Simple Machines and More

Applied Science

Work

- Work is done when a FORCE is applied over a DISTNACE
- The amount of work done depends on the amount of force exerted and the distance over which the force is applied.
- When a force is exerted and an object moves in the direction of the force, the amount of work done can be calculated as follows.

$$Work\ (J) = Applied\ Force\ (N) * Distance(m) \qquad W = Fd$$

Efficiency

- The work done by you on a machine is called the input work and is symbolized by W_{in}.
- The work done by the machine is called the output work and is abbreviated W_{out}.

$$Efficiency\ (\%) = \frac{Work\ Out\ (J)}{Work\ In\ (J)} * 100\%$$

$$Efficiency = \frac{W_{out}}{W_{in}} * 100\%$$

Mechanical Advantage

- The ratio of the output force to the input force is the **mechanical advantage** of a machine.
- The mechanical advantage of a machine can be calculated from the following equation.

$$Mechanical\ Advantage = \frac{Force\ Out\ (N)}{Force\ In\ (N)}$$

$$MA = \frac{F_{out}}{F_{in}}$$

Types of Simple Machines

- A Simple machines is…
- A machine that does work with only **one** movement of the machine.

- What are the six types of simple machines:

1. lever 2. pulley 3. wheel and axle
4. screw 5. wedge. 6. inclined plane

Making Work Easier

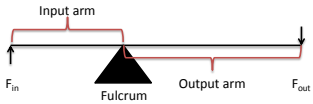
- Machines can make work easier by increasing the force that can be applied to an object.
- A second way that machines can make work easier is by increasing the distance over which a force can be applied.
- Machines can also make work easier by changing the direction of an applied force.

Levers

- A lever is a bar that is free to pivot or turn around a fixed point.
- The fixed point the lever pivots on is called the fulcrum.

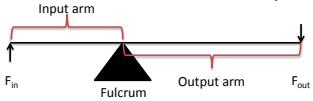
Levers

- The input arm of the lever is the distance from the...
  - fulcrum to the point where the input force is applied.
- The output arm is the distance from the…
  - fulcrum to the point where the output force is exerted by the lever.



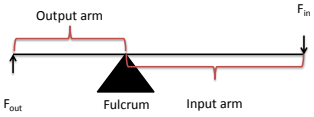
Levers

- The output force produced by a lever depends on the _____ of the input arm and the output arm.
- If the output arm is **longer** than the input arm, the law of conservation of energy requires that the output force be **less** than the input force.



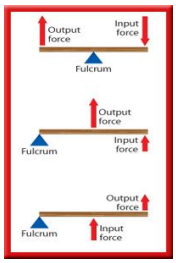
Levers

- If the output arm is **shorter** than the input arm, then the output force is **greater** than the input force.



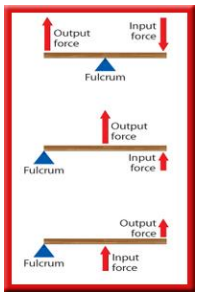
Levers

- How many classes of levers are there?
  - 3
- What are there names?
  - 1st class
  - 2nd class
  - 3rd class
- Draw each of them in your notebook.



Levers

- What is an example of a 1st class lever?
  - Teeter-totter, pry bar
- What is an example of a 2nd class lever?
  - Wheelbarrow
- What is an example of a 3rd class lever
  - Baseball bat



Ideal MA of a lever

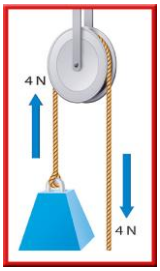
- What is the IMA equation for a lever?

_____

$$IMA = \frac{L_{in}}{L_{out}}$$ ← Notice the "in" and the "out" are switch from before!!

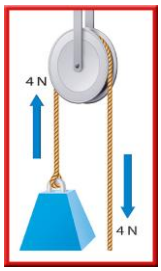
- Does it HAVE to be in meters?
  - No, just has to cancel out!

Pulley



- A **pulley** is a grooved wheel with a rope, chain, or cable running along the groove.
- A fixed pulley is a modified <u>first-class lever</u>.
- The axle of the pulley acts as the **<u>Fulcrum</u>** .

Pulley

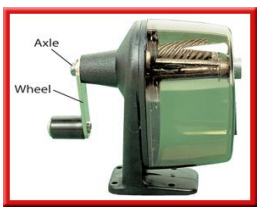


- The two sides of the pulley are the input arm and output arm.
- A pulley can <u>change the direction</u> of the input force or <u>increase input force</u>, depending on whether the pulley is fixed or moveable.

Fixed Pulley

- A fixed pulley is attached to something that doesn't move, such as a ceiling or wall.
- Because a fixed pulley changes only the direction of force, the MA is 1.

Wheel and Axel



- A **Wheel and Axel** is a simple machine consisting of a shaft or axle attached to the center of a larger wheel, so that the wheel and axle rotate together.

Wheel and Axel

- What are some examples of a wheel and axel?
  - Doorknobs, screwdrivers, faucet handles
- Usually the input force is applied to the wheel, and the output force is exerted by the axel.

MA of a Wheel and Axel

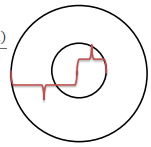
- A wheel and axle is another modified lever.
- The center of the axle is the **Fulcrum** .
- The input force is applied at the rim of the wheel.
- So the length of the input arm is the **radius** of the wheel.

MA of a Wheel and Axel

- The output force is exerted at the rim of the axle.
- So the length of the output arm is the radius of the **axle** .
- What is the equation for the MA of a wheel and axle?

$$Ideal\ Mechanical\ Advantage = \frac{Radius\ of\ Wheel\ (m)}{Radius\ of\ Axel\ (m)}$$

$$IMA = \frac{r_w}{r_a}$$

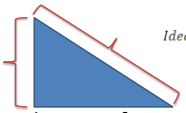


Inclined Plane

- A sloping surface, such as a ramp that reduces the amount of force required to do work, is an **Incline Plane**

MA of an incline plane

- By pushing a box up an inclined plane, the input force is exerted over a **longer** distance compared to lifting the box straight up.
- What is the MA equation for an inclined plane



$$Ideal\ Mechanical\ Advantage = \frac{Length\ of\ Slope\ (m)}{Height\ of\ Slope\ (m)}$$

$$IMA = \frac{l}{h}$$

- The MA of an inclined plane for a given height is increased by making the plane longer.

Screw

- A **Screw** is an inclined plane wrapped in a spiral around a cylindrical post.
- The MA of a screw is related to the spacing of the **threads** .
- The MA is larger if the threads are **closer** together. However, if the MA is larger, more **turns** of the screw are needed to drive it into some material.

Wedge

- The wedge is also a simple machine where the inclined plane moves through an object or material.
- A **wedge** is an inclined plane with one or two sloping sides. It changes the **direction** of the input force.