multiple-pulley systems. Students systematically investigate four pulley systems. They record data on each system. They graph and determine the advantage (and disadvantage) of different pulley systems.</p>	<ul style="list-style-type: none"> • Measure the effort to lift a load when the load remains constant and the effort changes position. • Measure the effort to lift a load when the effort remains stationary and the load moves. • Organize observations on a record sheet. • Discover the relationships between the parts of a lever. • Observe the behavior of different kinds of levers. • Compare the effort to lift loads with different kinds of levers. • Diagram the relative positions and sizes of lever components in different systems. • Analyze tools in terms of their application as levers. • Observe and measure the effort to lift a load with single-fixed and single-movable pulley systems • Organize information on a data sheet. • Diagram and compare the components of four kinds of pulley systems. • Observe and measure the effort to lift a load with one- and two-pulley systems. • Organize information on a data sheet. • Determine the advantage of pulley systems. • Measure and compare the distance the effort and load traveled in different pulley 	<ul style="list-style-type: none"> • A lever is a tool that provides the user with an advantage. • Fulcrum, load, effort, and lever arm are the components of a lever. When the load is in one position in a class-1 lever, the greater the distance at which the effort is applied, the less effort it takes to lift the load. • The three kinds of levers differ in the arrangement of the load, effort, and fulcrum: <ul style="list-style-type: none"> -Fulcrum in the middle is a class-1 lever (crowbar) -Load in the middle is a class-2 lever (wheelbarrow). -Effort in the middle is a class-3 lever (Broom). • When a device reduces the effort needed to lift a load, there is an advantage. • Levers and pulleys are examples of simple machines. • Two single pulleys can be used to construct a multiple-pulley system. • Pulley systems can be described using diagrams. • There is a relationship between the number of ropes supporting a load in a pulley system and the effort required to lift a load. • There is a cost associated with the advantage in a pulley system

			<p>systems.</p> <ul style="list-style-type: none">• Construct a lever or pulley system to make a complex machine.• Research complex machines to find levers and pulleys.• Understand that human beings have made tools and machines to sense and do things that they could not otherwise sense or do at all, or as quickly, or as well.• Understand that technology has been part of life on earth since the advent of the human species. Like language, ritual, commerce, and the arts, technology is an intrinsic part of human culture, and it both shapes society and is shaped by it; and that the technology available to people greatly influences what their lives are like.	
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**GEMS-Net Common Science Curriculum
SIXTH GRADE**

Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Life Science: Ecosystems (STC)	S1a, S1c S2a, S2d, S2e S3c, S3d S4a, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6c, S6d, S6e S7a, S7b, S7d, S7e S8a	<p>Ecosystems help students understand the relationships between plants and animals and the interdependence of living things and their environment. Students set up an aquarium into which they introduce snails and guppies, and a terrarium into which they add crickets, isopods, and grass, mustard, and alfalfa seeds. Students connect the bottles to create an “ecocolumn” that enables them to observe the relationship between the two environments. Students then simulate the effects of pollutants such as road salt, fertilizer, and acid rain on their miniature ecosystems. Later, students read about, explore, and discuss the Chesapeake Bay as a model ecosystem. They analyze this environment from the viewpoint of various users- waterman, dairy farmer, land developer, recreational boater, and resident and present their findings to the class. This activity enables students to appreciate the trade-off that must be made to reach mutually acceptable solutions to environmental problems. The concepts in this unit could be extended to</p>	<ul style="list-style-type: none"> • Use a hand lens, graph paper, measuring devices, and other testing equipment appropriately. • Conduct, record and organize daily observations. • Plan, implement and analyze experiments and draw conclusions from the results. • Make and test hypotheses. • Identify ecosystems as stable or disturbed and recognize the causes of a disturbed ecosystem as natural or human-made. • Read for more information about ecosystems and pollution. • Communicate information through writing, drawing and discussions. • Apply previously learned information to analyze a problem and suggest solutions. • Develop sensitivity toward living things and understand that human behavior can positively or negatively affect them. • Respect evidence from an experiment and recognize that evidence can inform a decision. • Develop an interest in investigating ecosystems. • Recognize the importance of 	<ul style="list-style-type: none"> • An ecosystem is a community of organisms and its interaction with its environment. Organisms can be categorized by the functions they serve in an ecosystem: producers, consumers, or decomposers. • Organisms in an eco-system have dependent and interdependent relationships, which can be illustrated by food webs. • To maintain a relatively stable ecosystem, all organisms must be able to grow and reproduce. • Factors that affect growth and reproduction of organisms in an ecosystem include light, water, temperature, and soil. • Natural and human-made events can “disturb” an ecosystem. • Pollution is anything that can cause harm when too much of it is released into the environment. • Pollution is the condition that results when pollutants interact with the environment. • Pollutants can affect the stability of an ecosystem; solutions can help minimize or alleviate the effects of pollutants. • Model ecosystems can be used to learn more about the complex relationships that exist on earth.

		Narragansett Bay or another local ecosystem (deciduous forest, tidepools, etc.)	repeating experiments to get valid test results.	
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Physical Science: Magnets and Motors (STC)	S1a, S1b, S1c S2a, S2c, S2e S4a, S4b, S4c, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6c, S6d, S6e S7a, S7b, S7d S8a	In Magnets and Motors students can build on the knowledge and skills they gained in the Electric Circuits unit. They explore properties of magnets and then investigate the magnetic properties of electric currents. They experiment with ways to vary the strength of electromagnets. Also, students build and use a magnetic compass and assemble several increasingly complex electric motors. They dismantle, experiment with and reassemble a manufactured motor, at one point reversing it to form an electric generator.	<ul style="list-style-type: none"> • Observe, describe, record and predict. • Analyze variables and draw conclusions. • Apply trouble-shooting strategies. • Design controlled experiments and communicate their results by writing, drawing, and discussing. • Develop interest in technology of motors. • Appreciate scientific advances. • Understand science as a human endeavor. • Understand the development of electricity over time. • Understand the effects of electricity and motors on culture. • Design controlled experiments. 	<ul style="list-style-type: none"> • Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. • Electric currents and magnets can exert a force on each other. • Magnets attract and repel each other. • Magnetic forces can cause motion in motors. • There is a relationship between magnetic fields and compasses. • There is a relationship between magnetism and electricity.
Topic	New Standards Performance Standards	Science Content	The student will:	Unifying Concepts
Technology: Measuring Time (STC)	S1b, S1c S3c S4a, S4db, S4d S5a, S5b, S5c, S5d, S5e, S5f S6a, S6d, S6e S7a, S7b, S7d, S7e S8a, S8b, S8c	Measuring Time is divided into two major sections. In the first part of the unit, “Keeping Time With the Sun and the Moon,” sixth-graders explore the use of natural phenomena, such as the phases of the moon, to keep time. In the second section, “Investigating Invented Clocks,” the students conduct experiments using	<ul style="list-style-type: none"> • Predict/test/draw conclusions. • Use outside resources. • Problem solve based on learned knowledge. • Replicate/repeat experiments to verify results. • Develop positive attitude toward science. • Appreciate contributions/ 	<ul style="list-style-type: none"> • Time measurement can be based on natural cycles as in the shadows of the phases of the moon. • Mechanical devices can be made to measure time.

		<p>some of the instruments that have been used to keep time throughout the centuries. They build and experiment with a water clock and investigate the characteristics of the pendulum. Finally, they apply what they have learned to assemble and evaluate a clock escapement and modify the device in order to make it more accurate. The unit provides students with an opportunity to learn about concepts such as energy and motion, the science of astronomy, and how to measure time and to investigate machines</p>	<p>advances made by others.</p> <ul style="list-style-type: none"> • Understand that in earlier times, the accumulated information and techniques of each generation of workers were taught on the job directly to the next generation of workers. Today, the knowledge base for technology can be found as well in libraries of print and electronic resources and is often taught in the classroom. • Understand that throughout history, people have carried out impressive ethnological feats, some of which would be hard to duplicate today even with modern tools. The purpose served by these achievements has sometimes been practical, sometimes ceremonial. 	
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**7th Grade
Weather and Climate
Life Forms**

Content	Standard “New Standards Performance Standards” A = Application Stds. S = Science Stds.	Skills Upon completion the student will be able to:	Texts/Materials
SCIENTIFIC APPLICATIONS			
Scientific measurement General lab safety Laboratory procedures Lab reports	A1a A1b A1c A3a A4a	<ul style="list-style-type: none"> • Measure accurately using the metric system; • Practice good lab safety techniques; • Select and use tools appropriately; • Build and interpret models; • Plan and participate in investigations; • Demonstrate scientific competence by completing a controlled experiment; • Draw conclusions from experimental data and observations; • Write clear, complete, and accurate lab reports; • Identify problems; propose and implement solutions; and evaluate the accuracy, design, and outcomes of investigations; <p>Explain a scientific concept or procedure to other students.</p>	
WEATHER AND CLIMATE			
Introduction <ul style="list-style-type: none"> • Practical applications of weather in daily life; • Relationships between factors of weather; • Impact of humans upon weather and climate; • Impact of weather and climate upon humans; 	S4a S6a S7a S7d S3a A3b	<ul style="list-style-type: none"> • Read, interpret and create weather maps and reports; • Read, create, and use weather instruments; • Collect, graph, and interpret data over time; • Prepare for weather events; • Extrapolate and predict weather events; • Explain the symbols which represent weather factors; • Define and describe: <ul style="list-style-type: none"> - Air pressure; - Humidity; - Temperature; - Phases of matter, density; 	<i>Weather and Climate,</i> Prentice-Hall, © 2000, ISBN: 0-13434494-4

		<ul style="list-style-type: none"> - Air masses/fronts - Types of storms; - Lightning; - Causes of climate. 	
Atmosphere <ul style="list-style-type: none"> • Importance of • Composition of • Air quality issues: Smog, acid rain • Air pressure: Description of; types of barometers; units utilized • Layers • Global Weather Changes: Greenhouse effect; ozone 	<p>S3a</p> <p>S4d S4c</p> <p>S5c S5d</p> <p>S7a</p>	<p>Student will demonstrate understanding of:</p> <ul style="list-style-type: none"> • the structure of the earth’s systems – weather and climate • the impact of technology • health issues such as personal and environmental safety, and resources and environmental stress <p>The student will:</p> <ul style="list-style-type: none"> • Use evidence from reliable sources to develop descriptions, explanations and models • Propose, recognize, analyze, consider, and critique alternative explanation; and distinguish between fact and opinion • Represent data and results in multiple ways 	
Weather Factors <ul style="list-style-type: none"> • Heat transfer in the atmosphere: Radiation, conduction, convection • Wind: Formation of, instruments used, types of wind – global and local • Water content in the atmosphere: Humidity, types of precipitation 	<p>S1c, S3a</p> <p>S5b</p>	<p>Student will demonstrate understanding of:</p> <ul style="list-style-type: none"> • Transfer of energy, such as transformation of energy as heat; light, mechanical motion, and sound. <p>Student will:</p> <ul style="list-style-type: none"> • Use concepts from science standards 1 – 4 to explain a variety of observations and phenomena 	
Weather Patterns <ul style="list-style-type: none"> • Air masses – characteristics and types • Fronts – characteristics and types • Storms: Thunderstorms, tornadoes, hurricanes • Reading and creating weather maps 	<p>S4a</p> <p>S6b</p> <p>S6d</p>	<p>Student will demonstrate understanding of:</p> <ul style="list-style-type: none"> • Big ideas and unifying concepts such as order and organization; models form, and function; change and constancy; and cause and effect. <p>Student will:</p> <ul style="list-style-type: none"> • Record and store data using a variety of formats, such as data bases, audiotapes, and videotapes. • Acquire information from multiple sources, such as print, the Internet, computer data bases and experimentation. 	

LIFE FORMS			
<p>Introduction</p> <ul style="list-style-type: none"> • Variety of life, from simple to complex; • Changes and adaptations of life forms over time; • Characteristics and functions of life forms; • Life cycle; • Cell structure and function. 	<p>S2e S2b</p> <p>S6a</p> <p>S8a</p>	<ul style="list-style-type: none"> • Use a simple taxonomic key to identify an organism; • Identify the kingdoms and certain phyla based on physical characteristics; • Demonstrate appropriate use of scientific tools, i.e., microscope, etc. • Collect, graph and interpret data about living things; • Demonstrate understanding of and appreciation for the variety of life forms; • Demonstrate understanding of changes over time as the result of genetic changes; • Explain how certain animals have adapted to fit their environments; • Explain the life cycle of seed plants: <ul style="list-style-type: none"> - Pollination; - Fertilization; - Seed development and dispersal; - Growth of new plants; • Compare and contrast the life cycles of plants and animals; • Explain the organizational key used by scientists to classify life into groups; • Discuss the varying needs of living organisms which must be met for their survival; • Demonstrate an understanding of cell structure and function. 	<p><i>Organisms: Macro to Micro</i>, STC/MS, 2005, ISBN: 0-89278-900-X</p> <p><i>From Bacteria to Plants</i>, Prentice-Hall, © 2000, ISBN: 0-13434490-1</p> <p><i>Animals</i>, Prentice-Hall, © 2000 ISBN: 0-13434477-4</p> <p><i>Cells and Heredity</i>, Prentice-Hall, © 2000 ISBN: 0-13434479-0</p>
<p>What is life?</p> <ul style="list-style-type: none"> • Classifying life • The kingdoms of life 	<p>S2a</p> <p>S2b</p>	<p>Student will demonstrate understanding of:</p> <ul style="list-style-type: none"> • Structure and function in living systems, such as the complementary nature of structure and function in cells, organs, tissues, organ systems, whole organisms, and ecosystems. • Reproduction and heredity, such as sexual and asexual reproduction; and the role of genes and environment on trait expression. 	
<p>Virus and Bacteria</p> <ul style="list-style-type: none"> • Virus: Bridging gap of living and non-living • Bacteria: helpful – foods, decay; harmful - diseases 	<p>S5c</p> <p>S6a</p>	<p>Student will:</p> <ul style="list-style-type: none"> • Use evidence from reliable sources to develop descriptions, explanations, and models. • Use technology and tools (such as traditional laboratory equipment, video, and computer aids) to observe and measure objects, organisms, and phenomena, directly, indirectly, and remotely. 	

<p>Protists and Fungus</p> <ul style="list-style-type: none"> • Protists: Plantlike – eugleno; animal-like – amoeba • Fungus: Uses; types; anatomy; reproduction of 	<p>S5a S6a S8b</p>	<p>Student will:</p> <ul style="list-style-type: none"> • Frame questions to distinguish cause and effect; and identify or control variables in experimental and non-experimental research settings; • Use technology to observe and measure; • Demonstrate scientific competence by completing a full Fieldwork investigation 	
<p>Plants</p> <ul style="list-style-type: none"> • From simple to complex: mosses ≡ flowering plants • Plant tissues: methods of reproduction 	<p>S2a S2c S2e S5f S6d S7a S8b</p>	<p>Student will:</p> <ul style="list-style-type: none"> • Work individually and in teams to collect and share information and ideas; • Acquire information from multiple sources; • Represent data in multiple ways; • Do field work; • Demonstrate understanding of: <ul style="list-style-type: none"> - structure and function in living things; - response to environmental stimuli; - adaptations of organisms. 	

**8th Grade
Chemistry
Motion, Forces and Energy**

Content	Standards “New Standards Performance Standards” A = Applied Standards S = Science Standards	Skills Upon completion the student will be able to:	Texts/Materials
SCIENTIFIC APPLICATIONS			
Scientific measurement General lab safety Laboratory procedures Lab reports	A1a, b, c A3a A4a S5c, e S7a, b, c, d S8a, b, c, d	<ul style="list-style-type: none"> • Measure accurately using the metric system; • Practice good lab safety techniques; • Select and use tools appropriately; • Build and interpret models; • Plan and participate in investigations; • Demonstrate scientific competence by completing a controlled experiment; • Draw conclusions from experimental data and observations; • Write clear, complete, and accurate lab reports; • Identify problems; propose and implement solutions; and evaluate the accuracy, design, and outcomes of investigations; • Explain a scientific concept or procedure to other students. 	
CHEMISTRY		•	
Periodic Table of the Elements - Atomic mass - Atomic number	S1a, b, c S2a – e S3a – d S5a – f S7a, b, d, e	<ul style="list-style-type: none"> • Use the Periodic Table to obtain information; • Explain how the Periodic Table works as a reference tool; • Differentiate between a group and a period on the Periodic Table; 	<i>Properties of Matter,</i> STC/MS, © 2005, ISBN: 0-89278-891-7 <i>Chemical Building Blocks,</i> Prentice-Hall, © 2000, ISBN: 0-13434480-4
Properties of Matter - Mass, volume, density; - States of matter - Element, compound, atom - Atoms and bonding	S1a S2a – e S3a – d S4a	<ul style="list-style-type: none"> • Define density and compare densities of various objects; • Identify substances from characteristic chemical properties; 	<i>Chemical Interactions,</i> Prentice-Hall, © 2000, ISBN: 0-13434482-0

Chemical equations	S1a, c S4a	<ul style="list-style-type: none"> Balance simple chemical equations. 	
Chemical reactions <ul style="list-style-type: none"> Ionic; Covalent; Synthesis; Decomposition; Single and double replacement 	S1a S2c, d, e S4a, c S7a – e S8a – d	<ul style="list-style-type: none"> Identify substances from characteristic chemical properties; Differentiate between chemical and physical changes; Identify acids and bases using chemical indicators; Mixtures, solutions; Heat transfer 	
MOTION, FORCES AND ENERGY		Student will be able to:	
Motion <ul style="list-style-type: none"> Definitions/Descriptions Measurement Acceleration 	S1a, b, c S4a, b, d S5a – f S6a – e S7a, b, d, e S8a - d	<ul style="list-style-type: none"> Demonstrate understanding of motion and forces such as inertia and the net effects of balanced and unbalanced forces; Measure motion and speed; Analyze graphs; Calculate acceleration and deceleration using appropriate formulas Construct and use an accelerometer 	<i>Motion, Forces and Energy</i> , Prentice-Hall, © 2000, ISBN: 0-13434492-8
Forces <ul style="list-style-type: none"> Nature of force; Mass, acceleration; Friction, gravity; Action, reaction; “Center of balance” - 	S1a – c S4a, b, d S5a – f S6a – e S7a - e S8a - d	<ul style="list-style-type: none"> Measure forces; Analyze Newton’s Laws Calculate pull of gravity 	
Energy and Power <ul style="list-style-type: none"> Conversion and conservation Energy Power 	S1a – c S4a, b, d S5a – f S6a – e S7a – e S8a – d	<ul style="list-style-type: none"> Describe states of energy Calculate kinetic energy Explain how energy and work are related Relate mass, velocity and kinetic energy Collect and analyze data using mathematics concepts and techniques such as mean, median, and mode; Explain outcome probability and reliability; Develop appropriate data displays. 	

<p>Work and Machines</p> <ul style="list-style-type: none"> - MA, efficiency - Simple machines, singly and in combinations - Concepts of work and power 	<p>S1a, b, c S4a – d S5a – f S6a – e S7a – e S8a – d</p>	<ul style="list-style-type: none"> • Calculate $W = F \times d$ • Calculate power = $W \div t$ • Explain MA • Identify and explain the functions of simple machines 	
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ASTRONOMY

Content	Standards “AAAS Benchmarks 2061” And “New Standards Performance Standards”	Skills Upon completion the student will be able to:	Texts/Materials
Size and Scope of the Universe	<p>“<u>Benchmarks 2061</u>” All items under each of these standards: 2A 4A 9A, 9B, 9C, 9D 12B, 12C, 12D, 12E</p> <p>“<u>NSPS</u>” S4A S5B, S5C, S5D S5F S6A-E S7A-E S8D</p>	<ul style="list-style-type: none"> Use scale models to accurately describe the size and scale of the universe and its constituent parts. 	<p><i>Astronomy: Journey to the Cosmic Frontier</i>, © 2006, Glencoe – MacGraw Hill, pub. ISBN: 0-07-299181-X</p> <p><i>The universe at your fingertips</i>, © 1995, Astronomical Society of the Pacific, ISBN 1-886733-00-7</p> <p><i>Rockets</i>, NASA EG- 2003-01-108-HQ (Note: Publication is in the public domain)</p>
History of Astronomy	<p>“<u>Benchmarks 2061</u>” 1A, 1B, 1C 10A, 10B, 10C</p> <p>“<u>NSPS</u>” S3D S4E S5B, S5C, S5D, S5F S6A-E S7A-E S8D</p>	<ul style="list-style-type: none"> Describe contributions from important historical individuals and events which played a role in our current understanding of the universe. 	<p><i>Imagine the Universe</i>, NASA, EG-1997(09)-004-GSFC (Note: Publication is in the public domain.)</p> <p><i>Space Based Astronomy</i>, NASA EG2001-01-122-HQ (Note: Publication is in the public domain.)</p>
Light and Atoms	<p>“<u>Benchmarks 2061</u>” 4A, 4D, 4E, 4F, 4G</p> <p>“<u>NSPS</u>” S1A-D, S1F S3D S5F S6A-E S7A-E S8B, S8D</p>	<ul style="list-style-type: none"> Demonstrate knowledge of atomic structure, the role it plays in producing electromagnetic energy and how that energy is studied by astronomers to understand the nature of the universe. 	<p>Video <i>Apollo 13</i>, MCA Universal Home Video, © 1995.</p> <p><i>Contact</i>, Warner Home</p>

Telescopes	<u>“Benchmarks 2061”</u> 1A, 1B 3A, 3B 4A <u>“NSPS”</u> S1F S5F S6A-E S7A-E S8B, S8D	<ul style="list-style-type: none"> • Demonstrate knowledge of how the universe is explored. • Understand the kinds and uses of telescopes. 	Video, © 1997. <i>October Sky</i> , Universal Studios, © 1999. <i>Voyage to the Outer Planets and Beyond</i> , Today Home Entertainment, © 1992. <i>Powers of 10</i> , The films of Charles and Ray Eams, © 1978
Planets, Moon and Solar System	<u>“Benchmarks 2061”</u> 1A, 1B, 1C 2A, 2B, 2C 3A, 3B, 3C 4A, 4F, 4G 9A, 9B, 9C, 9D 10A, 10B 12A, 12B, 12C, 12, 12E <u>“NSPS”</u> SID, SIF S3A, S3C, S3D S4A, S4E S5F S6A-E S7A-E S8B, S8D	<ul style="list-style-type: none"> • Demonstrate knowledge of our celestial neighbors, their composition, relative sizes and structures, motion from a celestial and terrestrial perspective. • Present, using the PowerPoint software package, information about the solar system. 	<i>Nova: Time Travel</i> , WGBH Productions, © 1999. Audio <i>Star Date</i> Radio Program © University of Texas at Austin. Software <i>Orbits 3.0</i> © 1994, WinterTech Software. <i>Rocket Lab</i> © 1998, Quantum Scientific
Sun	<u>“Benchmarks 2061”</u> 4A, 4D, 4E, 4F, 4G 9A, 9C <u>“NSPS”</u> S1A-F S3A, S3D S5F S6A-E S7A-E S8B, S8D	<ul style="list-style-type: none"> • Understand and demonstrate knowledge of the processes that the sun uses in producing energy and gravity. 	
Stars	<u>“Benchmarks 2061”</u> 4A, 4D, 4E, 4F, 4G 9A, 9C <u>“NSPS”</u> S1A-F	<ul style="list-style-type: none"> • Understand the life cycles of stars, and predict the fate of a star based on its mass, temperature or color. • Identify stars by spectral classification. 	

	S3D S5F S6A-E S7A-E S8B, S8D		
Constellations	<u>“Benchmarks 2061”</u> 1B, 1C 2A, 2C 4A, 4D, 4E, 4F 9A, 9B, 9C <u>“NSPS”</u> S3D S4A, S4E S5F S6A-E S7A-E S8B, S8D	<ul style="list-style-type: none"> • Identify, in the night sky and on paper, common constellations and asterisms. • Understand differences in mythology from different cultures in relation to the constellations. • Build a planisphere, star locator. • Build a star clock. • Approximate setting times of visible stars and planets. 	
Galaxies	<u>“Benchmarks 2061”</u> 1A, 1B, 1C 2A, 2B, 2C 3A, 3B 4A, 4D, 4E, 4F, 4G 9A, 9B, 9C, 9D, 9E 10A, 10B, 10C 12A, 12B, 12C, 12D, 12E <u>“NSPS”</u> S3D S5F S6A-E S7A-E S8B S8D	<ul style="list-style-type: none"> • Identify galaxies by type and spectral classification. 	
Exotic Bodies - Black Holes - Worm Holes	<u>“Benchmarks 2061”</u> 1A, 1B, 1C 2A, 2B, 2C 3A, 3B 4A, 4D, 4E, 4F, 4G 9A, 9B, 9C, 9D, 9E 10A, 10B, 10C 12A, 12B, 12C, 12D, 12E <u>“NSPS”</u> S3D	<ul style="list-style-type: none"> • Describe the differences between many real and science fiction exotic bodies. • Explain the current knowledge about these and distinguish science fact from science fiction. 	

	S5F S6A-E S7A-E S8B, S8D		
Cosmology	<u>“Benchmarks 2061”</u> 1A, 1B, 1C 2A, 2B, 2C 3A, 3B 4A, 4D, 4E, 4F, 4G 9A, 9B, 9C, 9D, 9E 10A, 10B, 10C 12A, 12B, 12C, 12D, 12E <u>“NSPS”</u> S3D S5F S6A-E S7A-E S8B S8D	<ul style="list-style-type: none"> • Appreciate the different possible fates of the universe, and appreciate the ongoing research to attempt to settle on which one will be the correct one. 	
Space Exploration	<u>“Benchmarks 2061”</u> 1A, 1B, 1C 2A, 2B, 2C 3A, 3B, 3C 4A, 4F, 4G 9A, 9B, 9C, 9D, 9E 10A, 10B, 10C 12A, 12B, 12C, 12D, 12E <u>“NSPS”</u> S4A, S4D, S4E S5A, S5C, S5D, S5E, S5F S6A-E S7A-E S8A-D	<ul style="list-style-type: none"> • Understand the different modes of space exploration. • Appreciate the influences that space research plays in their everyday life. • Explain the principles of rocketry needed in space exploration. 	

BIOLOGY

Content	Standard “Benchmarks 2061”	Skills Upon completion the student will be able to:	Texts/Materials
Scientific Method	1A2, 3 2A2 1B1, 2, 3 1B6, 7	<ul style="list-style-type: none"> • Define biology as the study of life. • Explain why Aristotle’s theory was incorrect. • Alter hypothesis as additional information is given. • Identify the basic units of the International System of Measurement. • Explain the steps involved in applying the scientific method. • Formulate a hypothesis and design an experiment to test a given problem. • Compare and contrast biogenesis and abiogenesis. • Recount the steps in Redi’s, Spallanzan’s and Pasteur’s experiments. • State the theory of biogenesis. • Explain what is meant by the term spontaneous generation. • Describe the historical context in which Lamarck, Darwin, and Pasteur were developed. 	<p><i>Biology: An Everyday Experience</i>, © 2003, ISBN: 0-07-829749-4, Glencoe/ McGraw-Hill, pub. (General Education)</p> <p><i>Biology: Dynamics of Life</i>, ©2004, ISBN: 0-07-829900-4, Glencoe/McGraw-Hill, pub. (CCP and Honors)</p>
Cells	5C1	<ul style="list-style-type: none"> • Describe the fluid mosaic model of cell membrane structure. • Explain why it is important that the cell membrane is semipermeable. • Describe the process of diffusion through a semipermeable membrane and indicate the direction a substance will move relative to its concentration. • Describe the process of osmosis. • Explain the movement of particles across a cell membrane by facilitated diffusion. • Compare and contrast passive transport and active transport. • List the factors that determine whether or not a particle will permeate the cell membrane. • List and give examples of the levels of biological organization. • Identify the raw materials and products of cellular 	

<p>Cells, con't</p>	<p>5C3</p> <p>5C5 (AP)</p> <p>5C2</p> <p>5C7, 8 (AP)</p> <p>New Standards Performance Standard – Science: The student →</p>	<p>respiration and photosynthesis.</p> <ul style="list-style-type: none"> • Define homeostasis and explain how this balance of life processes allows an organism to survive in a wide range of environmental conditions. • Differentiate between growth and development of organisms. • List the various functions carried out by cells. • Compare and contrast endocytosis, phagocytosis, and exocytosis. • Describe protoplasm and differentiate between nucleoplasm and cytoplasm. • Explain and give examples of reactions involved in metabolism. • Explain how organelles contribute to division of labor in a cell. • Distinguish between eukaryotes and prokaryotes. • Diagram, label, and describe the functions of mitochondria, endoplasmic reticulum, ribosomes, Golgi bodies, vacuoles, lysosomes, microfilaments, and microtubules. • Explain the formation of lysosomes and their contents and relate lysosome function to phagocytosis. • Describe the production and secretion of certain cellular chemicals. • State the functions of chloroplasts, cell wall, centrioles, cilia, and flagella and identify they types of cells in which they are found. • List the structures and functions of the parts of the nucleus. • Describe cell fractionation as a separation of cell parts, which makes use of properties of cell parts. • Distinguish a step density gradient from a linear density gradient. • Distinguish between prokaryotic and eukaryotic cells. • Describe the optimal conditions for cellular functions. • Define the organic molecules found in living things. • Recognize compounds by their chemical configuration. • List contributions made by Hooke, Schleiden, Schwann, and Virchow in the development of the cell theory. • State and explain the components of the cell theory. 	
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		<ul style="list-style-type: none"> • Identify some instruments and techniques used to study cells. • Distinguish between unicellular and multicellular organisms. <p>S6a – Uses technology and tools (such as traditional laboratory equipment, video, and computer aids) to observe and measure objects, organisms, and phenomenon, directly, indirectly and remotely, with appropriate consideration of accuracy and precision.</p>	
Cell Reproduction	5B1, 2, 3, 4, 5, 6	<ul style="list-style-type: none"> • Distinguish between chromatin and chromosomes. • Define mitosis as the process in which chromosomes are replicated and distributed to new nuclei. • Describe the part of a cell’s life cycle known as interphase. • Diagram interphase and the four phases of mitosis, identify the various structures, and explain what happens in each phase. • Explain how mitosis usually results in genetic continuity. • Differentiate between the diploid number and the monoploid number of chromosomes in a cell. • Define homologous and homolog. • Explain the functions of the egg and sperm in the reproduction process. • Explain why life is a continuous process. • Compare and contrast zygote, sperm and egg. • Define meiosis as the process that produces monoploid reproductive cells. • Diagram the phases of meiosis in a male animal, identify the various structures, and explain what happens in each phase. • Compare and contrast meiosis in a male and female animal. • Compare and contrast the process of meiosis and the process of mitosis. 	
Genetics/DNA	5C4, 6 6E2, 4 8A2, 5 8F7 (AP)	<ul style="list-style-type: none"> • Define genetics and the study of heredity. • Differentiate between the F₁ generation and the F₂ generation. • State the law of dominance and explain how Mendel arrived at this conclusion. • Distinguish between dominant and recessive traits. • Describe a Punnett square and demonstrate its use in determining the possible combinations of characters among offspring. 	

<p>Genetic/DNA, con't</p>	<p>8F3, 5, 6 (AP)</p>	<ul style="list-style-type: none"> • State the law of segregation. • Compare and contrast genotype and phenotype. • Differentiate between homozygous and heterozygous. • Compare the genotypic and phenotypic ratios in the solution of a genetics problem. • State the law of independent assortment and give an example. • Describe an example in which a trait is governed by more than two alleles. • Use either the Punnett square method or product rule method to solve genetics problems involving multiple alleles. • Explain how a given genotype results in a particular phenotype. • Compare and contrast structural and regulator genes and an operator. • Explain the process of enzyme induction in a prokaryote. • Identify several factors that influence genetic control in eukaryotes. • Describe the reasoning used in developing the hypothesis that one allele for a trait is carried on one homolog and that the other allele is carried on the other homolog. • Differentiate between the X and Y chromosomes and their role in sex determination. • Describe an example of nondisjunction during meiosis. • State and explain the chromosome theory of heredity. • Explain how linked genes reduce the chances of genetic recombination and variety among offspring. • Explain how crossing-over tends to increase variety among offspring by separating linked genes. • Explain how scientists use the results of crossing-over to develop genetic maps. • Explain continuous variation and describe an example of several pairs of genes controlling one characteristic. • Describe examples that indicate environment may affect the expression of genes. • List several examples of human genetic disease caused by recessive alleles. • Explain the causes and symptoms of hemophilia and color- 	
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	<p>2B1, 3, 4</p> <p>2C2</p>	<p>blindness.</p> <ul style="list-style-type: none"> • List and explain the causes of human diseases caused by chromosome defects. • Describe several ways genetic diseases may be detected in humans. • Define Selective Breeding and discuss its usefulness. • Explain what a chromosomal alteration is and identify several kinds of chromosomal alterations. • Describe Griffith's experiment in which DNA caused transformation to occur in Pneumococcus bacteria. • Indicate how DNA nucleotides join. • Describe the structure and replication of DNA and relate this to the process of mitosis and meiosis. • Explain how differences in enzymes and other proteins can cause differences among cells. • Indicate that genes are responsible for the synthesis of proteins. • Explain why at least three bases in a row are needed to represent an amino acid. • Compare and contrast the structure of RNA and DNA. Describe the production of messenger RNA. • Explain the structure and function of transfer RNA. • Compare and contrast transcription and translation. • Distinguish gene mutations and chromosome mutations. Describe functions of DNA outside the cell nucleolus. <ul style="list-style-type: none"> • Analyze population's stability using the Hardy-Weinberg Principle. • Apply the rules of probability or use the Punnett square method to solve a problem involving a sex-linked characteristic. 	
<p>Evolution</p>	<p>10H1, 2</p> <p>5F1, 2, 3, 4, 5</p>	<ul style="list-style-type: none"> • Define and cite examples of fossils and describe how they are formed. • Describe how scientists use radioactive isotopes to determine the age of fossils. • Describe how fossil records are used to support the ideas that organisms living today are descendants of organisms that lived previously. 	

		<p>Lamarck and Darwin.</p> <ul style="list-style-type: none"> • Describe the atmosphere and energy conditions thought to exist early in Earth’s history. • Explain the steps that might have led to the evolution of the first cells according to the heterotroph hypothesis. • Compare gradualism and punctuated equilibrium. • Describe a hypothesis explaining how eukaryote cells may have evolved. 	
<p>Classification</p> <p>Classification, con’t</p>	<p>11A1, 2, 3, 4</p>	<ul style="list-style-type: none"> • Identify taxonomy as the science of classifying organisms. • Explain why it is necessary that all scientists use a common system of naming and classifying organisms. • Describe Aristotle’s system for classification. • Compare and contrast the classification system used by Aristotle and the system used by Linnaeus. • Describe the system of binomial nomenclature. • List factors that are used in classifying organisms: homologous structures, biochemical similarities, and genetics. • List the classification categories in order from general to specific. • Explain that more closely related organisms have more similar classifications. • Distinguish between autotrophs and heterotrophs. • Explain why many scientists use a kingdom system of classification. • List major traits of organisms in each of the five kingdoms. • Demonstrate the use of a taxonomic key. 	
<p>Plants and Animals</p>	<p>5A1, 2, 3</p> <p>New Standards Performance Standards – Science: The student produces evidence that demonstrates under-</p>	<ul style="list-style-type: none"> • Compare and contrast levels of complexity in land plants: function of roots, stems and leaves. • Describe differences in plant propagation. • Compare and contrast levels of complexity in animals – sponges through vertebrates. • Describe common traits of major animal phyla. • Relate animal adaptations to their environments. <p>S2a - The cell, such as cell structure and function relationships;</p>	

	standing of: →	<p>regulation and biochemistry; and energy and photosynthesis.</p> <p>S2b - Molecular basis of heredity, such as DNA, genes chromosomes, and mutations.</p> <p>S2c - Biological evolution, such as speciation, biodiversity, natural selection, and biological classification.</p> <p>S2d - Interdependence of organisms, such as conservation of matter; cooperation and competition among organisms in ecosystems; and human effects on the environment.</p> <p>S2e - Matter, energy, and organization in living systems, such as matter and energy flow through different levels of organization; and environmental constraints.</p> <p>S2f - Behavior of organisms, such as nervous system regulation; behavioral responses; and connections with sociology, anthropology and psychology.</p>	
Ecology	<p>5D1</p> <p>5D2</p> <p>5D3</p> <p>5E1</p> <p>5E2</p> <p>5E3</p>	<ul style="list-style-type: none"> • Explain how adaptations enable organisms to survive in their environments. • Define ecology as the study of the relationship between organisms and their environments. • Identify the organisms found in a community and suggest reasons why they must live together. • Differentiate between food producers and consumers. • Identify photosynthesis as the process by which producers use sunlight to make food. • Distinguish between and give examples of parasites and saprophytes. • Explain that organisms require energy for biological work. • Identify the raw materials and products of photosynthesis and explain the role of sunlight and chlorophyll in the process. • Explain how the sun can be the source of energy for producers, consumers, predators, and decomposers. • Give an example of a food chain and explain what happens to the materials and the energy used by a community. • Explain that a community depends on a constant supply of energy for its survival. 	

THE SCIENCE AND TECHNOLOGY OF BOATBUILDING

Content	Standard “Benchmarks 2061”	Skills Upon completion the student will be able to:	Texts/Materials
Defining Science and Technology	3A1, 3A2, 3A3 9A1, 9A2 9B1, 9B2	<ul style="list-style-type: none"> • Compare and contrast science and technology; • Give examples of current issues in science and technology; • Create an example of science vs. technology; • Explain how the advancement of science and technology has been a constant in the nautical world. 	No text
Scientific Method and Problem Solving	1A1, 1A2 1B1, 1B2	<ul style="list-style-type: none"> • State and define the steps of the scientific method; • Use the scientific method correctly to solve any problem; • Identify how and why reasoning is “key” in science; • Explain why collaboration is so important. 	
Evolutions of Ships Design Shipbuilding Tools and Techniques	1A1, 1A2, 1A3 1C1 7D1	<ul style="list-style-type: none"> • Relate advances in technology to the need for transportation, military superiority, and exploration; • Describe the different types of ships and how/why evolved; • Explain and discuss how tools used to build boats have evolved with the boats being built. 	
Ships Through the Ages	3B1, 3B2, 3B3 7A1, 7A2, 7A3, 7E3 10I1, 10I2, 10I3	<ul style="list-style-type: none"> • Discuss what happens to outdated scientific principals and old technologies; • Relate changes in technology to changes in society; • Describe boatbuilding techniques and tools and how they have advanced. 	
Case Studies: Boats in History	3A1 10G1, 10G2, 10G3, 10G4	<ul style="list-style-type: none"> • Follow the evolution of man through the evolution of boats; • Compare and contrast important boats throughout recorded history; • Describe the individual advances in science and technology 	

		for specific boats.	
What a Shipwright Does	9A1, 9A2	<ul style="list-style-type: none"> • Determine how and what changes the tools and materials used for building boats; • Describe how the process of building a boat has changed over time; • Define the position of a shipwright and understand his/her many positions. 	
Mathematics in Boats	2A1	<ul style="list-style-type: none"> • Use math application and principles to construct shapes helpful in building a boat; • Make a perfect rectangle using just a ruler; • Explain why mathematicians of the past are so important to the present; • Describe the principles of Pythagoras, Archimedes, Boyle, and Aristotle. 	
Designing a Hull (Lofting)	2B1	<ul style="list-style-type: none"> • Make parallel lines; • Label the tools of a draftsman; • Discuss the importance of the “lines” of a boat; • Describe how hulls react to fluids. 	
Drawing a Boat to Scale	2B1	<ul style="list-style-type: none"> • Explain the importance of drawing first...building later; • Use knowledge of hull types to draw. 	
Planning to Make a Model	8A1, 8A2, 8A3 9A1, 9A2 9B1, 9B2	<ul style="list-style-type: none"> • Use tools and tables for scale drawings; • Explore the different types of boat hulls and choose a type that suits your needs; • Explore the different types of building materials and assess each one’s viability. 	
Scale in Modeling	11B1, 11B2 11D1	<ul style="list-style-type: none"> • Show a direct parallel between the model and a full sized vessel; • Understand the scale of things in the world in relation to 	

		<p>each other;</p> <ul style="list-style-type: none"> • Use correctly the tools that model makers employ in their craft. 	
Building Your Model	1A2 11B1	<ul style="list-style-type: none"> • Safely build a model of a boat of your design; • Use tools to form Styrofoam and plaster into a working, testable model. 	
Testing Your Designs	1A2 3B1, 3B2, 3B3	<ul style="list-style-type: none"> • Design an experiment to test your boat's capability and efficiency against others; • Determine what apparatus would accurately test the vessels; • Race your boat against others. 	
STATE CERTIFICATION Chapter 1		<ul style="list-style-type: none"> • Identify the different types of hulls and their performance characteristics; • Identify the basic parts of a boat, a PWC and a sailboat; • Identify the different kinds of engines commonly found in recreational vessels and their uses. 	
STATE CERTIFICATION Chapter 2		<ul style="list-style-type: none"> • Locate and understand a vessel's capacity plate; • Know how to file a proper float plan; • Fuel a vessel safely; • Launch and retrieve a vessel from a trailer safely and courteously; • Know what to do to prevent theft; • Know the basics of vessel and engine maintenance. 	
STATE CERTIFICATION Chapter 3		<ul style="list-style-type: none"> • Understand dangers inherent in boating near dams, locks and bridges and effects of tides and currents on vessels; • Be able to anchor correctly; • Be able to operate PWC safely and courteously; • Be strongly aware that power is required for steering control of PWC; • Understand how ignition safety switches work; • Be able to cast off and dock under different wind and current conditions; • Know three major responsibilities of a vessel operator; • Know what to do when encountering other boats. 	
STATE CERTIFICATION		<ul style="list-style-type: none"> • Know which boats need to be registered and how to do so; • Correctly place certificate numbers and validation decal on 	

<p>Chapter 4</p>		<p>vessel;</p> <ul style="list-style-type: none"> • Know where to find HIN number; • Know age and education restrictions on motorboat or PWC operation; • List reckless behaviors that should be avoided when operating a vessel; • Explain dangers of consuming alcohol or drugs while boating and penalties for doing so; • Identify classifications and uses of personal flotation devices and state legal requirements; • Know legal requirements for fire extinguishers, flame arrestors, ventilation systems and mufflers; • Know legal requirements for towing a skier with a vessel understand how to properly dispose of waste, oil and trash and properly use MSD. 	
<p>STATE CERTIFICATION Chapter 5</p>		<ul style="list-style-type: none"> • Understand how to practice risk management while boating; • Understand the effects of boating stressors; • Understand how dehydration occurs and how to recognize and prevent it; • Understand the increased effects of alcohol on the water; • Properly size a PFD for a wearer and check a PFD's condition; • Know how to avoid collisions; • Take the proper safety actions if a vessel capsizes, is swamped, or runs aground; • Respond properly to a fire emergency; • Recognize the symptoms of hypothermia, avoid hypothermia if trapped in cold water, and give basic treatment to victims; • Know how to prevent and be able to recognize the symptoms of carbon monoxide poisoning; • Obtain weather forecasts and recognize weather warnings and know what to do if caught in foul weather; 	
<p>STATE CERTIFICATION Chapter 6</p>		<ul style="list-style-type: none"> • Understand vessel operator's responsibility to their passengers; • Understand vessel owner's responsibility when allowing others to use his or her vessel; 	

		<ul style="list-style-type: none"> • Understand boaters' responsibility to environment; • Properly tow skier and recognize skier hand signals; • Understand shared responsibilities of all those enjoying the waters -- boaters, swimmers, anglers, water skiers, divers, windsurfers, canoeists and kayakers, and hunters/ 	
Making Frames	12A-D All standards	<ul style="list-style-type: none"> • Use mathematical principles and theories to create perfect frames on which the boat will be built; • Use T-squares, Scribes, and saws appropriately; • Determine which adhesives to use and why. 	
Form and Function of Skeleton	12A-D All standards	<ul style="list-style-type: none"> • Discuss how the whole is only as good as the sum of its parts; • Explain why accuracy and precision early on is so important; • Explain why the vessel needs a frame and how it will work; • Make the framework. 	
Why the Finish Matters: Mini-lab	12A-D All standards	<ul style="list-style-type: none"> • Determine which material would be best suited for the exterior of the boat and explain why; • Maintain high standards throughout the boatbuilding process; • Finish boat to be ready for sea trials and experimentation. 	
Pride and Accomplishment	12A-D All standards	<ul style="list-style-type: none"> • Describe why your boat was a success or failure; • Determine the significant events in class that lead to the boat's completion; • Reflect on a project with all of its ups and downs; • Enjoy the benefits of a job well done; • Bask in the glory of your personal accomplishments and those of your peers; 	

HUMAN ANATOMY AND PHYSIOLOGY

Content	Standard “New Standards Performance Standards	Skills Upon completion the student will be able to:	Texts/Materials
Scientific Inquiry	<p>Throughout the content areas, the following <u>Applied Learning Standards</u> may be present: A1a, A1b A2a, A2b, A2c A3c, A3c, A3d, A3e A4b, A4c A5a, A5b</p> <p>Throughout the content areas, the following performance standards may be present: SCIENCE S1a-e, S2a-f, S4a-e, S5a-f S6a-e, S7a-e, S8a-d ENGLISH/LANG. ARTS E1a, E1c, E2a-f, E3a-d, E4a-b E7b MATHEMATICS M1a, e, f, h, k; M2d, k M3e, f, h, k; M4a, e, f, g M5a-c; M6a ,b ,e ,g, j, l, m M7a-f; M8a, c</p>	<ul style="list-style-type: none"> • Questioning: Ask questions at various levels and refine questions to develop experimental procedures; • Laboratory Processes: Design investigations/experiments; • Identify variable, formulate hypotheses, control variables, make operational definitions, collect qualitative and/or quantitative data, constructing a data table, graphing, analyzing, and interpreting data and/or drawing conclusions; • Reporting Produce written reports of laboratory activities in accepted formats and use precise language for presentations or procedure, tables of data, graphs, analytical methods, results, and analyses or error; • Evaluate procedures, data, and conclusions to determine scientific validity; • Reference Technology: Demonstrate appropriate use of reference sources to access, analyze, evaluate and present information related to research problems, including use of current technologies such as CD-ROM, Internet and on-line data search to explore current research related to a science concept; • Safety: learn and use safety procedures specific to an investigation or research activity. 	<p><i>Essentials of Human Anatomy and Physiology, 7th ed.,</i> © 2003, ISBN 0-8053-0012-0, Pearson Prentice-Hall, pub.</p>
Scientific Enterprise		<ul style="list-style-type: none"> • Demonstrate understanding of, analyze, interpret, and discuss current issues such as ethics and technology 	
Technology and Science		<ul style="list-style-type: none"> • Use mathematics, creativity, logic and originality to improve upon technological problems that affect society. 	
Diversity of Life		<ul style="list-style-type: none"> • Compare and contrast anatomical and physiological variations of organisms. 	
Heredity		<ul style="list-style-type: none"> • Demonstrate understand of the processes involved in genetic variations and combinations. 	
Cells and Human Identity		<ul style="list-style-type: none"> • Differentiate between the cellular components of blood in terms of morphology, function, and origin; • Analyze the composition and role of blood plasma; • Relate functions of blood to homeostasis; • Explain the basis for blood typing; • Describe common blood disorders in terms of origin, 	

		<ul style="list-style-type: none"> manifestation, and treatment; Examine the macroscopic and microscopic structure of a typical bone; State functions and identify locations of red and yellow marrow; Describe the cells of the nervous system, differentiate between afferent and efferent fibers Identify compounds and elements necessary for maintaining life; Identify structural units for carbohydrates, lipids, proteins, and nucleic acids; Evaluate components of chemical reactions; Identify types of synthesis reactions; Compare and contrast methods of cell reproduction; Define the mechanisms that control transport of materials through plasma membrane; Illustrate how enzymes regulate cell activity and how DNA controls enzyme production; Explain interactions between organelles and how each organelle is related to cell function; 	<p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Analysis master</p>
Human Development		<ul style="list-style-type: none"> Relate the process of meiosis to formation of gametes; Describe the progression in the development of a fertilized egg; Explain the terms zygote, embryo, and fetus; Distinguish conditions required for ovulation, fertilization, and menstruation; Analyze the effects of male and female hormones during and after puberty; Describe common reproductive disorders in terms of origin, manifestation, and treatment. 	<p>Evaluation master</p>
Basic Functions		<ul style="list-style-type: none"> Structure, Function Definitions: Distinguish between the terms anatomy and physiology; Describe the levels of body organization; assess the relationships between organs and organ systems; describe anatomical positions and body regions when comparing relationships of body organs and structures; Identify mechanisms of homeostasis. Tissue Types: Differentiate among the three types of muscle tissue based upon their structure and function; Describe the basis for classifying connective tissue; Characterize neuron as functional unit of nervous system; Classify epithelial tissue based on location and functional characteristics. Integumentary - Structure and Function: Explain skin 	<p>Evaluation master</p> <p>Evaluation master</p>

		<p>structure and function;</p> <ul style="list-style-type: none"> • Identify factors contributing to the coloration of the skin; • Describe accessory organs of the skin. • Integumentary - Temperature Regulation: explain how the skin regulates the temperature of the body. • Skeletal - Enchondral/Intramembranous/Bone: Discuss the formation of endochondral and intramembranous bone and bone remodeling. • Skeletal - Structure and Function: Identify major bones of the axial and appendicular skeletons; • Distinguish between male and female skeletons. • Muscles - Structure and Function: Identify several skeletal muscles and the actions of each to produce movement; • Demonstrate different types of muscular movements and contractions.de • Muscles - Neurochemical Contraction: analyze the chemical and electrical events which occur in muscle contraction. • Muscle Exercise: determine changes which occur in muscular exercise; • Analyze factors that contribute to healthy muscles. • Nervous System - Structure and Function: explain the divisions of the nervous system and their activity in response to sensory input. • Nervous System - Membrane Potential: describe neuronal activity and distinguish between resting and action membrane potentials. • Sense Organs - Structure and Function: explain the structure and function of various sense organs. • Endocrine Structure and Function: differentiate between endocrine and exocrine glands; • Illustrate location of endocrine glands; • Describe function of each endocrine gland in terms of chemical physiology. • Endocrine System - Hormones: list the various hormones produced by each endocrine gland and the response each hormone generates; • Analyze hormones as regulators; • Describe the chemical process of entry and physiology effects of steroids and nonsteroid hormones on target cells. • Circulatory System - Structure/Function: describe the structure, function, and location of the parts of the heart; • Interpret cardiac physiology in terms of the cardiac cycle; • Compare and contrast structure and function of arteries, arterioles, capillaries, venules, and veins; 	<p>Evaluation master</p> <p>Evaluation master</p> <p>Analysis develop</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Analysis master</p> <p>Analysis master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation master</p> <p>Evaluation develop</p>
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<p>Physical Health</p>		<ul style="list-style-type: none"> • Skeletal - Disorder and Disease: describe skeletal changes associated with disease, disorders, injury, age and stress. • Nervous System - Disorders: identify disorders of the nervous system. • Sense Organs – Disorders and Correction: explain disorders of sense organs which do not function properly and the role of 	<p>Evaluation develop</p> <p>Evaluation master</p>

		<p>technology in compensating for those malfunctions.</p> <ul style="list-style-type: none"> • Integumentary – Disorders: describe common integumentary system disorders in terms of origin, manifestations, and treatment. • Muscle Physiology and Disease: analyze the impact of medical technology on muscle physiology and disease. • Endocrine – Hormones/Diseases/Disorders: identify common disorders or diseases of the endocrine system. • Circulatory – Regulation and Disorders: describe factors which affect blood pressure and regulate blood flow; • Analyze the social and economic impact of medical technology on cardiovascular disorders. 	<p>Evaluation develop</p> <p>Evaluation develop</p> <p>Analysis develop</p> <p>Application master</p> <p>Evaluation master</p>
Mental Health		<ul style="list-style-type: none"> • Describe what constitutes good mental health and the possible effects of biological or chemical abnormalities. 	
Health Technology		<ul style="list-style-type: none"> • Demonstrate understanding of and demonstrate how current technology, research, diagnosis, and treatment apply to improving both mental and physical health. 	

COMPARATIVE ANATOMY (ZOOLOGY)

Content	Standard “Benchmarks 2061”	Skills Upon completion the student will be able to:	Texts/Materials
Animal reproduction	3A1 3A2 5C4 5B1 5B2 5B3 6C4	<ul style="list-style-type: none"> • Compare and contrast budding and fragmentation in animals and give an example of each. • Explain asexual reproduction by parthenogenesis. • Compare and contrast animal life cycles. • List four conditions necessary for fertilization in animals. • Describe external reproduction in frogs and explain how the conditions necessary for fertilization are met. • Describe internal reproduction in grasshoppers and explain how the conditions necessary for fertilization are met. • Explain how estrous cycles and courtship patterns are adaptive. 	<i>Biology</i> , © 2006, ISBN: 0-13-166255-4, Pearson Prentice-Hall, pub.
Animal development	6B1 6C1 6E1 6E2	<ul style="list-style-type: none"> • Define embryology as the study of development of organisms and list life functions of an embryo. • List different ways by which embryos that develop externally are protected. • Describe frog metamorphosis and relate the pattern of development to the basic functions carried out by all embryos. • Compare and contrast complete and incomplete metamorphosis. • List the four membranes that develop from the embryo within the shelled egg and describe the function of each. • Describe development in monotremes. • Describe the development of marsupials and explain why this development is only partially internal. • Describe the formation of the placenta and the umbilical cord in placental mammals. • Explain the exchange of materials between embryo and mother in placental mammals. • Compare and contrast parental care of mammals with that of other animals. • Compare and contrast cleavage in a frog and a chick. • Identify the blastula as a ball of cells with a blastocoel. • Compare and contrast the development and characteristics of fraternal twins and identical twins. • Describe the series of events by which a blastula develops into a gastrula. • Define morphogenesis. • Explain that differentiation is that part of development leading to 	

		<ul style="list-style-type: none"> the formation of specialized body parts. Describe the formation of the neural tube. 	
Food getting and digestion	5C2 5C3 5C4	<ul style="list-style-type: none"> Describe the processes of filter feeding, chunk feeding, and digestion in sponges, hydra, planaria, and earthworms. Compare and contrast “two way traffic” and “one way traffic” digestive systems. Compare and contrast food getting and digestion in an arthropod and a starfish. Describe the functions of the mouth, pharynx, and esophagus in the human digestive system. List and describe the digestive processes that occur in the stomach of a human. Explain the role of the liver, gallbladder, and pancreas in the digestive process. List the enzymes that function in the small intestine and indicate the types of food the enzymes affect and the products of the reactions. Describe the absorption process and the various structures and systems involved as it occurs in the small intestine. Describe the structure and function of the large intestine. 	
Transport	5C2 5C3 5C4	<ul style="list-style-type: none"> Describe the transport system as a link between the cells of an animal and its environment. Describe the circulatory system in earthworms and compare and contrast it with that of arthropods. Describe the circulatory system in fish and indicate how it is different from those in earthworms and arthropods. Compare and contrast the heart structures and circulatory systems in amphibians and reptiles. Describe the heart structure and circulatory system in a human. 	
Respiration and excretion	5C2 5C3 5C4	<ul style="list-style-type: none"> Define respiration, differentiate between internal and external respiration, and explain that a moist area with a large surface is necessary for gas exchange. Compare and contrast respiration in <u>Nereis</u> and an earthworm. Describe the respiratory system in complex aquatic animals and explain the function of the gills. Describe the respiratory system of insects. Describe the various means of respiration in adult amphibians. Identify and indicate the function of each of the structures of the human respiratory system. Differentiate between respiration and breathing. Compare and contrast inspiration and expiration. Define excretion and explain why organisms must rid themselves of nitrogenous wastes. 	

		<ul style="list-style-type: none"> • Describe how planarians maintain osmotic balance and remove wastes. • Compare and contrast excretion in the earthworm and grasshopper. • Explain the human kidney nephron structure and describe the function of each structure. • Compare and contrast the function of the kidney in freshwater bony fish, marine bony fish, amphibians, birds, reptiles, and desert mammals. 	
Support and locomotion	5C1	<ul style="list-style-type: none"> • Compare and contrast support in aquatic and land animals. • Compare and contrast the activities of animals lacking skeletal systems with those having skeletal systems. • Compare and contrast the advantages and disadvantages of an exoskeleton. • Compare and contrast the structures and functions of an exoskeleton and an endoskeleton. • Describe the composition of bone and explain the importance of ossification of bone formation. • Describe locomotion in coelenterates, the earthworm, and <u>Nereis</u>. • Compare and contrast locomotion in clams and starfish. • Compare and contrast the point of origin and point of insertion of a muscle. • Describe the interaction of flexor and extensor muscles. • Explain why muscle tone is important for support of the body. • Compare and contrast the structures and functions of the three kinds of muscle found in vertebrates – striated, smooth, and cardiac. 	
Nervous control	5C4 6C2 6C3 5C2	<ul style="list-style-type: none"> • Explain that homeostasis is maintained by chemical and nervous control systems. • Compare and contrast the functions of receptors, conductors, and effectors. • Compare and contrast the functions of sensory neurons, motor neurons, and interneurons. • Differentiate between axons and dendrites and indicate their functions. • Compare the sensory organs in lower animals to vertebrates. • Compare vertebrate sensory organs across the classes. 	
Behavior	6B2 6B3 6B4	<ul style="list-style-type: none"> • Define behavior as the pattern of activities of an organism in reaction to stimuli. • Explain the relationship between the complexity of an organism and the complexity of its behavior. • Define innate behavior as behavior that is inherited. • Explain why a reflex is considered to be innate behavior. 	

		<ul style="list-style-type: none">• Distinguish between a reflex and an instinct.• List factors that may be involved in the migration of birds.• Explain the adaptive advantages of courtship behavior and give an example of such behavior.• Describe examples of behavior controlled by a biological clock.• Compare and contrast learned behavior and innate behavior.• Describe the use of motivation, reward, and punishment in the experiment involving the T-maze and earthworms.• Distinguish between the two types of conditioning.• Describe the learning pattern called imprinting.• Compare and contrast trial and error learning and insight.• Describe the manner of communication among bees as observed by Karl von Frisch• Define pheromones and give several examples of their functions.	
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Earth Science Curriculum

Content	Standards New Standards Performance Standards	Skills Upon completion, student will be able to:	Texts/Materials
Volcanoes	<ul style="list-style-type: none"> • S3 a, b, c, e • S4 a, b, c, d, e • S5 a, d, e • S6 a, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • understand the parts of a volcano and their functions. • differentiate the different types of volcanoes. • understand which types of volcanoes form where and why. • apply the concept of silica content to magma composition and rate of flow. • be able to differentiate between size of volcanic eruptions and how they are measured. • differentiate between the three types of tephra plumes. • understand the effects of volcanoes on the formation of the Earth's early atmosphere. • understand the effects of volcanoes on the Earth's global weather. 	<p><i>Earth's Fluid Spheres</i>, © 2001, ISBN: 1-58591-057-0, It's About Time, pub.</p> <p><i>Earth's Natural Resources</i>, © 2001, ISBN: 1-58591-058-9, It's About Time, pub.</p> <p><i>Earth System Evolution</i>, © 2001, ISBN: 1-58591-058-7, It's About Time, pub.</p>
Plate Tectonics	<ul style="list-style-type: none"> • S3 a, b, c • S4 a, b, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • understand the difference between eras and periods. • understand the transition in the Earth's appearance from Pangaea through modern day and make a valid conclusion of what the Earth will look like in the future. • differentiate between the continental drift theory and plate tectonics. • show an understanding of the Earth's internal structure. • differentiate between the lithosphere and asthenosphere and their relation to one another with respect to plate movement. • show an understanding of the number and location of the Earth's plates. • differentiate between the three types of plate boundaries. • understand the physical features/effects that occur due to plate interaction. 	
Earthquakes	<ul style="list-style-type: none"> • S3 a, c • S4 a, b, c, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • understand how and why earthquakes form. • differentiate between tension, compression, and shearing forces. • differentiate between rock fractures, faults, and folds. • differentiate between focus and epicenter. • differentiate between the different types of seismic waves. • explain how earthquakes are measured and compared. • evaluate the effects of earthquakes on their community. 	
Geographic Landforms and Topography	<ul style="list-style-type: none"> • S3 b, c • S4 a • S6 a • S7 a 	<ul style="list-style-type: none"> • define topography and be able to use and create different types of maps. • differentiate between the types of oceanic landforms. • differentiate between the types of continental landforms. • determine the effects of glaciers on local topography and geology. 	
Oceans	<ul style="list-style-type: none"> • S3 a, b, c, e 	<ul style="list-style-type: none"> • list the Earth's oceans and their relative sizes with respect to area 	

	<ul style="list-style-type: none"> • S4 a, b, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<p>and depth.</p> <ul style="list-style-type: none"> • analyze the effects of depth on pressure and temperature. • determine the level of ocean water salinity due to geographic locations and its affect on density. • understand the effects of ocean water circulation. • understand how the Earth’s rotation influences the direction of surface currents. • apply their knowledge of water circulation and heat transfer to the oscillation of weather patterns. • show a relationship between global conditions and weather patterns. 	
Severe Weather	<ul style="list-style-type: none"> • S3 a, b, c • S4 a, b, c, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • differentiate between the layers of the Earth’s atmosphere and the temperature and air pressure within the different layers. • differentiate the types of air masses. • understand how air masses move due to change in atmospheric conditions. • explain the role of the water cycle in cloud formation. • differentiate between the types of clouds. • evaluate the conditions between the types of precipitation formation. • explain the formation and dispersion of thunderstorms. • describe the conditions for lightning formation and its effects. • show an understanding of what conditions create floods. • demonstrate an understanding of severe weather formation. • read and interpret a weather map and be able to accurately forecast possible weather conditions from a reliable source. • track a hurricane formation and its path of travel. 	
Universe	<ul style="list-style-type: none"> • S3 a, b, c, d • S4 a, b, c, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • demonstrate an understanding of the theories behind the formation of the universe. • describe the major steps in the life cycle of a star. • demonstrate a knowledge of the size, scale, and age of the universe. 	
Solar System	<ul style="list-style-type: none"> • S3 a, b, c, d • S4 a, b, c, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • name the components of our solar system including size, position, and composition. • derive an explanation for the change in seasons. • be able to demonstrate an understanding of Kepler’s three laws of planetary motion. • have an understanding of the electromagnetic spectrum. 	
Earth/Moon System	<ul style="list-style-type: none"> • S3 a, b, c, d • S4 a, b, c, d, e • S5 a, b, c, d, e, f 	<ul style="list-style-type: none"> • show an understanding of the moon’s phases. • to differentiate between sidereal and synodic orbits. • understand the relationship of the moon and its position to tidal 	

	<ul style="list-style-type: none"> • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<p>patterns of the Earth.</p> <ul style="list-style-type: none"> • compare and contrast the surface features of the moon and the effects of space weathering. • have an understanding of the relationship of planetary bodies to impacts with Earth and/or moon. 	
Energy Sources	<ul style="list-style-type: none"> • S3 a, b, c, e • S4 a, c, d, e • S5 a, b, c, d, e, f • S6 a, b, c, d, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • identify the major types of energy sources. • decipher between a renewable and non-renewable energy source. • demonstrate how energy is transformed into usable forms. • understand how energy sources are recovered. • show an understanding of the formation and location of fossil fuels. • explain the differences between the three types of heat transfer. • express how the recovery of energy sources have a negative effect on the Earth's systems. 	
Rocks and Minerals	<ul style="list-style-type: none"> • S3 a, b, c • S4 a, c, d, e • S5 a, b, c, d, e, f • S6 a, e • S7 e • S8 a, b, c, d 	<ul style="list-style-type: none"> • identify the three types of rocks and express an understanding of the rock cycle. • show an understanding in the forms of rock decomposition. • differentiate between the physical properties used to classify types of minerals. • explain how minerals have been deposited and indicate where they are likely to be found. 	

ENVIRONMENTAL SCIENCE

Content	Standards AAAS Benchmarks 2061	Skills <i>Upon completion the student will be able to:</i>	Texts/Materials
Biogeochemical Cycles	4C1	<ul style="list-style-type: none"> • Understand the cycling of matter through the environment • Evaluate a diagram of a biogeochemical cycle and be able to identify the flow and change of the matter 	College Prep: <i>Environmental Science: How the World Works and Your Place in It (3rd edition)</i> , © 2005, ISBN: 0-920008-92-5, J.M. LeBel, Publishers Advanced Placement: <i>Living in the Environment, (12th Edition)</i> , Prentice Hall, Publishers
	4C2	<ul style="list-style-type: none"> • Analyze the parts of the rock cycle • Identify processes of change in rock cycle • Identify and describe three major rock types: igneous, sedimentary and metamorphic • Trace a route through the rock cycle from any given starting point 	
Transformation of Energy	4E3	<ul style="list-style-type: none"> • Explain how heat can be transferred through materials and how currents will be set up in fluids • Describe and analyze applications of currents in the environment 	
	4E6	<ul style="list-style-type: none"> • Explain the release of energy when nuclei of some atoms combine and when some atoms split • Explain the steps in harnessing the energy released by nuclear reactions to provide electricity to humans 	
	5E2	<ul style="list-style-type: none"> • Explain how energy, water, oxygen and minerals limit the amount of life supported by an ecosystem. • Explain the processes by which matter is cycled through an ecosystem. • Explain how human activities and technology change the flow of matter in the ecosystem. 	
Biodiversity	5A1	<ul style="list-style-type: none"> • Explain how variation in a population increases the chances of survival in changing environments • Identify adaptations of organisms to their environments • Describe advantages of organisms' adaptations to their environments both in the past and in the present 	
Adaptations	5F3	<ul style="list-style-type: none"> • Identify the mechanisms for evolution • Explain the advantages of certain characteristics in survival of species in certain environments 	
	5F6	<ul style="list-style-type: none"> • Explain the role of natural selection in a species survival 	

		<p>in particular environments</p> <ul style="list-style-type: none"> • Describe the effect of a changing environment on a population of organisms 	
Biomes and Ecosystems	5D1	<ul style="list-style-type: none"> • Identify environmental factors that affect populations of organisms • Describe stages in ecosystem recovery after natural and human-influenced disasters 	
	5D2	<ul style="list-style-type: none"> • Identify the climate changes that have occurred in the past and may be occurring now and in the future • Describe the effect of climate changes on an ecosystem • Identify and describe systems besides climate change that influence an ecosystem 	
Food webs	5E3	<ul style="list-style-type: none"> • Identify and be able to trace through a food web the molecules of essential elements and compounds which living organisms require • Recognize the various ways that the molecules combine and recombine in a food web • Describe the one-way flow of energy through a food web • Be able to trace the energy that originates from the sun or another energy source through a food web • Apply the Second Law of Thermodynamics to the various trophic levels of food webs 	
Fossil Fuels and Limiting Factors	5E1	<ul style="list-style-type: none"> • Identify environmental factors leading to the formation of fossil fuels • Describe the formation of the various forms of fossil fuels • Identify the major types of fossil fuels • Describe the advantages and disadvantages of using each type of fossil fuel as an energy source • Describe the environmental impact of burning each type of fossil fuel 	
	5E2	<ul style="list-style-type: none"> • Identify and describe the limiting factors of various ecosystems • Explain how human activities and technology affect limiting factors in the environment 	
Human Population	7C1	<ul style="list-style-type: none"> • Identify the factors that impact the size and rate of growth of human populations • Apply the “Rule of 70” to determine doubling time for a human population 	
	7C4	<ul style="list-style-type: none"> • Identify and describe government policies that influence human population growth in various countries • Describe the advantages and disadvantages to the 	

		government policies and incentives	
Human Population and Technology	7C1	<ul style="list-style-type: none"> Describe the interrelationship between rate of growth of human populations and various economical, religious, political, technological and environmental factors 	
	7C2	<ul style="list-style-type: none"> Identify and describe how decisions of one generation affect the range of possibilities available to the next generation 	
	7C4	<ul style="list-style-type: none"> Identify and describe ways in which government both brings about and impedes change in human populations 	
Complexities of Decision Making	7D1	<ul style="list-style-type: none"> Compare and contrast the benefits and costs of proposed choices concerning an environmental issue 	
	7D2	<ul style="list-style-type: none"> Answer an environmental question and identify the parties who will receive the benefits and those that will bear the cost 	
	7D3	<ul style="list-style-type: none"> Identify and describe the generational effects of environmental decisions 	
Technology and Science	3A1	<ul style="list-style-type: none"> Identify and describe the role of technology in environmental research Explain the advantages and disadvantages that technology plays in this research 	
	3A3	<ul style="list-style-type: none"> Identify the roles of science and technology in identifying, researching and solving environmental problems 	
Designs and Systems	3B3	<ul style="list-style-type: none"> Identify and analyze controls within a system, including human controls 	
	3B4	<ul style="list-style-type: none"> Identify types of risk Describe the steps of risk analysis when analyzing an environmental problem and its solution 	
	3B5	<ul style="list-style-type: none"> Identify components of complex systems and describe ways in which systems function Identify components of a system that detect, bypass, back up or compensate for minor failures 	

LANDSCAPE DESIGN

Content	Standard New Standards Performance Standards	Skills Upon completion the student will be able to:	Texts/Materials
Benefits of landscape design	S5f	<ul style="list-style-type: none"> • Explain the benefits of developing a landscape plan. • Describe the relationship between the designer, the contractor and the homeowner. 	<i>Introduction to Horticulture, 4th ed.</i> , © 2004, ISBN: 0-130364-13-4, Pearson – Prentice Hall, pub.
Contrast between hard and soft landscape attributes	E1c M2e	<ul style="list-style-type: none"> • List examples of hard landscaping, e.g., crushed rock, stepping stones. • List examples of soft landscaping, e.g., plants, shrubs, trees, lawns. • Discuss rock gardens and ponds. • Identify and explain the differences between hard and soft landscapes. • Research and list examples of hardy herbaceous landscape plants that are suitable for sun, shade, dry, moist, acidic or alkaline conditions. • Identify examples of hardy deciduous and coniferous landscape plants suitable for the above conditions. • Develop a simple draft landscape design of a typical city lot using hard landscape features. • Identify anticipated maintenance requirements for the following: <ul style="list-style-type: none"> - Residential lot; - Shopping center; - School; - Public park; - Golf course; - Urban renewal project; and - A landfill reclamation project. 	
Analysis of selected scenarios in relation to their potential design, installation and maintenance requirements	S5f E3a	<ul style="list-style-type: none"> • Resolve difficult landscape problems through design: <ul style="list-style-type: none"> - Golf course; - Public park; - School yard; - Residence. <p>Prepare an appropriate report describing the solution.</p>	
Interpretation of landscape construction	S4b M1d, l	<ul style="list-style-type: none"> • Interpret construction details for the following: 	

details		<ul style="list-style-type: none"> - Deck; - Fences; - Shade structures; - Benches; - Walkways; - Paving; - Retaining walls; - Steps; - Water features; and - Lighting. 	
Creation of landscape design plans	S3e S4b S5f S7a E3c M2e	<ul style="list-style-type: none"> • Create a landscape plan given specific criteria such as the size of a lot, location, function, and desired effect. • Prepare a sketch to act as a guide for a planting plan. • Prepare a planting plan to include all required elements including, plant varieties, soil needs, location (full sun or shade, etc.). • Research and describe other considerations of a plan. 	
Features of project budgets	S5f	<ul style="list-style-type: none"> • Research prices of landscape plants suitable for the chosen area and climate zone. • Devise a budget for their landscape project. 	
Draft a landscape design	S3e S7a E3c E7b M2b, c, d, e	<ul style="list-style-type: none"> • Develop a residential landscape design for a lot size and location. Plan will include buildings, hard landscape features, herbaceous, deciduous and coniferous plants. • Prepare a finished sketch and a finished plan for a residential landscape design. • Prepare an itemized planting list for a wide variety of seasonal features 	
Drafting a budget	S3e S4b S7a E7a	<ul style="list-style-type: none"> • Develop a budget itemizing expenses for hard landscape supplies, plant materials, and labor. • Develop an alternative project budget. • Prepare an extensive estimate and a formal tender for a large project such as a municipal park. 	
Importance of Landscape Industries	S6d	<ul style="list-style-type: none"> • Describe the importance of landscape industries. • Create a group report on the landscape industry. 	
Soil factors affecting plant growth	S5e	<ul style="list-style-type: none"> • Identify and demonstrate understanding of soil factors which affect plant growth. • Explain steps to improve the soil. 	
Environmental factors affecting plant growth	S3e	<ul style="list-style-type: none"> • Create an article on the effects of the environment on plants. • Prepare a chart for landscaping plant identification. • Create an outline to aid in plant identification. 	
Trees and shrubs	S3e S5f	<ul style="list-style-type: none"> • Differentiate between selected shade, flowering, and evergreen trees and shrubs. 	

	S6d, e S8b, d	<ul style="list-style-type: none"> • Create a chart to organize information on different types of trees and shrubs. • Demonstrate appropriate installation of trees and shrubs. • Explain different uses for trees in the landscape. • Create scale models to demonstrate appropriate use of trees and shrubs in the landscape. 	
Landscaping tools	S6a E3a	<ul style="list-style-type: none"> • Demonstrate proper tool use and maintenance. • Develop a chart for tool maintenance. 	
Planting and transplanting procedures	S3e E3b M1d M2c	<ul style="list-style-type: none"> • Compare and contrast procedures for planting and transplanting different trees and shrubs. • Demonstrate understanding of appropriate installation of trees and shrubs. 	
Plant installation and maintenance	S3e S4c S5b, e, f E3b M2b	<ul style="list-style-type: none"> • Demonstrate understanding of care and pruning of evergreens, deciduous trees, shrubs, hedges, and roses. • Prune trees, shrubs, etc. as needed in designated areas. • Demonstrate understanding of plant nutrients 	
Bedding Plants and Ground Covers	S3e S4a, b S5e, f S6b S7a S8c E4b	<ul style="list-style-type: none"> • Diagram the installation and maintenance of bedding plants and ground covers in a landscape. • Plant and transplant bedding plants and ground covers. 	
Turf installation and maintenance	S2d S4b, e S5d, e S6a S7b, d S8c	<ul style="list-style-type: none"> • Install turf, assess growth habits and maintenance needs of turf grasses. • Outline turf grass growth and classification. • Outline care schedule for all seasons. 	
Landscape site analysis	S2d S4e E2a E3c M2e	<ul style="list-style-type: none"> • Analyze a landscape site using existing features. • Analyze a future landscape site. 	
Landscape diagrams	S3e S4c S6b S8b, d, e E2b E3a,c E4b M1a	<ul style="list-style-type: none"> • Diagram a landscape site and draw a bare map to scale. • Use appropriate symbols in landscape plans. • Create landscape drawings using landscape symbols both manually and computer-generated. 	

NARRAGANSETT BAY STUDIES (OCEANOGRAPHY)

Content	Standards Benchmarks 2061	Skills Upon completion the student will be able to:	Texts/Materials
History of oceanography and bay history	1A2 1A3 1C1 1C2 1C3	<ul style="list-style-type: none"> • Demonstrate understanding of: <ul style="list-style-type: none"> - the role of the ocean in human history; - the development of ocean science; - the importance of technological advances in ocean science; - recent changes in the legal status of the ocean; - the different map projections, their uses and limitations. 	<i>Fundamentals of Oceanography</i> , © 2006, ISBN: 0-07-304081-9, Glencoe – McGraw Hill, pub.
Ocean basins	3A2 3A3	<ul style="list-style-type: none"> • Describe the principal features of the ocean basins and the major features of the ocean floor. • Explain the principal differences between ocean basins and continents. • Discuss principal features of the earth and principal features of plate tectonic theory. • Demonstrate understanding of how the evolution of the Earth has affected ocean basins, seawater and atmosphere. 	
Seawater, oceans, and climate	2B5 4D1 4D2	<ul style="list-style-type: none"> • Demonstrate understanding of the importance of the thermal and physical properties of water in ocean processes. • Demonstrate understanding of the processes controlling the composition of sea salts. • Differentiate conservative and nonconservative behavior of seawater constituents. • Explain: <ul style="list-style-type: none"> - the Earth's heat budget and the ocean's role in transporting heat; - the relationship between Earth's heat and water budgets; - the vertical structure of the ocean and its importance for oceanic processes; - how and where water masses form; - how sea ice forms and its importance. • Demonstrate understanding of: <ul style="list-style-type: none"> - how the ocean and atmosphere interact; - the effects of Earth's rotation on winds; - daily and seasonal effects on weather. • Differentiate weather and climate and the processes that affect them. • Present the history of Earth's climate and its changes. 	
Currents, waves, and tides	4E3 4E6	<ul style="list-style-type: none"> • Demonstrate understanding of basic features of ocean surface and 	

	4E7	<p>subsurface currents; and the interactions between winds and surface currents.</p> <ul style="list-style-type: none"> • Describe basic features of waves and how they form. • Differentiate shallow- and deep-water waves. • Describe wave effects in shallow water and on beaches. • Describe: <ul style="list-style-type: none"> - the general features and causes of ocean tides; - tides and their behavior in open-ocean basins; - the behavior of tides in coastal waters; - tidal currents, especially in coastal waters. 	
Coastal ocean	5E1 5E2 5E3	<ul style="list-style-type: none"> • Describe water movements in the coastal ocean. • Explain the behavior of water temperature and salinity in the coastal ocean. • Describe estuaries and estuarine circulation. • Explain processes affecting beaches and coastlines. • Describe the principal features of the coastal ocean. • Explain processes affecting deltas and other wetlands. 	
Plankton	5D1 5D2	<ul style="list-style-type: none"> • Demonstrate understanding of the principal features of oceanic eco-systems. • Demonstrate understanding of primary and secondary production in the ocean. • Describe the environment for open-ocean planktonic organisms. • Describe the role of microorganisms in the ocean 	
Nekton	11C3 11C4 11C5	<ul style="list-style-type: none"> • Describe swimming organisms. • Explain the roles of various large marine organisms. • Demonstrate understanding of the relationships between oceanic processes and abundances of marine organisms. • Describe variability in marine communities. 	
Benthos	11A1 11A4	<ul style="list-style-type: none"> • Describe the life environment for bottom-dwelling organisms. • Demonstrate understanding of oyster and coral reefs as communities of organisms. • Demonstrate understanding of the trophic relationships among organisms on the deep-ocean bottom and in vent communities. 	
Environmental Issues	7C1 7C2 7C4 7D2 7D3 7F1	<ul style="list-style-type: none"> • Describe the factors which caused declines in marine populations. • Explain sources of marine pollution. • Discuss social, economic, and political decisions in marine resource management. 	

PHYSICAL SCIENCE

Content	Standard Benchmarks 2061	Skills Upon completion the student will be able to:	Texts/Materials
MECHANICS Newton's Laws of Motion	4F1 4F2 4F4 4F7 4F13	<ul style="list-style-type: none"> • Explain how Aristotle classified motion; • State the difference between Aristotle's focus on classification and Galileo's focus on experimentation; • Describe Galileo's contribution to the science of motion; • Distinguish between speed and velocity; • State Newton's first law of motion and define inertia; • Distinguish between force and net force; • Explain the Equilibrium Rule, $\sum F = 0$. • Define support force; • Distinguish between static equilibrium and dynamic equilibrium; • Explain how an object not connected to the ground continues moving with the moving Earth; • Define acceleration and distinguish it from velocity; • State the relationship between acceleration and net force; • Distinguish between volume, weight, and inertia; • State the relationship between acceleration and mass; • Distinguish between "directly proportional to" and "inversely proportional to." • State Newton's second law of motion; • Explain how friction affects motion; • Apply Newton's second law to explain why the acceleration of an object in free fall does not depend on the mass of the object; • Describe what happens to the acceleration and the velocity of a falling object in the presence of air drag; • Define force in terms of interaction; • Explain why at least two objects are involved whenever a force acts; state Newton's third law of motion; • Explain why the accelerations caused by an action force and by a reaction force do not have to be equal; • Explain why action and reaction forces don't cancel. 	<i>Physical Science</i> , © 2005, ISBN: 0-07-860051-0, Glencoe – McGraw Hill, pub.
Dynamics	4E1	<ul style="list-style-type: none"> • Define momentum; • Calculate momentum given the mass and velocity in terms of mv. • Define impulse and relate it to momentum; • Give examples of how both size of the force and length of time interval affect change in momentum; • State the law of conservation of momentum; • Distinguish between an elastic collision and an inelastic collision; 	

		<ul style="list-style-type: none"> • Determine the amount of work done when given the force and the distance moved; • Calculate work as the product of force and distance; • Calculate the amount of power when work done and time are given; • Define work in terms of energy; • Distinguish between potential and kinetic energy; • Describe how the kinetic energy of an object depends on mass and speed; • State the law of conservation of energy; • Describe the function of a lever; • Define efficiency in terms of work done and work input. 	
Rocket Science	4F7 4G1	<ul style="list-style-type: none"> • Explain Newton's idea that the moon falls toward the Earth like an apple does; • Explain why the moon does not fall into the Earth and the planets do not fall into the sun; • State Newton's law of universal gravitation; • Explain the significance of an inverse-square law; • Explain how the moon causes ocean tides; • Describe for a projectile the changes in the horizontal and vertical components of its velocity; • Explain why a projectile moves equal horizontal distances in equal time intervals, when air drag is negligible; • Show the connection between a fast-moving projectile and Earth satellite; • Explain how the speed of a satellite in a circular orbit around the Earth is related to the distance an object falls in the first second due to gravity; • Describe how the speed of a satellite changes for different portions of an elliptical orbit; • Describe what is meant by an escape speed. 	
HEAT	4E1 4E2 4E3 4E4	<ul style="list-style-type: none"> • Describe the relationship between temperature and kinetic energy; • Distinguish between thermal energy and heat; • Describe the concept of absolute zero; • State the first law of thermodynamics and relate it to energy conservation; • State the second and third laws of thermodynamics; • Compare the specific heat capacity of different substances; • Give examples of the expansion of solids as they become warmer; • Compare the thermal expansion of liquids to solids; • Describe the unusual behavior of water as it is heated from 0° to 15°C; • Explain why two materials at the same temperature may not feel as if they are when touched; • Explain why porous materials are better insulators than nonporous 	

		<p>materials;</p> <ul style="list-style-type: none"> • Distinguish between conduction and convection from an atomic point of view; • Explain how heat is transmitted through empty space; • Compare the ability of an object to emit radiant energy with its ability to absorb it. 	
ELECTRICITY AND MAGNETISM	<p>4E1 4G2 4G3 4G4 4G5</p>	<ul style="list-style-type: none"> • Describe the differences and similarities between magnetic poles and electric charges; • Describe the magnetic field produced by a current-carrying wire and give examples of how the field can be made stronger; • Describe the conditions necessary for a magnetic field to exert a force on a charged particle in the field; • Suggest possible causes for the Earth's magnetic field; • Describe how voltage is induced in a coil of wire; • Describe a generator and explain how it works; • Explain how the electric and magnetic fields of an electro-magnetic wave regenerate each other so that the wave pattern moves outward; • Describe electrical forces between objects; • Distinguish a conductor from an insulator; • Distinguish between electric potential energy and voltage; • Describe the conditions necessary for electric charge to flow; • Relate the current in a circuit to the resistance of the circuit and the voltage across it; • Distinguish between direct current and alternating current; • Relate the power used by an electrical device to its current and voltage; • Distinguish between series circuits and parallel circuits and predict what will happen to the current in either series given certain conditions. 	
WAVES, SOUND AND LIGHT	<p>4E1 4E5 4F3 4F5 4F6</p>	<ul style="list-style-type: none"> • Relate the pitch of a sound to its frequency; • Describe what happens to air when sound moves through it; • Compare the transmission of sound through air with its transmission through solids, liquids, and a vacuum; • Describe factors that affect the speed of sound; • Give examples of forced vibrations; • Describe the conditions for resonance; • Describe the conditions for beats; • Explain why water waves have curved wave fronts after passing through a narrow opening; • Describe the conditions necessary for visible diffraction of waves; • Describe the conditions necessary for visible bright and dark fringes of light caused by interference; • Explain what causes the bright and dark bands reflected from a thin 	

		<ul style="list-style-type: none"> material; • Explain what causes the colors that shine from soap bubbles or gasoline slicks on a wet surface; • Distinguish laser light from lamplight; • Distinguish between a hologram and a photograph; • Describe the dual nature of light; • Describe the electromagnetic spectrum; • Explain what happens to light entering a substance; • Prove that light waves are transverse; • Explain how polarized sunglasses decrease glare; • Explain why black and white are not colors; • Describe how light interacts with atoms or molecules at various frequencies; explain why a material reflects, transmits, or absorbs light of a particular color; • Define complementary colors and give examples; • Tell what happens to light striking a metal surface compared to glass or water; • Predict the path of reflected light striking a reflective surface; • Define virtual image; • Describe the conditions for diffuse reflection; • Give examples of refraction of sound waves and its effects; • Give examples of refraction of light and its effects; • Explain how a prism separates white light; • Describe the conditions for a rainbow; • Distinguish between a converging and diverging lens; • Distinguish between a real image and a virtual image formed by a lens; • Give examples of aberration in lenses. 	
ATOMS	4D1 4D2 4D3 4D4 4D5 4E6 4G6	<ul style="list-style-type: none"> • Describe the relationship between atoms and elements; • Compare the ages of atoms to the ages of the materials they compose; • Give examples to illustrate the small size of atoms; • Identify the parts of the atomic nucleus; • Explain the significance of the horizontal rows and the vertical columns in the periodic table; • Distinguish between a physical and a conceptual model; • Explain why scientists know the identify of the chemical composition of stars; • Explain how the quantum hypothesis explains atomic spectra; • Explain the usefulness of the shell model of the atom; • Describe the role of neutrons in causing and sustaining nuclear fission; • Explain how nuclear fission can be controlled in a reactor; • Distinguish a breeder reactor from a uranium-based fission reactor; • Predict, from a graph of mass per nucleon vs. atomic number, whether 	

		<p>energy would be released if a given nucleus split via fission into fragments;</p> <ul style="list-style-type: none"> • Distinguish nuclear fission from nuclear fusion; • Describe the advantages of fusion over fission as a source of power; • Distinguish among the three types of rays given off by radioactive nuclei and compare their penetrating powers; • Given the half-life of a radioactive isotope and the original amount of the isotope, predict how much of the isotope will remain at the end of some multiple of the half-life; • Given the symbol for a radioactive isotope and the particle it gives off, predict the product of its decay; • Explain why additional exposure to radiation is harmful. 	
CHEMISTRY	4D6 4D7 4D8 4D9	<ul style="list-style-type: none"> • Demonstrate understanding of the nature of chemistry; • Distinguish between atoms and molecules; • Describe and explain properties of elements; • Analyze and explain atomic and molecular changes in a chemical reaction; • Compare and contrast physical and chemical properties; • Apply the shell model of the atom to chemical bonding; • Distinguish between an atom and an ion; • Predict the formula of an ionic compound using the periodic table; • Distinguish between ionic and covalent bonds; • Demonstrate understanding that some molecules are polar; • Demonstrate understanding that polarity of molecules affects macroscopic properties; • Recognize that most materials are mixtures of some sort; • Demonstrate understanding that mixtures can be separated by physical means; • Recognize that macroscopic samples cannot be classified as 100% pure; • Distinguish solutions and suspensions from heterogeneous mixtures; • Demonstrate understanding of the concept of the mole; • Use various terms associated with solutions; • Distinguish between molecular attractions and chemical bonds; • Compare and contrast the different types of molecular attractions; • Demonstrate understanding and apply the concept of solubility; • Articulate how soaps and detergents work; • Identify acids and bases found in their daily living; • Demonstrate understanding of acid/base as a behavior of chemicals; • Identify the hydronium and hydroxide ions; • Recognize a salt as the product of the reaction of an acid and a base; • Demonstrate understanding of acidic, neutral, and basic solutions; 	

		<ul style="list-style-type: none">• Describe and explain the concept of pH;• Find the log of simple exponential numbers;• Apply the concepts of acids and bases to our atmosphere;• Apply the concepts of acids and bases to our oceans.	
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PHYSICS

Content	Standards AAAS Benchmarks 2061	Skills Upon completion the student will be able to:	Texts/Materials
Thermodynamics	4E1 4E2 4E3	<ul style="list-style-type: none"> • Apply kinetic theory to achieve an understanding of the properties of liquids and solids; • Demonstrate understanding of the origin of evaporation and condensation from the viewpoint of the kinetic energy; • Recognize the difference between solids and liquids on a microscopic level; • Demonstrate understanding of the origin of the unique properties of water and ice; • Define elasticity of a solid; • Display an understanding of the origin of thermal expansion; • Solve problems on linear thermal expansion; state some examples of applications and difficulties caused by thermal expansion; • Define a plasma and give examples of plasmas in nature; • Demonstrate understanding of the nature of thermal energy in the kinetic theory; • Define temperature and distinguish it from thermal energy; • Demonstrate understanding of the process of obtaining equilibrium and its application to the measurement of temperature; • Describe the Celsius scale and the Kelvin scale; • Demonstrate the ability to convert between Celsius and Kelvin; • State the law of thermodynamics; • Distinguish heat from work and both from thermal energy; • Define a heat engine, refrigerator, and heat pump; • State the second law of thermodynamics; • Define entropy; • Define and display understanding of specific heat; • Calculate heat transfer; • Display an understanding of the application of conservation of energy to energy transfers; • Calculate temperature changes due to energy transfer; • Define heats of fusion and vaporization; • Demonstrate understanding of the microscopic basis of changes of state; • Calculate heat transfers needed to effect changes of state; • List the assumptions of the kinetic theory and the definition of an ideal gas; 	<p><i>Conceptual Physics: The High School Program</i>, © 2006, Pearson – Prentice Hall, pub. (for CCP)</p> <p><i>Physics, 6th ed.</i>, © 2004, John Wiley & Sons, pub. (for Honors)</p>

		<ul style="list-style-type: none"> • Demonstrate understanding of the microscopic cause of gas pressure and an understanding of the measurement of pressure and the definition of the Pascal and other pressure units; • State Boyle's law; demonstrate understanding of the microscopic basis of it; and use the law in solving problems; • State Charles' law; demonstrate understanding of the relationship of this law to absolute zero; and solve problems using Charles' law; • State the combined gas law and solve problems using it; • Demonstrate understanding of the formulation of the ideal gas law; • Demonstrate understanding of the limitations of the ideal gas law and the distinction between real and ideal gases. 	
Kinematics	2B3 4F1, 4F2, 4F7, 4F9 9B1, 9B2, 9B3, 9B4 9B5, 9B6 9D4	<ul style="list-style-type: none"> • Describe, qualitatively, the relationship among distance moved, the time it takes, and the speed and velocity of the body; • Distinguish scalar from vector quantities, giving examples of each; • Distinguish distance from displacement; • Define and give examples of instantaneous speed, distinguishing speed from velocity; • Calculate average speed and velocity and use the factorable method of unit conversion; • Solve a basic equation for the unknown; • Calculate acceleration, both positive and negative, giving examples of zero velocity with nonzero acceleration and vice versa; • Write the equation for final velocity after acceleration, applying the equation in solution of problems; • Write the two equations for the distance traveled during uniform acceleration and the equation for the final velocity of an object after acceleration over a given distance; apply the equation in solving problems; • Recognize the symmetry in motion problems; • State the value for acceleration due to gravity and use this value in the acceleration equations; • Select and analyze the quantities present in an equation; • Demonstrate an orderly approach to problem solving; • Demonstrate understanding of the relation of the position-time graph and recognize the meaning of the parabolic shape; • Find the slope at any point and interpret it correctly; • Demonstrate understanding of the meaning of the area under the curve in a velocity-time graph and calculate the displacement from such a graph; • Demonstrate understanding of the concept that uniformly accelerated motion versus time must yield a straight line and recognize the meaning of the area under the curve • Demonstrate understanding of the definition of free-fall and the origin of air resistance; recognize the reason terminal velocities exist; 	

		<ul style="list-style-type: none"> • Display an understanding of the independence of the vertical and horizontal velocities of a projectile; apply this knowledge in solving problems of projectiles launched horizontally; • Demonstrate an understanding of the motion of projectiles fired at an angle by solving problems illustrating such motion. 	
Vectors	9B1, 9B2, 9B3, 9B4 9B5, 9B6	<ul style="list-style-type: none"> • Recognize the application of elementary geometry and trigonometry to vector algebra and solve problems using these methods; • Specify the proper method of resolving vectors into perpendicular components; • Choose axes and resolve vectors graphically; • Add vectors by the graphical method, recognizing the commutative law of vector addition. 	
Forces	4F1 4F4	<ul style="list-style-type: none"> • Name the basic types of forces; • State the first law of motion and demonstrate an understanding of the concept of inertia; • State the second law of motion and use it in solving problems; • State the third law of motion and demonstrate understanding the forces act in pairs on different bodies; • Distinguish between weight and mass; • Demonstrate understanding of the agent that gives rise to weight and use the second law to relate mass and weight; • Demonstrate an understanding of the nature of frictional forces and use the coefficient of friction in solving problems; • Demonstrate an understanding of the meaning of net force and the ability to find the acceleration that results; • State the requirements for equilibrium; • State the meaning of equilibrant; differentiating between resultant and equilibrant; • Solve inclined plane problems; 	
Energy	4E1 4E2 4E3	<ul style="list-style-type: none"> • Define energy; explain the relation between work and energy; define the two forms of energy, kinetic and potential; • Calculate kinetic and potential energy; • State the law of conservation of energy; demonstrate understanding by solving problems involving energy changes; • Demonstrate understanding that work is the change in energy; • Recognize the component of the force that does the work; • Differentiate between work and power; • Calculate the power used. 	
Electricity and Magnetism	4G2 4G5	<ul style="list-style-type: none"> • Describe a series circuit; define effective resistance; state how the effective series resistance is calculated and find the current in a series circuit; • Use Ohm's law to calculate voltage drops in series circuits; • Describe a parallel circuit; state how the effective parallel resistance is 	

		<p>calculated; find the current in a parallel circuit;</p> <ul style="list-style-type: none"> • State important characteristics of parallel circuits; • Describe a series-parallel circuit; state how effective resistance is found using Ohm's law; • Distinguish between ammeters and voltmeters; state the important characteristics of each; and describe how each is wired into a circuit; • List the properties of magnets; • Describe the magnetic fields around permanent magnets and the field lines between like and unlike poles; • Recognize that electric currents produce magnetic fields; describe the field around a current carrying wire; and explain the use of the left-hand rule in finding the direction of this field; • Explain the magnetic field due to several loops of wire; apply the left-hand rule to determine the direction; • State the origin of magnetism in materials; • Define magnetic induction; display an understanding of direction of the force on a current carrying wire in magnetic field; • List the factors that determine the force on a wire; solve problems involving force, current, field strength, and length; • Explain the design and operation of the galvanometer; • Explain the design and operation of the electric motor; • Explain the process by which a changing magnetic field produces a force on electrons and thus a current; apply the left-hand rule correctly; • Define EMF; state the meaning of the terms BLV which describe the magnitude of the EMF; demonstrate understanding of the limitations of this equation and apply to the solution of problems; • Explain the generation of current by a rotating armature in an electric generator; • Explain the difference between peak and effective current and voltage and use in solving problems; • Compare generators and motors; • State Lenz's law; explain back-EMF and its relation to energy transfer in motors and generators; • Explain the nature of self-inductance and its effects in AC and DC circuits; • Describe the transformer; explain the effect of the ratio of turns in the primary and secondary; solve transformer problems; • State Coulomb's law and how the force depends on charges and their separation; • State the unit of charge; demonstrate understanding of the vector nature of the force; and solve problems using Coulomb's law; • Demonstrate understanding of the cause of the attractive force on neutral objects and applications of this force; 	
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		<ul style="list-style-type: none"> • Define an electric field; give the direction of the field; and distinguish between the field and field lines; • Relate electric field to the force on a test charge; solve problems involving the force due to a point charge; • Define the difference in electric potential in terms of work done in moving a unit charge; demonstrate understanding of the units of potential difference; and distinguish potential from potential difference; • Relate electric potential gravitational potential; solve problems involving uniform electric fields; • Demonstrate understanding of the use of electric fields by Millikan to determine the charge of the electron; • Demonstrate an understanding of the role of energy in the sharing of charge; define grounding; and relate charge to grounding; • Display an understanding of the location of charges on solid and hollow conductors; recognize the relation between conductor shape and electric field near the conductor; • Define capacitance; recognize the principle of the capacitor; and solve problems involving charge, potential difference, and capacitance; • Define an electric current; recognize the need of a potential difference if an electric current is to be maintained; • Recognize circuits as closed loops; explain the source and use of energy in circuits; • Define ampere; explain the definition of power in electric circuits; and solve problems involving current and power; • State Ohm's law; relate potential drop in a device to current flow through it; and solve problems using the law; • Diagram simple electric circuits; recognize the correct way to place ammeters and voltmeters; • Explain the relationship between electric energy and heat transfer; • Describe the reason for the use of high voltage lines in transmitting electric power; • Define kilowatt-hour; solve problems involving the use and cost of electric energy. 	
Gravitation	4G1	<ul style="list-style-type: none"> • Describe gravitational fields; • Indicate an understanding of Newton's law of gravity; • Demonstrate understanding of the quantities on which the force depends; • Illustrate how the law of gravitation demands that the acceleration or gravity be dependent on the mass of the Earth and the distance from its center; • Recognize that the motion of artificial satellites is circular motion about the Earth; • Solve problems which relate the orbital velocity to distance from the 	

		center of the Earth.	
Nature of Waves	4F5 4F6 4F8	<ul style="list-style-type: none"> • Define wavelength and frequency • Solve problems using the relationship between speed, wavelength, and frequency; • Demonstrate understanding that the speed of a wave depends on the medium, but is independent of the characteristics of the wave; • Describe the relationship between the amplitude of a wave and the energy it transfers; • List the characteristics of the behavior of waves at the boundaries between media; • Define node and antinode; • State the principle of superposition; • Define constructive and destructive interference; • Define the Doppler effect; • Display an understanding of resonance, especially as applied to an air column describe or sketch a standing wave; solve problems involving standing waves in resonating air columns. 	
Types of Waves	4F3	<ul style="list-style-type: none"> • Distinguish between mechanical and electromagnetic waves; • Define longitudinal and transverse waves; • Distinguish between a pulse and a wave. 	
Sound		<ul style="list-style-type: none"> • Describe the origin of sound in general; • List the properties of sound waves using the terms pitch and intensity or loudness; • Describe the meaning of the octave interval; • Use the decibel to define ratios of sound; • Recognize the source of beat notes and solve problems involving beats. 	
Light	4E4 4E5 4F3	<ul style="list-style-type: none"> • Define a ray and give examples of evidence that light travels in straight lines; • Recognize that light is an electromagnetic wave and know its wavelength and frequency; • Define the concepts and units of luminous intensity, luminous flux, and illuminance; solve illumination problems; • Display an understanding of the mixture of light colors and color absorption; • Explain the polarization of light. 	
Reflection/ Refraction	4F6	<ul style="list-style-type: none"> • State the law of reflection; • Distinguish between diffuse and regular reflection; • Define refraction; predict whether the ray will bend toward or away from the normal when light moves from one medium into another; • State Snell's law; apply the law to the solution of problems; • Relate the index of refraction to the speed of light in the medium; solve problems relating these two quantities; 	

		<ul style="list-style-type: none"> • Explain total internal reflection and the critical angle; • Explain effects caused by the refraction of light in a medium with varying refractive index; • Explain the dispersion of light in terms of index of refraction. 	
Geometric Optics	4F6	<ul style="list-style-type: none"> • Describe the image produced by a plane mirror; • Define focal point and explain the rules of ray tracing as applied to concave mirrors; • Define spherical aberration and describe the use of parabolic mirrors; • Distinguish between real and virtual images; • Explain the formation of real images by concave mirrors; use ray diagrams to locate the image; and calculate the location using the mirror equation; • Explain and demonstrate using ray diagrams, the formation of virtual, enlarged images by concave mirrors; • Explain and demonstrate using ray diagrams, the formation of virtual images by convex mirrors; and calculate the location of these images; • Differentiate between concave and convex lenses; • Describe the formation of an image by a convex lens; use a ray diagram to locate the image; and calculate the location using the lens equation; • Describe the formation of a virtual image by a convex lens; diagram and calculate the location of these images; • Describe the formation of virtual images by concave lenses; • Demonstrate understanding of the derivation of the lens equation. 	
Electric Charges	4G3 4G4	<ul style="list-style-type: none"> • Outline the structure of the atom; • Demonstrate understanding of the charges on electrons and protons; • Demonstrate understanding of how charging occurs; • State the differences between conductors, insulators, and semiconductors; • Demonstrate understanding of how an electroscope detects the presence of charge and how an item is charged by conduction; • Explain the separation of charge and charging by induction. 	

Robotics Curriculum

Content	Standard “New Standards Performance Standards”	Objectives	Instructional Strategies
Robotics – Introduction and Overview	S1d, S5f E2c	<p>As a result of this unit students will understand the course content, expectations of student participation, lab safety requirements, something about other students in the class, and how to write a short autobiography.</p> <p>As a result of the unit students will demonstrate understanding of:</p> <ul style="list-style-type: none"> • What the course includes and what course options are available • What after school and weekend participation is required for each course option • Where lab safety equipment is located in the room, how to use them, and when lab safety equipment will be used. • Who their classmates are and what they did during the summer. • How to write a short introductory autobiography. 	<p>While this course will be a project-based hands-on cooperative learning experience, the majority of this introductory unit is expository with a culminating lab safety test. Some individual homework effort will be required for students to decide what option of the course they will pursue. Individual effort will be required to produce the short autobiography. Students will learn about the other students summer experience by being paired off and each interviewing the other, then giving a one-minute presentation to the class of who their paired partner is and what they did during the summer.</p>
Robots in the News	S1def, S3cde, S4abcde, S5abcdef, S6abcd, S7ade A2ac, A3c E1c, E2a, E3c	<p>As a result of this unit students will understand what the definition of a robot is and be able to describe what a particular robot does, how it does it, and what effect it may have on society.</p> <p><i>As a result of the unit students will demonstrate understanding of:</i></p> <ul style="list-style-type: none"> • <i>whether or not a particular “appliance” can be classified as a robot;</i> • describe what a particular robot does, how it does it, what effect the robot may have on society 	<p>This is a project-based , individual-effort - presentation to the rest of the class on a robot in the news. A teacher presentation example will be made before any student is required to claim their article and make their presentation in accordance with a schedule.</p>
Engineering Journal	S1def, S3cde, S4abcde, S5abcdef, S7ade, S8abcd A1ab, A3c, A4bc E1c, E2f, E3ab, E4a M1aefhk, M2ehlm, M4e, M5b, M6aeklm	<p>As a result of this unit students will understand why scientists and engineers keep journals in order to accumulate data and status on various projects.</p> <p>As a result of the unit students will:</p> <ul style="list-style-type: none"> • <i>demonstrate understanding that an engineering journal is a valuable research and learning tool used widely in industry.</i> • be able to keep their own journals which will document what 	<p>The Engineering Journal Requirement will be described in detail with a handout. The Journal will be submitted weekly for grading in accordance with a grading rubric.</p>

		they learned in Robotics.	
Programming and Construction Challenges	S1def, S3cde, S4abcde, S5abcdef, S6abcd, S7ade, S8abcd A1abc, A3a, A4bc, A5ab E1c, E2ad, E4a, E7b M1aefhk, M2ehlm, M4e, M5b, M6aeklm, M7f, M8cd	As a result of this unit students will understand why a single design may not be robust enough to accomplish all possible tasks. As knowledge of the Robolab 2.5 programming is expanded, so are the challenges that are presented. <i>As a result of the unit students will:</i> <ul style="list-style-type: none"> • <i>demonstrate understanding that an engineering redesign might be needed to accomplish a specific task;</i> • be able to write specific autonomous programs designed to complete various challenges. 	Students will work in teams of 3 to 5. Each challenge is generally preceded with instruction on a new element of Robolab 2.5 programming. The design, programming, and challenge will be scheduled over about two to five class periods. This is hands-on-cooperative-learning material. Specific Programming and Construction Challenges Simple Programming Stories 1-4 Drag Racing Mars Mission Research Tractor Pull Sumo Challenge Timers and Containers Land Mine Challenge FLL Mission Mars Challenge
Extensions Extensions are for students who have mastered the basics of Robolab 2.5 Programming and could benefit from extra assignments in a competitive environment.	S1def, S3cde, S4abcde, S5abcdef, S6abcd, S7ade, S8abcd A1abc, A2bc, A3abc, A4bc, A5a E1c, E2a, E3c M1aefhk, M2ehlm, M4e, M5b, M6aeklm	As a result of this unit students will know how robots perform in the real world in a competitive environment with other roboticists. As a result of the unit students will: <ul style="list-style-type: none"> • demonstrate understanding that an engineering redesign might be needed to accomplish a specific task. • be able to write specific autonomous programs designed to complete various challenges. 	Students will work individually or in teams of 3 to 5. Resources generally restrict students participation in more than one extension. Most extensions will require after-school-practice and a weekend competition out-of-town. To a large extent, all extensions are hands-on-cooperative-learning material. Once elected, classroom time is mostly devoted to the extension. Specific Extensions: First Semester <ul style="list-style-type: none"> • FIRST LEGO LEAGUE ANNUAL CHALLENGE – - Lego Mindstorm Robotics Invention Competition for 14 year olds or younger on 1 January of the year preceding the competition. Competition to be held the

			<p>following January at a location within Rhode Island</p> <ul style="list-style-type: none"> • UNDERWATER ROV -- class competition on a Saturday before the week of mid-year exams at the URI Bay Campus Foster Middleton Laboratory. <p>Second Semester</p> <ul style="list-style-type: none"> • FIRE FIGHTING ROBOT COMPETITION - Trinity College, Hartford, CT - Competition in April. • UNDERWATER ROV - New England Regional Competition at times (April to May) and locations to be announced. If qualified, the team would go to the National Competition in June at locations to be announced. • BUILD A LINE- FOLLOWING ROBOT - individual effort. Using "Robot Building for Beginners," by David Cook. Apress, Berkeley, CA, 2002. • ROBOTICS PARK - CCRI Knight Campus, Warwick, RI - Chain Reaction Machine or One-Hour-Challenge
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NEW STANDARDS PERFORMANCE STANDARDS

S1 – Physical Sciences Concepts

Elementary School	Middle School	High School
<p>The student produces evidence that demonstrates understanding of:</p> <p>S1a. Properties of objects and materials, such as similarities and differences in the size, weight, and color of objects; the ability of materials to react with other substances; and different states of materials.</p> <p>S1b. Position and motion of objects, such as how the motion of an object can be described by tracing and measuring its position over time; and how sound is produced by vibrating objects.</p> <p>S1c. Light, heat, electricity, and magnetism, such as the variation of heat and temperature; how light travels in a straight line until it strikes an object or how electrical circuits work.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S1a. Properties and changes of properties in matter, such as density and boiling point; chemical reactivity; and conservation of matter.</p> <p>S1b. Motions and forces, such as inertia and the net effects of balanced and unbalanced forces.</p> <p>S1c. Transfer of energy, such as transformation of energy as heat; light, mechanical motion, and sound; and the nature of a chemical reaction.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S1a. Structure of atoms, such as atomic composition, nuclear forces, and radioactivity.</p> <p>S1b. Structure and properties of matter, such as elements and compounds; bonding and molecular interaction; and characteristics of phase changes.</p> <p>S1c. Chemical reactions, such as everyday examples of chemical reactions; electrons, protons, and energy transfer; and factors that affect reaction rates such as catalysts.</p> <p>S1d. Motions and forces, such as gravitational and electrical; net forces and magnetism.</p> <p>S1e. Conservation of energy and increase in disorder, such as kinetic and potential energy; energy conduction, convection, and radiation; random motion; and effects of heat and pressure.</p> <p>S1f. Interactions of energy and matter, such as waves, absorption and emission of light, and conductivity.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S2 – Life Sciences Concepts

Elementary School	Middle School	High School
<p>The student produces evidence that demonstrates understanding of:</p> <p>S2a. Characteristics of organisms, such as survival and environmental support; the relationship between structure and function; and variations in behavior.</p> <p>S2b. Life cycles of organisms, such as how inheritance and environment determine the characteristics of an organism; and that all plants and animals have life cycles.</p> <p>S2c. Organisms and environments, such as the interdependence of animals and plants in an ecosystem; and populations and their effects on the environment.</p> <p>S2d. Change over time, such as evolution and fossil evidence depicting the great diversity of organisms developed over geological history.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S2a. Structure and function in living systems, such as the complementary nature of structure and function in cells, organs, tissues, organ systems, whole organisms, and ecosystems.</p> <p>S2b. Reproduction and heredity, such as sexual and asexual reproductions; and the role of genes and environment on trait expression.</p> <p>S2c. Regulation and behavior, such as senses and behavior; and response to environmental stimuli.</p> <p>S2d. Populations and ecosystems, such as the roles of producers, consumers, and decomposers in a food web; and the effects of resources and energy transfer on populations.</p> <p>S2e. Evolution, diversity, and adaptation of organisms, such as common ancestry, speciation, adaptation, variation, and extinction.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S2a. The cell, such as cell structure and function relationships; regulation and biochemistry; and energy and photosynthesis.</p> <p>S2b. Molecular basis of heredity, such as DNA, genes, chromosomes, and mutations.</p> <p>S2c. Biological evolution, such as speciation, biodiversity, natural selection, and biological classification.</p> <p>S2d. Interdependence of organisms, such as conservation of matter; cooperation and competition among organisms in ecosystems; and human effects on the environment.</p> <p>S2e. Matter, energy, and organization in living systems, such as matter and energy flow through different levels of organization; and environmental constraints.</p> <p>S2f. Behavior of organisms, such as nervous system regulation; behavioral responses; and connections with anthropology, sociology, and psychology.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S3 – Earth and Space Sciences Concepts

Elementary School	Middle School	High School
<p>The student produces evidence that demonstrates understanding of:</p> <p>S3a. Properties of Earth materials, such as water and gases; and the properties of rocks and soils, such as texture, color, and ability to retain water.</p> <p>S3b. Objects in the sky, such as Sun, Moon, planets, and other objects that can be observed and described; and the importance of the Sun to provide the light and heat necessary for survival.</p> <p>S3c. Changes in Earth and sky, such as changes caused by weathering, volcanism, and earthquakes; and the patterns of movement of objects in the sky.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S3a. Structure of the Earth system, such as crustal plates and land forms; water and rock cycles, oceans, weather, and climate.</p> <p>S3b. Earth’s history, such as Earth processes including erosion and movement of plates; change over time and fossil evidence.</p> <p>S3c. Earth in the Solar System, such as the predictable motion of planets, moons, and other objects in the Solar System including days, years, moon phases, and eclipses; and the role of the Sun as the major source of energy for phenomena on the Earth’s surface.</p> <p>S3d. Natural resource management.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S3a. Energy in the Earth system, such as radioactive decay, gravity, the Sun’s energy, convection, and changes in global climate.</p> <p>S3b. Geochemical cycles, such as conservation of matter; chemical resources and movement of matter between chemical reservoirs.</p> <p>S3c. Origin and evolution of the Earth system, such as geological time and the age of life forms; origin of life; and evolution of the Solar System.</p> <p>S3d. Origin and evolution of the universe, such as the “big bang” theory; formation of stars and elements; and nuclear reactions.</p> <p>S3e. Natural resource management.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S4 – Scientific Connections and Applications

Elementary School	Middle School	High School
<p>The student produces evidence that demonstrates understanding of:</p> <p>S4a. Big ideas and unifying concepts, such as order and organization; models, form and function; change and constancy; and cause and effect.</p> <p>S4b. The designed world, such as development of agricultural techniques; and the viability of technological designs.</p> <p>S4c. Personal health, such as nutrition, substance abuse, and exercise; germs and toxic substances; personal and environmental safety.</p> <p>S4d. Science as a human endeavor, such as communication, cooperation, and diverse input in scientific research; and the importance of reason, intellectual honesty, and skepticism.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S4a. Big ideas and unifying concepts, such as order and organization; models, form, and function; change and constancy; and cause and effect.</p> <p>S4b. The designed world, such as the reciprocal nature of science and technology; the development of agricultural techniques; and the viability of technological designs.</p> <p>S4c. Health, such as nutrition, exercise, and disease; effects of drugs and toxic substances; personal and environmental safety; and resources and environmental stress.</p> <p>S4d. Impact of technology, such as constraints and trade-offs; feedback; benefits and risks; and problems and solutions.</p> <p>S4e. Impact of science, such as historical and contemporary contributions; and interactions between science and society.</p>	<p>The student produces evidence that demonstrates understanding of:</p> <p>S4a. Big ideas and unifying concepts, such as order and organization; models, form and function; change and constancy; and cause and effect.</p> <p>S4b. The designed world, such as the reciprocal relationship between science and technology; the development of agricultural techniques; and the reasonableness of technological designs.</p> <p>S4c. Health, such as nutrition and exercise; disease and epidemiology; personal and environmental safety; and resources, environmental stress, and population growth.</p> <p>S4d. Impact of technology, such as constraints and trade-offs; feedback; benefits and risks; and problems and solutions.</p> <p>S4e. Impact of science, such as historical and contemporary contributions; and interactions between science and society.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S5 – Scientific Thinking

Elementary School	Middle School	High School
<p>The student demonstrates scientific inquiry and problem solving by using thoughtful questioning and reasoning strategies, common sense and conceptual understanding from Science Standards 1 to 4, and appropriate methods to investigate the natural world; that is, the student:</p> <p>S5a. Asks questions about natural phenomena; objects and organisms; and events and discoveries.</p> <p>S5b. Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.</p> <p>S5c. Uses evidence from reliable sources to construct explanations.</p> <p>S5d. Evaluates different points of view using relevant experiences, observations, and knowledge; and distinguishes between fact and opinion.</p> <p>S5e. Identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.</p> <p>S5f. Works individually and in teams to collect and share information and ideas.</p>	<p>The student demonstrates scientific inquiry and problem solving by using thoughtful questioning and reasoning strategies, common sense and conceptual understanding from Science Standards 1 to 4, and appropriate methods to investigate the natural world; that is, the student:</p> <p>S5a. Frames questions to distinguish cause and effect; and identifies or controls variables in experimental and non-experimental research settings.</p> <p>S5b. Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.</p> <p>S5c. Uses evidence from reliable sources to develop descriptions, explanations, and models.</p> <p>S5d. Proposes, recognizes, analyzes, considers, and critiques alternative explanations; and distinguishes between fact and opinion.</p> <p>S5e. Identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.</p> <p>S5f. Works individually and in teams to collect and share information and ideas.</p>	<p>The student demonstrates scientific inquiry and problem solving by using thoughtful questioning and reasoning strategies, common sense and conceptual understanding from Science Standards 1 to 4, and appropriate methods to investigate the natural world; that is, the student:</p> <p>S5a. Frames questions to distinguish cause and effect; and identifies or controls variables in experimental and non-experimental research settings.</p> <p>S5b. Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.</p> <p>S5c. Uses evidence from reliable sources to develop descriptions, explanations, and models; and makes appropriate adjustments and improvements based on additional data or logical arguments.</p> <p>S5d. Proposes, recognizes, analyzes, considers, and critiques alternative explanations; and distinguishes between fact and opinion.</p> <p>S5e. Identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.</p> <p>S5f. Works individually and in teams to collect and share information and ideas.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S6 – Scientific Tools and Technologies

Elementary School	Middle School	High School
<p>The student demonstrates competence with the tools and technologies of science by using them to collect data, make observations, analyze results, and accomplish tasks effectively; that is, the student:</p> <p>S6a. Uses technology and tools (such as rulers, computers, balances, thermometers, watches, magnifiers, and microscopes) to gather data and extend the senses.</p> <p>S6b. Collects and analyzes data using concepts and techniques in Mathematics Standard 4, such as average, data displays, graphing, variability, and sampling.</p> <p>S6c. Acquires information from multiple sources, such as experimentation and print and non-print sources.</p>	<p>The student demonstrates competence with the tools and technologies of science by using them to collect data, make observations, analyze results, and accomplish tasks effectively; that is, the student:</p> <p>S6a. Uses technology and tools (such as traditional laboratory equipment, video, and computer aids) to observe and measure objects, organisms, and phenomena, directly, indirectly, and remotely.</p> <p>S6b. Records and stores data using a variety of formats, such as data bases, audiotapes, and videotapes.</p> <p>S6c. Collects and analyzes data using concepts and techniques in Mathematics Standard 4, such as mean, median, and mode; outcome probability and reliability; and appropriate data displays.</p> <p>S6d. Acquires information from multiple sources, such as print, the Internet, computer data bases, and experimentation.</p> <p>S6e. Recognizes sources of bias in data, such as observer and sampling biases.</p>	<p>The student demonstrates competence with the tools and technologies of science by using them to collect data, make observations, analyze results, and accomplish tasks effectively; that is, the student:</p> <p>S6a. Uses technology and tools (such as traditional laboratory equipment, video, and computer aids) to observe and measure objects, organisms, and phenomena, directly, indirectly, and remotely, with appropriate consideration of accuracy and precision.</p> <p>S6b. Records and stores data using a variety of formats, such as data bases, audiotapes, and videotapes.</p> <p>S6c. Collects and analyzes data using concepts and techniques in Mathematics Standard 4, such as mean, median, and mode; outcome probability and reliability; and appropriate data displays.</p> <p>S6d. Acquires information from multiple sources, such as print, the Internet, computer data bases, and experimentation.</p> <p>S6e. Recognizes and limits sources of bias in data, such as observer and sample biases.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S7 – Scientific Communication

Elementary School	Middle School	High School
<p>The student demonstrates effective scientific communication by clearly describing aspects of the natural world using accurate data, graphs, or other appropriate media to convey depth of conceptual understanding in science; that is, the student:</p> <p>S7a. Represents data and results in multiple ways, such as numbers, tables, and graphs; drawings, diagrams, and artwork; and technical and creative writing.</p> <p>S7b. Uses facts to support conclusions.</p> <p>S7c. Communicates in a form suited to the purpose and the audience, such as writing instructions that others can follow.</p> <p>S7d. Critiques written and oral explanations, and uses data to resolve disagreements.</p>	<p>The student demonstrates effective scientific communication by clearly describing aspects of the natural world using accurate data, graphs, or other appropriate media to convey depth of conceptual understanding in science; that is, the student:</p> <p>S7a. Represents data and results in multiple ways, such as numbers, tables, and graphs; drawings, diagrams, and artwork; and technical and creative writing.</p> <p>S7b. Argues from evidence, such as data produced through his or her own experimentation or by others.</p> <p>S7c. Critiques published materials.</p> <p>S7d. Explains a scientific concept or procedure to other students.</p> <p>S7e. Communicates in a form suited to the purpose and the audience, such as by writing instructions that others can follow; critiquing written and oral explanations; and using data to resolve disagreements.</p>	<p>The student demonstrates effective scientific communication by clearly describing aspects of the natural world using accurate data, graphs, or other appropriate media to convey depth of conceptual understanding in science; that is, the student:</p> <p>S7a. Represents data and results in multiple ways, such as numbers, tables, and graphs; drawings, diagrams, and artwork; technical and creative writing; and selects the most effective way to convey the scientific information.</p> <p>S7b. Argues from evidence, such as data produced through his or her own experimentation or data produced by others.</p> <p>S7c. Critiques published materials, such as popular magazines and academic journals.</p> <p>S7d. Explains a scientific concept or procedure to other students.</p> <p>S7e. Communicates in a form suited to the purpose and the audience, such as by writing instructions that others can follow; critiquing written and oral explanations; and using data to resolve disagreements.</p>

NEW STANDARDS PERFORMANCE STANDARDS

S8 – Scientific Investigation

Elementary School	Middle School	High School
<p>The student demonstrates scientific competence by completing projects drawn from the following kinds of investigations, including at least one full investigation each year and, over the course of elementary school, investigations that integrate several aspects of Science Standards 1 to 7 and represent all four of the kinds of investigation:</p> <p>S8a. An experiment, such as conducting a fair test.</p> <p>S8b. A systematic observation, such as field study.</p> <p>S8c. A design, such as building a model or scientific apparatus.</p> <p>S8d. Non-experimental research using print and electronic information, such as journals, video, or computers.</p> <p>A single project may draw on more than one kind of investigation.</p> <p>A full investigation includes:</p> <ul style="list-style-type: none"> • Questions that can be studied using the resources available. • Procedures that are safe, humane, and ethical; and that respect privacy and property rights. • Data that have been collected and recorded (see also Science Standard 6) in ways that others can verify and analyze using skills expected at this grade level (see also Mathematics Standard 4) • Data and results that have been represented (see also Science Standard 7) in ways that fit the context. • Recommendations, decisions, and conclusions based on evidence. • Acknowledgment of references and contributions of others. • Results that are communicated appropriately to audiences. • Reflection and defense of conclusions and recommendations from other sources and peer review. 	<p>The student demonstrates scientific competence by completing projects drawn from the following kinds of investigations, including at least one full investigation each year and, over the course of elementary school, investigations that integrate several aspects of Science Standards 1 to 7 and represent all four of the kinds of investigation:</p> <p>S8a. Controlled experiment.</p> <p>S8b. Fieldwork.</p> <p>S8c. Design.</p> <p>S8d. Secondary research, such as use of others’ data.</p> <p>A single project may draw on more than one type of investigation.</p> <p>A full investigation includes:</p> <ul style="list-style-type: none"> • Questions that can be studied using the resources available. • Procedures that are safe, humane, and ethical; and that respect privacy and property rights. • Data that have been collected and recorded (see also Science Standard 6) in ways that others can verify, and analyzed using skills expected at this grade level (see also Mathematics Standard 4). • Data and results that have been represented (see also Science Standard 7) in ways that fit the context. • Recommendations, decisions, and conclusions based on evidence. • Acknowledgment of references and contributions of others. • Results that are communicated appropriately to audiences. • Reflection and defense of conclusions and recommendations from other sources and peer review. 	<p>The student demonstrates scientific competence by completing projects drawn from the following kinds of investigations, including at least one full investigation each year and, over the course of elementary school, investigations that integrate several aspects of Science Standards 1 to 7 and represent all four of the kinds of investigation:</p> <p>S8a. Controlled experiment.</p> <p>S8b. Fieldwork.</p> <p>S8c. Design.</p> <p>S8d. Secondary research.</p> <p>A single project may draw on more than one type of investigation.</p> <p>A full investigation includes:</p> <ul style="list-style-type: none"> • Questions that can be studied using the resources available. • Procedures that are safe, humane, and ethical; and that respect privacy and property rights. • Data that have been collected and recorded (see also Science Standard 6) in ways that others can verify, and analyzed using skills expected at this grade level (see also Mathematics Standard 4). • Data and results that have been represented (see also Science Standard 7) in ways that fit the context. • Recommendations, decisions, and conclusions based on evidence. • Acknowledgment of references and contributions of others. • Results that are communicated appropriately to audiences. • Reflection and defense of conclusions and recommendations from other sources and peer review.

Benchmarks 2061 - AAAS

1. THE NATURE OF SCIENCE

A. SCIENTIFIC WORLD VIEW

1A1 Scientists assume that the universe is a vast single system in which the basic rules are the same everywhere. The rules may range from very simple to extremely complex, but scientists operate on the belief that the rules can be discovered by careful, systematic study.

1A2 From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Change and continuity are persistent features of science.

1A3 No matter how well one theory fits observations, a new theory might fit them just as well or better, or might fit a wider range of observations. In science, the testing, revising, and occasional discarding of theories, new and old, never ends. This ongoing process leads to an increasingly better understanding of how things work in the world but not to absolute truth. Evidence for the value of this approach is given by the improving ability of scientists to offer reliable explanations and make accurate predictions.

B. SCIENTIFIC INQUIRY

1B1 Investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.

1B2 Hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of the data (both new and previously available).

1B3 Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.

1B4 There are different traditions in science about what is investigated and how, but they all have in common certain basic beliefs about the value of evidence, logic, and good arguments. And there is agreement that progress in all fields of science depends on intelligence, hard work, imagination, and even chance.

1B5 Scientists in any one research group tend to see things alike, so even groups of scientists may have trouble being entirely objective about their methods and findings. For that reason, scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis. Checking each other's results and explanations helps, but that is no guarantee against bias.

1B6 In the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism. In the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.

1B7 New ideas in science are limited by the context in which they are conceived; are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly, through contributions from many investigators.

C. THE SCIENTIFIC ENTERPRISE

1C1 The early Egyptian, Greek, Chinese, Hindu, and Arabic cultures are responsible for many scientific and mathematical ideas and technological inventions.

1C2 Modern science is based on traditions of thought that came together in Europe about 500 years ago. People from all cultures now contribute to that tradition.

1C3 Progress in science and invention depends heavily on what else is happening in society, and history often depends on scientific and technological developments.

1C4 Science disciplines differ from one another in what is studied, techniques used, and outcomes sought, but they share a common purpose and philosophy, and all are part of the same scientific enterprise. Although each discipline provides a

conceptual structure for organizing and pursuing knowledge, many problems are studied by scientists using information and skills from many disciplines. Disciplines do not have fixed boundaries, and it happens that new scientific disciplines are being formed where existing ones meet and that some subdisciplines spin off to become new disciplines in their own right.

1C5 Current ethics in science hold that research involving human subjects may be conducted only with the informed consent of the subjects, even if this constraint limits some kinds of potentially important research or influences the results. When it comes to participation in research that could pose risks to society, most scientists believe that a decision to participate or not is a matter of personal ethics rather than professional ethics.

1C6 Scientists can bring information, insights, and analytical skills to bear on matters of public concern. Acting in their areas of expertise, scientists can help people understand the likely causes of events and estimate their possible effects. Outside their areas of expertise, however, scientists should enjoy no special credibility. And where their own personal, institutional, or community interests are at stake, scientists as a group can be expected to be no less biased than other groups are about their perceived interests.

1C7 The strongly held traditions of science, including its commitment to peer review and publication, serve to keep the vast majority of scientists well within the bounds of ethical professional behavior. Deliberate deceit is rare and likely to be exposed sooner or later by the scientific enterprise itself. When violations of these scientific ethical traditions are discovered, they are strongly condemned by the scientific community, and the violators then have difficulty regaining the respect of other scientists.

1C8 Funding influences the direction of science by virtue of the decisions that are made on which research to support. Research funding comes from various federal government agencies, industry, and private foundations.

2. THE NATURE OF MATHEMATICS

A. PATTERNS AND RELATIONSHIPS

2A1 Mathematics is the study of any patterns or relationships, whereas natural science is concerned only with those patterns that are relevant to the observable world. Although mathematics began long

ago in practical problems, it soon focused on abstractions from the material world, and then on even more abstract relationships among those abstractions.

2A2 As in other sciences, simplicity is one of the highest values in mathematics. Some mathematicians try to identify the smallest set of rules from which many other propositions can be logically derived.

2A3 Theories and applications in mathematical work influence each other. Sometimes a practical problem leads to the development of new mathematical theories; often mathematics developed for its own sake turns out to have practical applications.

2A4 New mathematics continues to be invented, and connections between different parts of mathematics continue to be found.

B. MATHEMATICS, SCIENCE AND TECHNOLOGY

2B1 Mathematical modeling aids in technological design by simulating how a proposed system would theoretically behave.

2B2 Mathematics and science as enterprises share many values and features: belief in order, ideals of honesty and openness, the importance of criticism by colleagues, and the essential role played by imagination.

2B3 Mathematics provides a precise language for science and technology-to describe objects and events, to characterize relationships between variables, and to argue logically.

2B4 Developments in science or technology often stimulate innovations in mathematics by presenting

new kinds of problems to be solved. In particular, the development of computer technology (which itself relies on mathematics) has generated new kinds of problems and methods of work in mathematics.

2B5 Developments in mathematics often stimulate innovations in science and technology.

C. MATHEMATICAL INQUIRY

2C1 Some work in mathematics is much like a game-mathematicians choose an interesting set of rules and then play according to those rules to see what can happen. The more interesting the results, the better. The only limit on the set of rules is that they should not contradict one another.

2C2 Much of the work of mathematicians involves a modeling cycle, which consists of three steps: (1) using abstractions to represent things or ideas, (2) manipulating the abstractions according to some logical rules, and (3) checking how well the results match the original things or ideas. If the match is not considered good enough, a new round of abstraction and manipulation may begin. The actual thinking need not go through these processes in logical order but may shift from one to another in any order.

3. THE NATURE OF TECHNOLOGY

A. TECHNOLOGY AND SCIENCE

3A1 Technological problems often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. The very availability of new technology itself often sparks scientific advances.

3A2 Mathematics, creativity, logic and originality are all needed to improve technology.

3A3 Technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs). In contrast, science affects society mainly by stimulating and satisfying people's curiosity and occasionally by enlarging or challenging their views of what the world is like.

B. DESIGN AND SYSTEMS

3B1 In designing a device or process, thought should be given to how it will be manufactured, operated, maintained, replaced, and disposed of and who will sell, operate, and take care of it. The costs associated with these functions may introduce yet more constraints on the design.

3B2 The value of any given technology may be different for different groups of people and at different points in time.

3B3 Complex systems have layers of controls. Some controls operate particular parts of the system and some control other controls. Even fully automatic systems require human control at some point.

3B4 Risk analysis is used to minimize the likelihood of unwanted side effects of a new technology. The public perception of risk may depend, however, on psychological factors as well as scientific ones.

3B5 The more parts and connections a system has, the more ways it can go wrong. Complex systems usually have components to detect, back up, bypass, or compensate for minor failures.

3B6 To reduce the chance of system failure, performance testing is often conducted using small-scale models, computer simulations, analogous systems, or just the parts of the system thought to be least reliable.

C. ISSUES IN TECHNOLOGY

3C1 Social and economic forces strongly influence which technologies will be developed and used. Which will prevail is affected by many factors, such as personal values, consumer acceptance, patent laws, the availability of risk capital, the federal budget, local and national regulations, media attention, economic competition, and tax incentives.

3C2 Technological knowledge is not always as freely shared as scientific knowledge unrelated to technology. Some scientists and engineers are comfortable working in situations in which some secrecy is required, but others prefer not to do so. It is generally regarded as a matter of individual choice and ethics, not one of professional ethics.

3C3 In deciding on proposals to introduce new technologies or to curtail existing ones, some key questions arise concerning alternatives, risks, costs, and benefits. What alternative ways are there to achieve the same ends, and how do the alternatives compare to the plan being put forward? Who benefits and who suffers? What are the financial and social costs, do they change over time, and who bears them? What are the risks associated with using (or not using) the new technology, how serious are they, and who is in jeopardy? What human, material, and energy resources will be needed to build, install, operate, maintain, and replace the new technology, and where will they come from? How will the new technology and its waste products be disposed of and at what costs?

3C4 The human species has a major impact on other species in many ways: reducing the amount of the earth's surface available to those other species, interfering with their food sources, changing the temperature and chemical composition of their habitats, introducing foreign species into their ecosystems, and altering organisms directly through selective breeding and genetic engineering.

3C5 Human inventiveness has brought new risks as well as improvements to human existence.

4. THE PHYSICAL SETTING

A. THE UNIVERSE

4A1 The stars differ from each other in size, temperature, and age, but they appear to be made up of the same elements that are found on the earth and to behave according to the same physical principles. Unlike the sun, most stars are in systems of two or more stars orbiting around one another.

4A2 On the basis of scientific evidence, the universe is estimated to be over ten billion years old. The current theory is that its entire contents expanded explosively from a hot, dense, chaotic mass. Stars condensed by gravity out of clouds of molecules of the lightest elements until nuclear fusion of the light elements into heavier ones began to occur. Fusion released great amounts of energy over millions of years. Eventually, some stars exploded, producing clouds of heavy elements from which other stars and planets could later condense. The process of star formation and destruction continues.

4A3 Increasingly sophisticated technology is used to learn about the universe. Visual, radio, and x-ray telescopes collect information from across the entire spectrum of electromagnetic waves; computers handle an avalanche of data and increasingly complicated computations to interpret them; space probes send back data and materials from the remote parts of the solar system; and accelerators give subatomic particles energies that simulate conditions in the stars and in the early history of the universe before stars formed.

4A4 Mathematical models and computer simulations are used in studying evidence from many sources in order to form a scientific account of the universe.

4A5 The sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night. The universe contains many billions of galaxies, and each galaxy contains many billions of stars. To the naked eye, even the closest of these galaxies is no more than a dim, fuzzy spot. ("by the end of grade 8 standard")

4A6 The sun is many thousands of times closer to the earth than any other star. Light from the sun takes a few minutes to reach the earth, but light from the next nearest star takes a few years to arrive. The trip to that star would take the fastest rocket thousands of years. Some distant galaxies are so far away that their light takes several billion years to reach the earth. People on earth, therefore, see them as they were that long ago in the past. ("by the end of grade 8 standard")

4A7 Nine planets of very different size, composition, and surface features move around the sun in nearly circular orbits. Some planets have a great variety of moons and even flat rings of rock and ice particles orbiting around them. Some of these planets and moons show evidence of geologic activity. The earth is orbited by one moon, many artificial satellites, and debris. ("by the end of grade 8 standard")

4A8 Large numbers of chunks of rock orbit the sun. Some of those that the earth meets in its yearly orbit around the sun glow and disintegrate from friction as they plunge through the atmosphere-and sometimes impact the ground. Other chunks of rocks mixed with ice have long, off-center orbits that carry them close to the sun, where the sun's radiation (of light and particles) boils off frozen material from their surfaces and pushes it into a long, illuminated tail. ("by the end of grade 8 standard")

B. THE EARTH

4B1 Life is adapted to conditions on the earth, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of radiation from the sun that allows water to cycle between liquid and vapor.

4B2 Weather (in the short run) and climate (in the long run) involve the transfer of energy in and out of the atmosphere. Solar radiation heats the land masses, oceans, and air. Transfer of heat energy at the boundaries between the atmosphere, the land masses, and the oceans results in layers of different temperatures and densities in both the ocean and atmosphere. The action of gravitational force on regions of different densities causes them to rise or fall-and such circulation, influenced by the rotation of the earth, produces winds and ocean currents.

C. PROCESSES THAT SHAPE THE EARTH

4C1 Plants alter the earth's atmosphere by removing carbon dioxide from it, using the carbon to make sugars and releasing oxygen. This process is responsible for the oxygen content of the air.

4C2 The formation, weathering, sedimentation, and reformation of rock constitute a continuing "rock cycle" in which the total amount of material stays the same as its forms change.

4C3 The slow movement of material within the earth results from heat flowing out from the deep interior and the action of gravitational forces on regions of different density.

4C4 The solid crust of the earth-including both the continents and the ocean basins-consists of separate plates that ride on a denser, hot, gradually deformable layer of the earth. The crust sections move very slowly, pressing against one another in some places, pulling apart in other places. Ocean-floor plates may slide under continental plates, sinking deep into the earth. The surface layers of these plates may fold, forming mountain ranges.

4C5 Earthquakes often occur along the boundaries between colliding plates, and molten rock from below creates pressure that is released by volcanic eruptions, helping to build up mountains. Under the ocean basins, molten rock may well up between separating plates to create new ocean floor. Volcanic activity

along the ocean floor may form undersea mountains, which can thrust above the ocean's surface to become islands.

D. THE STRUCTURE OF MATTER

4D1 Atoms are made of a positive nucleus surrounded by negative electrons. An atom's electron configuration, particularly the outermost electrons, determines how the atom can interact with other atoms. Atoms form bonds to other atoms by transferring or sharing electrons.

4D2 The nucleus, a tiny fraction of the volume of an atom, is composed of protons and neutrons, each almost two thousand times heavier than an electron. The number of positive protons in the nucleus determines what an atom's electron configuration can be and so defines the element. In a neutral atom, the number of electrons equals the number of protons. But an atom may acquire an unbalanced charge by gaining or losing electrons.

4D3 Neutrons have a mass that is nearly identical to that of protons, but neutrons have no electric charge. Although neutrons have little effect on how an atom interacts with others, they do affect the mass and stability of the nucleus. Isotopes of the same element have the same number of protons (and therefore of electrons) but differ in the number of neutrons.

4D4 The nucleus of radioactive isotopes is unstable and spontaneously decays, emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. This predictability of decay rate allows radioactivity to be used for estimating the age of materials that contain radioactive substances.

4D5 Scientists continue to investigate atoms and have discovered even smaller constituents of which neutrons and protons are made.

4D6 When elements are listed in order by the masses of their atoms, the same sequence of properties appears over and over again in the list.

4D7 Atoms often join with one another in various combinations in distinct molecules or in repeating three-dimensional crystal patterns. An enormous variety of biological, chemical, and physical

phenomena can be explained by changes in the arrangement and motion of atoms and molecules.

4D8 The configuration of atoms in a molecule determines the molecule's properties. Shapes are particularly important in how large molecules interact with others.

4D9 The rate of reactions among atoms and molecules depends on how often they encounter one another, which is affected by the concentration, pressure, and temperature of the reacting materials. Some atoms and molecules are highly effective in encouraging the interaction of others.

E. ENERGY TRANSFORMATIONS

4E1 Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.

4E2 Heat energy in a material consists of the disordered motions of its atoms or molecules. In any interactions of atoms or molecules, the statistical odds are that they will end up with less order than they began—that is, with the heat energy spread out more evenly. With huge numbers of atoms and molecules, the greater disorder is almost certain.

4E3 Transformations of energy usually produce some energy in the form of heat, which spreads around by radiation or conduction into cooler places. Although just as much total energy remains, its being spread out more evenly means less can be done with it.

4E4 Different energy levels are associated with different configurations of atoms and molecules. Some changes of configuration require an input of energy whereas others release energy.

4E5 When energy of an isolated atom or molecule changes, it does so in a definite jump from one value to another, with no possible values in between. The change in energy occurs when radiation is absorbed or emitted, so the radiation also has distinct energy values. As a result, the light emitted or absorbed by separate atoms or molecules (as in a gas) can be used to identify what the substance is.

4E6 Energy is released whenever the nuclei of very heavy atoms, such as uranium or plutonium, split into middleweight ones, or when very light nuclei, such as

those of hydrogen and helium, combine into heavier ones. The energy released in each nuclear reaction is very much greater than the energy given off in each chemical reaction.

F. MOTION

4F1 The change in motion of an object is proportional to the applied force and inversely proportional to the mass.

4F2 All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion.

4F3 Accelerating electric charges produce electromagnetic waves around them. A great variety of radiations are electromagnetic waves: radio waves, microwaves, radiant heat, visible light, ultraviolet radiation, x rays, and gamma rays. These wavelengths vary from radio waves, the longest, to gamma rays, the shortest. In empty space, all electromagnetic waves move at the same speed—the "speed of light."

4F4 Whenever one thing exerts a force on another, an equal amount of force is exerted back on it.

4F5 The observed wavelength of a wave depends upon the relative motion of the source and the observer. If either is moving toward the other, the observed wavelength is shorter; if either is moving away, the wavelength is longer. Because the light seen from almost all distant galaxies has longer wavelengths than comparable light here on earth, astronomers believe that the whole universe is expanding.

4F6 Waves can superpose on one another, bend around corners, reflect off surfaces, be absorbed by materials they enter, and change direction when entering a new material. All these effects vary with wavelength. The energy of waves (like any form of energy) can be changed into other forms of energy.

4F7 An unbalanced force acting on an object changes its speed or direction of motion, or both. If the force acts toward a single center, the object's path may curve into an orbit around the center. ("by the end of grade 8 standard")

4F8 Vibrations in materials set up wavelike disturbances that spread away from the source.

Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. (“by the end of grade 8 standard”)

4F9 Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have. (“by the end of grade 8 standard”)

4F10 Light from the sun is made up of a mixture of many different colors of light, even though to the eye the light looks almost white. Other things that give off or reflect light have a different mix of colors. (“by the end of grade 8 standard”)

4F11 Something can be “seen” when light waves emitted or reflected by it enter the eye, just as something can be “heard” when sound waves from it enter the ear. (“by the end of grade 8 standard”)

4F12 Human eyes respond to only a narrow range of wavelengths of electromagnetic radiation-visible light. Differences of wavelength within that range are perceived as differences in color. (“by the end of grade 8 standard”)

4F13 Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have. (“by the end of grade 5 standard”)

G. FORCES OF NATURE

4G1 Gravitational force is an attraction between masses. The strength of the force is proportional to the masses and weakens rapidly with increasing distance between them.

4G2 Electromagnetic forces acting within and between atoms are vastly stronger than the gravitational forces acting between the atoms. At the atomic level, electric forces between oppositely charged electrons and protons hold atoms and molecules together and thus are involved in all chemical reactions. On a larger scale, these forces hold solid and liquid materials together and act between objects when they are in contact-as in sticking or sliding friction.

4G3 There are two kinds of charges-positive and negative. Like charges repel one another, opposite charges attract. In materials, there are almost exactly equal proportions of positive and negative charges, making the materials as a whole electrically neutral. Negative charges, being associated with electrons, are far more mobile in materials than positive charges are. A very small excess or deficit of negative charges in a material produces noticeable electric forces.

4G4 Different kinds of materials respond differently to electric forces. In conducting materials such as metals, electric charges flow easily, whereas in insulating materials such as glass, they can move hardly at all. At very low temperatures, some materials become superconductors and offer no resistance to the flow of current. In between these extremes, semiconducting materials differ greatly in how well they conduct, depending on their exact composition.

4G5 Magnetic forces are very closely related to electric forces and can be thought of as different aspects of a single electromagnetic force. Moving electric charges produce magnetic forces and moving magnets produce electric forces. The interplay of electric and magnetic forces is the basis for electric motors, generators, and many other modern technologies, including the production of electromagnetic waves.

4G6 The forces that hold the nucleus of an atom together are much stronger than the electromagnetic force. That is why such great amounts of energy are released from the nuclear reactions in the sun and other stars.

5. THE LIVING ENVIRONMENT

A. DIVERSITY OF LIFE

5A1 The variation of organisms within a species increases the likelihood that at least some members of the species will survive under changed environmental conditions, and a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.

5A2 The degree of kinship between organisms or species can be estimated from the similarity of their DNA sequences, which often closely matches their classification based on anatomical similarities.

B. HEREDITY

5B1 Some new gene combinations make little difference, some can produce organisms with new and perhaps enhanced capabilities, and some can be deleterious.

5B2 The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents.

5B3 The information passed from parents to offspring is coded in DNA molecules.

5B4 Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on the offspring's success in its environment.

5B5 Gene mutations can be caused by such things as radiation and chemicals. When they occur in sex cells, the mutations can be passed on to offspring; if they occur in other cells, they can be passed on to descendant cells only. The experiences an organism has during its lifetime can affect its offspring only if the genes in its own sex cells are changed by the experience.

5B6 The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Different parts of the instructions are used in different types of cells, influenced by the cell's environment and past history.

C. CELLS

5C1 Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape and, for animal cells, movement.

5C2 Within every cell are specialized parts for the transport of materials, energy transfer, protein building, waste disposal, information feedback, and even movement. In addition, most cells in

multicellular organisms perform some special functions that others do not.

5C3 The work of the cell is carried out by the many different types of molecules it assembles, mostly proteins. Protein molecules are long, usually folded chains made from 20 different kinds of amino-acid molecules. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes is a consequence of attractions between the chain's parts.

5C4 The genetic information encoded in DNA molecules provides instructions for assembling protein molecules. The code used is virtually the same for all life forms. Before a cell divides, the instructions are duplicated so that each of the two new cells gets all the necessary information for carrying on.

5C5 Complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division. Cell behavior can also be affected by molecules from other parts of the organism or even other organisms.

5C6 Gene mutation in a cell can result in uncontrolled cell division, called cancer. Exposure of cells to certain chemicals and radiation increases mutations and thus increases the chance of cancer.

5C7 Most cells function best within a narrow range of temperature and acidity. At very low temperatures, reaction rates are too slow. High temperatures and/or extremes of acidity can irreversibly change the structure of most protein molecules. Even small changes in acidity can alter the molecules and how they interact. Both single cells and multicellular organisms have molecules that help to keep the cell's acidity within a narrow range.

5C8 A living cell is composed of a small number of chemical elements mainly carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Carbon atoms can easily bond to several other carbon atoms in chains and rings to form large and complex molecules.

D. INTERDEPENDENCE OF LIFE

5D1 Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more

environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one.

5D2 Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.

5D3 Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

E. FLOW OF MATTER AND ENERGY

5E1 At times, environmental conditions are such that plants and marine organisms grow faster than decomposers can recycle them back to the environment. Layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. By burning these fossil fuels, people are passing most of the stored energy back into the environment as heat and releasing large amounts of carbon dioxide.

5E2 The amount of life any environment can support is limited by the available energy, water, oxygen, and minerals, and by the ability of ecosystems to recycle the residue of dead organic materials. Human activities and technology can change the flow and reduce the fertility of the land.

5E3 The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going.

F. EVOLUTION OF LIFE

5F1 The basic idea of biological evolution is that the earth's present-day species developed from earlier, distinctly different species.

5F2 Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched off from one another.

5F3 Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.

5F4 Heritable characteristics can be observed at molecular and whole-organism levels-in structure, chemistry, or behavior. These characteristics strongly influence what capabilities an organism will have and how it will react, and therefore influence how likely it is to survive and reproduce.

5F5 New heritable characteristics can result from new combinations of existing genes or from mutations of genes in reproductive cells. Changes in other cells of an organism cannot be passed on to the next generation.

5F6 Natural selection leads to organisms that are well suited for survival in particular environments. Chance alone can result in the persistence of some heritable characteristics having no survival or reproductive advantage or disadvantage for the organism. When an environment changes, the survival value of some inherited characteristics may change.

5F7 The theory of natural selection provides a scientific explanation for the history of life on earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms.

5F8 Life on earth is thought to have begun as simple, one-celled organisms about 4 billion years ago. During the first 2 billion years, only single-cell microorganisms existed, but once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.

5F9 Evolution builds on what already exists, so the more variety there is, the more there can be in the future. But evolution does not necessitate long-term progress in some set direction. Evolutionary changes appear to be like the growth of a bush: Some branches

survive from the beginning with little or no change, many die out altogether, and others branch repeatedly, sometimes giving rise to more complex organisms.

6. THE HUMAN ORGANISM

A. HUMAN IDENTITY

6A1 The similarity of human DNA sequences and the resulting similarity in cell chemistry and anatomy identify human beings as a single species.

6A2 Written records and photographic and electronic devices enable human beings to share, compile, use, and misuse great amounts of information and misinformation. No other species uses such technologies.

B. HUMAN DEVELOPMENT

6B1 As successive generations of an embryo's cells form by division, small differences in their immediate environments cause them to develop slightly differently, by activating or inactivating different parts of the DNA information.

6B2 Using artificial means to prevent or facilitate pregnancy raises questions of social norms, ethics, religious beliefs, and even politics.

6B3 The very long period of human development (compared to that of other species) is associated with the prominent role of the brain in human evolution. The ability to learn persists throughout life and may improve as people build a base of ideas and come to understand how to learn well. Human mental abilities that apparently evolved for survival are used for newly invented cultural purposes such as art, literature, ritual, and games.

6B4 The development and use of technologies to maintain, prolong, sustain, or terminate life raise social, moral, ethical, and legal issues.

C. BASIC FUNCTIONS

6C1 The immune system is designed to protect against microscopic organisms and foreign substances that enter from outside the body and against some cancer cells that arise within.

6C2 The nervous system works by electrochemical signals in the nerves and from one nerve to the next. The hormonal system exerts its influences by chemicals that circulate in the blood. These two systems also affect each other in coordinating body systems.

6C3 Communication between cells is required to coordinate their diverse activities. Some cells secrete substances that spread only to nearby cells. Others secrete hormones, molecules that are carried in the bloodstream to widely distributed cells that have special receptor sites to which they attach. Along nerve cells, electrical impulses carry information much more rapidly than is possible by diffusion or blood flow. Some drugs mimic or block the molecules involved in transmitting nerve or hormone signals and therefore disturb normal operations of the brain and body.

6C4 Reproduction is necessary for the survival of any species. Sexual behavior depends strongly on cultural, personal, and biological factors.

D. LEARNING

6D1 Differences in the behavior of individuals arise from the interaction of heredity and experience—the effect of each depends on what the other is. Even instinctive behavior may not develop well if the individual is exposed to abnormal conditions.

6D2 The expectations, moods, and prior experiences of human beings can affect how they interpret new perceptions or ideas. People tend to ignore evidence that challenges their beliefs and to accept evidence that supports them. The context in which something is learned may limit the contexts in which the learning can be used.

6D3 Human thinking involves the interaction of ideas, and ideas about ideas. People can produce many associations internally without receiving information from their senses.

E. PHYSICAL HEALTH

6E1 Some allergic reactions are caused by the body's immune responses to usually harmless environmental substances. Sometimes the immune system may attack some of the body's own cells.

6E2 Faulty genes can cause body parts or systems to work poorly. Some genetic diseases appear only when an individual has inherited a certain faulty gene from both parents.

6E3 New medical techniques, efficient health care delivery systems, improved sanitation, and a fuller understanding of the nature of disease give today's human beings a better chance of staying healthy than their forebears had. Conditions now are very different from the conditions in which the species evolved. But some of the differences may not be good for human health.

6E4 Some viral diseases, such as AIDS, destroy critical cells of the immune system, leaving the body unable to deal with multiple infection agents and cancerous cells.

F. MENTAL HEALTH

6F1 Stresses are especially difficult for children to deal with and may have long-lasting effects.

6F2 Biological abnormalities, such as brain injuries or chemical imbalances, can cause or increase susceptibility to psychological disturbances.

6F3 Reactions of other people to an individual's emotional disturbance may increase its effects.

6F4 Human beings differ greatly in how they cope with emotions and may therefore puzzle one another.

6F5 Ideas about what constitutes good mental health and proper treatment for abnormal mental states vary from one culture to another and from one time period to another.

7. THE HUMAN SOCIETY

A. CULTURAL EFFECTS ON BEHAVIOR

7A1 Cultural beliefs strongly influence the values and behavior of the people who grow up in the culture, often without their being fully aware of it. Response to these influences varies among individuals.

7A2 The ways that unacceptable social behavior is punished depend partly on beliefs about the purposes of punishment and about its effectiveness. Effectiveness is difficult to test scientifically because circumstances vary greatly and because legal and ethical barriers interfere.

7A3 Social distinctions are a part of every culture, but take many different forms, ranging from rigid classes based solely on parentage to gradations based on the acquisition of skill, wealth, or education. Differences in speech, dress, behavior, or physical features are often taken by people to be signs of social class. The difficulty of moving from one social class to another varies greatly with time, place, and economic circumstances.

7A4 Heredity, culture, and personal experience interact in shaping human behavior. Their relative importance in most circumstances is not clear.

B. GROUP BEHAVIOR

7B1 The behavior of a group may not be predictable from an understanding of each of its members.

7B2 Social organizations may serve business, political, or social purposes beyond those for which they officially exist, including unstated ones such as excluding certain categories of people from activities.

C. SOCIAL CHANGE

7C1 The size and rate of growth of the human population in any location is affected by economic, political, religious, technological, and environmental factors. Some of these factors, in turn, are influenced by the size and rate of growth of the population.

7C2 The decisions of one generation both provide and limit the range of possibilities open to the next generation.

7C3 Mass media, migrations, and conquest affect social change by exposing one culture to another. Extensive borrowing among cultures has led to the virtual disappearance of some cultures but only modest change in others.

7C4 To various degrees, governments try to bring about social change or to impede it through policies,

laws, incentives, or direct coercion. Sometimes such efforts achieve their intended results and sometimes they do not.

D. SOCIAL TRADE-OFFS

7D1 Benefits and costs of proposed choices include consequences that are long-term as well as short-term, and indirect as well as direct. The more remote the consequences of a personal or social decision, the harder it usually is to take them into account in considering alternatives. But benefits and costs may be difficult to estimate.

7D2 In deciding among alternatives, a major question is who will receive the benefits and who (not necessarily the same people) will bear the costs.

7D3 Social tradeoffs are often generational. The cost of benefits received by one generation may fall on subsequent generations. Also, the cost of a social trade-off is sometimes borne by one generation although the benefits are enjoyed by their descendants.

E. POLITICAL AND ECONOMIC SYSTEMS

7E1 In the free-market model, the control of production and consumption is mainly in private hands. The best allocation of resources is believed to be achieved by individuals and organizations competing in the marketplace. Individual initiative, talent, and hard work are expected to be rewarded with success and wealth. Government's role is primarily to protect political and economic freedoms for society as a whole—even at the cost of some individual or group material benefits.

7E2 In the central-planning model, production and consumption are controlled by the government. The best allocation of resources is thought to be achieved through government planning by experts. Dedication to the good of the society as a whole is expected to motivate initiative, talent, and hard work. The main purpose of government is to promote comparable welfare for all individuals and groups—even at the cost of some individual and group freedoms.

7E3 In practice, countries make compromises with regard to economic models. Central planning has to allow for some individual initiative, and markets have to provide some protection for unsuccessful

competitors. The countries of the world use elements of both systems and are neither purely free-market nor entirely centrally controlled. Countries change, some adopting more free-market policies and practices, others more central-planning ones, and still others doing some of each.

F. SOCIAL CONFLICT

7F1 Conflict between people or groups arises from competition over ideas, resources, power, and status. Social change, or the prospect of it, promotes conflict because social, economic, and political changes usually benefit some groups more than others. That, of course, is also true of the status quo.

7F2 Conflicts are especially difficult to resolve in situations in which there are few choices and little room for compromise. Some informal ways of responding to conflict—use of pamphlets, demonstrations, cartoons, etc.—may sometimes reduce tensions and lead to compromise but at other times they may be inflammatory and make agreement more difficult to reach.

7F3 Conflict within a group may be reduced by conflict between it and other groups.

7F4 Intergroup conflict does not necessarily end when one segment of society gets a decision in its favor, for the "losers" may then work all the harder to reverse, modify, or circumvent the change. Even when the majority of the people in a society agree on a social decision, the minority who disagree must be protected from oppression, just as the majority may need protection against unfair retaliation from the minority.

G. GLOBAL INTERDEPENDENCE

7G1 The wealth of a country depends partly on the effort and skills of its workers, its natural resources, and the capital and technology available to it. It also depends on the balance between how much its products are sought by other nations and how much of other nations' products it seeks. Even if a country could produce everything it needs for itself, it would still benefit from trade with other countries.

7G2 Because of increasing international trade, the domestic products of any country may be made up in part by parts made in other countries. The international trade picture is often complicated by

political motivations taking priority over economic ones.

7G3 Migration across borders, temporary and permanent, legal and illegal, plays a major role in the availability and distribution of labor in many nations. It can bring both economic benefits and political problems.

7G4 The growing interdependence of world social, economic, and ecological systems does not always bring greater worldwide stability and often increases the costs of conflict.

8. THE DESIGNED WORLD

A. AGRICULTURE

8A1 New varieties of farm plants and animals have been engineered by manipulating their genetic instructions to produce new characteristics.

8A2 Government sometimes intervenes in matching agricultural supply to demand in an attempt to ensure a stable, high-quality, and inexpensive food supply. Regulations are often also designed to protect farmers from abrupt changes in farming conditions and from competition by farmers in other countries.

8A3 Agricultural technology requires tradeoffs between increased production and environmental harm and between efficient production and social values. In the past century, agricultural technology led to a huge shift of population from farms to cities and a great change in how people live and work.

B. MATERIALS AND MANUFACTURING

8B1 Manufacturing processes have been changed by improved tools and techniques based on more thorough scientific understanding, increases in the forces that can be applied and the temperatures that can be reached, and the availability of electronic controls that make operations occur more rapidly and consistently.

8B2 Waste management includes considerations of quantity, safety, degradability, and cost. It requires social and technological innovations, because waste-disposal problems are political and economic as well as technical.

8B3 Scientific research identifies new materials and new uses of known materials.

8B4 Increased knowledge of the molecular structure of materials helps in the design and synthesis of new materials for special purposes.

C. ENERGY SOURCES AND USE

8C1 A central factor in technological change has been how hot a fire could be made. The discovery of new fuels, the design of better ovens and furnaces, and the forced delivery of air or pure oxygen have progressively increased the available temperature. Lasers are a new tool for focusing radiation energy with great intensity and control.

8C2 At present, all fuels have advantages and disadvantages so that society must consider the tradeoffs among them.

8C3 Nuclear reactions release energy without the combustion products of burning fuels, but the radioactivity of fuels and by-products poses other risks, which may last for thousands of years.

8C4 Industrialization brings an increased demand for and use of energy. Such usage contributes to the high standard of living in the industrially developing nations but also leads to more rapid depletion of the earth's energy resources and to environmental risks associated with the use of fossil and nuclear fuels.

8C5 Decisions to slow the depletion of energy sources through efficient technology can be made at many levels, from personal to national, and they always involve tradeoffs of economic costs and social values.

D. COMMUNICATION

8D1 Almost any information can be transformed into electrical signals. A weak electrical signal can be used to shape a stronger one, which can control other signals of light, sound, mechanical devices, or radio waves.

8D2 The quality of communication is determined by the strength of the signal in relation to the noise that tends to obscure it. Communication errors can be reduced by boosting and focusing signals, shielding

the signal from internal and external noise, and repeating information, but all of these increase costs. Digital coding of information (using only 1's and 0's) makes possible more reliable transmission of information.

8D3 As technologies that provide privacy in communication improve, so do those for invading privacy.

E. INFORMATION PROCESSING

8E1 Computer modeling explores the logical consequences of a set of instructions and a set of data. The instructions and data input of a computer model try to represent the real world so the computer can show what would actually happen. In this way, computers assist people in making decisions by simulating the consequences of different possible decisions.

8E2 Redundancy can reduce errors in storing or processing information but increases costs.

8E3 Miniaturization of information-processing hardware can increase processing speed and portability, reduce energy use, and lower cost. Miniaturization is made possible through higher-purity materials and more precise fabrication technology.

F. HEALTH TECHNOLOGY

8F1 Owing to the large amount of information that computers can process, they are playing an increasingly larger role in medicine. They are used to analyze data and to keep track of diagnostic information about individuals and statistical information on the distribution and spread of various maladies in populations.

8F2 Almost all body substances and functions have daily or longer cycles. These cycles often need to be taken into account in interpreting normal ranges for body measurements, detecting disease, and planning treatment of illness. Computers aid in detecting, analyzing, and monitoring these cycles.

8F3 Knowledge of genetics is opening whole new fields of health care. In diagnosis, mapping of genetic instructions in cells makes it possible to detect defective genes that may lead to poor health. In

treatment, substances from genetically engineered organisms may reduce the cost and side effects of replacing missing body chemicals.

8F4 Inoculations use weakened germs (or parts of them) to stimulate the body's immune system to react. This reaction prepares the body to fight subsequent invasions by actual germs of that type. Some inoculations last for life.

8F5 Knowledge of molecular structure and interactions aids in synthesizing new drugs and predicting their effects.

8F6 The diagnosis and treatment of mental disorders are improving but not as rapidly as for physical health. Techniques for detecting and diagnosing these disorders include observation of behavior, in-depth interviews, and measurements of body chemistry. Treatments range from discussing problems to affecting the brain directly with chemicals, electric shock, or surgery.

8F7 Biotechnology has contributed to health improvement in many ways, but its cost and application have led to a variety of controversial social and ethical issues.

9. THE MATHEMATICAL WORLD

A. NUMBERS

9A1 Comparison of numbers of very different size can be made approximately by expressing them as nearest powers of 10.

9A2 Numbers can be written with bases different from ten (which people probably use because of their 10 fingers). The simplest base, 2, uses just two symbols (1 and 0, or on and off).

9A3 When calculations are made with measurements, a small error in the measurements may lead to a large error in the results.

9A4 The effects of uncertainties in measurements on a computed result can be estimated.

B. SYMBOLIC RELATIONSHIPS

9B1 In some cases, the more of something there is, the more rapidly it may change (as the number of births is proportional to the size of the population). In other cases, the rate of change of something depends on how much there is of something else (as the rate of change of speed is proportional to the amount of force acting).

9B2 Symbolic statements can be manipulated by rules of mathematical logic to produce other statements of the same relationship, which may show some interesting aspect more clearly. Symbolic statements can be combined to look for values of variables that will satisfy all of them at the same time.

9B3 Any mathematical model, graphic or algebraic, is limited in how well it can represent how the world works. The usefulness of a mathematical model for predicting may be limited by uncertainties in measurements, by neglect of some important influences, or by requiring too much computation.

9B4 Tables, graphs, and symbols are alternative ways of representing data and relationships that can be translated from one to another.

9B5 When a relationship is represented in symbols, numbers can be substituted for all but one of the symbols and the possible value of the remaining symbol computed. Sometimes the relationship may be satisfied by one value, sometimes more than one, and sometimes maybe not at all.

9B6 The reasonableness of the result of a computation can be estimated from what the inputs and operations are.

C. SHAPES

9C1 Distances and angles that are inconvenient to measure directly can be found from measurable distances and angles using scale drawings or formulas.

9C2 There are formulas for calculating the surface areas and volumes of regular shapes. When the linear size of a shape changes by some factor, its area and volume change disproportionately: area in proportion to the square of the factor, and volume in proportion to its cube. Properties of an object that depend on its area or volume also change disproportionately.

9C3 Geometric shapes and relationships can be described in terms of symbols and numbers-and vice versa. For example, the position of any point on a surface can be specified by two numbers; a graph represents all the values that satisfy an equation; and if two equations have to be satisfied at the same time, the values that satisfy them both will be found where their graphs intersect.

9C4 Different ways to map a curved surface (like the earth's) onto a flat surface have different advantages.

D. UNCERTAINTY

9D1 Even when there are plentiful data, it may not be obvious what mathematical model to use to make predictions from them or there may be insufficient computing power to use some models.

9D2 When people estimate a statistic, they may also be able to say how far off the estimate might be.

9D3 The middle of a data distribution may be misleading-when the data are not distributed symmetrically, or when there are extreme high or low values, or when the distribution is not reasonably smooth.

9D4 The way data are displayed can make a big difference in how they are interpreted.

9D5 Both percentages and actual numbers have to be taken into account in comparing different groups; using either category by itself could be misleading.

9D6 Considering whether two variables are correlated requires inspecting their distributions, such as in two-way tables or scatterplots. A believable correlation between two variables doesn't mean that either one causes the other; perhaps some other variable causes them both or the correlation might be attributable to chance alone. A true correlation means that differences in one variable imply differences in the other when all other things are equal.

9D7 For a well-chosen sample, the size of the sample is much more important than the size of the population. To avoid intentional or unintentional bias, samples are usually selected by some random system.

9D8 A physical or mathematical model can be used to estimate the probability of real-world events.

E. REASONING

9E1 To be convincing, an argument needs to have both true statements and valid connections among them. Formal logic is mostly about connections among statements, not about whether they are true. People sometimes use poor logic even if they begin with true statements, and sometimes they use logic that begins with untrue statements.

9E2 Logic requires a clear distinction among reasons: A reason may be *sufficient* to get a result, but perhaps is not the only way to get there; or, a reason may be *necessary* to get the result, but it may not be enough by itself; some reasons may be both sufficient and necessary.

9E3 Wherever a general rule comes from, logic can be used in testing how well it works. Proving a generalization to be false (just one exception will do) is easier than proving it to be true (for all possible cases). Logic may be of limited help in finding solutions to problems if one isn't sure that general rules always hold or that particular information is correct; most often, one has to deal with probabilities rather than certainties.

9E4 Once a person believes in a general rule, he or she may be more likely to notice cases that agree with it and to ignore cases that don't. To avoid biased observations, scientific studies sometimes use observers who don't know what the results are "supposed" to be.

9E5 Very complex logical arguments can be made from a lot of small logical steps. Computers are particularly good at working with complex logic but not all logical problems can be solved by computers. High-speed computers can examine the validity of some logical propositions for a very large number of cases, although that may not be a perfect proof.

10. HISTORICAL PERSPECTIVES

A. DISPLACING THE EARTH FROM THE CENTER OF THE UNIVERSE

10A1 People perceive that the earth is large and stationary and that all other objects in the sky orbit

around it. That perception was the basis for theories of how the universe is organized that prevailed for over 2,000 years.

10A2 Ptolemy, an Egyptian astronomer living in the second century A.D., devised a powerful mathematical model of the universe based on constant motion in perfect circles, and circles on circles. With the model, he was able to predict the motions of the sun, moon, and stars, and even of the irregular "wandering stars" now called planets.

10A3 In the 16th century, a Polish astronomer named Copernicus suggested that all those same motions could be explained by imagining that the earth was turning around once a day and orbiting around the sun once a year. This explanation was rejected by nearly everyone because it violated common sense and required the universe to be unbelievably large. Worse, it flew in the face of the belief, universally held at the time, that the earth was at the center of the universe.

10A4 Johannes Kepler, a German astronomer who lived at about the same time as Galileo, showed mathematically that Copernicus' idea of a sun-centered system worked well if uniform circular motion was replaced with uneven (but predictable) motion along off-center ellipses.

10A5 Using the newly invented telescope to study the sky, Galileo made many discoveries that supported the ideas of Copernicus. It was Galileo who found the moons of Jupiter, sunspots, craters and mountains on the moon, and many more stars than were visible to the unaided eye.

10A6 Writing in Italian rather than in Latin (the language of scholars at the time), Galileo presented arguments for and against the two main views of the universe in a way that favored the newer view. That brought the issue to the educated people of the time and created political, religious, and scientific controversy.

B. UNITING THE HEAVENS AND EARTH

10B1 Isaac Newton created a unified view of force and motion in which motion everywhere in the universe can be explained by the same few rules. His mathematical analysis of gravitational force and motion showed that planetary orbits had to be the very ellipses that Kepler had proposed two generations earlier.

10B2 Newton's system was based on the concepts of mass, force, and acceleration, his three laws of motion relating them, and a physical law stating that the force of gravity between any two objects in the universe depends only upon their masses and the distance between them.

10B3 The Newtonian model made it possible to account for such diverse phenomena as tides, the orbits of planets and moons, the motion of falling objects, and the earth's equatorial bulge.

10B4 For several centuries, Newton's science was accepted without major changes because it explained so many different phenomena, could be used to predict many physical events (such as the appearance of Halley's comet), was mathematically sound, and had many practical applications.

10B5 Although overtaken in the 20th century by Einstein's relativity theory, Newton's ideas persist and are widely used. Moreover, his influence has extended far beyond physics and astronomy, serving as a model for other sciences and even raising philosophical questions about free will and the organization of social systems.

C. RELATING MATTER & ENERGY AND TIME & SPACE

10C1 As a young man, Albert Einstein, a German scientist, formulated the special theory of relativity, which brought about revolutionary changes in human understanding of nature. A decade later, he proposed the general theory of relativity, which, along with Newton's work, ranks as one of the greatest human accomplishments in all of history.

10C2 Among the surprising ideas of special relativity is that nothing can travel faster than the speed of light, which is the same for all observers no matter how they or the light source happen to be moving.

10C3 The special theory of relativity is best known for stating that any form of energy has mass, and that matter itself is a form of energy. The famous relativity equation, $E = mc^2$, holds that the transformation of even a tiny amount of matter will release an enormous amount of other forms of energy, in that the c in the equation stands for the immense speed of light.

10C4 General relativity theory pictures Newton's gravitational force as a distortion of space and time.

10C5 Many predictions from Einstein's theory of relativity have been confirmed on both atomic and astronomical scales. Still, the search continues for an even more powerful theory of the architecture of the universe.

D. EXTENDING TIME

10D1 Scientific evidence indicates that some rock near the earth's surface is several billion years old. But until the 19th century, most people believed that the earth was created just a few thousand years ago.

10D2 The idea that the earth might be vastly older than most people believed made little headway in science until the publication of *Principles of Geology* by an English scientist, Charles Lyell, early in the 19th century. The impact of Lyell's book was a result of both the wealth of observations it contained on the patterns of rock layers in mountains and the locations of various kinds of fossils, and of the careful logic he used in drawing inferences from his data.

10D3 In formulating and presenting his theory of biological evolution, Charles Darwin adopted Lyell's belief about the age of the earth and his style of buttressing his argument with vast amounts of evidence.

E. MOVING THE CONTINENTS

10E1 The idea of continental drift was suggested by the matching shapes of the Atlantic coasts of Africa and South America, but rejected for lack of other evidence. It just seemed absurd that anything as massive as a continent could move around.

10E2 Early in the 20th century, Alfred Wegener, a German scientist, reintroduced the idea of moving continents, adding such evidence as the underwater shapes of the continents, the similarity of life forms and land forms in corresponding parts of Africa and South America, and the increasing separation of Greenland and Europe. Still, very few contemporary scientists adopted his theory.

10E3 The theory of plate tectonics was finally accepted by the scientific community in the 1960s, when further evidence had accumulated in support of

it. The theory was seen to provide an explanation for a diverse array of seemingly unrelated phenomena, and there was a scientifically sound physical explanation of how such movement could occur.

F. UNDERSTANDING FIRE

10F1 Lavoisier invented a whole new field of science based on a theory of materials, physical laws, and quantitative methods, with the conservation of matter at its core. He persuaded a generation of scientists that his approach accounted for the experimental results better than other chemical systems.

10F2 Lavoisier's system for naming substances and describing their reactions contributed to the rapid growth of chemistry by enabling scientists everywhere to share their findings about chemical reactions with one another without ambiguity.

10F3 John Dalton's modernization of the ancient Greek ideas of element, atom, compound, and molecule strengthened the new chemistry by providing a physical explanation for reactions that could be expressed in quantitative terms.

10F4 While the basic ideas of Lavoisier and Dalton have survived, the advancement of chemistry since their time now makes possible an explanation of the bonding that takes place between atoms during chemical reactions in terms of the inner workings of atoms.

G. SPLITTING THE ATOM

10G1 The Curies made radium available to researchers all over the world, increasing the study of radioactivity and leading to the realization that one kind of atom may change into another kind, and so must be made up of smaller parts. These parts were demonstrated by other scientists to be a small, dense nucleus that contains protons and neutrons and is surrounded by a cloud of electrons.

10G2 Ernest Rutherford of New Zealand and his colleagues discovered that the heavy radio active element uranium spontaneously splits itself into a slightly lighter nucleus and a very light helium nucleus.

10G3 Later, Austrian and German scientists showed that when uranium is struck by neutrons, it splits into

two nearly equal parts plus one or two extra neutrons. Lise Meitner, an Austrian physicist, was the first to point out that if these fragments added up to less mass than the original uranium nucleus, then Einstein's special relativity theory predicted that a large amount of energy would be released. Enrico Fermi, an Italian working with colleagues in the United States, showed that the extra neutrons trigger more fissions and so create a sustained chain reaction in which a prodigious amount of energy is given off.

10G4 A massive effort went into developing the technology for the two nuclear fission bombs used on Japan in World War II, nuclear fusion weapons that followed, and reactors for the controlled conversion of nuclear energy into electric energy. Nuclear weapons and energy remain matters of public concern and controversy.

10G5 Radioactivity has many uses other than generating energy, including in medicine, industry, and scientific research in many different fields.

H. EXPLAINING THE DIVERSITY OF LIFE

10H1 The scientific problem that led to the theory of natural selection was how to explain similarities within the great diversity of existing and fossil organisms.

10H2 Prior to Charles Darwin, the most widespread belief was that all known species were created at the same time and remained unchanged throughout history. Some scientists at the time believed that features an individual acquired during its lifetime could be passed on to its offspring, and the species could thereby gradually change to fit its environment better.

10H3 Darwin argued that only biologically inherited characteristics could be passed on to offspring. Some of these characteristics were advantageous in surviving and reproducing. The offspring would also inherit and pass on those advantages, and over generations the aggregation of these inherited advantages would lead to a new species.

10H4 The quick success of Darwin's book *Origin of Species*, published in the mid-1800s, came from the clear and understandable argument it made, including the comparison of natural selection to the selective breeding of animals in wide use at the time, and from

the massive array of biological and fossil evidence it assembled to support the argument.

10H5 After the publication of *Origin of Species*, biological evolution was supported by the rediscovery of the genetics experiments of an Austrian monk, Gregor Mendel, by the identification of genes and how they are sorted in reproduction, and by the discovery that the genetic code found in DNA is the same for almost all organisms.

10H6 By the 20th century, most scientists had accepted Darwin's basic idea. Today that still holds true, although differences exist concerning the details of the process and how rapidly evolution of species takes place. People usually do not reject evolution for scientific reasons but because they dislike its implications, such as the relation of human beings to other animals, or because they prefer a biblical account of creation.

J. HARNESSING POWER

10J1 The Industrial Revolution happened first in Great Britain because that country made practical use of science, had access by sea to world resources and markets, and had an excess of farm workers willing to become factory workers.

10J2 The Industrial Revolution increased the productivity of each worker but it also increased child labor and unhealthy working conditions, and it gradually destroyed the craft tradition. The economic imbalances of the Industrial Revolution led to a growing conflict between factory owners and workers and contributed to the main political ideologies of the 20th century.

10J3 The Industrial Revolution is still underway as electric, electronic, and computer technologies change patterns of work and bring with them economic and social consequences.

11. COMMON THEMES

A. SYSTEMS

11A1 A system usually has some properties that are different from those of its parts, but appear because of the interaction of those parts.

11A2 Understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis. In defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other systems, and identify what its input and its output are expected to be.

11A3 The successful operation of a designed system usually involves feedback. The feedback of output from some parts of a system to input of other parts can be used to encourage what is going on in a system, discourage it, or reduce its discrepancy from some desired value. The stability of a system can be greater when it includes appropriate feedback mechanisms.

11A4 Even in some very simple systems, it may not always be possible to predict accurately the result of changing some part or connection.

B. MODELS

11B1 The basic idea of mathematical modeling is to find a mathematical relationship that behaves in the same ways as the objects or processes under investigation. A mathematical model may give insight about how something really works or may fit observations very well without any intuitive meaning.

11B2 Computers have greatly improved the power and use of mathematical models by performing computations that are very long, very complicated, or repetitive. Therefore computers can show the consequences of applying complex rules or of changing the rules. The graphic capabilities of computers make them useful in the design and testing of devices and structures and in the simulation of complicated processes.

11B3 The usefulness of a model can be tested by comparing its predictions to actual observations in the real world. But a close match does not necessarily mean that the model is the only "true" model or the only one that would work.

C. CONSTANCY AND CHANGE

11C1 A system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small. But large disturbances may cause it to escape that equilibrium and eventually settle into some other state of equilibrium.

11C2 Along with the theory of atoms, the concept of the conservation of matter led to revolutionary advances in chemical science. The concept of conservation of energy is at the heart of advances in fields as diverse as the study of nuclear particles and the study of the origin of the universe.

11C3 Things can change in detail but remain the same in general (the players change, but the team remains; cells are replaced, but the organism remains). Sometimes counterbalancing changes are necessary for a thing to retain its essential constancy in the presence of changing conditions.

11C4 Graphs and equations are useful (and often equivalent) ways for depicting and analyzing patterns of change.

11C5 In many physical, biological, and social systems, changes in one direction tend to produce opposing (but somewhat delayed) influences, leading to repetitive cycles of behavior.

11C6 In evolutionary change, the present arises from the materials and forms of the past, more or less gradually, and in ways that can be explained.

11C7 Most systems above the molecular level involve so many parts and forces and are so sensitive to tiny differences in conditions that their precise behavior is unpredictable, even if all the rules for change are known. Predictable or not, the precise future of a system is not completely determined by its present state and circumstances but also depends on the fundamentally uncertain outcomes of events on the atomic scale.

D. SCALE

11D1 Representing large numbers in terms of powers of ten makes it easier to think about them and to compare things that are greatly different.

11D2 Because different properties are not affected to the same degree by changes in scale, large changes in scale typically change the way that things work in physical, biological, or social systems.

11D3 As the number of parts of a system increases, the number of possible interactions between pairs of parts increases much more rapidly.

12. HABITS OF MIND

A. VALUES AND ATTITUDES

12A1 Know why curiosity, honesty, openness, and skepticism are so highly regarded in science and how they are incorporated into the way science is carried out; exhibit those traits in their own lives and value them in others.

12A2 View science and technology thoughtfully, being neither categorically antagonistic nor uncritically positive.

B. COMPUTATION AND ESTIMATION

12B1 Use ratios and proportions, including constant rates, in appropriate problems.

12B2 Find answers to problems by substituting numerical values in simple algebraic formulas and judge whether the answer is reasonable by reviewing the process and checking against typical values.

12B3 Make up and write out simple algorithms for solving problems that take several steps.

12B4 Use computer spreadsheet, graphing, and database programs to assist in quantitative analysis.

12B5 Compare data for two groups by representing their averages and spreads graphically.

12B6 Express and compare very small and very large numbers using powers-of-ten notation.

12B7 Trace the source of any large disparity between an estimate and the calculated answer.

12B8 Recall immediately the relations among 10, 100, 1000, 1 million, and 1 billion (knowing, for example, that 1 million is a thousand thousands).

12B9 Consider the possible effects of measurement errors on calculations.

C. MANIPULATION AND OBSERVATION

12C1 Learn quickly the proper use of new instruments by following instructions in manuals or by taking instructions from an experienced user.

12C2 Use computers for producing tables and graphs and for making spreadsheet calculations.

12C3 Troubleshoot common mechanical and electrical systems, checking for possible causes of malfunction, and decide on that basis whether to make a change or get advice from an expert before proceeding.

12C4 Use power tools safely to shape, smooth, and join wood, plastic, and soft metal.

D. COMMUNICATION SKILLS

12D1 Make and interpret scale drawings.

12D2 Write clear, step-by-step instructions for conducting investigations, operating something, or following a procedure.

12D3 Choose appropriate summary statistics to describe group differences, always indicating the spread of the data as well as the data's central tendencies.

12D4 Describe spatial relationships in geometric terms such as perpendicular, parallel, tangent, similar, congruent, and symmetrical.

12D5 Use and correctly interpret relational terms such as *if . . . then . . . and, or, sufficient, necessary, some, every, not, correlates with, and causes*.

12D6 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

12D7 Use tables, charts, and graphs in making arguments and claims in oral and written presentations.

E. CRITICAL RESPONSE SKILLS

12E1 Notice and criticize arguments based on the faulty, incomplete, or misleading use of numbers,

such as in instances when (1) average results are reported, but not the amount of variation around the average, (2) a percentage or fraction is given, but not the total sample size (as in "9 out of 10 dentists recommend..."), (3) absolute and proportional quantities are mixed (as in "3,400 more robberies in our city last year, whereas other cities had an increase of less than 1%), or (4) results are reported with overstated precision (as in representing 13 out of 19 students as 68.42%).

12E2 Check graphs to see that they do not misrepresent results by using inappropriate scales or by failing to specify the axes clearly.

12E3 Wonder how likely it is that some event of interest might have occurred just by chance.

12E4 Insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position being taken-whether one's own or that of others-can be judged.

12E5 Be aware, when considering claims, that when people try to prove a point, they may select only the data that support it and ignore any that would contradict it.

12E6 Suggest alternative ways of explaining data and criticize arguments in which data, explanations, or conclusions are represented as the only ones worth consideration, with no mention of other possibilities. Similarly, suggest alternative trade-offs in decisions and designs and criticize those in which major trade-offs are not acknowledged.