Sixth Grade Science

Curriculum Map

Red Clay Consolidated School District

August 2008

ACKNOWLEDGEMENTS

The following curriculum map was designed with the assistance, suggestions, and recommendations of the following sixth grade science teachers in the Red Clay Consolidated School District. The Office of Curriculum and Instruction is grateful for the input you have provided:

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Kim Fanny, Cab Calloway School of Arts

Frederika Jenner, H.B. DuPont Middle School

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SIXTH GRADE SCOPE AND SEQUENCE

September

Topic	Standards	GLEs	Assessment
Nature of Science	1.1.1, 1.1.2, 1.1.4, 1.1.5	6.1.a, 6.1.d, 6.1.e	**1.** Science Vocabulary in Context--Operational Terms in Science from SchoolNet, questions 1-5
Safety	Right-to-know Law		**2.** Safety Quiz/safety contract
Experimental design My Body & Me, Activities 1-4	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	6.1.a, 6.1.b, 6.1.c, 6.1.d, 6.1.e, 6.1.f	**3.** My Body & Me, Activity 3, Written procedure.

October

Topic	Standards	GLEs	Assessment
Studying Humans MBAM Activities 5-10	6.1.1, 6.1.6, 6.3.1, 6.4.2 (in addition to all of standard 1)	6.1.a, 6.1.b, 6.1.c, 6.1.d, 6.1.e, 6.1.f, 6.6.h, 6.6.i, 6.6.j	**4.** Evidence and Trade-offs **5.** Experimental Design
The Human Body	6.1.1, 6.1.6, 6.3.1, 6.4.2	6.6.a, 6.6.c, 6.6.d, 6.6.e	**6.** Human Body Systems

November

Topic	Standards	GLEs	Assessment
Digestion	1.1.1, 1.1.3, 6.1.1, 6.1.6, 6.2.3, 6.3.1	6.1.a, 6.1.c, 6.6.e, 6.6.f, 6.6.h, 6.6.i, 6.6.j	**7.** Digestion
Respiration and Circulation	5.1.4, 6.1.1, 6.1.6, 6.2.1, 6.2.3, 6.3.1	6.6.a, 6.6.b, 6.6.d, 6.6.f, 6.6.g, 6.6.h, 6.6.i	**8.** Breathing and Circulation

December

Topic	Standards	GLEs	Assessment
The Heart and Fitness	6.1.1, 6.1.6, 6.2.3, 6.3.1, 6.4.1, 6.4.2	6.6.a, 6.6.b, 6.6.f, 6.6.g, 6.6.h, 6.6.i, 6.6.j	**9.** (writing prompt) Heart Healthy

January

Topic	Standards	GLEs	Assessment
Motion and Speed	1.1.1, 1.1.2, 1.1.3, 1.2.1, 3.1.2, 3.2.1,	6.1.a, 6.1.b, 6.1.c, 6.3.a, 6.3.f, 6.3.g, 6.3.h	**10.** Speed Measurement
Gravitational Force, Force on an object	3.1.2, 3.2.1, 3.2.2	6.3.a, 6.3.f, 6.3.i, 6.3.j, 6.3.k, 6.3.l, 6.3.m	**11.** Gravity and Other Forces

February

Topic	Standards	GLEs	Assessment
Levers	1.1.1, 1.1.2, 3.1.2, 3.2.1, 3.2.3	6.1.a, 6.1.b, 6.3.k, 6.3.n, 6.3.o, 6.3.p	**12.** Levers
Pulleys	1.1.1, 1.1.2, 3.1.2, 3.2.1, 3.2.3, 3.3.1	6.1.a, 6.1.b, 6.3.k, 6.3.n, 6.3.o, 6.3.p	**13.** Pulleys
Force/distance relationships	1.1.1, 1.1.2, 3.1.2, 3.2.1, 3.2.3	6.1.a, 6.1.b, 6.3.k, 6.3.n, 6.3.o, 6.3.p	**14.** Force and Distance

March

Topic	Standards	GLEs	Assessment
Electrical Energy	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.2.2, 3.1.5, 3.2.8, 3.2.9, 3.3.1, 3.4.3,	6.1.a, 6.1.b, 6.1.c, 6.1.d, 6.1.e, 6.3.a, 6.3.b, 6.3.c, 6.3.d, 6.3.e, 6.3.q, 6.3.r	**15.** Electrical Energy
Observation and Inference	1.1.1, 1.1.4	6.1.a, 6.1.d	Assessed with Rock Layers (April)

April

Topic	Standards	GLEs	Assessment
Sedimentary Rock Layers	5.1.3, 5.2.2, 5.2.3, 5.2.4, 5.2.11	6.5.a, 6.5.b, 6.5.d, 6.5.e, 6.5.f	**16.** Sedimentary Rock Layers
Weathering and Erosion	5.1.2, 5.1.3, 5.1.4, 5.2.3, 5.2.4	6.5.c, 6.5.d, 6.5.e, 6.5.f	**17.** Weathering and Erosion

May

Topic	Standards	GLEs	Assessment
Time and Plate Tectonics	5.2.11, 5.2.12	6.5.b, 6.5.g	**18.** Geologic Time
Fossils	5.2.11, 5.2.12	6.5.g	**19.** Fossils

UNDERSTANDING THE SCIENCE CURRICULUM MAP
MIDDLE SCHOOL
Fall 2008

The Red Clay Consolidated School District is in the process of creating curriculum maps for each grade (K-12) in science. We have prepared a brief description of how the curriculum maps can be used in planning, delivering, and assessing science instruction.

Why use curriculum maps?

Beginning in August 2007, public schools in Delaware will be using the revised (2006) Delaware science standards (http://www.doe.k12.de.us/programs/pcs/science.shtml). The Science Coalition of Delaware has worked hard to create a rich science curriculum at all grades to meet these standards. The curriculum map will allow teachers to create a plan of instruction to meet these standards using curricula in which they have been trained. The map will allow teachers to adjust the pacing of their instruction to the needs of the students, the availability of resources, and the schedule of the school and district.

How are the curriculum maps organized?

I. Standards and GLEs:

The curriculum maps for each grade begin with a list of the standards for that grade cluster and the GLEs (Grade Level Expectations) for that grade. Red Clay has developed a coding system for both the standards and GLEs, and these coding systems are explained (see "Understanding the Revised Science Standards" and "Understanding the GLEs" enclosed). The standards represent the required instruction. In Delaware, the emphasis in science is on big ideas and concepts, not on memorizing facts, formulas, and other trivia. The GLEs represent the sorts of tasks, understandings, and skills we aim for our students to achieve in each grade.

II. Scope and Sequence:

Each map includes a Scope and Sequence. This is a timetable for the school year, organized by month. Listed for each month is a broad topic name, the standards (by number), the GLEs (by number) and the assessments for each topic. **The Scope and Sequence is driven by the assessments.** The purpose of the scope and sequence is to give an estimate of how long to spend on various topics and a rough sequence of topics. **This sequence may be adjusted as needed.** In every school, teachers should adjust topics of instruction to meet the needs of their students. Also, since resources are often shared among several teachers, some "juggling" of topics will always be necessary. The most important things about the Scope and Sequence are 1) the Standards must be taught, since the DSTP is a test of the Standards and 2) the Assessments (discussed below) must be administered and scored.

The order of topics on the Scope and Sequence is based on the training schedule at the Science Coalition of Delaware of the big units and the kit delivery schedule for Red Clay. The big units for sixth grade are My Body and Me, Forces that Cause Motion (including Electric Force, Simple Machines, and Earth History. Since teachers who take these trainings are expected to teach the units while in training, the Scope and Sequence reflects the Coalition's sequence. If teachers must deviate from this sequence, this need should be discussed with the building principal and the Secondary Science Specialist. Because students sometimes change science classes during the year, it is important that they receive a consistent science program.

III. Assessments:

Each topic on the Scope and Sequence has an associated assessment. The assessments are referred to by number (19 in all). The assessments come in several formats:

a. **Short answer questions**. A topic may have 1-4 short answer questions for students to answer. They are in the same format as short answer questions on the DSTP, and like the DSTP questions, each has a scoring option of 2 points (complete response) 1 point (partial response) and 0 (incorrect response). The rubric which describes the criteria for each is a guideline. Teachers are encouraged to determine whether or not students have met the standards from answers on the assessments.

b. **Writing prompts:** Some of the assessments include a writing prompt, consisting of a letter or position statement that will require more extensive design on the part of the student. The rubric for writing prompts is included with each prompt.

These are formative assessments. They may be used in a variety of ways: as a warm-up question, as a quiz or test question, or as part of a larger activity. Their purpose is to determine if students have met the standards or not. Each big unit has a checklist for the assessments. Teachers will make a copy of each checklist for each of their classes in the content area. However the assessments are used, teachers will record student results on the checklist.

Some of these assessments are taken from the Science Coalition of Delaware's assessment website (www.scienceassessment.org). The Coalition website uses a two digit rubric to score student responses. While this is an acceptable way to score the Red Clay assessments, teachers are not required to use the two digit rubric, since it is extremely time consuming. However, if teachers require specific data about student misconceptions, they are encouraged to use the two digit rubric. Contact the Secondary Science Specialist for more information.

IV. Vocabulary: The vocabulary list includes terms that students may have difficulty with, not just terms from the glossary in the student book. The vocabulary list can be helpful for those teachers who use word walls and other vocabulary exercises.

V. Suggested Activities:

This is a list of Science Coalition activities that address each topic. Not all topics have suggested activities. If teachers have received Coalition training, these activities have been practiced. The curriculum map indicates which science standards and GLEs are correlated with each activity. In addition, the goals, synopsis, and context of each activity is included. Teachers are encouraged to use whatever activities they believe will best communicate the Standards to their classes. If teachers wish to use other activities (or to create their own), they should identify which Standards the activities support.

Finally:

This curriculum map is designed to make the teacher's job easier so the teacher can concentrate on our students. If teachers finish a topic early in a given month, they are encouraged to move on. Likewise, if a topic takes longer than indicated by the map, they should use as much time as necessary to meet the students' needs. The Office of Curriculum and Instruction will need your feedback about how useful this map is. Any comments, questions, criticisms, or concerns (or praise) should be directed to any of the following:

Edward J. McGrath, Science Coordinator
Susan Rash, Director of Curriculum
Carolyn Zogby, Director Instruction

UNDERSTANDING THE REVISED SCIENCE STANDARDS

There are eight standards in the Delaware Science Content Standards, each clustered for grades K-3, 4-5, 6-8, and 9-12. These clusters are the grade clusters assessed by the Delaware Student Testing Program (DSTP), are similar to the experiences and certification of teachers, and take into account the organization of schools and the frameworks of other content standards.

Standard 1, The Nature and Application of Science and Technology, is the ***foundational*** standard on which all others have been developed. This standard emphasizes learning content through inquiry, the interconnectedness of science, technology, and society, and the history and context of science.

The content standards for physical (standards 2 and 3), earth (standards 4 and 5), and life (standards 6, 7, and 8) science focus on big ideas and concepts that are important for all students to know. The eight standards are composed of broad standard statements which communicate the big ideas in the standards.

Each content standard is subdivided into **strands** with concepts that spiral up through the grade clusters and are written in developmentally appropriate ways guided by current educational research and experience. The big ideas and concepts in each standard are central to science education and focus on depth of concepts rather than breadth of facts or topics. All eight content standards comprise what is to be taught, learned, and assessed. For each strand, there is at least one **Enduring Understanding** and **Essential Question** identified. The Standards, Strands, Enduring Understandings, and Essential Questions are the same for all grade level clusters.

Within each grade level cluster, there are **substrands** which identify the content and/or skills that are addressed for that grade level cluster.

Understanding the coding system for the science standards:

Each of the substrands is identified by a three digit code. The first digit identifies the standard number. The second digit identifies the strand, and the third digit identifies the sub-strand. ***Please note: when identifying the standards by their three digit code, it is necessary to specify the grade level cluster.***

For example, for the 6-8 grade level cluster, standard 2.1.4 refers to

Standard 2: Materials and their Properties
Strand 1: Properties and Structure of Materials
Substrand 4: An important property of materials is their ability to conduct heat. Some materials, such as certain metals, are excellent conductors of heat while other materials, such as glass, are poor conductors (good thermal insulators).

UNDERSTANDING THE GRADE LEVEL EXPECTATIONS (GLE) IN SCIENCE

In revising the Delaware Science Content Standards, the Science Design Team has identified a series of Grade Level Expectations (GLEs) for each grade from Kindergarten through twelfth grade. These statements describe activities or performances that are designed to help students meet the standards at each grade level. Although students are tested (through the Delaware Student Testing Program in science) on the Content Standards, the Grade Level Expectations represent a mechanism by which students are expected to meet the standards.

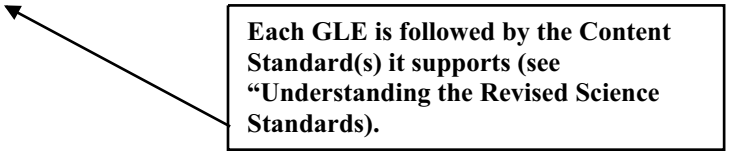
Understanding the coding system for the GLEs:

Each of the GLEs is identified by two numerals (or K) followed by a letter. The first numeral represents the grade (K for Kindergarten). The second numeral represents the standard number as indicated below:

Standard 1: Nature and Application of Science and Technology
Standard 2: Materials and their Properties
Standard 3: Energy and its Effects
Standard 4: Earth in Space
Standard 5: Earth's Dynamic Systems
Standard 6: Life Processes
Standard 7: Diversity and Continuity of Living Things
Standard 8: Ecology

For example, GLE 7.2.k refers to

Grade 7
Standard 2
GLE k: Conduct investigations to determine the effect of temperature on saturation point. Construct a solubility curve based on data collected. Describe solubility and saturation point using the particle model. (1.1.3) (1.1.4) (1.1.5) (2.2.4) (3.1.4)



At the end of the GLE document is a table which summarizes which GLEs support each standard.

RED CLAY SIXTH GRADE ASSESSMENT LOG SY_____

Unit 1: General science/My Body and Me

Student Name	# 1 Word Splash	#2 Safety Quiz	#3 Report for Clinical Trial	#4 Evidence and Trade-offs		#5 Experimental Design					#6 Human Body Systems		#7 Digestion			#8 Breathing and Circulation			#9 Heart Healthy

Comments:

Teacher:_____

School:_____

Period:_____

RED CLAY SIXTH GRADE ASSESSMENT LOG SY_____

Units 2 and 3: Forces that Cause Motion/Simple Machines

Student Name	# 10 Speed Measurement		#11 Gravity and Other Forces			#12 Levers		#13 Pulleys		#14 Force and Distance		#15 Electricity	

Comments:

Teacher:_____

School:_____

Period:_____

RED CLAY SIXTH GRADE ASSESSMENT LOG SY_____

Unit 4: Earth History

Student Name	# 16 Sedimentary Rock Layers			#17 Weathering and Erosion			#18 Geologic Time			#19 Fossils	

Comments:

Teacher:_____

School:_____

Period:_____

SEPTEMBER

Topic 1: Nature of Science

Standards:

1.1.1. Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2. A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

1.1.4. There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

1.1.5. Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.

GLEs:

6.1.a. Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.d. Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

6.1.e. Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.

Assessments:

1. Science Vocabulary in Context--Operational Terms in Science from SchoolNet, questions 1-5.

Vocabulary:

characteristic (n): a way of describing an individual object (e.g. color, size, shape)

compare: give a similarity and a difference between (among) two or more things.

conclusion: a statement which summarizes a procedure and possibly gives an introduction to a later one.

contrast (v): differentiate between two things.

data: information obtained during a scientific investigation.

describe: list observable features.

evidence: observations that may support a position.

explain: give a reason for an observation or an occurrence.

function (n): the task performed by someone or something.

hypothesis: a possible explanation for an observation or occurrence based on prior understandings. A hypothesis can be tested.

observation: a statement about some occurrence perceived by the senses.

process: a series of events leading to a final outcome.

property: a way of describing a type of matter that does not depend on its amount.

Suggested Activities:

Science Vocabulary in Context--Operational Terms in Science from SchoolNet.

Topic 2: Safety

Activities: General safety training—Right-to-Know Law

Assessments: **1.** Safety Quiz
Safety Contract/Contrato de Seguiridad signed by each student

Text References/Vocabulary: none
Standards: none
GLEs: none

Topic 3: Experimental Design

Standards:

1.1.1. Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2. Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

1.1.3. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

1.1.4. Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

1.1.5 Understand that: Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.

1.1.6. Understand that: Scientific habits of mind and other sources of knowledge and skills are essential to scientific inquiry. Habits of mind include tolerance of ambiguity, skepticism, openness to new ideas, and objectivity. Other knowledge and skills include mathematics, reading, writing, and technology.

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.b Design and conduct investigations with controlled variables to test hypotheses.

6.1.c Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

6.1.d Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

6.1.e Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.

6.1.f Use mathematics, reading, writing, and technology in conducting scientific inquiries.

Assessments:

3. My Body & Me, Activity 3, written procedure.

Vocabulary:

clinical trial: An experiment which tests the effectiveness and safety of a medicine or medical procedure on volunteers before the medicine or procedure is made available to the public.

control group: The subjects in a clinical trial who receive a medicine or procedure that does not contain the ingredient being tested (e.g. they receive a pill with no active ingredients). The control group ensures that the effect of the treatment can be identified as distinct from any other effects.

disease: A condition in a living thing where normal processes of life are interrupted.

ethics: The system of standards of judgment in society and of moral conduct.

experiment: An investigation designed to answer a testable question.

experimental design: The general format that an experiment is conducted. Experimental design can give insights into sources of error.

germ: A microscopic organism or virus. The term “germ” is often used to indicate an agent of infectious disease.

inference: A conclusion or opinion generated by observations.

informed consent: The practice of a volunteer agreeing to a course of action after being provided with potential outcomes of the action. Informed consent is usually documented.

nutrition: The process by which an organism obtains and uses food and food supplements.

placebo: A form of medication which contains no active ingredient. A placebo is used in a clinical trial as a control substance to distinguish specific effects of a treatment from effects associated with the experiment (e.g. if a clinical trial seeks to study the effect of an injected medication, a placebo would be a similar injected solution without the medication. The placebo will identify reactions associated with the process of injection and the introduction of any substance by injection but not reactions associated with the medication.)

placebo effect: The physiological effects created by the belief by subjects in the control group of a clinical trial that the treatment they had received exerted an effect, even though they had not received the actual treatment.

sample size: The number of test subjects in a clinical trial. The larger the sample size, the more likely the results of the trial will represent the effect of the treatment in the general population.

side-effect: A reaction of a medication or treatment not related to its desired effect.

simulation: A procedure that models a more complicated, more time-consuming, or more dangerous procedure. A simulation will illustrate the important aspects of the actual procedure, but will do so in a more convenient and safe environment.

trade-offs: Negative consequences of a course of action that has positive consequences.

treatment group: The subjects in a clinical trial who receive the tested medication or procedure.

Suggested Activities:

Activity 1: Save Fred

Standard 1.1.1
GLE 6.1.a

GOALS: In this lab activity, students will

- Examine the steps involved in problem solving.
- Collaborate to identify different approaches to scientific problem solving.
- Document the procedure they used to solve a problem.

ACTIVITY OVERVIEW: A synopsis of this lesson is as follows

Students work together to accomplish a task involving common edible materials. Students document different approaches to placing a gummy Life Saver ™ over a gummi worm using paperclips as utensils.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

This activity is the opening activity for the year. Students investigate a problem and learn that there is no one "scientific method" for solving problems. The basic procedure requires students to identify a procedure that works for them, and extensions (e.g. having students trade procedures with other groups) allow them to identify multiple approaches to problem solving. The idea that one "scientific method" is inadequate for all scientific investigations becomes evident during the Earth History unit as well.

Activity 2: The Pellagra Story:

Standards 1.1.1, 1.1.3, 1.1.4, 1.2.2, 1.3.1
GLEs: 6.1.a, 6.1.c, 6.1.d, 6.6.j

GOALS: In this lab activity, students will

- Analyze the collection and use of evidence in solving a scientific question of historical importance.
- Discuss the ethical implications of using human subjects in experiments.

ACTIVITY OVERVIEW: A synopsis of this lesson is as follows

After watching a video segment on the investigation of pellagra, students compare this investigation to the traditional scientific method. They also analyze this investigation in terms of ethics and trade-offs.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

This activity addresses the concept of experimental design, which students have worked with throughout elementary school. Unlike traditional treatments of this topic, this activity introduces the idea that when humans are the subject of scientific inquiry, certain ethical issues tend to arise. The idea of trade-offs is introduced and developed extensively to indicate that all decisions carry advantages and disadvantages.

Activity 3: Testing Medicines: A Clinical Trial
Activity 4: Testing Medicines Scientifically

Standards 1.1.2, 1.1.3, 1.1.5, 1.1.6, 1.2.2
GLEs: 6.1.b, 6.1.c, 6.1.e, 6.1.f,

GOALS: In this lab activity, students will

- Design and carry out a simulation of a clinical trial.
- Discuss the need for a control in a scientific experiment.
- Display data from a scientific experiment in a meaningful way through graphs.

ACTIVITY OVERVIEW: A synopsis of this lesson follows

Students model a clinical trial of an experimental headache medicine (using sweetened and unsweetened lemonade). Students analyze and discuss the importance of controls (placebos) in these trials.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

This activity has students design an actual investigation involving control groups, treatment groups, and unexpected side-effects. Although this exercise is highly structured, it gives students an introduction to how to design and document an actual scientific experiment.

SCIENCE SAFETY QUIZ

Write your responses in the boxes provided.

1. Why should we wear goggles in the lab?

2. What should you do if you cut yourself in lab (even if it's not bleeding)?

3. You've spilled water on the floor. What should you do?

4. You and a friend are working in lab, and you start chasing each other. Why is this dangerous?

_____

_____

_____

_____

_____

5. Write one safety rule that is important for everyone to follow. It should not be one of the ones mentioned above.

_____

_____

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_____

_____

SCIENCE SAFETY QUIZ--RUBRIC

Write your responses in the boxes provided. (two points each.) NOTE: there are no criteria for a partial response (1). Each question is scored as a complete response (2) or an incorrect response (0)

1. What are two times when we should wear goggles in the lab?

Whenever we work with chemicals, with heat, with glassware, or with any danger from flying projectiles. (**two of these are required for a complete response**)

2. What should you do if you cut yourself in lab (even if it's not bleeding)?

Immediately tell the teacher and hold the cut under running water. Clean the injury with soap, and see the school nurse. (**all parts of response are required for a complete response**)

3. You've spilled water on the floor. What should you do?

Clean it up immediately with dry paper towels. Inform the teacher and any other people nearby that there is water on the floor. (**all parts of response are required for a complete response**)

4. You and a friend are working in lab, and you start chasing each other. Why is this dangerous?

Besides being disruptive, this kind of behavior can cause glassware to break from being knocked over, it can cause substances to spill on the floor or on other people, or it can cause heat sources to be knocked into other people (**accept any of these responses for a complete response**).

5. Write one safety rule that is important for everyone to follow. It should not be one of the ones mentioned above.

Accept any rule that is correctly stated for a complete response.

REPORT—TESTING MEDICINES: A CLINICAL TRIAL

Write a report which summarizes Activity 3 of My Body and Me, starting on page A-11 of the student lab manual. Your report should include the following:

1) What question did the activity attempt to answer?

2) How did you simulate the following:

    a) headache before treatment
    b) experimental headache medicine
    c) placebo

3) How did you simulate the following results:

    a) treatment did not work
    b) treatment worked
    c) treatment worked, but there were side effects

4) A data table with your class results

5) The answer to the question in part 1

RUBRIC FOR REPORT—TESTING MEDICINES: A CLINICAL TRIAL

This rubric is taken from the Teacher's Guide of Science and Life Issues, SEPUP, page a-3: Scoring Guide for Designing and Conducting Investigations. This rubric has been modified from the original.

Score	Recording Design or Procedure **What to look for:** Response states procedures that are described completely, accurately, and safely	Organizing Data **What to look for:** Response accurately records and logically displays data.	Analyzing and Interpreting Data **What to look for:** Response correctly summarizes data; detects patterns and trends, and draws valid conclusions based on the data obtained.
3	Accomplishes Level 2 **and** goes beyond in some way (e.g. identifies alternate procedures, indicates sources of experimental error).	Accomplishes Level 2 **and** goes beyond in some way (e.g. creates a graph)	Accomplishes Level 2 **and** goes beyond in some way (e.g. evaluates the investigation, suggests a further investigation)
2	Appropriate design with reproducible procedure	Logically reflects complete and accurate data.	Analyzes and interprets data correctly. Conclusion is compatible with data analysis.
1	Incomplete design/procedure **or** significant errors.	Reports data logically **but** records are incomplete.	Notes patterns or trends, but does so incompletely. No conclusion of investigation.
0	Incorrect or inappropriate design **or** section is missing.	Reports data but records are illogical or contain incorrect data **or** section is missing.	Interpretation is illogical or shows a lack of understanding **or** section is missing.

OCTOBER

Topic 4: Studying Humans

Standards:

1.1.1. Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2. Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

1.1.3. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

1.1.4. Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

1.1.5 Understand that: Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.

1.1.7. Understand that: Scientific habits of mind and other sources of knowledge and skills are essential to scientific inquiry. Habits of mind include tolerance of ambiguity, skepticism, openness to new ideas, and objectivity. Other knowledge and skills include mathematics, reading, writing, and technology.

6.1.6. The human body has systems that perform functions necessary for life. Major systems of the human body include the digestive, respiratory, reproductive, and circulatory systems.

6.3.1. Regulation of an organism's internal environment involves sensing external changes in the environment and responding physiologically to keep conditions within the range required for survival (e.g., increasing heart rate with exertion).

6.4.2. The functioning and health of organisms are influenced by many factors (i.e., heredity, diet, lifestyle, bacteria, viruses, parasites, and the environment). Certain body structures and systems function to protect against disease and injury.

GLEs:

6.1.g Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.h Design and conduct investigations with controlled variables to test hypotheses.

6.1.i Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

6.1.j Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

6.1.k Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.

6.1.l Use mathematics, reading, writing, and technology in conducting scientific inquiries.

6.6.h Conduct simple investigations (how the body reacts to exercise, changes in temperature, etc.) to determine how the systems in the human organism respond to various external stimuli to maintain stable internal conditions.

6.6.j Research and report on how body systems are affected by lifestyle choices such as diet or exercise (for example lack of exercise leads to cardiovascular disease).

Assessments:

4. Evidence and Trade-offs
5. Experimental Design

Vocabulary:

environment: The surrounding location of interest.

involuntary: Describing a response or action that occurs without a conscious effort. e.g.: the heart beating.

nerve: a structure in animals that conveys information from the environment to other parts of the body rapidly.

nervous system: The interconnecting association of brain, spinal cord, nerves, and sensory organs in an animal.

qualitative: Describing data that conveys characteristics but not measurable amounts.

quantitative: Describing data that conveys measurable amounts.

range: The difference between the lowest value and the highest value of a data set.

reproducible: Describing an experiment that will yield the same results if the exact same procedure is followed.
sensitivity: The ability of the nervous system to detect a change in the environment.

touch receptor: A nerve in the skin that responds to the sensation of being pressed gently.

variable: A factor in an experiment that may be changed.

voluntary: Describing a response or action that occurs as a result of a conscious decision. e.g.: walking.

Suggested Activities:

Activity 5: Can You Feel the Difference?
Activity 6: Finding the Nerve

Activity 7: Human Variation

Standards: 1.1.1, 1.1.2, 1.1.3, 1.1.4, 6.1.1, 6.1.6, 6.3.1, 6.4.2
GLEs: 6.1.a, 6.1.b, 6.1.c, 6.1.d, 6.6.h, 6.6.i

GOALS: In these lab activities, students will

- Identify variables that may or may not be kept the same when identifying sensitive touch receptors.
- Explore reasons why different areas of the body have different sensitivities to touch.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students conduct an exploratory investigation into human sensitivity to touch using the concept of variables. They test their ability to feel the difference between one and two points on different parts of their hands and arms. Then, they investigate why sensitivity to touch varies in different parts of the body.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

These activities continue to reinforce the importance of experimental design, introducing the idea that variables in an investigation must be kept constant so that effects of a treatment can be recognized. These activities also address the idea of nerve sensitivity in a structure/function context.

Activity 8: Studying People
Activity 9: Data Toss
Activity 10: Evaluating Clinical Trials

Standards 1.1.1, 1.1.2, 1.1.4, 1.1.5, 1.1.6, 1.2.2, 1.3.1
GLEs: 6.1.a, 6.1.b, 6.1.d, 6.1.e, 6.1.f, 6.6.j

GOALS: In these lab activities, students will

- Design an experiment using good experimental design, creating appropriate displays of data.
- Explain the value in qualitative and quantitative data in an experiment.
- Establish an appropriate sample size for an investigation.
- Evaluate research proposals in terms of evidence and trade-offs

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students design and conduct an experiment on variations in tossing a ball, accounting for qualitative and quantitative data, and appropriate sample size. Students also read descriptions of proposed clinical trials of medications and treatments for human health conditions, evaluating each in terms of experimental design and recommendations for changes and for funding.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

These activities complete the introduction to experimental design. Students create their own experiment, making decisions about experimental conditions, data analysis and presentation, and variable control. Activity

10 asks the students to evaluate clinical trial proposals, giving the students a true justification for why experimental design skills are valued in the scientific community (and the world at large).

Topic 5: The Human Body

Standards:

6.1.1. Living organisms share common characteristics that distinguish them from non-living, dead, and dormant things. They grow, consume nutrients, exchange gases, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cell(s).

6.1.6. The human body has systems that perform functions necessary for life. Major systems of the human body include the digestive, respiratory, reproductive, and circulatory systems.

6.3.1. Regulation of an organism's internal environment involves sensing external changes in the environment and responding physiologically to keep conditions within the range required for survival (e.g., increasing heart rate with exertion).

6.4.2. The functioning and health of organisms are influenced by many factors (i.e., heredity, diet, lifestyle, bacteria, viruses, parasites, and the environment). Certain body structures and systems function to protect against disease and injury.

GLEs:

6.6.a Explain that human body systems are comprised of organs (e.g., the heart, the stomach, and the lungs) that perform specific functions within one or more systems.

6.6.c Label and describe the functions of the basic parts of the male and female reproductive systems.

6.6.d Label and describe the functions of the basic parts of the respiratory system including the trachea, bronchi and lungs.

6.6.e Label and describe the functions of the basic parts of the digestive tract including the mouth, esophagus, stomach, small intestine, liver, large intestine (colon), rectum and anus.

Assessments:

6. Human Body Systems

Vocabulary:

abdomen: The large cavity in the human body found between the diaphragm and the pelvis. The abdomen contains most of the digestive, excretory, and reproductive organs.

bladder: A sac which collects urine from the kidneys and eliminates it from the body. The bladder is part of the excretory system.

cholesterol: a lipid in animals that provides structure to cell membranes and is converted to many different hormones in humans. An excess of cholesterol is correlated to problems with the heart and blood vessels.

circulatory system: A system of tissues and organs in humans whose function is to transport water, oxygen, food, and wastes to all the parts of the body.

cirrhosis: A disease of the liver in which damage to liver tissue causes formation of scar tissue and loss of liver function. Cirrhosis seems to be associated with repeated exposure to certain toxins (e.g. alcohol, environmental poisons) and medications (e.g. acetaminophen).

digestive system: A system of tissues and organs in humans whose function is to break food into smaller and simpler components through mechanical and chemical means. The final products of this breakdown are transported into the bloodstream.

donor: A person who gives an item to another person. In a medical context, a donor usually gives blood or an organ.

esophagus: An organ consisting of a hollow tube through which food travels from the mouth to the stomach. The esophagus is sometimes called the gullet (especially in nonhuman animals).

excretory system: A system of tissues and organs in humans whose function is to remove waste products of digestion from the body. NOTE: Although the rectum is designed to remove solid waste from the body, it is usually considered to be part of the digestive system.

heart: A muscular organ in the center of the chest which pumps blood continuously to the lungs and to the rest of the body.

hepatitis: A viral disease which attacks liver tissue, causing severe loss of liver function. There are several types of hepatitis, classified by route of transmission, type of virus, and severity of illness. Some types of hepatitis can be prevented through vaccination.

herbal remedy: A dietary supplement which may have properties in common with Food and Drug Administration (FDA) regulated medications. Since herbal remedies are classified as foods by the United States government, they are not regulated by the FDA as medications are.

kidney: An organ shaped like a bean found in the upper back of humans whose function is to remove nitrogen containing wastes, excess salt, and excess water (in the form of urine) from the blood stream. Humans are born with two kidneys (a left and a right kidney), but they can survive with one healthy functioning kidney.

large intestine: A large diameter hollow tube connecting the small intestine to the outside of the body in humans. The large intestine absorbs water from undigested food and carries the remains of this food out of the body as feces.

liver: A large brown organ found in the abdomen of humans which carries out many functions for the digestive and circulatory systems. The liver produces many digestive enzymes, helps to break down fat, and deactivates many toxins in the blood.

lung: A paired organ in the chest which introduces oxygen from the air into the bloodstream and removes carbon dioxide from the blood and out of the body.

muscle: A tissue in humans that can expand and contract, causing movement. Muscles work with bones to create lever systems in the body.

nervous system: A system of tissues and organs in humans whose function is to transmit and process information in the environment and within the human quickly.

organ: A functional part of an organism made up of different tissues.

organ system: A group of organs in a human which work together to carry out several related functions. Although many organ systems feature organs that are physically connected to one another, some organ systems are distributed all over the body.

rectum: The end of the large intestine where the remains of undigested food and intestinal bacteria (feces) are removed from the body.

regenerate: To grow a body part (or section of a body part) after it has been damaged or removed.

regulation: The process by which organisms respond to environmental changes to maintain a consistent living state.

reproductive system: A group of organs in a living organism that enables the organism to produce other organisms of the same species. Usually, this organ system enables sexual reproduction.

rib cage: A group of bones that surrounds the heart, lungs, the top part of the kidneys, and other organs in the chest cavity.

scar tissue: A group of cells that form after tissue injury. The scar tissue does not carry out the functions of the damaged tissue, and often has a different appearance from the damaged tissue.

skeletal system: A group of tissues in most animals that provides support, enables movement, and stores minerals. In humans, the skeletal system consists of the bones and cartilage.

small intestine: A long tube in humans (6-7 meters long) in which nutrients and food molecules enter the bloodstream.

spinal cord: A large bundle of nerves running from the base of the human brain down the center of the vertebral column. The spinal cord is part of the central nervous system and is responsible for coordinating many of the involuntary responses in humans.

sternum: A large bone in the center of the rib cage over the heart. Also called the *breast bone.*

stomach: A sac which receives food from the esophagus. The stomach breaks food into smaller portions with strong muscle contractions. The stomach also produces enzymes and strong acids to break food into simpler chemical compounds before moving it through the rest of the digestive system.

torso: The exterior surface of the abdomen.

toxin: A poisonous substance to humans.

trachea: A hollow tube leading from the mouth to the rest of the respiratory system through which inhaled and exhaled air passes. Another name for the trachea is *windpipe.*

transplant: In medicine, an organ or tissue that is removed from one person and placed into another. In some cases, the transplanted tissue may be removed from a person and given back to that same person later.

vaccination: A process of preventing infectious disease. A person is given a form of a disease causing toxin or microorganism that cannot cause disease (or causes a mild form of disease) but allows the body to recognize the disease in the future. By this process, when a person is infected with the actual disease, vaccination has allowed the body to prevent the infection from causing harm.

virus: A microorganism that lives by invading a cell (called the host cell), using the cell's biological processes to reproduce. The new viruses then go on to invade other cells. In humans, certain diseases are caused by viral infection.

Suggested Activities:

Activity 11: Sick Day

Activity 12: What's Happening Inside?
Activity 13: Living with your Liver

Standards: 6.1.2, 6.1.6, 6.3.1, 6.4.2
GLEs: 6.1.f, 6.6.a, 6.6.e, 6.6.f , 6.6.i

GOALS: In these lab activities, students will

- Discuss benefits and trade-offs of various remedies for illness.
- Describe major human body systems in terms of structure, role in keeping the organism alive, and interconnectedness.
- Explain how the liver functions in more than one body system to regulate the body's internal environment.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students begin by discussing the trade-offs of taking a medication when they are ill. They use "mental maps" and models to identify preconceptions about the locations, structures, and functions of organs and organ systems in the body. Finally, the students use a scripted role-play to learn the various regulatory functions of the liver.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

These three activities carry the thinking of trade-offs developed in the last activity to the issue of describing human body systems. These activities introduce the unit on human body systems by assessing preconceptions. The human body is taught in terms of organs and organ systems, and this first set of activities focuses on the interplay among the various body systems. In the next few units, individual systems are learned.

1. Following winter break, a wrestler returns to school with 2 days of practice before the next meet, which is against the rival team. Unfortunately the wrestler has gained 5 pounds over the break, as a result of too much holiday food and no wrestling practice. The wrestler weighs 115 pounds and has to weigh 110 pounds in less then 48 hours, to be able to wrestle in the match. The wrestler has 2 choices:

   Choice 1. Lose 5 pounds by not eating or drinking, and by exercising for several hours to make the weight in time to wrestle in match.

   Choice 2. Lose the 5 pounds slowly by eating nutritious foods and going to wrestling practice but missing the match.

Identify the trade-off for the wrestler for each of the following choices.

Choice 1_____

_____

_____

Choice 2_____

_____

_____

2. In each choice the wrestler's goal is to lose five pounds. **Identify and explain at least 2 possible risk factors the wrestler needs to think about when making his choice between 1 and 2.**

RUBRIC FOR ASSESSMENT—EVIDENCE AND TRADE-OFFS

1. Identify the trade-off for the wrestler for each of the following choices.

This item measures the student's ability to understand and to identify the trade-offs in each of the two choices that the wrestler can make to lose five pounds.

Criteria for a complete response (2):

1. Student indicates that in choice 1 the wrestler will lose the weight to wrestle in the match but may be too weak, or tired to wrestle.
2. Student indicates that in choice 2 the wrestler will lose the weight in a healthy manner, but will not be able to wrestle in the meet.

Criteria for a partial response (1):

Student meets one of the criteria but not both.

Criteria for an incorrect response (0):

Student identifies only benefits or only disadvantages to either method without the other.

2. In each choice the wrestler's goal is to lose five pounds. Identify and explain at least 2 possible risk factors the wrestler needs to think about when making his choice between 1 and 2.

This item requires the student to identify reasonable risk factors the wrestler should consider when making his choice and to provide rationale for the risk factors they listed.

Criteria for a complete response (2):

a Student provides two reasonable risk factors associated with the wrestler's decision to choose between 1 and 2.

Possible responses:

- Fatigue
- Irritability
- Illness
- Injury
- Low energy
- Loss of coordination

b Student explains their choices e.g., when fatigued from starvation and over-exercising, the wrestler's performance suffers; injuries occur more often when athletes are not at peak performance level.

Criteria for a partial response (1):

Student provides one reasonable risk factor with an appropriate explanation **or** student provides two risk factors, but only one is related to the wrestler's health. The other is a consequence unrelated to health (e.g. parents will be mad, won't wrestle well).

Criteria for an incorrect response (0):

Student provides no explanation for any risk factors (e.g. only writes a list as shown in part a) **or** provides only consequences unrelated to health.

ASSESSMENT—DESIGN AN EXPERIMENT

Your baby sister just turned 6 months old and is now ready to begin eating solid baby food along with her formula. You go shopping with your mother and buy carrots, applesauce, and green beans.

After one day of eating these foods, your sister burps very loudly about 15 minutes after every meal. Although the burping is harmless (in fact, it seems to make her laugh!), she has never burped this loudly before.

Because your sister has had the same formula for the last six months, you don't think the burping resulted from the formula.

Design an experiment to determine if any of the new foods are the reason for the loud burping.

When designing your experiment use the following steps:

1. Identify the **purpose** of your experiment.
2. State a **testable hypothesis** for your experiment.
3. List at least two **variables** you will keep the same.
4. Determine the number of **trials** will you conduct.
5. List your procedures for the experiment; be sure to include a **data table** for recording observations.

Use the space on the following page to write your response.

RUBRIC FOR ASSESSMENT—DESIGN AN EXPERIMENT

This item measures the student's understanding of experimental design.

1. Purpose of experiment:

Criteria for a correct response (2):

Identifies the purpose of the experiment is to determine the cause of the baby's loud burping.

Criteria for a partial response (1):

Identifies the purpose of the experiment is to determine if a specific food is the cause of the baby's loud burping.

Criteria for an incorrect response (0):

Writes a statement that does not identify a purpose.

2. Hypothesis:

Criteria for a correct response (2):

Identifies a reasonable hypothesis with a justification or explanation.

Criteria for a partial response (1):

Identifies a reasonable hypothesis but does not include an explanation or the explanation does not match the hypothesis.

Criteria for an incorrect response (0):

Hypothesis is vague or unreasonable.

3. two variables kept the same:

Criteria for a correct response (2):

1. Identifies at least 2 variables that need to be kept the same, such as:
    - Formula
    - Feeding times
    - Brand of Food
    - Amount of Food
    - How fast baby is fed
2. Gives appropriate reasoning for keeping the above variables the same, e.g.,
    - Formula- baby has consistently used the same formula since birth

- Feeding times- make sure that the baby has the same time to eat to exclude it from possible causes
- Brand of Food- Want to determine if the original brand of food is responsible for rash
- Amount of food- Keep amount of food consistent between food types

Criteria for a partial response (1):

Identifies only one variable with correct reasoning **or** identifies two variables but gives no reasons or gives incorrect reasoning.

Criteria for an incorrect response (0):

Identifies variables over which the experimenter has no control **or** identifies variables that are not relevant to the problem (e.g. baby's clothing).

4. Number of trials:

Criteria for a correct response (2):

1. Selects at least three trials for the experiment.
2. Explains that the need for three or more trials improves the validity of the experiment.

Criteria for a partial response (1):

Identifies correct number of trials but gives no explanation **or** identifies two trials with a correct explanation (NOTE: if student states "two or more trials" with a correct explanation, this counts as a partial response).

Criteria for an incorrect response (0):

Student identifies two trials without an explanation **or** student identifies a single trial, with or without an explanation.

5. Procedure:

Criteria for a complete response (2):

1. Student gives an appropriate procedure for the experiment:

    - Keep feeding formula
    - Introduce 1 solid food for one day
    - Make observations
    - Record Data
    - Repeat for 2 or more trials
    - Repeat steps with other 2 solid food.

2. Provides a data table for recording observations, such as:

FOOD	Trial	Observation
Carrots	1	
	2	
	3	
Applesauce	1	
	2	
	3	
Green Beans	1	
	2	
	3	

Criteria for a partial response (1):

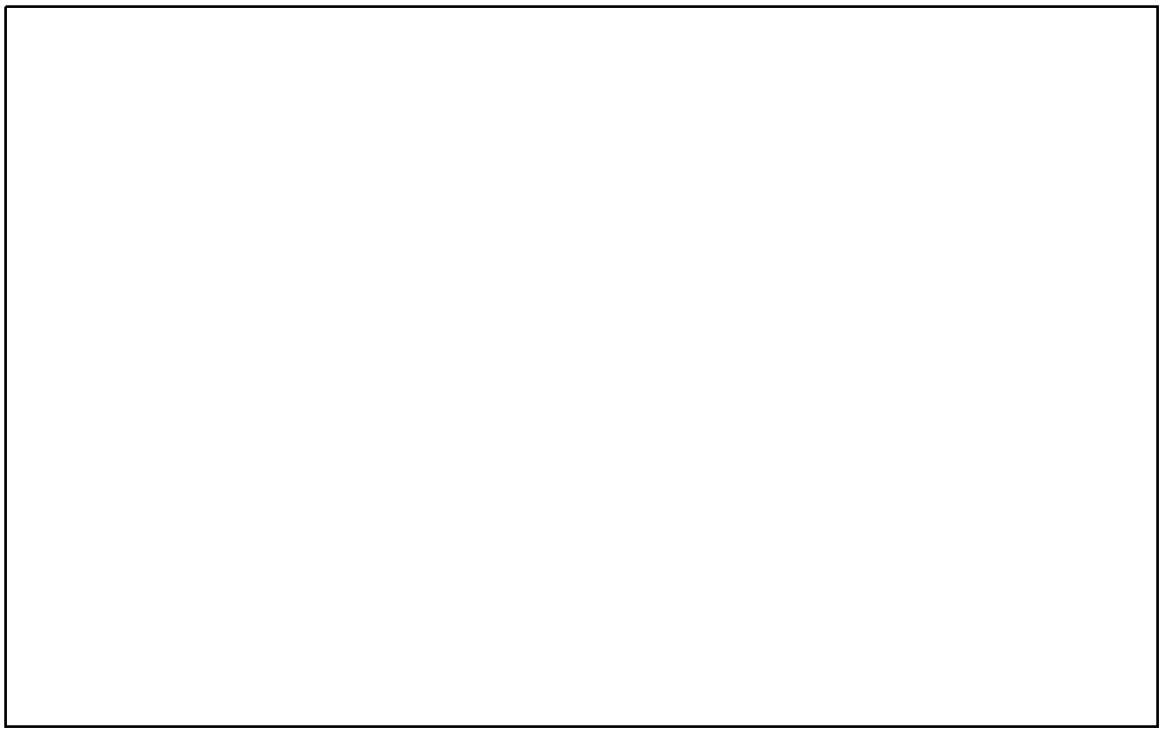
Meets the criteria for procedure but data table is missing, incomplete, or illogical **or** data table meets the criteria but procedure is incomplete, illogical, or impossible to follow.

Criteria for an incorrect response (0):

Neither procedure nor data table meet the criteria for a complete response.

1. You have studied the following systems in science: digestive, circulatory, respiratory, reproductive, and nervous. Choose two of these systems and explain how they interact with each other. Be sure to include specific examples of how each system affects the other.

2. Your stomach and liver belong to the digestive system. Name one function of each organ that contributes to the digestive system.



RUBRIC FOR ASSESSMENT—HUMAN BODY SYSTEMS

1. You have studied the following systems in science: digestive, circulatory, respiratory, reproductive, and nervous. Choose two of these systems and explain how they

interact with each other. Be sure to include specific examples of how each system affects the other.

This item measures the student's ability to explain the interaction of two systems within the human body.

Criteria for a complete response (2):

Student chooses two systems and correctly explains how they interact with each other. For example:

- Digestive and circulatory systems- digested nutrients are passed on to the blood of circulatory system which transports the nutrients throughout the body.
- Circulatory and respiratory systems- oxygen enters through the lungs of the respiratory system and it is passed on to the blood which carries it to the organs. The organs gives carbon dioxide back to the lungs for gas exchange.

Criteria for a partial response (1):

Student correctly describes the functions of the two systems but does not explain how the systems interact with each other.

Criteria for an incorrect response (0):

Student describes an incorrect function of one of the systems or an incorrect/illogical interaction of the systems.

2. Your stomach and liver belong to the digestive system. Name one function of each organ that contributes to the digestive system.

This item measure the student's ability to associate two organs with the system they belong to in the human body and to identify a function of each organ.

Criteria for a correct response (2):

Student describes the function of the stomach as one of the following possible choices:

- Chemical breakdown
- Some mechanical breakdown
- Stores food
- Absorbs some nutrients

Student describes the function of the liver as one of the following possible choices:

- Removes toxins
- Regulates sugars and cholesterol
- Digests fats

Criteria for a partial response (1):

Student describes a correct function of only one of the organs.

Criteria for an incomplete response (0):

Student describes a function that is incorrect or incomplete for both organs.

NOVEMBER

Topic 6: Digestion

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.3 Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

6.1.1 Living organisms share common characteristics that distinguish them from non-living, dead, and dormant things. They grow, consume nutrients, exchange gases, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cell(s).

6.1.6 The human body has systems that perform functions necessary for life. Major systems of the human body include the digestive, respiratory, reproductive, and circulatory systems.

6.2.3 Most living things use sugar (from food) and oxygen to release the energy needed to carry out life processes (cellular respiration). Other materials from food are used for building and repairing cell parts.

6.3.1. Regulation of an organism's internal environment involves sensing external changes in the environment and responding physiologically to keep conditions within the range required for survival (e.g., increasing heart rate with exertion).

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.c Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

6.6.e Label and describe the functions of the basic parts of the digestive tract including the mouth, esophagus, stomach, small intestine, liver, large intestine (colon), rectum and anus.

6.6.f Express how the human circulatory, respiratory, and digestive systems work together to carry out life processes.

6.6.h Conduct simple investigations (how the body reacts to exercise, changes in temperature, etc.) to determine how the systems in the human organism respond to various external stimuli to maintain stable internal conditions.

6.6.i Use knowledge of human body systems to synthesize research data and make informed decisions regarding personal and public health.

6.6.j Research and report on how body systems are affected by lifestyle choices such as diet or exercise (for example lack of exercise leads to cardiovascular disease).

Assessments:

7. Digestion

Vocabulary:

absorption: The digestive process in which nutrients and necessary chemicals in food are transported from the digestive system into the blood.

bile: A liquid produced by the liver that breaks fats down into smaller pieces (emulsifies). Bile is a type of detergent, and it contributes to mechanical (not chemical) breakdown. This process happens in the duodenum; bile normally is not excreted from the body without being chemically changed first.

Calorie: A unit of heat energy equal to the heat required to increase the temperature of a kilogram of water by one Celsius degree. The Calorie (capitalized) content of food is a measure of how much usable (by the body) energy can be obtained from a food.

carbohydrate: A food molecule that contains carbon, hydrogen, and oxygen. Carbohydrates (in humans) provide energy sources that are easily available and quickly exhausted.

chemical breakdown (chemical digestion): The process of changing the properties of food substances in the digestive system through the action of acids or digestive enzymes.

fat: A food molecule that contains carbon, hydrogen, and very little oxygen. Fats provide long term energy sources and a form of stored energy. If carbohydrate molecules cannot be used for immediate energy needs, they are converted to fat molecules for long term storage.

FDA: Food and Drug Administration. A United States government organization that regulates medicines and food products distributed in and by the United States.

mechanical breakdown (mechanical digestion: The process of physically reducing the size of food during digestion. This increases the surface area of the food and increases the rate of chemical digestion and absorption.

mucus: A sticky coating on the surface of moist areas of the body. In the stomach, a mucus lining protects the stomach wall from damage from strong digestive acids.

nutrient: Any chemical substance that provides a benefit to an organism.

pancreas: A digestive organ in humans located behind the stomach. The pancreas secretes digestive enzymes that cause the chemical breakdown of proteins, starch, and fats. The pancreas also secretes insulin into the blood. Insulin allows sugar molecules to enter cells from the bloodstream.

protein: A food molecule that contains carbon, hydrogen, oxygen, and nitrogen. Proteins create the structure of many cell and body parts. They also act as chemical messengers, and in some cases, serve as an energy source.

surface area: The amount of exposed area on the outside of an object. A high surface area to volume ratio in an organism results in rapid transfer of substances in and out of the organism.

ulcer: A disease state in which a hole develops in a body part. A stomach ulcer is a hole in the stomach lining.

USDA: United States Department of Agriculture. A government organization which regulates crops and other farmed goods grown in the United States.

villi (sing. villus): Tiny fingerlike projections in the wall of the small intestine. Villi increase the surface area of the small intestine, enhancing absorption of nutrients.

Suggested Activities:

Activity 14: Breakdown

Standards: 1.1.1, 1.1.3, 6.1.1, 6.1.6, 6.2.3, 6.3.1

GLEs: 6.1.a, 6.1.c, 6.6.e, 6.6.f

GOALS: In these lab activities, students will

- Design and conduct an experiment to determine the effect of increasing surface area of an antacid tablet on its reactivity in vinegar.
- Create a model to simulate and characterize the effects of mechanical breakdown and chemical breakdown in digestion.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students design an experiment to investigate the effect of mechanical breakdown on chemical breakdown during digestion. They will employ all the concepts learned in the first ten activities about experimental design.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

This activity sometimes surprises students and teachers. The usual hypothesis is that breaking the tablet causes the reaction to come to completion faster. In fact, it causes a more intense reaction, but the time factor does not seem to change by crushing the tablet. One important concept that is introduced with this activity is the idea of surface area. Students learn that the reason the broken tablet is more reactive than the intact one is that more surface area of the tablet is exposed when it is broken. This concept (which is not explored in the math standards until seventh grade) is repeated in the next activity and in the respiration activity.

Activity 15: Digestion—an Absorbing Tale
Activity 16: Balancing Act (optional)

Standards: 6.1.1, 6.1.2, 6.1.6, 6.2.1, 6.2.3, 6.3.1
GLEs: 6.6.a, 6.6.e, 6.6.h, 6.6.i, 6.6.j

GOALS: In these lab activities, students will

- Explain how the various organs of the digestive system contribute to mechanical and chemical breakdown of food.
- Correlate increased surface area of food and of the lining of the small intestine with complete chemical breakdown and absorption.
- Make decisions about the nutrition in a type of food, identifying benefits and trade-offs.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Activity 15 is a reading in which students place the digestive organs in the sequence in which they contribute to digestion. Students also explain how the organs contribute to mechanical breakdown, to chemical breakdown, and to absorption. Activity 16 allows students to create an energy bar using common foods. This activity involves considerable math operations, converting measurements to Calorie content. Students are introduced to the idea of energy content of food, and storage of unused food. The concept of trade-offs is revisited.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

Activity 14 is the main source of content about the digestive system. Students are introduced to the actual digestive organs and their roles in the sequential process of digestion. Chemical breakdown may be a challenge for students. They only need to know that the food is changed into new substances that the body can use. This is unlike mechanical breakdown which is just a reduction in the size of the food. Students do not need to know about individual enzymes or how they work; only that the carbohydrates, proteins, fats, and other nutrients of the food are removed for absorption into the blood. The idea of surface area is reintroduced. This concept that greater surface area means greater interaction with the environment will become a big idea throughout middle school and high school science.

Topic 7: Respiration and Circulation

Standards:

5.1.4 The atmosphere is a mixture having as its principal components a fixed ratio of nitrogen and oxygen and, depending on the location, variable amounts of carbon dioxide, water vapor, and dust particles.

6.1.1 Living organisms share common characteristics that distinguish them from non-living, dead, and dormant things. They grow, consume nutrients, exchange gases, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cell(s).

6.1.6 The human body has systems that perform functions necessary for life. Major systems of the human body include the digestive, respiratory, reproductive, and circulatory systems.

6.2.1 All organisms require energy. A general distinction among organisms is that plants use solar energy to make their own food (sugar) and animals acquire energy directly or indirectly from plants.

6.2.3 Most living things use sugar (from food) and oxygen to release the energy needed to carry out life processes (cellular respiration). Other materials from food are used for building and repairing cell parts.

6.3.1. Regulation of an organism's internal environment involves sensing external changes in the environment and responding physiologically to keep conditions within the range required for survival (e.g., increasing heart rate with exertion).

GLEs:

6.6.a Explain that human body systems are comprised of organs (e.g., the heart, the stomach, and the lungs) that perform specific functions within one or more systems.

6.6.b Label and describe the functions of the basic parts of the circulatory system including the heart, arteries, veins and capillaries.

6.6.d Label and describe the functions of the basic parts of the respiratory system including the trachea, bronchi and lungs.

6.6.f Express how the human circulatory, respiratory, and digestive systems work together to carry out life processes.

6.6.g Trace how the circulatory, respiratory, and digestive systems interact to transport the food and oxygen required to provide energy for life processes.

6.6.h Conduct simple investigations (how the body reacts to exercise, changes in temperature, etc.) to determine how the systems in the human organism respond to various external stimuli to maintain stable internal conditions.

6.6.i Use knowledge of human body systems to synthesize research data and make informed decisions regarding personal and public health.

Assessments:

8. Breathing and Circulation

Vocabulary:

alveoli (sing. alveolus): Tiny air sacs that make up lung tissue. When breathing occurs, the alveoli fill with air, and gas exchange occurs across the walls of the alveoli and the small capillaries lining them.

aorta: The largest artery in the body. The aorta leaves the heart from the left ventricle and carries oxygen rich blood to the body.

artery: A thick walled blood vessel that carries blood away from the heart.

atrium (left/right): The upper chamber of the heart which receives blood from the veins. The right atrium receives oxygen poor blood from the body, and the left atrium receives oxygen rich blood from the lungs.

capillary: A thin walled narrow blood vessel that connects arteries to veins. Nutrient/waste exchange and gas exchange always occur across the walls of capillaries.

carbon dioxide: A gas in the air that is produced as a waste product of breathing.

diaphragm: A thick band of muscle that separates the chest cavity from the abdominal cavity. Raising and lowering of the diaphragm causes the air pressure in the chest cavity to change, which in turn causes the lungs to exhale and inhale (respectively).

exhale: To expel air from the lungs.

indicator: A solution that detects changes in acid/base content (pH) by changing color. Indicators generally do not participate directly in chemical reactions with acids and bases.

inhale: To introduce air into the lungs.

oxygen: A gas in the air that allows most living organisms (including humans) to use food to obtain biological energy.

solution: A mixture of substances that has the same composition throughout.

tissue: Part of the living material (made of cells) that serves as a functional component of organs or organ systems.

valve: A thick piece of tissue in the heart or in the veins which is designed to close in one direction. The valves prevent back flow of blood.

vein: A moderately thick walled blood vessel that returns blood to the heart.

ventricle (left/right): The larger lower chamber of the heart which sends blood from the heart through arteries. The right ventricle sends oxygen poor blood to the lungs. The left ventricle sends oxygen rich blood through the body.

Suggested Activities:

Activity 17: Gas Exchange

Standards: 5.1.4, 6.1.1, 6.1.6, 6.2.1, 6.2.3, 6.3.1
GLEs: 6.6.d, 6.6.g, 6.6.h, 6.6.i

GOALS: In these lab activities, students will

- Design and carry out an experiment using Bromothymol Blue (BTB) indicator to determine the relative carbon dioxide content of exhaled air.
- Explain how the structure of the lungs and the blood vessels allows gas exchange to occur.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

In this investigation, students quantitatively measure the amount of carbon dioxide in exhaled air using BTB indicator. They also investigate the role of increased surface area on the ability of the lungs to obtain oxygen and exchange it with the environment.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

This activity continues to develop the concept of increased surface area as a factor in rate of reaction. Students first learn about the structure of the lungs. This is the first time they use pH indicators, so it is only important that they realize that BTB is used to identify carbon dioxide.

A common misconception for students is that the air only contains oxygen, and that exhaled air only contains carbon dioxide. Transparency 7.2 illustrates the idea that air is a mixture of gases and that oxygen is indeed present in exhaled air (mention that if it weren't, cardiopulmonary resuscitation (CPR) would not work.

This activity also introduces the idea that the respiratory system depends on the circulatory system to be effective (and vice-versa). This idea is developed more in the next activity.

Activity 18: The Circulation Game
Activity 23: Heart Parts (introduction)

Standards: 6.1.1, 6.1.6, 6.2.3, 6.3.1
GLEs: 6.6.a, 6.6.b, 6.6.f, 6.6.g, 6.6.h, 6.6.i, 6.6.j

GOALS: In these lab activities, students will

- Trace the flow of blood to and from the heart around the body and lungs.
- Explain how the heart and circulatory system allow blood to exchange gases, nutrients, and wastes.
- Trace the flow of blood through the chambers of the heart.
- Identify blood as oxygen rich or oxygen poor and predict where this blood will be sent to (or received from) by the heart.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

In the Circulation Game, students conduct a role play illustrating the path of blood through the body. In this role play, blood is sent by the heart to collect oxygen and food, exchange these with body parts for carbon dioxide and waste, and then blood is returned to the heart to start the cycle again. Heart parts may be introduced at this point (and revisited later) to illustrate the chambers of the heart and the flow of blood through the heart.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

The Circulation Game allows students to experience the cyclic nature of blood flow and how the heart works continuously to provide all parts of the body with oxygen, food, and waste removal. This concept of moving in a closed system is revisited in the Electrical Energy unit. The Circulation Game also provides a way of connecting the concepts learned in digestion and respiration. Students learn that the body systems are inter-connected, in part, through the circulatory system.

It is not necessary to introduce Heart Parts if time is a factor; however, illustrating the parts of the heart and their role in sending blood to the appropriate parts of the body may help clarify the Circulation Game.

The components of blood (red blood cells, serum proteins, clotting factors) are not addressed in this unit. These will be addressed in tenth grade biology.

1. Starting with the mouth and ending with the large intestine **list** the "order of operations" of the organs in the digestive system.

Organs:	mouth	small intestine	liver
	stomach	large intestine	esophagus

2. Explain the function(s) that each organ listed in question 1 performs in the breakdown of food.

3. When we consider the process of digestion, we often refer to the surface area, (the amount of exposed area of an object) of various structures or objects.

- The teeth chew the food before swallowing
- The length of the small intestine of an adult human is approximately 20 feet long.
- The inside of the small intestine is lined with thousands of fingerlike projections called villi.

Choose two of the sentences in the bulleted list above. Explain how the concept in that sentence relates to surface area.

RUBRIC FOR ASSESSMENT—DIGESTION

1. Starting with the mouth and ending with the large intestine **list** the "order of operations" of the organs in the digestive system. **Be sure to include the function(s) that each organ performs in the breakdown of food.**

Organs: mouth small intestine
stomach large intestine esophagus

This item measures students understanding of the structural organization of the human digestive system.

Criteria for a correct response (2):

Student lists the appropriate order of the organs in the digestive system as follows:

Mouth
Esophagus
Stomach
Small intestine
Large intestine

Criteria for a partial response (1):

Only four or more of these are in the correct order.

Criteria for an incorrect response (0):

Fewer than four of these are in the correct order.

2. Explain the function(s) that each organ listed in question 1 performs in the breakdown of food.

This item measures the student's understanding of the function of each organ in the system in the breakdown of food.

Criteria for a complete response (2):

Student explains the correct function(s) of each organ n the digestive system as follows:

- Mouth- Mechanical (may say “chewing”) **or** chemical breakdown (saliva) of food.
- Esophagus- Movement of food to stomach.
- Stomach- Chemical (stomach acid) **or** mechanical breakdown of food.
- Small intestine- Completes the chemical breakdown of food **or** absorption of food.
- Large intestine- Water absorption, solid waste production.

Criteria for a partial response (1):

Student explains the correct function of three or four of these organs.

Criteria for an incorrect response (0):

Student explains the correct function of fewer than three of these organs.

4. When we consider the process of digestion, we often refer to the surface area, (the amount of exposed area of an object) of various structures or objects.

- The teeth chew the food before swallowing
- The length of the small intestine of an adult human is approximately 20 feet long.
- The inside of the small intestine is lined with thousands of fingerlike projections called villi.

Choose two of the sentences in the bulleted list above. Explain how the concept in that sentence relates to surface area.

This item measures the student's understanding that increased surface area allows food to be digested more easily and more quickly.

Criteria for a complete response (2):

Student explains two of the following correctly:

- chewing food increases its surface area. This enables the food to be digested more easily **or** be absorbed more easily.
- the length of the small intestine increases its surface area, allowing for greater absorption of food.
- the projections in the small intestine increase the surface area. This allows for faster absorption of food.

Criteria for a partial response (1):

Student explains one of these three correctly. Other responses do not show the correlation between surface area and digestion or absorption.

Criteria for an incorrect response (0):

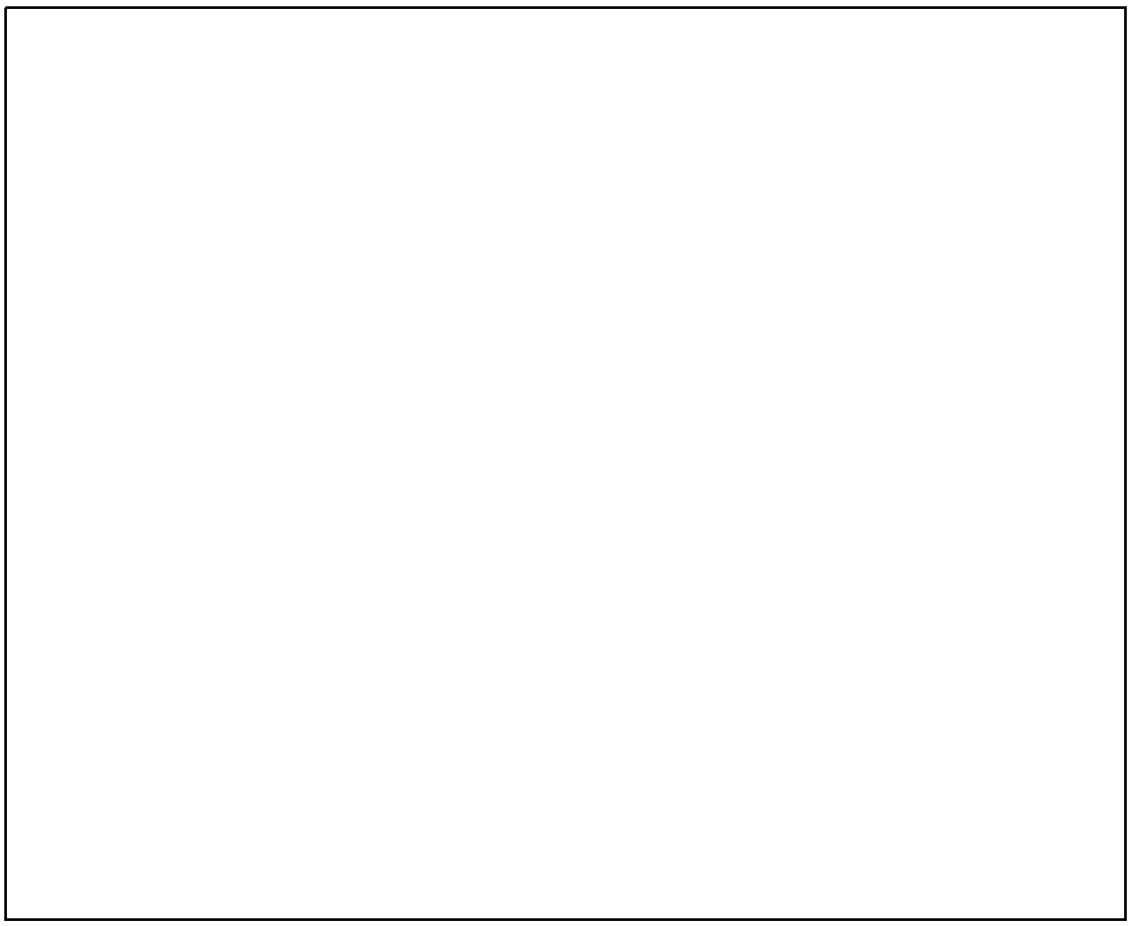
Student is unable to show the correlation between surface area and digestion/absorption for any of these situations.

1. When a person exercises by lifting weights or running, they start breathing faster. Explain why, using information you have learned about what oxygen does in the body.

2. Why is it necessary for the heart to pump blood continuously, even when a person is asleep?

3. After sitting for a long period (an hour), most people become sleepy. If these same people stand up and walk around for a minute, they feel more awake and energized.

Explain why they feel tired, but then gain a “burst of energy” in terms of breathing and circulation.



RUBRIC FOR ASSESSMENT—BREATHING AND CIRCULATION

1. When a person exercises by lifting weights or running, they start breathing faster. Explain why, using information you have learned about what oxygen does in the body.

This item measures the student's understanding of the function of the respiratory system.

Criteria for a complete response (2):

Student states that since oxygen allows the body to obtain energy from food, the exercise creates a need for more energy. Breathing faster provides more oxygen to the blood to allow the body to obtain the extra energy needed.

Criteria for a partial response (1):

Student states that exercise causes the body to need more oxygen, and as a result, the person breathes faster, but does not associate oxygen with obtaining energy from food.

Criteria for an incorrect response (0):

Student states that breathing faster cools the person off.

2. Why is it necessary for the heart to pump blood continuously, even when a person is asleep?

This item measures the student's understanding that all parts of the body continuously need food and oxygen and to remove carbon dioxide and wastes.

Criteria for a complete response (2):

Student states that the heart pumps blood to all parts of the body to provide food and oxygen and to remove carbon dioxide and wastes. The body needs this to occur at all times.

Criteria for a partial response (1):

Student states that the heart needs to supply food/oxygen **or** remove carbon dioxide/wastes but not both.

Criteria for an incorrect response (0):

Student states that if the heart does not pump continuously, the person will die, but does not explain why.

3. After sitting for a long period (an hour), most people become sleepy. If these same people stand up and walk around for a minute, they feel more awake and energized.

Explain why they feel tired, but then gain a "burst of energy" in terms of breathing and circulation.

This item measures the student's ability to connect food/oxygen to energy and carbon dioxide/waste to lack of energy.

Criteria for a complete response (2):

Student states that sitting causes the blood to circulate less, causing the body to receive less oxygen **or** build up more carbon dioxide. Walking improves circulation, allowing all parts of the body to receive oxygen and remove carbon dioxide, resulting in more energy.

Criteria for a partial response (1):

Student correctly explains lack of energy from sitting **or** renewed energy with walking but not both.

Criteria for an incorrect response (0):

Student gives an explanation for both phenomena that does not mention circulation, oxygen, or carbon dioxide.

DECEMBER

Topic 8: The Heart and Fitness

Standards:

6.1.1 Living organisms share common characteristics that distinguish them from non-living, dead, and dormant things. They grow, consume nutrients, exchange gases, respond to stimuli, reproduce, need water, eliminate waste, and are composed of cell(s).

6.1.6 The human body has systems that perform functions necessary for life. Major systems of the human body include the digestive, respiratory, reproductive, and circulatory systems.

6.2.3 Most living things use sugar (from food) and oxygen to release the energy needed to carry out life processes (cellular respiration). Other materials from food are used for building and repairing cell parts.

6.3.1. Regulation of an organism's internal environment involves sensing external changes in the environment and responding physiologically to keep conditions within the range required for survival (e.g., increasing heart rate with exertion).

6.4.1. Technological advances in medicine and improvements in hygiene have helped in the prevention and treatment of illness.

6.4.2. The functioning and health of organisms are influenced by many factors (i.e., heredity, diet, lifestyle, bacteria, viruses, parasites, and the environment). Certain body structures and systems function to protect against disease and injury.

GLEs:

6.6.b Explain that human body systems are comprised of organs (e.g., the heart, the stomach, and the lungs) that perform specific functions within one or more systems.

6.6.b Label and describe the functions of the basic parts of the circulatory system including the heart, arteries, veins and capillaries.

6.6.f Express how the human circulatory, respiratory, and digestive systems work together to carry out life processes.

6.6.g Trace how the circulatory, respiratory, and digestive systems interact to transport the food and oxygen required to provide energy for life processes.

6.6.h Conduct simple investigations (how the body reacts to exercise, changes in temperature, etc.) to determine how the systems in the human organism respond to various external stimuli to maintain stable internal conditions.

6.6.i Use knowledge of human body systems to synthesize research data and make informed decisions regarding personal and public health.

6.6.j Research and report on how body systems are affected by lifestyle choices such as diet or exercise (for example lack of exercise leads to cardiovascular disease).

Assessments:

9. Heart Healthy

Vocabulary:

American Heart Association: A non-profit organization whose work is directed at raising money for research into heart disease and educating the public about cardiac health.

breathing rate: The number of times per minute a person inhales and exhales.

cardiac (heart) output: The volume (ml) of blood the heart pumps out in one minute.

cardiologist: A doctor who specializes in treatment and diseases of the heart.

coronary artery: An artery that brings oxygenated blood to the heart tissue.

efficiency: The relative amount of emptying the heart is capable of in each beat. High efficiency, a characteristic of good heart health, is evidenced by low resting pulse and high cardiac output.

fitness: Overall health of a person, usually as a function of the heart.

heart attack: A serious (sometimes fatal) occurrence in which the heart muscle is deprived of normal blood flow. The heart tissue is killed from lack of food/oxygen and buildup of wastes.

pulmonary artery/pulmonary vein: A major blood vessel connecting the heart to the lungs. Oxygen poor blood travels to the lungs through the pulmonary arteries, and oxygen rich blood returns to the heart through the pulmonary veins.

pulse: The vibration of the heartbeat as felt or heard in an artery. Heart rate is usually determined by finding pulse rate.

resting pulse: The number of beats per minute (as measured by the pulse) the heart beats when the body has not exercised.

risk factor: A characteristic or behavior that increases the likelihood of an undesired occurrence or disease.

siphon: A tube that moves liquid from one container to another through differences in pressure.

stroke: A pathological event in which brain tissue is killed from lack of blood flow.

Suggested Activities:

19. Heartily Fit

Standards: 6.1.1, 6.1.6, 6.2.3, 6.3.1
GLEs: 6.6.a, 6.6.b, 6.6.f, 6.6.g, 6.6.h

GOALS: In these lab activities, students will

- Determine their own resting pulse and pulse after exercise.
- Explain the relationship between recovery time and fitness
- Design an experiment to compare resting pulses and recovery times among classmates.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students design an experiment where they measure their own (or each other's) resting pulses, then exercise for a period of time and determine recovery time. Students correlate their findings with their level of fitness and discuss ways to improve their overall fitness.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

The circulation game (Activity 18) gave students an idea of what path through the body blood takes and what happens at each stage. This activity allows them (through experimental design) to relate this information to themselves and calculate aspects of their own health. This activities often generates questions and discussion about how the results relate to their own situations (e.g. "my resting pulse is …. Is that bad?) Students should be encouraged to speak to their parents and health care professionals about any specific health related issues that arise.

This activity is the first of the final activities in My Body and Me, in which students relate the human body to healthy lifestyle choices.

Activity 21: Inside a Pump
Activity 22: The Heart—a muscle
Activity 24: Round and Round

Standards: 6.1.1, 6.1.6, 6.2.3, 6.3.1
GLEs: 6.6.a, 6.6.b, 6.6.f, 6.6.g, 6.6.h, 6.6.i, 6.6.j

GOALS: In these lab activities, students will

- Explain why blood flow through the heart is one-directional and why it must be one-directional.
- Explain the way in which the heart rests, and how improved fitness enables the heart to rest more easily.
- Use a diagram to show how the heart separates oxygen poor blood from oxygen rich blood.

ACTIVITY OVERVIEW: A synopsis of these lessons follows

Students investigate the strength of heart muscle as they pump water at their resting pulse. They also study the role of valves in heart function as they design a working model of the heart and the circulatory system.

CONTEXT: The concepts that we have been developing and how this activity serves as the next step can be explained as follows:

Activity 20, Great Aunt Lily's Will, is optional. While it is a useful activity illustrating evidence and trade-offs, it may need to be skipped in the interest of time.

These activities are useful in showing students the structure of the heart and how the heart is able to function around the clock. Activity 21 may also be skipped at the teacher's discretion. The important idea here is that blood flow is unidirectional. Any reversal would result in mixing of oxygen rich blood with oxygen poor blood. As a result, cells would not be able to receive enough oxygen from the blood, nor would they be able to remove enough wastes into the blood.

The remaining activities in My Body and Me address various aspects of heart disease and heart health. Teachers may do these activities as needed to complete Assessment 9. However, teachers should plan to be finished My Body and Me by the end of December at the latest.

WRITING PROMPT—HEART HEALTHY

You will work as part of a pair for this project.

Your school is preparing a year long program to promote community health. One of the major concerns is heart health for all age groups. Your group will write a two part proposal to promote activities and lifestyle choices aimed at improving the health of the heart.

Team member 1: You will write a description of ways that an exercise program can improve the heart's ability to pump. In your essay (2-3 pages), you will need to write about the following:

- How the heart functions
- What happens to the heart when we exercise
- Why a regular exercise program improves the function of the heart
- What kinds of exercises should people do to improve heart health
- How often should we exercise? For how long?

Team member 2: You will write a description of lifestyle choices (besides exercise) that may improve the health of the heart. Your essay (2-3 pages) should include information about the following:

- How the heart functions
- What foods improve heart health and why
- What foods could harm the heart and why
- lifestyle choices to avoid. Why do these choices harm the heart? (for example: smoking)
- lifestyle choices to practice. Why do these choices help the heart? (for example: regular checkups)

RUBRIC FOR WRITING PROMPT—HEART HEALTHY

Exercise paper:

Characteristics of a level 3:

The student gives an accurate description of how the heart pumps blood. The explanation of what happens when we exercise includes a description of pulse rate, an explanation of the increased need for oxygen and waste removal, and a description of recovery time. The explanation of why regular exercise improves heart functioning includes information about resting pulse being lower and recovery time being shorter. These findings are both associated with greater efficiency of pumping blood. Exercises that are chosen are challenging yet reasonable, and the schedule of exercises is appropriate. The overall presentation is persuasive, inviting, and includes information suitable to multiple age groups (e.g. children, teenagers, and adults). The essay contains no errors in standard written English.

Characteristics of a level 2:

The student gives an accurate description of how the heart pumps blood. The explanation of what happens when we exercise includes a description of pulse rate, an explanation of the increased need for oxygen and waste removal, and a description of recovery time. The explanation of why regular exercise improves heart functioning includes information about resting pulse being lower and recovery time being shorter. These findings are both associated with greater efficiency of pumping blood. Exercises that are chosen are challenging yet reasonable, and the schedule of exercises is appropriate. The essay contains few errors in standard written English, none of which interfere with understanding.

Characteristics of a level 1:

Although the student gives an accurate description of how the heart pumps blood, some details about the process may be missing. The explanation of what happens when we exercise may include a description of pulse rate, an explanation of the increased need for oxygen and waste removal, and a description of recovery time; however, one of these concepts may be missing or incorrect. Exercises that are chosen are challenging yet reasonable, and the schedule of exercises is appropriate. The essay contains few errors in standard written English, none of which interfere with understanding.

Characteristics of a level 0:

The student gives an inaccurate description of how the heart pumps blood or no description. The explanation of what happens when we exercise may be inaccurate or unrelated to the heart. Exercises that are chosen are unreasonable or inadequate for raising the resting pulse rate, and the schedule of exercises may be inappropriate (e.g. excessive or too infrequent). . The essay contains major errors in standard written English, some of which may interfere with understanding.

Lifestyle Paper:

Characteristics of a level 3:

The student gives an accurate description of how the heart pumps blood. The list of heart-healthy foods shows variety and explains how these foods benefit the heart. The list of foods that harm the heart explains why these foods are harmful. The section on lifestyle choices explains in detail why beneficial practices help the heart and why detrimental practices harm the heart. Although the student may refer to exercise as a beneficial lifestyle choice, this paper is not a restatement of the exercise paper. The overall presentation is persuasive, inviting, and includes information suitable to multiple age groups (e.g. children, teenagers, and adults). The essay contains no errors in standard written English.

Characteristics of a level 2:

The student gives an accurate description of how the heart pumps blood. The list of heart-healthy foods shows variety and explains how these foods benefit the heart. The list of foods that harm the heart explains why these foods are harmful. The section on lifestyle choices explains in detail why beneficial practices help the heart and why detrimental practices harm the heart. Although the student may refer to exercise as a beneficial lifestyle choice, this paper is not a restatement of the exercise paper. The essay contains few errors in standard written English, none of which interfere with understanding.

Characteristics of a level 1:

Although the student gives an accurate description of how the heart pumps blood, some details about the process may be missing The list of heart-healthy foods may show little variety or may not explain how these foods benefit the heart. The list of foods that harm the heart may not explain why these foods are harmful to the heart (e.g. they may say that the food is fattening, but may not link this finding to heart function. The section on lifestyle choices explains in detail why beneficial practices help the heart and why detrimental practices harm the heart, although they may put a heavy focus on the role of exercise as a restatement of the exercise paper. The essay contains few errors in standard written English, none of which interfere with understanding.

Characteristics of a level 0:

The student gives an inaccurate description of how the heart pumps blood or no description. The list of heart health foods may not explain how the foods help the heart and in fact, may not be beneficial to the heart. The list of foods that harm the heart may not explain why these foods are harmful to the heart. The lifestyle choices that are chosen may not be related to heart function as stated, or they may only address the benefits of exercise (a restatement of the exercise paper). The essay contains major errors in standard written English, some of which may interfere with understanding.

JANUARY

Topic 9: Motion and Speed

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2 Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

1.1.3 Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

1.2.1 Advances in technology can expand the body of scientific knowledge. Technological tools allow people to observe objects and phenomena that otherwise would not be possible. Technology enhances the quality, accuracy, speed and analysis of data gathered.

3.1.2 Mechanical energy comes from the motion (kinetic energy) and position (potential energy) of objects. Gravitational potential energy and elastic potential energy are important forms of potential energy that contribute to the mechanical energy of objects.

3.2.1 When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.b Design and conduct investigations with controlled variables to test hypotheses.

6.1.c Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

6.3.a List, as basic forms of energy, light, heat, sound, electrical, and energy of motion.

6.3.f Conduct investigations on a moving object and make measurements of time and distance traveled and determine the average speed of moving objects.

6.3.g Graph and interpret distance versus time graphs for constant speed. Use the graphs to describe how the position of an object changes in a time interval.

6.3.h Describe how the speed of an object depends on the distance traveled and the travel time. Explain how the motion of an object can be described by its position, speed, and direction of motion.

Assessments:

10. Speed Measurement

Vocabulary:

average speed: The total distance an object travels divided by the total time it traveled. Average speed does not take into account changes in speed during the time period.

constant speed: A state where an object moves at the same speed over a given period of time. A stationary object moves with a constant speed of zero m/sec.

GPS: Global Positioning Satellite. A system by which an object on Earth can be identified through satellite imaging. GPS can identify the position and the speed of an object within a few feet.

motion: A description of the way an object moves or stays still.

speed: The distance traveled by an object over a period of time.

stationary: A description of an object that is not moving.

Suggested Activities:

Activity 1: How Fast is it Going?
Activity 2: Graphical Displays of Motion

GOALS: In these lab activities, students will

- Design and conduct an experiment to determine the speed of a moving object (a buggy).
- Compare the speeds of two moving objects qualitatively (which is faster, which is slower) and quantitatively (how much faster does one object move than the other).
- Investigate the differences between motion with constant speed and motion with changing speed.
- Learn to use the simple technology of Dot-Cars to collect motion data.
- Create bar graphs and line plot graphs to illustrate constant speed motion and changing speed motion.
- Learn how graphs can be used to understand an object's motion using probe technology and computers to collect and graph motion data.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

Students devise a plan to determine the speed of a red motorized buggy and a blue one. They will then carry out your planned investigation, collect data, and communicate the results of their investigation to the rest of the class. In the second activity, students will use a Dot car to determine how the car's position changed during its motion. Students will make qualitative conclusions about the car's speed. By measuring the distance between the marks, students will calculate the average speed of the car. Finally, the students will use the Dot-Cars to compare constant speed motion and changing speed motion.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

In this activity students will develop strategies to determine the speeds of buggies using a guided inquiry approach. The students will collect appropriate data and use tables to organize their data. Students will learn how to use their data to calculate the average speeds of the buggies. They will record their results in tables, and interpret these results to answer questions about the motion of the buggies. In the 5th grade ***Motion and Design*** unit they have discussed speed and some factors that affect the speed of an object. The idea of average speed will be used when investigating the energy of motion in the 8th grade ***Transformation of Energy*** unit.

In the second activity, the students make measurements using the Dot-Car. The car enables the students to track the motion of the car as it moves. The average speed calculation learned in the previous activity will be used to calculate the speed of the car at different points in its motion. Bar graphs will be used to display how the speed changes during the motion. Line plots will also be used to illustrate the motion. Students will be taught that the graphs can be used to interpret the motion of the Dot-Car. It is important for students to distinguish constant speed motion from changing speed motion. The skills acquired in this activity will be used later in this unit when students are asked to make the connection between the total force acting on an object and the way the motion of the object changes. Students will see similar information in graphical form in the 8th grade ***Transformation of Energy*** unit.

Topic 10: Gravity and Other Forces

Standards:

3.1.2 Mechanical energy comes from the motion (kinetic energy) and position (potential energy) of objects. Gravitational potential energy and elastic potential energy are important forms of potential energy that contribute to the mechanical energy of objects.

3.2.1 When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

Gravity is a force that acts between masses over very large distances. Near the Earth's surface, gravity pulls objects and substances vertically downward.

GLEs:

6.3.a List, as basic forms of energy, light, heat, sound, electrical, and energy of motion.

6.3.f Conduct investigations on a moving object and make measurements of time and distance traveled and determine the average speed of moving objects.

6.3.i Explain that the earth will pull on all objects with a force called gravity that is directed inward toward the center of the Earth.

6.3.j Give examples of moving objects and identify the forces that act on these objects. Select examples where only one force acts on the object and examples where two or more forces act on the object. Explain that unbalanced forces acting on an object will change its speed, direction of motion or both

6.3.k Conduct investigations to describe how the relative directions of forces simultaneously acting on an object (reinforce or cancel each other) will determine how strongly the combination of these forces influences the motion of the object.

6.3.l Conduct investigations and describe how a force can be directed to increase the speed of an object, decrease the speed of the object or change the direction in which the object moves.

6.3.m Explain that an object that feels the effects of balanced forces may be at rest or may be moving in a straight line with a speed that does not change.

Assessments:

11. Gravity and Other Forces

Vocabulary:

air resistance: A force exerted by air when an object passes through it. Air resistance tends to act in the opposite direction as the object is moving. If the object is falling, air resistance may reduce the speed at which it falls.

force: A "push" or a "pull" on an object that changes its motion (it may change the direction of motion, it may stop a moving object, or cause a stationary object to move).

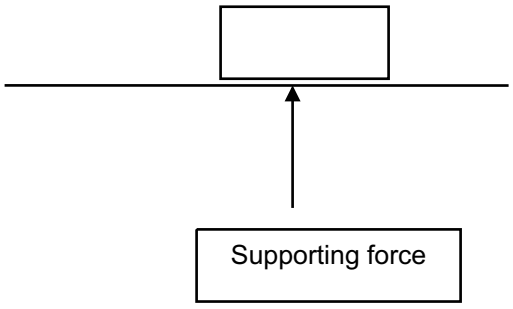
friction: A force that occurs when two objects are in close contact with one another. Friction acts in the opposite direction of the movement of an object, and tends to reduce slipping of the surfaces of the two objects.

gravity: A force exerted by the center of mass on an object to attract all other forms of matter. This force is generally very weak unless one of the objects is extremely large (like a planet, star, or moon).

horizontal(ly): In a sideways direction.

mass: A measureable description of the total amount of matter in an object.

plumb line: A string with a weight on the end designed to create a vertical path.
supporting force: A force exerted by a surface on which an object is located. The supporting force (also called "normal force") is perpendicular to the direction of the surface.



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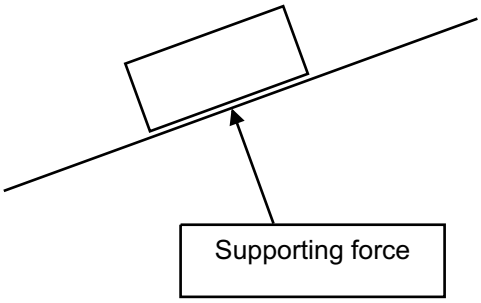


terminal speed: The maximum speed that a falling object experiencing air resistance can reach. At this speed, the object is falling at a constant speed.

total force: The sum of all forces acting on an object. By determining the size and direction of the total force, the motion of an object can be predicted.

traction: Another term for "friction." Traction usually refers to a situation where friction is enabling an object to move (e.g. a person walking).

vertical(ly): The direction in which gravity acts.

weight: The force of gravity on an object. Unlike mass, weight depends on the mass of a second object and the distance between the two objects.

Suggested Activities:

Activity 3: A Look at Gravity.

GOALS: In this lab activity, students will

- Learn that gravity is an inescapable force that acts between all objects.
- Learn that all objects exert a force of gravity on other objects, but these forces are too small to detect unless one of the objects is huge; a star, a planet or a moon.
- Examine the difference between mass and weight.
- Investigate the direction in which the force of gravity acts.

ACTIVITY OVERVIEW: A synopsis of thi lesson follows:

Students transition from investigating motion to investigating the cause of motion – forces. The force of gravity influences nearly everything on our planet. It is also the force responsible for holding our solar system together. Over the course of the next few activities, we will be identifying and investigating many forces that affect the motion of objects.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

We begin the shift in focus from looking at motion to looking at forces and how these forces affect motion. The investigation begins with the most common force in our daily lives – gravity. Here we begin to clarify many of the concepts that have been only touched upon in previous units. The notion that gravity is the force responsible for the orbits of the planets around the Sun and the distinction between mass and weight will be encountered in this activity. This may be the first time students seriously address these topics. These discussions provide the foundation for more in-depth discussions in the 8th grade curriculum. The activity that follows this one will ask students to identify gravity and other forces acting on common objects. Students will also be asked to investigate the characteristics of these forces.

Activity 4: Identifying Forces
Activity 5: Drawing Forces

GOALS: In this lab activity, students will

- Recognize that there are always forces acting on objects.
- Learn that forces cannot be seen and are often difficult to detect, but there are clues that we can use to identify when a force is acting on an object.
- Learn that the forces investigated in this activity have specific properties. Understanding these properties help us to predict the effect these forces will have on objects and the objects' motion.
- Recognize that the direction in which a force acts is an important property of the force and will influence the effect that the force has on the object.
- Practice identifying the forces that act on objects in different situations.
- Practice identifying the direction of the forces acting on different objects.
- Learn how to combine forces to find the total force.
- Learn how to recognize when the forces acting on an object are balanced and when the forces are unbalanced.
- Learn how the size and direction of the total force determines how the motion of an object will change.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

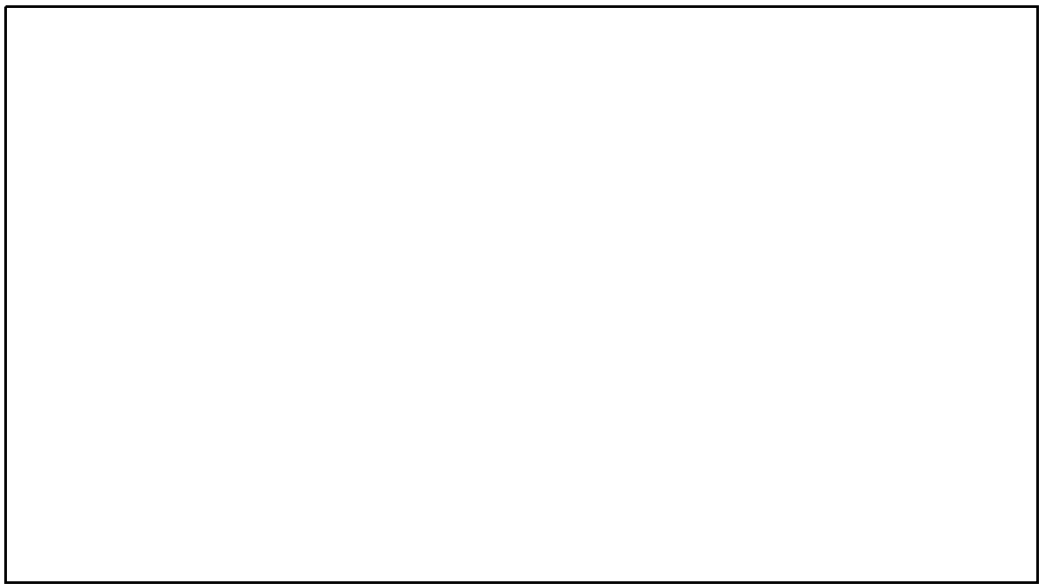
Students are presented with several scenarios involving objects. Some of the objects will be at rest, while others will be in motion. They identify all of the forces acting on the object in question and to determine the direction of each force. They also begin a discussion of the properties of everyday forces in this activity and how each force can influence the motion of objects. Then, students learn to represent each force using the arrow symbol (→). They create a diagram that shows all of the forces acting on an object (called a ***force diagram***). Students learn how to combine these forces to find the ***total force***. The size and the direction of the total force will be used to predict how the motion of the object will change.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

The activities in the beginning of the unit were designed to strengthen the students' understanding of speed and average speed. Forces, and only forces can change the motion of objects. In this activity we continue our discussion of forces. Students will learn to identify forces and determine the direction in which they act. The skills leaned in these activities enable students to develop a better understanding of energy concepts, especially in the area of energy transfer. The suggested curriculum is designed so that the Simple Machines unit follows this unit on forces and motion. The emphasis in Simple Machines will be to discuss how forces transfer energy, thus shifting discussions away from how forces change the motion of an object to discussions of how the forces change the object's energy.

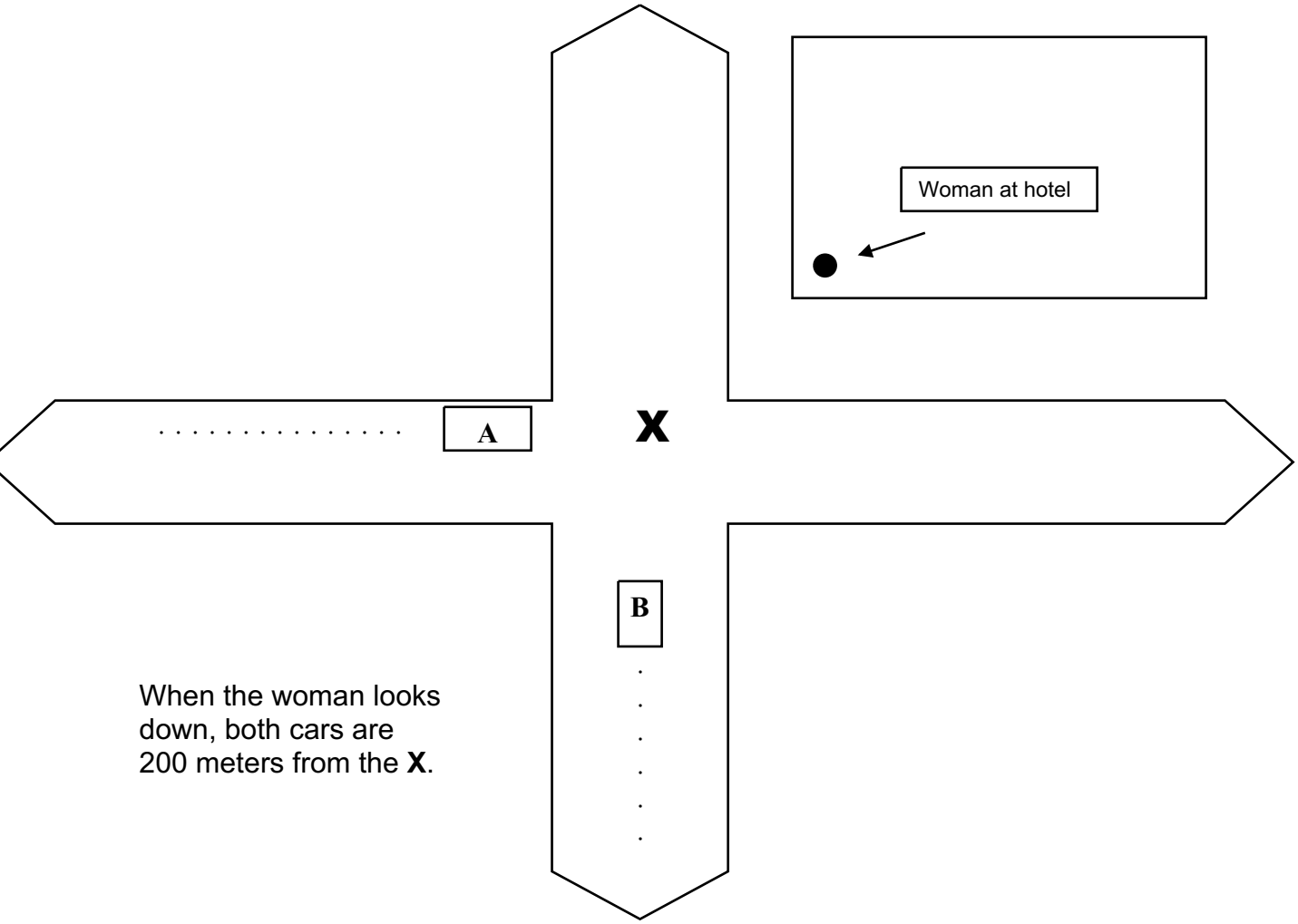
ASSESSMENT—SPEED MEASUREMENT

1. You just saw a new sneaker advertised in a magazine that promises it will “make you run twice as fast as the sneakers you are wearing.” If you are given a pair of the new sneakers and your own sneakers, design an experiment that would test if this statement is true. Be sure to identify exactly what variables you would measure and what results you will get if this is true.



2. Two cars are approaching the intersection of Broad Street and Vine Street from different directions. Each car is dripping oil from the rear exhaust pipe at one drop each second.

There is a high-rise hotel at this intersection, and a woman on the top floor looks down on the street below. She sees the following on the street below:



When the woman looks down, both cars are 200 meters from the **X**.

1. Which car will go over the X mark first? Explain your reasoning in terms of the woman's observations

RUBRIC FOR ASSESSMENT—SPEED MEASUREMENT

1. You just saw a new sneaker advertised in a magazine that promises it will "make you run twice as fast as the sneakers you are wearing." If you are given a pair of the new sneakers and your own sneakers, design an experiment that would test if this statement is true. Be sure to identify exactly what variables you would measure and what results you will get if this is true.

This item measures the student's ability to describe how to measure speed in a real situation, incorporating experimental design, distance measurement, and time measurement.

Criteria for a complete response (2):

Student designs an experiment that involves the following:

- Measurement of the distance run by a person wearing each type of sneaker in a given time period **or**
- Measurement of the time needed to run a given distance.

For the first criterion, the new sneaker must enable the wearer to run twice the distance as the old sneaker. For the second criterion, the new sneaker must enable the wearer to run the distance in half the time as the other sneaker.

Criteria for a partial response (1):

Student designs an experiment according to the criteria above but does not identify the expected results.

Criteria for an incorrect response (0):

Student designs an experiment that measures only distance or time but does not explain the need to keep the other variable constant, with or without identifying expected results.

2. Which car will go over the X mark first? Explain your reasoning in terms of the woman's observations

.

This item measures the student's ability to interpret graphical data (dot patterns) to predict relative speeds of moving objects and use these interpretations to predict possible events.

Criteria for a complete response (2):

Student states that car B will go through the intersection first. Since the dots are spaced further apart than those of car A, car B is moving faster. Therefore, it will travel the same distance as car A in less time.

Criteria for a partial response (1):

Student states that car B will go through the intersection first. Student explains that car B is going faster, but does not give evidence for this.

Criteria for an incorrect response (0):

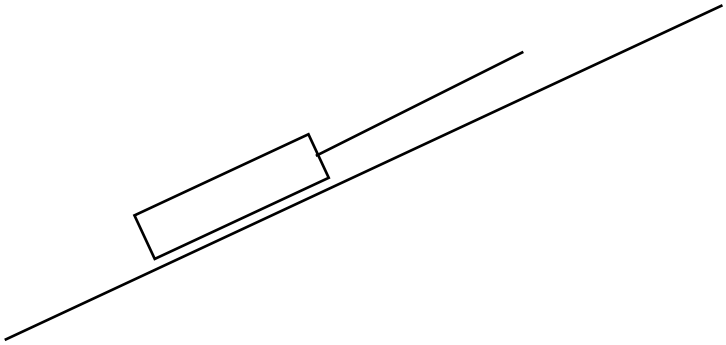
Student states that car B will go through the intersection first, but gives no explanation, or gives an incorrect explanation (e.g. that car B is closer to the X) **or** states that car A will go through first (with or without an explanation) **or** that the cars will collide (with or without an explanation).

ASSESSMENT—GRAVITY AND OTHER FORCES

1. When astronauts walked on the moon, they discovered that their weight on the moon was less than their weight on Earth. Explain.

2. If you were to drop an entire deck of loose playing cards from a table (“52-pickup”), it would take more time for all of the cards to hit the floor than if you dropped the whole deck packed together with a rubber band. Explain why.

3. Make a force diagram <u>of a block</u> being pulled by a string up a ramp. Use arrows to indicate each force, and give the name of each force.



RUBRIC FOR ASSESSMENT—GRAVITY

1. When astronauts walked on the moon, they discovered that their weight on the moon was less than their weight on Earth. Explain.

This item measures a student's understanding that gravity is a force that depends on the mass of the objects involved.

Criteria for a complete response (2):

Student states that the moon has a smaller mass than Earth. Therefore the force of gravity of any object on the moon will be less than the force of gravity on Earth.

Criteria for a partial response (1):

Student states that all objects on the moon weigh less than they do on Earth, but doesn't explain why.

Criteria for an incorrect response (0):

Student states that the object loses matter on the trip to the moon **or** that objects weigh less on the moon because the moon has no atmosphere (in fact, there is no atmosphere because there is less gravity on the moon).

2. If you were to drop an entire deck of loose playing cards from a table ("52-pickup"), it would take more time for all of the cards to hit the floor than if you dropped the whole deck packed together with a rubber band. Explain why.

This item measures the student's understanding that air exerts a force on a falling object that acts in the opposite direction of motion.

Criteria for a complete response (2):

Student explains that falling objects are affected by the force of gravity (pulling them down) and the force of air resistance (pushing them up). If the mass of the object is low (as it is with each card in the first situation), the two forces are close enough that air resistance will cause the object to fall more slowly than it would with a more massive object (the bundled pack of cards). In the second situation, the force of gravity is much greater than the force of air resistance, so the pack falls faster.

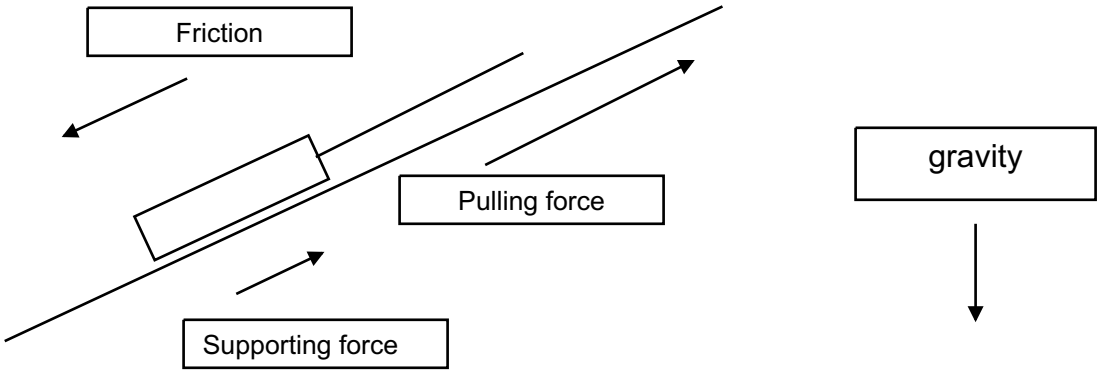
Criteria for a partial response (1):

Student explains that the pack of cards is more massive than each individual card, but does not mention the forces acting on the cards.

Criteria for an incorrect response (0):

Student explains that in the first situation there are fewer cards than in the second **or** that friction causes the individual cards to fall slower.

3. Make a force diagram <u>of a block</u> being pulled by a string up a ramp. Use arrows to indicate each force, and give the name of each force.



This item measures the student's ability to identify forces acting on a moving object.

Criteria for a complete response (2):

Student identifies all four forces, including the directions of each.

Criteria for a partial response (1):

Student identifies all four forces, but indicates incorrect directions **or** only identifies three of the forces (with correct directions).

Criteria for an incorrect response (0):

Student identifies fewer than three of the forces with correct directions.

FEBRUARY

Topic 11. Levers

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2 Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

3.1.2 Mechanical energy comes from the motion (kinetic energy) and position (potential energy) of objects. Gravitational potential energy and elastic potential energy are important forms of potential energy that contribute to the mechanical energy of objects.

3.2.1 When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

3.2.3 Forces can be used to transfer energy from one object to another. Simple machines are used to transfer energy in order to simplify difficult tasks.

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.b Design and conduct investigations with controlled variables to test hypotheses.

6.3.k Conduct investigations to describe how the relative directions of forces simultaneously acting on an object (reinforce or cancel each other) will determine how strongly the combination of these forces influences the motion of the object.

6.3.n Conduct investigations using simple machines to demonstrate how forces transfer energy. Explain that simple machine may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred by the simple machine is equal to the amount of energy transferred to the simple machine.

6.3.o Explain that the transfer of energy from one object to another is caused by the exertion of a force. Use the size of the force and the distance over which the force acts to compare how much energy is transferred into a simple machine to how much energy is transferred out of a simple machine.

6.3.p Design a device that relies on the directional and/or mechanical advantage of a simple machine to perform a task (e.g., lift a weight, move a heavy object). Identify the forces and motions involved, the source of the energy used to complete the task, and how the energy is used by the simple machine.

Assessments:

12. Levers

Vocabulary:

effort force: For a simple machine, the force that is exerted on the machine.

first class lever: A lever in which the fulcrum is located between the effort force and the resistance force. The two forces act in opposite directions.

fulcrum: The point of a lever around which the forces pivot.

lever: A simple machine that works by moving a beam around a pivot point. Levers can be used to lift, to crush, or to move objects large distances.

machine: Any device that makes work easier. Machines do not reduce the amount of work done.

mechanical advantage: The number of times a machine magnifies effort force.

Newton: A unit of force equal to one kg-m/sec^2. Weight can be expressed as newtons; one pound is approximately 21.5 newtons (abbreviated N).

pivot: To rotate around a point while standing on it.

resistance force (load force): The force needed to move an object. A machine can reduce this force by increasing the distance over which the force is exerted.

second class lever: A lever in which the resistance force is located between the fulcrum and the effort force. Second class levers are used to lift very heavy objects (e.g. a wheelbarrow) or to crush (e.g. a nutcracker).

simple machine: A machine which makes work easier with only one effort force.

third class lever: A lever in which the effort distance is located between the fulcrum and the resistance force. Third class levers do not reduce resistance force; rather, they increase the resistance distance. Third class levers are generally used as an extension of body parts (indeed, arms, legs, and fingers often act as third class levers).

Suggested Activities:

Activity 1: Getting Some Leverage on Simple Machines
Activity 2: Levers Move the World
Activity 3: Other Lever Systems

GOALS: In these lab activities, students will

- Identify the effort force, the fulcrum, and the resistance force in a simple lever system.
- Recognize that the placement of the effort force, the fulcrum, and the resistance force will affect the effectiveness of the lever system.
- Identify the effort force, the fulcrum, and the resistance force in a simple lever system.
- Investigate the effect of lengthening the effort arm on the effort force and the mechanical advantage of a lever system.
- Collect data and draw conclusions about the collected data.
- Investigate the effort force & effort distance relationship.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

These activities introduce students to one of the most common simple machines – the lever. In the first part they look at how levers are useful, sometimes even essential, in accomplishing a task that we may encounter in our everyday life. In the second part of the lesson, levers are used to lift a large object, such as a teacher, off of the ground. Then, students investigate levers in a more quantitative manner. The placement of the effort force are varied during the investigation and the resulting effect on the amount of effort force exerted to complete the task will be quantified. The distance traveled by the effort force during the completion of the task is also quantified. The force – distance relationship are revisited during this activity. Finally, students investigate placement of the fulcrum, effort force, and resistance force in other lever systems. They investigate how these types of levers make work easier without necessarily increasing mechanical advantage. Students look at real life examples of all three classes of levers.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

In the previous section, students were introduced to forces as actions that change motion. In this section, that forces act over a distance, and the way to overcome one force may be to use another force. The final activity illustrates that a simple machine may not necessarily increase mechanical advantage to make work easier. This provides a good transition to the next section on pulleys.

Topic 12: Pulleys

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2 Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

3.1.2 Mechanical energy comes from the motion (kinetic energy) and position (potential energy) of objects. Gravitational potential energy and elastic potential energy are important forms of potential energy that contribute to the mechanical energy of objects.

3.2.1 When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

3.2.2 Forces can be used to transfer energy from one object to another. Simple machines are used to transfer energy in order to simplify difficult tasks.

3.3.1 Energy can be transformed from one form into another. Energy transformations often take place while energy is being transferred to another object or substance. Energy transformations and energy transfers can be used to explain how energy flows through a physical system (e.g., photosynthesis, weathering, electrical circuits).

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.b Design and conduct investigations with controlled variables to test hypotheses.

6.3.k Conduct investigations to describe how the relative directions of forces simultaneously acting on an object (reinforce or cancel each other) will determine how strongly the combination of these forces influences the motion of the object.

6.3.n Conduct investigations using simple machines to demonstrate how forces transfer energy. Explain that simple machine may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred by the simple machine is equal to the amount of energy transferred to the simple machine.

6.3.o Explain that the transfer of energy from one object to another is caused by the exertion of a force. Use the size of the force and the distance over which the force acts to compare how much energy is transferred into a simple machine to how much energy is transferred out of a simple machine.

6.3.p Design a device that relies on the directional and/or mechanical advantage of a simple machine to perform a task (e.g., lift a weight, move a heavy object). Identify the forces and motions involved, the source of the energy used to complete the task, and how the energy is used by the simple machine.

Assessments:

13. Pulleys

Vocabulary:

pulley: A simple machine in which a rope winds around a wheel. A pulley generally provides a directional advantage to make work easier, but some also increase mechanical advantage.

single fixed pulley: A pulley system in which the wheel is attached to a fixed support. The pulley does not move with the object being lifted.

directional advantage: A situation in which a simple machine works by changing the direction of the effort force so that the force is exerted in the same direction as gravitational force. The effort force may be equal to the resistance force.

single moveable pulley: A pulley system in which the wheel moves with the object being lifted. Single moveable pulleys increase the mechanical advantage.

Suggested Activities:

Activity 4: Pulleys

GOALS: In this lab activity, students will

- Identify the effort force, the pulley (as either fixed or moveable), and the resistance force in pulley systems.
- Investigate the effect of using fixed and moveable pulleys on the effort force, effort distance, and the mechanical advantage of a pulley system.
- Distinguish between a mechanical advantage and a directional advantage.
- Collect data and draw conclusions about the collected data.
- Investigate the effort force & effort distance relationship in pulleys.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

In this activity we move from the lever to another common simple machine – the pulley. Single and double pulley systems will be investigated in this lesson. Different pulley systems will be discussed in terms of the advantages that they provide to the user and the disadvantages that they also carry with them. Data will be taken during the activity for effort force and for effort distance.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

This activity introduces a different kind of simple machine; the pulley. Like a lever, a pulley makes work easier by increasing the distance over which the work is done. This activity further develops the concept of directional advantage. The idea is that even if a simple machine does not magnify the effort force, it may confer an advantage by changing the direction of the effort force. This activity also sets the stage to introduce the concept that simple machines do not change the total work being done.

Topic 13: Force and Distance Relationships

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2 Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

3.1.2 Mechanical energy comes from the motion (kinetic energy) and position (potential energy) of objects. Gravitational potential energy and elastic potential energy are important forms of potential energy that contribute to the mechanical energy of objects.

3.2.1 When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

3.2.2 Forces can be used to transfer energy from one object to another. Simple machines are used to transfer energy in order to simplify difficult tasks.

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.b Design and conduct investigations with controlled variables to test hypotheses.

6.3.k Conduct investigations to describe how the relative directions of forces simultaneously acting on an object (reinforce or cancel each other) will determine how strongly the combination of these forces influences the motion of the object.

6.3.n Conduct investigations using simple machines to demonstrate how forces transfer energy. Explain that simple machine may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred by the simple machine is equal to the amount of energy transferred to the simple machine.

6.3.o Explain that the transfer of energy from one object to another is caused by the exertion of a force. Use the size of the force and the distance over which the force acts to compare how much energy is transferred into a simple machine to how much energy is transferred out of a simple machine.

6.3.p Design a device that relies on the directional and/or mechanical advantage of a simple machine to perform a task (e.g., lift a weight, move a heavy object). Identify the forces and motions involved, the source of the energy used to complete the task, and how the energy is used by the simple machine.

Assessments:

14. Force and Distance

Vocabulary:

energy: The measurable quantity that describes changes in matter brought about by forces. Energy as work can be calculated as Force X distance moved.

inclined plane: A simple machine that consists of creating a sloped ramp from one point to another point of higher elevation. The longer the inclined plane, the greater the mechanical advantage. Some variations of the inclined plane include stairs, a screw, and a wedge.

Suggested Activities:

Activity 5: Simple Machines and Energy
Activity 6: Inclined Planes

GOALS: In these lab activities, students will

- Use numerical data to show that an inverse relationship exists between the effort force and the effort distance.
- Recognize that when a simple machine is used, by applying an effort force over a specific effort distance, energy is transferred from the user to the machine to accomplish a task.
- Interpret data from previous activities and draw conclusions about the effort distance, effort force, and the energy transferred during the process.
- Quantify the amount of energy used by a simple machine to accomplish a task.
- Identify the effort force and the effort distance in an inclined plane system.
- Investigate the effect of lengthening the effort distance on the effort force and the mechanical advantage of a lever system.
- Collect data and draw conclusions about the collected data.
- Describe inclined plane systems in terms of the effort force & effort distance relationship and the concept of energy.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

This activity introduces the concept of energy, which is pivotal in the understanding of simple machines. Data taken in previous activities will be used in the analysis of levers and pulleys now in terms of energy. Then, inclined planes, or 'ramps' as they are commonly called, are investigated in terms of effort force and effort distance. Three inclined plane lengths (40 cm, 80 cm, & 120 cm) are compared.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

This activity is pivotal in understanding the key idea behind all of the simple machines – the concept of energy. This activity asks students to reflect back to the lever activities and the pulley activities to make better sense of the data that they collected. They have already recognized the pattern that as the effort force reduces, the effort distance increases and vice versa. This activity tells them why this is so; the reason is that in every case the amount of energy put into the system (lever, pulley, etc.) is exactly the same. The next activity on inclined planes is meant to reinforce this concept.

This section also introduces the students to the notion that energy can be transferred from one object to another object through the action of forces. This concept will be further investigated in grades 7 and 8, setting the stage for the high school where energy is the underlying principle of all of the units of study.

Inclined planes are used as a way to reinforce the concept of energy discussed in the previous activity. The unit then sets the stage for subsequent discussions in energy, primarily the Transformation of Energy unit in 8th grade.

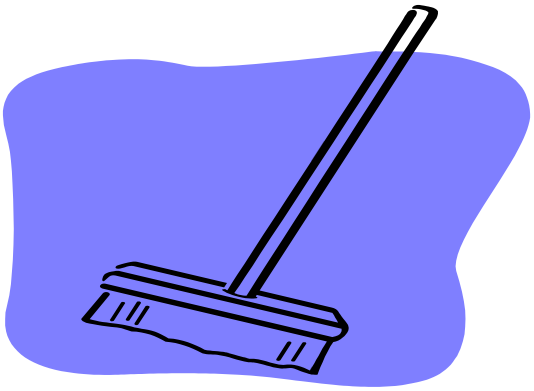
ASSESSMENT—LEVERS

1. A teacher is standing on one end of a beam and a 3rd grade student is standing on the other end. The student has been challenged to lift the teacher. She can place the fulcrum anywhere under the beam to create a lever system to accomplish this task.

Draw where the fulcrum should be placed under the beam to provide the student with the **greatest** mechanical advantage. Explain why your placement of the fulcrum makes the task easier.

2. A broom is an example of a third class lever. Like all third class levers, a broom does not make work easier by increasing mechanical advantage.

On the broom below, identify the locations (approximate) of the fulcrum, the load force, and the effort force. Then, explain how the broom makes the task of picking up dirt easier than it would be with a brush.



RUBRIC FOR ASSESSMENT—LEVERS

1. A teacher is standing on one end of a beam and a 3rd grade student is standing on the other end. The student has been challenged to lift the teacher. She can place the fulcrum anywhere under the beam to create a lever system to accomplish this task.

Draw where the fulcrum should be placed under the beam to provide the student with the **greatest** mechanical advantage. Explain why your placement of the fulcrum makes the task easier.

This item measures the student's ability to position a fulcrum to create the maximum mechanical advantage in a lever system and explain their understanding of mechanical advantage in terms of force and distance.

Criteria for a complete response (2):

1. Student identifies the position of the fulcrum as close as possible to the feet of the teacher (within 2 cm for the greatest MA)

2. Student explains that the closer the fulcrum is to the load force, the effort force needed to accomplish the task is decreased. The student may also discuss the relationship between effort distance and load/resistance distance.

Criteria for a partial response (1):

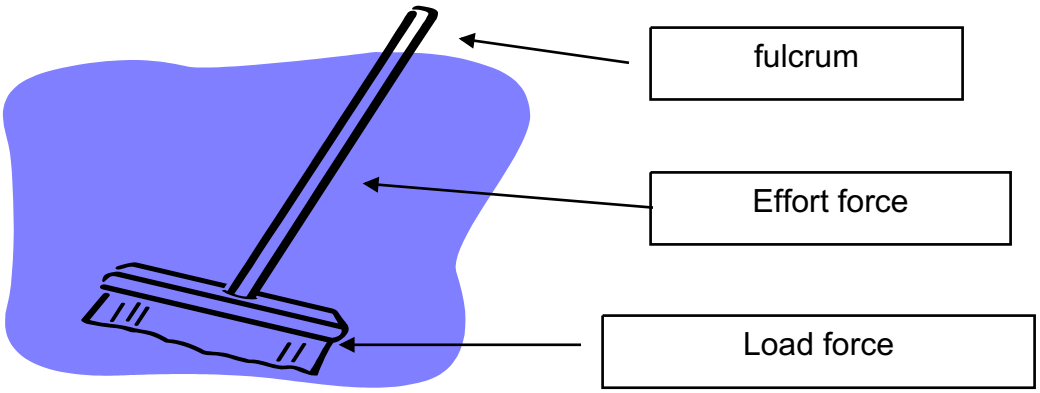
Students has correct placement of fulcrum, but no explanation or an incorrect/incomplete explanation **or** student provides correct explanation but doesn't place fulcrum correctly for the **greatest** mechanical advantage.

Criteria for an incorrect response (0):

Student has an incorrect placement of fulcrum.

2. On the broom below, identify the locations (approximate) of the fulcrum, the load force, and the effort force. Then, explain how the broom makes the task of picking up dirt easier than it would be with a brush.

This item measures a student's understanding of the difference between a first and third class lever, and how a lever can make work easier without increasing mechanical advantage.



Criteria for a complete response (2):

Student correctly identifies the fulcrum, effort force, and load force **and** explains that this machine allows work to be done over a greater distance than with a brush.

Criteria for a partial response (1):

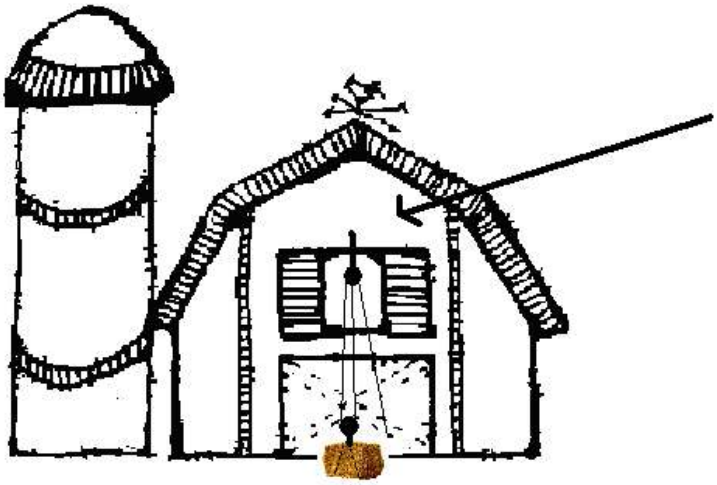
Student correctly identifies the fulcrum, effort force, and load force **or** explains that this machine allows work to be done over a greater distance than with a brush, but not both.

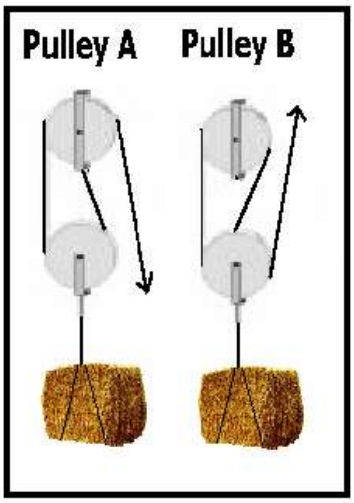
Criteria for an incorrect response (0):

Student has incorrect placement of fulcrum, effort force, and load force **and** does not correctly explain how a broom makes work easier. The explanation may state that a broom increases mechanical advantage.

ASSESSMENT—PULLEYS

1. Joe and Bob need to move bales of straw up into the loft of the barn for their father. The bales of straw are quite heavy, so they decide to use a system of pulleys similar to what they used in science class. The brothers have two different ideas for possible pulley systems that they could use (Pulley A and Pulley B) to complete this task.





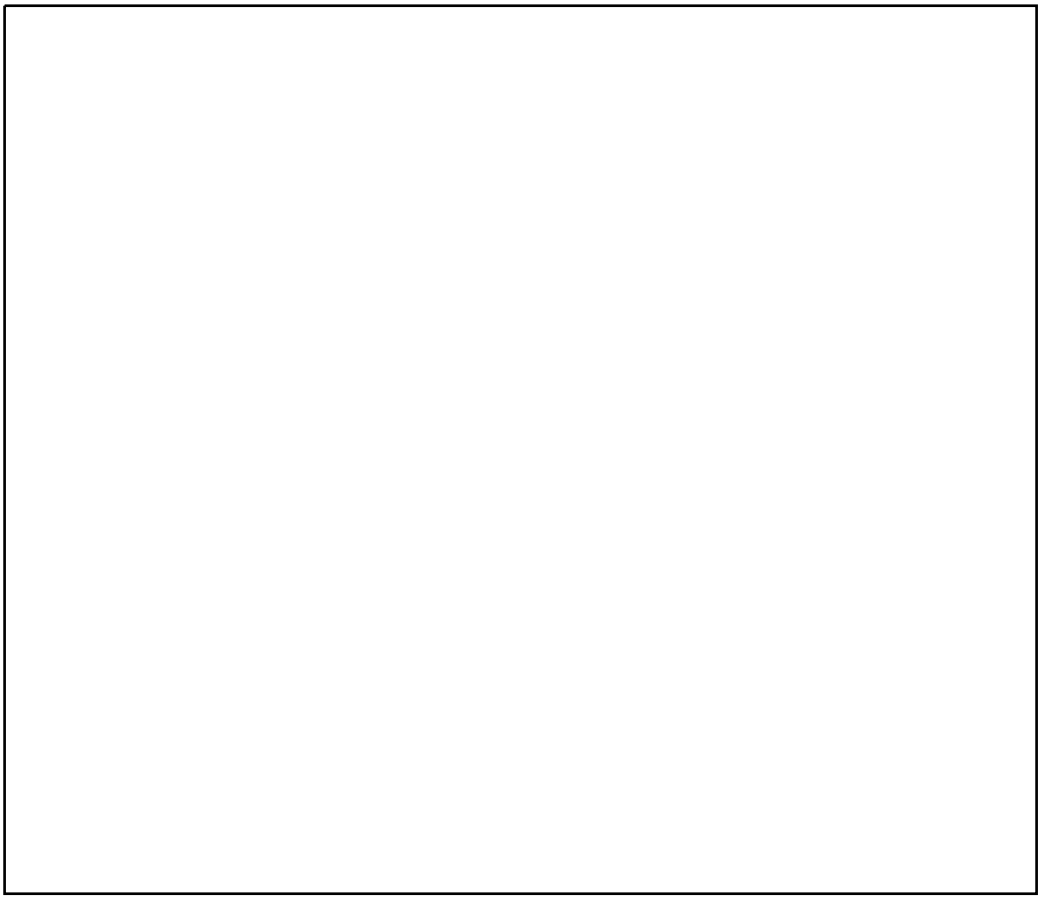
Describe the advantages of using <u>each</u> pulley system to assist the brothers in their decision-making process for this task.

2. Susan conducted a pulley investigation that required her to lift a box of books from the floor to the tabletop using five different pulley systems. The results of her investigation were recorded in the following data table.

DATA TABLE FOR A PULLEY EXPERIMENT

	Pulley System #1	**Pulley System #2**	**Pulley System #3**	**Pulley System #4**	**Pulley System #5**
Effort Force	20 N	10 N	5 N	2 N	1 N
Effort Distance	1 m	2 m	4 m	10 m	20 m
Energy Input					

Susan reviewed the data table and stated that more energy was required to lift the load using pulley system #1 than with any of the other pulley systems. Is Susan correct? Explain your answer, using the ideas of effort force, effort distance, and energy.



RUBRIC FOR ASSESSMENT—PULLEYS

1. Describe the advantages of using each pulley system to assist the brothers in their decision-making process for this task.

This item measures the student's ability to identify the advantages that each pulley system provides.

Criteria for a complete response (2):

Student explains that the pulley system in **Pulley A** provides directional advantage, which allows them to pull down to lift the bale instead of pulling upwards. (The student may also state the Pulley A provides a MA, but that it is not as great as with **Pulley B**).

Student explains that the pulley system in **Pulley B** provides a mechanical advantage because it takes less effort force to lift the bale of straw (as compared to Pulley A).

Criteria for a partial response (1):

Student explains only one pulley system correctly.

Criteria for an incorrect response (0):

Student does not provide an adequate explanation of either method.

2. Susan reviewed the data table and stated that more energy was required to lift the load using pulley system #1 than with any of the other pulley systems. Is Susan correct? Explain your answer, using the ideas of effort force, effort distance, and energy.

This item measures the student's ability to compare sample experimental data to support or refute another student's analysis of the data in terms of force, distance, and energy.

Criteria for a correct response (2):

1. The student states that Susan is incorrect in her analysis of the data.
2. Student states the reason is because all of the pulley systems require the same energy input. (20 units of energy)
3. The student states that as the effort force decreases, the distance that the effort is applied increases. Alternatively, student may state that as effort force increases, effort distance decreases.

Criteria for a partial response (1):

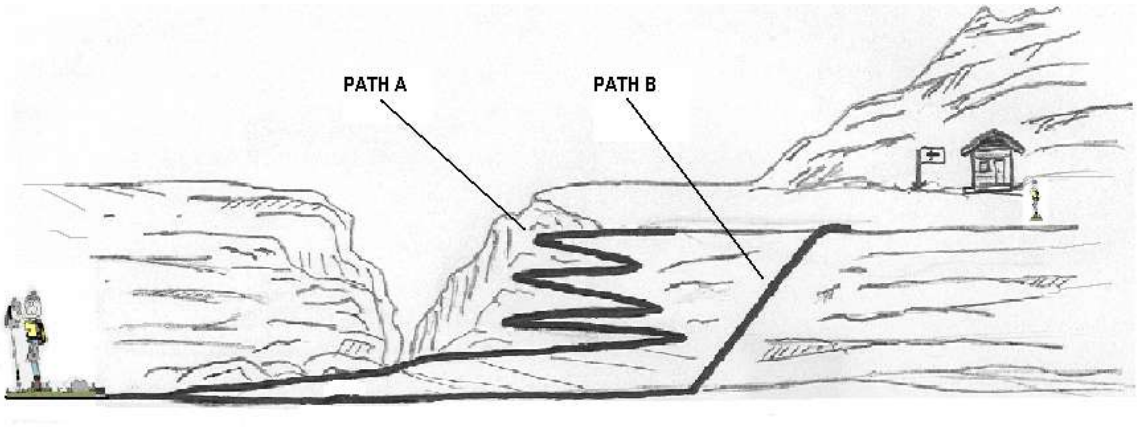
Student only states that all of the energy is the same but omits the force and distance relationship **or** student only states that as the effort force decreases, the distance that the effort is applied increases.

Criteria for an incorrect response (0):

Student states that Susan is correct, with or without an explanation.

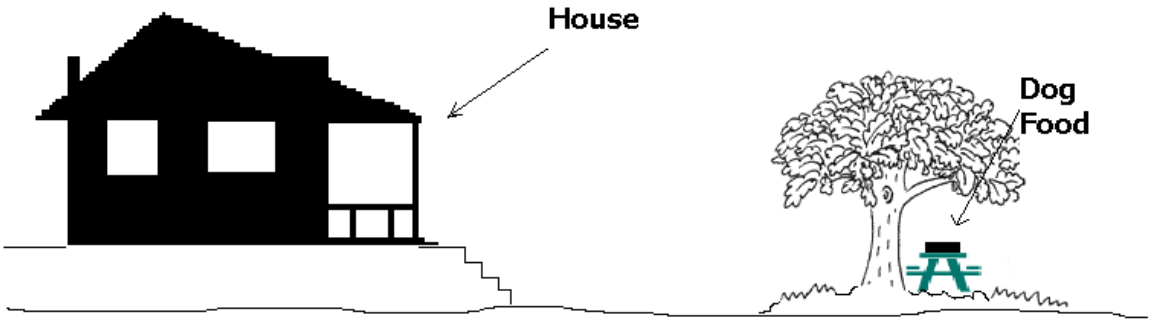
ASSESSMENT—FORCE AND DISTANCE

1. A hiker is at the bottom of a canyon and needs to get to the medical station at the top of the canyon, which is located one mile above the canyon floor. There are two paths (**Path A** and **Path B)** that lead to the top of the canyon. Both paths require the same amount of energy to reach the top of the rim.



The hiker prefers to use path A, saying it is easier than using path B. How is this possible? Explain using the concepts of effort force, effort distance, and energy.

2. A sixth grader returns home from a long day at school to find that her father has left the new dog food bag out on the picnic table. She has to move the 150 pound bag of dog food from the picnic table, across the yard and up the steps to the back porch, without opening the bag, so that it will be safe from the other neighborhood dogs.



Choose <u>at least</u> **two** simple machines to show how the student could accomplish this task. Use the pictures below to help illustrate your solution and then explain in words how your idea will work.

RUBRIC FOR ASSESSMENT—FORCE AND DISTANCE

1. The hiker prefers to use path A, saying it is easier than using path B. How is this possible? Explain using the concepts of effort force, effort distance, and energy.

This item measures the student's ability to compare the force and distance relationship in terms of energy.

Criteria for a complete response (2):

The student explains that Path A zig-zags across the canyon and states that it involves the greatest distance to travel, but requires the least amount of effort force.

Criteria for a partial response (1):

The student explains effort force or effort distance but not both.

Criteria for an incorrect response (0):

The student only refers to the shape of the paths (zig-zag vs steep) but does not refer to force or total distance.

2. Choose at least **two** simple machines to show how the student could accomplish this task. Use the pictures below to help illustrate your solution and then explain in words how your idea will work.

This item measures the student's ability to apply knowledge of simple machines to solve a real-life situation.

Criteria for a complete response (2):

1. Student will provide a reasonable written solution to this problem using at least 2 simple machines. (Wheelbarrow, crowbar, pulley, ramp, etc.)
2. Student provides an illustration as to how the simple machines will complete the task.

Criteria for a partial response (1):

Student provides a correct written explanation **or** a correct illustration but not both.

Criteria for an incorrect response (0):

Student only uses one simple machine in the response **or** student uses devices that are not simple machines (e.g. forklift, crane, etc).

MARCH

Topic 14: Electrical Energy

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.2 Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.

1.1.3 Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

1.1.4 Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

1.1.5 Understand that: Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.

1.1.6 Understand that: Scientific habits of mind and other sources of knowledge and skills are essential to scientific inquiry. Habits of mind include tolerance of ambiguity, skepticism, openness to new ideas, and objectivity. Other knowledge and skills include mathematics, reading, writing, and technology.

1.2.2 Science and technology in society are driven by the following factors: economical, political, cultural, social, and environmental. Increased scientific knowledge and technology create changes that can be beneficial or detrimental to individuals or society through impact on human health and the environment.

3.1.5 Electrical energy is a form of energy that can be transferred by moving charges through a complete circuit.

3.2.8 Electrical systems can be designed to perform a variety of tasks. Series or parallel circuits can be used to transfer electrical energy to devices. Electrical circuits require a complete loop through which the electrical charges can pass.

3.2.9 Moving electric charges produce magnetic fields.

3.3.1 Energy can be transformed from one form into another. Energy transformations often take place while energy is being transferred to another object or substance. Energy transformations and energy transfers can be used to explain how energy flows through a physical system (e.g., photosynthesis, weathering, electrical circuits).

3.4.3 Responsible use of energy requires consideration of energy availability, efficiency of its use, the environmental impact, and possible alternate sources.

GLEs:

6.1.m Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.n Design and conduct investigations with controlled variables to test hypotheses.

6.1.o Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

6.1.p Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

6.1.q Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.

6.1.r Use mathematics, reading, writing, and technology in conducting scientific inquiries.

6.3.a List, as basic forms of energy, light, heat, sound, electrical, and energy of motion.

6.3.b Explain that electrical energy is a form of energy that is transferred through circuits to devices that are designed to make use of this form of energy (e.g., lamps, fans, computers, etc.).

6.3.c Describe the role of electrical charge in circuits by using a model of electrical circuits.

6.3.d Relate that electrical energy carried by charges in a circuit is transferred to devices in the circuit and is usually changed into (transformed) different kinds of energy by these devices (e.g., light bulbs change electrical energy into light and heat energy, motors turn the electrical energy into energy of motion). Trace the flow of energy from electrical energy to other forms of energy, such as light. Express whether energy was transferred, transformed or both.

6.3.e Construct both series and parallel circuits to investigate and describe how multiple devices in series or parallel (bulbs, motors) perform (dim versus bright, fast versus slow). Describe how the way the devices are connected affects the functioning (i.e., dim versus bright) of the device and relate this to how much electrical energy is received.

6.3.q Show how electrical energy carried by currents in wires can be used to create magnetic fields. Demonstrate how these fields exert magnetic forces on permanent magnets. Explain how these magnetic forces in electric motors are used to change the electrical energy into the energy of motion.

6.3.r Compare the differences in power usage in different electrical devices/appliances. Discuss which devices/appliances (i.e., washer, dryer, refrigerator, electric furnace) are manufactured to require less energy. Select one device/appliance, research different brands and their energy usage, determine which would be the better buy, and report on the findings.

Assessments:

15. Electrical Energy

Vocabulary:

battery: A container that transforms chemical energy to electrical energy.

complete circuit (closed circuit): An electric circuit with a continuous connection through electric conductors from an energy source back to the energy source.

conductor (electric): A material that is able to transfer electric charges.

device: Any connection in an electric circuit that uses some of the electrical energy to perform a task but still conducts the charges.

electric charge: A positive or negative influence which may be attractive (if two electric charges are unlike) or repulsive (if two electric charges are the same).

electric circuit: A continuous chain of electric devices, energy sources, and conductors that provide a path for electric energy to flow.

electrical energy: Energy transferred by moving electric charges.

insulator (electric): A material that resists the flow of electricity.

magnetic force: An attractive or repulsive force occurring in certain metals (iron, cobalt, or nickel) that respond to similar forces generated from Earth's center.

motor: A device that transforms electrical energy to mechanical energy.

parallel circuit: An electric circuit which contains devices that provide separate paths to complete a circuit. The devices in a parallel circuit do not depend on one another to complete the circuit.

repel: Push away.

series circuit: An electric circuit which contains devices that form a single path to complete the circuit. Devices in a series circuit depend on one another to complete the circuit—if one of these is disabled, the circuit is incomplete.

static electricity: Electric charges that are transferred as a single event (as opposed to transfer through a circuit).

switch: A device in an electric circuit that can close or open the circuit as desired.

Suggested Activities:

Activity 1: A Review of Simple Circuits (optional)
Activity 2: Electric Charge, Electric Forces, and Electric Circuits
Activity 3: Investigating Series and Parallel Circuits

GOALS: In these lab activities, students will

- Review and describe basic electric circuits and their components (series and parallel).
- Create an electric circuit diagram and then construct the actual circuit depicted in the diagram.
- Make qualitative observations regarding the behavior of circuits.
- Learn about electric charges and the forces they exert on each other.
- Learn that electric forces can be used to attract or repel charges and can be used to make charges move.
- Investigate batteries more carefully to see why they are important elements of an electric circuit.
- Learn that there is a difference between electric charge and electric energy
- Use a model and animations to learn how electric circuits work.
- Practice drawing and building a variety of circuits that contain two or three devices.
- Use energy concepts to make qualitative predictions about the performance of light bulbs and motors in series and parallel circuits.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

Students will learn about a model that will help us understand how electrical energy reaches these devices. The model will help them make predictions of how light bulbs and motors will perform in a variety of circuits.

Then, electric circuits will be investigated in greater detail. Electric charge will be described and the forces that charges exert on each other will be investigated. A model will be used to explain the importance of electric charge, batteries and electrical energy in circuits.

Finally, students will investigate the properties of series and parallel circuits. They will make predictions about the performance of light bulbs in both types of circuits. The students will build a variety of circuits and test their predictions by using the brightness of the light bulbs as a quantitative measure of how much electrical energy is being delivered to the bulbs. Students will then be asked to analyze more complicated circuits and test their understanding by building these circuits and observing the performance of light bulbs and electric motors.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

The first activity is a review of the circuit activities most students completed in the 4th grade. Students learn that only complete circuits work. They conclude through observations that the performance of light bulbs depends on how they are added to a circuit. This activity is designed to replicate those goals, and nothing more. In the next activity students are introduced to electric charge, electric forces and electrical energy. They are taught a model used to understand the behavior of different electric circuits. In the third activity the students will apply their understanding of the flow of electric charges and electrical energy to analyze a variety of circuits. Students are asked to predict the performance of light bulbs and motors in a variety of circuits. They apply the model of electric circuits to make these predictions and then build the circuits and observe the performance of the bulbs and motors.

Topic 15: Observation and Inference

Standards:

1.1.1 Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.

1.1.4 Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.

GLEs:

6.1.a Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.

6.1.d Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

Assessments:

This topic is assessed with Topic 16: Sedimentary Rock Layers

Vocabulary:

canyon: A V-shaped valley eroded by a river.

composition: The way the parts or elements of something are put together.

floodplain: The flat land that surrounds a stream and becomes submerged when the stream overflows its bank.

formation: A group of rock layers composed mostly of the same rock type or combination of rock types recognizable from one place to another.

outcrop: The part of a body of rock that is exposed at Earth's surface.

plain: A nearly level area that has been eroded or where material has been deposited.

plateau: A nearly level area that has been uplifted.

Suggested Activities:

Investigation 1: Pushing the Envelope (optional)
Investigation 2: Into the Grand Canyon

GOALS: In these lab activities, students will

- Make observations and generate evidence to support an idea.
- Make inferences based on evidence.
- Use photographic and video images of rocks and landforms to gather data about the Grand Canyon.
- Observe, describe, and compare rocks using appropriate tools.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

In these activities, students record their observations of several postmarked envelopes. They use the evidence to make inferences about the envelopes, origins, travels, and destinations. They consider how the processes of observation and making inferences contribute to answering questions. Then, students observe and compare photos and rocks from the Grand Canyon and begin to generate questions about what they observe. They read excerpts from John Wesley Powell's diary to learn about the contemporary history of the canyon.

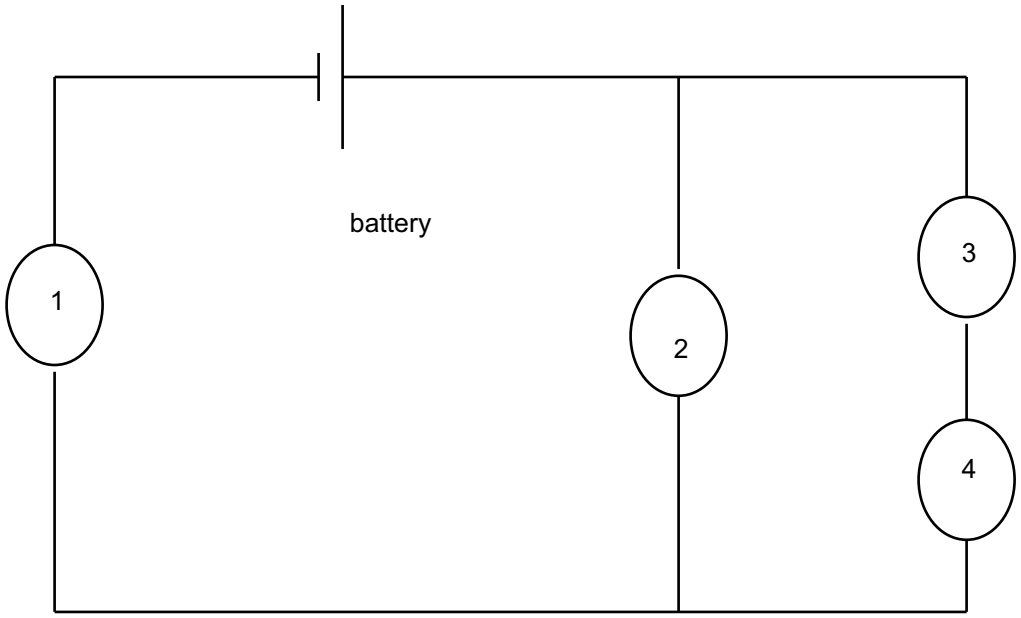
CONTEXT: The role that this activity plays in the concept development can be explained as follows:

Activity 1 is a review of concepts and activities from My Body and Me. If students have mastered the distinction between observation and inference, this activity may be omitted. Activity 2 serves as a good introduction to the history and geology of the Grand Canyon. Since many of the students (and teachers) may never have been to the Grand Canyon, these activities are recommended to introduce the final unit of sixth grade.

ASSESSMENT—ELECTRICITY

1. A student found some batteries in a drawer and stored them in a bag full of metal paper clips. Within an hour, the bag became extremely hot. Explain why.

2. In the following circuit diagram, describe what would happen to all the other bulbs in the circuit if bulb 3 were unscrewed. Explain your answer in terms of the energy being delivered in the circuit.



RUBRIC FOR ASSESSMENT—ELECTRICITY

1. A student found some batteries in a drawer and stored them in a bag full of metal paper clips. Within an hour, the bag became extremely hot. Explain why.

This item measures the student's understanding that electrical energy is transformed to heat energy, and that electricity will flow if a circuit is complete.

Criteria for a complete response (2):

Student states that the paper clips must have created a complete circuit with the battery. This allowed electrical energy to flow. Since there were no devices in the circuit, the electrical energy was transformed to heat energy. This could have created a dangerous situation.

Criteria for a partial response (1):

Student explains that a short circuit is formed but does not explain the transformation to heat energy.

Criteria for an incorrect response (0):

Student states that the bag became hot because the paper clips punctured the battery.

2. In the following circuit diagram, describe what would happen to all the other bulbs in the circuit if bulb 3 were unscrewed. Explain your answer in terms of the energy being delivered in the circuit.

This item measures the student's understanding of how energy is transferred and delivered in a series and parallel circuit.

Criteria for a complete response (2):

Student explains that bulb 4 will go out, but bulbs 1 and 2 will be unaffected. The reason is that bulbs 3 and 4 are connected in series, so the energy that 4 received had to pass through 3 first. Bulbs 1 and 2 are connected in parallel to each other and to the series bulbs (3 and 4). They receive the same amount of electrical energy and together form a complete circuit to the battery.

Criteria for a partial response (1):

Student explains the outcome for bulb 4 **or** the outcome for bulbs 1 and 2, but not both.

Criteria for an incorrect response (0):

Student gives incorrect outcomes, with or without an explanation.

APRIL

Topic 16: Sedimentary Rock Layers

Standards:

5.1.3 The formation of sediment and soil requires a long period of time as rocks are weathered, eroded and deposited.

5.2.2. Water within a watershed travels over and through the land at various speeds based on the rate of change in elevation and the permeability and porosity of the soil. Water carries with it products of human activity.

5.2.3. Surface water always flows downhill. Areas of higher elevation separate watersheds. In Delaware, this water eventually reaches the Delaware River, the Delaware Bay, the Atlantic Ocean or the Chesapeake Bay.

5.2.4 Constructive processes that build up the land and the destructive processes of weathering and erosion shape and reshape the land surface. The height of Earth landforms is a result of the difference between the rate of uplift and the rate of erosion at a particular location.

5.2.11 Past geological events and environments can be reconstructed by interpreting fossilized remains and successive layering of sedimentary rocks.

GLEs:

6.5.c Investigate and describe how factors such as abrasion, frost/ice wedging, temperature changes, and plant growth cause physical weathering of rocks. Infer the environment in which the sedimentary particles were formed based on the results of weathering.

6.5.d Investigate how weathered materials are transported (i.e., mass movement and wind, water, and ice processes) in the process of erosion. Explain how erosion shapes rock particles.

6.5.e Describe the process by which eroded materials can form horizontal layers of sedimentary rock.

6.5.f Explain how sedimentary rocks are formed through the processes of weathering, erosion, and deposition.

Assessments:

16. Sedimentary Rock Layers

Vocabulary:

Chalk: A type of limestone; a powdery, fine-grained rock composed of almost pure calcite.

Correlate: To determine if two or more rocks or rock layers separated by a distance are the same.

Frosted: Having a rough, pitted appearance resulting from impacts. Sand grains blown by the wind are usually frosted because they bang into each other.

Layer: A thickness or bed of rock.

Limestone: A sedimentary rock formed from calcium carbonate. Limestone may crystallize when a lake evaporates or it may be formed from the fossil remains of bones or mollusk shells.

Reef limestone: A rock formation formed in warm shallow seas. Reef limestones are composed of the skeletons of marine organisms.

Sandstone: A sedimentary rock formed by cementing grains of sand over time.

Shale: A sedimentary rock formed from mud being deposited and compressed over time. Shale, like limestone, may contain fossils.

Strata**:** Layers (or beds) of sedimentary rocks.

Superposition: A geological principle that states that layers of sedimentary rocks are formed on top of older layers.

Suggested Activities:

Investigation 3: Grand Canyon Rocks
Investigation 4: My Sediments Exactly
Investigation 5: Limestone

GOALS: In these lab activities, students will

- Identify and name three sedimentary rocks: sandstone, shale, and limestone.
- Use acid to test for the presence of calcium carbonate in a rock sample.
- Correlate the rocks from two locations along the Colorado River.
- Investigate how sand can be made from larger rocks.
- Model the formation of layers of sandstone and shale in an ancient environment.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

Students observe and compare photographs and rocks exposed at two locations in the Grand Canyon. They correlate similar rocks at the two sites. Then, they make sand and compare it to other sand samples. They make sandstone in a basin, observe shale, and add a layer of shale to their basins. Finally, students observe limestone and create calcium carbonate by blowing into limewater. They observe fossils from the Grand Canyon and use this information to interpret the sequence of enironments that existed in that region in the past.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

These activities emphasize the idea of superposition; that "the present is the key to the past." The skill of drawing inference from observation is employed to correlate rock layers. Analysis of sandstone, shale, and limestone allows the students to employ inquiry skills to solving an identification problem.

This unit may be challenging because students are asked to envision millions of years in Earth's past. This is a leap into abstract thinking.

Topic 17: Weathering and Erosion

Standards:

5.1.2 The movement of water among the geosphere, hydrosphere and atmosphere affects such things as weather systems, ocean currents, and global climate.

5.1.3 The formation of sediment and soil requires a long period of time as rocks are weathered, eroded and deposited.

5.1.4 The atmosphere is a mixture having as its principal components a fixed ratio of nitrogen and oxygen and, depending on the location, variable amounts of carbon dioxide, water vapor, and dust particles.

5.2.3 Surface water always flows downhill. Areas of higher elevation separate watersheds. In Delaware, this water eventually reaches the Delaware River, the Delaware Bay, the Atlantic Ocean or the Chesapeake Bay.

5.2.4. Constructive processes that build up the land and the destructive processes of weathering and erosion shape and reshape the land surface. The height of Earth landforms is a result of the difference between the rate of uplift and the rate of erosion at a particular location.

GLEs:

6.5.c Investigate and describe how factors such as abrasion, frost/ice wedging, temperature changes, and plant growth cause physical weathering of rocks. Infer the environment in which the sedimentary particles were formed based on the results of weathering.

6.5.d Investigate how weathered materials are transported (i.e., mass movement and wind, water, and ice processes) in the process of erosion. Explain how erosion shapes rock particles.

6.5.e Describe the process by which eroded materials can form horizontal layers of sedimentary rock.

6.5.f Explain how sedimentary rocks are formed through the processes of weathering, erosion, and deposition.

Assessments:

17. Weathering and Erosion

Vocabulary:

Deposition: The settling out of sediments carried by water, wind or ice to form sedimentary rocks.

Erosion: The removal and transportation of weathered materials by mass wasting and the action of water, wind, and ice.

Weathering: The breaking apart of rock caused either by chemical decomposition of the minerals or by successive freezing and thawing of water in cracks.

Suggested Activities:

Activity 4: My Sediments Exactly

GOALS: In these lab activities, students will

- Relate the processes of weathering, erosion, and deposition to the formation of sedimentary rock and landforms.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

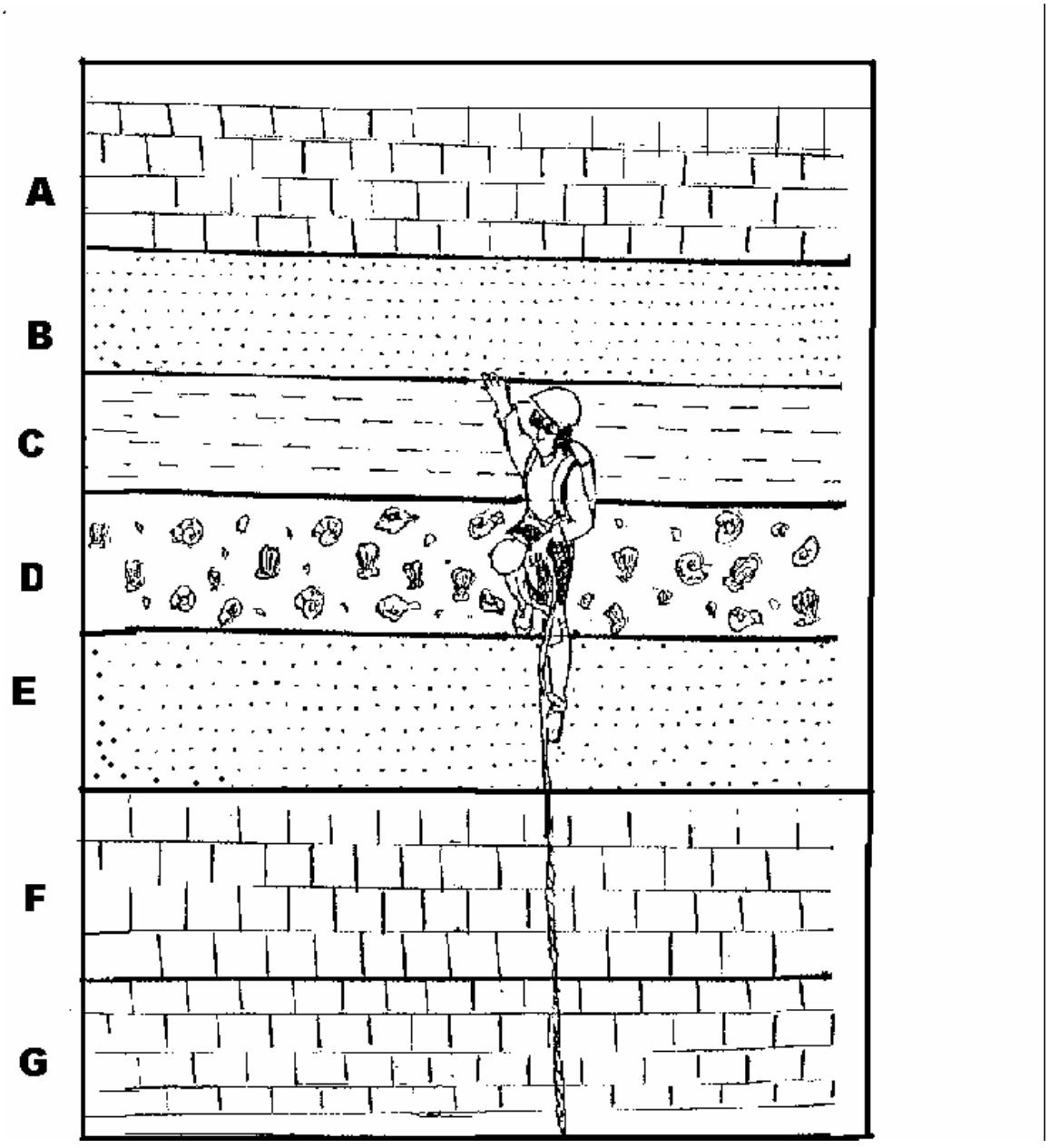
Students investigate the processes of erosion and deposition and how they contribute to the formation of sedimentary rocks. They observe erosion and deposition in a stream table and consider it in relationship to the source material for sandstone.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

This activity brings the earlier information about the age and formation of the Grand Canyon together with the information of how sedimentary rocks form. These concepts will form the basis for the final activities, which address the amount of time Earth has existed and how old rocks really are.

ASSESSMENT—SEDIMENTARY ROCK LAYERS

A mountain climber is climbing up a cliff. On the way up, he notices seashell fossils in one of the rock layers.



1. What can you infer about the environment in which this limestone layer (D) was formed? Explain your inference.

2. Why is the limestone layer (D) no longer on the top surface?

3. Which layer of the cliff is the oldest and which layer is the youngest? Explain how you arrived at your answer.

RUBRIC FOR ASSESSMENT—SEDIMENTARY ROCK LAYERS

1. What can you infer about the environment in which this limestone layer (D) was formed? Explain your inference.

This item measures the student's knowledge that seashell fossils occur in a marine environment or aquatic environment.

Criteria for a complete response (2):

Infers that this layer formed in an aquatic or marine environment because shellfish live in aquatic environments and the fossil would remain where it had died.

Criteria for a partial response (1):

Student states that the layer formed in an aquatic/marine environment but does not explain why.

Criteria for an incorrect response (0):

Student states that sea shells were deposited on a beach **or** states that rock layer formed at sea level **or** states that rock layer was formed on land.

2. Why is the limestone layer (D) no longer on the top surface? Why are no seashells found above layer D?

This item measures the student's understanding of the concept of layering.

Criteria for a complete response (2):

Student explains that different sediment (layers) have been deposited (formed) on top of the seashell layer. No seashells are found above layer D because the environment must have changed.

Criteria for a partial response (1):

Student answers the first question correctly **or** answers the second question correctly but not both.

Criteria for an incorrect response (0):

Student answers both questions incorrectly or incompletely.

3. Which layer of the cliff is the oldest and which layer is the youngest? Explain how you arrived at your answer.

This item measures the student's understanding of layering.

Criteria for a complete response (2):

1. Includes that layer A is the youngest and layer G is the oldest.

2. Includes that rock layers are generally successively deposited one on top of the other. Student may refer to superpositioning, but this term is not required for a complete response.

Criteria for a partial response (1):

Student meets criterion one or criterion two (while omitting criterion one), but not both.

Criteria for an incorrect response (0):

Student identifies layer A (or some other layer) as the oldest with or without an explanation

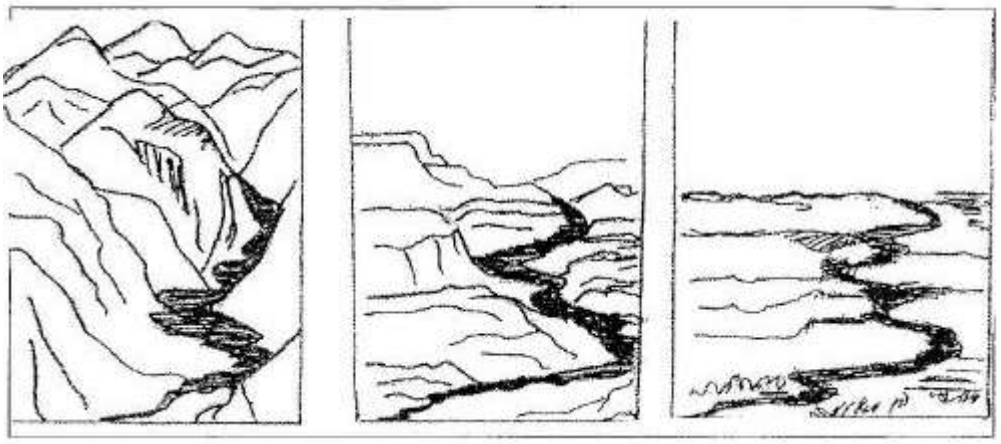
ASSESSMENT—WEATHERING AND EROSION

1. Using the tools provided, observe the three rock samples, A, B, and C.

   One is sandstone, one is shale, and one is limestone. Make a chart to record your observations for each sample; include sample letter, color, texture, fossil evidence and reaction to acid. Identify each sample.

2. Choose a sample of sandstone or shale. What can you infer about the environment in which this sample was formed? Give evidence to support your inference.

3.



The three pictures above show the same land area over a period of time.

Name the processes and describe how each of these processes changed the land surface over time.

RUBRIC FOR ASSESSMENT—WEATHERING AND EROSION

1. Using the tools provided, observe the three rock samples, A, B, and C.

   One is sandstone, one is shale, and one is limestone. Make a chart to record your observations for each sample; include sample letter, color, texture, fossil evidence and reaction to acid. Identify each sample.

   This item measures the student's ability to observe and organize data.

Criteria for a complete response (2):

Chart should include: identify A, B, and C, texture, color, fossil evidence and reaction to HCl test. See sample chart below.

Rock Sample	Color	Texture	Fossil Evidence	Reaction to Acid	Identity
7			Ferns	No fizz	Shale
8			None	No fizz	Sandstone
9			Yes/no	fizz	Limestone

Criteria for a partial response (1):

Includes correctly constructed chart with two or less omissions or errors in data **or** descriptions are subjective (e.g. "ugly")

Criteria for an incorrect response (0):

Includes an organized chart with more than two omissions or errors in data **or** omits an organized chart **or** identifications of samples are incorrect.

2. Choose a sample of sandstone or shale. What can you infer about the environment in which this sample was formed? Give evidence to support your inference.

This item measures the student's ability to use data to make a valid inference.

Criteria for a complete response (2):

1. Chooses sandstone and states that the environment might have been a beach, desert or mountain; or chooses shale and states that the environment might have been marsh, swamp or wetlands.

2. Gives evidence (i.e. fine grain, smooth, ferns fossils present, etc.)

Criteria for a partial response (1):

Student identifies sandstone or shale accurately but does not give evidence for the choice.

Criteria for an incorrect response (0):

Identifies incorrect environment for the sample chosen **or** identifies the sample incorrectly with or without an explanation.

3. The three pictures above show the same land area over a period of time.

Name the processes and describe how each of these processes changed the land surface over time.

This item measures the student's understanding of weathering, erosion and deposition in the context of change over time.

Criteria for a complete response (2):

1. Names the three processes (weathering, erosion, and deposition)

2. Describes each of the processes that occur to cause the changes in landforms. (i.e. Over this time period, rock has been broken down by wind or water and the land surface has become more rounded. The weathered material has been carried away by wind or water from the land surface and deposited in another location due to gravity.)

Criteria for a partial response (1):

Describes two of the three processes correctly.

Criteria for an incorrect response (0):

Describes fewer than two of the three processes correctly.

MAY

Topic 18: Time and Plate Tectonics

Standards:

5.2.11 Past geological events and environments can be reconstructed by interpreting fossilized remains and successive layering of sedimentary rocks.

5.2.12 The fit of continental coastlines, the similarity of rock types and fossilized remains provide evidence that today's continents were once a single land mass. The continents moved to their current positions on plates driven by energy from Earth's interior.

GLEs;

6.5.b Examine sedimentary rock formations. Use relative dating and fossil evidence to correlate sedimentary rock sequences. Infer the succession of environmental events that occurred from one rock sequence to another (transgression or regression of the seas). Use the correlated sedimentary rock sequences to support Earth's geologic time scale.

6.5.g Cite three lines of evidence such as the fit of coastlines, the similarity of rock type and contiguousness of bedding areas, and similarity of fossilized remains that indicate that the continents were once a large land mass.

Assessments:

18. Geologic Time

Vocabulary:

absolute age: The exact amount of time since an event occurred or since an object or living being came into existence. Absolute age is measured in standard units of time (usually years).

continental drift: A theory that explains the positions of continents. Continental drift explains that the continents move along the crust on plates and continually change their positions.

eon: The longest period of geologic time.

epoch: A short period of geologic time referring to recent (50 million years to the present day.)

era: A large expanse of geologic time. Three eras are recognized: the Paleozoic era (ancient organisms), the Mesozoic era (dinosaurs), and the Cenozoic era (mammals predominate).

geologic time: A measurement of time based on geologic changes on Earth. Geologic time is usually measured in millions or billions of years.

glacier: A large landform made of ice. Glaciers are a major source of erosion on land.

Pangaea: A proposed supercontinent—the designation of the land mass that existed millions of years ago when all land was joined. Pangaea broke into pieces over geologic time through the process of plate tectonics to create the continents as they exist today.

plate tectonics: A theory that explains why the continents change position over time. Plate tectonic theory explains that the energy within Earth's interior creates convection currents within the mantle. These currents cause uplift in some areas and sinking (subduction) in others. These convection currents act as a sort of conveyer belt for the plates of Earth's crust, and as a result, the continents move.

relative age: The amount of time since an event occurred as measured by the sequence of several events.

time line: A graphic organizer which places several events in sequence from oldest to most recent.

Suggested Activities:

Investigation 6: It's About Time
Investigation 7 part 3 (from Science Coalition) Plate Tectonics

GOALS: In these lab activities, students will

- Create a personal time line of some period in their lives.
- Construct a time line of geological events and prehistoric life.
- Apply the concept of a time line to Earth history.
- Determine the relative age of rocks, based on association with other rocks.
- Cite three pieces of evidence that indicate the continents were once a large land mass.

ACTIVITY OVERVIEW: A synopsis of these lessons follows:

Students construct personal time lines to record their own history. They expand their understanding of time lines to construct geological time lines and begin to grapple with the large numbers that represent geological time. Then, students use a diagram of the continents with symbols representing fossil remains and rock types to reconstruct the possible shape of Pangaea.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

These activities illustrate how geologic time is an unimaginably long period. This concept is important for this unit because students don't always realize that our observations are made on incomplete information. This idea of forming a theory to explain what we observe is reinforced each year in science through middle school and high school.

Topic 19: Fossils

Standards:

5.2.11 Past geological events and environments can be reconstructed by interpreting fossilized remains and successive layering of sedimentary rocks.

5.2.12 The fit of continental coastlines, the similarity of rock types and fossilized remains provide evidence that today's continents were once a single land mass. The continents moved to their current positions on plates driven by energy from Earth's interior.

GLEs;

6.5.g Cite three lines of evidence such as the fit of coastlines, the similarity of rock type and contiguousness of bedding areas, and similarity of fossilized remains that indicate that the continents were once a large land mass.

Assessments:

19. Fossils

Vocabulary:

amber: A resin which hardens into a clear yellow material. Many insects have been fossilized by being preserved in amber.

calcite: A mineral form of calcium carbonate. Calcite is deposited from bones and shells of animals.

fossil record: A time line of fossils that have been found based on the time period when they were fist deposited.

fossil: Any remains, trace, or imprint of an organism preserved in rock; any evidence of past life.

index fossil: A fossil that is found over a relatively short span of geological time and can be used in dating formations.

mineralization: The process of replacing body fluids of carcasses with minerals like calcium carbonate. Mineralization is an important step iin fossilization.

paleontology/paleontologist: A scientist who studies fossils to learn about prehistoric life.

Suggested Activities:

Investigation 7: Fossils and Time

GOALS: In these lab activities, students will

- Use index fossils to correlate rock layers in three locations on the Colorado Plateau.
- Compare various events and fossils to derive a succession of animals over geologic time.
- Make inferences from fossil evidence that contribute to an understanding of fossil succession.

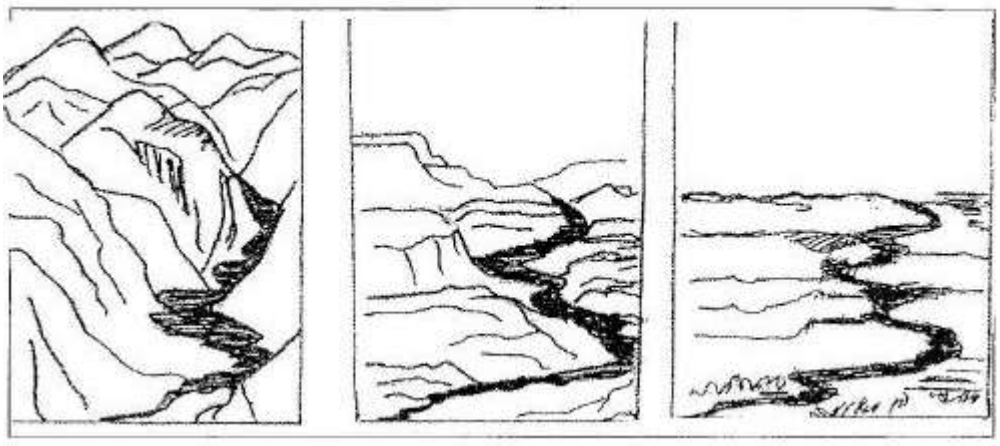
ACTIVITY OVERVIEW: A synopsis of these lessons follows:

Students use index fossils to reconstruct Earth's past environments. They use the fossils to put layers of rocks from three locations on the Colorado Plateau into relative-age sequence. Then, students sequence thirty major events in the history of Earth.

CONTEXT: The role that this activity plays in the concept development can be explained as follows:

The study of fossils provides the final piece to the exploration of Earth's history. Students have probably heard of fossils through their experiences, but they haven't been taught how fossils form, what animals can and cannot produce fossils, or how fossils are used to study Earth's history. This is a suitable unit to complete the sixth grade year because in seventh grade, students begin science with Diversity of Life. Here, they learn about how living things are classified and can revisit concepts from this unit.

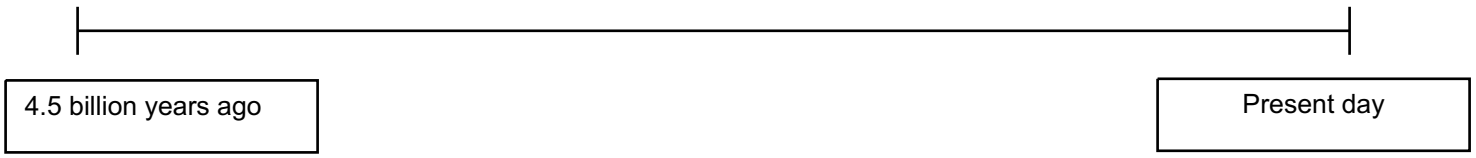
ASSESSMENT—GEOLOGIC TIME



1. The three pictures above show the same land area over a period of time.

Predict what this same area of land will look like 10 million years in the future. Describe in words what the land area would look like. Explain your reasoning. You may make a labeled drawing with your description.

2. Below is a geologic timeline. Place an "**X**" on the timeline showing where a geologist would place the **appearance of Humans**. Explain why you placed your "X" where you did.



3. Rocks with scratch marks from glaciers have been found in regions with very warm climates. Use the theory of continental drift or plate tectonics to explain how this is possible.

RUBRIC FOR ASSESSMENT—GEOLOGIC TIME

1. The three pictures above show the same land area over a period of time.

Predict what this same area of land will look like 10 million years in the future.
Describe in words what the land area would look like. Explain your reasoning. You may make a labeled
drawing with your description.

This item measures the student's ability to use information and observations from the present to make predictions about how Earth processes will affect future outcomes.

Criteria for a complete response (2):

Student predicts that the area will show a meandering river and a very wide floodplain because over time, erosion and deposition will continue, causing the river to eventually slow and widen. Student may also suggest that the river would dry up with a reasonable explanation.

Criteria for a partial response (1):

Student makes predictions indicated with a complete response but does not provide an explanation.

Criteria for an incorrect response (0):

Student makes predictions that are illogical or not supported by observations in the picture. Explanation is missing or does not support the prediction.

2. Below is a geologic timeline. Place an "**X**" on the timeline showing where a geologist would place the **appearance of Humans**. Explain why you placed your "X" where you did.

This item measures the student's understand of the relative time humans have been on Earth.

Criteria for a correct response (2):

Includes placement of the appearance of humans at same location or just next to present day. (i.e. within one cm). Student explains that humans have only been on Earth for a short period of its existence, so the X belongs very close to present day.

Criteria for a partial response (1):

Student places X in the correct spot, but does not provide an explanation or provides an incorrect or illogical explanation (e.g. confuses present day location with beginning of Earth location on timeline).

Criteria for an incorrect response (0):

Labels the appearance of humans more than 1 cm away from present day with or without an explanation.

3. Rocks with scratch marks from glaciers have been found in regions with very warm climates. Use the theory of continental drift or plate tectonics to explain how this is possible.

This item measures the student's understanding of how plate tectonic theory explains anomalies in Earth's history.

Criteria for a complete response (2):

Student explains that these theories suggest that the continents were in different locations long ago, and that the continents where these rocks were found were once in a frozen location with glaciers.

Criteria for a partial response (1):

Student explains that the continents were in different locations long ago, but does not explain how this theory explains the findings of glacial scratch marks in regions with warm climates.

Criteria for an incorrect response (0);

Student explains that the rocks with glacial scratch marks have been moved from other regions without suggesting that the continents themselves have moved.

ASSESSMENT—FOSSILS

1. Why have no fossils of jellyfish ever been found?

2. The trilobite is an extinct ocean dwelling creature with a very hard shell and many legs. Trilobites lived on Earth for over 300 million years (note: dinosaurs lived on Earth for about 160 million years.) Fossils of trilobite shells have been found around the world.

   Why would trilobites not be considered an index fossil?

RUBRIC FOR ASSESSMENT—FOSSILS

1. Why have no fossils of jellyfish ever been found?

This item measures the student's understanding of the processes by which fossils are formed.

Criteria for a complete response (2):

Student explains that since jellyfish have no hard parts, there is no way for minerals to deposit in their bodies. When jellyfish die, their bodies are decomposed.

Criteria for a partial response (1):

Student explains that a jellyfish has no hard parts but does not explain why this prevents it from becoming a fossil.

Criteria for an incorrect response (0):

Student explains that jellyfish have not been on Earth long enough to appear in the fossil record.

2. Why would trilobites not be considered an index fossil?

This item measures the student's ability to apply a series of characteristics of an unfamiliar organism to a definition.

Criteria for a complete response (2):

Student explains that since trilobites existed on Earth for such a long period of time, it would be impossible to pinpoint them to any one time period. An index fossil must have appeared for a short period of time. (NOTE: a student may be aware that trilobites became extinct 250 million years ago, and therefore, may be considered index fossils to indicate formations that are older than 250 million years old. This explanation should be considered complete and correct).

Criteria for a partial response (1):

Student explains that trilobites lived for a long period of time but does not explain why this does not fit the definition of index fossil.

Criteria for an incorrect response (0);

Student explains that because trilobites lived all around the world, they are not index fossils.