## Skeggs/Hanna Spring Work Packet 8th Grade Science

Lesson 1: Gravity and Friction

Lesson 2: Newton's 1 Law

Lesson 3: Newton's 2 Law

\*\*Use textbook pages to complete the worksheets and answer all questions on a separate sheet of paper EXCEPT Critical Thinking Section\*\*

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noncontact force p. 46 mass p. 47 gravity p. 47 contact force p. 45 19rcs p. 45 Vocabulary weight p. 48 siiding past each other?

friction p. 40

Multilingual eGlossay

What's Science Got to do With H? Video

Mow does friction affect the melion of two objects

w What is the law of universal

nothing is touching the ball? It is it possible to make the bull move even when touching it? Can you make a ball move without You can make a ball move by kicking it or throwing

Search

r.

- Read and complete a lab safety form.
- Roll a tennis ball across the floor. Think about what makes the ball move.
- Toss the ball into the air. Watch as it moves up and then falls back to your hand.
- Drop the ball onto the floor Let It bounce once. and then catch it.



- Think About This What made the ball move when you rolled, tossed, and dropped it? What made it stop? Key Concept Did something that was touching the ball or not touching the ball cause

It to move in each case?

### Types of Ferces

Other forces are applied even when objects do not touch or person. Some forces are applied only when objects touch out a chair to sit down. A push or a pull an an object is called a might have pushed toothpaste out of a tube. Maybe you pulled layes. An object or a person can apply a lorce to another object Think about all the things you pushed or pulled today. You

### Contact Forces

a force to an object that it louched. A confact force is a push or a pull on one object by another that is touching it. a ball with a bat. In each case, a person or an object applied seen a musician strike the keys of a piano and an athlete hit the stack of boards and broke them. You have probably also The hand of the karate expert in Figure 1 applied a force to

plate upward. can create mountain ranges if one plate pusites another Earth's erast called plates also apply strong contact forces move, resulting in an earthquake. The large sections of such as when large sections of underground rock suddenly keys on a computer keyboard. They also can be strong, against each other. Over long periods of time, these forces Contact forces can be weak, like when you press the

This astronaut is on an aircraft that flies at steep angles and provides a sense of weightlessness. Why doesn't he fall? He

aircraft moves downward at the same speed. does! Earth's gravity pulls the astronaut down, but the

> Figure 1. The man's hand applies a contact force to com Lucia firstic output

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Giossary

Index

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gravity and friction.



stand on end. Figure 2. A noncontact force causes the girl's hair to

### Noncontact Forces

girf's hair to sland on end. noncontact force. The magnetic force, which attracts certain another noncontact force, called the electric force, causes the apply to another object without touching it is a noncontact force. metals to magnets, is also a noncontact force. In Figure 2, Gravity, which pulled on your pencil and the parachutist, is a though nothing is touching him. A force that one object can falls toward the floor. A parachutist falls toward Earth even Lift a pencil and then release it. What happens? The pencil

noncontact forces?

indicate the streagth and direction of a force. Figure 3 Arrows can

## Strength and Direction of Forces

cases. Different things happen because the direction of the textbook away from you, it probably slides across your desk-What happens if you push down on your book? It probably Forces have both strength and direction. If you push your

As shown in Figure 3, arrows can be used to show forces. The

show these forces, the water's arrow would be 20 times longer about 1 N when lifting a stick of butter. You use a force of about 20 N when lifting a 2-1, bottle of water, if you use arrows to The SI unit for force is the newton (N). You apply a force of

the lengths of the arrows Visual Check How are

forces on the two balls? related to the different

Chooler 2

Key Concept Check What are some contact forces and some

applied force is different. does not move. You can use the same strength of force in both

direction that an arrow points shows the direction in which ger than the force applied by the table-tennis paddle. As a result, the arrow showing the force of the tennis racquet is longer. The the figure that the force applied by the tennis racquet is stronlength of an arrow shows the strength of the force. Notice in force was applied.

## What is gravity?

least one of the objects increases. Gravitational force increases if the mass of at

The gravitational force between objects decreases as the objects move apart

1

object. Mass is often measured in kilograms (kg). all objects that have mass. Mass is the amount of matter in an force on objects? Gravity is an almative force that exists between force on them. Did you know that you also exert an attractive Objects fall to the ground because farth exerts an attractive

# The Law of Universal Gravitation

mass of each object and the distance between them. gravitational force. The strength of the force depends on the Sir Isaac Newton, developed the law of universal gravitation. This law states that all objects are attracted to each other by a In the late 1600s, an English scientist and mathematician,

Key Concept Check What is the law of universal gravitation?

Effect of Distance

on Gravity

one or both objects increases, the gravitational force between objects affects gravity is shown in Figure 4. When the mass of Each object exerts the same attraction on the other object marbles are the same size even when one object has less mass. them also increases. Notice that the force arrows for each pair of Gravitational Force and Mass. The way in which the mass of

would only be about 0.12 N. The relationship between gravita-For example, if your mass is 45 kg, the gravitational force objects decreases as the distance between the objects increases. on gravity is also shown in Figure 4. The attraction between Gravitational Force and Distance The effect that distance has 384,000 km away, the gravitational force between you and Earth between you and Earth is about 440 N. On the Moon, about ional force and distance is shown in the graph in Figure 5.

Reading Check What effect does distance have on gravity?

on the mass of the objects and the distance between between abjects depends gravitational force ▲ Figure 4 🐃 汞



them.

Personal Tutor



objects increases. objects decreases as the gravitational force between distance between the A Figure 5 The

Distance

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Glossary

weight is a force, it is measured in newtons. the gravitational force Earth exerts on you is greater than the is the gravitational force exerted on the object by Earth. Because force exerted on an object. Near Earth's surface, an object's weight force exerted by any other object. Weight is the gravitational Earth has more mass than any object near you. As a result,

weight. Near Earth's surface, the weight of an object in The Relationship Between Weight and Mass An object's has twice the mass of another object, it also has twice the newtons is about ten times its mass in kilograms. weight is proportional to its mass. For example, if one object

Reading Check What is the relationship between mass and

Academic Vocabulary :

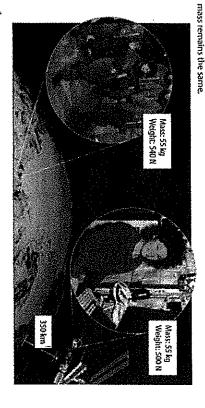
(ud)ective) unpartent.

astronauts in orbit around Earth are weightless. Their weight is gravitational force to change much. The distance between the in weight when the distance increases so much? Earth is so of the astronaut in Figure 6 is about 55 kg. Her weight is about Weight and Mass High Above Earth You might think that astronaut and Earth is small compared to the size of Earth. large that an astronaut must be much farther away for the above Earth's surface. Why is there no significant change \$40 N on Earth and about 500 N on the space station 350 km about 90 percent of what it is on Earth. The mass

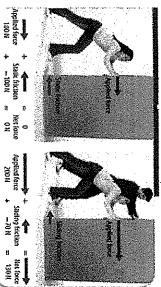
Reading Lineck, virily to the gravitational force exerted on you by Earth? Reading Check Why is the gravitational force that a friend exerts

weight changes, but her

station, the astronaut's from Earth to the space Figure 6 As she travels



Wisual Check What would be the weight of a 110-kg object on Earth? On the space station?



#### Friction

quickly at first and then stop. The force that slows you is that are touching. There are several types of friction. triction. **Eriction** is a force that resists the motion of two surface If you slide across a smooth floor in your socks, you move

### Static Friction

girl's applied force is balanced by static friction. Static friction because the static friction also increases. the girl increases the applied force, the hox still will not move prevents surfaces from sliding past each other. Up to a limit, the strength of static friction changes to match the applied force. If The box on the left in Figure 7 does not move because the

### Sliding Friction

stop because of sliding friction. slide faster. If the students stop pushing, the box will slow and pushing is greater than the static friction between the box and the floor. Sliding friction opposes the motion of surfaces sliding box will move. As shown in Figure 7, the force of two students does not change, increasing the applied force makes the box past each other. As long as the box is sliding, the sliding friction When static friction reaches its limit between surfaces, the

#### Fluid Friction

oncoming fluid decreases the air resistance against the object. moving through a fluid. Decreasing the surface area toward the as water or air, that flows-is fluid friction. Fluid friction between a surface and air is air resistance. Suppose an object is because it has less surface area and less air resistance. The crumpled paper in Figure 8 falls faster than the flat paper friction between a surface and a fluid-any material, such

> Sliding friction slows the on the left from maying. friction prevents the box theright motion of the box on

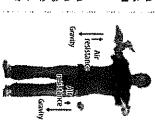
■ Figure 7 Static

### Science Use V. Common Use -

no mollon Science Use at rest or lusting Static

duced in a radio or a relevision Common Use noise pro-

Figure 8 Air resistance is greater on the flat paper.























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How does friction affect

Read and surface. safety form. complete a lab

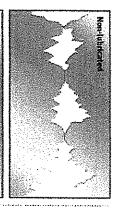


🛂 Use tape to fasten sandpaper to a table. with an eyehook in it. Attach a spring scale to a wooden block

Record in your Science Journal the force then on the table. required to gently pull the block at a constant speed on the sandpaper and

### Analyze and Conclude

- Compare the forces required to pull the block across the two surfaces.
- Key Cancept How did reducing friction affect the motion of the block?





caused by microscopic roughness. Figure 9 Lubricants such as oil decrease friction

hands together. together than when you sub your soapy more friction when you rub your dry hands slide them past each other easily. You feel feel? If your hands were soapy, you could Rub your hands together. What do you

catch on the dips and bumps on the other all surfaces. When surfaces slide past each sliding and is a source of friction. surface. This microscopic roughness slows other, the dips and bumps on one surface Figure 9. Microscopic dips and bumps cover Look at the close-up view of surfaces in What causes friction between surfaces?

Kay Concept Check How does friction past each other? affect the motion of two objects sliding

of friction between the surfaces. attraction slows sliding and is another source attraction occurs between the particles. This by a negative charge on the other surface, an When a positive charge on one surface slides particles contain weak electrical charges. molecules—make up all surfaces. These In addition, small particles-atoms and

Reading Check What are two causes of friction?

### Reducing Friction

slide past each other, as shown in Figure 9. the electrical charges of your hands. Soap soapy water slightly separates the surfaces of your hands. There is less contact between between moving parts of a car's engine. Motor oil is a lubricant that reduces friction With less friction, it is easier for surfaces to acts as a lubricant and decreases friction. the microscopic dips and bumps and between When you rub soapy hands together, the

the paper's surface area reduces the fluid friction between it and the air. on the falling paper in Figure 8. Reducing Look again at the effect of air resistance

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as gravity. Each type is Forces can be either and direction. chap, or noncontact, such contact, such as a karate described by its strength

Gravity is an attractive force that acts between any two objects that have mass. The altraction is stronger for objects with greater mass.

You push a book sitting on a desk with a force of 5 N, but the book does not move

What is the static friction?

Explain the difference between a contact

force and a noncontact force.

Understand Key Concepts

Distinguish between weight and mass

Define friction in your own words.

Use Vocabulary



Apply According to the law of universal

B 58

A. 0 N

C. between 0 N and 5 N

greater than 5 N



friction that slows the past each other. Air resis speed of objects sliding Friction can reduce the speed of a falling object rance is a type of fluid

of the chapter. Use your lesson Foldable to review the tesson. Save your foldable for the project at the end

### Interpret Graphics

elephant and Earth? Why? force between you and Earth or an gravitation, is there a stronger gravitational

Interpret Look at the forces on the feather.



feather falls slowly rather than fast. In terms of these forces, explain why the

Organize information Copy and fill in the this lesson. Add as many rows as you need table below to describe forces mentioned in

### +01C Description

What do you think 💛 🖑

beginning of the chapter.

force of gravity. touching surfaces.

fou first read the statements below at the You pull on objects around you with the

### Critical Thinking

Decide Is it possible for the gravitational force between two 50-kg objects to be less than the gravitational force between a 50-kg object and a 5-kg object? Explain.







any false statements to make them true. agree or disagree with the statements? Rewrite

Did you change your mind about whether you Friction can act between two unmoving.











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	Data	Class
Mame	Date	

#### **Lesson Outline**

**LESSON 1** 

#### **Gravity and Friction**

	es of Forces
1.	A push or a pull is called a(n)
2.	A(n) is a push or a pull on an object by another object that is touching it.
3.	A force that one object can apply to another object without touching it is
	a(n)
`.	Gravity,, and electric forces are examples of noncontact forces.
5.	Forces have and
6.	An arrow can be used to show a force; the shows the strength of the force, and the direction of the arrow shows the of the force.
7.	Forces are measured in units called
B. Wh	nat is gravity?
	is the amount of matter in an object.
	is an attractive force that exists between all objects that
	have mass.
· 3	. Mass is often measured in
4	According to the law of, all objects are attracted to one another with a gravitational force that is proportional to the mass of the objects and the distance between them.
	a. When the mass of one or both objects increases, the gravitational force between
	the objects
	<b>b.</b> When the distance between two objects increases, the attraction between the
	objects
į	is the gravitational force exerted on an object.
	a. Near Earth's surface, an object's weight is the gravitational force exerted on the
	object by
	<b>b.</b> The of an object on Earth decreases significantly onl when the object moves a great distance away from Earth.

	Date	Class
	<del></del>	
on Outline continued		
riction	•	
1 is a f	force that resists the motio	n of two surfaces that are
touching.		
<b>2.</b> frict	ion prevents surfaces from	sliding past each other.
3. Up to a limit, the	of static frict	ion changes to match
the applied force.	<del></del>	•
<b>4.</b> frict	ion opposes the motion of	surfaces sliding past
each other.		
a. When an object is sliding, the	e force of sliding friction d	oes not
	for this reason, increasing	
a sliding object move		
<b>b.</b> If you stop pushing a sliding		ntually
		<b>,</b>
		nd a fluid such as air
<b>5.</b> is fr	riction between a surface a	na muia, sacii as an
or water.	bolles simis to	
a. Fluid friction between an ob		
<b>b.</b> Decreasing an object's surfac		pe .
	the object's air resistance.	
6. One reason for friction between	n surfaces is the	or the
dips and bumps on one surface	e that catch on those of th	e other surface.
7. One reason for friction between	n surfaces is that atoms an	d molecules with
ch	arges attract each other.	
<b>8.</b> de	crease friction by causing	a slight separation betwe
solid surfaces so they don't co	ontact each other.	

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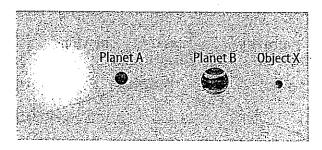
#### Key Concept Builder



**LESSON 1** 

#### **Gravity and Friction**

**Key Concept** What is the law of universal gravitation?



This diagram represents a star orbited by two planets—planet A and planet B. The star is also orbited by a mysterious object, object X, that entered into the star's gravitational field.

**Directions:** Use the diagram to answer each question or respond to each statement.

- 1. The gravitational force between the star and planet A is the same as the gravitational force between the star and planet B. Explain why this is true.
- 2. The gravitational force between the star and object X is equal to the forces between the star and the two planets. From that information, what can you conclude about object X?

**Directions:** Answer each question on the lines provided.

- **3.** What is gravity?
- 4. What happens to the gravitational attraction between two objects as the distance between them increases?

FRICTION	Name	Class	Date
Determine if th	ne following statements an	e true or false.	
1. Friction	on is never useful.		
2. Too r	nuch friction can cause pa	arts to wear out.	
3. Friction	on can cause scrapes on t	the skin.	
4. Some	e surfaces are so smooth t	that they have no friction.	
5. You u	use friction when you strike	e and lìght a match.	
6. It tak	es more force to slide thar	n to roll a heavy object.	
7. Friction	on works in the same dire	ction as the force applied to move	an object.
8. Wher	n a dolly is stationary, there	e is rolling friction between the wh	neels and ground.
9. Statio	friction prevents you from	n sliding out of your chair to the fl	oor.
10. The	brakes on a bike create ro	olling friction.	
Read this pass What Is Fricti	_	swer the questions that follow.	
or against us.	For example, putting sand other hand, too much frid	between two surfaces that are tou d on an icy sidewalk increases fric ction between moving parts in a ca	tion so you are less likely
unaided eye a pipes are so s microscope, t	ppear rough or bumpy who mooth that they are shiny he surface appears to be l	erfectly smooth. Even surfaces the nen viewed under a microscope. F . But if you examine the metal und bumpy. All those mountains and v ace that contacts the metal. This o	For example, new metal der a high-power valleys catch and grab the
Questions:	•		
1. Define fricti	on.		
	**************************************		
2. Give an exa	ample of friction that is use	eful and friction that is not useful.	
3. Explain who	at causes friction.		

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Gravity to the rescue!

placet. This force kneets the Moon is orbit around Eacts Those objects are Earth and an asteroid. Asteroids are and Earth in orbit around the Sun. Gravity can also rocky bodies found mostly in the asteroid bett between Mark and fupilier fubilities strong gravity cursend objects on a collision copise—e problem other change the orbits of asteroids over time, accasionally sending them dangerously close to Earth

asteroids near Earth. More than a thousand asteroids are surpsemengh in state serious starrage if they collide work Earth. It an attered were heading our way, how could me prevent the collision? One locals to barrich a Astronomers use passectal telescopes to track spaced art into the asteroid. The impact could slow it seem emough to cause it to mass faith. But if the astero brake apart, the pieces could rain down onto Earth!

a massive spacecraft into an orbit close to the asteroid The spacecraft's quarity weight exect a small trigger the asteroid. Over time, the asteroid's path was lid be altered enough to pass by Earth. Astronomens track objects now that are many years away from crosson, paths with barth Scientists have another idea. They propose fundand ibus gives thens encuegh tuhe to set a plan acanonid and of the objects appears to be on a collision course

PROBLEM SOLVING With a group, come up with a plan for providing an assential's collision with Earth, Present your plan to the class, include diagrams and details that explain exactly how your plan will work.

### Reading Guide

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 What is Newton's first law ESSENTIAL QUESTIONS Key Concepts

 How is motion related to balanced and unbalanced of motion? forces?

 What effect does inertia object? have on the motion of an

net force p. 55 Vocabulary

balanced forces p. 56

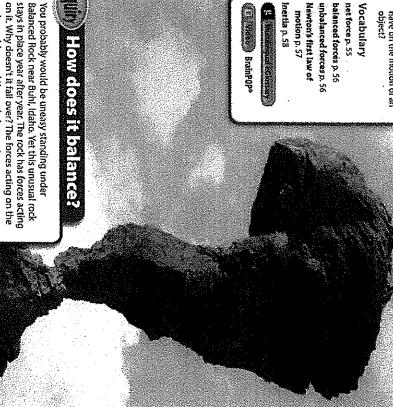
unbalanced forces p. 56 Newton's first law of motion p. 57



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rock combine, and the rock does not move.







Glossary Index

# Can you balance magnetic forces? 🏞

 Read and complete a lab safety form. magnetic forces? or repel each other. Can you balance these on how you hold them, magnets either attract Magnets exert forces on each other. Depending

- Have your tab partner hold a ring magnet vertically on a pencil, as shown in the use it to push the first magnet along the picture.
- Place a third magnet on the same pencil so that the outer magnets push against the middle one. Does the middle magnet still move along the pencil?



### Think About This

- Describe the forces that the other magnets exert on the first magnet in steps 3 and 4.
- Key Concept Describe how the motion of the first magnet seemed to depend on whether each force on the magnet was balanced by another force

### **Identifying Forces**

near the young birds walting for food. nest, it will slow its speed and land softly on the nest's edge. climb high into the air. Before the osprey comes to rest on its its talons. It then stretched out its wings and used them to neared the water, it moved its legs forward to grab the fish with toward a nearby lake after seeing a fish in the water. As it was in the air in a high-speed dive. It might have plunged Perhaps several minutes ago, the mother osprey in Figure 10 Ospreys are birds of prey that live near bodies of water

change the motion of this osprey. Figure 10 Forces

shape, decreasing its surface area and air resistance. Gravity tance. In a dive, it held its wings close to its body, changing its Some of the forces were contact forces, such as air resistance. also pulled the osprey toward the ground When soaring, the osprey spread its wings, increasing air resisdirection of its motion. Recall that a force is a push or a pull. Forces helped the mother osprey change the speed and

change the motion of objects. the forces acting on it. In this lesson you will read how forces To understand the motion of an object, you need to identify

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> > <sup>کا ور</sup>

combine depends on the directions of the forces applied to an acting on an object is the net force. The way in which forces an object, the forces combine. The combination of all the forces do not have to push as hard. When two or more forces act on the dresser in Figure 11. If you push on the dresser by yourself, you have to push hard on the dresser to overcome the static friction and move it. If you ask a friend to push with you, you Suppose you try to move a piece of heavy furniture, such as

# **Combining Forces in the Same Direction**

case, the direction of the net force is the same as the direction of the Individual forces. tion, the net taxce is the sum of the individual forces. In this When the forces applied to an object act in the same direc-

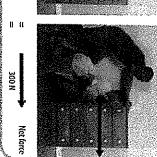
a force of 300 N to the right. dresser is the same as if one person pushed on the dresser with is 200 N + 100 N = 300 N to the right. The force applied to the example, you would probably choose "to the right" as the postwith a force of 100 N to the right. The net force on the dresser with a force of 200 N to the right. The other person pushes ing in the same direction. One person pushes on the dresser tive reference direction, Both forces then would be positive. ence direction when you combine forces. In Figure 11, for The net force on the dresser is the sum of the two forces push-Because forces have direction, you have to specify a refer-

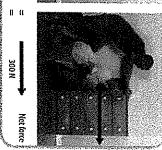
Reading Check How do you calculate the net force on an object if two forces are acting on it in the same direction?

### REVIEW VOCABULARY ....

from a starting point to describe an object's position a direction that you choose reference direction







forces.

combine, the net force is in the same direction force is the sum of the also in the same direction Figure 11 When forces The strength of the net

180 N? in the same direction with and the other boy pushed one boy pushed with 250 N would the net force be if Wisual Check What

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200 N

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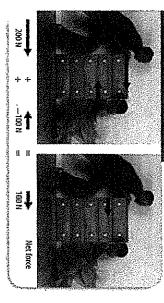




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the net force is the sum of larger force. The strength of combine, the net force is in opposite directions acting on an object in the positive and negative the same direction as the



# **Combining Forces in Opposite Directions**

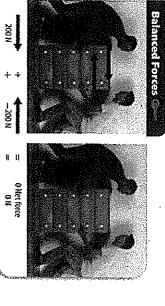
tive forces. The net force on the dresser is 100 N to the right. is negative. The net force is the sum of the positive and negathat direction is positive, and a force in the opposite direction right" again as the reference direction in Figure 72. A force in force is still the sum of the forces. Suppose you choose "to the When forces act in opposite directions on an object, the net

## Balanced and Unbalanced Forces

However, the net force on the dresser in Figure 12 is not zero. forces. Balanced forces do not change the motion of an object. on an object that combine and form a net force of zero are balanced same as if there were no forces acting on the object. Forces acting in Figure 13, the net force on the object is zero. The effect is the hine and form a net force that is not zero are umbalanced forces. There is a net force to the right. Forces acting on an object that com-When equal forces act on an object in opposite directions, as

are balanced. 👺 same strength, the forces opposite directions are the acting on an object in Figure 13 When two forces

different? figure alike? How are they the balanced forces in the are the force arrows for Visual Check How



of the object does not change. As a result, balanced forces and unbalanced forces have difif the net farce on an object is zero, the motion According to Newton's first law of motion, terent results when they act on an object. rules known as Newton's laws of motion. the motion of objects. He developed three

Sir Isaac Newton studied how forces affect

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Kay Concept Check What is Newton's first law of motion?

## Balanced Forces and Motion

of gravity acting on a falling object. Terminal velocity is the constant velocity moves downward at his ternimal velocity. and gravity—are balanced, the parachutist true when an object is at rest or in motion. reached when air resistance equals the force because the forces in Figure 14—air resistance when they apply balanced forces. Similarly, before the boys push on it. It remains at rest velocity (speed in a certain direction). This is look again at Figure 13. The dresser is at rest balanced forces cause no change in an object's According to Newton's first law of motion,

Reading Check What happens to the velocity of a moving car if the forces on it are balanced?

## **Unbalanced Forces and Motion**

anced forces affect an object's motion in the next lesson. object's speed, direction of motion, or both change. You will read more about how unbalforces act on an already moving object, the the object starts moving. When unbalanced unbalanced forces act on an object at rest, to balanced forces acting on an object. When Newton's first law of motion only applies

Key Concept Check How is motion related to balanced and unbalanced



Figure 14 Balanced forces acting on an object do not change the object's speed and direction.



- Attach spring scales to opposite sides of a lab safety form. a wooden block with eyehooks.
- With a partner, gently pull the scales so including the force readings on each Sketch the setup in your Science Journal, that the block moves toward one of you.
- Repeat step 3, pulling on the block so that it does not move.

### Analyze and Conclude

- Explain Use Newton's first law of motion to explain what occurred in steps 3 and 4.
- motion related to balanced and Key Concept How was the block's





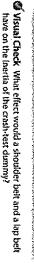








forward after the car stops.



#### inertia

WORD ORIGIN .... from Latin thers, means "without skill, marrive"

dummy continues moving forward because of its inertia. in an unbalanced force on the car, and the car stops. The velocity because of inertia. The impact with the barrier results and dummy would have continued moving with constant constant velocity. If no other force had acted on them, the car Figure 15. Before the crash, the car and dummy moved with shuh). Inertia explains the motion of the crash-test dummy in will not change if balanced forces act on it. The undency of an object to resist a change in its motion is called inertia (tha UR According to Newton's first law, the motion of an object

Key Concept Check What effect does inertia have on the motion of an object?

# Why do objects stop moving?

greater force. If you stop pushing, friction stops the book. book and the table. The book moves in the direction of the you apply to the book is greater than static friction between the in place because of inertia. When you push the book, the force object's movement. A book sitting on a table, for example, stays What would happen if there were no friction between the Think about how friction and mertia together affect an

are related. Afterward son's vocabulary terms and show how this lescolumns and six rows Make a chart with six

Use your chart to define

OLDABLES

Newton's First Law. and label the outside rold your chart in half

to the ten later had

move at the same speed in the same direction as your push. According to Newton's first law, the book would continue to book and the table? Inertia would keep the book moving.

least as strong as friction must be applied continuously. Objects For an object to start moving, a force greater than static friction stop moving because friction or another force acts on them. must be applied to it. To keep the object in motion, a force at On Earth, friction can be reduced but not totally removed

### Jisual Summary

Unbalanced forces cause an object to



zero, the object's motion does not motion, if the net Newton's first law of According to





In the motion of an inertia is a property that resists a change

of the chapter. Use your lesson Foldable to review the lesson Save your Foldable for the project at the end

### Use Vocabulary

Define net fanc in your own words.

ロナンとはアコレンはいば

111

Ø

Q Search

min annua

🕝 Distinguish between balanced forces and unbalanced forces.

### **Understand Key Concepts**

- Which causes an object in motion to remain in mollon?
- B. gravity A. friction
- D. velocity C. inertia
- Apply You push a coln across a table. The balanced and unbalanced forces? coin stops. How does this motion relate to
- Explain Use Newton's first law to explain why a book on a desk does not move.

### nterpret Graphics

Analyze What is the missing force?



Organize Information Copy and fill in Newton's first law of motion in each case the graphic organizer below to explain

Object in motion	Object at rest

### **Critical Thinking**

What do you think 🌂 🚉

beginning of the chapter.

fou first read the statements below at the

- Strend Three people push a piano on wheels with forces of 130 N to the right, 150 N to the right, and 165 N to the right. What are the strength and direction of the net force on the plane?
- Assess A child pushes down on a box lid with a force of 25 N. At the same time, her children close the box? Why or why not? upward with a force of 60 N. Can the of 30 N. The spring on the box lid pushes friend pushes down on the lid with a force











any faise statements to make them true. agree or disagree with the statements? Rewrite

Did you change your mind about whether you

4. A moving object will stop if no forces act 3. Forces acting on an object cannot be











#### **Lesson Outline**

**LESSON 2** 

3

#### Newton's First Law

Α.	Identifying	Forces
----	-------------	--------

2i

<b>1.</b> To	understand the motion of an object, you need to understand the
	acting on it.
2. WI	nen two or more forces act on an object, the forces
a.	The combination of all the forces that act on an object is
b.	When the forces applied to an object act in the same direction, the net force is
	the of the individual forces.  Because forces have direction as well as strength, when you combine forces, you
	also have to specify a(n)
d.	When you combine forces in two opposite directions, one force is  and the other force is
•	When the forces applied to an object act in exact opposite directions, the first force is the of the individual positive and negative forces.
a	orces that combine and form a net force of zero are of an object.  Balanced forces have no effect on the of an object.  Forces that combine and form a net force that is not zero are
1. /	According to, if the net force on an object is zero, the
2.	Mhen forces act on an object, the object's velocity does not change.  If unbalanced forces act on an object at rest, the object will

4. If unbalanced forces act on a moving object, the object will change

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#### **Lesson Outline continued**

**5.** The tendency of an object to resist a change in its motion is called \_\_\_\_\_\_

**C.** Why do objects stop moving?

1. A book sitting on a table stays in place because of \_\_\_\_\_\_

2. If you want to make the book move, you have to push the book hard enough to overcome the \_\_\_\_\_\_ between the book and the table.

**3.** On Earth, \_\_\_\_\_ can be reduced, but it never goes away completely.

**4.** On Earth, to keep an object in motion, a(n) \_\_\_\_\_\_ that balances friction must be applied continuously to it.

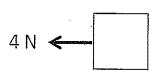
#### Net Force Worksheet

Name: \_ Period: 1 2 3 4 5 6 7

The force that results from all the combined forces acting on the object is called the net force. Calculate the net force acting on the box in the following problems.

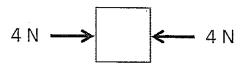
Be sure to include the direction of the net force (left or right)!

1.



Net Force:

3.



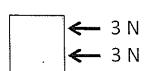
Net Force:

5.



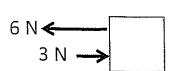
Net Force:

7.



Net Force:

9.



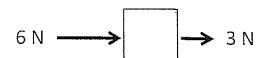
Net Force:

2.



Net Force:

4.



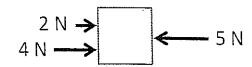
Net Force:

6.



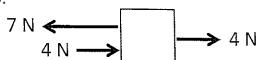
Net Force:

8.



Net Force:

10.



Net Force:

#### 11. What is net force?

	•
Show your work on problems 12-14 12. A boy pulls a wagon with a force of 6 N e east. What is the net force?	east as another boy pushes it with a force of 4 N
13. Mr. Smith and his wife were trying to m of 30 N while Mrs. Smith pushes with a forc force?	ove their new chair. Mr. Smith pulls with a force e of 25 N in the same direction. What is the net
14. The classes are playing tug of war. Mrs. Ms. Mitko's homeroom pulls with a force of force? And who won?	Larson's homeroom pulls with a force of 50 N. 45 N in the opposite direction. What is the net
15. What is a balanced force?	
16. What is an unhalanced force?	

17. Draw a picture below that shows an example of a balanced force (examples: a bird's nest in a tree, a hat on a person's head, or a light hanging from a ceiling). Show the forces acting on the object. In a separate picture show what would happen to the object if the forces became unbalanced.

## of motion? How can you model Newton's first law

Materials

błack, greenj fred, blue, markers

> their effects on the motion of an object. of objects at rest or in motion. You can model different forces and According to Newton's first law of motion, balanced forces do not change an object's motion. Unbalanced forces change the motion

#### Learn It

unbalanced forces on motion by can model the effect of balanced and ence, you act it out, or imitate it. You using movements on a line.

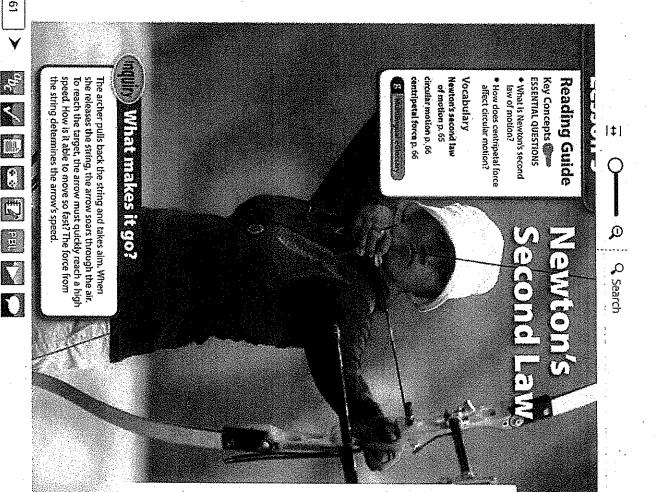
When you model a concept in sci-

- Draw a line across a sheet of lined to the left will model 1 N west. force of 1 N east, and each space the right of the X will model a an X at the center, Each space to notebook paper lengthwise. Place
- Suppose a force of 3 N east and a is from X, 8 N west. is modeled by how far this point 11 spaces to the left, The net force point and draw a blue arrow to the right. Then, start at that drawing a red arrow three spaces moving object. Model these force of 11 N west act on a forces by starting at X and
- Are the forces you modeled the forces change the object's balanced or unbalanced? Will

#### Apply It

- Suppose a force of 8 N east, a model the forces on the object. Use different colors of markers to 4 N east act on a moving object. force of 12 N west, and a force of
- What is the net force on the Model other examples of change the object's motion? unbalanced? Will the forces modeled balanced or object? Are the forces you
- decide which forces will act on acting on an object, in each case, balanced and unbalanced forces
- William Key Concept For each forces will change the object's or unbalanced. Then, decide if the decide if the forces are balanced determine the net force, and of the forces you modeled,





### Glossary index

### along a curved path? What forces affect motion

your motion? When traveling in a car or riding on a roller What are these forces? How do they affect on you as you move along a curved path coaster, you can feel different forces acting

- Read and complete a lab safety form.
- Attach a plece of string about 1 m long to a rolled-up sock.



classmates for the next steps, WARNING: Find a spot away from your

- While holding the end of the string, swing the sock around in a circle above your head. Natice the force tugging on the string.
- Repeat step 3 with two socks rolled together. In your Science Journal, compare the force of swinging one sack to the force of swinging two sacks.

### Think About This

- Describe the forces acting along the string while you were swinging it. Classify each force as balanced or unbalanced
- Key Concept How does the force from the string seem to affect the sock's motion?

#### How do forces change motion?

change an object's motion by changing its and the ice. Suppose you are pushing a someone riding a bicycle? The forces of the speed, its direction, or both its speed and its You can change its direction by pushing it in wheelbarrow across a yard. You can change of the bicycle to turn faster and the bicycle's can change an object's motion. For example, the direction you want to move, Forces because of friction between the skates speed to increase. The speed of a skater its speed by pushing with more or less force. slowly sliding across ice gradually decreases person's feet on the pedals cause the wheels how do forces change the motion of Think about different ways that forces

## Unbalanced Forces and Velocity

barrow's direction will not change. direction that you are pushing, the wheelwith the same force but in the opposite skates. If someone pushes the wheelbarrow the skater pushes back against the ice with a wheels. A skater's speed will not decrease if pedals is greater than friction that slows the unless the forces of the person's feet on the velocity. A bicycle's speed will not increase Only unbalanced forces change an object's force greater than the friction against the Velocity is speed in a certain direction.

In the previous lesson, you read about Newton's first law of motion—balanced anced forces affect the velocity of an object this lesson you will read about how unbal forces do not change an object's velocity. In

\$



at rest, the object begins moving in the direction of the net tion of the net force. When unbalanced forces act on an object ward. You know that the forces on the ball are now unbalanced rest. When the hand moves out of the way, the ball falls down-Because the forces on the ball are balanced, the ball remains at rest is shown in Figure 16. At first the ball is not moving. The because the ball's motion changed. The ball moves in the direchand holds the ball up against the downward pull of gravity. An example of how unbalanced forces affect an object at

# Unbalanced Forces on an Object in Motion

Recall that one way to change an object's velocity is to change Unbalanced forces change the velocity of a moving object.

speed increases. Because the net force is in the direction of motion, the sled's up, For example, a net force acts on the sled in Figure 17, the direction that the object is moving, the object will speed Speeding Up if the net force acting on a moving object is in

acts in the direction opposite to his motion. Because the net Slowing Down Think about what happens if the direction of force is in the direction opposite to the sled's motion, the sled's the sled in Figure 17 pushes his foot against the snow, iriction object moves. The object slows down. When the boy sliding on the net force on an object is opposite to the direction the

Reading Check What happens to the speed of a wagon rolling to the right if a net force to the right acts on it?



unbalanced forces act on a ball at rest, it moves in the direction of the net force. ▲ Figure 16 When

to gravity



to speed up or slaw down. forces can cause an object Figure 17 Unbalanced

would the net force and Visual Check How

pushed harder? photo change if the girl velocity arrows in the lef













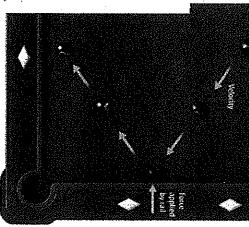


ilil









ball, causing its direction to change. Figure 18 Unbalanced forces act on the billiard

## **Changes in Direction of Motion**

moving pieces called plates. The direction of crust. Recall that the crust is broken into direction. The ball in Figure 18 moved at a constant velocity until it hit the rail of the change an object's velocity is to change its against it with an unbalanced force. one plate changes when another plate pushes anced forces change the direction of Earth's changed the ball's direction. Likewise, unbalbilliard table. The force applied by the rall Another way that unbalanced forces can

#### Acceleration **Unbalanced Forces and**

speed, its direction, or both. make an object accelerate by changing its the table, the ball accelerated because its the billiard ball in Figure 18 hit the side of accelerated because its speed changed. When velocity over time is acceleration. When the direction. Another name for a change in change an object's velocity by changing its direction changed. Unbalanced forces can girl in Figure 17 pushed the sied, the sied speed, its direction, or both its speed and its You have read how unbalanced forces can

Reading Check How do unbalanced forces affect an object at rest or in motion?

10 minutes



How are force and mass related?

object change? the object increases, how does the force required to accelerate the Unbalanced forces cause an object to accelerate. If the mass of

- Read and complete a lab safety form.
- Tie a string to a small box. Pull the box about 2 m across the floor. Notice the force required to cause the box to accelerate.
- Put clay in the box to increase its mass. Pull the box so that its acceleration is about the same as before. Notice the force required

### Analyze and Conclude

- Compare the strength of the force needed to accelerate the box each time.



- Key Concept How did the mass affect the force needed to accelerate the box?

### **Newton's Second Law of Motion** 111

Q Search

acting on the object divided by the object's mass. The direction of object's acceleration (change in velocity over time) and the net acceleration is the same as the direction of the net force. of motion, the acceleration of an abject is equal to the net force force that acts on an object. According to Newton's second law Isaac Newton also described the relationship between an

Key Concept Check What is Newton's second law of motion?

Newton's second law.

Newton's seconds

a sheet of notebook nize your notes on paper. Use it to orga-Make a half-book from SELBWOTO

## Newton's Second Law Equation

acceleration (in m/s²) = net force (in N)
mass (in kg)

# ∰#

this equation, it follows that a newton is the same as kg-m/s2. (m/s²), mass in kilograms (kg), and force in newtons (N). From units. Acceleration is expressed in meters per second squared Notice that the equation for Newton's second law has SI



## Newton's Second Law Equation

Solve for Acceleration You throw a 0.5-kg basketball with a force of 10 N. What is the acceleration of the ball?

- 🚱 This is what you know:
- Orce: mass F == 10 N or 10 kg-m/s3 m = 0.5 kg
- This is what you need to find: acceleration:

- # || ||

Use this formula:

🔾 Substitute:

 $a = \frac{10 \text{ N}}{0.5 \text{ kg}} = 20 \frac{\text{kg·m/s}^2}{\text{kg}} = 20 \text{ m/s}^2$ 

Answer: The acceleration of the ball is  $20 \text{ m/s}^T$ 

into the formula and divide. the values for F and m

#### **Practice**

1. A 24-N net force acts on an 8-kg rock. What is the acceleration of the rock?

 Personal Tutor Math Practice 

- 2. A 30-N net force on a skater produces an acceleration of 0.6 m/s². What is the mass of the
- 3. What net force acting on a 14-kg wagon produces an acceleration of 1.5 m/s?























Circular Motion

1

P

O Search

Online Quiz

between an object's change in velocity over time, or acceleration, and unbalanced forces acting on the object. You already in which an object is moving along a curved path. also applies to circular motion. Circular motion is *uny motion* read how this relationship applies to motion along a line. It Newton's second law of motion describes the relationship

### Centripetal Force

of motion, toward the center of the curve, is centripetal (sen TRIFI arrows show that the ball has a tendency to move along a puh tuhl) force. The figure also shows that the ball accelerates in circular motion, a force that acts perpendicular to the direction ball's path is curved because the string pulls the ball inward straight path, Inertia-not a force-causes this motion. The in the direction of the centripetal force. The ball in Figure 19 is in circular motion. The velocity

WORD ORIGIN ..... centripetal trup latin competus means "noward the center"

Key Concept Check How does centripetal force affect circular motion?

# The Motion of Satellites and Planets

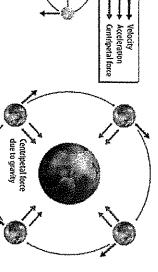
changes the direction of its satellites, including Earth. changes the Moon's direction. Similarly, the Sun's gravity is a satellite of Earth. As shown in Figure 19, Earth's gravity that keeps a satellite in orbit by changing its direction. The Moon lite. A satellite is any object in space that orbits a larger object. gravity pulls a satellite inward. Gravity is the centripetal force path because of inertia. But just as the string pulls the ball inward, Like the ball in Figure 19, a satellite tends to move along a straight Another object that experiences centripetal force is a satel-

#### from the direction of its velocity of a satellite differ

Circular Motion

does the direction of the Visual Check How and the Moon. circular motion of the ball the object produce the centripetal force acting on moving object and the Figure 19 Inertia of the

n Manon) Animation



by string force exerted Centriperal

### Visual Summary



direction, speed up, slow cause an object to down, or change Unbalanced forces

Use the term circular matica in a sentence.

explain Newton's second law of motion in

your own words.

Use Vocabulary

A cat pushes a 0.25-kg toy with a net force

Understand Key Concepts 🗫



net force on the to its mass and the of motion relates an Newton's second law object's acceleration

Describe how centripetal force affects

circular motion.

B. 4 m/s<sup>2</sup>

'n 32 m/s<sup>2</sup> 16 111/5

A. 2 m/s<sup>2</sup>

what is the acceleration of the ball? of 8 N. According to Newton's second law



Any motion in which an object is moving along a corved path is circular motion.

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end

of the chapter.

### Interpret Graphics

Apply Copy and fill in the graphic organizer below. Give examples of unbalanced forces on an object that could cause an object to accelerate.



Complete Copy the graphic organizer below Newton's second law. and complete each equation according to



### Critical Thinking

Design You need to lift up a 45-N object. strength and direction of the force used to lift the object. Draw an illustration that explains the

6. If an object's mass increases, its acceleration also increases if the net force acting on the

object stays the same.

When an object's speed increases, the

object accelerates.

beginning of the chapter.

You first read the statements below at the

What do you think 🖓 🗥

### Math Skills

Math Practice -

The force of Earth's gravity is about 10 N downward. What is the acceleration of a

56 - 67







any false statements to make them true. agree or disagree with the statements? Revvite Did you change your mind about whether you

















Lesson Outline	LESSON 3
Newton's Second Law	
A. How do forces change motion?	ite
<b>1.</b> Forces change an object's motion by changing its or both.	,
2. Only forces can change t	he velocity of an object.
<ol> <li>Only</li> <li>You know unbalanced forces are acting on an object</li> </ol>	that is at rest when the object
starts	of a moving object.
4. Unbalanced forces change the	that the object is moving.
<b>a.</b> If a net force acts on a moving object in the direct	HOII that the object to me and
the object will	
Let a net force acts on a moving object in the direct	tion that is opposite to the
in that the object moves, the object	•
Another way unbalanced forces can change the v	relocity of a moving object to se
of the ob	oject's motion.
5. The force of gravity acts on a ball that is thrown by	y changing the direction of the
hall nulling if	
Another name for change in velocity over time is	
7. Unbalanced forces can make an object accelerate b	y changing the object's
	, or both.
B. Newton's Second Law of Motion	the design of the second of
1. According to, the acce	eleration of an object is equal t
1. According to, the the net force acting on the object divided by the	•
2. The direction of acceleration is the same as the di	irection of
the	continuon anno anno anno anno anno anno anno
<ul> <li>B. Newton's Second Law of Motion</li> <li>1. According to, the acceptance of the net force acting on the object divided by the continuous of the direction of acceleration is the same as the direction.</li> <li>3. The units for Newton's second law are SI units—figures is measured in; mass is measured in</li> </ul>	torce is illeasured in
3. The units for Newton's second law are of directions.; mass is measured in	
acceleration is measured in	·
to a in the same as one	

4. One newton is the same as one \_\_\_\_\_

Class \_\_\_

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3

lame	Date	<u>.                                    </u>	Class _	
3-111111				

#### Lesson Outline continued

C. Circular Motion

is any motion in which an object is moving in a

curved path.

2. \_\_\_\_\_ causes objects to tend to move along a straight path.

**3.** In circular motion, a force that acts perpendicular to the direction of motion toward the center of the circle is called a(n) \_\_\_\_\_\_.

**4.** An object that is moving in a curve accelerates in the \_\_\_\_\_\_ of the centripetal force.

5. Any object that circles a larger object is called a(n) \_\_\_\_\_\_

a. Satellites move in a circle because a(n) \_\_\_\_\_\_ acts on them.

b. \_\_\_\_\_ is the centripetal force that acts on satellites by continuously changing their direction of motion; this results in

\_\_\_\_\_ motion.

**6.** Earth's \_\_\_\_\_ keeps the Moon in orbit around Earth.

**7.** The planets remain in orbit because the \_\_\_\_\_\_ gravity pulls on them.

	·.			
Name	With the same of t	Date		Class
Content Prac	tice A			LESSON 3
Newton's Se	cond Law			
<b>Directions:</b> On each used only once.	line, write the term	from the word bank that correct	ly completes each sente	ence. Each term is
acceleration	center	centripetal force	direction	gravity
inertia	mass	newton	speed	straight
1. An object's vel	ocity can be cha	inged by changing its		, its
-	, O:	r both.		٠
2. A change in ve	locity over time	is called	<del></del> • .	
				•
<b>3.</b> The increasing	speed of a fallir	ng object is caused by		
<b>4.</b> One kg·m/s <sup>2</sup> ca	an also be expre	ssed as 1		
		n describes acceleration a	s force divided	÷
by		_•		
<b>6.</b> Because of		, an object in cir	cular motion has a	tendency to
move away in	a(n)	line		

7. The force that pulls an object in circular motion and keeps it in circular motion

8. The direction of the force that pulls an object in circular motion is toward the

\_\_\_\_ of the circle.

is \_\_

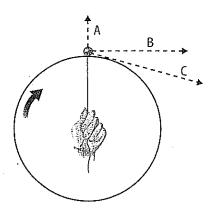
#### Key Concept Builder



**LESSON 3** 

#### Newton's Second Law

Key Concept How does centripetal force affect circular motion?



**Directions:** The diagram shows a ball on a string being swung around in a circle. Use the diagram to answer each question.

- 1. What force keeps the ball moving in a circle?
- **2.** What is producing this force?
- **3.** Why is the ball accelerating?
- **4.** In which direction is it accelerating?
- 5. If the ball broke away from the string at the position shown, would it move away on line A, B, or C?
- **6.** What causes it to take this path?
- 7. After breaking away from the string, what is the main force that would be acting on the ball?