Space Day:
Prospecting for Knowledge

20-Orbital Forces – Teacher Page

Purpose: To demonstrate orbital motions and forces using a tennis ball swung by a ribbon.

Background: A center-directed force that causes an object to follow a circular path is called a centripetal force. When you swing a tennis ball from the end of a ribbon, you must pull on the ribbon - exerting a centripetal force. When you let go of the ribbon, the ball travels in a straight path but at a right angle to the ribbon at the moment of release. In other words, the ball follows a tangential path to the circle it was orignially traveling in.

Part of Newton's first law of motion states that an object in motion will move in a straight line unless acted on by an unbalance force. In the case of the tennis ball, your inward pull on the ribbon is the unbalance force that keeps the ball traveling in a circle instead of a straight line. Upon release, the ball travels away in a straight line in the exact direction it was traveling at that very moment.

In the case of a satellite in space, the launch vehicle that carried it up to orbit aimed it in a direction parallel to the Earth's surface. According to Newton's first law, the satellite will travel in a straight line. So, why doesn't it keep traveling straight away from us? Earth's gravity acts as an unbalance force, pulling on the satellite and causing the satellite to follow a circular path.

This Activity: The tennis ball and ribbon demonstration is a good analogy of a satellite in orbit. The pull of your hand through the ribbon represents gravity.

Preparation: Collect the following: one old tennis ball, one yard of one-inch-wide cloth ribbon, one dowel rod which is two inches long by 3/16 inches in diameter, sharp knife, needle and thread, stapler, and white glue.

To construct: loop one end of the ribbon over the dowel rod and glue or staple together. Hem or tie the other end of the ribbon to prevent raveling. Cut a one-ich-wide slit in the tennis ball. Then slip the dowel and ribbon at an angle through the slit in the tennis ball. The rod will prevent the ribbon from being pulled out.

Alternative: Instead of using a tennis ball and ribbon, you could simply tie a string around an eraser.

In Class: Conduct this activity outside where flying tennis balls or erasers will not harm people or property.

Wrap-Up:

Activity courtesy of University of Hawaii Institute of Geophysics and Planetology

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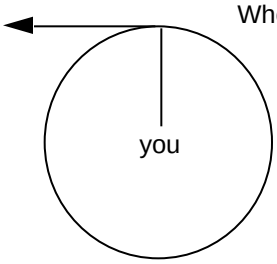

When released, the ball will fly off on a tangent to the circle

Activity courtesy of University of Hawaii Institute of Geophysics and Planetology

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20-Orbital Forces – Student Page

Purpose: To demonstrate orbital motions and forces using a tennis ball swung by a ribbon.

Materials: Tennis ball on ribbon; Pencil and paper

Background: A center-directed force that causes an object to follow a circular path is called a centripetal force. When you swing a tennis ball from the end of a ribbon, you must pull on the ribbon - exerting a centripetal force. What happens when you let go?

Procedure:

1. Hold the free end of the ribbon and swing the ball in a circle.

2. In this activity, the centripetal force on the ball is produced by ribbon tension. That is, the ribbon ransmits the centripetal force which pulls the ball nto a circular path. For a satellite orbiting Earth, here is no ribbon connection! What produces the centripetal "towards the center of the Earth" force?

3. Let go of the ribbon and watch which direction the ball travels. The ribbon makes it easier to follow the direction of the ball.

4. Where did the ball go?

5. The circle shown on the left represents the path of the ball while you were swinging it with the ribbon. Draw an arrow from the circle to represent the path of the ball when you released it. Explain your answer.