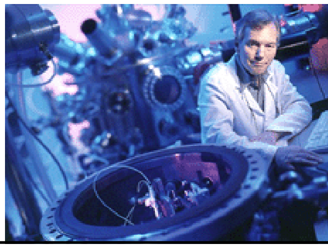
Work and Energy

Chapter 8



Integrated Science I & Honors

Mrs. King

Work, Power & Machines

- Work
  - Measures the effects of a force acting over a distance
- Power
  - Measures rate
- Mechanical Advantage
  - Measures how a machine multiplies force or distance

Work

Work = force x distance

- W = F x d
- Work in joules
- Force in Newtons
- Distance in meters

1 N*m = 1 J = 1 kg*m^2/s^2

- N*m aka joules
- Pushing
- Pulling
- Lifting

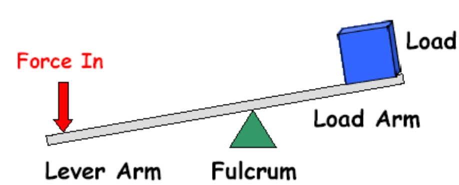
Power

- rate at which work is done
- SI unit - watts
  - Amount of power required to do 1 J of work in 1 s
- Power = work/time
  - P = W/t
  - Don't confuse work (*W*) with watts (W) – they both use w for symbol

Mechanical Advantage

- describes **how much** the machine multiplies force **or** increases distance.

Machines & Mechanical Advantage



Machines allow you to lift heavy objects easily.

You can apply a small force in over a long lever arm to produce a large force out over a short load arm.

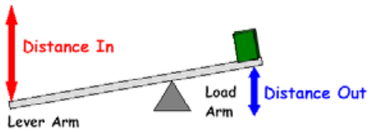
Photo: http://www.physics.ohio-state.edu/~maryw/p103/overheads_pdf/Per7_over.pdf

Theoretical Mechanical Advantage

$$MA_{theoretical} = \frac{D_{in}}{D_{out}}$$

D_{in} = distance you move the machine

D_{out} = distance the load moves



Theoretical mechanical advantage is an ideal case with no energy wasted by frictional forces.

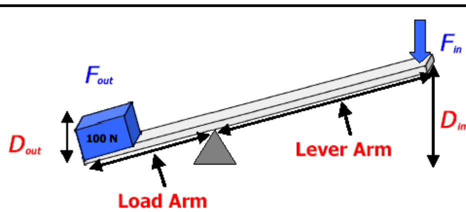
Actual Mechanical Advantage

$$MA_{actual} = \frac{F_{out}}{F_{in}}$$

F_{in} = the force you exert on the machine

F_{out} = the force exerted on the load by the machine

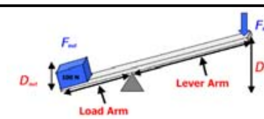
Actual mechanical advantage takes into account the energy wasted by frictional forces.



Using a lever, you lift a 20 kg box a distance of 0.5 meters. If you apply a force of 50 newtons to the lever, over what distance must the lever move?

$$F_{in}\ D_{in} = F_{out}\ D_{out}$$

$$F_{in}\ D_{in} = F_{out}\ D_{out}$$

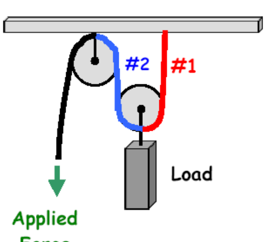


Solve the equation for D_{in} by dividing both sides by F_{in}

$$\frac{\cancel{F_{in}}\ D_{in}}{\cancel{F_{in}}} = \frac{F_{out}\ D_{out}}{F_{in}} =$$

$$\frac{20\ \cancel{kg} \times 9.8\ \cancel{m/s^2} \times 0.5\ m}{50\ \cancel{kg\ m/s^2}} = 2.0\ m$$

Pulleys & Mechanical Advantage

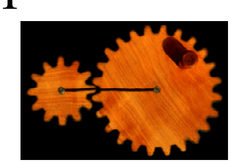


This pulley system has two attached ropes

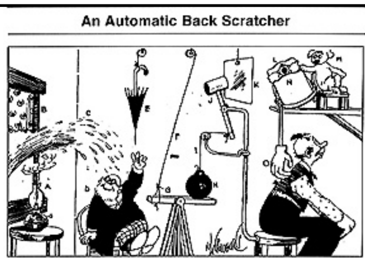
MA = 2

The theoretical mechanical advantage of a pulley system equals the number of directly attached rope segments supporting the load. (The rope you pull on to apply force does not count.)

Simple Machines

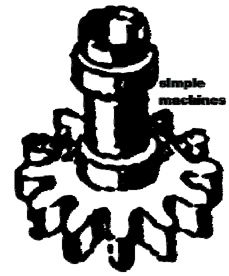


Click here



- A machine is a tool used to make work easier.
- Simple machines are simple tools used to make work easier.
- Compound machines have two or more simple machines working together to make work easier.

Simple Machines



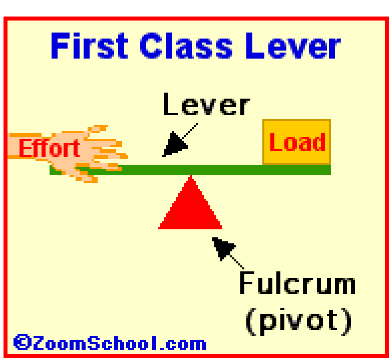
6 basic types
- Simple lever
- Pulley (modified)
- Wheel & axle
- Inclined plane
- Wedge
- screw

The ramp, the shovel, and the see-saw are simple machines.

- Children do work when they go up and down on a see-saw.
- The furniture movers use a ramp to slide boxes into a truck.
- The gardeners use a hand shovel to help break through the weeds.

Levers

- one of the basic tools
- probably used in prehistoric times.
- first described about 260 BC by the ancient Greek mathematician Archimedes (287-212 BC).

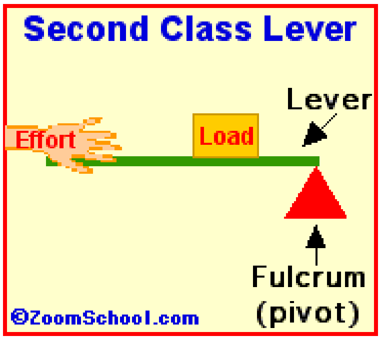


Type 1 Lever

Type 1 Lever

- the pivot (fulcrum) is between the effort and the load.
- In an off-center type one lever (like pliers), the load is larger than the effort, but is moved through a smaller distance.

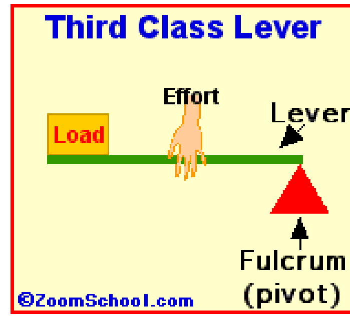
The load is between the pivot (fulcrum) and the effort.



Type 2 lever

Type 3 lever

- The effort is between the pivot (fulcrum) and the load.



Many basic tools use levers

- simple machine that makes work easier for use; it involves moving a load around a pivot using a force.
  - scissors - 2 class 1 levers
  - pliers - 2 class 1 levers
  - hammer claws - a single class 2 lever
  - nut crackers - 2 class 2 levers
  - tongs –2 class 3 levers