Science Fair Projects

6th Grade to 10th Grade

Title: Anatomy

"Human Machine"

Stating the Problem – The Big Question

What kind of simple machine is your forearm?

Materials

Plastic Bucket with a Handle

Planning the Procedure

1. Place your elbow on a table so that your forearm lies flat and your hand extends straight out over the table's edge. The palm of your hand should be face up.

2. Place the handle of the bucket in the hand of your extended arm.

3. Lift your forearm, but do not raise your elbow from the table.

Results

As the height of your forearm above the table increases, the height of the bucket also increases.

This project is from Janice VanCleave's book, *Guide to the Best Science Fair Projects*, New York, Jossey-Bass Publisher, A Wiley Imprint, 1997. The Guide is available on line at: SchooDoodle.com

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"Human Machine" (continued)

Why?

A ***lever*** is a simple machine, consisting of a rigid bar and a fixed point of rotation called a ***fulcrum***, that is used to life or move things. In a ***third-class lever***, such as your forearm, the ***effort force*** (the force that you apply) is between the fulcrum and the ***load*** (the object being lifted or moved by a machine), in this case, your hand and the bucket. As your raise your forearm, it rotates at the elbow, and thus your elbow acts as a fulcrum. The weight of your hand plus the weight of the bucket make up the ***resistance force*** (the weight of the load). The effort force needed to lift the load is applied by the muscles in the arm. The total amount of resistance that you can lift depends on the strength of these muscles. As in all third-class levers, the effort force lies between the fulcrum and the load, making the ***effort arm*** (the distance from the effort force to the fulcrum) shorter than the ***resistance arm*** (the distance from the load to the fulcrum of a lever).

Let's Explore

1. The distance from the elbow to the point where the muscles are attached to the bones of the forearm is the effort arm. The distance from the palm of the hand to the elbow is the resistance arm. Would increasing the length of the resistance arm affect the effort needed to raise the load? Repeat the experiment twice, holding a yardstick (meterstick) in your hand. First, hang the bucket on the stick near your hand. Then, hang the bucket on the far end of the stick.

2 a. What is the greatest load that you can lift using your forearm as a third-class ever? Repeat the original experiment, asking a helper to place heavy objects, such as rocks, in the bucket one at a time until you can barely lift the load. Use a food scale to measure the weight of the bucket.

2 b. Would increasing the resistance arm affect the results? Repeat the previous experiment, using the yardstick (meterstick) as in Let's Explore 1.

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Show Time!

1. The amount by which a machine increases an effort force is its ***mechanical advantage*** (MA). If the MA for your forearm is 4, then the resistance force is 4 times the effort force applied by your arm. Use this average MA to determine the effort force needed to lift the empty bucket.

   * First, calculate the resistance force using these steps:

     A. Measure and record the weight of the bucket.

     B. Keeping your elbow on the table, place your hand on the food scale and record its weight.

     C. Calculate the total resistance force by adding the weight of the bucket and your hand.

   * Then, divide the resistance force by 4.

2. Construct a cardboard model of a forearm. Label and use the model as part of a project display to demonstrate a third-class lever. Label the parts of the lever and include a short explanation of how muscles work.

CHECK IT OUT!

Your lower jaw, like your forearm, acts as a third-class lever. Find out more about how the human body compares to simple machines. ...

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