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HUGK12 Activity

TITLE:

Rotational Equilibrium

PREPARED BY:

Tamara L. Muhammad
(Adapted from Wood, Elaine and Walker, Pam. 50 Terrific Science Experiments. Grand Rapids, Michigan: Instructional Fair • TS Denison, 1998.)

DCPS STANDARDS:

8.7.2
Observe and explain that when the forces on an object are balanced (equal and opposite forces that add up to zero), the motion of the object does not change. (The activity is indirectly related to this objective in that the actual concept is that net torque equals zero rather than net force equaling zero.)

8.1.7
Use tables, charts, and graphs in making arguments and claims in presentations about lab work.

8.1.8
Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, or temperatures, and choose appropriate units. Explain how to interpolate on analog scales.

GOALS:

1. Students will understand what a lever is.

2. Students will differentiate among the different types of levers.

OBJECTIVES:

1. Students will use a ruler as a lever.

2. Students will utilize a spring scale to measure the amount of force necessary to balance a load placed at the zero end of a ruler when the fulcrum is placed at the 6" mark, the 3" mark, and the 9" mark.

PREREQUISITE KNOWLEDGE:

A lever is a thin rod that rests on a pivot point called a fulcrum.

The load is the object to be lifted or have work done on.

The effort is the force that the user inputs to the lever.

The load arm is the distance from the load to the fulcrum.

The effort arm is the distance from the applied force to the fulcrum.

In a first class lever, the load force is at one end of the rod, the effort is made at the other end of the rod and the fulcrum is between the load and the effort.

In a second class lever, the fulcrum is at one end of a rod, the effort force is at the other end of the rod, and the load is between the two.

In a third class lever, the fulcrum is at one of the rod, the load is at the other end of the rod, and the effort force is between the two.

ESSENTIAL QUESTIONS:

How does a first class lever work?

LABORATORY MATERIALS:

For each work station:

4 empty compact disc jewel cases (standard size)

masking tape

two spring scales

4 quarters

3 twelve inch wooden ruler

modeling clay

Setup of experimental apparatus:

Prop up one CD case perpendicular to the edge of a lab worktable using modeling clay.

Use masking tape to attach a CD case along its narrow edge to the CD case at the base. Continue the process to make a narrow column 4 CD cases high. This is the fulcrum of the lever.

Angle a ruler at approximately 45 degrees. Tape the high end of the ruler to the CD tower and the other end to the table to support the tower. A second ruler may be used in the same configuration on the other side of the tower.

Preferably, allow the modeling clay to dry overnight for a stable base.

DIFFERENTIATING INSTRUCTION:

None

RATIONALE:

This activity will lead students to the conclusion that a long effort arm relative to the load arm will allow them to use less force to lift the same load. This preliminary understanding will help them to understand torque in the future.

RESEARCH ACTIVITY:

1. Place students in groups of four.

2. Have each group cut two six inch strips from the masking tape and form two loops with the sticky side of the tape on the inside. Attach one loop as close as possible to the zero end of the ruler and the other loop as close as possible to the 12" end of the ruler.

3. At the ruler's zero end, attach four quarters along with a spring scale to the tape's sticky side.

4. Place another spring scale in the loop of tape at the ruler's 12" end. Place the 6" marking of the ruler over the CD case and lightly support it. Now gently pull down on the spring scale at the 12" end until the other end of the ruler is level with the 12" end and is balanced. (At the exact balance point, no additional support will be needed at the fulcrum.) Write down the amount of force required to balance the quarters.

5. Repeat the procedure above; however, move the point at which the ruler rests on the CD case as noted below:

   A. 3-inch mark
   B. 9-inch mark

Evaluation and Assessment:

Have students discuss the relationship between the placement of the fulcrum and the amount of force needed to balance the lever.

References:

Motion and Forces. McDougal Littell, 2005.

Tippens, Paul E. Physics. Columbus, Ohio: Glencoe/McGraw-Hill, 2001.

Wood, Elaine and Walker, Pam. 50 Terrific Science Experiments. Grand Rapids, Michigan: Instructional Fair • TS Denison, 1998.

Wood, Elaine and Walker, Pam. Scientific Investigations. Grand Rapids, Michigan: Instructional Fair • TS Denison, 1998. (Source of terminology "load arm" and "effort arm)