GOOD YEAR BOOKS

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MORE SUPER SCIENCE with SIMPLE STUFF!

Susan R. Popelka

GOOD YEAR BOOKS

Dedication

To my mom, Dorothy Huberty, my sister, Lynn Johnson, my high school English teacher, Mrs. Muelmanns, and my college physics teacher, Mr. Bergsten.

Acknowledgments

Many people helped me with this book. I would like to thank my family, Carl, Erin, Mike, and Gail Popelka, who encouraged me and waited patiently for their turn on the computer while I did yet one more rewrite. I would not have been able to finish the book without the daily question, *Are you done with your book yet?*

For the past ten years I have been teaching hands-on science workshops to elementary teachers. I wrote this book because those teachers asked me to write it. The activities in the book are their favorites, and they have tried and tested all of them. I owe them a heartfelt thank you for teaching me as I was teaching them.

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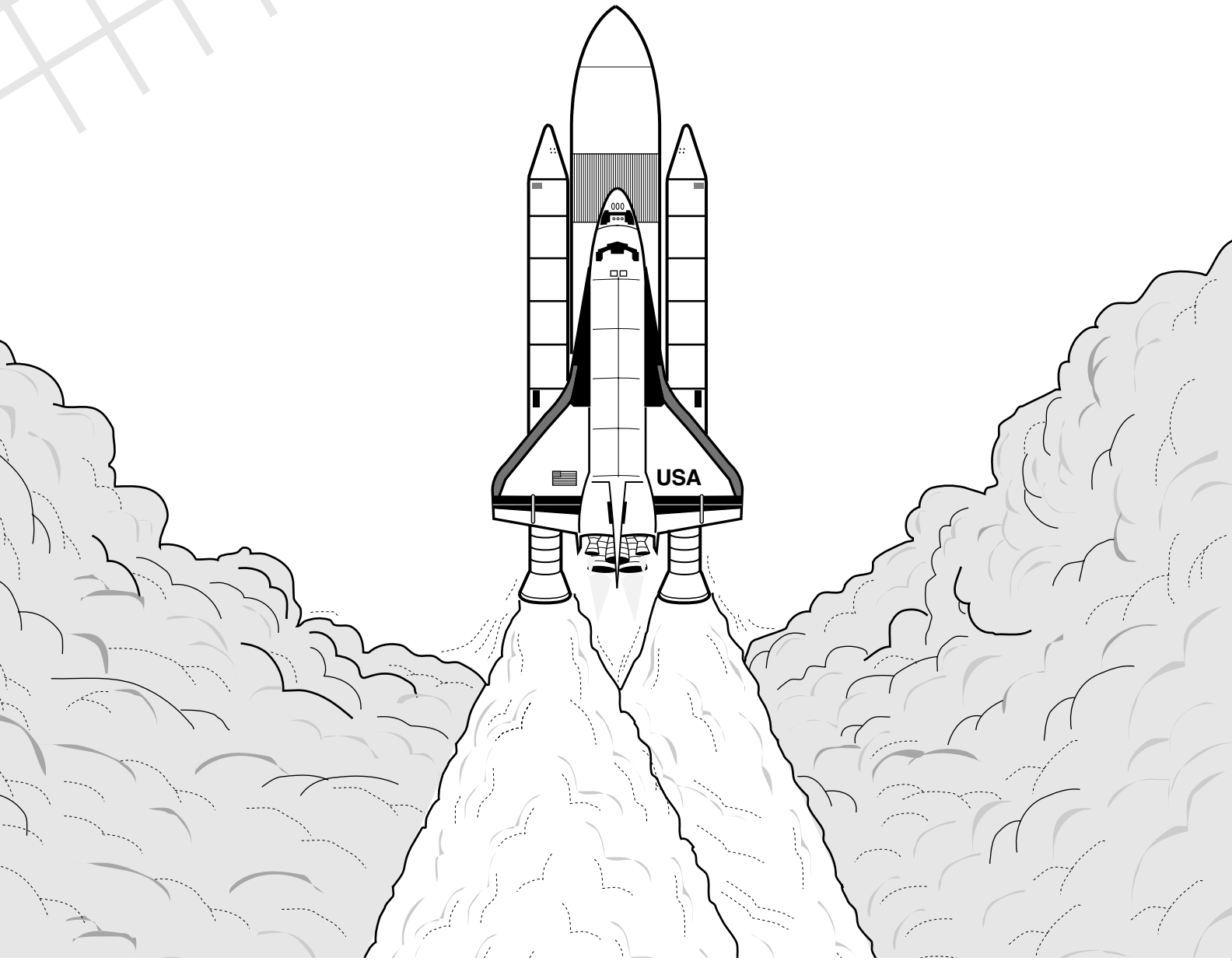
CHAPTER 2 ENERGY



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.

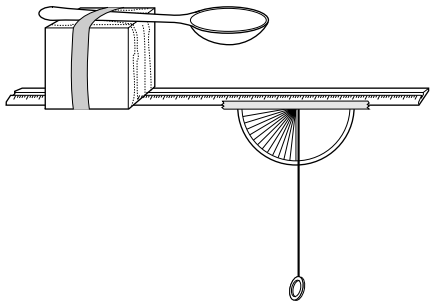
- *Light energy* results from the motion of electrons in the atom. Blue light has greater energy than red light, because blue light has a higher frequency than red light.

- *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.

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

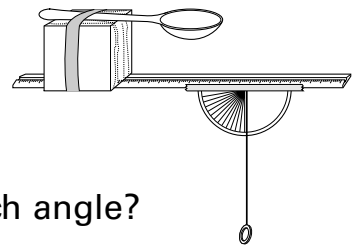
The launch angle of a projectile determines the distance that it travels horizontally as well as vertically. The horizontal distance traveled is called the *range.* The range is greatest when the launch angle is 45°. The range will be the same for angles that add up to 90°. For example, launch angles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

Try It!

★ Try measuring the height the paper ball travels at different launch angles.

★ Try placing the top end of the catapult against a wall and the bottom edge on the floor. Change the angle of launch by sliding the top end of the catapult up and down the wall.

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?

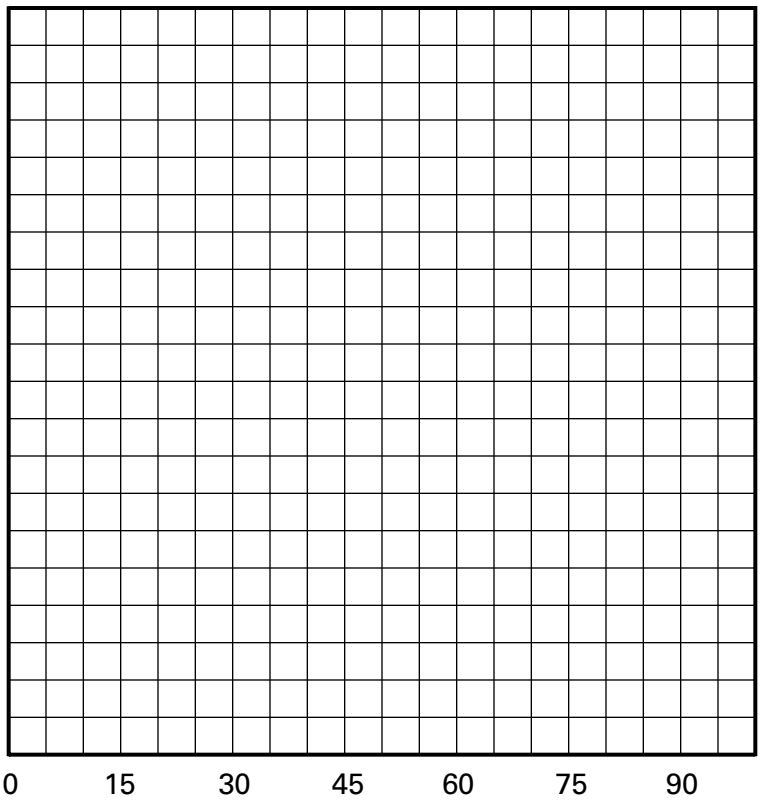
Are there any pairs of launch angles that have about the same average range?

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

CATAPULT CANNON

GRAPH IT!

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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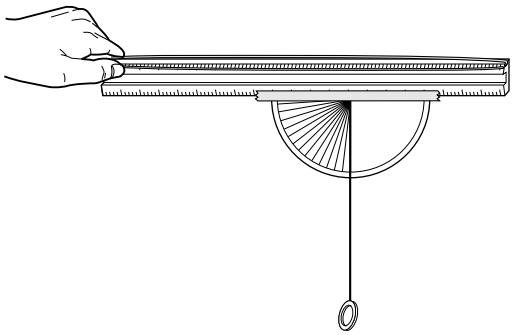
RUBBER BAND BLAST

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

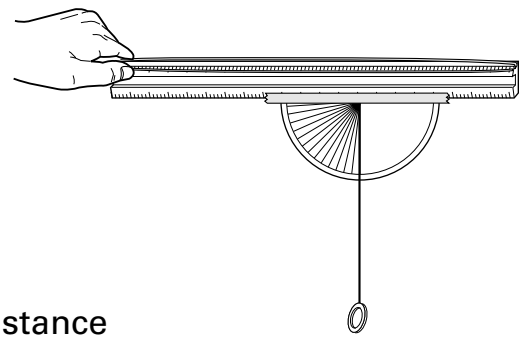
The launch angle of the rubber band determines the distance that it travels horizontally (the range) as well as vertically. The range is greatest when the launch angle is 45°. The range will be the same for angles that add up to 90°. For example, launch angles of 60° and 30° will have the same range.

Try It!

★ Try different sizes of rubber bands.

★ Place a target on the floor, and try to hit it with the rubber band by changing the launch angle.

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?

Graph It Next

RUBBER BAND BLAST

GRAPH IT!

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.
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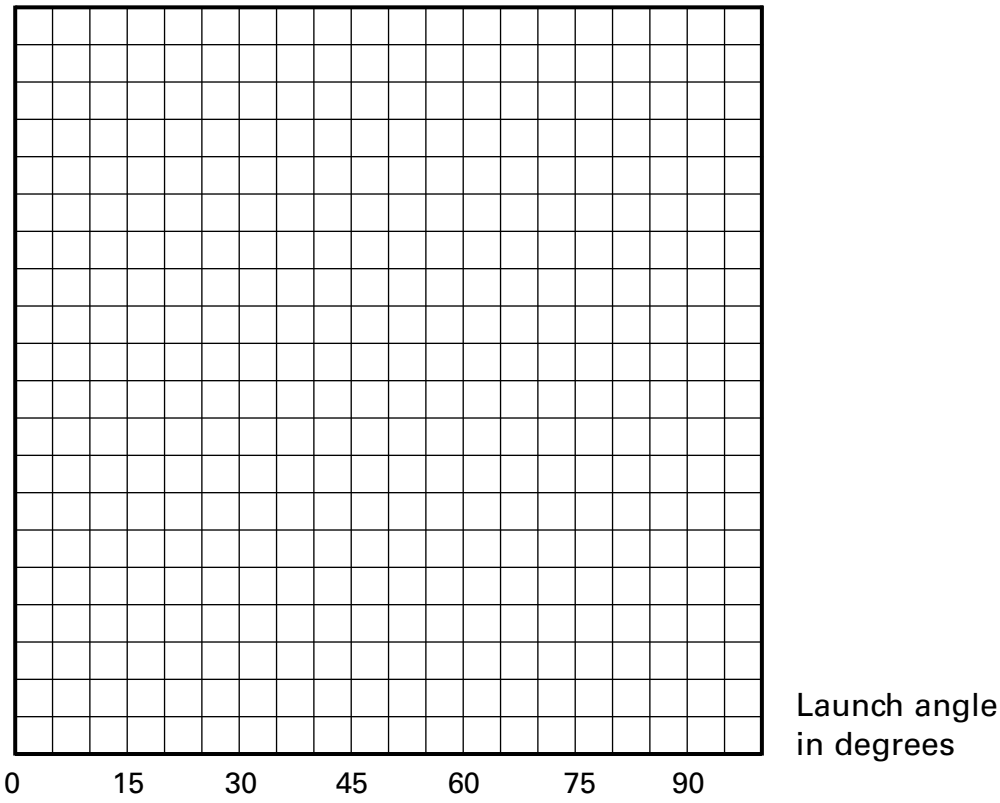

What does your graph show about how the range changes as the angle of launch increases?

_____