# Fourth Grade Science

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# The definition of force in physics

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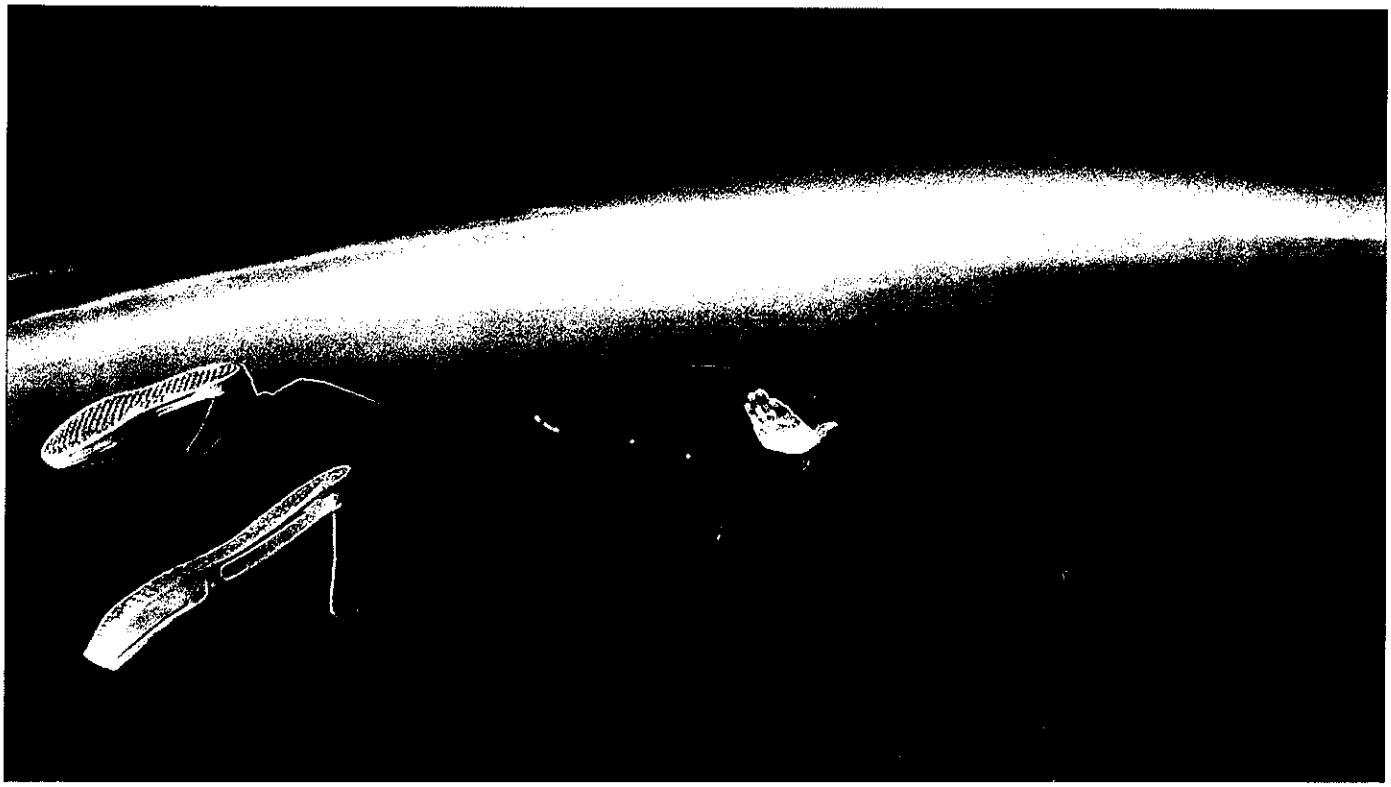


Image 1. When skydivers fall through the air. they experience air resistance. Air resistance is a type of contact force. Photo by: Graiki/Getty Images

Force is a description of an interaction between two objects. That interaction pushes or pulls on the objects. How much it pushes or pulls is measured as force. An object may speed up, slow down or change direction based on the force it meets with; or it may stay at rest because the forces are in balance. Force is a quantitative description. This means that force can be measured.

There are two types of forces in the universe: contact and non-contact. Contact force is the force exerted when two physical objects come in direct contact with each other. Other forces, however, don't require contact. These are called non-contact forces. Gravity and electricity are two examples of non-contact forces. They can happen across long distances. They can even happen across the vacuum of space.

### Units Of Force

Force is a vector. A vector is a quantity that has both direction and magnitude. Magnitude refers to a size or amount. The unit that we use to measure force is called the newton (N). One newton is the force needed to accelerate one kilogram of mass at one meter per second squared.

This formula can be written as:

$N = kg * m/s2$

Force is proportional to acceleration. Acceleration is defined as the rate of change of speed. That means that the increase in force leads to a proportional increase in the acceleration of the object. If you double the force, then you double the acceleration.

### Contact Vs. Non-contact Force

How are contact forces and non-contact forces different? Contact forces take place when objects touch each other. This happens, for example, when someone kicks a ball: one object (the foot) comes in contact with the other object (the ball). Non-contact forces are those where objects do not touch each other. However, a force affects one of them anyway.

There are six types of contact forces:

• Tension force: This is the pulling force exerted through a wire or rope. It happens when forces act to pull in opposite directions.

• Spring force: the force exerted by a spring that is stretched or compressed; the force pushes or pulls to return to its balance position.

• Normal force: Normal forces occur when one object provides a reaction to a force exerted upon it; one example is a box sitting on the ground. It presses downward on the Earth. The Earth presses back.

• Friction: the force exerted when an object moves across another; one example is a ball rolling across a concrete surface.

• Air resistance: This is the drag on an object as it moves through the air. A skydiver would experience air resistance.

• Applied force: the force exerted on an object by physical contact with another object; for example, the force when a bat strikes a ball.

Three types of non-contact forces include:

• Gravity: the force from the attraction between two objects. For example, when you let go of a stone, gravity pulls it to the Earth. The size of this gravitation pull would depend on each objects' mass. Mass is how much matter is in an object. Weight is a measure of how gravity acts on mass.

• Electrical force: This is due to the electrical charges present in two bodies. For example, a rubbed balloon can raise the hairs on your arm.

• Magnetic force: a force pulling or pushing between electrically charged particles in two bodies; such as the way magnets pull or push on each other.

### Force And Newton's Laws Of Motion

The concept of force was first defined by Sir Isaac Newton. He was an English mathematician and physicist. He explained the concept in his three laws of motion in 1687. He described gravity as an

attractive force. He said that it occurs between bodies that have mass. More than 200 years later, Einstein did not agree. In his general theory of relativity, he states that gravity is not a force.

This article is available at 5 reading levels at https://newsela.com.

## Quiz

1 Read the section "Contact Vs. Non-contact Force."

Which selection explains a type of force that happens when objects touch each other?

(A) Friction: the force exerted when an object moves across another; one example is a ball rolling across a concrete surface.

(B) Gravity: the force from the attraction between two objects. For example, when you let go of a stone, gravity pulls it to the Earth.

(C) Electrical force: This is due to the electrical charges present in two bodies. For example, a rubbed balloon can raise the hairs on your arm.

(D) Magnetic force: a force pulling or pushing between electrically charged particles in two bodies; such as the way magnets pull or push on each other.

2 Read the paragraph below from the section "Units Of Force."

*Force is proportional to acceleration. Acceleration is defined as the rate of change of speed. That means that the increase in force leads to a proportional increase in the acceleration of the object. If you double the force, then you double the acceleration.*

Based on this sentence, choose the statement that is TRUE.

(A) An increase in force does not affect acceleration.

(B) Acceleration is always much greater than force.

(C) A change to force causes a change to acceleration.

(D) Force and acceleration mean the exact same thing.

3 Read the selection from the section "Force And Newton's Laws Of Motion."

*The concept of force was first defined by Sir Isaac Newton. He was an English mathematician and physicist. He explained the concept in his three laws of motion in 1687. He described gravity as an attractive force.*

What does "concept" refer to?

(A) a problem that can occur

(B) a disagreement between people

(C) an idea that someone has

(D) a formula that describes force

4 Read the paragraph from the introduction [paragraphs 1-2].

*Force is a description of an interaction between two objects. That interaction pushes or pulls on the objects. How much it pushes or pulls is measured as force. An object may speed up, slow down or change direction based on the force it meets with; or it may stay at rest because the forces are in balance. Force is a quantitative description. This means that force can be measured.*

Which word from the paragraph helps the reader understand the meaning of "quantitative"?

(A) an interaction

(B) is measured

(C) stay at rest

(D) are in balance

Focus on the York State ng Standards

Lesson 30

# Mechanical Force

**PS 5.1a** The position of an object can be described by locating it relative to another object or the background.
**PS 5.1b** The position or direction of motion of an object can be changed by pushing or pulling.
**PS 5.1d** The amount of change in the motion of an object is affected by friction.
**PS 5.1f** Mechanical energy may cause change in motion through the application of force and through the use of simple machines such as pulleys, levers, and inclined planes.

## Force and friction affect the motion of an object.

**Force** is a push or a pull on an object.

**Friction** is force that resists the motion of one surface past another surface.

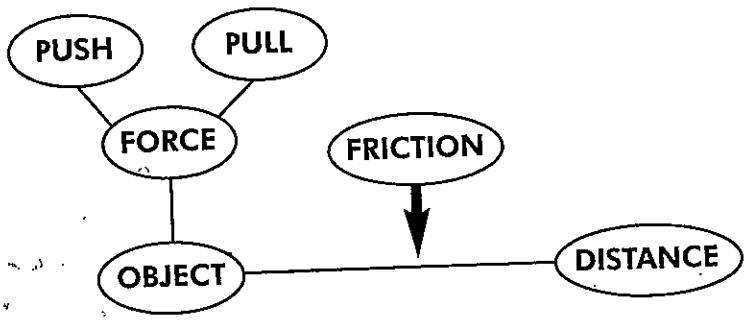
uided ruction

**Directions** Read the following information.

Imagine you have an empty wagon that you want to move a short distance. You might push the wagon or you might pull it. Either way, you would use force to move the wagon. A **force** is a push or a pull. An object, such as the wagon, starts to move only when something pushes it or pulls on it.

If you give the wagon just a little push, it would most likely move only a little bit. If you and three friends give it a big push, the wagon would travel further. That is because the amount of force used determines how far the object moves. And if you filled the wagon with bricks, your wagon would be heavier and you would need more force to move it.

Friction also changes the motion of an object. **Friction** is the force that resists the motion of one surface past another surface. *Resist* means to fight against. Friction slows down a rolling wagon.




**Guided Questions**

What is **force?**

What is **friction?**

Explain what happens when you push a box across the floor.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Rubbing a piece of foil over wood does not have much friction. Rubbing a piece of sandpaper over wood does have friction. When you rub a piece of sandpaper back and forth across a piece of wood, the sandpaper and wood will feel warm when you touch them. When surfaces rub against each other, the roughness of the surfaces slow the movement and produce heat. The wheels on your wagon make it easier to pull it. That's because the simple machine of wheels and axles reduces friction and reduces the amount of force needed to move the wagon.

Other things, such as the mechanical energy provided by simple machines, also affect the motion of an object. Pushing the wagon uphill would take more force than pushing the wagon downhill. The hill acts like a simple machine called an inclined plane, which changes the motion of the object.

**Guided Questions**

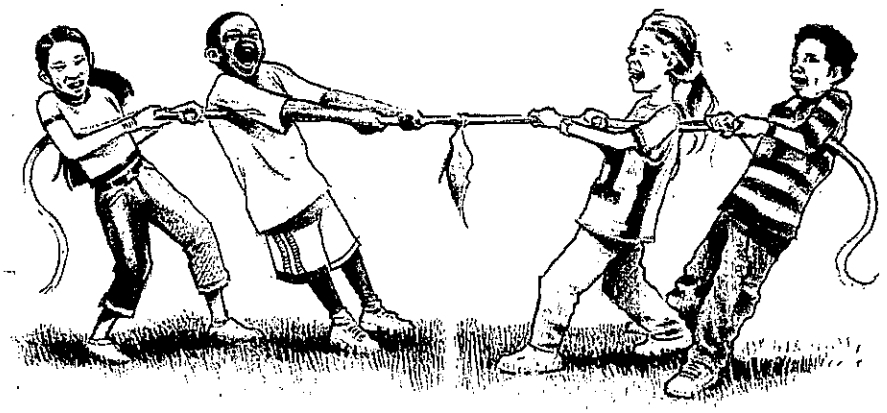
**Directions** For each question, write your answer in the space provided.

**1.** What do you need to do to make a wagon move?

_____

**2.** Look at the drawing below. What happens in a tug of war when both sides are pulling with equal force?

_____



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3. If another student joins the game and stands behind the two students already in the game, how will the game be changed?

4. Which would take more force: moving an automobile one mile or moving it ten miles? Why?

5. Is it more difficult to ride a bicycle uphill or on a level surface? Why?

6. Describe and compare what forces are needed to make a bicycle move and stop.


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Apply the New York State Learning Standards to the State Test

*Directions (7–10)*: For each question, write your answer in the spaces provided. Base your answers to questions 7 through 10 on the paragraph below.

Imagine pushing an empty sled over ice. The sled is light in weight and you can move it easily by yourself. Also, the smooth, slippery ice makes the work of pushing the sled quite easy, because there is little friction between the smooth sled runners and the surface of the ice.

**7** Suppose you are pushing the same sled over a rocky road. Why will it take more force to push the sled over a rocky road than over ice?

_____

_____

_____

**8** Two friends come along and want to ride on the sled. Explain whether it will take more or less force to push the sled over ice with two friends riding on it.

_____

_____

**9** You decide to go sledding on a snow-covered hill. Which will take more force: to pull the sled over level ground to the bottom of the hill or to slide downhill from the top of the hill to the bottom? Why?

_____

_____

_____

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**10** Which would take more force to move over ice: a sled with a rough metal bottom or a sled with a smooth metal bottom? Why?

_____

_____

_____

*Directions (11–16)*: Each question is followed by four choices. Decide which choice is the best answer. Circle the number of the answer you have chosen.

**11** What will happen if you push or pull a small object?

A The object will move.
B The object will not move.
C The object will float.
D The object will disappear.

**12** On which path would it take the least amount of force to move a bicycle forward?

A uphill path
B downhill path
C straight and level path
D upward spiral path

**13** The least amount of force would be used to pull a sled along a path that is covered with

A grass
B sand
C ice
D stones

**14** Which of the following best reduces the force needed to move a wagon?

A wheels
B a handle
C metal sides
D painting it red


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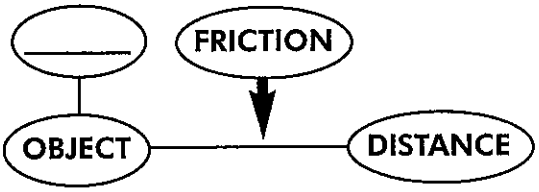
**15** When sandpaper is rubbed over wood, both surfaces become warm. This is a result of

A tension
B fraction
C suction
D friction

**16** Which word completes this diagram to explain the movement of an object?




A friction
B wagon
C force
D motion

**NYS Test Tip**

**Physical Science** Friction always acts opposite to an object's motion.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Focus on the New York State Learning Standards

Lesson 8.1

## Simple Machines

**PS 5.1f** Mechanical energy may cause change in motion through the application of force and through the use of simple machines such as pulleys, levers, and inclined planes.

**Six simple tools make work easier.**

**Simple machines** make work easier by changing the strength, direction, or speed of a force.

**Mechanical energy** is the energy an object has because of its motion and the forces acting on it.

Guided Instruction

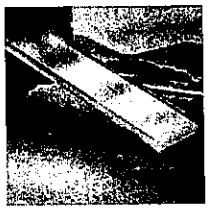
**Directions** Read the following information.

**Guided Questions**

What are **simple machines?**

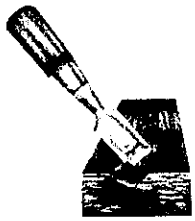
Tools with only one or two parts are known as **simple machines**. Simple machines use **mechanical energy** to change the strength, direction, or speed of a force. Work, such as lifting, cutting, prying, tightening, and moving objects, is easier when you use simple machines. Here are six simple machines:

### Inclined Plane



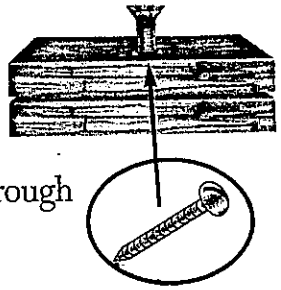
A smooth board is a plane. When the board, or plane, is slanted, it can help you move objects across distances. A ramp is a common inclined plane. Moving a heavy box is easier if you slide the box up or down a ramp.

### Wedge



When you use the pointed edges of an inclined plane to push things apart, the inclined plane is a wedge. A chisel, when used to split a piece of wood, is a wedge.

### Screw



An inclined plane wrapped around a cylinder becomes a screw. Every turn of a metal screw helps you move a piece of metal through a wooden space.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### Lever

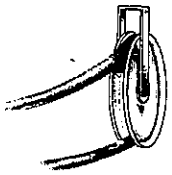
A tool that pries something loose or that lifts with an arm-like motion is a lever. A shovel or a playground seesaw can be a lever.


### Wheel and Axle

Another kind of simple machine is the wheel and axle. The wheel turns the axle, which causes movement. For example, on a wagon, the metal wagon bed rests on top of the axles. The wheels below rotate on the axle and the wagon moves.

### Pulley

The wheel can also rotate a rope. This is a pulley. In a pulley, a rope wraps around a wheel. As the wheel rotates, the rope will move. The rope can be used to raise and lower objects. For example, a flag on a flagpole is raised and lowered by a pulley.



**Guided Questions**

Where is the wheel and axle on a wheelbarrow?

What are the names of the six simple machines?

**Directions** For each question, write your answer in the space provided.

1. Which two simple machines would be useful if you wanted to move a heavy box up a stairway?

_____

2. Which simple machine would be useful to attach two pieces of wood together?

_____

3. Which simple machine would you find on a wagon, a car, and a truck?

_____

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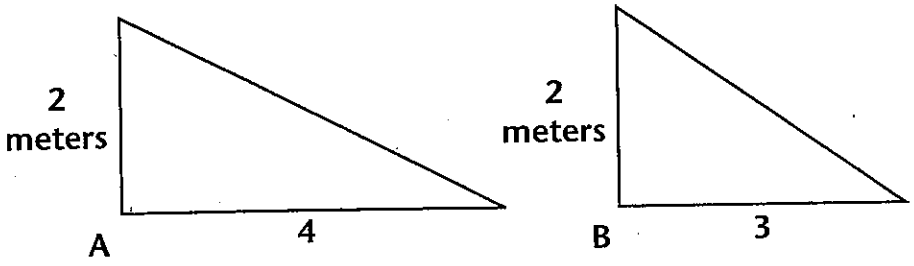
4. Which three simple machines are based on inclined planes?

5. Do you think a baseball bat and a tennis racket are simple machines? Why or why not?

6. If an axe head is a wedge, are scissors a pair of wedges? Why or why not?

**Apply the New York State Learning Standards to the State Test**

*Directions:* For each question, write your answer in the spaces provided. Base your answers to questions 7 through 11 on the figures below.




7 Two ramps lead to a door at the top of a high step. Both ramps are 2 meters high, but Ramp A is 4 meters long and Ramp B is 3 meters long. You need to push or pull a wagon to the door. Which ramp would make your work easier? Explain your answer.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**8** How might you use a rope and pulley to move the wagon up the ramp?

**9** How could you use a rope and pulley without the ramp to get the wagon to the door? Where would the pulley need to be attached? Explain or draw your answer.

**10** How do the rope and pulley change the direction of the force on the wagon?

**11** Explain or draw how you could use a lever to lift a rock.


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*Directions (12–17)*: Each question is followed by four answer choices. Decide which choice is the best answer. Circle the letter of the answer you have chosen.

**12** What are tools with few or no moving parts called?

A force
B work
C simple machines
D compound machines

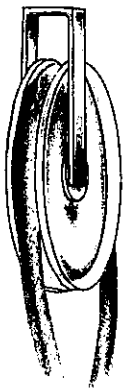
**13** What are simple machines?

A machines that make work harder
B machines that make work easier
C machines that make work more expensive to complete
D machines that make work impossible to do

**14** Which simple machine helps you move your bike up stairs?

A screw
B wheel and axle
C wedge
D inclined plane

Use the diagram to answer questions 15 and 16.



**15** What simple machine is shown in the diagram?

A lever
B screw
C pulley
D inclined plane

**16** What action would you take to raise a box attached to one end of the rope?

A Pull down on the free end of the rope.
B Push up on the free end of the rope.
C Swing the box back and forth.
D Twist the box.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Focus on the New York State Learning Standards

Lesson 32

## Gravity and Magnetism

**PS 5.1c** The force of gravity pulls objects toward the center of Earth.
**PS 5.1e** Magnetism is a force that may attract or repel certain materials.
**PS 5.2a** The forces of gravity and magnetism can affect objects through gases, liquids, and solids.
**PS 5.2b** The force of magnetism on objects decreases as distance increases.

**You can describe the effects of gravity and magnetism.**

**Gravity** is a force of attraction between two objects.

**Magnetism** is a force that may attract or repel certain materials.

**Magnetic field** is the space around a magnet where the force of attraction is felt.

Guided Instruction

**Directions** Read the following information.

In the 17th century, Isaac Newton wondered why the Moon orbits Earth. He also wondered why apples fall from apple trees. What Newton discovered was the force called **gravity**. Gravity is a force of attraction between objects. It pulls apples toward the center of Earth and it also keeps the Moon in orbit around Earth.

The Moon doesn't fall to Earth like an apple. If there were no gravity, the motion of the Moon would be a straight path away from Earth. But the pull of gravity causes the path of the Moon to curve around Earth. The Moon has gravity too. Because the Moon is smaller than Earth, its gravity is less than Earth's.

Gravity works through gases, liquids, and solids. Air stays around Earth because of gravity. Oceans do not fly off into space because of gravity. Rocks and soil stay on Earth because of gravity. You stay on Earth because of gravity too. Without gravity, gases, liquids, and solids would not be pulled to the center of Earth.

**Guided Questions**

What is **gravity?**

What keeps the Moon in a path around Earth?


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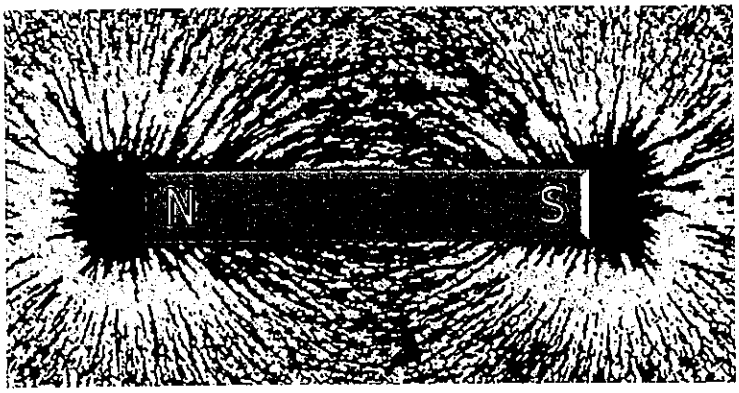
**Guided Questions**

**Magnetism** is the force that may attract certain materials. Iron or materials with iron in them such as paper clips and iron nails are attracted to a magnet. And, like gravity, the force of magnetism can have this effect through gases, liquids, and solids. You know a magnet can hold paper on a refrigerator. The magnetic force is going through the solid paper. If you use the magnet to hold two pieces of paper, the magnet will still hold the paper on the refrigerator. What happens if you try to use the magnet to hold ten pieces of paper? The magnet probably would not work. That is because the force of magnetism on objects decreases as the distance increases.

What is **magnetism?**

The **magnetic field** of a magnet is the space around the magnet where its force, or magnetism, can be felt. If you lay a piece of clear plastic over a magnet and sprinkle iron filings on the plastic sheet, the filings line up in a pattern of curved lines as shown in the diagram below. The filings make the pattern because the magnetic field is strongest near the ends, or poles, of the magnet.

What happens when a nail gets close to a **magnetic field?**




Where is the magnetic field the strongest?

If a magnet is hung so that it can move freely, one pole will point north. That is because Earth itself is a large magnet. Magnets have two poles, a north pole and a south pole. If you placed two magnets side by side, you would see that opposite poles attract, or come together, and like poles repel, or move apart from, each other.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**Directions** For each question, write your answer in the space provided.

1. How are falling apples and the orbit of the Moon alike? How are they different?

   Alike: _____

   Different: _____

2. How would the motion of the Moon be different if there were no gravity?

   _____

   _____

3. Give an example that shows that gravity affects objects through gases, liquids, and solids.

   Gases: _____

   Liquids: _____

   Solids: _____

4. How are the forces of gravity and magnetism alike?

   _____

5. If you sprinkle iron filings on a plastic sheet that is placed over a magnet, what will you see? Draw your answer.

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6. If you use a magnet to pick up steel pins, where on the magnet would you expect the most pins to stick? Why?

Apply the New York State Learning Standards to the State Test

*Directions*: For each question, write your answer in the spaces provided. Base your answers to questions 7 through 10 on the paragraph and table below.

Your class asks the following question: Are all kinds of objects attracted to a magnet? To test this question, you gather several items and a bar magnet and test each object for its attraction to the magnet. Then you record the data in the following table:

| OBJECT | ATTRACTED TO THE MAGNET? |
|---|---|
| staple | yes |
| rubber eraser | no |
| string | no |
| safety pin | yes |
| toothpick | no |
| aluminum foil | no |
| copper penny (one cent) | no |
| silver ring | no |
| paper clip | yes |

7 What conclusion can you make about the objects in the table?


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**8** What conclusions about metal objects can you make from the information in the table?

_____

**9** Explain why some metal objects are not attracted to the magnet.

_____

**10** Magnets attract some common objects because they are made of steel, which is mostly iron. From the information in the table, which objects might be made of steel?

_____

*Directions (11–16)*: Each question is followed by four choices. Decide which choice is the best answer. Circle the letter of the answer you have chosen.

**11** What is gravity?

A the space around a magnet where the force of attraction is felt
B a force that may attract or repel certain materials
C a force of attraction between two objects
D Isaac Newton's middle name

**12** What keeps the Moon in orbit around Earth?

A magnetism
B gravity
C a magnetic field
D radiation from the Sun

**13** Through which of the following can magnetic force pass?

A gases
B solids
C liquids
D all of the above


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**14** Which of the following objects would be attracted to a magnet?

**NYS Test Tip**

**Magnetism** The metals iron, nickel, and cobalt are magnetic.

A a shoelace
B a refrigerator door
C a roll of 100 pennies
D a silver necklace

**15** Why does a baseball hit up into the air lose force and fall back to Earth?

A The baseball was not hit hard enough.
B The force of gravity causes the baseball to fall to the ground.
C The magnetic outfield attracts the baseball downward.
D It was a foul ball.

The chart below lists some objects and shows if they are picked up by a bar magnet.

| OBJECT | ATTRACTED TO THE MAGNET? |
|---|---|
| eraser | no |
| string | no |
| steel wire | yes |
| pin | yes |
| staple | yes |

**16** Which conclusion can be drawn from the information in the chart?

A The eraser was picked up by the magnet.
B The magnet picked up every object.
C The metal objects can be picked up by a magnet.
D The rubber objects can be picked up by a magnet.


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