

## Giant Lever Demonstration



Visitors will adjust fulcrum and load position on a large lever as they experience mechanical advantage first-hand.

- Mechanical advantage
- Simple machines
- Force
- Gravity
- Work

**Related exhibits:** Give It A Lift, Earthmovers

**Time:** 10-15 minutes

**Ages:** 8 and up (Grades 3 – 12+)

**Staff :** Must be facilitated by at least 1 teen/volunteer.

**Safety issues/special notes:** Visitors, especially very young children, have a tendency to push down on the lever and release very quickly. The facilitator should always keep one hand just above the lever end closest to the user, so that they do not allow it to raise too quickly and hit the visitor/user.

### **Materials:**

- Lever fulcrum and base, supplied
- Lever arm, supplied
- Container with weight, supplied
- Carabineer clip, supplied

### **Preparation:**

1. Position the fulcrum and base so that there is ample room on all sides for visitors to move around and see what is happening (keep in mind the lever length).
2. Position the lever arm so that the first notch rests on the top-most metal bar of the fulcrum.
3. Using the carabineer, attach the weight container to the screw-eye at the end of the longest side of the lever arm.
4. If you notice that there are very young children (shorter) in the audience, you can move the lever arm to one of the lower metal rungs on the fulcrum, so that it is closer to the ground.

### **Procedure:**

1. Start by explaining that this is a lever, and that levers are a simple machine because they help us do work more easily.

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## Giant Lever Demo continued...

2. Have visitors take turns lifting the weight without using the lever, so that they can see it is heavy, but not so heavy it cannot be lifted.
3. Have visitors take turns seeing how much “easier” it is using the lever. None will be able to lift it because the fulcrum is so far from the load (or weight) that the applying force is reduced by several factors.
4. Ask visitors what might make it easier to lift the weight? Ask them to think of a see-saw or teeter-totter as a clue.
5. Allow visitors to move the lever arm position so that it is perfectly centered and let them try lifting the weight again to see if it has gotten easier.
6. How could it be even easier? Continue to let visitors change the arm position, and then try lifting the weight again, until the load is as close to the fulcrum as possible.

### **Questions to Think About:**

If levers make things easier to lift, why was it so hard the first time?

*It depends on the position of the fulcrum and the length of the lever. Since the weight was 8 times farther away from the fulcrum than the visitor, 8 times as much force was needed to lift it.*

When the fulcrum is at the middle of the lever arm, what makes it easier to lift the weight?

*When the fulcrum is centered, the applied force is neither increased or decreased. You are pushing down instead of lifting up, so gravity is helping, not making it harder.*

Where can we find levers in our everyday lives?

*Everywhere! Doors, crowbars, wrenches, see-saws, cranes, and even your arm are all levers.*

### **Science Content:**

A lever is an object that is used with a pivot point, or 'fulcrum', to multiply the force applied to another object. This multiplication of force is called mechanical advantage. The lever allows less effort to be expended to move an object a greater distance. The force on one side ( $F_1$ ), multiplied by its distance from the fulcrum ( $d_1$ ), must equal the force on the other side ( $F_2$ ) multiplied by its distance from the fulcrum ( $d_2$ )

$$F_1d_1 = F_2d_2$$

For instance, to use a lever to lift a weight using only half of the normal force, the distance from the fulcrum to the spot where force is applied must be double the distance between the weight and the fulcrum. If the weight is 2 meters away from the fulcrum, the force must be 4 meters away. Levers are one of the six simple machines.

### Related activities:

- *Hydraulic/Pneumatic Robot Arm*
- Have a simple machines scavenger hunt to identify every-day examples.
- Challenge visitors to move a heavy object a great distance using only simple machines.
- Simple Machine experiments – “Physics for Every Kid”, J. VanCleave, *Wiley & Sons*, pp 108 – 127
- Turning Forces – “How Science Works”, J. Hann, *Readers Digest*, pg 68.
- Simple Machine experiments – “The Science Factory” by Jon Richards, *Cooper Beech Books*, pp 157-175.