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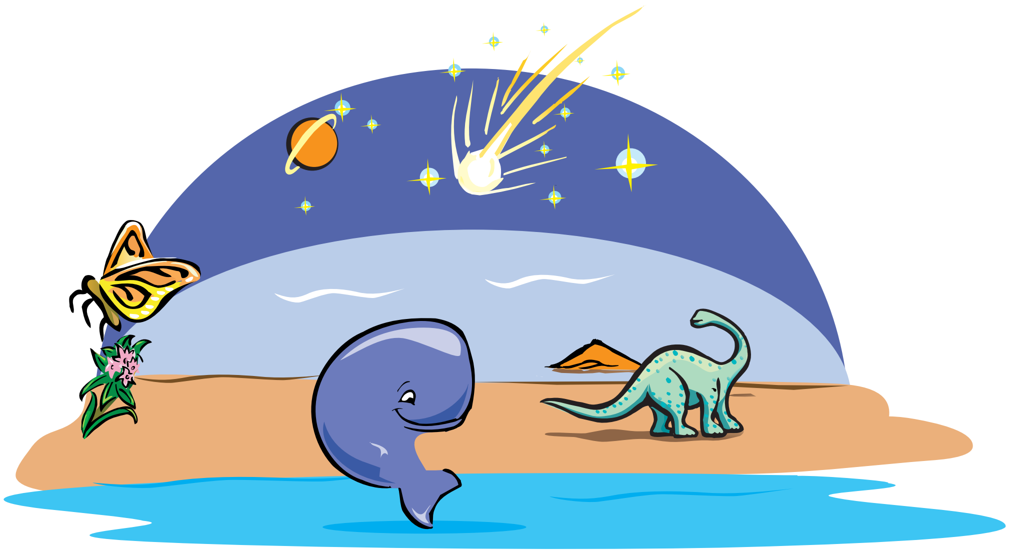
# Energy

## Grades 3-6



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# Contents




Materials in this printable book were excerpted from *More Super Science with Simple Stuff*, by Susan R. Popelka, published by Good Year Books. Visit them on the Web at http://www.goodyearbooks.com.

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# Experiencing Energy

- *Potential energy* is stored energy. It can be changed to *kinetic energy,* or *energy of motion.* There are many different kinds of potential and kinetic energy, some of which are investigated in this chapter.

- The range of a projectile (horizontal distance it travels from the place it was launched) depends on the angle and the speed of the launch. At a given angle of launch, the greater the speed of projectile when it is launched, the greater the range. At a given speed, the range is greatest at a 45° launch angle. The range is the same for angles that add up to 90°, such as a 30° angle and a 60° angle.

- Potential energy can be changed to kinetic energy, and kinetic energy can be changed back to potential energy, but the total amount of energy *has* to stay the same. That's the law of conservation of energy.

- The higher an object is above the ground, the more potential energy it has at that point, and the more kinetic energy it will have just before it hits the ground when dropped.

- A pendulum is a good example of conservation of energy. As the pendulum swings back and forth, potential energy is constantly being changed to kinetic energy and vice versa. When the pendulum is at the top of its swing, its potential energy is greatest and the kinetic energy is momentarily zero. When the pendulum hits the low point of its swing, its kinetic energy is greatest and its potential energy is momentarily zero.

- Similarly, a vertically oscillating spring changes energy from kinetic to potential and back again. At the top and bottom of its oscillation, its potential energy is greatest; and at the middle, its kinetic energy is greatest.

- Most of the time, energy is associated with the mechanical forms discussed above, but light, heat, and sound are also forms of energy.

- *Heat energy* results from the motion of atoms and molecules. When an object is heated, molecules that make up the object move faster. When an object is cooled, the molecules move more slowly.

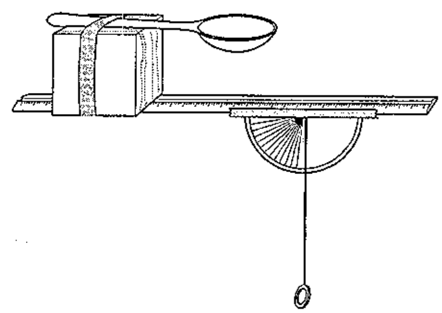
- *Light energy* results from the motion of electrons in the atom. Blue light has greater energy than red light, because blue light has a higher frequency than red light.

- *Sound energy* results from the vibrations of particles in matter. The faster the object vibrates, the higher the frequency, the higher the energy, and the higher the pitch of the sound.

Name________________________________ Date__________________________

# Catapult Cannon



**Science** The range of an object launched from a catapult depends on the launch angle.

**Stuff** Wooden block (about 1 inch × 1 inch × 2 inches); ruler; masking tape or duct tape; plastic spoon; marker; astrolabe from "Angles and Astrolabes"; paper; meter stick

## What to Do

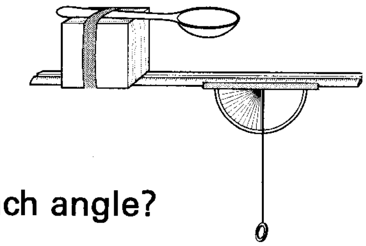
1. Place the block of wood on the flat side of one end of the ruler. Tape the spoon handle to the block, wrapping the tape around the block and the ruler. You have just made a catapult.
2. Place a mark on the bowl of the spoon, close to the middle.
3. Tape the straw of the astrolabe to the bottom flat side of the ruler. You may have to shorten the string on the astrolabe if the washer touches the floor.
4. Tear off a piece of paper about two-inches square, and roll it into a small ball.
5. Place the catapult on the floor so that the ruler is vertical. The reading on the astrolabe should be 90°.
6. Place the ball of paper on the mark on the spoon. Pull the top of the spoon back until it touches the ruler. Release the spoon.
7. Measure the distance from where the paper lands to where the catapult touches the floor. Repeat steps 6 and 7 twice.
8. Change the angle that the catapult makes with the floor, and repeat steps 6 and 7. Launch the paper ball three times at each angle.

## What's Going On Here

The launch angle of a projectile determines the distance that it travels horizontally as well as vertically. The horizontal distance traveled is called the *range*. The range is greatest when the launch angle is 45°. The range will be the same for angles that add up to 90°. For example, launch angles of 60° and 30° will have the same range.

Name______________________________ Date______________________

# Catapult Cannon



## What You Want to Know

How does the distance traveled by a paper ball launched from a catapult depend on the launch angle?

## What You Think Will Happen

The paper ball launched from the catapult will travel the greatest distance horizontally when it is launched at an angle of

**a.** 90°. **b.** 0°. **c.** 45°. **d.** 30° or 60°.

## What Happened

Record the launch angle and the *range,* or distance that the paper ball traveled horizontally. For each launch angle, add the three range numbers, and then divide by three to get the average range. Record the average range in the third column.

| Launch angle | Range | | | Average range |
|---|---|---|---|---|
| 0° | | | | |
| 15° | | | | |
| 30° | | | | |
| 45° | | | | |
| 60° | | | | |
| 75° | | | | |
| 90° | | | | |

## What It Means

What do your observations tell you about which launch angle has the greatest range?

______________________________________________

Are there any pairs of launch angles that have about the same average range?

______________________________________________

If you want to throw a baseball the greatest distance forward, what angle do you think you should throw it at, and why?

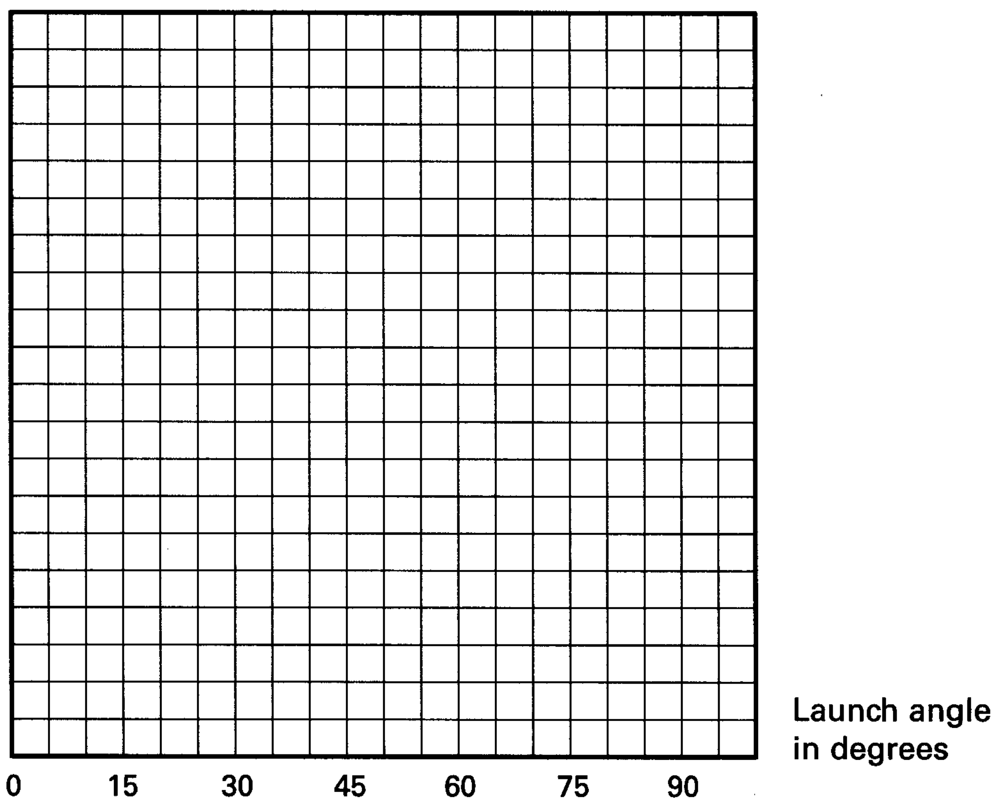
______________________________________________

______________________________________________

Name________________________________ Date________________________

# Catapult Cannon

1. Label the vertical axis "average range in centimeters." Pick a convenient scale and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened." Use the average range values.
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




If you launched the paper ball at 35°, what do you think the range would be? Is there another angle that would have the same range? Explain.

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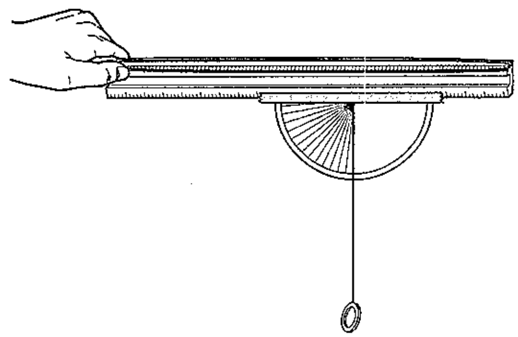
# Rubber Band Blast

**Science** The range of a rubber band depends on its launch angle.

**Stuff** Tape; astrolabe from "Astrolabes and Angles"; ruler with centimeter marks; rubber band



## What to Do

1. Tape the straw of the astrolabe to the edge of the ruler.
2. Hold the ruler away from your body at shoulder height so that it is horizontal and the astrolabe reads 0°.
3. Wrap the rubber band around the end of the ruler farthest from your body, and pull it back five centimeters. Look at the mark on the ruler to which the rubber band has been pulled back. Remember this location.
4. Release the rubber band.
5. Record the horizontal distance (the range) from where the rubber band landed to where you were standing when you launched it. Repeat this step twice.
6. Change the angle that the ruler makes with the floor; repeat steps 3, 4, and 5. Launch the rubber band three times at each angle. Make sure that you hold the ruler at shoulder height and that you pull the rubber band back the same distance each time.

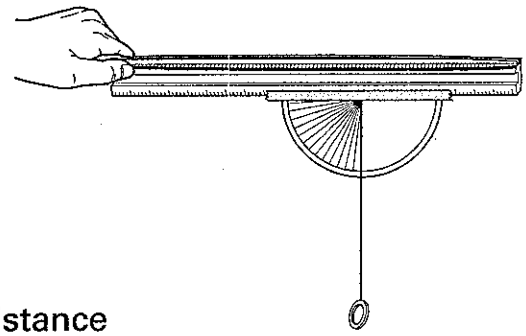
## What's Going On Here

The launch angle of the rubber band determines the distance that it travels horizontally (the range) as well as vertically. The range is greatest when the launch angle is 45°. The range will be the same for angles that add up to 90°. For example, launch angles of 60° and 30° will have the same range.

Name________________________________ Date________________________

# Rubber Band Blast



## What You Want to Know

How does the distance a rubber band travels depend on the launch angle?

## What You Think Will Happen

The rubber band will travel the greatest distance horizontally when it is launched at an angle of

**a.** 90°. **b.** 0°. **c.** 45°. **d.** 30° or 60°.

## What Happened

Record the launch angle and the distance that the rubber band traveled horizontally (the *range*). For each launch angle, add the three range numbers, and then divide by three to get the average range. Record the average range in the third column.

| Launch angle | Range | | | Average range |
|---|---|---|---|---|
| 0° | | | | |
| 15° | | | | |
| 30° | | | | |
| 45° | | | | |
| 60° | | | | |
| 75° | | | | |
| 90° | | | | |

## What It Means

What do your observations tell you about which launch angle has the greatest range?

______________________________________________

Are there any pairs of launch angles that have about the same average range?

______________________________________________

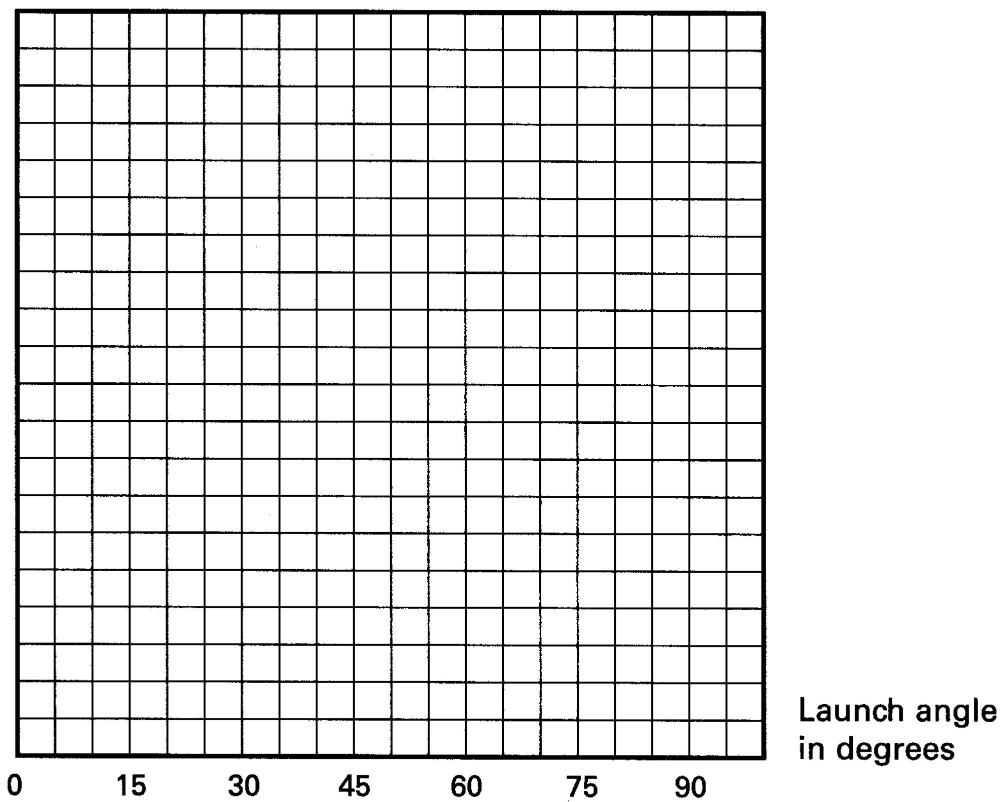
If you want to spray water with a hose, at what angle do you think you should spray the water to have it go the farthest horizontal distance?

______________________________________________

Name________________________________ Date________________________

# Rubber Band Blast

1. Label the vertical axis "average range in centimeters." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened." Use the average range values.
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




What does your graph show about how the range changes as the angle of launch increases?

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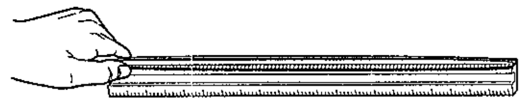
# Rubber Band Barrage

**Science** The range of a rubber band depends upon how far the rubber band is stretched.



**Stuff** Ruler with centimeter marks; rubber band

## What to Do

1. Hold the ruler out away from your body at shoulder height so that it is horizontal.
2. Wrap the rubber band around the end of the ruler farthest from your body, and pull it back to the nearest centimeter mark on the ruler after it has begun to stretch.
3. Release the rubber band.
4. Record the horizontal distance (the range) that the rubber band traveled from where it landed on the floor to where you were standing when you launched it. Repeat this step twice.
5. Repeat steps 2 to 4 at one-centimeter intervals until you reach the end of the ruler.

## What's Going On Here

When you pull the rubber band back, you are doing work on it; the work that you do is stored in the rubber band as elastic potential energy. When you release the rubber band, the potential energy is changed to kinetic energy, the energy of motion. The rubber band moves a distance (the range). The farther back you pull the rubber band, the more work you do on it, and the more potential energy is stored in it; therefore, it has more kinetic energy on its release and travels farther. If you place a small target in front of the rubber band, you knock it over. The kinetic energy of the moving rubber band is able to do work on the target, providing a force to knock it over. There is a lot of physics involved in this simple science activity.

Name________________________________ Date________________________

# Rubber Band Barrage

## What You Want to Know

How does the distance that a rubber band travels depend on how far back it is pulled before it is launched?

## What You Think Will Happen

As you pull the rubber band farther back before releasing it, it will travel a farther horizontal distance

**a.** each time.

**b.** up to a certain point; after that point it will travel the same distance each time.

**c.** up to a certain point; after that point it will travel a shorter distance each time.

## What Happened

For each distance that the rubber band was pulled back (stretched distance), record the distance that the rubber band traveled horizontally (the *range*). For stretched distance, add the three range numbers, and then divide by three to get the average range. Record the average range in the third column.

| Stretched distance | Range | | | Average range |
|---|---|---|---|---|
| 1 cm | | | | |
| 2 cm | | | | |
| 3 cm | | | | |
| 4 cm | | | | |
| 5 cm | | | | |
| 6 cm | | | | |
| | | | | |
| | | | | |

## What It Means

What do your observations tell you about how the range of a rubber band depends on how far it is pulled back before it is fired?

______________________________________________________________

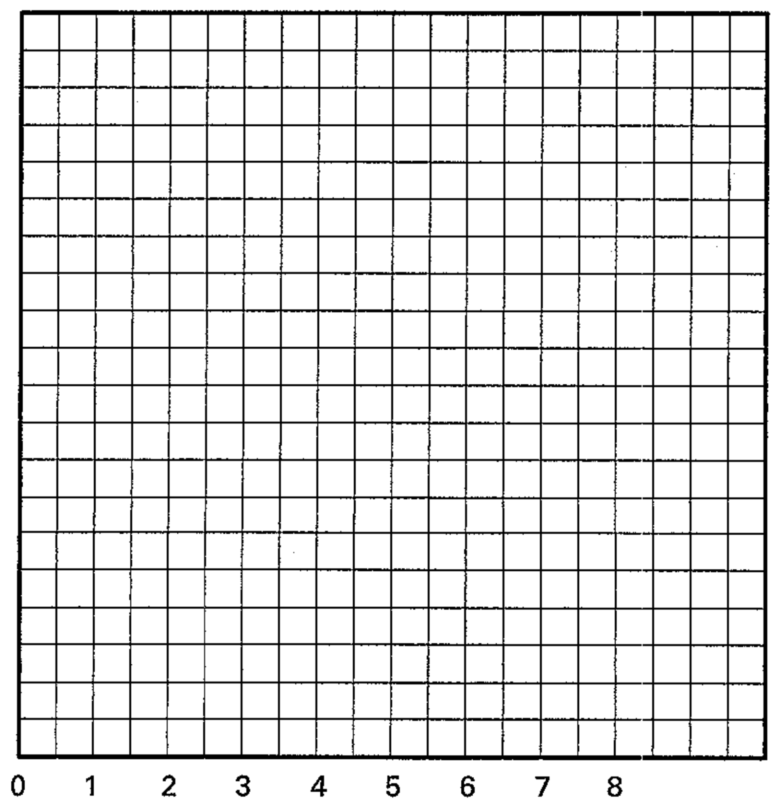
If you were to do this activity again, what would you change? What would you keep the same?

______________________________________________________________

Name________________________________ Date________________________

# Rubber Band Barrage

1. Label the vertical axis "average range in centimeters." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened." Use the average range values.
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




What does your graph show about how the range changes when the stretched distance is increased?

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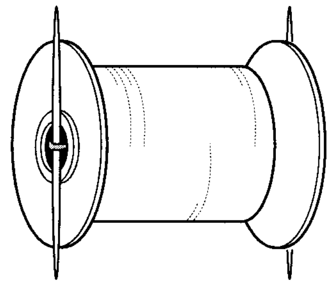
# Speedy Spool

**Science** Potential energy can be changed to kinetic energy.

**Stuff** 2 toothpicks; rubber band (a little longer than the spool); empty spool; masking tape; washer (smaller than spool diameter); ruler with centimeter marks



## What to Do

1. Put one toothpick through one loop of the rubber band.
2. Insert the rubber band into the hole in the spool. Tape the toothpick flat across the bottom of the spool, making sure that it is centered with equal amounts protruding.
3. Put the washer on the top of the spool, so that the hole in the washer lines up with the hole in the spool.
4. Use the second toothpick to reach through the washer into the spool to grab the free loop of the rubber band. Pull the loop of the rubber band out of the spool, and place the toothpick through the loop.
5. Adjust the second toothpick on the top of the spool, so that equal amounts of the toothpick are protruding on each side of the spool. Do **not** tape the toothpick.
6. Place a small piece of tape on the floor. This is your starting line.
7. Hold the spool with one hand, and wind the unattached toothpick with the index finger of your other hand. Wind the rubber band three complete turns.
8. Place the spool on the starting line, and let it go.
9. Measure the distance the spool travels on the floor.
10. Repeat steps 7 through 9, using 6, 9, 12, 15, and 18 complete turns of the unattached toothpick. If possible, try even more turns.

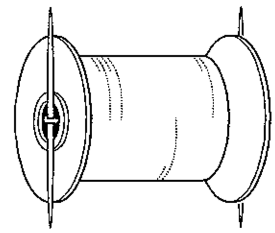
## What's Going On Here

When you wind the rubber band, you are doing work on it by moving your index finger around. The work you do on the rubber band is stored in the rubber band as potential energy. When you let the spool go on the floor, the potential energy is changed to kinetic energy, the energy of motion.

Friction between the spool and the floor slows the spool down. Some of the kinetic energy of the spool is changed to heat energy (produced by the friction). There may also be some kinetic energy that is changed to sound energy; listen for it as the spool moves.

Name________________________________ Date_________________________

# Speedy Spool



## What You Want to Know

How far will a spool that is powered by a rubber band travel on the floor?

## What You Think Will Happen

How far do you think the spool will travel when you wind the toothpick three turns?

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How far do you think the spool will travel when you wind the toothpick 15 turns?

_______________________________________________

## What Happened

Record the distance that the spool traveled for each number of toothpick turns.

| Toothpick turns | Distance traveled |
|---|---|
| 3 | |
| 6 | |
| 9 | |
| 12 | |
| 15 | |
| 18 | |
| | |
| | |
| | |

## What It Means

In this activity, potential energy in the wound-up rubber band is changed to kinetic energy when the spool rolls across the floor. Where do you think the potential energy in the rubber band came from?

_______________________________________________

If you could redesign the spool, what changes would you make so that it would roll even farther?

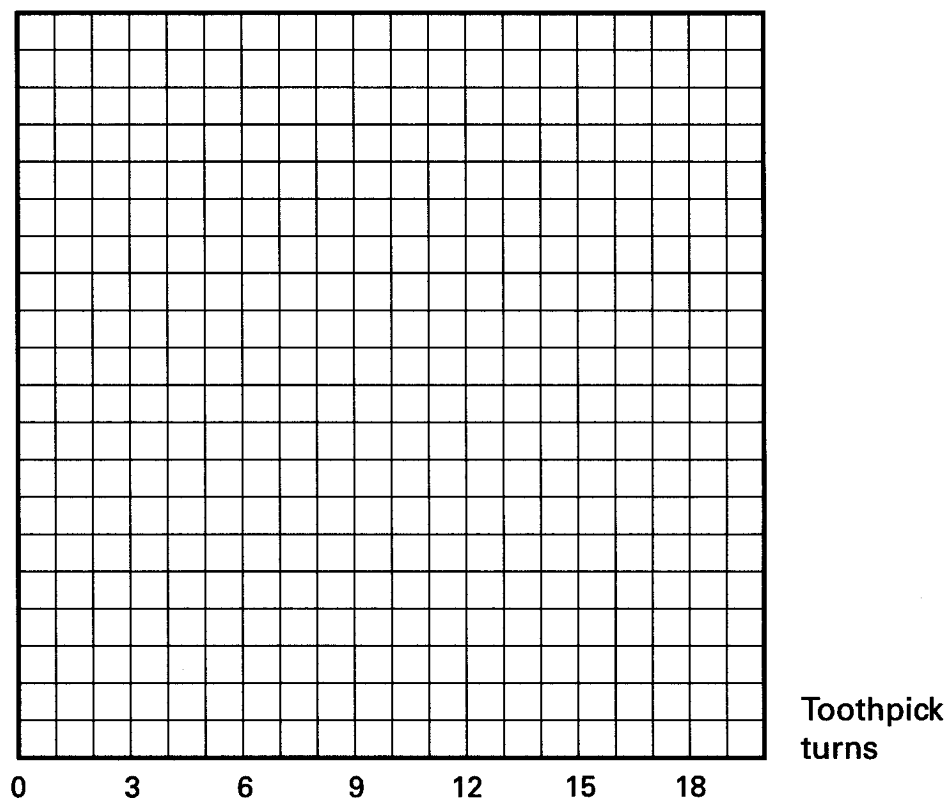
_______________________________________________

_______________________________________________

Name________________________________ Date_______________________

# Speedy Spool

1. Label the vertical axis "distance traveled in inches." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened."
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




How far would the spool travel with 20 toothpick turns? Explain your answer using the graph.

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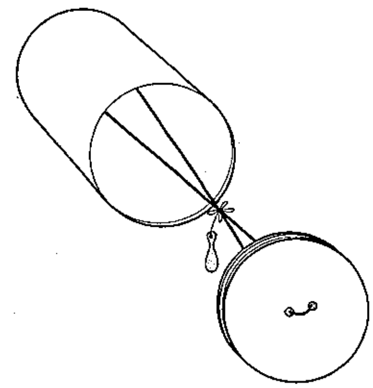
Name__________________________________ Date_________________________

# Changing-Course Can



**Science** Potential energy in a rubber band can be changed into kinetic energy, and vice versa.

**Stuff** Nail and hammer; small can with plastic lid; 2 rubber bands (each about the length of the can); string; small fishing weight or several washers

## What to Do

1. Use the hammer and nail to punch two holes $\frac{1}{2}$ inch apart in the middle of both the bottom of the can and the lid.
2. Thread one rubber band through the two holes in the bottom of the can, leaving the ends of the rubber band inside the can. Thread the other rubber band through the lid the same way.
3. Use a piece of string to tie all four loops of the rubber bands together in the middle of the can.
4. Use another piece of string to tie the fishing weight to the place where the rubber bands are connected. Allow the fishing weight to hang down from the string by about an inch.
5. Place the top on the can. The rubber bands should pull the lid tightly onto the can. If the rubber band is loose, tighten it by sliding rolled-up paper under the rubber band outside of the can on the bottom.
6. Roll the can gently on the floor. If the fishing weight is dragging on the side of the can, remove the lid, and shorten the string attaching the weight to the rubber bands.
7. Roll the can gently across the floor. When it appear to come to a stop, coax it back to you by calling, "Here can, here can." The can should respond. Count the number of times the can reverses direction before it stops completely.

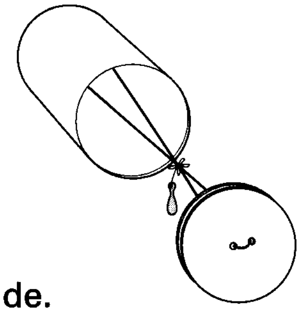
## What's Going On Here

The changing-course can is an excellent example of energy changing from potential to kinetic and back again. When you roll the can across the floor, it has kinetic energy due to its motion. As the can rolls across the floor, the rubber bands twist inside the can as the kinetic energy of the rolling can is changed to potential energy in the rubber bands. As the potential energy increases, the kinetic energy decreases until the can completely stops. Then the potential energy changes to kinetic energy as the rubber bands unwind, and the can begins to roll in the opposite direction. This changing of kinetic energy to potential energy and then back to kinetic energy continues until the forces of friction between the can and the floor cause the can to stop completely.

Name________________________________ Date_______________________

# Changing-Course Can



**What You Want to Know**
How can you make a can that will change direction when rolled across the floor?

**What You Think Will Happen**
Draw a picture of the inside of the can that you made.

When you roll the can across the floor, it will

**a.** continue to roll in a straight line.

**b.** come back and then stop right away.

**c.** come back and then roll away again.

**What Happened**
Describe the motion of the changing-course can when you rolled it across the floor.

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Did the can change directions? If so, how many times did it change?

_______________________________________________

**What It Means**
Use the word *energy* to describe the motion of the can when you rolled it across the floor.

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How would you redesign the can to make it change course even better?

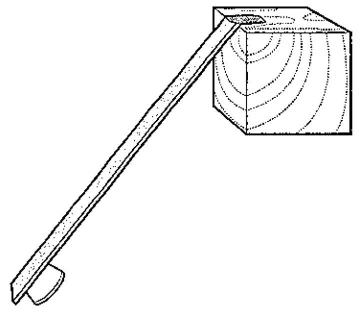
_______________________________________________

Name________________________________ Date________________________

# Penny Pendulum

**Science** The farther back a pendulum is pulled, the more potential energy it has, and the more kinetic energy it will have at the bottom of its swing.

**Stuff** Duct tape; ruler or paint stick; small block of wood; scissors; small paper cup; penny; yardstick



## What to Do

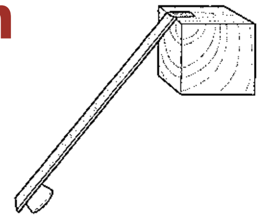
1. Tape the bottom of a ruler or paint stick to the top edge of a block. (If you have a table with a vertical edge along the top, you can tape the ruler directly to the table.) The ruler should be able to swing back freely, and when released it should swing until it hits the block of wood.
2. Cut the paper cup down so that it is about as high as the width of a penny.
3. Tape the paper cup to the bottom of the ruler so that the bottom of the cup is against the ruler.
4. Tape the block of wood to the top of a table, on the edge, so that when the ruler is pulled back and then released, the paper cup is below the top of table.
5. Test the pendulum by putting a penny, flat side down, in the cup. Holding the edge of the penny with your forefinger, pull the ruler back, and then release it. The ruler should stop when it hits the block, and the penny should fly out of the cup onto the floor.
6. Put a small piece of tape on the floor directly under the cup when it is in the stopped position.
7. Put the penny back in the cup. Pull the ruler back, and measure the distance from the bottom of the ruler to the floor using the yardstick. Release the ruler.
8. Measure the distance from the piece of tape you placed on the floor in step 6 to where the penny landed on the floor. If the penny rolls along the floor, do not measure the distance; instead repeat this step.
9. Repeat steps 7 and 8 five times, pulling the ruler back different amounts each time.

## What's Going On Here

When you pull the ruler back, you are doing work against gravity: Gravity is pulling the ruler and cup downward, and you are pulling them upward. Because of the work that you have done on the ruler by moving it back, the ruler has potential energy and is able to do work. When you released the ruler, its potential energy was changed to kinetic energy, the energy of motion. At the bottom of its swing, the ruler had its greatest kinetic energy and its greatest speed. The ruler hit the block of wood and stopped. The penny kept moving due to *inertia*, the tendency of an object to keep moving once it is moving. The more kinetic energy the penny had, the greater its speed at the bottom of its swing and the farther it was able to travel before it hit the floor.

Name________________________________ Date________________________

# Penny Pendulum



### What You Want to Know

How does the amount that you pull a pendulum back affect how much speed it has at the bottom of its swing?

### What You Think Will Happen

If you pull the pendulum farther back each time, it will have

**a.** more speed at the bottom of its swing.

**b.** less speed at the bottom of its swing.

**c.** the same speed at the bottom of its swing.

### What Happened

Record the height of the pendulum from the floor and the distance that the penny traveled.

| Height of pendulum | Distance penny traveled |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

At what part of its swing was the pendulum moving fastest?

______________________________________________________________

### What It Means

What do your observations tell you about how the amount that the pendulum was pulled back affects how far the penny will travel?

______________________________________________________________

______________________________________________________________

The faster an object is moving, the more kinetic energy it has. At what point in the ruler's swing did it have the greatest kinetic energy?

______________________________________________________________

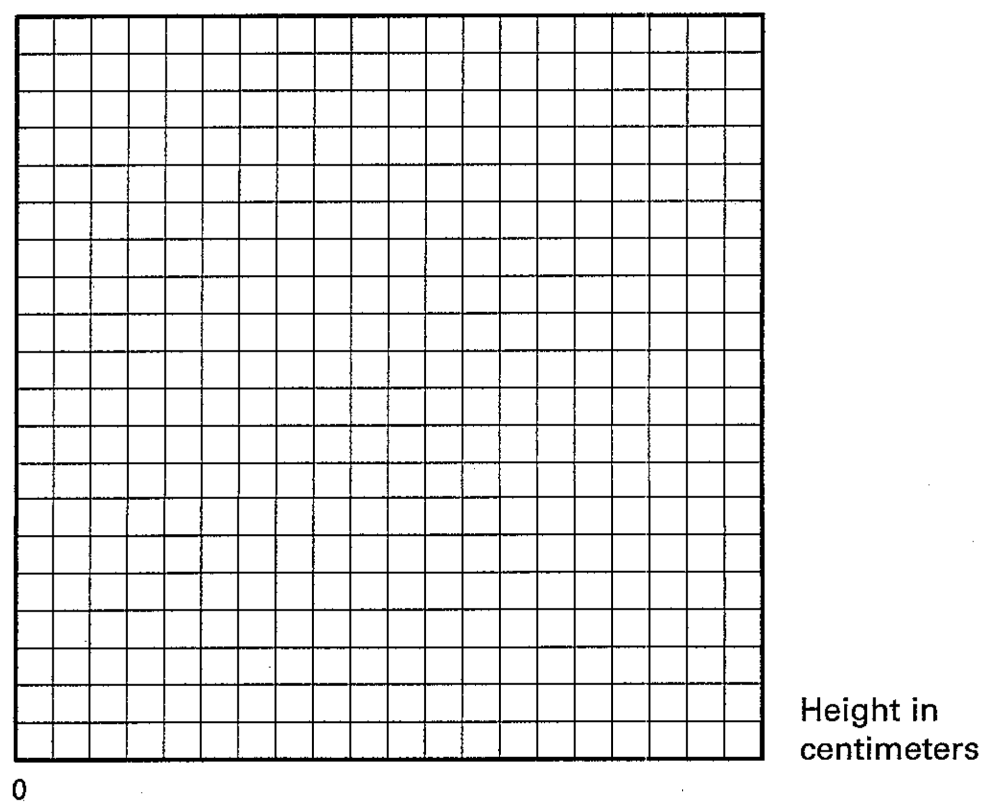
At which distance from the floor was the ruler's kinetic energy the greatest?

______________________________________________________________

Name______________________________ Date________________________

# Penny Pendulum

1. Label the vertical axis "distance traveled in centimeters." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis. Put numbers on the horizontal axis, too.
2. Plot the data from the table in "What Happened."
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




What does the graph show about how the height of the pendulum affects the distance that the penny will travel?

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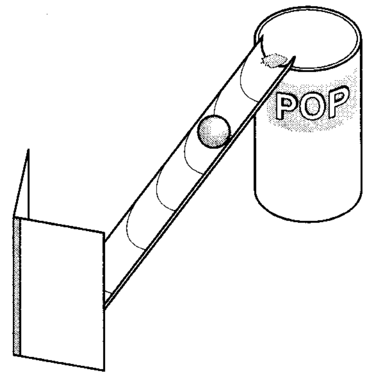
Name________________________________ Date_________________________

# Tube Target




**Science** The kinetic energy of an object rolling down a ramp depends on the height of the ramp.

**Stuff** Scissors; paper towel tube; marker; ruler with centimeter marks; marble; tape; pop can; two 3 inch × 5 inch index cards

## What to Do

*You will need a relatively flat surface to do this activity, such as a long table or the floor.*

1. Cut the paper towel tube in half along the long edge to form a trough.
2. Make a mark in the trough about an inch from one end of the tube. This will be the starting line for the marble.
3. Tape the tube to the top of the pop can and to the table, so that the trough is clear and the tube is secure.
4. Fold both index cards in half along the short side, and tape them together to make a thicker card. Open the taped cards halfway to make a target. The target will resemble a greeting card.
5. Place the target almost touching the end of the tube, so that when the marble is rolled down the tube, it will hit the inside of the folded index cards and move them some distance.
6. Place the marble at the mark on the towel tube, and allow it to roll down the tube.
7. Measure the distance that the target moved from the end of the tube. Measure the height of the top of the tube from the table.
8. Move the top of the tube down about one centimeter, and repeat steps 6 and 7. Continue to move the tube down the side of the can until you reach the bottom.

## What's Going On Here

The marble has potential energy at the top of the tube. As the marble rolls down the tube, the force of gravity increases it speed. The marble has kinetic energy due to its speed, and it is able to do work by moving the target at the bottom of the trough. The greater the height from which the marble is rolled, the more speed it has, and thus the more energy it has to do work on the target by moving it.

Name________________________________ Date_________________________

# Tube Target

## What You Want to Know

When a marble is rolled down a ramp, how does the height it is rolled from affect how far it can move a target at the bottom of the ramp?

## What You Think Will Happen

A marble is rolled down a ramp and strikes a target at the bottom of the ramp, moving the target some distance. How does the height from which the marble is rolled affect the distance the target is moved?

**a.** If you roll the marble from a higher point, the target will move the same amount as from a lower point.

**b.** If you roll the marble from a higher point, the target will move less than it moves from a lower point.

**c.** If you roll the marble from a higher point, the target will move more than it does from a lower point.

## What Happened

Record the distance that the target moved when the tube was at different heights.

| Height of tube | Distance that target moved |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

## What It Means

What do your observations tell you about how the height from which a marble rolls down a ramp affects the distance that it can move a target at the bottom of the ramp?

______________________________________________________________________

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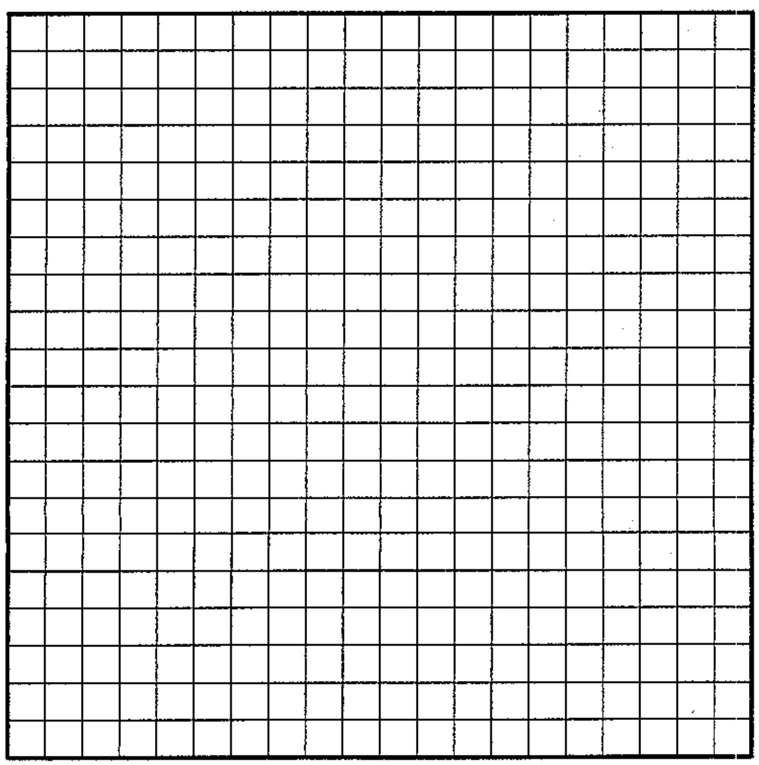
Name________________________________ Date__________________________

# Tube Target

1. Label the vertical axis "distance target moved in centimeters." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis. Put numbers on the horizontal axis, too.
2. Plot the data from the table in "What Happened."
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




What factors beside tube height affect how far the target is moved?

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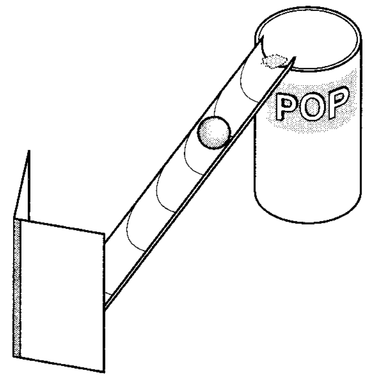
Name________________________________ Date__________________________

# Tube Target Two




**Science** The kinetic energy of an object rolling down a ramp depends on the forces that act on the object to increase or decrease its speed.

**Stuff** Scissors; paper towel tube; marker; ruler; marble; tape; pop can; two 3 inch × 5 inch index cards; smooth and rough surfaces, such as fabric, sandpaper, waxed paper, aluminum foil, crepe paper

## What to Do

*You will need a relatively flat surface to do this activity, such as a long table or the floor.*

1. Cut the paper towel tube in half along the long edge to form a trough.
2. Make a mark in the trough about an inch from one end of the tube. This will be the starting line for the marble.
3. Tape the tube to the top of the pop can and to the table, so that the trough is clear and the tube is secure.
4. Fold both index cards in half along the short side and tape them together to make a thicker card. Open the taped cards halfway to make a target. The target will resemble a greeting card.
5. Place the target almost touching the end of the tube so that when the marble is rolled down the tube, it will hit the inside of the folded index cards and move them some distance.
6. Place the marble at the mark on the towel tube, and allow it to roll down the tube.
7. Measure the distance that the target moved from the end of the tube. Measure the height of the top of the tube from the table.
8. Line the bottom of the trough with one of the smooth or rough surfaces. Trim the excess material if necessary. Repeat steps 5, 6, and 7.
9. Try all the other surfaces, one at a time.

## What's Going On Here

The marble has potential energy at the top of the tube. As the marble rolls down the tube, the force of gravity increases its speed. Friction between the marble and the surface that lines the tube opposes the force of gravity. Rough surfaces introduce more friction than smooth surfaces. The marble has kinetic energy due to its speed, and it is able to do work by moving the target at the bottom of the trough. The less friction the marble encounters as it rolls down the trough, the more speed it has at the bottom and thus the more energy it has to do work on the target by moving it.

Name ______________________________ Date ______________________

# Tube Target Two

## What You Want to Know

When a marble is rolled down a ramp, how does the type of surface that it is rolling on affect how far it can move a target at the bottom of the ramp?

## What You Think Will Happen

A marble is rolled down a ramp and strikes a target at the bottom of the ramp, moving the target some distance. The marble will move the target the farthest

**a.** on a rough surface.

**b.** on a smooth surface.

**c.** on any kind of surface (the target will always be moved the same distance).

## What Happened

Record the distance that the target moved when the tube was lined with different materials.

| Material lining the tube | Distance that target moved |
|---|---|
| none | |
| | |
| | |
| | |
| | |
| | |
| | |

## What It Means

What do your observations tell you about how the surface of the tube affects how far the marble can move a target at the bottom of the tube?

______________________________________________________________

______________________________________________________________

What other material would you like to try for the tube's surface? How far do you think the marble would move the target with this material? Explain.

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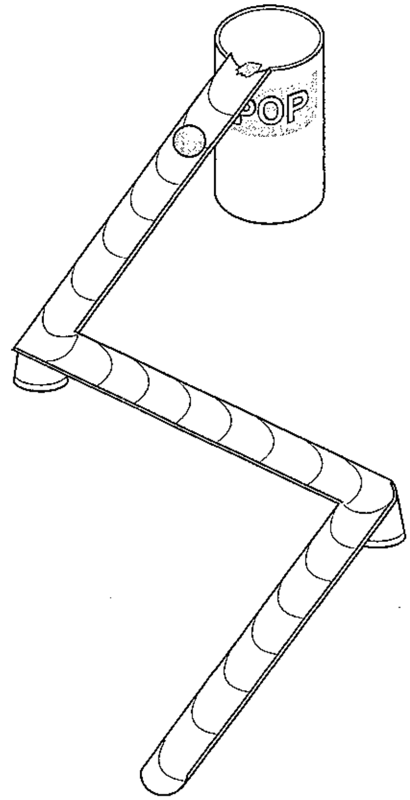
Name______________________________ Date______________________

# Tube Target Three




**Science** The energy of an object rolling down a ramp depends on the forces that act on the object to increase or decrease its speed.

**Stuff** 2 paper towel tubes; marble; pop can; scissors; 36 inches of masking tape; 12 inch squares each of fabric, waxed paper, and aluminum foil; 4 index cards; 4 small paper cups; stop watch or watch with a timer; marker

## What to Do

*This is an open-ended activity that allows students to experiment with what they observed and learned in the two previous activities.*

1. Using only the materials in the above list, design a device that meets the following criteria:
   - **a.** The pop can must stand upright on the floor, and the marble must move from the top of the can to the floor, taking as much time as possible.
   - **b.** You may use all or some of the materials.
   - **c.** Time will start when the marble starts rolling, and time will stop when the marble stops moving, whether on the floor or somewhere on the way down.
   - **d.** You cannot touch the marble or move air toward it after you start it rolling.
2. Once you have designed, tested, and redesigned the device, time how long it takes for the marble to roll from the top of the can to the floor.

## What's Going On Here

The marble has potential energy at the top of the tube. As the marble rolls down the tube, the force of gravity increases it speed. Friction between the marble and the surfaces that it rolls on or comes into contact with opposes the force of gravity. The marble has kinetic energy as it moves toward the floor. The more kinetic energy it has, the faster it moves. Since you want the kinetic energy to be small, you need to design the tube so that the potential energy the marble has at the top of the tube is changed to heat energy instead of kinetic energy of motion. You can do this by making sure that the marble encounters as much friction as possible, but not so much that it stops moving altogether.

Name________________________________ Date________________________

# Tube Target Three

### What You Want to Know

What kind of device will make a marble take the greatest amount of time to travel from the top of a pop can to the floor?

### What You Think Will Happen

Draw a sketch of your design in the space below. Identify all the materials you will be using.

### What Happened

How long did it take the marble to travel from the top of the can to the floor?

_______________________________________________

Describe the motion of the marble as it moved down the ramp. When did it move slowest? When did it move fastest?

_______________________________________________

_______________________________________________

### What It Means

What changes would you make to your design so that the marble could move even more slowly?

_______________________________________________

_______________________________________________

What other materials would you like to use in your design? How would the materials be used to make the marble move even more slowly?

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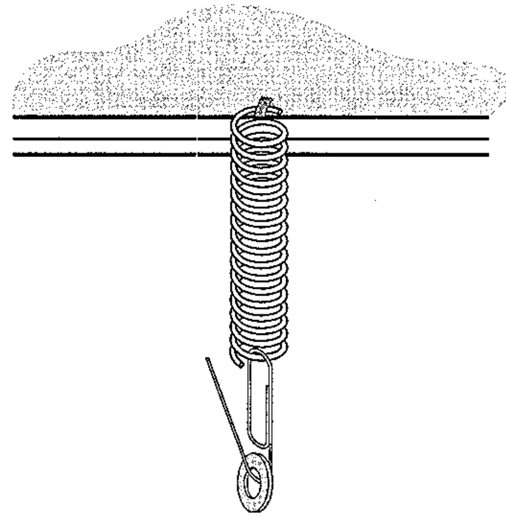
Name________________________________ Date________________________

# Spring Stretch



**Science** A spring will stretch when mass is suspended from it. As more mass is added, the spring will stretch more.

**Stuff** Tape; several springs (available at hardware stores); large paper clip; ruler with centimeter marks; 6 large washers

## What to Do

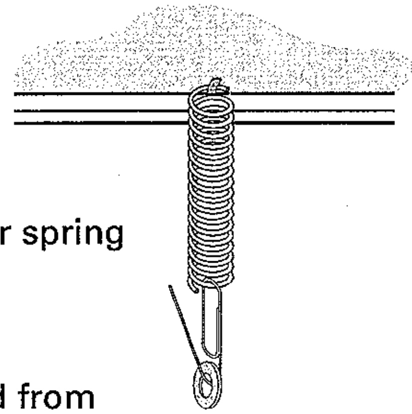
1. Tape one end of a spring to the side of a table so that the spring hangs freely.
2. Hang a large paper clip on the free end of the spring. Bend one free end of the paper clip slightly, so that washers can be hung from the paper clip.
3. With the ruler, measure the distance from the top of the spring to the bottom of the spring.
4. Place a washer on the paper clip, and measure the distance from the top of the spring to the bottom of the spring. Subtract the distance you got in step 3 from this distance to find the amount of "stretch."
5. Place one additional washer at a time on the paper clip, repeating step 4 each time, until all the washers have been used.
6. Repeat steps 1 through 5 using the other springs.

## What's Going On Here

When mass is suspended from the spring, the force of gravity pulls the spring downward. A force in the spring, called the *restoring force,* pulls back on the mass. The force of gravity and the restoring force are equal in size and opposite in direction. The more mass suspended from the spring, the more the spring will be stretched. In fact, if you double the mass, you will double the amount that the spring is stretched. A stiffer spring will not stretch as much as a loose spring. A simple experiment like the one you just performed can be used to determine the "spring constant" of a spring, which gives an indication of how "stretchy" a spring is.

Name________________________________ Date________________________

# Spring Stretch



## What You Want to Know

How does the amount of mass attached to a spring affect how far it stretches? Will a stiffer spring stretch more or less than a looser spring?

## What You Think Will Happen

If you double the amount of mass suspended from a spring

- **a.** the spring will stretch about twice as far.
- **b.** the spring will stretch about the same.
- **c.** the spring will stretch quite a bit less than twice as far.
- **d.** the spring will stretch quite a bit more than twice as far.

## What Happened

For each spring you tested, record the amount of "stretch" of the spring when mass was suspended from it.

| Number of washers | Amount of stretch | | |
|---|---|---|---|
| | Spring #1 | Spring #2 | Spring #3 |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |

## What It Means

What do your observations tell you about how the "stretch" changes when you double the mass that is suspended from the spring? Is this true for all the springs you tested?

______________________________________________________________

______________________________________________________________

Which of the springs seems to be the stiffest? Explain your answer.

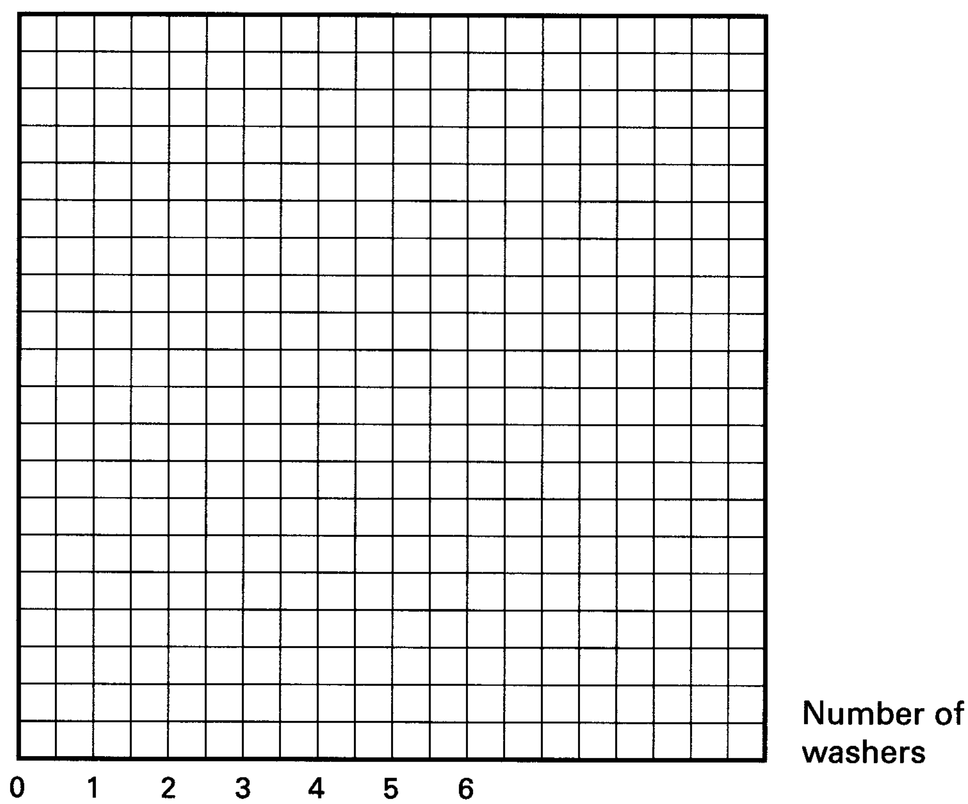
______________________________________________________________

______________________________________________________________

Name________________________________ Date________________________

# Spring Stretch

1. Label the vertical axis "stretch in centimeters." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened." Use a different color for each spring.
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot. Label each line with the spring number.
4. Put a descriptive title at the top of your graph.




What does the graph show about which spring is the stiffest?

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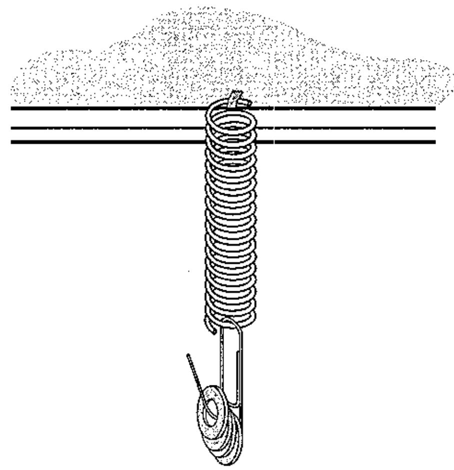
Name________________________________ Date__________________________

# Spring Swing



**Science** The time it takes for a mass suspended on a spring to swing up and down depends on the amount of mass and the stiffness of the spring.

**Stuff** Tape; 2 different springs; large paper clip; 6 large washers; stop watch or watch with a timer

## What to Do

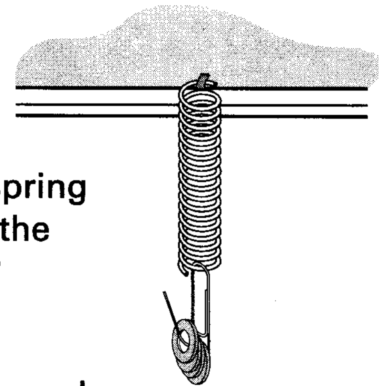
1. Tape one end of a spring to the side of a table, so that the spring hangs freely.
2. Hang a large paper clip on the free end of the spring. Bend one free end of the paper clip slightly, so that washers can be hung from the paper clip.
3. Place two washers on the paper clip. Bend the free end of the paper clip back in place, so that the washers do not slip off.
4. Pull the washers down a few inches, and let go. Time ten complete swings of the washers. (A complete swing is the motion of the washers starting from where you released them and ending at the same point.)
5. Place four washers on the paper clip, and time ten complete swings. Now try six washers. Try to pull the washers down the same distance each time before releasing them.
6. Repeat steps 1 through 5 using the other spring.

## What's Going On Here

When you initially release the washers, the restoring force of the spring pulls them upward, increasing their speed. The washers have energy due to this speed and are able to use this energy to compress the spring. Potential energy in the compressed spring is changed to kinetic energy when the spring moves downward again. Gravity is a force that is constantly acting to pull the mass downward. The swinging back and forth of the mass on the end of the spring is an excellent example of how energy is changed from one kind (kinetic) to another kind (potential). The time it takes to complete a full swing back and forth depends on the mass on the end of the spring and the stiffness of the spring. If more mass is suspended from the spring, the time for a complete swing will be longer. In fact, the time will be doubled when the mass is four times the initial mass. A stiffer spring will take a shorter time to complete a swing.

Name________________________________ Date________________________

# Spring Swing



## What You Want to Know

Does the time it takes for the mass on the end of a spring to make a complete swing up and down depend on the mass? Does it depend on the stiffness of the spring?

## What You Think Will Happen

If you put more mass on a spring, the time it takes to make one complete swing up and down

**a.** will be longer. **b.** will be shorter. **c.** will stay about the same.

Compared to a looser spring, the time it takes the mass on the end of a stiff spring to make one complete swing up and down

**a.** will be longer. **b.** will be shorter. **c.** will stay about the same.

## What Happened

Record your observations in the tables. (To calculate the time for one swing, divide by the time it took for 10 swings.)

**Spring #1**

| Number of washers | Time for 10 swings | Time for one swing |
|---|---|---|
| 2 | | |
| 4 | | |
| 6 | | |

**Spring #2**

| Number of washers | Time for 10 swings | Time for one swing |
|---|---|---|
| 2 | | |
| 4 | | |
| 6 | | |

## What It Means

What do your observations tell you about how the time it takes for the mass on the end of a spring to make one complete swing depends on the mass?

______________________________________________________________

______________________________________________________________

What effect does the stiffness of the spring have on the amount of time it takes for the mass to make one complete swing?

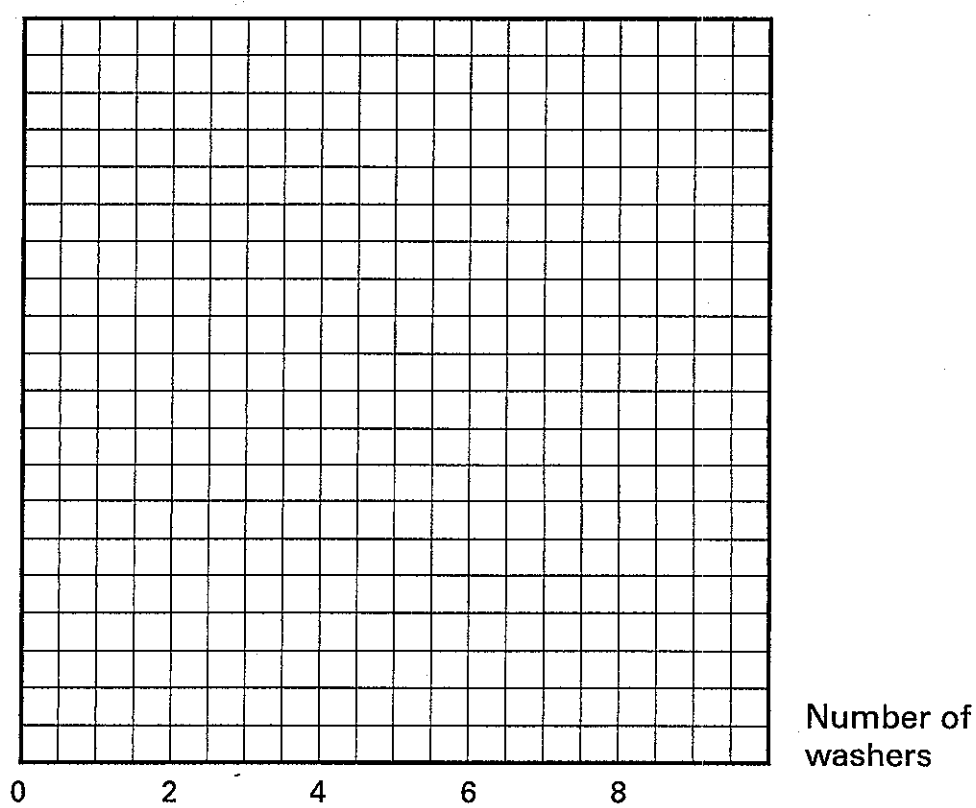
______________________________________________________________

______________________________________________________________

Name______________________________ Date______________________

# Spring Swing

1. Label the vertical axis "time for one swing in seconds." Pick a convenient scale, and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the data from the table in "What Happened." Use a different color for each spring.
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot. Label each line with the spring number.
4. Put a descriptive title at the top of your graph.

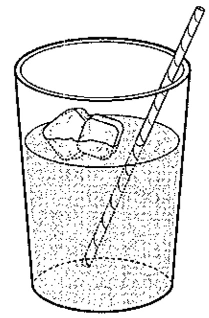



Using the graph, determine what the time for one swing would be using 10 washers. Do this for both springs. Be sure to label your answers.

________________________________________________

Name____________________________________ Date__________________________

# Warmer Water



**Science** A cup of ice water warms up steadily at room temperature after the ice has melted.

**Stuff** Cold water; plastic cup or glass; ice cubes; spoon or other stirrer; thermometer; clock or watch

## What to Do

1. Pour cold water into the plastic cup or glass.
2. Put four ice cubes into the water. Stir the water for a few minutes.
3. Record the temperature of the water every two minutes, making sure to stir the water between readings. Continue to record the temperature until the water seems to stay at the same temperature for several minutes.
4. Dump the water out of the cup. Pour hot tap water into the cup. Record the temperature of the water. Add four ice cubes to the water, and stir.
5. Record the temperature of the water every two minutes, making sure to stir the water between readings. Continue to record the temperature until the water seems to stay at the same temperature for several minutes.

## What's Going On Here

When you started with ice water and took the temperature of the water every two minutes, the temperature stayed the same until the ice melted, and then steadily rose. The air surrounding the cup of ice water was a source of heat energy. Heat energy flowed from the warm air to the cold water, and the water responded by warming up until it reached room temperature. Before the ice melted, the temperature stayed at about 32°F or 0°C. Heat energy was being supplied by the surrounding warm air, but that energy did not go to heating up the water; it went to melting the ice. When you added ice to hot water and took the temperature every two minutes, you noticed a decrease in temperature, but it was not a steady decrease. Instead, the temperature decreased more rapidly at the beginning and more slowly at the end. This is because the hot water was the main source of energy to melt the ice. As the hot water lost energy to melt the ice and warm the colder water, there was less heat energy available to warm up the water. The air surrounding the cup also affected the cooling of the water, but it was a constant supplier of energy, as compared to the variable water.

Name________________________________ Date________________________

# Warmer Water

## What You Want to Know

How does the temperature of ice water change as it warms up? How does the temperature of hot water change when ice is added to it?

## What You Think Will Happen

When ice water stands at room temperature,

**a.** the temperature will go up right away and will continue to rise about the same amount every two minutes.

**b.** the temperature will stay the same for a while and then go up about the same amount every two minutes.

**c.** the temperature will stay the same for a while and then go up, but not by the same amount every two minutes.

When ice is added to hot water and the water stands at room temperature,

**a.** the temperature will stay the same and then go down about the same amount every two minutes.

**b.** the temperature will go down about the same amount every two minutes.

**c.** the temperature will go down but not by about the same amount every two minutes.

## What Happened

Record the temperature of water every two minutes.

| Time | Ice water | Hot water |
|---|---|---|
| 2 minutes | | |
| 4 minutes | | |
| 6 minutes | | |
| 8 minutes | | |
| 10 minutes | | |
| 12 minutes | | |
| 14 minutes | | |
| 16 minutes | | |
| 18 minutes | | |
| 20 minutes | | |

## What It Means

Is the change in temperature more steady when ice water is warmed or when hot water is cooled? Explain your answer.

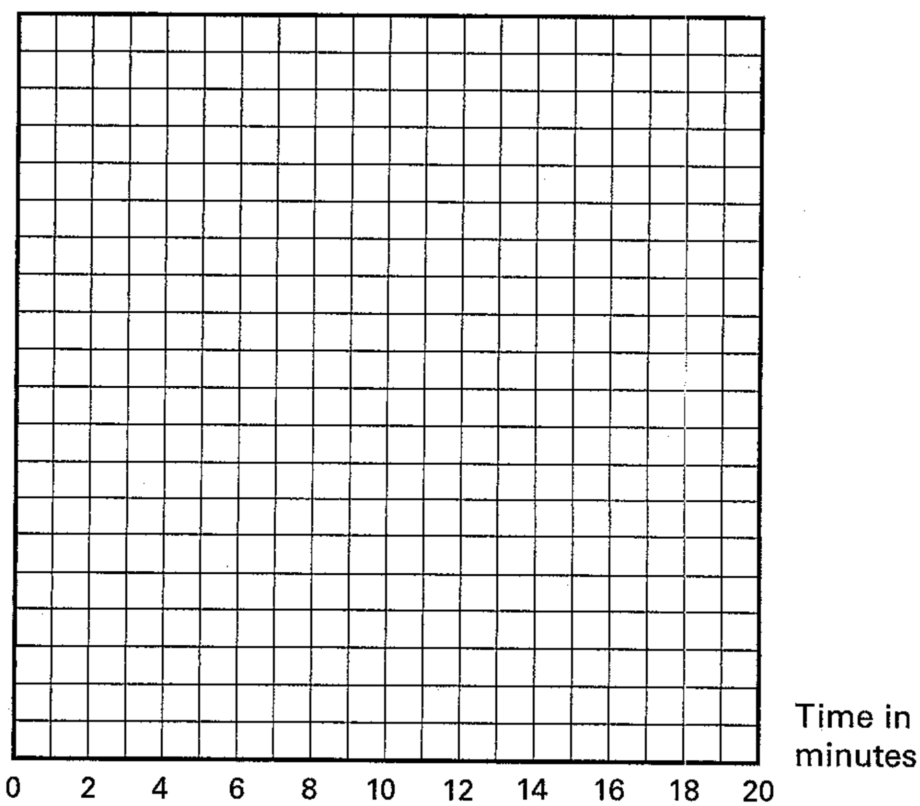
_____________________________________________________________

_____________________________________________________________

Name________________________________ Date________________________

# Warmer Water

1. Label the vertical axis "temperature in degrees F" or "temperature in degrees C" (whichever you used). Pick a convenient scale and write numbers on the vertical axis starting at 0. Keep the scale the same on the entire vertical axis.
2. Plot the hot water data from the table in "What Happened."
3. If your points look like they are on a straight line, use a straightedge to draw a line. The line should touch most of the points; those that it misses, it should miss by just a little bit. If your points look like they are on a curve, draw a smooth curved line through the points. Do not connect the points dot-to-dot.
4. Put a descriptive title at the top of your graph.




When did the temperature of the water seem to change the fastest? Explain how you got your answer.

______________________________________________________________

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Materials in this printable book were excerpted from *More Super Science with Simple Stuff*, by Susan R. Popelka, published by Good Year Books. Visit them on the Web at http://www.goodyearbooks.com.