

Grade 8 Science — Understanding Mechanical Advantage

Name: _____ Class: _____ Date: _____

Force

You might remember that a force is any push or pull. This can be created with a natural thing like gravity or be produced by you or a magnet or motor (electric or gas powered). You need an energy source to create a force. In the case of gravity, it is called potential energy. Forces are measured in Newtons (Named after Sir Isaac Newton). One Kilogram on Earth has a gravitational force of 10 N so, 1 N equals exactly 100g.

Mass

Mass is the amount of matter in an object and does not involve force. It is measured in grams or kilograms, pounds, tons, tonnes, etc.

Weight

Weight is a more specific in science – it is a force and is a result of gravity pulling on the mass of an object. Weight changes depending on the force of gravity. On Earth, it is usually constant but when you are quickly changing your height from Earth (elevator, roller coaster or in an airplane), it changes your weight. In space, on the moon and other extreme places, your weight changes (your mass is constant)

Ideal Mechanical Advantage (IMA)

This is calculated by measuring the distances involved in the machine ($MA = \text{Effort Arm} / \text{Load Arm}$). It does not take into account friction.

Actual Mechanical Advantage (AMA)

This is what really happens in a machine – including the effect of friction. This is often calculated by measuring the Effort Force divided by the Load Force.

Friction

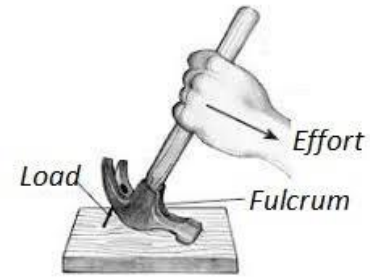
The resistance to movement due to the contact and rubbing of materials moving past each other. This loss of energy is converted into heat in most cases (sometimes sound energy too).

Work

In Science, work is a mathematical concept and not just a job or a career. In Science, work is measured by taking the amount of force (measured in Newtons) and multiplying it over the distance that force is applied (measured in meters). The resulting measure units is a Nm (pronounced ‘Newton Metre’). A Newton Meter is also known as a Joule (Not Jewel but pronounced the same).

Simple machines are used to change the amount of force, the direction for force or to reduce the friction.

Think of the hammer claw. It is a lever that allows us to pull out nails from wood that we are not able to do since it is difficult or impossible. The hammer claw is a lever that is designed to grab the head of a nail and apply sufficient force to remove the nail. We will try this in class.

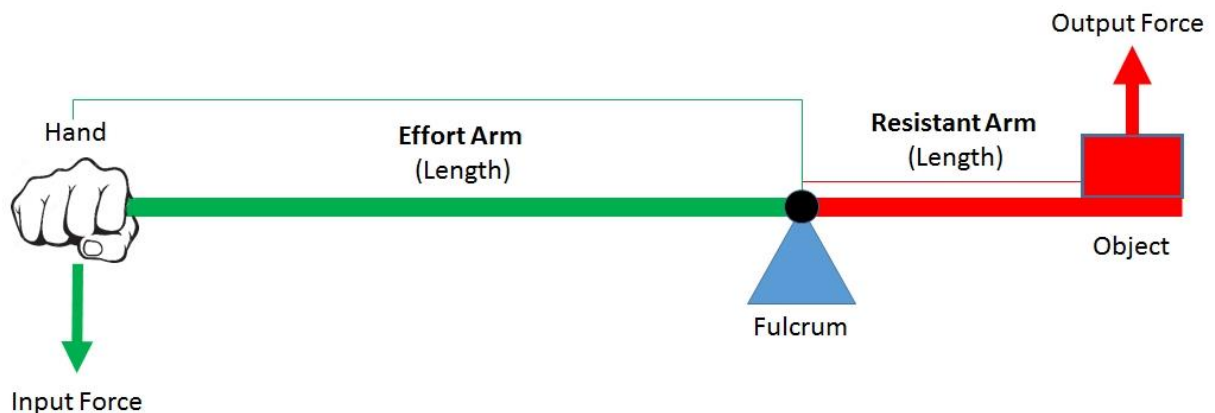


The Greek scientist Archimedes (lived ~ 2250 years ago) stated, “Give me a lever long enough, a fulcrum and a place to stand, and I will move the world.” Source:

<https://www.britannica.com/biography/Archimedes> . This explains why the lever is such a powerful simple machine – and, no, he did not move the world. We will see how he contributed to science and fluids in our next unit on fluids too.



The trick of why this amplifies the force applied is the placement of the fulcrum and the difference in the distance from the fulcrum to the load and the distance from the fulcrum to the applied effort.



From this diagram we can see that the different distances from the fulcrum create a difference in the force. It is this difference in distances that creates the differences in forces. We can quantify or measure this ratio by either measuring the distances or measure the input and output forces. This ratio is called the **Mechanical Advantage**. It is a ratio and does not have units. We will use a specially designed apparatus to demonstrate the mechanical advantage that can be created by shifting where the fulcrum is on a lever. Remember that this works with all classes of levers.

