Moving Objects

4th Grade, Unit 4, Lesson 1

This activity is suggested to be taught in 2mini lessons to provide time for students to process and cover unit concepts. Make instructional decisions as needed.

NGSS/Science Standards:

4-PS3-1 Energy
Use evidence to construct an explanation relating the speed of an object to the energy of that object. [Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

4-PS3-3 Energy
Ask questions and predict outcomes about the changes in energy that occur when objects collide. [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Science and Engineering Practices: **Use evidence to construct an explanation.** Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
Disciplinary Core Ideas: **Definitions of Energy; Conservation of Energy and Transfer of Energy; Relationship Between Energy and Forces.** The faster a given object is moving, the more energy it possesses. When objects collide, the contact forces transfer energy so as to change the objects' motions.
Crosscutting Concept: **Energy and Matter.** Energy can be transferred in various ways and between objects.

Content Objectives: Your job is to observe how an object's speed affects its energy and what happens to the energy when objects collide.

Literacy Objective: You will be observing the differences in the speed of objects, writing down your observations and communicating with your peers about what an object's speed tells you about changes in energy.

Focus Questions:

Lesson 1: What is the relationship between an object's movement and the energy it possesses?
Lesson 2: What happens to energy when object collide?

Materials list:

Engage:
For each student:

- Science Journal

Explore:
For each group of 4 students:

- 1 heavy ball (check with PE teachers for kickballs, basketballs, or soccer balls)
- 1 croquet mallet

Elaborate:
For each group of 4 students:

- 3 heavy balls (check with PE teachers for kickballs, basketballs, or soccer balls)
- 1 croquet mallet

Day 1 (45 minutes)

Focus Question: What is the relationship between an object's movement and the energy it possesses?

Engage (15 minutes):

Ask students to think about exactly how you would use a croquet mallet to hit a ball, from rest, to get it to roll on a smooth level floor:

a.) In a straight line at a constant
speed: b.) In a straight line and
speeding up:
c.) In a straight line and slowing to a
stop: d.) In a circle around a chair:

Students should discuss in their groups and then record their predictions in their science journals for each scenario. They should use diagrams and written descriptions. Have them label these predications as "Moving Objects Predications 1." After predictions have been recorded have students share out their ideas.

Explore (25 minutes)

Groups will now have a chance to use a croquet mallet and ball to test their ideas about motion. Tell students to identify and discuss any of their ideas that may have been incorrect or in need of refinement. Ask them to record their observations in their science journals under the label "Moving Objects Test 1."

As students complete the activities as them – "How would you hit the ball at rest to make it go from a mark (tape on the floor), in a figure eight pattern around two chairs and back to the mark as quickly as possible?" Remind students to record their observations and ideas.

Closing (5 minutes)

Have students work within their groups to make a list of "IDEAS ABOUT MOVING OBJECTS" about which they all agree. These can be new ideas that have been developed during this activity, or ideas that you already had prior to the activity. Also, have them make a list of "QUESTIONS ABOUT MOVING OBJECTS". Tell students that we will revisit these lists and refine it as we continue to explore moving objects.

Day 2 (45 minutes)

Focus Question: What happens to energy when object collide?

Explain (10 minutes)

__Vocabulary:__

Energy - power derived from the use of physical or chemical resources; strength required to sustain physical activity

Speed - the rate at which someone or something is able to move

Revisit student lists from Day 1 and guide a class discussion over the changes in their thinking and what questions they still have. If necessary, have students create their own investigation to answer some of their questions before moving on the next activity.

Students should understand the following at this point:

The energy of an object is directly related to the speed of an object.

- The faster something is traveling the more energy it has.
- If you are in the car with your parents and you are driving fast on the highway and then you head towards home and you start to drive much slower, where do you think your car has the most potential energy? The highway or your neighborhood? What about kinetic energy?

Elaborate (25 minutes)

Have students make predications within their groups about the following situations:

a.) Two balls traveling in a straight line towards each other:

b.) One ball that is in motion approaches another ball that is at rest:

c.) Three balls are in lined up 1 meter apart, you tap the first ball with the mallet:

Students should discuss in their groups and then record their predictions in their science journals for each scenario. They should use diagrams and written descriptions. Have them label these predications as "Moving Objects Predications 2." After predictions have been recorded have students share out their ideas.

Next, have groups use a croquet mallet and balls to test their ideas about what happens when objects collide. Tell students to identify and discuss any of their ideas that may have been incorrect or in need of refinement. Ask them to record their observations in their science journals under the label "Moving Objects Test 2."

__Vocabulary:__

Collide - hit with force when moving; crash into

Evaluate (10 minutes):

Have students discuss their findings as a whole class from Day 2's activities. Correct any misgivings, and then have students complete the Claim-Evidence-Reasoning graphic organizer.

Name____

Claim-Evidence-Reasoning Statement

Focus Question:

- What is the relationship between an object's movement and the energy it possesses?
- What happens to energy when object collide?

Claim: A statement that answers the original focus question or problem.

What conclusion can you make about your original focus question or problem?

Evidence: Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.

What data or observations do you have to support your claim?

Energy on the Move

4th Grade, Unit 4, Lesson 2

This activity is suggested to be taught in 2mini lessons to provide time for students to process and cover unit concepts. Make instructional decisions as needed.

NGSS/Science Standards:

4-PS3-2 Energy

Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [*Assessment Boundary: Assessment does not include quantitative measurements of energy*.]

4-PS3-4 Energy

Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound*.]

Science and Engineering Practices: Constructing Explanations and Designing Solutions. Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Disciplinary Core Ideas: Conservation of Energy and Transfer of Energy; Energy in Chemical Processes and Everyday Life; Defining Engineering Problems. Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically produced. Light also transfers energy from place to place. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

Crosscutting Concept: Energy and Matter. Energy can be transferred in various ways and between objects.

Content Objectives: Students will be able to demonstrate how energy can be transferred from one object to another, by melting an ice cube on colored paper.

Literacy Objective: Students will communicate with your team, record your observations and discuss the outcomes of your experiments.

Focus Questions:

How is energy transferred between objects or systems?

Materials list:

Engage:

For each pair of students:

2 different sized balls – ex. Tennis ball and kickball

Explore:

For each student:

Science journal

For each group of 3 students:

1 3-inch square piece of each colored paper: black, white, purple, yellow, red, green*

6 ice cubes

For the class:

Stopwatch or timer for teacher's use during activity

***Advance preparation**: Teacher needs to cut colored paper into 3 inch squares, enough for each group of three students to have one piece of each color.

Elaborate:

Per group of 3 students:

3 marshmallows

3 graham crackers

3 miniature Hershey's chocolates

1 shallow aluminum pan

1 piece of plastic wrap large enough to cover pan

1 full piece of paper from Day 1 activity

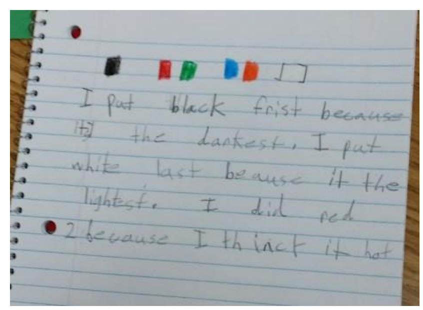
Day 1(45 minutes)

Engage (10 minutes)

- Allow students time to experiment with bouncing the two balls together, so that one bounces off the top of the other.
- Have students describe the reaction of the balls being dropped together, which direction to they go?
- Ask students why they think the top ball was able to bounce, even though it didn't touch the floor.
- Ask students why they think the top ball went the direction it did.

Explore (20 minutes)

Split students into groups of three. Give each group six different sheets of colored paper. The paper is pre-cut into 3 inch squares. (white, black, green, red, purple, yellow) Instruct students that they will work together to predict and explore which color of paper will **cause** the ice cube to melt the **quickest**. (*Some students will already have an idea that dark paper will melt the ice cube quicker because they have prior experiences with this idea, however, the hands on investigation allows students to carry out an investigation, practice observation skills and draw conclusions from the investigation, all important components of the NGSS.*)



Example of student predictions in their science journals: This student has ordered the paper from the paper that will absorb the most light to the least light.

The inquiry part of this lesson is critically important. Scientific inquiry reflects how scientists come to understand the natural world, and it is at the heart of how students learn. From a very early age, children interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences.

Scientific inquiry is a powerful way of understanding science content. Students learn how to ask questions and use evidence to answer them. In the process of learning the strategies of scientific inquiry, students learn to conduct an investigation and collect evidence from a variety of sources, develop an explanation from the data, and communicate and defend their conclusions.

After prediction s have been made give each partner group six small ice cubes in a cup. For the next part of the lesson teachers can use an open area outside or set up desk lamps at stations around the room. Students bring all supplies with them and then set their paper under the sun or lamp stations. Students then place an ice cube on each sheet of colored paper at the same time. Students record their observations in their science notebooks. As each minute goes by, the teacher calls out how long the ice cubes have been on the paper.

As students make observations, the teacher circulates between partner groups and asks guiding questions to propel thinking.

Explain: (15 minutes)

When most groups are finished with observations, lead a class discussion with the students about light and absorption. Many fourth graders already know or have background knowledge that black colors absorb light, while light colors reflect light. Through the class discussion, guide students to see that light energy can be **converted** to heat or **thermal energy** when certain materials absorb it. Some materials are heated more than others by light that shines on them.
Dark materials absorb more of the visible spectrum of light. The absorbed light energy is converted and is released as heat energy. Since more of the spectrum is absorbed there is more energy that is converted to heat. Light colored materials absorb less and reflect more of the light spectrum (less energy) so less energy is released as heat
Also, in the class discussion, go over the results of the partner experiments. Check to see if groups arrive at similar results. If groups did not get similar results, talk with students about reasons why that could occur.

Adapted from Chillin' with Colored Paper by Melissa Romano

Day 2(45 minutes total)

Elaborate: (35 minutes)

Divide students back into their groups of three from day 1's activity.

Provide groups with the following materials: shallow aluminum pans, plastic wrap, graham crackers, marshmallows, chocolate, full sheets of the colored papered used in day 1's activities.

Tell students that their job is to design and construct a device to make a s'more. Students will test their designs against their classmates designs to see which design "cooks" the s'more the quickest when placed in the sun (or under a halogen light, if sunlight is unavailable). As students are building their devices have them record their design in their science journals.

As students complete their designs have them test them by placing them in the light source and timing how long it takes for the chocolate melt and the marshmallow to become sticky. Students can take turns timing. Those students who are not timing should be recording observations at 2-3 minute time frames.

Evaluate: (10 minutes)

Have students share out their results and compare the different devices effectiveness at melting the chocolate and marshmallow. Then have students complete the Claim-Evidence-Reasoning statement for this lesson.

Name____

Claim-Evidence-Reasoning Statement

Focus Question:

- How is energy transferred between objects or systems?

Claim: A statement that answers the original focus question or problem.
What conclusion can you make about your original focus question or problem?

Evidence: Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.
What data or observations do you have to support your claim?

4-PS3-1 Energy

Students who demonstrate understanding can:

4-PS3-1. **Use evidence to construct an explanation relating the speed of an object to the energy of that object.** [*Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.*

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct an explanation.	**PS3.A: Definitions of Energy** • The faster a given object is moving, the more energy it possesses.	**Energy and Matter** • Energy can be transferred in various ways and between objects.

Observable features of the student performance by the end of the grade:			
1	Articulating the explanation of phenomena		
	a	Students articulate a statement that relates the given phenomenon to a scientific idea, including that the speed of a given object is related to the energy of the object (e.g., the faster an object is moving, the more energy it possesses).	
	b	Students use the evidence and reasoning to construct an explanation for the phenomenon.	
2	Evidence		
	a	Students identify and describe the relevant given evidence for the explanation, including:	
		i.	The relative speed of the object (e.g., faster vs. slower objects).
		ii.	Qualitative indicators of the amount of energy of the object, as determined by a transfer of energy from that object (e.g., more or less sound produced in a collision, more or less heat produced when objects rub together, relative speed of a ball that was stationary following a collision with a moving object, more or less distance a stationary object is moved).
3	Reasoning		
	a	Students use reasoning to connect the evidence to support an explanation for the phenomenon. In the explanation, students describe a chain of reasoning that includes:	
		i.	Motion can indicate the energy of an object.
		ii.	The faster a given object is moving, the more observable impact it can have on another object (e.g., a fast-moving ball striking something (a gong, a wall) makes more noise than does the same ball moving slowly and striking the same thing).
		iii.	The observable impact of a moving object interacting with its surroundings reflects how much energy was able to be transferred between objects and therefore relates to the energy of the moving object.
		iv.	Because faster objects have a larger impact on their surroundings than objects moving more slowly, they have more energy due to motion (e.g., a fast-moving ball striking a gong makes more noise than a slow-moving ball doing the same thing because it has more energy that can be transferred to the gong, producing more sound). [Note: This refers only to relative bulk motion energy, not potential energy, to remain within the DCI.]
		v.	Therefore, the speed of an object is related to the energy of the object.

4-PS3-2 Energy

Students who demonstrate understanding can:

4-PS3-2. **Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** [*Assessment Boundary: Assessment does not include quantitative measurements of energy.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- Light also transfers energy from place to place.
- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

Observable features of the student performance by the end of the grade:		
1	Identifying the phenomenon under investigation	
	a	From the given investigation plan, students describe the phenomenon under investigation, which includes the following ideas:
		i. The transfer of energy, including:
		1. Collisions between objects.
		2. Light traveling from one place to another.
		3. Electric currents producing motion, sound, heat, or light.
		4. Sound traveling from one place to another.
		5. Heat passing from one object to another.
		6. Motion, sound, heat, and light causing a different type of energy to be observed after an interaction (e.g., in a collision between two objects, one object may slow down or stop, the other object may speed up, and the objects and surrounding air may be heated; a specific sound may cause the movement of an object; the energy associated with the motion of an object, via an electrical current, may be used to turn on a light).
	b	Students describe the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon, including the idea that energy can be transferred from place to place by:
		i. Moving objects.

		ii. Sound.
		iii. Light.
		iv. Heat.
		v. Electric currents.
2	Identifying the evidence to address the purpose of the investigation	
	a	From the given investigation plan, students describe the data to be collected that will serve as the basis for evidence, including:
		i. The motion and collision of objects before and after an interaction (e.g., when a given object is moving fast, it can move another object farther than when the same object is moving more slowly).
		ii. The relative presence of sound, light, or heat (including in the surrounding air) before and after an interaction (e.g. shining a light on an object can increase the temperature of the object; a sound can move an object).
		iii. The presence of electric currents flowing through wires causally linking one form of energy output (e.g., a moving object) to another form of energy output (e.g., another moving object; turning on a light bulb).
	b	Students describe how their observations will address the purpose of the investigation, including how the observations will provide evidence that energy, in the form of light, sound, heat, and motion, can be transferred from place to place by sound, light, heat, or electric currents (e.g., in a system in which the motion of an object generates an observable electrical current to turn on a light, energy (from the motion of an object) must be transferred to another place (energy in the form of the light bulb) via the electrical current, because the motion doesn't cause the light bulb to light up if the wire is not completing a circuit between them; when a light is directed at an object, energy (in the form of light) must be transferred from the source of the light to its destination and can be observed in the form of heat, because if the light is blocked, the object isn't warmed.
3	Planning the investigation	
	a	From the given investigation plan, students identify and describe how the data will be observed and recorded, including the tools and methods for collecting data on:
		i. The motion and collision of objects, including any sound or heat producing the motion/collision, or produced by the motion/collision.
		ii. The presence of energy in the form of sound, light, or heat in one place as a result of sound, light, or heat in a different place.
		iii. The presence of electric currents in wires and the presence of energy (in the form of sound, light, heat, or motion resulting from the flow of electric currents through a device).
	b	Students describe the number of trials, controlled variables, and experimental set up.
4	Collecting the data	
	a	Students make and record observations according to the given investigation plan to provide evidence that:
		i. Energy is present whenever there are moving objects, sound, light, or heat.
		ii. That energy has been transferred from place to place (e.g., a bulb in a circuit is not lit until a switch is closed and it lights, indicating that energy is transferred through electric current in a wire to light the bulb; a stationary ball is struck by a moving ball, causing the stationary ball to move and the moving ball to slow down, indicating that energy has been transferred from the moving ball to the stationary one).

4-PS3-3 Energy

Students who demonstrate understanding can:

4-PS3-3. **Ask questions and predict outcomes about the changes in energy that occur when objects collide.** [Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.] [*Assessment Boundary: Assessment does not include quantitative measurements of energy.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer

- Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.

PS3.C: Relationship Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motions.

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

Observable features of the student performance by the end of the grade:			
1	Addressing phenomena of the natural world		
	a	Students ask questions about the changes in energy that occur when objects collide, the answers to which would clarify:	
		i.	A qualitative measure of energy (e.g., relative motion, relative speed, relative brightness) of the object before the collision.
		ii.	The mechanism of energy transfer during the collision, including:
			1. The transfer of energy by contact forces between colliding objects that results in a change in the motion of the objects.
			2. The transfer of energy to the surrounding air when objects collide resulting in sound and heat.
	b	Students predict reasonable outcomes about the changes in energy that occur after objects collide, based on patterns linking object collision and energy transfer between objects and the surrounding air.	
2	Identifying the scientific nature of the question		
	a	Students ask questions that can be investigated within the scope of the classroom or an outdoor environment.	

4-PS3-4 Energy

Students who demonstrate understanding can:

4-PS3-4. **Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*** [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [*Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Apply scientific ideas to solve design problems.

Disciplinary Core Ideas

PS3.B: Conservation of Energy and Energy Transfer

- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

PS3.D: Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

ETS1.A: Defining Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*(secondary)*

Crosscutting Concepts

Energy and Matter

- Energy can be transferred in various ways and between objects.

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Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers improve existing technologies or develop new ones.

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Connections to Nature of Science

Science is a Human Endeavor

- Most scientists and engineers work in teams.
- Science affects everyday life.

Observable features of the student performance by the end of the grade:		
1	Using scientific knowledge to generate design solutions	
	a	Given a problem to solve, students collaboratively design a solution that converts energy from one form to another. In the design, students:
		i. Specify the initial and final forms of energy (e.g., electrical energy, motion, light).
		ii. Identify the device by which the energy will be transformed (e.g., a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion).
2	Describing criteria and constraints, including quantification when appropriate	
	a	Students describe the given criteria and constraints of the design, which include:
		i. Criteria:
		1. The initial and final forms of energy.
		2. Description of how the solution functions to transfer energy from one form to another.

		ii. Constraints:
		1. The materials available for the construction of the device.
		2. Safety considerations.
3	Evaluating potential solutions	
	a	Students evaluate the proposed solution according to how well it meets the specified criteria and constraints of the problem.
4	Modifying the design solution	
	a	Students test the device and use the results of the test to address problems in the design or improve its functioning.