Lesson Plan: “Force”

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Teaching Plan:

Introduction ~ 10 minutes

-Introduce the concepts of force, centripetal motion, and air pressure

Activity 1: The Spinning Penny ~15 minutes

Activity 2: Force related Air Pressure ~25 minutes

Mentors Scientific Background

In physics, a force is any influence that causes a free body to undergo an acceleration. Force can also be described by intuitive concepts such as a push or pull that can cause an object with mass to change its velocity (which includes to begin moving from a state of rest), i.e., to accelerate, or which can cause a flexible object to deform. A force has both magnitude and direction, making it a vector quantity. Newton's second law, F=ma, can be formulated to state that an object with a constant mass will accelerate in proportion to the net force acting upon and in inverse proportion to its mass, an approximation which breaks down near the speed of light. Newton's original formulation is exact, and does not break down: this version states that the net force acting upon an object is equal to the rate at which its momentum changes.

Introduction for the Mentees

The Spinning Penny is almost like scientific poetry in motion. To understand how and why it works, you have to look at the forces that are acting on the penny. The shape of the balloon makes the penny move in a circular path - otherwise the penny would want to continue to move in a straight line. Another force to consider is friction. There's very little friction between the edge of the penny and the balloon. More friction would cause the penny to slow down and stop.

The real force in action here is called *centripetal force*, which means center-seeking. This is a force that is always directed toward the center of the circle and is actually responsible for keeping the penny moving in a circular motion inside the balloon.

Try using different sized coins and compare how long it takes for the coin to stop spinning once you stop swirling the balloon. Does the size of the coin make any difference?

The bags in the jars will act somewhat like a hammock with a person lying in it.

To pull up the hammock, one also has to lift the person resting on it. Likewise, to pull up the bag, one has to lift the air resting on it. This air extends as far up as air goes - hundreds of kilometers! No child can lift this much air; it weighs far too much. Air under pressure is used to operate many devices that require great force. Car lifts in service stations use compressed air. Air brakes on a truck apply far more force that drivers can with just muscles. Air-filled tires support cars and trucks. Because air is a fluid, it can enter small openings and fill spaces of all shapes easily. Also, the pressure at any point in confined air is the same. Thus, air can be squeezed into a tire through the tiny opening in the valve stem. Once in the tire, air presses on all parts of the tire equally. The larger the area on which the confined air presses, the greater is its total force

Modules/Demos or Project

(1) The Spinning Penny

(2) Force related Air Pressure

Materials

(1) The Spinning Penny

- Clear balloon (9-inch latex helium balloons from a party store work great)
- Penny (you might want to try an assortment of coins)

(2)Force related to Air Pressure

- Gallon jars
- 2 rubber bands for each jar
- string
- strong plastic bags

Procedure

(1)The Spinning Penny

- Squeeze a penny through the mouth of a clear balloon. Make sure that the penny goes all the way into the balloon so that there is no danger of it being sucked out while blowing up the balloon.
- Blow up the balloon. When properly inflated, the balloon will be almost clear in the middle and cloudy at the area near the neck and at the end opposite the neck. The cloudiness at the ends is unstretched latex, which provides stress relief. If the balloon is completely clear all over, it is overinflated.
- Tie off the balloon and you're ready to go.
- Grip the balloon at the stem end as you would a bowling ball. The neck of the balloon will be in your palm and your fingers and thumb will extend down the sides of the balloon.
- While holding the balloon palm down, swirl it in a circular motion. The penny may bounce around at first, but it will soon begin to roll around the inside of the balloon. The best orbit or path for the coin is one parallel to the floor.
- Once the coin begins spinning, use your other hand to stabilize the balloon. Your penny should continue to spin for 30 seconds or more.

(2) Force related to Air Pressure

- Ask the students to fill their bags with air. Usually they will do this by blowing, but show them that a bag can also be filled by pulling it through the air quickly.
- Have the students help each other tie an air-filled bag, upside down, to each jar with its mouth over the opening of the jar. They should wind a string (tightly) around the bag and jar several times without crossing ridges of glass, and tie it with a bow knot.
- Ask the children to press down on the bags, lean on them, and rest objects on top of them. (Why don't they go down?) What other things act like this? Pupils may mention inflated beach toys, air mattresses, and tires.
- Have the children untie the bags, put them down inside the jars with the mouth of each bag folded over the mouth of the jar and again tie them on tightly. When all are ready, ask them (at the same time) to hold the jars and pull out the bags. Surprise! Why is it difficult to pull the plastic out of the jar?

Discussion and Conclusion

-What is a force and describe how it relates to acceleration?

-What is Newton's Second Law?

-Describe centripetal force.

-Explain how air pressure relates to force and give several examples.

References/Citations

Wikipedia, Spangler Elementary School