



Flatland BMX and the Center of Gravity - Forces

Teacher Pre-Activity Introduction and Preparation

Texas Essential Knowledge and Skills (TEKS) Alignment within this Activity

Sixth Grade

(6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (A) identify and describe the changes in position, direction of motion, and speed of an object when acted upon by force.

Seventh Grade

(6) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (B) demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not being subjected to an unbalanced force.

Eighth Grade

(7) Science concepts. The student knows that there is a relationship between force and motion. The student is expected to: (A) demonstrate how unbalanced forces cause changes in the speed or direction of an object's motion.

Teacher Notes

The first bicycle was reportedly built in the 1860s, and progress in the 1880s included pneumatic tires and better turning and handling. This type of bicycle allowed the rider to perform tricks and maneuvers which soon appeared in circus and music hall performances. In the 1970s, bicycle “trick riders” began to advance a series of flatland maneuvers that were just starting to be invented. Flatland BMX is a form of cycling in which the rider spins, rolls, hops and scuffs the tires while maneuvering the bike forward, backward or on one wheel.

Billy Gawrych is a professional flatland BMX competitor and performer who travels across the country performing with GT Bikes and the Pro Impact Stunt Team. Billy typically performs a routine often set to music, in which tricks are linked together in a series of connected and flowing patterns. He is known for his high speed tricks and being able to perform maneuvers in front of high numbers of spectators. A rider like Billy must control his center of gravity in order to balance and do cool tricks. In an individual, the center of gravity is a point that defines the center of your mass, and it is roughly located at a person's belly button. Performers like Billy add to the legacy of the sport and encourage BMX riders everywhere to try new tricks and seek out their own style.



Teacher Post-Activity Materials

Answers to Questions

1. What is the center of gravity? The center of gravity is a point that defines the center of the mass of an object.
2. How does the center of gravity change as the size and or shape of an object changes? The center of gravity moves if the change in the size and shape of an object is not uniform. For uniform changes, the center of gravity will stay in roughly the same place, such as when a person grows from a child to an adult. The relative position is still the same, but the exact location has changed.
3. How can the change in the center of gravity be altered? The center of gravity can be changed by changing the mass of an object, the size of an object, or the shape of an object. You can affect one of these traits (or all of them) and alter the center of gravity.
4. How can the center of gravity be realigned in an object? The center of gravity can be realigned by changing the mass of an object, the size of an object, or the shape of an object. You can affect one of these traits (or all of them) and realign the center of gravity. In the experiment, the students changed the mass of the object in order to realign the center of gravity to its original position.
5. Where is the center of gravity located on a person? In a person, the center of gravity is roughly located at a person's belly button.

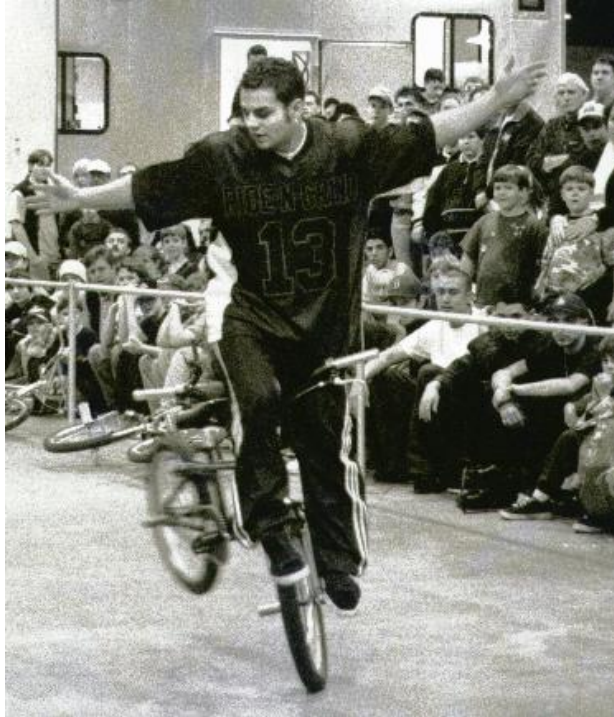
Extensions

Have students take different sized objects of varying shapes and masses and see if they can determine the center of gravity on each object. Students can bring in household items and use the same techniques in the lab to find the center of gravity. Examples could be empty soda cans, plastic jugs, books, Tupperware containers or egg cartons. Students should also be encouraged to make connections between an object's mass (and lack of mass), the distribution of the mass and the location of the center of gravity. The approach to solving this type of three dimensional center of gravity will require the learner to look for new ways of determining the center of gravity, such as looking to balance the items first. The student can also use the string approach, but will have to use x-axis, y-axis and z-axis intersections. As an extension, the teacher might pose the problem, "How can we determine a 3-dimensional item's center of gravity and demonstrate that we have found it?" The students could use this open-ended exploration as a way to deepen and broaden their understanding of the center of gravity in real life situations.



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Student Laboratory Activity



Introduction

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Dr. Skateboard's Action Science – Activity Guide

Purpose

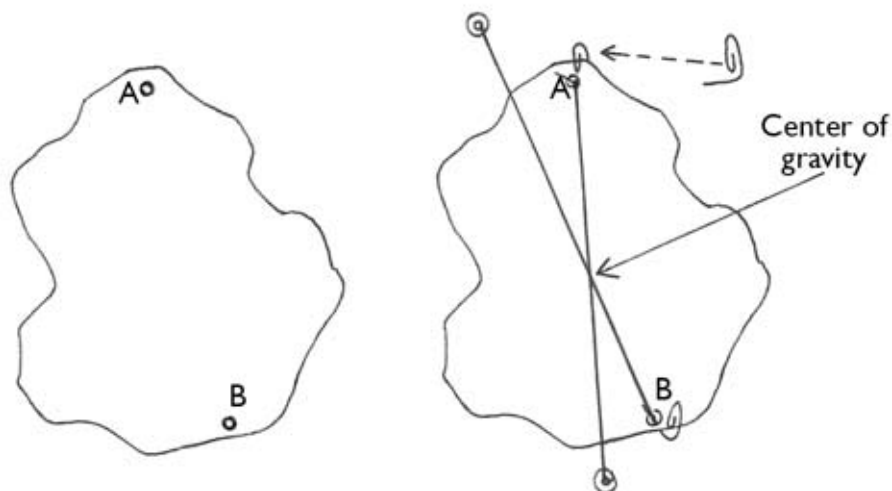
The purpose of this activity is for the student to know that there is a relationship between force and motion. The student is expected to demonstrate how unbalanced forces, such as changes in the mass, size or shape of an object, can cause changes in the center of gravity.

Things You Need

- Plenty of string, cut in pieces of 20-30 cm in length
- Washers
- Thick card stock cut into 10 by 15 cm pieces (post cards will also work)
- Scissors
- Large paper clips
- Pencils with flat erasers
- Colored markers or colored pencils
- Hole punch
- Rulers

What to Do

1. The purpose of this activity is for you to locate the center of gravity in a cardboard object that is not of uniform size or shape.
2. With a partner, obtain some card stock and draw an irregularly shaped object of your own design on the card stock. Your unique shape should not be a square, circle, rectangle or any other symmetrical design. You should create a creative and non uniform shape.
3. Carefully cut out the shape you have drawn on the card stock.
4. Next, predict where the center of gravity of your object is located with a letter "P". See if you can balance the object at the center of gravity you identified using the eraser end of a pencil. Do not change your prediction.
5. Then, carefully punch two holes near any opposite edges of their cardboard structure, and use a colored marker or colored pencil to label the holes A and B.
6. Bend one end of a paper clip so that it forms an "L" shape. Tie one end of the string to the paper clip and the other end to a washer.
7. Put the paper clip through the hole labeled "A", so that the object you created hangs freely from that point. Then, draw a line on the cardboard object that follows the vertical line of the string. Then try and hang the cardboard object from hole B, and draw a second line that follows the vertical line of the string. Use a different colored marker or pencil for each line.
8. The center of gravity is the point at which the two lines intersect. You can test this out by trying to balance the object at this point on the eraser end of a pencil.
9. The main idea is that when an object is suspended at a single point, the center of gravity will hang directly below or at that point. In order to test this idea, you will use a piece of string attached to a washer to construct a vertical line beneath a point of suspension. Then choose another point and construct a second line. The center of gravity is where the two lines intersect.



10. Remove a piece of the object you have created and locate the center of gravity again. As the distribution of mass of an object changes, the position of the center of gravity also changes. Mark this new center of gravity with another line, in another color.
11. Finally, change the distribution of the weight of the object by adding paper clips in such a way that the center of gravity is moved back to the original location on the cardboard object you created.
12. As an extension, try and construct a BMX bike out of the materials you used to construct your previous shape, and see if you can determine the center of gravity of the BMX bike that you created.





Student Laboratory Data Sheet

Questions to Answer

Once you have finished the procedures, answer these questions to draw some conclusions about what you have learned.

1. What is the center of gravity?
2. How does the center of gravity change as the size and or shape of an object changes?
3. How can the center of gravity be altered?
4. How can the center of gravity be realigned in an object?
5. Where is the center of gravity located on a person?



Dr. Skateboard's Action Science – Activity Guide

What Is Going On?

Because the cardboard cutouts by the students are irregular and asymmetrical shapes, students should discover that the center of gravity is not necessarily found in the geometric center of an object. When students remove part of the cardboard cutouts they created, they will change its weight distribution. Students will then discover that the center of gravity has moved to a different point. Students should be encouraged to think of other objects for which the center of gravity is located, such as a boomerang, a basketball, or an empty cup. In order to move the center of gravity back to a location on the cardboard, students need to add paper clips as weights near the area where they removed part of the cardboard.

Where Does This Happen in Real Life?

In order to be successful in skateboarding or BMX, a rider must understand how to control the distribution of his/her mass by controlling the center of gravity. In an individual, the center of gravity is a point that defines the center of mass, and it is roughly located at a person's belly button. The closer the center of gravity is to the center of the board, bike or rotational axis, the better chance the rider has of successfully completing a trick. Good riders tend to lower their center of gravity closer to the board or bike by bending their knees and shifting their weight.

Conversely, when a rider elevates the center of gravity, by straightening their legs, the center of gravity extends too far from the board or bike, and inevitably, the force of gravity or the centrifugal force overcomes the rider, leading to a crash. The center of gravity needs to be over the center of the board or bike, and the best way to ensure this happens is to bend your knees and lower your center of gravity. A person's center of gravity and the ability of the rider to control the location of that center relative to the board or bike are the keys to progressing with bigger and better tricks.

