OVERVIEW OF THE PERFORMANCE STANDARDS
Elementary School

The elementary school standards are set at a level of performance approximately equivalent to the end of fourth grade. It is expected that some students might achieve this level earlier and others later than this grade. (See "Deciding what constitutes a standard-setting performance," page 10.)

Science

S1 Physical Sciences Concepts

- S1a Demonstrates understanding of properties of objects and materials.
- S1b Demonstrates understanding of position and motion of objects.
- S1c Demonstrates understanding of light, heat, electricity, and magnetism.

S2 Life Sciences Concepts

- S2a Demonstrates understanding of characteristics of organisms.
- S2b Demonstrates understanding of life cycles of organisms.
- S2c Demonstrates understanding of organisms and environments.
- S2d Demonstrates understanding of change over time.

S3 Earth and Space Sciences Concepts

- S3a Demonstrates understanding of properties of Earth materials. organisms.
- S3b Demonstrates understanding of objects in the sky. organisms.
- S3c Demonstrates understanding of changes in Earth and sky.

S4 Scientific Connections and Applications

- S4a Demonstrates understanding of big ideas and unifying concepts.
- S4b Demonstrates understanding of the designed world.
- S4c Demonstrates understanding of personal health.
- S4d Demonstrates understanding of science as a human endeavor.

S5 Scientific Thinking

S5a Asks questions about natural phenomena; objects and organisms; and events and discoveries.

S5b Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.

S5c Uses evidence from reliable sources to construct explanations.

S5d Evaluates different points of view using relevant experiences, observations, and knowledge; and distinguishes between fact and opinion.

S5e Identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.

S5f Works individually and in teams to collect and share information and ideas.

S6 Scientific Tools and Technologies

S6a Uses technology and tools to gather data and extend the senses.

S6b Collects and analyzes data using concepts and techniques in Mathematics Standard 4.

S6c Acquires information from multiple sources, such as experimentation and print and non-print sources.

S7 Scientific Communication

S7a Represents data and results in multiple ways.

S7b Uses facts to support conclusions.

S7c Communicates in a form suited to the purpose and the audience.

S7d Critiques written and oral explanations, and uses data to resolve disagreements.

S8 Scientific Investigation

S8a Demonstrates scientific competence by completing an experiment.

S8b Demonstrates scientific competence by completing a systematic observation.

S8c Demonstrates scientific competence by completing a design.

S8d Demonstrates scientific competence by completing non-experimental research using print and electronic information.

S1 Physical Sciences Concepts

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

S1a The student produces evidence that demonstrates understanding of properties of objects and materials, such as similarities and differences in the size, weight, and color of objects; the ability of materials to react with other substances; and different states of materials.

Examples of activities through which students might demonstrate conceptual understanding of physical sciences include:

* Investigate the browning process of apple slices and the factors that slow or speed up the process. 1a
* Use physical properties such as color, texture, or hardness to sort objects into two or more categories; change the categories to include a new object; and explain the rule to another student. 1a, 4a
* Use diagrams to explain the characteristics of ice melting, water boiling, and steam condensing; and illustrate how these kinds of characteristics can affect environments and the organisms that live in them. 1a, 2a, 2b, 2c

New York State Learning Standards for Math, Science, & Technology[1]
Standard 4 Science
Physical Setting

3. Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Students:
observe and describe properties of materials using appropriate tools.
describe chemical and physical changes including changes in the states of matter. p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[2]

Standard B Physical Science

Properties of Objects and Materials

Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, rulers, balances, and thermometers.

Objects are made of one or more materials, such as paper, wood and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort groups of objects or materials.

Materials can exist in different states—solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling. p. 127

Project 2061, AAAS[3]

Benchmarks for Science Literacy

Chapter 4 The Physical Setting

4B The Earth

Water can be a liquid or a solid and can be made to go back and forth from one form to the other. p. 67

4D Structure of Matter

Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.).

Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them. p. 76

Heating and cooling cause changes in the properties of materials.

When a new material is made by combining two or more materials, it has properties that are different from the original materials. p. 77

Chapter 8 The Designed World

8B Materials and Manufacturing

Naturally occurring materials such as wood, clay, cotton, and animal skins may be processed or combined with other materials to change their properties. p. 188

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S1 Physical Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

S1b The student produces evidence that demonstrates understanding of position and motion of objects, such as how the motion of an object can be described by tracing and measuring its position over time; and how sound is produced by vibrating objects.

Examples of activities through which students might demonstrate conceptual understanding of physical sciences include:

* Predict the bouncing pattern of a basketball under different throwing conditions using previous observations of force and motion. 1b
* Make a musical instrument, explain the relationship between sound and shape, and compare this to a structure/function relationship in an organism. 1b, 2a

New York State Learning Standards for Math, Science, & Technology[4]

Standard 4 Science
Physical Setting

5. Energy and matter interact through forces that result in changes in motion.

Students:
describe how forces can operate across distances. p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[5]

Standard B Physical Science

Position and Motion of Objects

The position of an object can be described by locating it relative to another object or the background.

An object's motion can be described by tracing and measuring its position over time.

The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration. p. 127

Project 2061, AAAS[6]

Benchmarks for Science Literacy

Chapter 4 The Physical Setting

4F Motion

Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have.

How fast things move differs greatly. Some things are so slow that their journey takes a long time; others move too fast for people to even see them.

Things that make sound vibrate. p. 89

4G Forces of Nature

The earth's gravity pulls any object toward it without touching it.

Without touching them, a magnet pulls on all things made of iron, and either pushes or pulls on other magnets. p. 94

Chapter 11 Common Themes

11C Constancy and Change

Things can change in different ways, such as size, weight, color, and movement. Some small changes can be detected by taking measurements. p. 272

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S1 Physical Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

S1c The student produces evidence that demonstrates understanding of light, heat, electricity, and magnetism, such as the variation of heat and temperature; how light travels in a straight line until it strikes an object or how electrical circuits work.

Examples of activities through which students might demonstrate conceptual understanding of physical sciences include:

* Investigate heat and friction by burning, rubbing, or mixing substances together; explain similarities and differences. 1c
* Use knowledge of magnetism to predict what materials will be attracted, repelled, or unaffected by a magnet, then conduct an experiment to confirm or reject their predictions. 1c, 3a

New York State Learning Standards for Math, Science, & Technology[7]

Standard 4 Science
Physical Setting

4. Energy exists in many forms, and when these forms change, energy is conserved.

Students:

describe a variety of forms of energy (e.g., heat, chemical, light) and the changes that occur in objects when they interact with those forms of energy.

observe the way one form of energy can be transformed into another form of energy present in common situations (e.g., mechanical to heat energy, mechanical to electrical energy chemical to heat energy).

5. Energy and matter interact through forces that result in changes in motion.

Students:

describe the effects of common forces (pushes and pulls) on objects, such as those caused by gravity, magnetism, and mechanical forces.

describe how forces can operate across distances. p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[8]

Standard B Physical Science

Light, Heat, Electricity, and Magnetism

Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.

Heat can be produced in many ways, such as burning, rubbing, or mixing one substance with another. Heat can move from one object to another by conduction.

Electricity in circuits can produce light, heat, sound and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.

Magnets attract and repel each other and certain kinds of other materials. p. 127

Project 2061, AAAS[9]

Benchmarks for Science Literacy

Chapter 4 The Physical Setting

4E Energy Transformation

Things that give off light often also give off heat. Heat is produced by mechanical and electrical machines, and nay time one thing rubs against something else.

When warmer things are put with cooler ones, the warm ones lose heat and the cool ones gain it until they are all at the same temperature. A warmer object can warm a cooler one by contact or at a distance.

Some materials conduct heat much better than others. Poor conductors can reduce heat loss. p. 84

4G Forces of Nature

The earth's gravity pulls any object toward it without touching it.

Without touching them, a magnet pulls on all things made of iron and either pushes or pulls on other magnets.

Without touching them, material that has been electrically charged pulls on all other materials and may either push or pull other charged materials. p. 94

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S2 Life Sciences Concepts

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:

S2a Characteristics of organisms, such as survival and environmental support; the relationship between structure and function; and variations in behavior.

Examples of activities through which students might demonstrate conceptual understanding of life sciences include:

* Predict how long a plant will live planted in a closed glass jar located by a window; and explain what additional information regarding the plant and the surrounding environment would be needed to improve the prediction. 2a, 1a, 3a, 3b
* Complete a 4-H animal care project; write a report explaining the growth and development of the animal and present the animal at the county-wide fair. 2a, 2b, 2c, 7a, 8b
* Explain the differences between inherited and environmental features of individuals such as flower colors or bike riding ability and describe the physical characteristics of the environment that could affect these features. 2a, 2b, 2c, 2d, 1a, 4a
* Plan the supplies and equipment needed for a camping trip and explain their purposes. 2a, 2c, 4b, 4d, M8d, A1c
* Explain how organisms, both human and other, cause changes in their environments and how some of these changes can be detrimental to other organisms. 2a, 2b, 2c, 2d, 1a, 4a, 4b
* Describe the similarities and differences between fossils and related contemporary organisms and explain how environmental factors contributed to these similarities and differences. 2a, 2c, 2d, 1a, 3a, 3c, 4a

New York State Learning Standards for Math, Science, & Technology[10]

Standard 4 Science
The Living Environment

1. Living things are both similar to and different from each other and non-living things.

Students:

describe the characteristics of and variations between living and non-living things.

describe the life processes common to all living things.

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5. Organisms maintain a dynamic equilibrium that sustains life.

Students:

describe the basic life functions of common living specimens (guppy, mealworm, gerbil).

describe some survival behaviors of common living species.

describe the factors that help promote good health and growth in humans. p. 31

National Documents which guided New York State and New York City

NRC National Science Education Standards[11]

Standard C Life Science

Characteristics of Organisms

Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light.

Each plant or animal has different structures that serve different functions in growth, survival and reproduction.

The behavior of individual organisms is influenced by internal cues (such as hunger) and external cues (such as a change in the environment). p. 129

Project 2061, AAAS[12]

Benchmarks for Science Literacy

Chapter 5 The Living Environment

5A Diversity of Life

A great variety of kinds of living things can be sorted into groups in many ways using various features to decide which things belong to which group. p. 103

5C Cells

Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in. p. 111

5D Interdependence of Life

For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. p. 116

Chapter 6 The Human Organism

6D Learning

Human beings can use the memory of their past experiences to make judgments about new situations. p. 140

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S2 Life Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S2b Life cycles of organisms, such as how inheritance and environment determine the characteristics of an organism; and that all plants and animals have life cycles.

Examples of activities through which students might demonstrate conceptual understanding of life sciences include:

* Complete a 4-H animal care project; write a report explaining the growth and development of the animal and present the animal at the county-wide fair. 2a, 2b, 2c, 7a, 8b
* Make drawings of observations showing the life cycle of a plant or animal. 2b
* Explain the differences between inherited and environmental features of individuals such as flower colors or bike riding ability and describe the physical characteristics of the environment that could affect these features. 2a, 2b, 2c, 2d, 1a, 4a
* Explain how organisms, both human and other, cause changes in their environments and how some of these changes can be detrimental to other organisms. 2a, 2b, 2c, 2d, 1a, 4a, 4b

New York State Learning Standards for Math, Science, & Technology[13]
Standard 4 Science
The Living Environment

2. Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

Students:

recognize that traits of living things are both inherited and acquired or learned.

recognize that for humans and other living things there is genetic continuity between generations

4. The continuity of life is sustained through reproduction and development.

Students:

describe the major stages in the life cycle of selected plants and animals.

describe evidence of growth, repair, and maintenance, such as nails, hair and bone, and the healing of cuts and bruises.

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6. Plants and animals depend on each other and their physical environment.

Students:

describe the relationship of the sun as an energy source for living and non-living cycles. p. 31

National Documents which guided New York State and New York City

NRC National Science Education Standards[14]

Standard C Life Science
Life Cycles of Organisms

Plants and animals have life cycles.

Plants and animals closely resemble their parents.

Many characteristics of an organism are inherited from the parents of the organism, but others are a result from the environment. p. 129

Project 2061, AAAS[15]
Benchmarks for Science Literacy

Chapter 5 The Living Environment
5B Heredity

Some likenesses between children and parents such as eye color in human beings or fruit or flower color in plants, are inherited. Other likenesses, such as people's table manners or carpentry skills are learned.

For offspring to resemble their parents, there must be a reliable way to transfer information from one generation to the next. p. 107

5D Interdependence of Life

For any particular environment, some kinds of plants and animals survive well, some survive less well and some cannot survive at all. p. 116

5E Flow of Matter and Energy

Over the whole earth, organisms are growing, dying and decaying and new organisms are being produced by the old ones. p. 119

5F Evolution of Life

Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing. p. 123

Chapter 6 The Human Organism
6B Human Development

There is a usual sequence of stages physical and mental development in human beings although individuals differ in exactly when they reach each stage. p. 132

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S2 Life Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S2c Organisms and environments, such as the interdependence of animals and plants in an ecosystem; and populations and their effects on the environment.

Examples of activities through which students might demonstrate conceptual understanding of life sciences include:

* Complete a 4-H animal care project; write a report explaining the growth and development of the animal and present the animal at the county-wide fair. 2a, 2b, 2c, 7a, 8b
* Explain the differences between inherited and environmental features of individuals such as flower colors or bike riding ability and describe the physical characteristics of the environment that could affect these features. 2a, 2b, 2c, 2d, 1a, 4a
* Plan the supplies and equipment needed for a camping trip and explain their purposes. 2a, 2c, 4b, 4d, M8d, A1c
* Explain how organisms, both human and other, cause changes in their environments and how some of these changes can be detrimental to other organisms. 2a, 2b, 2c, 2d, 1a, 4a, 4b
* Use more than one medium such as models, text, drawings, or oral explanations to show how various organisms have changed over time to fill a variety of niches. 2c, 2d, 4a
* Describe the similarities and differences between fossils and related contemporary organisms and explain how environmental factors contributed to these similarities and differences. 2a, 2c, 2d, 1a, 3a, 3c, 4a

New York State Learning Standards for Math, Science, & Technology[16]
Standard 4 Science
The Living Environment

6. Plants and animals depend on each other and their physical environment.

Students:

describe how plants and animals, including humans, depend upon each other and the non-living environment.

describe the relationship of the sun as an energy source for living and non-living cycles.

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7. Human decisions and activities have had a profound impact on the physical and living environment.

Students:
identify ways in which humans have changed their environment and the effects of those changes. p. 31

National Documents which guided New York State and New York City

NRC National Science Education Standards[17]
Standard C Life Science
Organisms and Their Environments

All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

An organism's patterns of behavior are related to the nature of that organism's environment, including the kinds and numbers of other organisms present, the availability of food and resources, and the physical characteristics of the environment. When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

All organisms cause changes in the environment where they live. Some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

Humans depend on their natural and constructed environments. Humans change environments in ways that can be either beneficial or detrimental for themselves and other organisms. p. 129

Project 2061, AAAS[18]
Benchmarks for Science Literacy
Chapter 5 The Living Environment
5D Interdependence of Life

For any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Insects and various other organisms depend on dead plant and animal material for food.

Organisms interact with one another in various ways besides providing food. Many plants depend on animals for carrying their pollen to other plants for dispersing their seeds. p. 116

5F Evolution of Life

Individuals of the same kind differ in their characteristics and, sometimes, the difference give individuals an advantage in survival and reproducing. p. 123

Chapter 7 Human Society
7E Political and Economic Systems

People tend to live together in groups and therefore have to have ways of deciding who will do what. p. 168

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S2 Life Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs, or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S2d Change over time, such as evolution and fossil evidence depicting the great diversity of organisms developed over geologic history.

Examples of activities through which students might demonstrate conceptual understanding of life sciences include:

* Explain the differences between inherited and environmental features of individuals such as flower colors or bike riding ability and describe the physical characteristics of the environment that could affect these features. 2a, 2b, 2c, 2d, 1a, 4a
* Explain how organisms, both human and other, cause changes in their environments and how some of these changes can be detrimental to other organisms. 2a, 2b, 2c, 2d, 1a, 4a, 4b
* Use more than one medium such as models, text, drawings, or oral explanations to show how various organisms have changed over time to fill a variety of niches. 2c, 2d, 4a
* Describe the similarities and differences between fossils and related contemporary organisms and explain how environmental factors contributed to these similarities and differences. 2a, 2c, 2d, 1a, 3a, 3c, 4a

New York State Learning Standards for Math, Science, & Technology[19]
Standard 4 Science
The Living Environment

2. Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parent and offspring.

Students:

recognize that traits of living things are both inherited and acquired or learned.

recognize that for humans and other living things there is genetic continuity between generations.

3. Individual organisms and species change over time.

Students:

describe how the structures of plants and animals complement the environment of the plant or animal.

observe that differences within a species may give individuals an advantage in surviving and reproducing. p. 31

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National Documents which guided New York State and New York City

NRC National Science Education Standards[20]

Standard D Earth and Space Science
Properties of Earth Materials

Fossils provide evidence about the plants and animals that lived long ago and in the nature of the environment at that time. p. 134

Project 2061, AAAS[21]
Benchmarks for Science Literacy

Chapter 5 The Living Environment
5F Evolution of Life

Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.

Fossils can be compared to one another and to living organisms according to their similarities and differences. Some organisms that lived long ago are similar to existing organisms, but some are quite different. p. 123

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S3 Earth and Space Sciences Concepts

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S3a Properties of Earth materials, such as water and gases; and the properties of rocks and soils, such as texture, color, and ability to retain water.

Examples of activities through which students might demonstrate conceptual understanding of Earth and space sciences include:

* Investigate how the properties of soil can affect the growth of a plant. 3a, 1a, 2a, 2b, 2c, 4a
* Predict what kinds of materials would be useful for different purposes, such as in buildings or as sources of fuel, because of their physical and chemical properties. 3a, 1a
* Write a story that describes what happens to a drop of water and the physical environment through which it flows as it travels from a lake to a river via the Earth's atmosphere. 3a, 3b, 1a, 4a

New York State Learning Standards for Math, Science, & Technology[22]

Standard 4 Science
Physical Setting

2. Many of the phenomena that we observe on earth involve interactions among components of air, water, and land.

Students:
describe the relationships among air, water, and land on Earth. p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[23]

Standard D Earth and Space Science
Properties of Earth Materials

Earth materials are solid rocks and soils, water, and the gasses of the atmosphere. The varied materials have different ways for example as building materials as sources of fuel or for growing the plants we use as food. Earth provides many of the resources humans use.

Soils have properties of color and texture, the capacity to retain water, and the ability to support the growth of many kind of plants. p. 134

Project 2061, AAAS[24]
Benchmarks for Science Literacy

Chapter 4 The Physical Setting
4B The Earth

Water can be a liquid or a solid and can be made to go back and forth from one form to the other. If water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.

Water left in an open container disappears but water in a closed container does not disappear. p. 67

When liquid water disappears it turns into a gas in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water. Clouds and fog are made up of tiny droplets of water. p. 68

4C Processes that Shape the Earth

Chunks of rocks come in many sizes and shapes, from boulders to grains of sand and even smaller.

Soil is made partly from weathered rock, partly from planet remains—and also contains living organisms. p. 72

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S3 Earth and Space Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S3b Objects in the sky, such as Sun, Moon, planets, and other objects that can be observed and described; and the importance of the Sun to provide the light and heat necessary for survival.

Examples of activities through which students might demonstrate conceptual understanding of Earth and space sciences include:

* Observe and keep a record of the shape of the Moon for several months; and then make drawings predicting what will happen during the next week. 3b, 3c
* Make observations of the changes in an object's shadow during the course of a day and investigate the source of the variation. 3b, 3c
* Write a story that describes what happens to a drop of water and the physical environment through which it flows as it travels from a lake to a river via the Earth's atmosphere. 3a, 3b, 1a, 4a
* Collect information from a weather station and use the information to explain the patterns of change from fall to winter in terms of weather and the position and movement of objects in the sky. 3b, 3c, 4a, M1a, M1c, M1f, A1a

New York State Learning Standards for Math, Science, & Technology[25]
Standard 4 Science
Physical Setting

1. The earth and celestial phenomena can be described by principles of relative motion and perspectives.

Students:
describe patterns of daily, monthly, and seasonal changes in their environment.

4. Energy exist in many forms, when these forms change, energy is conserved.

Students:
describe a variety of forms of energy (e.g.. heat, chemical, light) and the changes that occur in objects when they interact with those forms of energy.

observe the way one form of energy can be transformed into another form of energy present in common situations (e.g.. mechanical to heat energy, mechanical to electrical energy, chemical to heat energy). p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[26]

Standard D Earth and Space Science
Objects in the Sky

The sun, moon, stars, clouds, birds, and airplanes all have properties, locations and movement that can be observed.

The sun provides the light and heat necessary to maintain the temperature of the earth. p. 134

Project 2061, AAAS[27]
Benchmarks for Science Literacy

Chapter 4 The Physical Setting
4A The Universe

There are more stars in the sky than anyone can easily count, but they are not scattered evenly, and they are not all the same in brightness or color.

The sun can only be seen in the daytime but he moon can be seen sometimes at night and sometimes during the day. The sun, moon, and stars all appear to move slowly across the sky.

The moon looks a little different everyday, but looks the same again every four weeks. p. 62

Planet change their positions against the back ground of stars.

The earth is one of several planets that orbit the sun, and the moon orbits around the earth.

Stars are like the sun, some being smaller and some larger, but so far away that they look like points of lights. p. 63

Chapter 8 The Designed World
8C Energy Sources and Use

The sun is the main source of energy for people and they use it in various ways. The energy in fossil fuels such as oil and coal comes from the sun indirectly, because the fuels come from plants that grew long ago. p. 193

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S3 Earth and Space Sciences Concepts (cont.)

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:
S3c Changes in Earth and sky, such as changes caused by weathering, volcanism, and earthquakes; and the patterns of movement of objects in the sky.

Examples of activities through which students might demonstrate conceptual understanding of Earth and space sciences include:

* Observe and keep a record of the shape of the Moon for several months; and then make drawings predicting what will happen during the next week. 3b, 3c
* Make observations of the changes in an object's shadow during the course of a day and investigate the source of the variation. 3b, 3c
* Collect information from a weather station and use the information to explain the patterns of change from fall to winter in terms of weather and the position and movement of objects in the sky. 3b, 3c, 4a, M1a, M1c, M1f, A1a

New York State Learning Standards for Math, Science, & Technology[28]

Standard 4 Science
Physical Setting

1. The earth and celestial phenomena can be described by principles of relative motion and phenomena.

Students:
describe patterns of daily, monthly, and seasonal changes in their environment.

2. Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Students:
describe the relationships among air, water, and land on Earth. p. 30

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National Documents which guided New York State and New York City

NRC National Science Education Standards[29]

Standard D Earth and Space Science
Changes in the Earth and Sky

The Surface of the earth changes. Some changes are due to slow processes, such as erosion and weathering and some changes are due to rapid processes, such as landslide, volcanic eruptions and earthquakes.

Weather changes from day to day and over the seasons weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.

Objects in the sky have patterns of movement. The sun for example, appears to move across the sky in the same way everyday, but its path changes slowly over the seasons. The moon moves across the sky on a daily basis much like the sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month. p. 134

Project 2061, AAAS[30]
Benchmarks for Science Literacy

Chapter 4 The Physical Setting
4A The Universe

The patterns of stars in the sky stay the same although they appear to move across the sky nightly and different stars can be seen in different seasons.

Planets change their position against the background of stars.

The earth is one of several planets that orbits the sun, and the moon orbits the earth. p. 63

4C Processes that Shape the Earth

Waves, wind, water, and ice shape and reshape the earth's land surface by eroding rock and soil in some areas n depositing them in other areas sometimes in seasonal layers.

Rock is composed of different combinations of minerals. Smaller rocks come from breakage, and weathering of bedrock and larger rocks. Soil is made partly from weathered rock, partly from plant remains - and also contains many living organisms. p. 72

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S4 Scientific Connections and Applications

The student demonstrates conceptual understanding by using a concept accurately to explain observations and make predictions and by representing the concept in multiple ways (through words, diagrams, graphs or charts, as appropriate). Both aspects of understanding—explaining and representing—are required to meet this standard.

The student produces evidence that demonstrates understanding of:

S4a Big ideas and unifying concepts, such as order and organization; models, form and function; change and constancy; and cause and effect.

S4b The designed world, such as development of agricultural techniques; and the viability of technological designs.

S4c Personal health, such as nutrition, substance abuse, and exercise; germs and toxic substances; personal and environmental safety.

S4d Science as a human endeavor, such as communication, cooperation, and diverse input in scientific research; and the importance of reason, intellectual honesty, and skepticism.

Examples of activities through which students might demonstrate conceptual understanding of scientific connections and applications include:

* Conduct an experiment to determine which brand of paper towel is the best in terms of form and function, cause and effect, cost and personal preference, and write an advertisement for the brand highlighting findings of the experiment. 4a, 4b, 1a, 3a
* Earn the Webelos Engineer Badge (Boy Scouts of America) or the Brownie Building Art Try-It (Girl Scouts of the U.S.A.) and explain the design of the model. 4b, 4d, 1a, 1b, 1c
* Explain why people should wash their hands when preparing food. 4c, 3c
* Make recommendations to improve the selection of food in the school vending machines so that students can make healthier choices. 4c, 2b, M8a, A1b
* Build a solar cooker and explain what foods can or cannot be cooked safely within the temperature range achieved. 4b, 4c, 2a
* Interview a person who has a job that interests you and write a report explaining how studying science helped the person prepare for the job. 4d

New York State Learning Standards for Math, Science, & Technology[31]

Standard 6 Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

Systems Thinking

1. Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Models

2. Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design. p. 48

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Magnitude and Scale

3. The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems.

Equilibrium and Stability

4. Equilibrium is a state of stability due either to a lack of changes (static equilibrium) or a balance between opposing forces (dynamic equilibrium). p. 49

Patterns of Change

5. Identifying patterns of change is necessary for making predictions about future behavior and conditions.

Optimization

6. In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs. p.50

National Documents which guided New York State and New York City

NRC National Science Education Standards[32]

Unifying Concepts and Processes

Systems, order, and organization

Evidence, models, and explanation

Constancy, change, and measurement

Evolution and equilibrium

Form and function pp. 115-119

Standard E Science and Technology pp. 135-138

Standard F Science in Personal and Social Perspectives

Personal Health

Characteristics and Changes in Populations

Types of Resources

Changes in Environments

Science and Technology in Local Challenges pp. 138-141

Standard G History and Nature of Science p. 141

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Project 2061, AAAS[33]
Chapter 3 The Nature of Technology pp. 41-57
Chapter 6 The Human Organism pp. 127-149
Chapter 8 The Designed World pp. 181-207
Chapter 10 Historical Perspectives pp. 237-259
Chapter 11 Common Themes
11A Systems
11B Models
11C Constancy and Change
11D Scale pp. 261-279

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S5 Scientific Thinking

The student demonstrates scientific inquiry and problem solving by using thoughtful questioning and reasoning strategies, common sense and conceptual understanding from Science Standards 1 to 4, and appropriate methods to investigate the natural world; that is, the student:

S5a Asks questions about natural phenomena; objects and organisms; and events and discoveries.

S5b Uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.

S5c Uses evidence from reliable sources to construct explanations.

S5d Evaluates different points of view using relevant experiences, observations, and knowledge; and distinguishes between fact and opinion.

S5e Identifies problems; proposes and implements solutions; and evaluates the accuracy, design, and outcomes of investigations.

S5f Works individually and in teams to collect and share information and ideas.

Examples of activities through which students might demonstrate scientific thinking include:

* Evaluate the claims of a new product: describe the questions and evidence required to substantiate the claims; conduct an investigation to test ideas; and evaluate the accuracy of the conclusions. 5a, 5b, 5c, 5e
* Work with others to examine the changes in the flora, fauna, and environment in a one square meter plot, caused by recent construction, explain the observations, and make predictions about the future of this microsystem. 5a, 5b, 5c, 5d, 5f, 2a, 2b, 2c
* Use data from one investigation to generate a prediction and conduct a new investigation. 5a, 5b, 5c, 5e
* Summarize a series of newspaper and magazine articles on a current topic, e.g., El Niño; use multiple sources to evaluate accuracy in the articles; and write a revised article putting all the relevant ideas together. 5a, 5b, 5c, 5d, 3a

New York State Learning Standards for Math, Science, & Technology[34]

Standard 1 Analysis, Inquiry, and Design
Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.
2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity. p. 2
3. The observations made while testing explanations, when analyzed using conventional and invented methods, provide new insights into phenomena. p. 3

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National Documents which guided New York State and New York City

NRC National Science Education Standards[35]

Standard A Science As Inquiry

Ask a question about objects, organisms, and events in the environment. Students should answer their questions by seeking information from reliable sources of scientific information and from their own observations and investigations.

Use data to construct a reasonable explanation. Students should check their explanations against scientific knowledge, experiences, and observations of others. p. 122

Scientific investigations involve asking and answering a question and comparing the answer with what scientists already know about the world.

Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations. p. 123

Project 2061, AAAS[36]

Chapter 1 The Nature of Science

1B Scientific Inquiry

Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think. Sometimes scientists have different explanations for the same set of observations. That usually leads to their making more observations to resolve the differences. p. 11

1C The Scientific Enterprise

In doing science, it is often helpful to work with a team and to share findings with others. All team members should reach their own conclusions, however, about what the findings mean. p. 15

Chapter 12 Habits of Mind

12A Values and Attitudes

Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out. p. 285

12E Critical Response Skills

Seek better reasons for something than "Everybody knows that..." or "I just know" and discount such reasons when given by others. p. 299

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S6 Scientific Tools and Technologies

The student demonstrates competence with the tools and technologies of science by using them to collect data, make observations, analyze results, and accomplish tasks effectively; that is, the student:

S6a Uses technology and tools (such as rulers, computers, balances, thermometers, watches, magnifiers, and microscopes) to gather data and extend the senses.

S6b Collects and analyzes data using concepts and techniques in Mathematics Standard 4, such as average, data displays, graphing, variability, and sampling.

S6c Acquires information from multiple sources, such as experimentation and print and non-print sources.

Examples of activities through which students might demonstrate competence with the tools and technologies of science include:

* Collect information from the United States Geological Survey and use the information to identify trends in geologic movement in your hometown or state. 6c, 3a, 3c, 5c
* Conduct a survey of students' electricity and gas use at home, compare the data to that of other students, and select an appropriate way to display the comparative data. 6b, 2c, 4b
* Use telecommunications to compare data on similar investigations with students in another school. 6c
* Use electronic data bases to find out about the nutritional value of food available in the cafeteria and compare with alternative selections or snack foods. 6c, 4c

New York State Learning Standards for Math, Science, & Technology[37]

Standard 2 Information Systems

1. Information technology is used to retrieve, process, and communicate information and as a tool to enhance learning.

Students:

use a variety of equipment and software packages to enter, process, display, and communicate information in different forms using text, tables, pictures, and sound. p. 8

Standard 3 Mathematics
Modeling/Multiple Representation

4. Students use mathematical modeling/multiple representation to provide a means of presenting, interpreting, and communicating, and connecting mathematical information and relationships. p. 15

Measurement

5. Students use measurement in both metric and English measure to provide a major link between the abstractions of mathematics and the real world in order to describe and compare objects and data. p. 16

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Standard 5 Technology

3. Computers, as tools for design, modeling, information processing, communication, and systems control, have greatly increased human productivity and knowledge. p. 37

Standard 7 Interdisciplinary Problem Solving

2. Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas. p. 60

National Documents which guided New York State and New York City

NRC National Science Education Standards[38]

Standard A Science as Inquiry

Employ simple equipment and tools to gather data and extend the senses. p. 122

Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses. p. 123

Project 2061, AAAS[39]
Chapter 1 The Nature of Science
1B Scientific Inquiry

Tools such as thermometers, magnifiers, rulers, or balances often give more information about things than can be obtained by just observing things without their help. p. 10.

Chapter 12 Habits of Mind
12 C Manipulation and Observation

Measure and mix dry and liquid materials (in the kitchen, garage, or laboratory) in prescribed amounts, exercising reasonable safety. p. 293

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S7 Scientific Communication

The student demonstrates effective scientific communication by clearly describing aspects of the natural world using accurate data, graphs, or other appropriate media to convey depth of conceptual understanding in science; that is, the student:

S7a Represents data and results in multiple ways, such as numbers, tables, and graphs; drawings, diagrams, and artwork; and technical and creative writing.

S7b Uses facts to support conclusions.

S7c Communicates in a form suited to the purpose and the audience, such as writing instructions that others can follow.

S7d Critiques written and oral explanations, and uses data to resolve disagreements.

Examples of activities through which students might demonstrate competence in scientific communication include:

* Write and illustrate a creative story to explain the food chain to a younger brother or sister. 7a, 7c, 2c
* Make a poster of charts and graphs to communicate effective nutrition and health habits. 7a, 2a, 4b
* Work with other students to create a skit depicting the sequence of events and the characters in an important scientific discovery. 7c, 4d
* Prepare a report, with graphs, charts, and diagrams, on the optimal number and placement of recycling containers, based on trash disposal data from the classroom and the entire school. 7a, 4b, 6b, M7, A1b

New York State Learning Standards for Math, Science, & Technology[40]

Standard 1 Analysis, Inquiry, and Design
Scientific Inquiry

3. The observations made while testing explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Students:

organize observations and measurements of objects and events through classification and the preparation of simple charts and tables. p. 3

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National Documents which guided New York State and New York City

NRC National Science Education Standards[41]

Standard A Science as Inquiry

Communicate investigations and explanations. Students should begin developing the abilities to communicate, critique, and analyze their work and the work of others. p. 122

Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations.

Scientists review and ask questions about the results of other scientists' work. p. 123

Project 2061, AAAS[42]

Chapter 1 The Nature of Science
1B Scientific Inquiry

Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others. p. 10

Scientists do not pay much attention to claims about how something they know about works unless the claims are backed up with evidence that can be confirmed and with a logical argument. p. 11

1C The Scientific Enterprise

Clear communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world. p. 16

Chapter 9 The Mathematical World
9B Symbolic Relationships

Tables and graphs can show how values of one quantity are related to values of another. p. 218

Chapter 12 Habits of Mind
12D Communication Skills

Write instructions that others can follow in carrying out a procedure.

Make sketches to aid in explaining procedures or ideas.

Use numerical data in describing and comparing objects and events. p 296

12E Critical Response Skills

Buttress their statements with facts found in books, articles, and databases, and identify the sources used and expect others to do the same. p. 299

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S8 Scientific Investigation

The student demonstrates scientific competence by completing projects drawn from the following kinds of investigations, including at least one full investigation each year and, over the course of elementary school, investigations that integrate several aspects of Science Standards 1 to 7 and represent all four of the kinds of investigation:

S8a An experiment, such as conducting a fair test.

S8b A systematic observation, such as a field study.

S8c A design, such as building a model or scientific apparatus.

S8d Non-experimental research using print and electronic information, such as journals, video, or computers.

A single project may draw on more than one kind of investigation.
A full investigation includes:

- **Questions that can be studied using the resources available.**
- **Procedures that are safe, humane, and ethical; and that respect privacy and property rights.**
- **Data that have been collected and recorded (see also Science Standard 6) in ways that others can verify and analyze using skills expected at this grade level (see also Mathematics Standard 4).**
- **Data and results that have been represented (see also Science Standard 7) in ways that fit the context.**
- **Recommendations, decisions, and conclusions based on evidence.**
- **Acknowledgment of references and contributions of others.**
- **Results that are communicated appropriately to audiences.**
- **Reflection and defense of conclusions and recommendations from other sources and peer review.**

Examples of projects through which students might demonstrate competence in scientific investigation include:

* Design, make, and fly kites; modifying the kites so they fly higher, maneuver more easily, or achieve some other goal. 8a, 8c
* Investigate why different plants live in the cracks of the sidewalk in different areas around the school. 8b, 2a
* Design and build a Rube Goldberg device and explain how changing aspects of the design made it work better. 8c, 4b
* Research a particular disease; compare local with national risk factors; and produce an information pamphlet that communicates the characteristics and risk associated with the disease. 8d, 4c
* Make a series of drawings and explain the seasonal succession of plants in a field near the school. 8d, 2b
* With a partner, select an endangered plant or animal in your area; collect information from reference books, magazines, video; debate whether the plant or animal should be saved or allowed to disappear, and why. 8d, 2c, 6c

New York State Learning Standards for Math, Science, & Technology[43]

Standard 1 Analysis, Inquiry, and Design

Scientific Inquiry

1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.
2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity. p. 2
3. The observations made while testing explanations, when analyzed using conventional and invented methods, provide new insights into phenomena. p. 3

Engineering Design

1. Engineering design is an iterative process involving modeling and optimization finding the best solution within given constraints which is used to develop technological solutions to problems within given constraints. p. 3

National Documents which guided New York State and New York City

NRC National Science Education Standards[44]

Standard A Science as Inquiry

Plan and conduct a simple investigation. In the earliest years, investigations are largely based on systematic observations. As students develop, they may design and conduct simple experiments to answer questions. The idea of a fair test is possible for many students to consider by fourth grade. p. 122

Scientists use different kinds of investigations depending on the questions they are trying to answer. Types of investigations include describing objects, events, and organisms, classifying them and doing a fair test (experimenting). p. 123

Standard E Science and Technology

Identify a simple problem.

Propose a solution.

Implementing proposed solutions.

Evaluate a product or design.

Communicate a problem, design, and solution. pp. 137-138.

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Project 2061, AAAS[45]

Chapter 1 The Nature of Science

1B Scientific Inquiry

Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments. p. 11

Chapter 3 The Nature of Technology

3B Design and Systems

There is no perfect design. Designs that are best in one respect (safety or ease of use, for example) may be inferior in other ways (cost or appearance). Usually some features must be sacrificed to get others. How such trade-offs are received depends on which features are emphasized and which are down-played. p. 49

Chapter 12 Habits of Mind

12E Critical Response Skills

Recognize when comparisons might not be fair because some conditions are not kept the same. p. 299

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Work Sample & Commentary: *Light or Dark?* Elementary School Science

The task

Student teams compared the absorption of solar energy by light and dark surfaces. Students performed an initial procedure and then followed it with two experiments, changing one variable in each experiment. Data were collected and recorded on table matrices provided by the publisher of this particular investigation.

Circumstances of performance

This sample of student work was produced under the following conditions:

alone	√ in a group
√ in class	as homework
√ with teacher feedback	√ with peer feedback
timed	√ opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards:[46]

S1c Physical Sciences Concepts: Light, heat, electricity, and magnetism.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S5b Scientific Thinking: Use concepts from Standards 1 to 4.

S6a Scientific Tools and Technologies: Use technology and tools.

S7a Scientific Communication: Represent data and results in multiple ways.

What the work shows

S1c Physical Sciences Concepts: The student produces evidence that demonstrates understanding of light, heat…such as the variation of heat and temperature….

(A) The student collected and recorded data showing variations in temperature.

(B) The student interprets the data in terms of temperature increase.

(C) The student makes a prediction based on the data interpretation.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts such as…cause and effect.

(C) The student recognizes the causal relationship between color of materials and the amount of change in temperature in the presence of sunlight.

(D) In the conclusion, the student correctly applies the causal relationship noted in (C).

[46] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

S5b Scientific Thinking: The student uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.

(D) The student applied understanding of the concept of heat variation from S1c by explaining "that light trays reflect the sunlight and the black trays don't reflect the sunlight." The student's confidence in his/her understanding of the concept is evident in the use of the words, "I know this is true...."

S6a Scientific Tools and Technologies: The student uses technology and tools (such as...thermometers...) to gather data and extend the senses.

(A) (E) The work clearly illustrates use of the thermometers and watches as tools to gather data.

S7a Scientific Communication: The student represents data and results in multiple ways, such as numbers, tables, and graphs...and technical and creative writing.

(A) (E) (F) (G) (H) The student presents data in charts and line graphs, and uses narrative writing to describe outcomes and conclusions. Note that in (F) and (H), the student begins each line graph at 0°. The student needs some minor assistance to understand how to record the initial data on a line graph. However, recordings after the initial one on each graph are correct.

Name _____

Energy Sources
Section 5 • Chapter 16

A.

- Add a tumblerful of water to each tray.
- Pour the water all over the tray.
- Put the trays out in the sun for 30 minutes.

Record starting time: 11:10

Record ending time: 11:40

A

	Starting temperature	Final temperature	Change in temperature
Open black tray	25°C	26°C	+1°C
Closed black tray	25°C	37°C	+12°C
Closed white tray	25°C	30°C	+5°C

B.

- Describe what your team found out.

B

My team found that all of the trays (open black tray closed black tray and a closed white tray) showed an increase in temperature. It also showed that a covered black tray absorbs more heat than the other trays. The uncovered tray had the lowest increase in temperature.

C.

- Suppose you put water into an open white tray and leave it out in the sun for 30 minutes. What do you think will happen to the water temperature?

C

I think the water temperature will stay the same because the opened black tray only went up 1°C and white reflects the sun's rays.

SCIS3+ 39

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Name _____

Energy Sources
Section 5 • Chapter 17

A

A.

- How does the amount of water in a tray affect the rise in temperature?
- Everyone will use covered black trays.
- All trays will be left out for 30 minutes.
- The amount of water in each tray will be different.

starting time _____

ending time _____

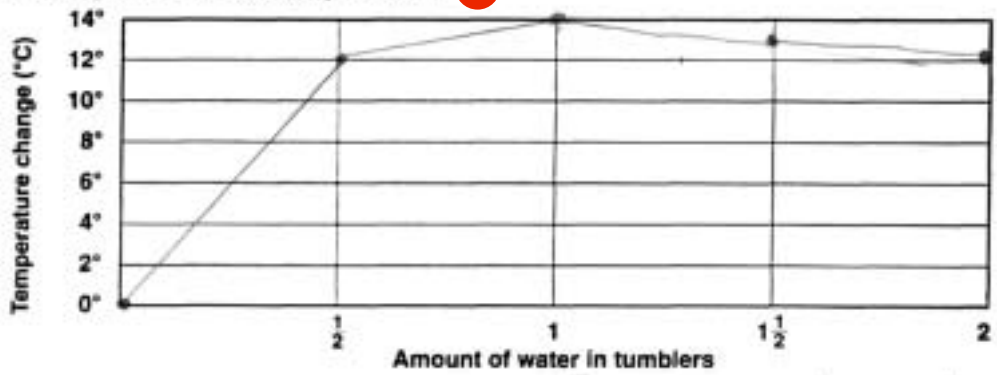
E

Amount of water	Starting temperature	Final temperature	Temperature change
$\frac{1}{2}$ tumbler	26°C	38°C	+12°C
1 tumbler	26°C	40°C	+14°C
$1\frac{1}{2}$ tumblers	26°C	39°C	+13°C
2 tumblers	26°C	38°C	+12°C

B.

- Make a graph of the results for your team.

F



- What variables were not changed in this experiment? Every one used covered black trays for the experiment and all of the water stayed out for the same amount of time.

40

SCIS3+

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Name _____

Energy Sources
Section 5 • Chapter 17

A

A.

- How does changing the time affect the temperature of the water?
- Everyone will use covered black trays.
- All trays will be filled with 1 tumblerful of water.
- The time you leave your trays out will be different.

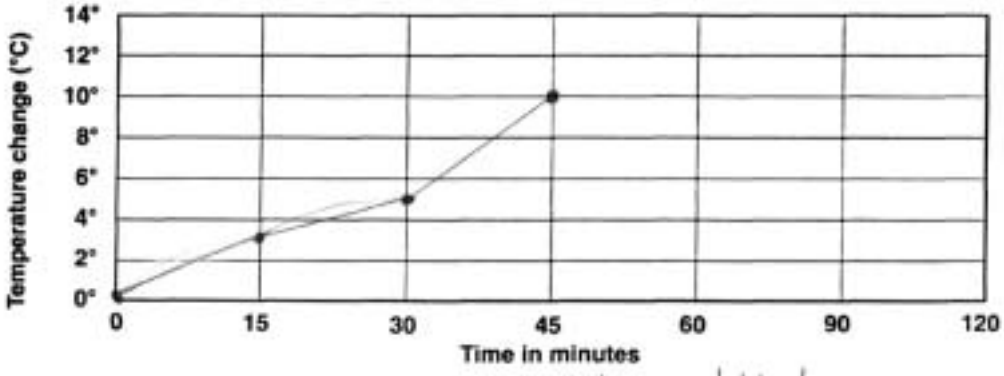
G

Time left out	Starting temperature	Final temperature	Temperature change
15 minutes	25 °C	28 °C	+ 3 °C
30 minutes	25 °C	30 °C	+ 5 °C
45 minutes	25 °C	35°C	+ 10°C
60 minutes (optional)			
90 minutes (optional)			
120 minutes (optional)			

B.

- Make a graph of the results for your team.

H



- What variables were not changed in this experiment? We used black covered trays and all of them were filled with 1 tumbler of water.

SCIS3+ 41

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NAME _____

WHITE CARS OR DARK CARS?

Suppose a friend is moving to southern Arizona or Florida. On the basis of the evidence from the experiments with the solar trays, what color car would you advise him or her to buy?

D

I would tell my friend to buy a white car because it would reflect the sunlight. I know this is true because I learned during our experiments with the trays that light trays reflect the sunlight and the black trays don't reflect the sunlight. If I were to do another experiment I would test different types of cloth to see if the same was true for clothing.

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Work Sample & Commentary: *The Come Back Can*
Elementary School Science

The task[47]

Students were instructed to construct several model energy cans. After constructing the original model can, students were asked to make a change in the design of the can that would affect its performance (e.g., different rubber band, different mass suspended from the rubber band, different size of can). The task calls for the student to design and carry out the task; to compare and contrast the behavior of the original and the modified can; and to describe the effect of the changed variable. Within this explanation, the student needed to demonstrate an understanding of potential and kinetic energy.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
√	in class		as homework
√	with teacher feedback	√	with peer feedback
	timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards:[48]

S1a Physical Sciences Concepts: Properties of objects and materials.

S1b Physical Sciences Concepts: Position and motion of objects.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S5b Scientific Thinking: Use concepts from Standards 1 to 4.

S7a Scientific Communication: Represent data and results in multiple ways.

S7b Scientific Communication: Use facts to support conclusions.

What the work shows

S1a Physical Sciences Concepts: The student produces evidence that demonstrates understanding of properties of objects and materials, such as similarities and differences in the size, weight…of objects….

(A) The student observed, "The sinkers twist the rubber band when you push it away from you. The rubber band, as it is twisted, contains the stored or potential energy." This observation demonstrates an understanding of properties of the sinker (weight) and the rubber band (elasticity).

(B) The student noted a difference in the size of the sinker.

---

[47] For related work on Force and Motion, see "Mechanical Nut", page 188, and "Challenger", page 368.
[48] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

(C) The student hypothesized that the heavier weight will work better because "…the rubber band will store more potential energy." This indicates an understanding of the differences in weight and the effect of increasing the weight.

(D) The student stated that the rubber band did not store the potential energy because the heavier weight did not allow the rubber band to twist, indicating an understanding of the property of weight.

S1b Physical Sciences Concepts: The student produces evidence that demonstrates understanding of position and motion of objects….

(A) The student observed, "The sinkers twist the rubber band when you push it away from you. The rubber band, as it is twisted, contains the stored or potential energy." This explanation indicates an understanding that the positions and motions of objects can be changed by pushing or pulling.

(C) The student hypothesized that the heavier weight "will work because it will store more potential energy." Although the student's use of the word "it" leaves the object unclear (clarified later), it is apparent that the student grasps the relationship between potential energy and motion.

(D) The student implied that the heavier weight did not impel the can further, as hypothesized. The student stated that the rubber band did not store potential energy because of the effect of the weight. These statements indicate understanding of the cause and effect relationship between the weight, the rubber band, and the motion (or lack thereof) of the can.

(E) The student suggests tightening the rubber band in order to store more potential energy, once again indicating an understanding of the relationship between the weight, the rubber band, and the motion of the can.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…cause and effect.

(D) The statement concerning the effect of the weight on the rubber band is evidence of a specific understanding of cause and effect.

(E) The student's "remedy" is distinguished by the informed judgment that another variable, tightness of the rubber band, needs to be changed, evidence of a specific understanding of cause and effect.

S5b Scientific Thinking: The student uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena….

(A) (C) (D) The student presents several applications of **S1b** (position and motion of objects).

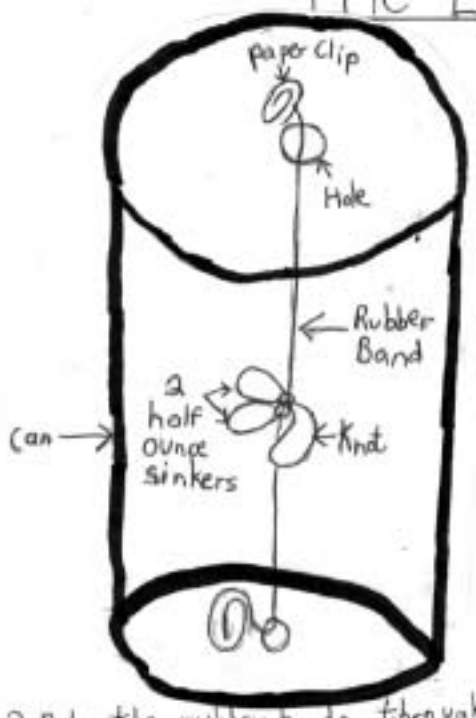
S7a Scientific Communication: The student represents data and results in multiple ways, such as…drawings, diagrams…and technical writing.

(B) (C) (D) (E) Writing and diagrams are significantly clearer in the recording of the second procedure.

S7b Scientific Communication: The student uses facts to support conclusions.

(A) The student accurately uses facts related to position and motion of objects in the statements concerning the effects of the sinkers on the rubber band.

The Energy Can



Materials

2 Paper Clips
1 Coffee Can
1 Rubber Band
2 half ounce sinkers
1 tape measure

Procedure

1. Take the rubber band and the weights.
2. Slide the weights into the middle of the rubber band and tie the weights together.
3. Poke the rubber bands through the holes on the top and the bottom of the can.
4. Slide a paperclip into the rubber band. do the same to the other side.
5. Now test it. Will the can roll back?

A

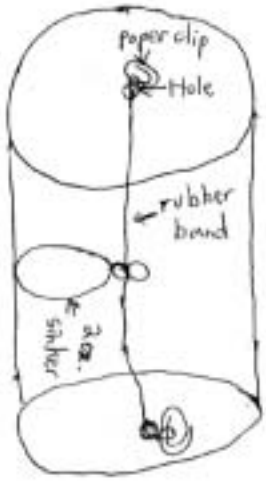
Explanation of Results

The sinkers twist the rubber band when you push it away from you. The rubber band, as it is twisted, contains the stored or potential energy. The potential energy is going to turn into kinetic energy as it is twisted backwards. The force moves it backwards.

Roll Back Result: 404 centimeters or 160 inches

The Energy Can Part II

The Change in Materials



B I had the same can and the same rubber band plus the same paper clips. I changed the weight to a 2 ounce heavy sinker.

C Hypothesis

I think it will roll back more. I think it will work because the rubber band will store more potential energy, because of the additional weight.

Procedure

1. Take the rubber band and weight. Slide the weight into the center of the rubber band and tie it.
2. Poke the rubber band into the 2 holes and slide each paper clip onto each loop on the rubber band.

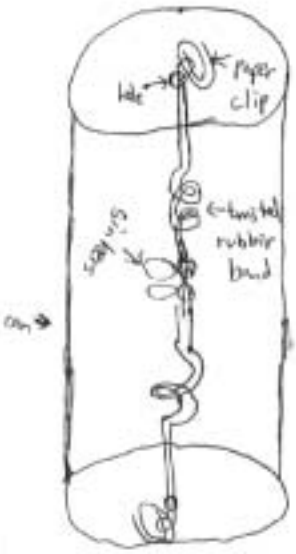
D Explanation of Results

The can did not come back. The different weight matters because the rubber band doesn't really support the 2 ounce weight and the weight hangs down on the bottom and doesn't really twist the rubber band to store the potential energy. The potential energy in the other can quickly turned into kinetic energy because it was half the weight in the can.

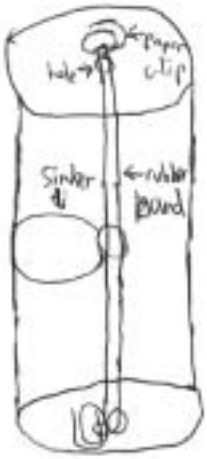
E Remedy

You need to tighten the rubber band to make the 2 ounce heavy sinker come up instead of dragging down on the bottom. I tested it and it worked almost as good as the original can.

One ounce



two ounce



Roll Back Result with a tightened rubber band:

392 centimeters or 155 inches

The task[49]

Student teams made pendulums and were asked to hypothesize about how to increase the number of swings during a given period of time (15 seconds). Students tested their hypotheses, collected data, and presented the data in the form of written reports.

Circumstances of performance

This sample of student work was produced under the following conditions:

√ alone	√ in a group
√ in class	√ as homework
with teacher feedback	with peer feedback
timed	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [50]

S1a Physical Sciences Concepts: Properties of objects and materials.

S1b Physical Sciences Concepts: Position and motion of objects.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S5f Scientific Thinking: Work individually and in teams.

S6a Scientific Tools and Technologies: Use technology and tools.

S7a Scientific Communication: Represent data and results in multiple ways.

S7c Scientific Communication: Communicate in a form suited to the purpose and the audience.

S8a Scientific Investigation: An experiment.

What the work shows

S1a Physical Sciences Concepts: The student produces evidence that demonstrates understanding of properties of objects and materials, such as similarities and differences in the size [and] weight…of objects….

(A) (B) The student describes how changing the properties of the system affected the data. In changing the variables of weight and string length and by describing the effects of those changes, the student demonstrates an understanding of those properties.

[49] For related work on Pendula, see "Pendulum Experiment", page 340.
[50] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

S1b Physical Sciences Concepts: The student produces evidence that demonstrates understanding of position and motion of objects, such as how the motion of an object can be described by measuring its position over time….

(C) The student's observation about the consistent number of swings (oscillations) over the same period of time clearly meets the standard.

(D) The student demonstrates an understanding of position over time when comparing the effects of long and short strings on the number of swings.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…cause and effect.

(E) The student clearly understands the causal relationship between the length of the string and the number of swings. (The substitution of "effect" for "affect," a minor error that occurs in two places, should be corrected in a revision.)

S5f Scientific Thinking: The student works individually and in teams to collect and share information and ideas.

(A) (B) (F) The use of the word "we" throughout the work indicates that the student worked in a group.

(G) The entire written report is an individual effort.

S6a Scientific Tools and Technologies: The student uses technology and tools (such as rulers,…watches) to gather data and extend the senses.

Although the student neglects to mention these tools, it is evident from the description of the procedure that the student used a centimeter ruler (B), a protractor (F), and a watch (H).

S7a Scientific Communication: The student represents data and results in multiple ways, such as numbers, tables, and graphs;…and technical and creative writing.

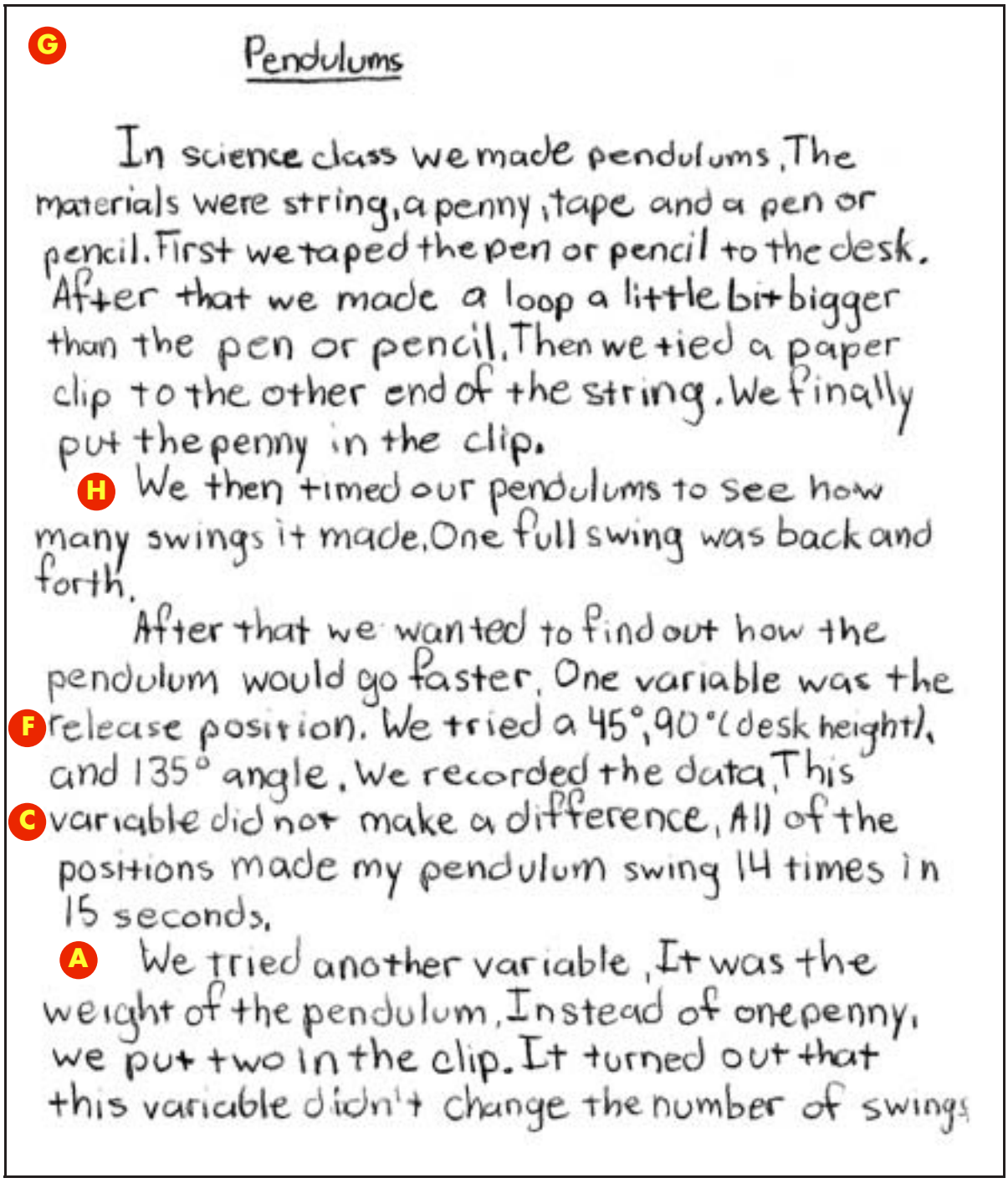
(G) (I) (J) The entire narrative is well-written and accurately describes the investigation. The student represents data in both table and graph formats. By convention, the dependent variable, number of swings, would be plotted on the y-axis, and the independent variable, length of string, would be plotted on the x-axis. This is not necessarily expected of elementary students.

S7c Scientific Communication: The student communicates in a form suited to the purpose and the audience, such as writing instructions that others can follow.

(G) Other students could easily replicate the investigation by following the procedure described in the narrative.

S8a Scientific Investigation: The student demonstrates scientific competence by completing…an experiment, such as conducting a fair test.

(G) This work sample is evidence that the student conducted a fair test. Each of three variables was tested separately to determine which variable affected the speed (period of oscillation) of the pendulum.



G

Pendulums

In science class we made pendulums. The materials were string, a penny, tape and a pen or pencil. First we taped the pen or pencil to the desk. After that we made a loop a little bit bigger than the pen or pencil. Then we tied a paper clip to the other end of the string. We finally put the penny in the clip.

H We then timed our pendulums to see how many swings it made. One full swing was back and forth.

After that we wanted to find out how the pendulum would go faster. One variable was the

F release position. We tried a 45°, 90° (desk height), and 135° angle. We recorded the data. This

C variable did not make a difference. All of the positions made my pendulum swing 14 times in 15 seconds.

A We tried another variable. It was the weight of the pendulum. Instead of one penny, we put two in the clip. It turned out that this variable didn't change the number of swings

B We finally tried the length of the string. We measured our first pendulum (43cm). Then we made a smaller (20cm) and a larger (60cm) pendulum. We finally found out our answer. The length of the string effects the number of swings. E

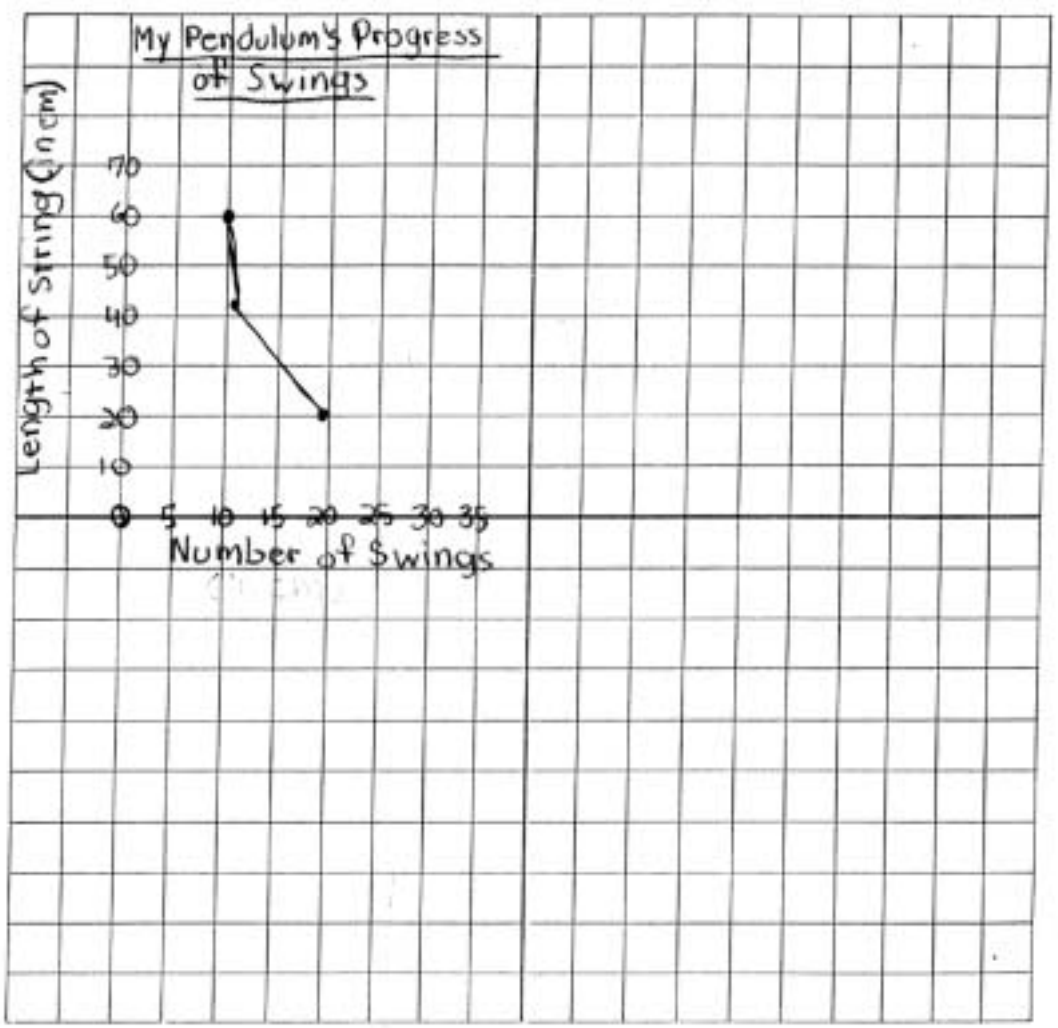
D It turned out that my hypothesis was right. I guessed it would effect the number of swings because a long string would have a very wide swing. A little size string would move much faster because it does not have a wide swing.

I

Length of String	# of swings
20 cm	19
43 cm	12
60 cm	10

J

CENTIMETRE GRAPH PAPER



Work Sample & Commentary: *Acid/Base*
Elementary School Science

The task[51]

As an assessment of prior investigations working with red cabbage juice as an indicator, the teacher asked students to see what would happen when they blew through a straw with BTB (bromthymol blue) solution. Students were given BTB, water, cups, and straws. They designed and recorded their own procedures and observations and were asked to explain what happened. When they were done, they conducted a further exploration with vinegar and BTB solution to test their initial conclusion that the color change of BTB from blue to yellow indicated the presence of an acid.

Circumstances of performance

This sample of student work was produced under the following conditions:

	alone	√	in a group
√	in class		as homework
√	with teacher feedback	√	with peer feedback
	timed	√	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [52]

S1a Physical Sciences Concepts: Properties of objects and materials.

S4a Scientific Connections and Applications: Big ideas and unifying concepts.

S5b Scientific Thinking: Use concepts to explain observations.

S5e Scientific Thinking: Identify problems, propose and implement solutions, and evaluate the accuracy, design, and outcomes of investigations.

S6a Scientific Tools and Technologies: Use technologies and tools.

S7a Scientific Communication: Represent data and results in multiple ways.

S7c Scientific Communication: Communicate in a form suited to the purpose and audience.

What the work shows

S1a Physical Sciences Concepts: The student produces evidence that demonstrates understanding of properties of objects and materials, such as similarities and differences in…color…[and] the ability of materials to react with other substances….

(A) The data table indicates recognition of a change of color and the ability of materials to react with different substances.

(B) In the conclusion, the students state, "The color of the liquid changed, so there was a chemical change."

(C) In light of (B), the students' connection of color change to acid/base determination is evidence of an understanding that a chemical reaction has occurred between the materials.

---

[51] For related work on Acids and Bases, see "Acid Rain", page 198, and "Buffer Lab", page 375.
[52] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

S4a Scientific Connections and Applications: The student produces evidence that demonstrates understanding of big ideas and unifying concepts, such as…cause and effect.
(C) (D) The students recognized that the color change was caused by the addition of certain chemicals and that similar chemicals will have similar effects.

S5b Scientific Thinking: The student uses concepts from Science Standards 1 to 4 to explain…observations and phenomena.
(C) (D) The students applied an understanding of **S1a**, properties of objects and materials, and **S4a**, cause and effect, to explain the results of the experiment.

S5e Scientific Thinking: The student identifies problems, proposes and implements solutions, and evaluates the accuracy, design, and outcomes of investigations.
(E) The students developed another experiment, hypothesized, and evaluated the outcome based on previous knowledge and the results of both experiments.

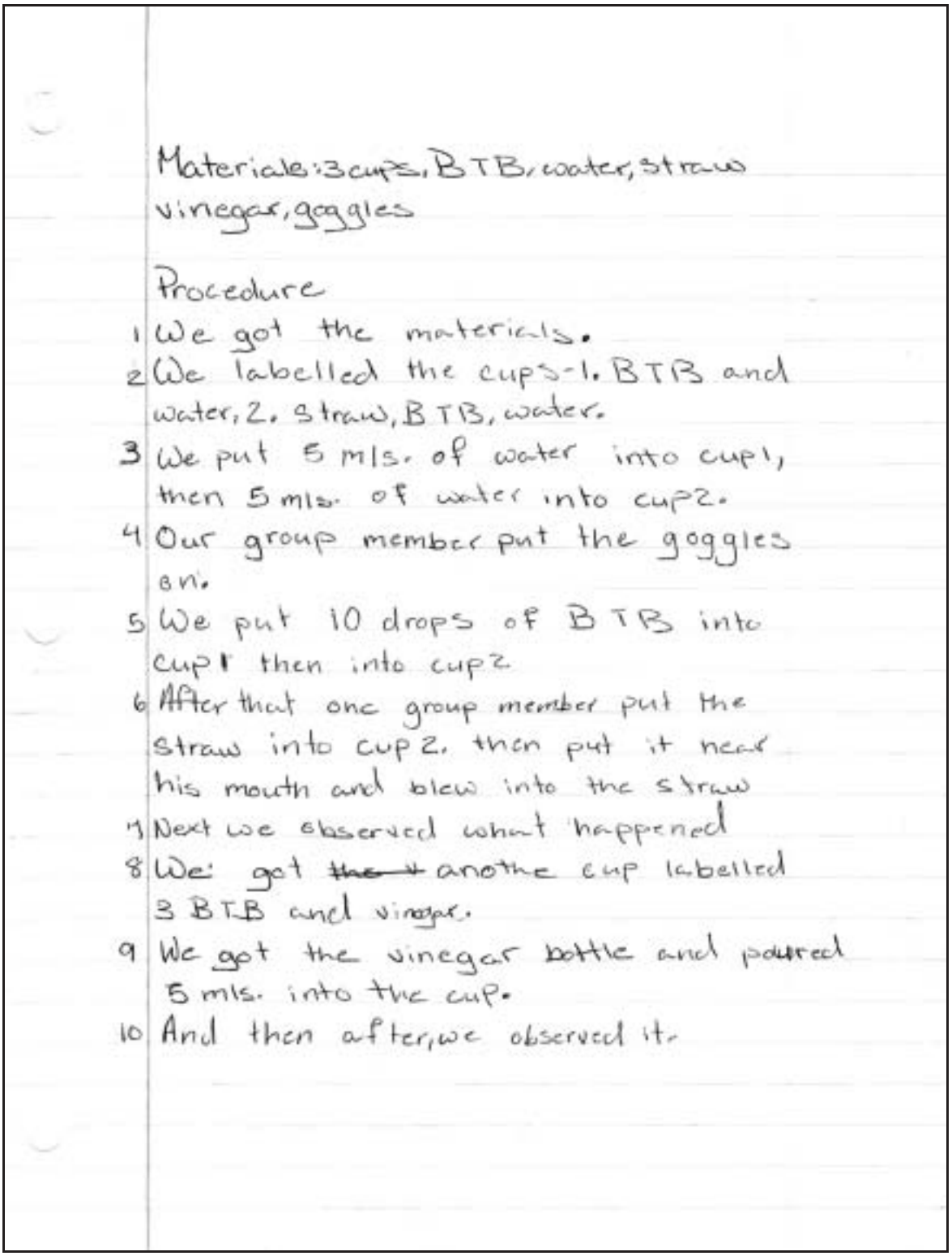
S6a Scientific Tools and Technologies: The student uses tools…to gather data.
(E) Use of the BTB in the students' follow-up experiment is evidence of accurate use of BTB as a tool.

(F) "…the BTB was an indicator…" demonstrates understanding that indicators can be used to detect acids and bases.

S7a Scientific Communication: The student represents data and results in multiple ways, such as…tables…drawings, diagrams, and art work.
(A) (G) Both the table and the student's color diagram clearly show the results of the experiment.

S7c Scientific Communication: The student communicates in a form suited to the purpose and audience, such as writing instructions that others can follow.
(A) (B) (D) (F) Throughout the work, appropriate scientific vocabulary is applied, such as accurate use of "interaction", "chemical change", "exhaled", "carbon dioxide", and "indicator".

(E) The procedure in the students' follow-up experiment clearly describes the steps of the experiment in a way that would allow replication by another elementary student.



Materials: 3 cups, BTB, water, straw
vinegar, goggles

Procedure

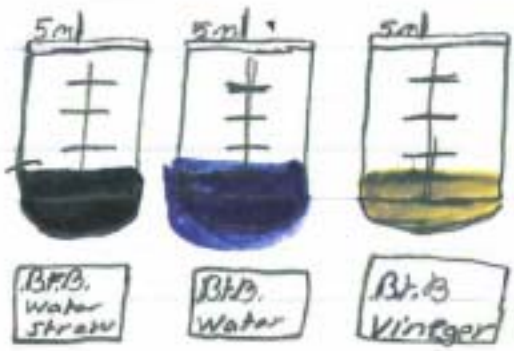
1 We got the materials.
2 We labelled the cups-1. BTB and water, 2. Straw, BTB, water.
3 We put 5 mls. of water into cup1, then 5 mls. of water into cup2.
4 Our group member put the goggles on.
5 We put 10 drops of BTB into cup1 then into cup2
6 After that one group member put the straw into cup 2. then put it near his mouth and blew into the straw
7 Next we observed what happened
8 We got ~~the~~ another cup labelled 3 BTB and vinegar.
9 We got the vinegar bottle and poured 5 mls. into the cup.
10 And then after, we observed it.

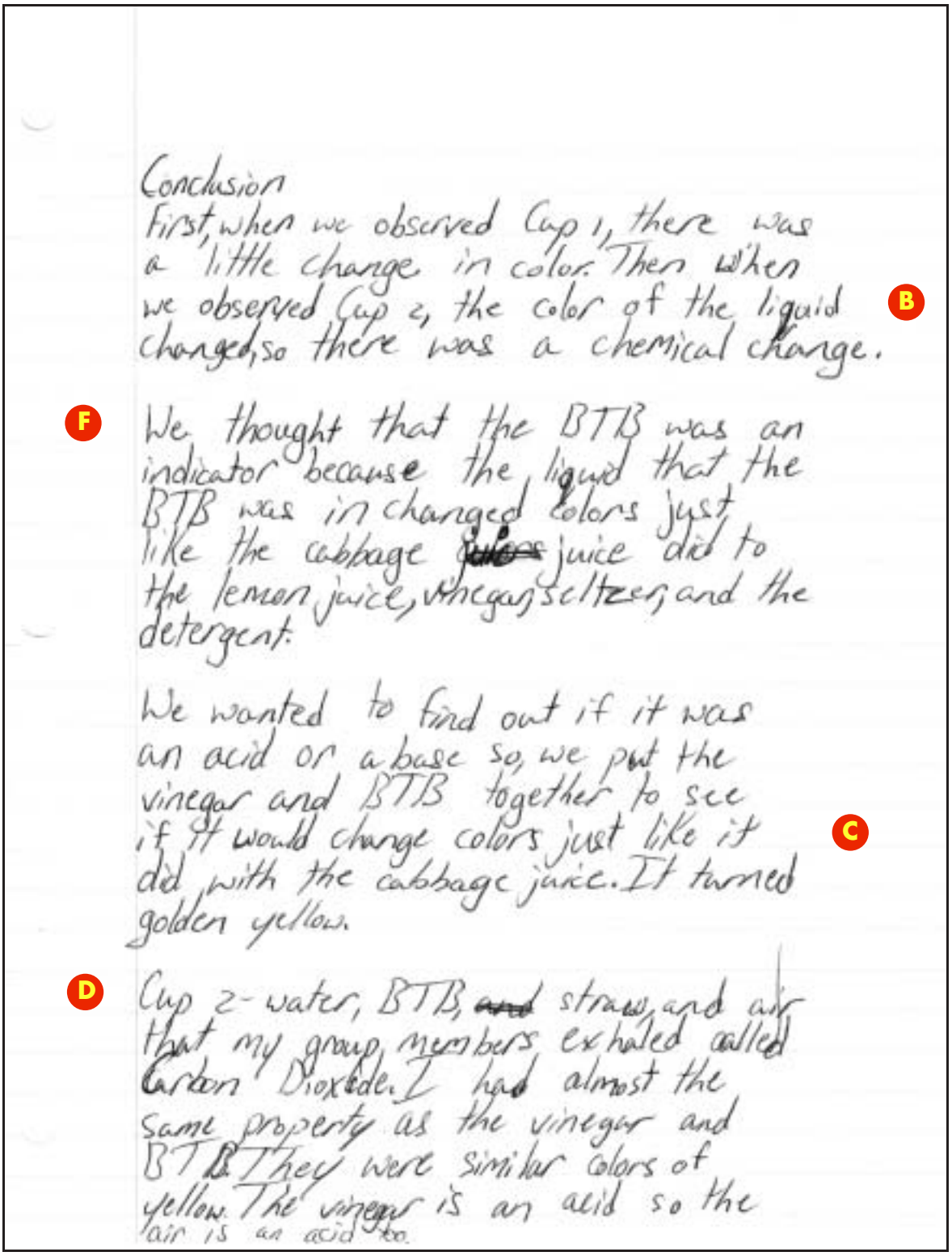
Results:

Cup	Liquid	Add BTB	Add Straw	Evidence of Interaction
Cup 1-	Water	✓		-turned light blue
Cup 2-	Water	✓	✓	-turned green -Small bubbles -then turned yellow -Big bubbles
Cup 3-	Vinegar	✓		-turned golden yellow

A

G



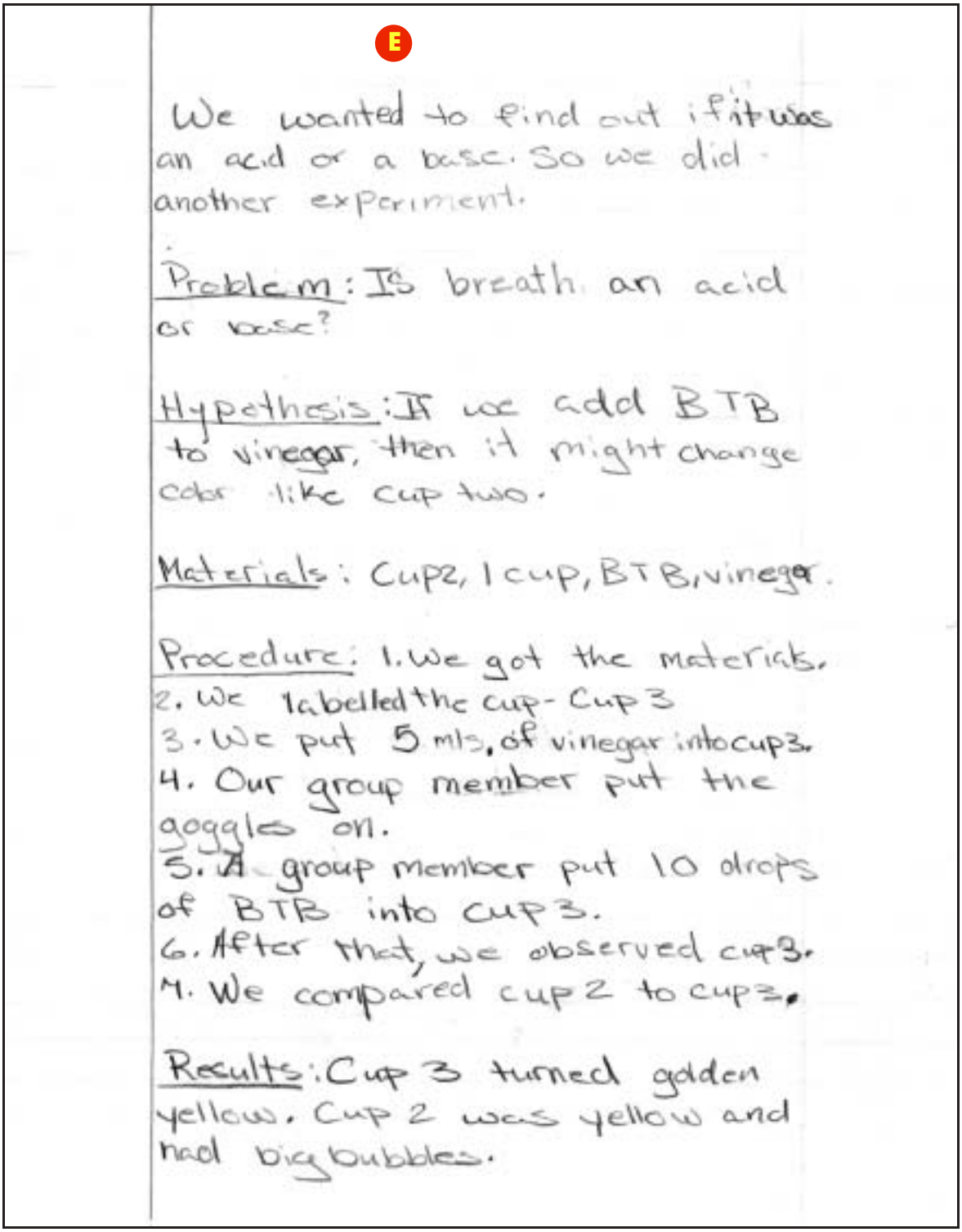


Conclusion
First, when we observed Cup 1, there was a little change in color. Then when we observed Cup 2, the color of the liquid changed, so there was a chemical change. B

F We thought that the BTB was an indicator because the liquid that the BTB was in changed colors just like the cabbage ~~juice~~ juice did to the lemon juice, vinegar, seltzer, and the detergent.

We wanted to find out if it was an acid or a base so, we put the vinegar and BTB together to see if it would change colors just like it did with the cabbage juice. It turned golden yellow. C

D Cup 2- water, BTB, ~~and~~ straw, and air that my group members exhaled called Carbon Dioxide. I had almost the same property as the vinegar and BTB. They were similar colors of yellow. The vinegar is an acid so the air is an acid too.



E

We wanted to find out if it was an acid or a base. So we did another experiment.

Problem: Is breath an acid or base?

Hypothesis: If we add BTB to vinegar, then it might change color like cup two.

Materials: Cup2, 1 cup, BTB, vinegar.

Procedure: 1. We got the materials.
2. We labelled the cup- Cup 3
3. We put 5 mls. of vinegar into cup3.
4. Our group member put the goggles on.
5. A group member put 10 drops of BTB into cup 3.
6. After that, we observed cup3.
7. We compared cup 2 to cup3.

Results: Cup 3 turned golden yellow. Cup 2 was yellow and had big bubbles.

Work Sample & Commentary: *Flinkers*
Elementary School Science

The task[53]

Students were instructed to complete a laboratory activity in which they adjusted the mass and/or the volume of an object so that the object would not float on top of water or sink…it would "flink."

The task calls for the student to explore the range of available floating and sinking objects. In order to accomplish the task, it is necessary to combine floating and sinking objects to construct one of the correct density.

Circumstances of performance

This sample of student work was produced under the following conditions:

alone	√	in a group
in class	√	as homework
with teacher feedback		with peer feedback
timed		opportunity for revision

This work sample illustrates a standard-setting performance for the following part of the standards:[54]

S1a Physical Sciences Concepts: Properties of objects and materials.

What the work shows

S1a Physical Sciences Concepts: The student produces evidence that demonstrates understanding of properties of objects and materials, such as similarities and differences in the size, weight, and color of objects….

The drawings provide evidence of sorting objects by observable properties and representing the findings.

(A) The students sorted common objects into those that floated and those that sank and recorded their findings.

(B) They used trial and error to find combinations that were neutrally buoyant (that "flinked") and drew the results.

The written summary provides evidence of conceptual understanding of density, an observable and measurable property of objects and materials.

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[53] For related work on Density, see "Discovering Density", page 209, "Density of Sand", page 412, and "Density", page 423.

[54] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

(C) The statement, "To make something flink, the mass and volume had to equal one," is acceptable for the elementary school level. At the middle school level, one would expect the student to discuss density in terms of a ratio; for example, "To make something flink, the ratio of the mass and the volume had to equal one," or "To make something flink, the mass divided by the volume had to equal one." Further, and although this is perhaps taken for granted, an adequate middle school response would make explicit the density of water, which equals one.

(D) Additional evidence of understanding the concept of density is provided in this sentence which says that the addition of mass changes the buoyancy of the object.

(E) The final sentence completes the summary with reference to observable properties.

This work is an unrevised piece of homework. There are three spelling errors ("prosess," "absorbe," and "detirmination") and a missing apostrophe ("partners").

SCIENCE ENTRY SLIP
Your name_____ Date work was completed Feb. 6
Date work placed in portfolio Feb. 6

What was the assignment? (Attach a copy if possible)

To get the mass and volume of an object to equal 1 so it wouldn't float or sink, it would flink.

Is this part of a long-term investigation or a shorter task?

A short task.

Who selected this piece of work?

What tools or resources did you use? How much feedback or help did you get from your teacher or other adults?

We used things from home that would float and others that sank and put them together just right. My partners mom helped us try out different combinations.

Did you work alone or with a group?

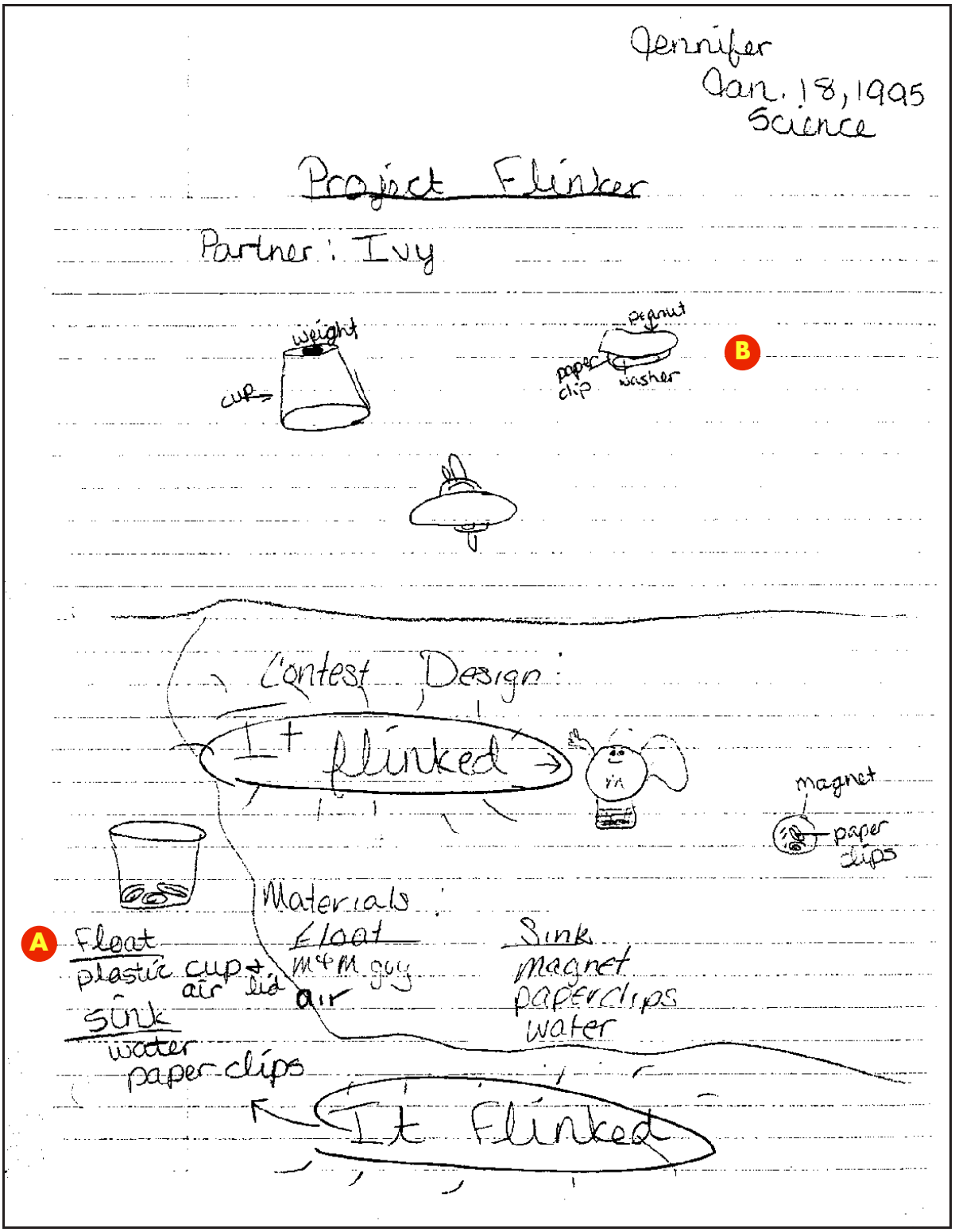
I worked with a partner.

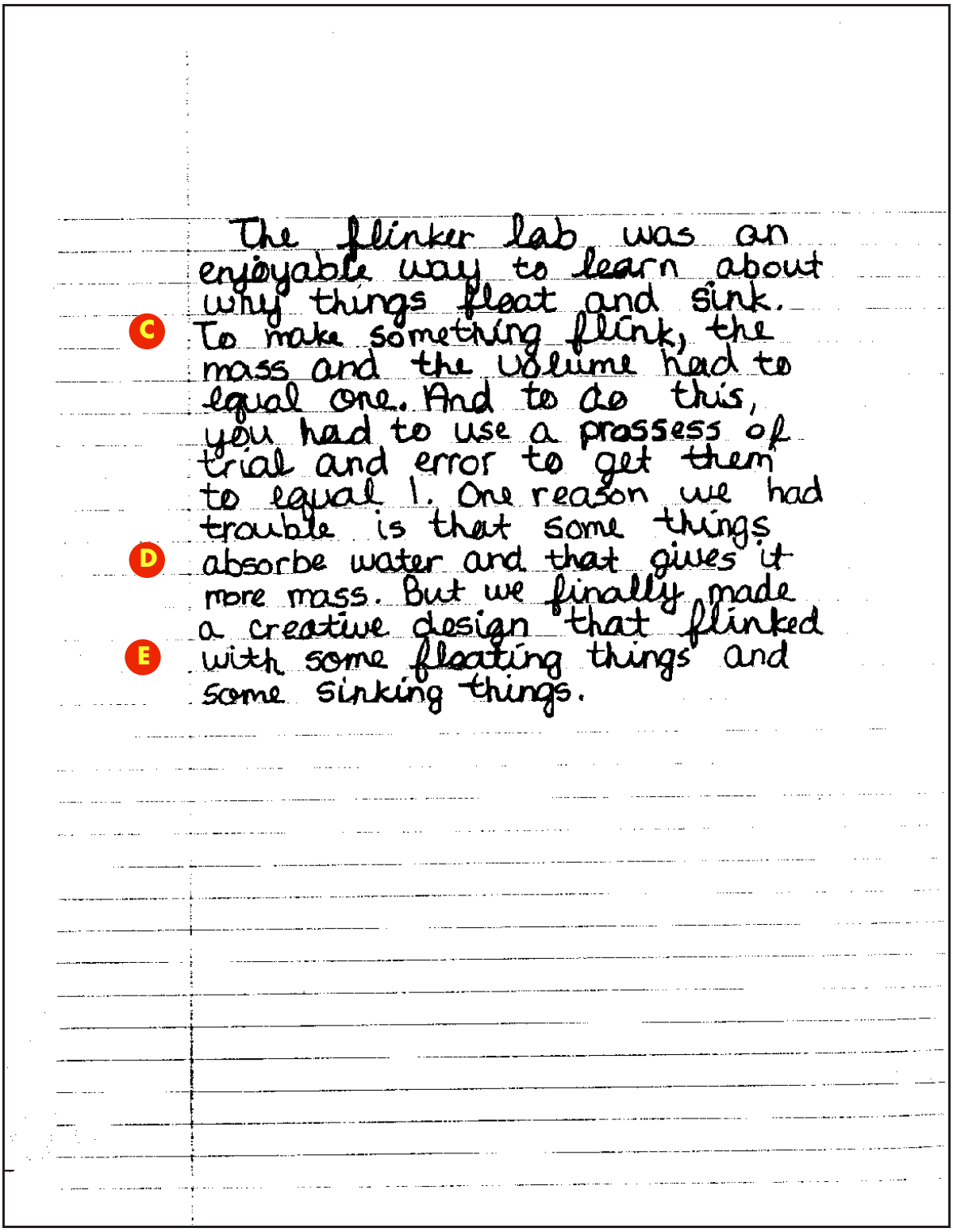
What do you want the reader to notice about this work? Why did you select this piece of work?

That it took determination and patience to get an object to flink, but it was also fun.

What were the important scientific ideas in this task?

To learn about floating, sinking, and density.


Jennifer
Jan. 18, 1995
Science
Project Flinker
Partner: Ivy
weight
cup
peanut
paper clip
washer
B
Contest Design:
It flinked
magnet
paper clips
A
Float
plastic cup
air
lid
air
Sink
water
paper clips
Materials:
Float
M&M guy
air
Sink
magnet
paperclips
water
It flinked



The flinker lab was an enjoyable way to learn about why things float and sink.

C To make something flink, the mass and the volume had to equal one. And to do this, you had to use a prossess of trial and error to get them to equal 1. One reason we had trouble is that some things

D absorbe water and that gives it more mass. But we finally made a creative design that flinked

E with some floating things and some sinking things.

The task[55]

A fourth grade class designed a controlled experiment, under the guidance of their science cluster teacher, to compare and contrast the structures and growth of six different varieties of bean plants during the plants' life cycles. The students were asked to select two of the varieties and to determine which of the two they would want to plant, if they were farmers, and why. Each student was given an individual opportunity during science class to observe the plants by using magnifying lenses and to take measurements using string and rulers. Each student kept a log of findings and wrote a conclusion based on them.

Circumstances of performance

This sample of student work was produced under the following conditions:

√ alone	in a group
√ in class	as homework
with teacher feedback	with peer feedback
timed	opportunity for revision

This work sample illustrates a standard-setting performance for the following parts of the standards: [56]

S2b Life Sciences Concepts: Life cycles of organisms.

S5b Scientific Thinking: Use concepts to explain observations.

S6a Scientific Tools and Technologies: Use technology and tools.

S7a Scientific Communication: Represent data and results in multiple ways.

S7b Scientific Communication: Use facts to support conclusions.

S7c Scientific Communication: Communicate in a form suited to audience and purpose.

S8a Scientific Investigation: An experiment, such as a fair test.

What the work shows

S2b Life Sciences Concepts: The student produces evidence that demonstrates understanding of life cycles of organisms…and that all plants and animals have life cycles.

(A) The student began the documentation of the bean plant life cycle with a drawing of the germination of five seeds.

(B) Understanding of a subsequent stage in the bean plant life cycle is demonstrated in the entry for 9/25/98 in both the labeled diagram and in the wording: "Three [of the initial five seeds] are now seedlings."

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[55] For related work on Response to Environment, see "Water Tolerance", page 98, "Toasted Bread", page 111, "Snails", page 244, and "Endocrine Feedback Exercise ", page 449.

[56] The quotations from the Science performance descriptions in this commentary are excerpted. The complete performance descriptions are shown on pages 22-53.

(C) Evidence of understanding of other life cycle stages is found in the conclusion. The student notes that the bush bean plants produced more flowers and pods than the kidney bean plants did. The student clearly understands that pods produce beans. The student also uses the term "life cycle" in a correct comparison based on observations.

S5b Scientific Thinking: The student uses concepts from Science Standards 1 to 4 to explain a variety of observations and phenomena.

(C) The student's conclusion applies concepts from S2b.

S6a Scientific Tools and Technologies: The student uses…tools (such as rulers,…magnifiers) to gather data and extend the senses.

(D) In the 11/2/98 entry, the measurements for pod length and width are recorded next to a diagram of the bean pods. The student used a metric ruler to measure lengths and widths of pods.

(E) (F) The student measured and recorded plant height and circumference using a metric ruler and string.

(G) The student used a magnifying lens to examine the structures of the flowers and the emergent pods.

S7a Scientific Communication: The student represents data and results in multiple ways, such as…drawings, diagrams, and artwork, and…technical writing.

(D) The student used a labeled drawing to communicate measurement of the bean pods and used two sentences to convey these observations.

(H) In all of the entries from 10/5/98 through 10/27/98, the student used labeled drawings in brief log entries to illustrate understanding of differences between compound and simple leaves and to note the development of flowers and pods.

S7b Scientific Communication: The student uses facts to support conclusions.

(A) (B) (D) (G) (H) Observations and data recorded in the log kept over the course of the experiment support the conclusion.

(C) The student observed that the bush beans produced the greater number of flowers. To arrive at the conclusion, the student combined this fact with an understanding, explicitly indicated in the conclusion, that bean flowers produce bean pods and pods produce seeds.

S7c Scientific Communication: The student communicates in a form suited to the purpose and the audience, such as writing instructions that others can follow.

(I) The work includes a step-by-step procedure that would allow for replication of the experiment by another elementary student.

S8a Scientific Investigation: The student demonstrates scientific competence by…an experiment, such as conducting a fair test.

(J) The procedure indicates that all factors were kept the same in the germination and growth of the two kinds of bean plants. In the conclusion, the student cites observations of differences in the relative hardiness of the plants that resulted from the procedure.

The Bean Farmer's Experiment

Which bean seed is best to plant

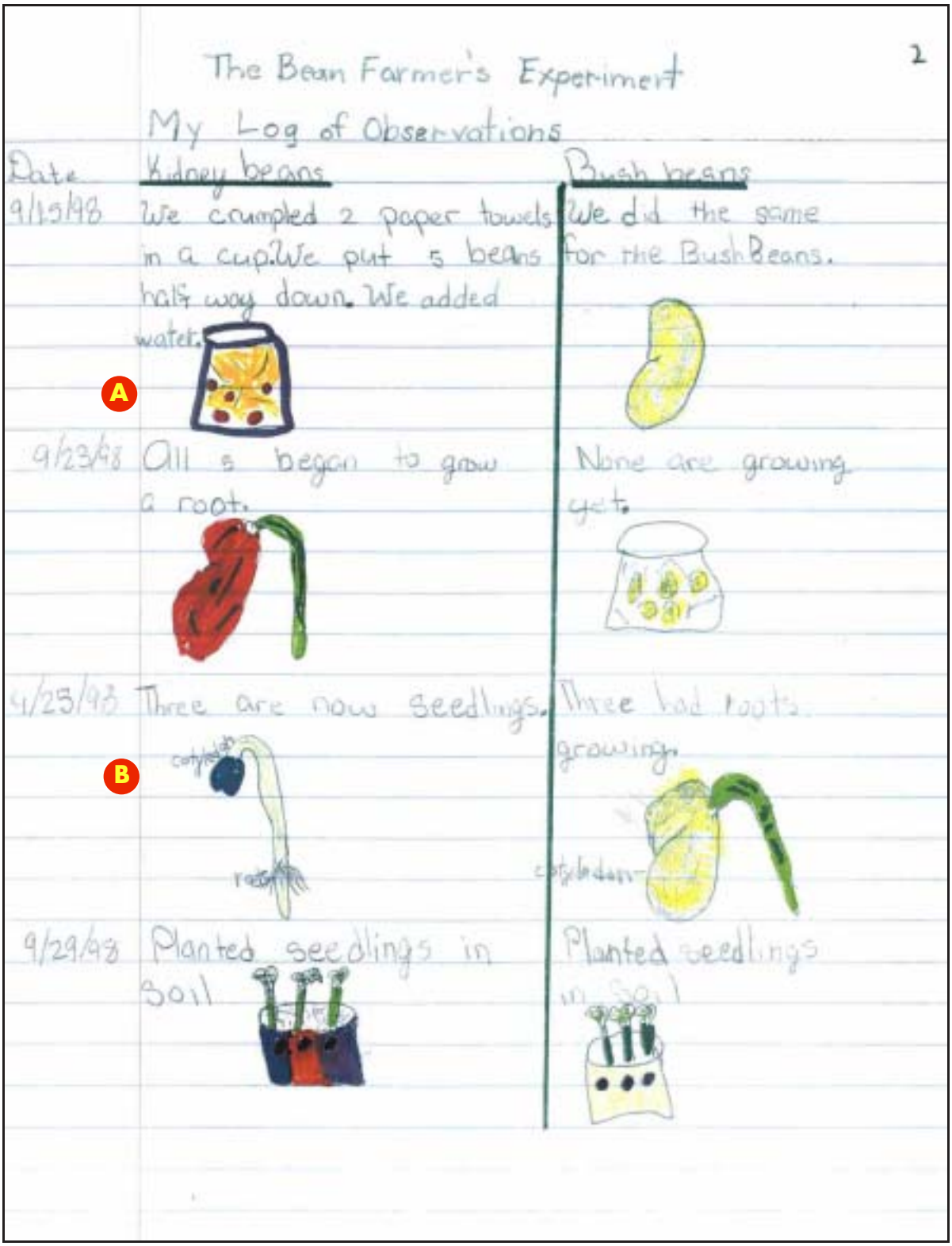
Problem: because it will produce the hardiest plant and the most beans?

Hypothesis: I think the Bush Bean plant will be the hardiest and produce the most seeds because the seed is bigger to begin with.

Materials: 5 Bush Bean seeds, 5 Kidney Bean seeds, 2 clear cups, rulers, magnifying lens, plastic pea fence, two bamboo stakes, string, twist ties, crayons, drawing paper, log paper, pots, and soil

I Procedure: 1. Crumple 2 paper towels and put them in a clear cup.
2. Add water to make the towels damp.
3. Place five Kidney Beans halfway down the cup between the cup and the paper towels
J 4. Repeat for the Bush Beans.
5. Keep moist + out of the light. Check each day. Fill in the log every few days, as needed.
6. When leaves appear, move to a sunny location. 7. Plant the seedlings in soil when the plant is established. 8. Add support when the plants get tall. Fill two pots with moist soil. Put a bamboo pole in each pot. Attach pea fence between the poles. Secure the fence with twist ties. Place the bean plants next to the fence.
9. When the plants produce beans, germinate them starting back at # 1. of this procedure.

Observation: * See log entries



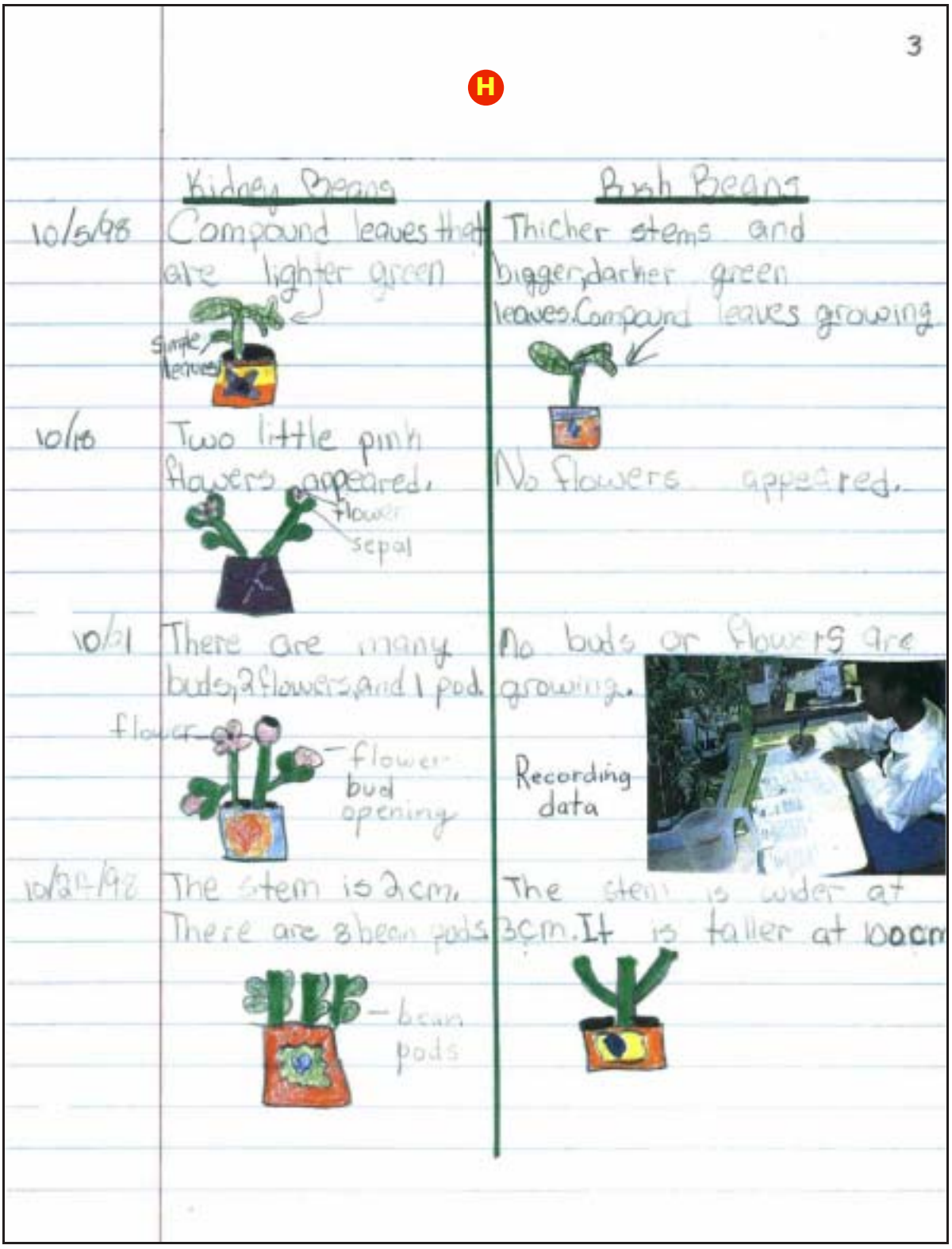
The Bean Farmer's Experiment 2

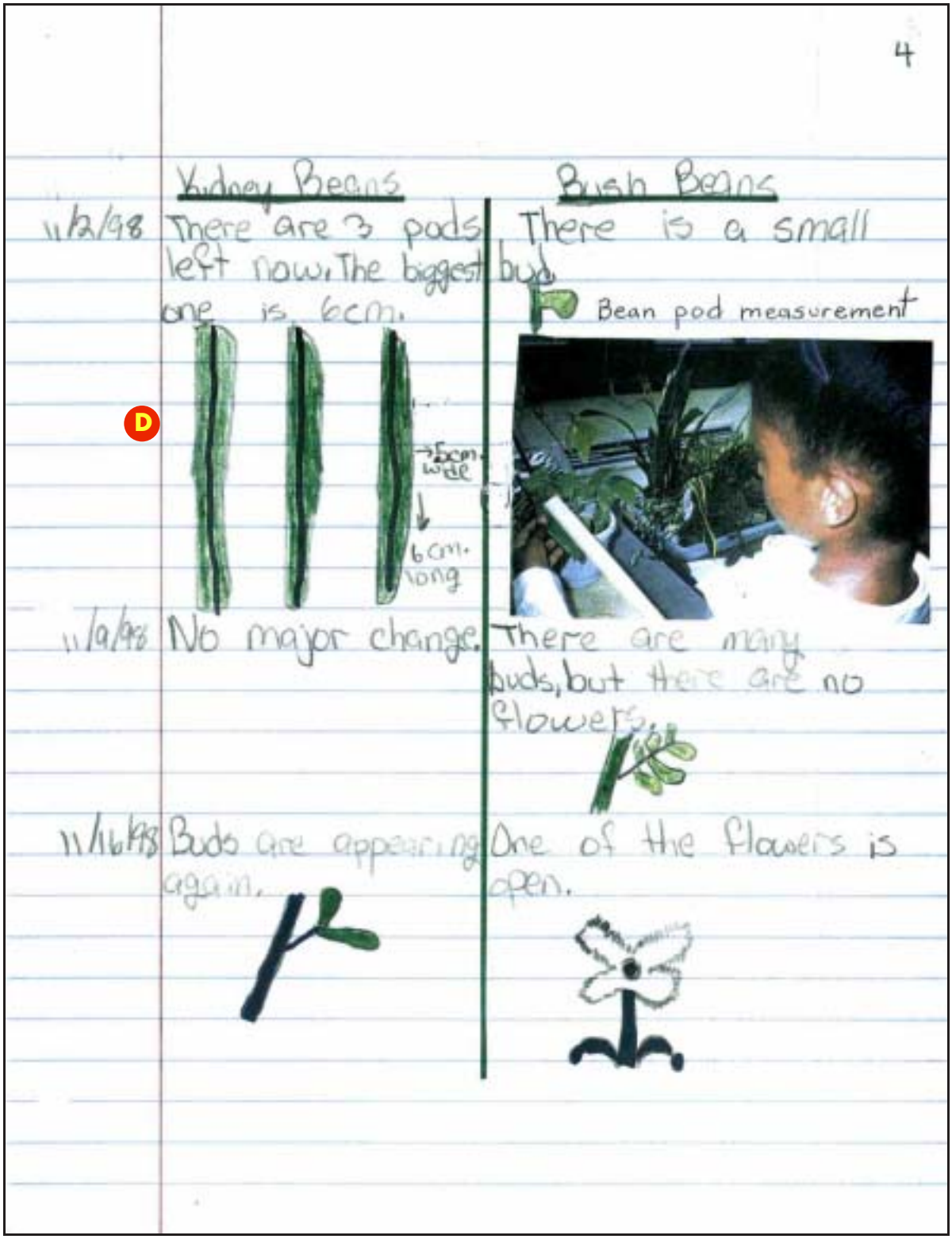
My Log of Observations

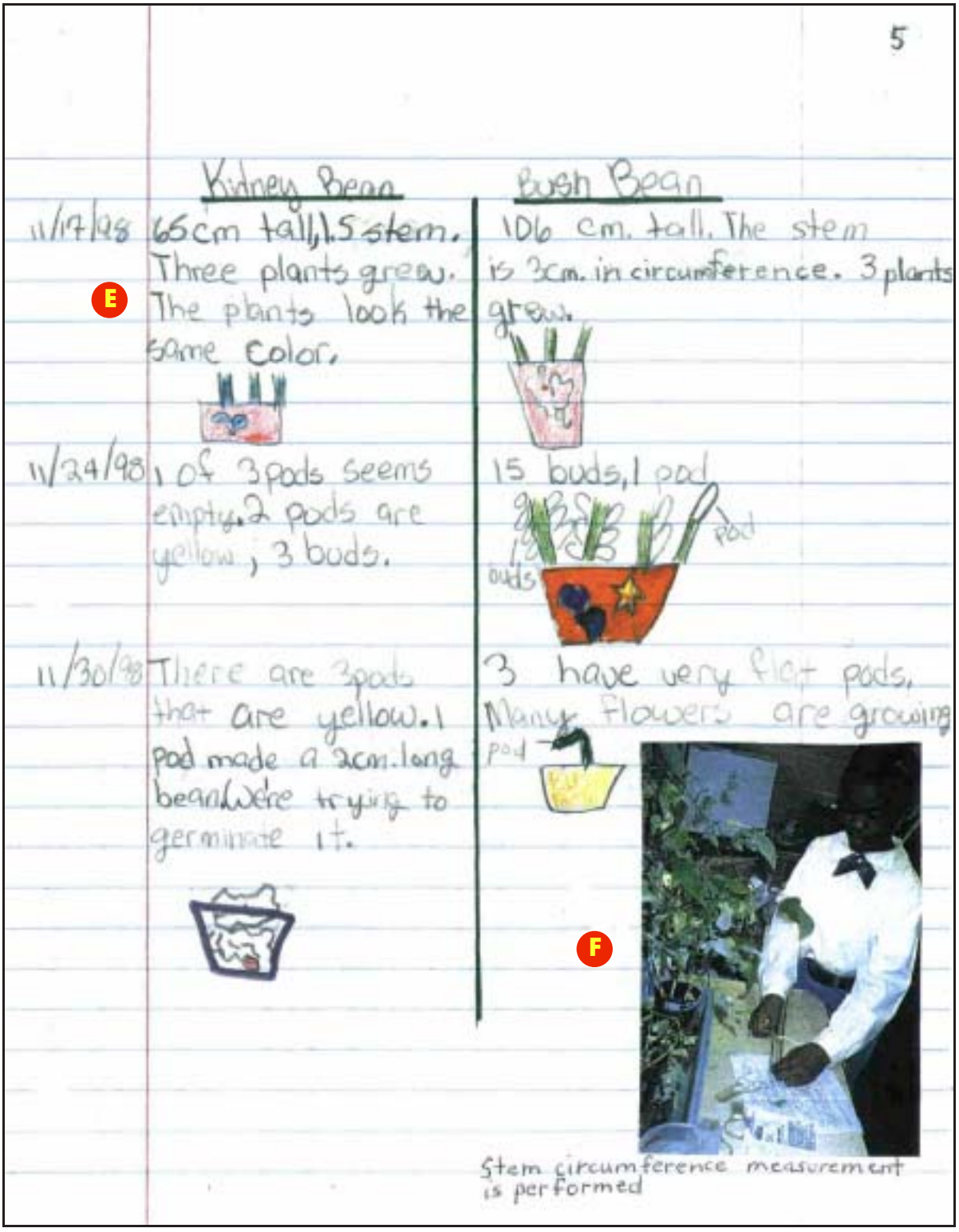
Date	Kidney beans	Bush beans
9/15/98	We crumpled 2 paper towels in a cup. We put 5 beans half way down. We added water.	We did the same for the Bush Beans.
9/23/98	All 5 began to grow a root.	None are growing yet.
9/25/98	Three are now seedlings.	Three had roots growing.
9/29/98	Planted seedlings in soil	Planted seedlings in soil

A

B


3
H
Kidney Beans
Bush Beans
10/5/98
Compound leaves that are lighter green
Simple leaves
Thicker stems and bigger, darker green leaves. Compound leaves growing
10/10
Two little pink flowers appeared.
flower
sepal
No flowers appeared.
10/21
There are many buds, 2 flowers, and 1 pod.
flower
flower bud opening
No buds or flowers are growing.
Recording data
10/28-98
The stem is 2cm. There are 8 bean pods
bean pods
The stem is wider at 3cm. It is taller at 10cm


4
Kidney Beans
Bush Beans
11/2/98
There are 3 pods left now. The biggest one is 6cm.
There is a small bud.
Bean pod measurement
D
5cm wide
6cm. long
11/9/98
No major change.
There are many buds, but there are no flowers.
11/16/98
Buds are appearing again.
One of the flowers is open.


5
Kidney Bean
Bush Bean
11/17/98
65cm tall, 1.5 stem. Three plants grew. The plants look the same color.
E
106 cm. tall. The stem is 3cm. in circumference. 3 plants grew.
11/24/98
1 of 3 pods seems empty. 2 pods are yellow, 3 buds.
15 buds, 1 pod
pod
buds
11/30/98
There are 3 pods that are yellow. 1 pod made a 2cm. long bean. We're trying to germinate it.
3 have very flat pods. Many flowers are growing
pod
F
Stem circumference measurement is performed

6

My Conclusion

C Based on my log I would plant the Bush Beans. They grew the tallest and the widest. They also had more flowers and pods than the Kidney Beans. The Bush Beans may have a longer life cycle but right now I think they will produce more beans. I think it pays to wait longer to get more beans.

G Bush bean plants showing many flowers.