The NASA SCI Files™
The Case of the
Galactic Vacation

Segment 3

After learning that space travel is going to take a little longer than the tree house detectives had anticipated, they decide to learn more about traveling in space. They meet up with Dr. D at Busch Gardens to ride a few roller coasters to learn about gravity, acceleration, G-forces, and weightlessness. After having way too much fun, they decide that their next stop is to visit NASA's Starship 2040, where Mr. Wang of NASA Marshall Space Flight Center explains and shows them what space travel will be like in about 50 years. The tree house detectives realize that no matter where they go for their "out-of-this-world" vacation, they will need to have a different rocket (propulsion) system than is currently available. They decide to visit Dr. Franklin Chang-Diaz of NASA Johnson Space Center to learn more about plasma rockets and how they will help us travel faster in the future.

Objectives

The students will

- understand that gravity is an attractive force.
- understand that microgravity is free-falling.
- learn what future space travel will be like.
- learn how rockets are powered.

Vocabulary

acceleration—the rate of change of velocity with respect to time

fusion—the act or process of melting or making fluid by heat; the union of light atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy

inertia—a property of matter by which it remains at rest or in unchanging motion unless acted on by some external force

navigation—the science of getting ships, aircraft, or spacecraft from place to place; especially the method of figuring out position, course, and distance traveled

parabola—a curve formed by the intersection of a cone with a plane parallel to a straight line in its surface; something that is bowl-shaped

plasma—a collection of charged particles (as in the atmospheres of stars) that shows some characteristics of a gas but that differs from a gas in being a good conductor of electricity and in being affected by a magnetic field

propulsion—the action of pushing or driving, usually forward or onward

satellite—any object that revolves around another object

weightlessness—having little weight; lacking apparent gravitational pull

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Galactic Vacation,* discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the web, as was previously mentioned in Segment 1.
4. Focus Questions–Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program to answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions–Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the web site ahead of time for students to copy into their science journals.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Galactic Vacation* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about the solar system, the Moon, Mars, and space travel. Organize the information, place it on the Problem Board, and determine if any of the students' questions from Segment 2 were answered.
4. Decide what additional information is needed for the tree house detectives to design their "out-of-this-world" vacation. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under "After Viewing" on page 15 and begin the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:

   • **Research Rack**–books, internet sites, and research tools

   • **Problem-Solving Tools**–tools and strategies to help guide the problem-solving process.

   • **Dr. D's Lab**–interactive activities and simulations

   • **Media Zone**–interviews with experts from this segment

   • **Expert's Corner**–listing of Ask-An-Expert sites and biographies of experts featured in the broadcast
7. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the PBL Facilitator Prompting Questions instructional tool found in the educator area of the web site.
8. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the tree house, the online PBL investigation main menu section, "Problem-Solving Tools," and the "Tools" section of the educator's area for more assessment ideas and tools.

Careers

chemical engineer
roller coaster designer
flight controller
mission specialist
flight surgeon

Resources

Books

Challoner, Jack: *Eyewitness: Energy*. DK Publishing, 2000, ISBN: 0789455765.

Daynes, Katie: *Living in Space*. Usborne Publishing Ltd., 2003, ISBN: 0794503012.

Farndon, John: *Rockets and Other Spacecraft*. Millbrook, 2000, ISBN: 0761308407.

Hopping, Lorraine Jean: Sally Ride: *Space Pioneer*. McGraw-Hill Trade, 2000, ISBN: 0071357408.

Lafferty, Peter: *Eyewitness: Force & Motion*. DK Publishing, 2000, ISBN: 0789448823.

Langille, Jacqueline and Bobbie Kalman: *The Space Shuttle (Eye on the Universe)*. Crabtree Publishing, 1998, ISBN: 0865056889.

Simon, Seymour: *Destination: Space.* HarperCollins Children's Books, 2002, ISBN: 0688162908.

Skurzynski, Gloria: *Zero Gravity*. Simon & Schuster, 1994, ASIN: 0027829251.

VanCleave, Janice: *Janice VanCleave's Gravity: Mind-boggling Experiments You Can turn Into Science Fair Projects*. John Wiley & Sons, 1992, ISBN: 0471550507.

Vogt, Gregory: *Rockets (Exploring Space)*. Bridgestone Books, 1999, ISBN: 0736801987.

Wiese, Jim: *Cosmic Science: Over 40 Gravity-Defying, Earth-Orbiting, Space-Cruising Activities for Kids*. John Wiley & Sons, 1997, ISBN: 0471158526.

Web Sites

NASA's Beginners Guide to Propulsion
This web site provides background information for teachers on basic propulsion.
http://www.grc.nasa.gov/WWW/K-12/airplane/bgp.html

NASA's Beginners Guide To Model Rockets
This web site provides background information for teachers on basic rocketry.
http://www.grc.nasa.gov/WWW/K-12/airplane/bgmr.html

NASA Kids
This site is an extraordinary site for students and teachers. Kids can play games, learn what they would weigh on another planet, print coloring pages, explore space and rockets, and much more!
http://kids.msfc.nasa.gov/

Amazing Space: Gravity
Play "Planet Impact" and learn how a planet's gravity affects a comet path.
http://amazing-space.stsci.edu/capture/gravity/

Amazing Space
Visit this web site for a wealth of information and resources. Games, information, pictures, and lesson plans are available for just about everything that has to do with space, from black holes to the electromagnetic spectrum.
http://amazing-space.stsci.edu/capture/

Activities and Worksheets

On the Web

3-2-1 Launch!

Design, build, and test paper pencil rockets.

Newton's Car

Build a car to demonstate Newton's Second Law of Motion.

There's a Micro in My Gravity? Two Fun Activities

Problem

To understand microgravity*

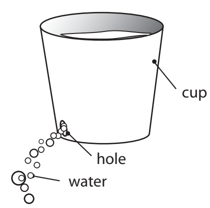
At the Drop of a Cup

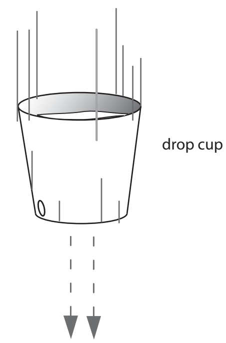
Materials

foam cup
pencil or scissors
water
large tub or basin
science journal

Procedure

1. Using a sharp pencil or scissors, punch a small hole in the side of the cup near its bottom.
2. Hold your thumb over the hole as you fill it with water. What will happen if you move your thumb?
3. Hold the cup over a large tub and remove your thumb. Observe and record your observations in your science journal.
4. Hold your thumb over the hole again and fill cup with water.
5. Hold the cup up as high as you can. Drop the filled cup into the tub. Record your observations.





Conclusion

1. What happened when you removed your thumb in step 2? Why?
2. What happened when you dropped the cup? Why?

The Weight is Falling

Materials

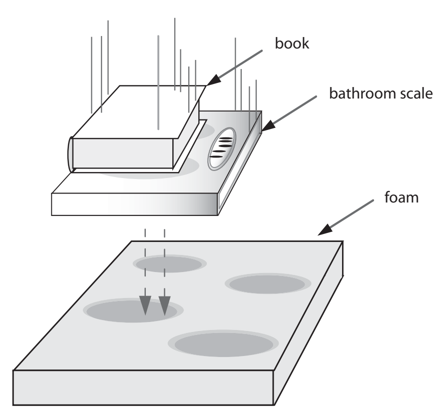
bathroom scale
heavy book
large pillow or foam
science journal

Procedure

1. Place a heavy book on a bathroom scale and record the book's weight in your science journal.
2. Hold the scale with the book on it 1 meter over a large pillow or piece of foam.
3. Let go of the scale so that the book and the scale fall together. As it drops, quickly observe the book's weight. Record.

Conclusion

1. What happened to the weight of the book when you dropped the book and the scale together? Explain.
2. Using what you have observed in these two activities, explain why astronauts experience microgravity in space.
3. Where can you experience microgravity?



*** Microgravity Defined**

The prefix micro- (m) derives from the original Greek mikros meaning small. By this definition, a microgravity environment is one in which the apparent weight of a system is small compared to its actual weight due to gravity. Quantitative systems of measurement, such as the metric system, commonly use micro- to mean one part in a million. Using that definition, the apparent weight experienced by an object in a microgravity environment would be one-millionth (10) of that experienced at Earth's surface. The use of the term microgravity in this guide will correspond to the first definition.

All Aboard for Destinations Unknown

Purpose

To build a model space ship to simulate travel to space

Materials

boxes of various sizes
Velcro®
poster board
markers
glue
2-liter bottles
milk cartons
various objects as needed

Procedure

1. You are in charge of the first tourist space mission and it is your job to design a spacecraft that will be comfortable, safe, and practical for trips into space.
2. Below find some suggestions on how to construct a spacecraft, but be creative!
   a. Stack three or four boxes of different sizes on top of each other. Cut a door in the biggest box and a hole in the top of it. Fasten a second, slightly smaller box over this box with the open side down. Make a cone from poster board and attach it to the top of the space shuttle. Paint the space shuttle with white paint and draw a NASA insignia on the side.
   b. Use a large refrigerator box with a cone-shaped roof attached. Cut windows in the side of the box and cover with clear plastic. Attached shuttle wings on the sides. Paint.
   c. For inside your space shuttle use Velcro® to attach items such as pens, small notebooks, glasses, telescopes, silverware, mirrors, toothbrushes, combs, etc.
3. Design life support gear for astronauts to wear while working outside the spacecraft. You might want to use plastic milk cartons with aquarium tubing attached to a 2-liter bottle (oxygen tank) to create space helmets. Also, don't forget to provide a way for the astronauts to tether themselves to the spacecraft while working outside. We wouldn't want to lose anyone!
4. Share and enjoy your spacecraft with your classmates! If possible, find music that is appropriate for "space" travel and play it to soothe the passengers.

Extension

1. Design a brochure describing the first tourist flight and the destinations that are planned for the trip. Be sure to include activities for your travelers while they are on their long journey.

Rocket Go Round

Problem

To understand the action-reaction principle of a rocket

Background

Newton's Third Law of Motion states that every action is accompanied by an opposite and equal reaction.

Materials

wooden pencil with eraser
straight pen
round balloon
flexible straw
tape
safety goggles

Procedure

1. To stretch out the balloon, blow it up and release the air several times.
2. Place the end of the straw without the bend inside the open neck of the balloon.
   See diagram 1.
3. Use a small piece of tape to seal the balloon to the straw. The balloon should inflate when you blow through the straw.
4. Bend the straw at a right angle. See diagram 2.
5. Place the straw and balloon onto one of your fingers and move it around until it balances.
6. At the balance point (the place where your finger is touching the straw when it balances), push the straight pen through the straw.
7. Push the straight pen into the center of the eraser and finally into the wood of the pencil. See diagram 3.
8. Spin the straw a few times to loosen up the hole the pen made in the straw.
9. Put on safety goggles.
10. Once it spins freely, blow up the balloon and hold your finger over the end of the straw to keep the air from escaping.
11. Hold the pencil away from your body and then release the straw.

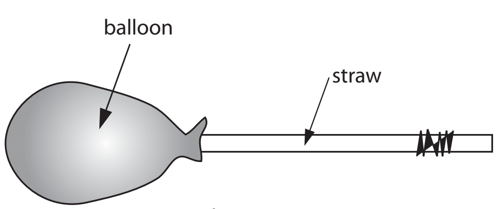


Diagram 1

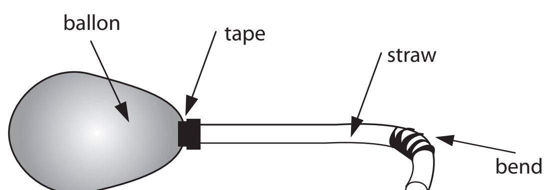


Diagram 2

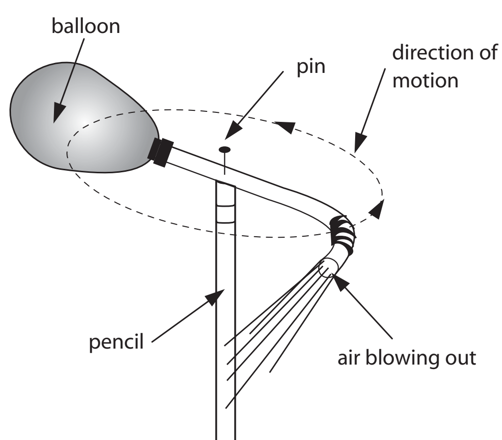


Diagram 3

Conclusion

1. In which direction did the straw and balloon spin? Why?
2. Use Newton's Third Law to explain what happened in this experiment.

Rocket Racer

Purpose

To observe Newton's Third Law of Motion to understand the principles behind rockets

Materials

foam meat tray
tape
flexible straw
scissors
4 pins
marker
rounded balloon
metric ruler
pencil
wheel pattern (p. 52)
masking tape

Procedure

1. Using scissors cut out the wheel patterns.
2. Place the patterns on the foam meat tray and trace around the edges.
3. Use the metric ruler to draw a rectangle 7.5 cm by 18 cm on the foam meat tray. See diagram 1.
4. Blow up the balloon a few times to stretch it out.
5. Place the end of the straw with the bend inside the open neck of the balloon.
6. Use a small piece of tape to seal the balloon to the straw. The balloon should inflate when you blow through the straw.
7. Lay the straw in the center of the rectangle, having the end without the balloon hanging 1 cm over the front edge. Bend the straw upward at the bendable section and tape the entire straw into place. See diagram 2.
8. Push the pins through the hubcaps into the wheels and then into the edges of the rectangle. See diagram 3.
9. Make a starting line by placing a piece of masking tape on the floor.
10. Blow up the balloon and pinch the end of the straw to hold in the air.
11. Place the racer on the floor at the starting line and release. See diagram 4.
12. Measure the distance that your racer traveled and record in your science journal.
13. Discuss how you could improve your Rocket Racer so that it might go farther.
14. Make any changes decided upon and repeat steps 10-13.
15. Repeat for two more trials.
16. Find the average distance your Rocket Racer traveled in all four trials.

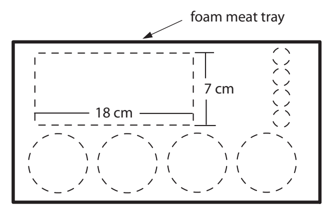


Diagram 1

Diagram 2

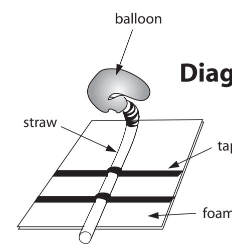


Diagram 3

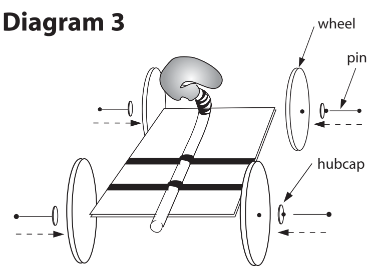
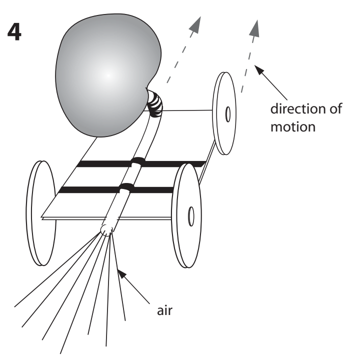


Diagram 4



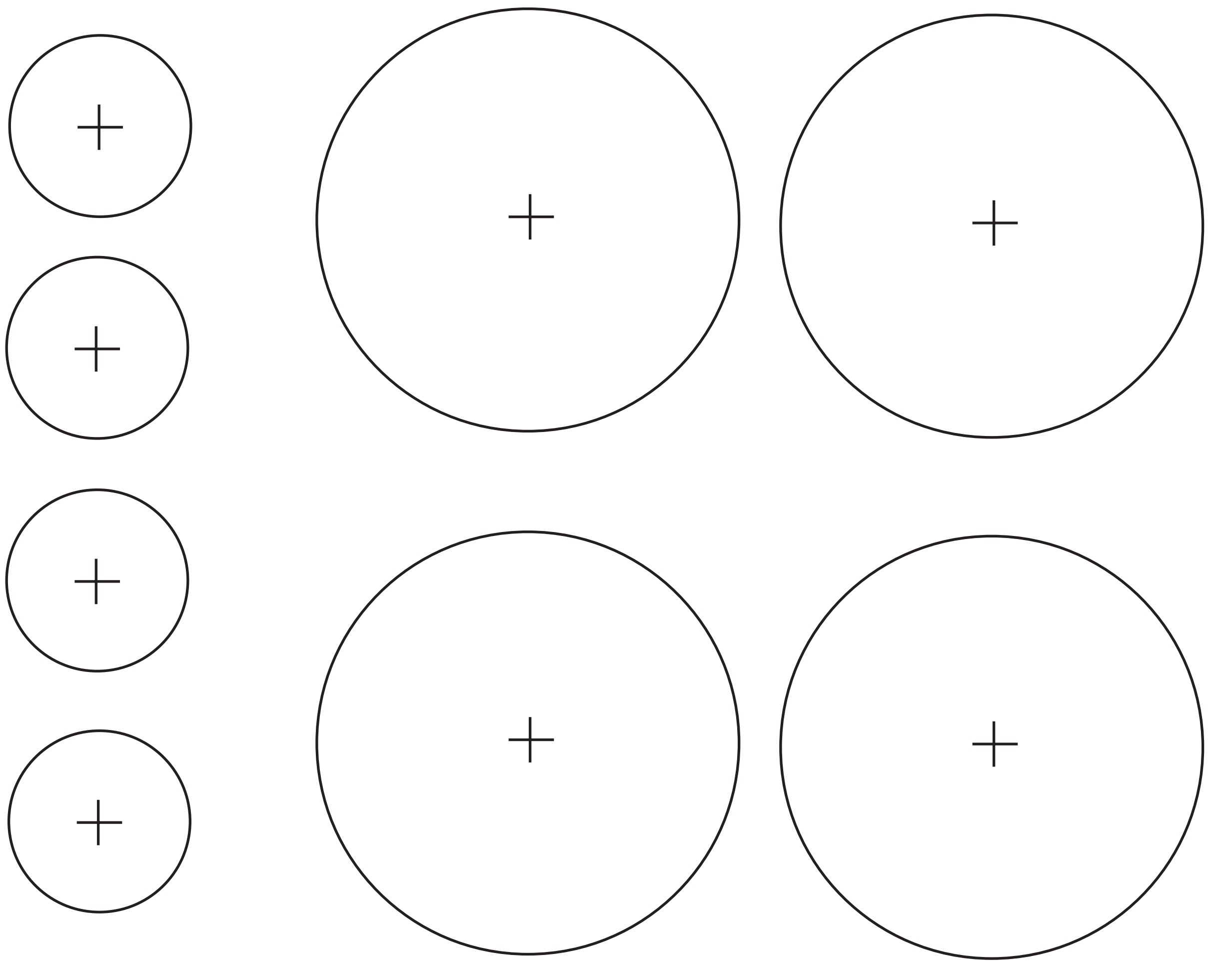
Conclusion

1. Did your Rocket Racer travel the same distance each time? Why or why not?
2. Explain how the Rocket Racer got its power to travel.
3. What could you do to improve your Rocket Racer?

Rocket Racer (concluded)

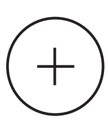
Wheel Patterns

Crosses mark the centers



Hubcap Patterns

Crosses mark the centers



There's an Ant In Your Acid

Problem

To investigate methods of increasing the power of rocket fuels by manipulating surface area and temperature

Background

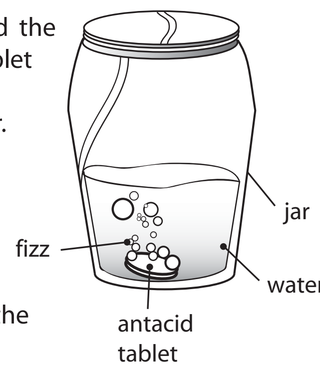
When rocket propellants (fuel) burn faster, the amount (mass) of exhaust gases expelled increases and so does the speed at which gases accelerate out of the rocket nozzle. Newton's Second Law of Motion states that the force of a rocket engine is directly proportional to the mass expelled times its acceleration.

Materials

effervescent antacid tablets (4 per group)
2 glass jars (same size)
tweezers or forceps
scrap paper
watch or clock with second hand
thermometer
goggles
water (warm and cold)
metric-measuring cup
wooden block

Procedure

1. Fill each jar with 50 ml of tap water.
2. Put on your goggles.
3. Predict how long it will take for the tablet to dissolve in the water. Record your prediction in the chart below.
4. Drop one of the tablets into the first jar and using a clock with a second hand, time how long it takes for the tablet to dissolve. Record in the chart below.
5. Place a second tablet on a piece of paper and wrap it around the tablet. Use a wooden block or other heavy item to crush the tablet into small pieces.
6. Predict how long it will take for the tablet to dissolve in the water. Record your prediction.
7. Drop the crushed tablet into the second jar and time how long it takes to dissolve. Record.
8. Empty both jars and rinse thoroughly.
9. Fill the first jar with 50 ml of very warm water.
10. Place a thermometer in the jar and wait a minute or two. Record the temperature reading on the thermometer in the chart below.
11. Predict how long it will take for the tablet to dissolve and record.



	Prediction	Actual Dissolving Time	Observation Notes
Tap Water Whole Tablet			
Tap Water Crushed Tablet			
Warm Water			
Cold Water			

12. Drop the tablet into the warm water and time how long it takes to dissolve. Record.
13. Add 50 ml of very cold water to the second jar and repeat steps 10-12.

Conclusion

1. Which tablet dissolved faster, the whole tablet or the crushed tablet? Why?
2. Which tablet dissolved faster, the one in warm water or the one in cold water? Why?
3. Using what you learned from this experiment, how could you make the tablet dissolve even faster?
4. How would this information help scientists make rockets go faster?

Answer Key

There's a Micro in My Gravity?

A Drop of a Cup

1. When you removed your thumb, the water poured out of the hole in the cup because the force of gravity pulled the water down toward the Earth.
2. When you dropped the cup, the water did not come out the hole because the water was in a state of freefalling. Even though the water stayed in the cup, it was still attracted to the Earth by gravity and ended up in the same place that the water did in the first experiment!

The Weight is Falling

1. When you dropped the book and the scale together, the weight went to zero because both the book and the scale were falling toward the Earth at the same time, creating microgravity.
2. Astronauts in space and the space shuttle are both falling toward Earth at the same rate of speed. The freefall creates microgravity and allows the astronauts to "float."
3. Answers will vary but might include roller coaster rides, springboard (diving), and elevators.

Rocket Go Round

1. The balloon spun in the opposite direction of the air coming out the end of the straw.
2. The balloon produces an action by squeezing on the air inside, causing it to rush out the straw. The air, traveling around the bend in the straw creates a reaction force at a right angle to the straw. The result is that the balloon and straw spin around the pin.

Rocket Racer

1. Answers will vary, but most likely the Rocket Racer did not travel the same distance each time. The difference in distance could have been due to different amounts of air being used to blow up the balloons or variances in the wheels (roundness, smooth edges, and so on).
2. The Rocket Racer is propelled along the floor according to the principle stated in Newton's Third Law of Motion, "For every action there is an opposite and equal reaction." Because the balloon is attached to the car, the force of the air expelling from the balloon pulls the car along.
3. Answers will vary but might include smoothing out the edges of the wheels, blowing the balloon up with more air, using different materials, and so on.

There's an Ant In Your Acid

1. The crushed tablet dissolved faster because when you crushed the tablet, you increased the surface area. Increasing the surface area increases its reaction rate with the water.
2. The tablet in warm water dissolved faster because tablets in warm water react more quickly than tablets in cold water. The heat helps to speed up the reaction.
3. A combination of a crushed tablet and warm water would provide the faster way to dissolve the tablet.
4. In a rocket, scientists can make the rocket's thrust greater by increasing the burning surface area of its propellant and by adding heat or preheating the propellant.