



Weightless in Space
Astronaut aboard International Space Station



Abstract of Lesson

Students use the inquiry process to explore the effects of friction on moving objects. They build and operate a CD Glider to simulate motion in a frictionless environment and to investigate and predict the motion of the Personal Satellite Assistant (PSA) while it is moving in the test environment of the International Space Station (ISS).

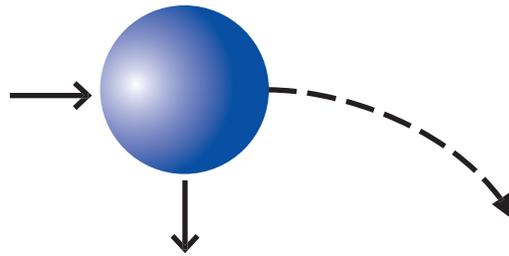


Introduction

Students explore how different forces influence the motion of an object. They discover how gravity and friction affect the motion of objects on Earth. They use a simulation of the PSA, a soccer-ball shaped robot, to explore how objects move in space when the influences of gravity and friction are removed. See <http://psa.arc.nasa.gov/>.



M Main Concept
Objects move differently on Earth than they do in space because of the effects of gravity and friction.



M Major Concepts

- A force is anything that changes an object’s motion or causes an object to move.
- An object in motion will remain in motion, unless an unbalanced force acts on it.
- An object at rest will remain at rest, unless an unbalanced force acts on it.
- On Earth, the force of gravity makes objects remain in contact with the ground. The rubbing of objects on the ground is called friction.
- On Earth, friction acts as a force that slows down objects.
- In space, the reduced effects of gravity result in less friction on objects so that they move at a constant speed in the same direction unless a force is applied to them.

Prerequisite Concepts	Links To Lessons Or Resources That Address Concepts
<ul style="list-style-type: none"> • Objects move in many different ways, such as straight, zigzag, round and round, back and forth, fast and slow. 2061:4F (K-2) #1 • The way to change how something is moving is to give it a push or a pull. 2061:4F (K-2) #2 	<p>http://whyfiles.larc.nasa.gov/text/kids/D_Lab/activities/expressions_motion.html</p> <p>http://whyfiles.larc.nasa.gov/text/educators/activities/2002_2003/inclass/sticky_friction.html</p> <p>http://spaceplace.nasa.gov/en/kids/ds1_mgr.shtml</p>
Objectives	Education Standards/Benchmarks
<ol style="list-style-type: none"> 1. Students will describe the motion of CDs sliding on a flat surface, CDs gliding on air, and a robot on the ISS. They will draw conclusions about how friction affects motion. 2. Students will compare the forces on a robot on Earth with the forces on a robot on the ISS, and their resulting motion. They will explain how and why these robots will need to be controlled differently. 	<p>Meets:</p> <ul style="list-style-type: none"> ISTE 3, 5 <p>Partially Meets:</p> <ul style="list-style-type: none"> 2061:4F (3-5) #1 2061:4F (6-8) #3





Suggested Timeline

Prior to this lesson, build several CD Gliders (directions provided at the back of this lesson). Depending on time constraints, these gliders can either be used for the experiment by the students, or will serve as examples if students are building the gliders themselves.

Estimated time for lesson: 90–120 minutes



Materials and Equipment

- Copies of the Student Handout, one per student or group of students
- Copies of “Directions for Building and Using the CD Gliders,” one per group
- Chart paper
- 1 egg or small ball for demonstration
- Paper towels or newspapers
- 1 straw per student
- 2 meter sticks per group
- 2 CDs per group of 3-4 students
- Tape for each group
- Hot glue gun, instant glue, or modeling glue for each group
- 1 water bottle top with valve per group
- Balloons (long or round) for each group
- 1 3x5 index card per group
- 1 small square of transparency film (1 to 2 square inches)
- 1 balloon pump per group (optional)
- Tables that are flat, smooth, and clean
- Pictures and videos of the International Space Station (Images can be found at the following Web sites):
 - NASA Human Space Flight Space Station Gallery <http://spaceflight.nasa.gov/gallery/images/station/>
 - Kennedy Space Center ISS Payload Processing Directorate <http://www-ss.ksc.nasa.gov/>
 - NASA Human Space Flight International Space Station <http://spaceflight.nasa.gov/station/>
- Computer with Internet connection (see table, next page) to link to <http://psa.arc.nasa.gov/>



S System Requirements to Run PSA Website Activities

Platform	Browser
Windows 95 Windows 98 Windows Me	Internet Explorer 4.0 or later (Internet Explorer 5.0 or later is recommended), Netscape Navigator 4 or later, Netscape 7.0 or later (Netscape 6 is not recommended) JavaScript enabled
Windows NT Windows 2000 Windows XP or later	Internet Explorer 4.0 or later, Netscape Navigator 4 or later, Netscape 7.0 or later, with standard install defaults (Netscape 6 is not recommended) JavaScript enabled
Macintosh: 8.6 thru 9.7	Netscape 4.5 or later (Netscape Communicator 4.7 or Netscape 7.0 are recommended), Netscape 7.0 or later, (Netscape 6 is not recommended) Microsoft Internet Explorer 5.0 or later JavaScript enabled
Macintosh: OS X 10.1 or later	Netscape 7.0 or later (Netscape 6 is not recommended), Microsoft Internet Explorer 5.1 or later JavaScript enabled
Browser plug-ins	Flash Player 6 or higher QuickTime Player 6 or higher

P Preparation

- Gather the materials for the lesson (e.g., glue guns, CDs, bottle tops, balloons, index cards, transparency squares, balloon pump, meter sticks).
- Make copies of the Student Handout and directions for the CD Glider.
- Post pictures of the International Space Station.
- Set up the computer with Internet link to <http://psa.arc.nasa.gov/>.
- Prepare the chart paper with the major concepts of the lesson to post at the end of the lesson.



LESSON Engage

1. Draw on students' prior knowledge of motion and introduce the purpose of the lesson.

Ask students to give examples of things that move on the Earth. List these on the board. They may mention cars, bikes, bouncing balls, falling trees, people, and animals.

Ask students how the objects on the list move differently on Earth than in space. They will probably observe from prior experience that most objects move on the surface of Earth, while things in space seem to float.



Tell students that NASA is developing a wide variety of robots to support human exploration of space. One possible concept that NASA has been exploring is a spherical robot that can move around in microgravity or in reduced gravity environments as it provides long-term support for humans. This prototyped robot is called Personal Satellite Assistant, or PSA, and could be used on a wide variety of spacecraft or even on Mars. In developing this robot, NASA would test it in a number of environments, including the International Space Station (ISS).

Tell students that they will be doing a number of activities related to the motion and control of PSA in microgravity environments. In order to control the motion of PSA in microgravity, they will first learn how and why objects move on Earth and in space.

2. Introduce forces.

Place an egg on a table.

Note: An egg is suggested, because it will emphasize the force of gravity when dropped and because it will get students' attention. However, you can also use a small ball or other spherical object, if you prefer.

- Question: How long will this egg stay at rest?
- Answer: It will stay there until someone or something moves it.

- Question: How can we make this egg move?
- Answer: We could push or pull the egg to make it move.



Tell students that anything that changes an object's motion or causes an object to move is called a force. An object at rest will stay at rest until a force acts upon it and moves it.



Hold the egg above the ground, and ask students what will happen when you let go. Students will probably realize that the egg will fall to the ground. Let go of the egg and validate the students' hypotheses. You probably want to put paper towels or newspapers on the ground to avoid making a mess.

Question: What caused the egg to fall to the ground?

Answer: *The short answer that most students will give is that gravity caused the egg to fall to the ground.*

MISCONCEPTION: *There are many misconceptions about gravity, and so this concept really warrants more discussion dedicated to it. This is a good time to draw out students' misconceptions so that they can be addressed more easily. Students typically do not understand gravity as a force. They see "falling" as a natural action and don't see a need to explain it, or they think that the object is falling due to an internal effort.*

To help to address these misconceptions, discuss with students their ideas about what gravity is and how they know. Throughout this unit, reinforce gravity as a downward force that pulls things toward the center of the Earth. The GEMS guide "Earth, Moon and Stars" is a great resource for further exploring the concept of gravity.

<http://www.lhs.berkeley.edu/gems/GEM250.html>

Question: If gravity caused the egg to fall to the ground, what would have happened if gravity were not present?

Answer: *The egg would not have moved.*

MISCONCEPTION: *Some students might think the egg will float away if gravity were not present. Explore this hypothesis if it is made. The fundamental flaw in this hypothesis is that it assumes that nature has a preferential direction of motion, and gravity serves to counter that natural motion. Ask students in which direction they think the egg would float and why. Ask at what point they think the egg would stop floating in that direction and why.*

Question: What causes an object to move or change its motion?

Answer: *A force causes an object to move or change its motion.*

Question: Did gravity cause the egg to move or change its motion?

Answer: *Yes, gravity pulled the egg to the ground.*

Question: So what do we know about gravity?

Answer: *Gravity is a force.*

Question: Looking at the list of moving objects we made, what are some other forces you have observed that move these objects? That is, what have you observed that causes the motion of an object to change?

Answer: *(Answers will vary, but may include car engines, a force exerted by people on objects by pushing, pulling or throwing, wind, or the force exerted by an animal's muscles. Encourage students to describe the directions and speeds of objects they have observed including zig-zag, back and forth, round and round, and fast and slow.)*



Question: What causes objects to stop moving?

Answer: Allow students to discuss their ideas about this, but don't give them the answer. They will explore this question in the lesson.

Tell students that they will be exploring the movement of objects, and as they explore, they will want to think about what causes the objects to move and to stop moving on Earth and in space.

Explore – Part 1

1. Have students conduct the Sliding CDs experiment.

Students should work in teams of three or four.

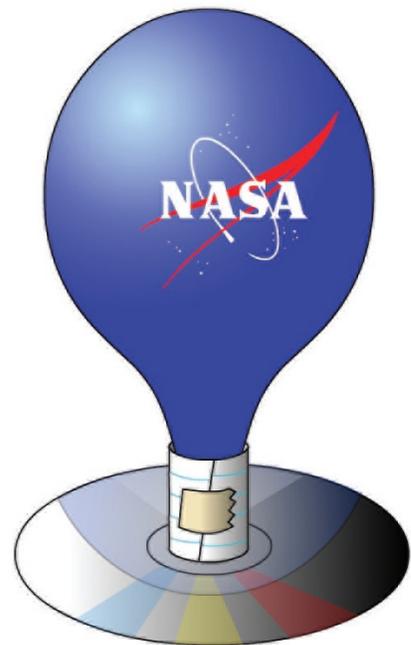
Tell students they will examine some other forces that occur in everyday life.

Distribute:

- Student Handout sheets, one per student or group
- 2 meter sticks per group
- 1 straw per student
- Tape
- Provide each group with a ready-made CD Glider, or, if time permits, the instructions and materials for building one per group.

Note: Students will not be inflating balloons to glide the CD Gliders in this step, but will be measuring how far they slide without inflating the balloons. In order to control variables as much as possible, they will construct the CD Glider so that the weight and dynamics will be the same for both situations.

CAUTION: Warn students that glue guns can get very hot. They should not touch the tip of the glue gun, and need to make sure that the glue gun is on a stand so that its tip does not touch the table surface when it's not in use. If students are using instant glue, follow all precautions listed on the label.



Ask student groups of 3–4 to:

- Tape the meter sticks to the ground to create tracks. Make sure the tracks are a little more than one CD-length apart.
- Place the CD between the meter stick tracks and measure how far they can slide the CD along the tracks on the ground.
- Write their measurements on the Student Handout sheets.

To slide the CD, students should use a straw to blow the CD as hard as they can.

Note: *In testing, students didn't like using the straws at first, but got used to it. The use of straws will help them keep the force as consistent as possible.*

Ask students to identify what force(s) caused the CD to slide across the floor and what force(s) caused the CD to stop sliding.

Tell students to form a hypothesis about how the CD would move if it could glide above the floor, without their touching it. Would the CD move farther, shorter, or the same distance as when it touched the ground?

Explain – Part 1

1. Ask students to share their ideas about what forces caused the CD to start and stop moving.

Listen to the students' ideas and write a list of all the different ideas on the board. Students will probably recognize that they provided the initial force that caused the CD to move. It may be necessary to guide students to conclude that the rubbing on the floor provided the force that stopped the CD from moving.

Tell students that friction is a force that acts on objects sliding on a surface. Friction tends to slow an object's motion and can cause it to stop entirely.

Ask students to share their hypotheses of what would happen to the CD if it didn't touch the ground.

Explore – Part 2

1. Introduce students to the Gliding CDs experiment.

Explain that by blowing up the balloon, the CD Glider will ride on a thin cushion of air (from the balloon) in a similar way that an air hockey puck glides across an air hockey table with little friction.

Provide each group with a ready-made CD Glider, or, if time permits, the instructions and materials for building one per group.



CAUTION: Make sure that students who inflate the balloons are not allergic to latex. If they are allergic, use a balloon pump.

Question: When conducting this experiment, what are we trying to learn?

Answer: We are trying to learn if a CD that is not touching the table will affect the motion of the CD.

Question: So what is the one difference between the two CDs that we are comparing?

Answer: We are comparing a CD Glider that is touching the table with one that is floating or gliding above the table.

Question: Why is it important that everything else in the two situations be as alike as possible?

Answer: If something else is different, then you will not know what caused the change in your experiment.

Note to Teacher: With older students, the terms “control” and “variable” could be introduced at this point in the discussion. Be sure to discuss with students the importance of having everything exactly the same in both the control and variable, except for the item that is being tested.

Question: What other things could be different that could affect the experiment?

Answers may include: Some things that could be different are where the CD is started, how long the air in the balloon lasts, how long it takes to launch the CD glider, the procedure used, how hard a student blows, the student who is doing the blowing, or the size of the balloon.

Discuss with students how they can try to control for as many of these variables as possible. Also have students do ten trials of each, which will help to control these variables.

2. Have students conduct the Gliding CDs experiment.

Ask students to:

- Follow the directions for “How to Use” the CD Glider in the “Instructions for Building and Using a CD Glider” handout.
- Measure how far they can slide the CD Glider.
- Write their measurements on the Student Handout sheets.

Note: Students will probably inflate the balloon and release the glider so that it moves about erratically on the table, finally coming to a stop once the balloon is deflated. The meter stick tracks are used to help guide the motion of the gliders.

3. Once students have recorded their measurements, ask them to:

- Compare their results with the distance the CD slid in the first experiment.
- Record any differences in the motion of the glider compared to the sliding CD.
- Speculate on the reasons for the differences in motion.



Explain – Part 2

1. Have students share their findings.

Question: What kinds of motions did you observe and record?

■ Answer: *Answers will vary.*

Question: How did the motion of the gliding CD compare with the motion of the sliding CD?

■ Answer: *Answers will vary, but should include observations that the gliding CD with the inflated balloon acted more erratically and less predictably.*

Question: Did the gliding CD travel farther, not as far, or the same distance as the sliding CD on the ground?

■ Answer: *If students are able to control the motion of the gliding CD well enough, it will travel farther than the sliding CD. If students were not able to control the motion of the gliding CD, ask them to speculate what would happen if the glider's motion were less erratic.*

Question: Why did the gliding CD travel farther?

■ Answer: *The gliding CD was not rubbing on the ground, so friction did not slow it down.*

Question: Why is the motion of the two CDs different?

■ Answer: *In the gliding CD, air is being released from the balloon, which creates a cushion of air between the CD and the table. The air prevents the CD from rubbing on the table and helps to remove friction.*

Question: What would happen if you had a balloon with an endless supply of air, which simulates a frictionless environment?

■ Answer: *(Students may expect the glider to move forever, and it will travel a long distance. However, friction from the surrounding air (drag) will slow the glider down and eventually stop it from moving. To get at this, ask students if an object that is not rubbing on the ground has anything touching it that might slow it down eventually. Ask them if they have ever ridden a bike against the wind and how this affected their ability to move the bike forward. Ask them if a flying, coasting bicycle would ever slow down and why.)*

Extend

1. Have students conduct the Online PSA Activity.

Ask students what they think the PSA will do onboard the ISS if it is pushed. Will it slow and stop or will it keep moving until it hits something?

Question: What forces will affect the PSA once it is moving?

■ Answer: *The only force that may slow the PSA down is friction from the air (drag).*



Have students click “Activities” to go to <http://psa.arc.nasa.gov/acti.shtml> and observe how the PSA will move on the ISS.

Ask students to complete the following Forces and Motion activities individually or in pairs:

- Introductory video (if this is their first introduction to the PSA)
- Experiment 1: How long does it take the PSA to stop on its own?

2. Discuss with students what they observed in the online activities.

Question: In the online activities, what happens if you push the PSA in a direction and do not stop it?

■ Answer: *The PSA will continue to move until it hits a wall and bounces back in the opposite direction.*

Question: Does the PSA ever stop moving?

■ Answer: *No, it keeps moving back and forth.*

Question: Why doesn't the PSA stop?

■ Answer: *There is very little friction to slow it down and counteract the original force applied to it.*

Note: *Drag has not been programmed into the simulation, so in the simulation the PSA would in fact move forever; however, in reality there is some friction with the air on the ISS, so the PSA would eventually stop—although it would take a very long time to do so.*

Say: The environment inside the ISS is a microgravity environment—a place where there is very little gravity and there is hardly any friction. From the Web site and other television pictures you've seen of astronauts in space, how do they move?

■ Answer: *Answers will vary but may include that astronauts seem to move slowly and deliberately. Their hair seems to move upward by itself, and they seem to float.*

Question: Why do they move that way?

■ Answer: *There's little force from gravity or friction working against their motions, so their actions need to be controlled differently.*

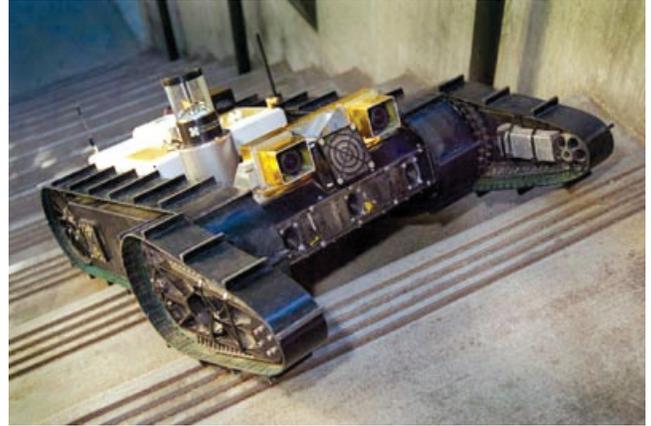


Evaluate

1. Have students conduct the Comparing Robots activity.

Have students compare two robots—one on Earth and one on the ISS. Both robots need to be able to move from one place to another. The robot on Earth is a vacuum that cleans the floor. It is moving down the hallway to vacuum the hall. The robot on the ISS is moving from its base to a panel at the end of the module to take a sensor reading to make sure that the temperature and air quality are in a safe range. For each robot, use forces to explain the following:

- How will you start the robot moving and in what direction?
- How will you stop the robot from moving?
- How will you control the movement of the robot in space differently from the robot on Earth and why?



NASA URBIE Robot
Autonomous Operation Using Sensors and Cameras

2. As a class, create an assessment rubric for this lesson.

Suggested criteria for the rubric include:

- Reasonable assessment of different forces acting on a sliding and gliding CD.
- Appropriate measurements and comparisons of distances traveled by the sliding and gliding CDs.
- Correct identification of friction as a force that resists an object's motion.
- Clear oral reasoning as to how the motion of the PSA onboard the ISS will be different from the motion of an object on Earth.
- Clear written presentation of results.
- Clear oral presentation of results.
- Clear explanation of constraints taken into consideration.

Use the rubric to assess student comparisons of a robot on Earth with one on the ISS to make sure that they have mastered the major concepts.

Consider using chart paper to post the main concepts of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the "conceptual flow" and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding.



Student Handout

A. Sliding CDs

1. In the table below, record the distance that a CD slides across the ground when you blow it as hard as you can. Do this ten times to make sure your results are consistent and repeatable.

Sliding CD	
Trial #	Distance (centimeters)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. What force(s) caused the CD to slide across the surface?

3. What force(s) caused the CD to stop moving?



B. Gliding CDs

1. In the table below, record the distance that a CD Glider slides across the ground when you blow it as hard as you can. Do this ten times to make sure your results are consistent and repeatable.

CD Glider	
Trial #	Distance (centimeters)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

2. How does the distance that a sliding CD moves compare to the distance a gliding CD moves? Why is there a difference?



C. Online PSA Activity

1. What would happen if you pushed the PSA in a direction and did not stop it? Why?

D. Comparing Robots

Compare two robots—one on Earth and one on the International Space Station (ISS). Both robots need to be able to move from one place to another. The robot on Earth is a vacuum that cleans the floor. It is moving down the hallway to vacuum the hall. The robot on the ISS is moving from its base to a panel at the end of the module to take a sensor reading to make sure that the temperature and air quality are in a safe range. For each robot, use forces to answer the following questions. You may use pictures to help your explanation. Label the parts.

1. How will you start the robot moving and in what direction?



2. How will you stop the robot from moving?

3. How will you control the movement of the robot in space differently from the robot on Earth and why?



Teacher Handout (Answer Key)

Sliding CDs/Gliding CDs

Instructions on how to build a CD Glider are provided at the end of this lesson.

The sliding CD moves because blowing applies a force; it stops primarily due to the friction between it and the ground. The CD Glider does not experience friction with the ground, so it will travel farther.

Online PSA Activity

The PSA is in a microgravity environment, where it does not typically experience friction with the ground. If pushed, the PSA will continue to move until it hits something, which will then send it in the opposite direction. It will continue to move for a very long time if no other forces are applied to it.

Comparing Robots

Earth Robot

Students might say that they will push or pull the robot on Earth, or that it will have motors and gears that will move the wheels so that it can move forward.

Students might say that they would stop the Earth robot by applying a break to the wheels so they no longer move forward.

Microgravity Robot

Students might say that they will push or pull the robot in microgravity or that they will have it use blowers, fans, or flippers to propel it forward.

Students might say that they would stop the robot in microgravity by using blowers, fans, or flippers to push back in the opposite direction.

Comparing Movement in Space and on Earth

Students should observe that it is much easier to stop a robot on Earth from moving, because they can use friction on the ground to stop the robot. The lack of friction in space makes it harder to stop the robot.



NASA Mars EVA Simulation
Haughton Crater, Devon Island, Canada



Sample Scoring Tool

4

Calculations are correct and clearly presented.
Students correctly determine the differences in motion between objects in an environment with friction and one without friction.
Reasoning is logical and clear explanations are provided.
Oral and written presentations are clear.

3

Most calculations are correct and attempts are made to present them clearly.
Students determine most of the differences in motion between objects in an environment with friction and one without friction.
Attempts are made to reason logically and provide clear explanations.
Attempts are made to provide clear oral and written presentations.

2

Some calculations are correct and attempts moderately clear.
Students correctly determine some of the differences in motion between objects in an environment with friction and one without friction.
Explanations demonstrate limited logical bases.
Oral and written presentation skills need improvement.

1

Few calculations are correct and attempts are unclear.
Students correctly determine few of the differences in motion between objects in an environment with friction and one without friction.
Explanations do not demonstrate understanding of lesson content.
Oral and written presentations do not effectively express results or reasoning.
Instructions for Building and Using a CD Glider



Instructions for Building and Using a CD Glider

Have you ever wondered what to do with all those free CDs you get in the mail? Wonder no more—you're going to learn how to simulate being in space!

If you've played air hockey, you know that the puck rides on a thin cushion of air just above the table, allowing it to travel with virtually no friction. We're going to use the same effect to make a CD glide across a table.

Materials

- Hot glue gun, instant glue or modeling glue
- 1 water bottle top with a valve—you can get these at the grocery store (sports bottles).
Try to get one with a large valve stem; they control airflow better.
- 1 CD, without any nicks or scratches
- Balloons, either round or long
- 1 balloon pump per group (optional)
- 1 3x5 index card per group
- 1 small square of transparency film (1 to 2 square inches)
- Tape

Directions

1. If you are using a glue gun, plug it in and let it warm up.
2. Twist off the top from the water bottle and put the bottle aside—you can drink the water while you work, if you want.
3. Cut transparency film into a circle that fits between the bottle top and the CD. Poke a hole in the middle of the film about the size of a pencil tip. This will allow the air in the balloon to release more slowly.
4. Turn the CD so that the label is facing up and the silvery side with no label is facing down.
5. Draw a line of glue around the edge of the transparency piece. Glue the transparency piece onto the label side of the CD, covering the CD hole. Make sure the transparency hole is in the middle of the CD hole. Don't use so much glue that it is dripping. Make sure the glue does not go through the CD hole to the other side of the CD. This will prevent the CD from gliding properly.
6. Draw a line of glue around the bottom of the bottle top: it should be a thick bead going all the way around. If you are using a glue gun, you will need to do this quickly; neatness does not matter, but don't use so much glue that it is dripping.
7. Before the glue begins to set, place the bottle top on top of the transparency piece over the center hole of the CD and press together. Don't worry about getting the bottle top exactly in the middle; as long as the CD hole is covered by the bottle top, you're OK. The bottle top should be attached to the label side of the CD.
8. After letting the glue set, draw another bead around the joint between the bottle top and the CD. Let all the glue dry.
9. Make a collar out of a 3x5 index card by cutting it in half lengthwise and rolling it so that the diameter roughly matches the bottle top nozzle and it has a height of 1 1/2 inches. This will provide support for the balloon so that it will not fall over as it deflates. Start by threading the balloon through the collar, then inflate, and finally twist the balloon closed and attach to the bottle top.



How to Use

1. Make sure the valve of the bottle top is closed.
2. Inflate a balloon and twist the bottom, then pull the balloon over the valve. If your valve is shut, you can release the balloon without losing any air.

Note: To attach the inflated balloon, it might be helpful to have one person hold the balloon closed while another puts the balloon over the bottle top to prevent air from escaping.

3. Carefully pull the valve up until you hear a hiss of air.
4. Place the CD Glider, silvery side down, on a flat, smooth surface
5. Work in pairs for glider "launch" so that one student holds the balloon in the ready position and releases the bottle top and the second student is responsible for blowing the CD with a straw.

Have fun!

Troubleshooting

- *The CD Glider drifts to one side all the time.*
 - Is the table level?
 - Does the joint between the CD and bottle top have any holes or gaps?
- *The CD Glider doesn't glide very far.*
 - Did you open the valve just enough to hear air hiss out?
 - Did you glue the bottle top on the silvery side with no printing?
 - Does the printed side have large scratches or cuts, or excess glue?
- *The balloon flops over and drags on the table.*
 - Try bracing it with tape or a paper cylinder. Be creative!

