Grade 6 Science, Quarter 4, Unit 4.1

Space Science

Overview

Number of instructional days: 20 (1 day = 45 minutes)

Content to be learned

- Use models to describe relative motion/position of the earth, sun, and moon.
- Explain how day/night, seasons and years are the result of the regular and predictable motion of the earth, sun, and moon.
- Explain how tides are the results of the regular and predictable motion of the earth, sun, and moon.
- Use models of the earth, sun, and moon to recreate the phases of the moon.
- Define earth's gravity as a force that pulls objects on or near the earth toward its center without touching it.
- Identify the sun as a medium-sized star located near the edge of a disk shaped galaxy of stars.

Science processes to be integrated

- Examine patterns of change.
- Examine interactions within systems.
- Use and analyze models.

Essential questions

- What causes the regular cycles of day and night?
- How does the motion of the earth, sun, and moon, and gravity result in predictable changes in tides?
- What is the relationship between motions in the earth, sun, moon system and the regular event of seasons and years?
- How could models be used to recreate the phases of the moon?
- Where in the universe is our sun located and how would it compare to other stars?

Written Curriculum

Grade Span Expectations

ESS2 - The earth is part of a solar system, made up of distinct parts that have temporal and spatial interrelationships.

ESS2 (5-8) SAE+ POC –8

Explain temporal or positional relationships between or among the Earth, sun, and moon (e.g., night/day, seasons, year, tides) or how gravitational force affects objects in the solar system (e.g., moons, tides, orbits, satellites).

ESS2 (5-6)-8 Students demonstrate an understanding of temporal or positional relationships between or among the earth, sun, and moon by …

8a using models to describe the relative motion/position of the earth, sun, and moon.

8b explaining ~~night/day~~, seasons, ~~year~~, and tides as a result of the regular and predictable motion of the Earth, sun, and moon.

8c using a model of the earth, sun and moon to recreate the phases of the moon.

8d defining the earth's gravity as a force that pulls any object on or near the earth toward its center without touching it.

ESS3 - The origin and evolution of galaxies and the universe demonstrate fundamental principles of physical science across vast distances and time

No further targets for EK ESS3 at the 5-8 Grade Span

The GSEs listed below are assessed at the local level only

ESS3 (5-6)–9 Students demonstrate an understanding of the structure of the universe by …

9b identifying the sun as a medium-sized star located near the edge of a disk-shaped galaxy of stars.

Clarifying the Standards

Prior Learning

In grades K–5, students began to make observations about the sun and the moon, recognizing that the sun can be seen during the day while the moon can be seen at times during both the day and night. Within these grades, students began to take note of the apparent movement of the sun. In grades 3–4, they observed the moon and saw that it looks slightly different from day to day, but looks the same after about four weeks. By the end of fourth grade, students began to understand that earth rotates on its axis, which in turn produces the 24-hour day/night cycle as well as understanding that the sun is the center of our solar system; the earth is one of several planets that orbits the sun; the moon orbits the earth, and the earth orbits the sun, which takes approximately 365 days. By the end of fifth grade, students will compare/identify size, location, atmosphere and movement of objects within the solar system.

Current Learning

At this level, students are still concrete learners, and the abstract nature of these concepts causes them to still be in the developmental stages of learning. Students learn about the relationship of the earth, sun, and moon—including their motion as well as their position relative to the solar system and each other. They also learn about the impact of the motion of these heavenly bodies on the seasons and tides as a result of their predictable motion. Students learn to create models to demonstrate the phases of the moon and their effect on the earth. The concept of gravity must also be taught via models and diagrams. Students should use the process of scientific inquiry to further their understanding of the functions of gravity and the sun, earth, and moon in relation to one another. Students should have a clear understanding of cycles, models, and scale. Students should be able to predict and hypothesize what might happen in experimental situations with their models and objects. As these activities take place, students should be able to draw conclusions from their observations. Creative technology on the part of the instructor will be necessary to increase the understanding of all students. While students will be building upon concepts previously learned about phases of the moon, the focus at this grade level is the relationship between the relative positions of the sun, earth, and moon and moon phases. Again, the difficulty of this unit is the abstract nature of the topic. Multiple experiments and models will be necessary.

Future Learning

Within grades 7–8, students will begin to learn about major discoveries from different scientists and how these discoveries have contributed to the understanding of the solar system. They will use or create a model of the earth, sun, and moon system to show rotation and revolution, explain night/day, seasons, year, and tides as a result of the regular and predictable motion of the earth, sun, and moon. A model of the earth, sun, and moon may also be used to recreate the phases of the moon. These are all concepts that have been previously taught in sixth grade, but due to the abstract nature of the topic, it warrants being re-taught at this level and the GSEs present it as new information to support this fact. This will help prepare the students for the new concepts of mass, distance, and the relationship of gravitational force among objects.

Additional Research Findings

"Students cannot accept that gravity is center-directed if they do not know the earth is spherical. Nor can they believe in a spherical earth without some knowledge of gravity to account for how people on the bottom do not fall off."

"Research suggests teaching the concepts of spherical earth, space, and gravity in close connection to each other. Students can understand basic concepts of the shape of the earth and gravity by fifth grade if the students' ideas are directly discussed and corrected in the classroom."

"Elementary-school students typically do not understand gravity as a force. They see the phenomenon of falling body as "natural' with no need for further explanation or they ascribe to it an internal effort of the object that is falling. If students do view weight as a force, they usually think it is the air that exerts this force."

"Students of all ages may hold misconceptions about the magnitude of the earth's gravitation force. " (*Atlas of Science Literacy, Vol. 1,* p. 42)

"The ideas that the sun is a star and the earth orbits the sun appear counter-intuitive to elementary school students and are not likely to believed or even understood in those grades. Whether is it possible for elementary students to understand these concepts even with good teaching needs further investigation."

"Explanation of the day-night cycle, the phases of the moon, and the seasons are very challenging for students. To understand these phenomena, students should first master the idea of a spherical earth, itself a challenging task. Similarly, students must understand the concept of light reflection and how the moon gets its light from the sun before they can understand the phases of the moon. Finally, students may not be able to understand explanations of any of these phenomena before they reasonably understand the relative size, motion, and distance of the sun, moon, and earth." (*Atlas of Science Literacy, Vol. 1*, p. 44)

Students also have misconceptions about the properties of light that allow us to see objects such as the moon. "Although children will say they live on a ball, probing questions will reveal that their thinking may be very different." (*National Science Education Standards*, p. 134)

By grades 5–8, students have a clear notion about gravity, the shape of the earth, and the relative positions of the earth, sun, and moon. Nevertheless, more than half of the students will not be able to use these models to explain the phases of the moon, and correct explanations for the seasons will be even more difficult to achieve. (*National Science Education Standards*, p. 159)

Notes About Resources and Materials

Reading Street Level Readers

- Riches from the Earth
- The Solar System and Beyond
- Earth's Place In Space

Online Resources

- McGraw-Hill Higher Ed

  http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::800::600::/sites/dl/free/0072482621/78778/Seasons_Nav.swf::Seasons%20Interactive

  http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::800::600::/sites/dl/free/0072482621/78778/Lunar_Nav.swf::Lunar%20Phases%20Interactive

- Edusource.org

  http://edusource.hawthorn73.org/uploads/allgrade/6th_Science_SEM_Common_Assessment.pdf

Moon phase animation

- National Optical Astronomy Observatory

  http://www.noao.edu/education/phases/phases_demo.html

- University of Wisconsin Department of Astronomy

  http://www.astro.wisc.edu/~dolan/java/MoonPhase.html

Worksheet sample

- Centre for Mathematics, Science, and Technology Education

  http://www.ioncmaste.ca/homepage/resources/web_resources/CSA_Astro9/files/html/module3/lessons/lesson6/student_handout.pdf

Diagrams of solar and lunar eclipses and phases of the moon

- Earth View Eclipse Network

  http://www.earthview.com/tutorial/causes.htm

- Cooley, K. *Keith's Moon Page.*

  http://home.hiwaay.net/~krcool/Astro/moon/moonphase/

Short video and photographs of eclipses

- www.space.com/eclipse/
- www.mreclipse.com/MrEclipse.html
- www.exploratorium.edu/ronh/solar_system/
- www.internet4classrooms.com/tide.htm
- http://middleschoolscience.com/earth.htm
- www.brainpop.com/science/

Movies at Oak Lawn

- Bill Nye Outer Space
- Planets
- Eyewitness Plants
- 25th Anniversary of Man on the Moon

Space science

- http://www.youtube.com/watch_popup?v=KZrFC988Thc
- http://spacescience.nasa.gov/

Phases of the moon

- Cooley, K. *Keith's Moon Page.*

  http://home.hiwaay.net/~krcool/Astro/moon/moonphase/

- Casey, B. *BrianCasey.org*.

  http://www.briancasey.org/artifacts/astro/moon.cgi

- Harcourt School

  http://www.harcourtschool.com/activity/moon_phases

- University of Utah

  http://sunshine.chpc.utah.edu/labs/tides/tides_main.html

- National Aeronautics and Space Administration (NASA), Phases of Matter. http://www.grc.nasa.gov/WWW/K-12/airplane/state.html

King of Tides

- Greenclassroom.com, King of Tides http://www.greeneclassroom.com/tideswebquest.html
- http://oceanservice.noaa.gov/education/kits/tides/tides08_othereffects.html

Grade 6 Science, Quarter 4, Unit 4.2

Forces and Motion

Overview

Number of instructional days: 5 (1 day = 45 minutes)

Content to be learned

- Determine the overall effect of multiple forces on the speed of an object.
- Use data and graphs to compare relative speed of objects.
- Predict the overall effect of multiple forces on the speed of an object.

Science processes to be integrated

- Analyze data and graphs.
- Examine patterns of change.
- Make scientific comparisons.
- Make scientific predictions.

Essential questions

- How do forces like friction have on the speed of an object?
- What causes the relative speed of objects to be similar or different?
- What would happen to the speed of an object if the force of gravity on the object increased?

Written Curriculum

Grade Span Expectations

PS 3 - The motion of an object is affected by forces.

PS3 (5-8) INQ+ POC –8

Use data to determine or predict the overall (net effect of multiple forces (e.g., friction, gravitational, magnetic) on the position, speed, and direction of motion of objects.

PS3 (5-6)–8 Students demonstrate an understanding of motion by…

8a using data or graphs to compare the relative speed of objects.

Clarifying the Standards

Prior Learning

In grades K–2, students were introduced to the concept of motion by showing how a push or pull moves or does not move an object. They also predicted the direction that an object will move or not move when a force is applied to it. This made it possible for students to make connections among pushing, pulling, and force.

In grades 3–4, students furthered their understanding of motion by describing the motion of objects when a force is applied to it. They also described changes in position relative to other objects or backgrounds. Students were introduced to the idea of speed by investigating and describing that different amounts of force can change the direction or speed of an object that is in motion.

By the end of fifth grade, students investigated how different amounts of force can change the direction or speed of an object in motion. They recognized that a force is a push or a pull and explained that forces cause changes in speed or direction of motion.

Current Learning

In grade 6, instruction will be at the reinforcement level. Sixth-grade teachers need to reinforce that changes in speed or direction of motion are caused by forces and should begin the unit helping students access this prior knowledge by completing activities that review this concept that introduced in fifth grade. Students need to understand that the motion of an object can be measured and represented on a graph. If the object is not being subjected to a force, it will continue to move at a constant speed and in a straight line. Unbalanced forces will cause changes in the speed or direction of an object's motion. In this unit of study, students investigate how one or more forces can change the relative speed of an object. Grade 6 students need to understand that speed ($s = d/t$) shows the average amount of distance covered in a set amount of time. Since students are not introduced to the graphing of objects in different reference planes until high school science, it is important not to confuse this standard with the concepts that underlie that content. Instead, at this grade level, students compare the speed of objects in the same reference plane. Students need to collect speed data about different objects and graph this data to make comparisons about their relative speed when different amounts of force are applied. For example, students could determine the speed of an object as it moves down a ramp, then change the elevation of the ramp and measure the speed again. This will allow them to make connections between the force of gravity on an object and the speed of the object. Students could also measure the speed of objects as they move

across smooth or rough surfaces in order to describe the relative speed of an object when the force of friction varies. Students need to use appropriate tools and techniques to collect, analyze, and display this data.

Future Learning

In the future grades, students will be measuring distance and time for a moving object and using those values as well as the relationship $s = d/t$ to calculate speed and graphically represent the data. As well as solving for any unknown in the expression $s = d/t$ given values for the other two variables. Students will be differentiating among speed, velocity, and acceleration. Students will be making and testing predictions on how unbalanced forces acting on objects can change the speed or direction of motion, (or both), and describing or graphically representing that the acceleration of an object is proportional to the force on the object and inversely proportional to the object's mass. In high school, students will predict and graph the path of an object in different reference planes and justify their explanations.

Additional Research Findings

"Some research indicates that middle school students can start to understand the effect of constant forces to speed up, slow down, or change the direction of motion of an object. This research also suggests it is possible to change middle school students' belief that a force always acts in the direction of motion. Students have difficulty appreciating that all interactions involve equal forces acting in opposite directions on the separate, interacting bodies." (*Benchmarks for Science Literacy,* p. 339)

"The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph. Unbalanced forces will cause changes in the speed or direction of an object's motion. (*National Science Education Standards,* p. 155)

"It is common for pupils to think that, if speed is increasing, then acceleration is also increasing. The term acceleration is not commonly used with school–age pupils prior to science class. Everyday terms such as 'going faster' are used in ambiguous ways." (*Making Sense of Secondary Science,* p. 155)

"Pupils' ideas about motion seem to be well-established by the age of 9 and hard to charge after this age and yet the difficulties of quantitative approaches for younger pupils are acknowledged. Therefore, attempts to teach about motion in a qualitative way at an earlier stage are recommended. It is suggested that they need to develop the ability to perform thorough experiments. (*Making Sense of Secondary Science,* p. 160)

Notes About Resources and Materials

Forces and Speed

http://www.sciencelearn.org.nz/Science-Stories/Cycling-Aerodynamics/Forces-and-speed

Forces and Movement Simulation

http://www.bbc.co.uk/schools/scienceclips/ages/6_7/forces_movement.shtml

Grade 6 Science, Quarter 4, Unit 4.3

Properties of Matter

Overview

Number of instructional days: 5 (1 day = 45 minutes)

Content to be learned

- Recognize that different substances have properties.
- Recognize how properties can be used to identify substances regardless of the size of the sample.
- Differentiate the characteristics of solids, liquids, and gases.
- Predict the effect of heating and cooling on the physical state, volume, and mass of a substance.

Science processes to be integrated

- Classify substances based on their properties.
- Perform investigations.
- Make scientific comparisons.
- Predict the impact of heat energy on systems.
- Use and make predictions about models.

Essential questions

- How can the properties of matter be used to identify substances?
- How do the properties of solids, liquids, and gases compare to each other?
- What is the effect of heating and cooling on the physical state of a substance?
- What is the effect of heating and cooling on the volume and mass of a substance?

Written Curriculum

Grade Span Expectations

PS1 - All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another (independent of size or amount of substance).

PS1 (5-8) INQ+POC –2

Given data about characteristic properties of matter (e.g., melting and boiling points, density, solubility) identify, compare, or classify different substances.

PS1 (5-6) –2 Students demonstrate an understanding of characteristic properties of matter by …

2a recognizing that different substances have properties, which allow them to be identified regardless of the size of the sample.

PS1 (5-8) SAE+MAS – 4

Represent or explain the relationship between or among energy, molecular motion, temperature, and states of matter.

PS1 (5-6) – 4 Students demonstrate an understanding of states of matter by …

4a differentiating among the characteristics of solids, liquids, and gases.

4b predicting the effects of heating and cooling on the physical state, volume and mass of a substance.

Clarifying the Standards

Prior Learning

In grades K–2, students identified and compared solids and liquids. Students also described the properties of solids and liquids and made predictions about the changes in the state of matter when heat is added or taken away.

In grades 3–4, students reviewed the comparison of properties of solids and liquids, and were introduced to the properties of gases. Students also made logical predictions about the changes in the state of matter when adding or taking away heat, for example, boiling water, condensation, and evaporation.

In grade 5, students classified and compared substances using the characteristic properties of the substances.

Current Learning

The instructional level for the content of this unit is reinforcement. Students build on their understanding of the characteristic properties of matter by recognizing that the intrinsic properties of matter remain the same regardless of the size of the sample. Some examples include, specific heat, melting point, boiling point, freezing point, and solubility. While density is also an intrinsic property, it will not be introduced to students until grades 7–8.

Processes used by the students include scientific inquiry, using tools and techniques, making observations, predicting and using evidence to draw conclusions to identify the properties of matter. Students make observations and predictions and test different substances in order to determine how their intrinsic properties differ. Students need to know that these properties are attributes of the substance and are distinctive features of the substance; therefore they can be used to identify the substance.

Students also need to make connections between energy, molecular motion, temperature, and the different states of matter. They explain how these factors impact the characteristics of solids, liquids, and gases. Students use this understanding to make predictions about what happens to the state of matter, volume, and mass when heat is added or taken away. In order to understand this concept, students need to know that all matter is made up of particles that are in motion and that, when heat is added to the substance, the particles move more rapidly, changing their volume and density.

Future Learning

In grades 7–8, students will identify an unknown substance given its characteristic properties. Students will classify and compare substances using characteristic properties (e.g., solid, liquid, gas, metal, non-metal) and create diagrams or models that represent the states of matter at the molecular level. Students will explain the effect of increased and decreased heat energy on the motion and arrangement of molecules and will observe the physical processes of evaporation and condensation, or freezing and melting, and describe these changes in terms of molecular motion and conservation of mass.

Additional Research Findings

The structure of matter is difficult for this grade span. Historically, much of the evidence and reasoning used in developing atomic/molecular theory is complicated and abstract. Going into the detail of the structure of the atom is unnecessary at this level. Students should become familiar with characteristics of different states of matter and their transitions between them. More importantly, students should see a great many examples of reaction between substances that produce new substances that are very different from the reactants. (*Benchmarks for Science Literacy,* pp. 77–78)

The research indicated that younger children tend to regard any rigid material as a solid, any powder as a liquid and any non-rigid material as intermediate between a solid and a liquid. Pupils explained that powders are liquids because they ‘can be poured’ and that non-rigid material are neither solid nor liquid because they are ‘soft’ or ‘crumble’ or ‘can be torn.’ Students tend to judge a state of a material according to its appearance. They need to elaborate on the other characteristics or properties to understand the actual state of the material. (*Making Sense of Secondary Science,* p. 79)

Notes About Resources and Materials

Particles of Solids, Liquids, and Gases

- http://harcourtschool.com/activity/states_of_matter/
- http://www.chem4kids.com/files/matter_intro.html
- http://www2.mcdaniel.edu/Graduate/TI/pages/LEWIS/matterweb.htm

Reading Street Leveled Readers

- Elements in Our Universe