

# Work

Physics Work is defined as Force times Displacement

$$W=Fs$$

Force and displacement are vectors and **MUST** be in the same direction in order to calculate work.

Work is a form of energy.

Energy is a human accounting system that allows us to predict and explain changes.

# Work

Work is scalar. It has no direction **BUT** work can be done on an object or the object can do work on something else.

To identify the input and output work + and – signs are used.

Positive (+) work identifies input work on an object.

Negative (-) work identifies output work by an object.

# Work

Metric units of work include:

Nm → Newton meters

J → Joules

$\text{kg m}^2/\text{s}^2$  → kilogram meters squared per second squared

ws → watt seconds

kwhr → kilowatt hours

# Machines

Simple machines are devices that allow us to change how the work is done.

Simple machines include:

inclined planes

pulleys

levers

wheel and axle

wedge

screw

# Machines

Machines do not change the amount of energy required to do work.

Reminder of the Law of Conservation of Energy.

Energy is neither created or destroyed.

Machines change the amount of force required to do some particular work.

The trade off for reducing the force is increasing the distance (the amount of work is the same if there is no friction).

# Machines

Ideal Mechanical Advantage is a description of the force advantage for a particular machine.

Ideal Mechanical Advantage (IMA) is defined as  $\text{distance}_{\text{in}}$  divided by  $\text{distance}_{\text{out}}$ .

$$\text{IMA} = \frac{\text{distance}_{\text{in}}}{\text{distance}_{\text{out}}}$$

# Machines

Actual Mechanical Advantage is a description of the force advantage for a particular machine that includes the tradeoff of friction.

Actual Mechanical Advantage (AMA) is defined as  $\text{Force}_{\text{out}}$  divided by  $\text{Force}_{\text{in}}$ .

$$\text{AMA} = \frac{F_{\text{out}}}{F_{\text{in}}}$$

# Efficiency

Because real machines “waste” some of the input work caused by friction it is useful to describe how much work is put out from a machine compared to how much work is put into the machine. This quantity is called efficiency.

$$\text{efficiency} = \frac{\text{Work}_{\text{out}}}{\text{Work}_{\text{in}}} \times 100$$

Efficiency is expressed as percents



# Efficiency

Efficiency can also be calculated from the mechanical advantages.

$$\text{efficiency} = \frac{\text{AMA}}{\text{IMA}} \times 100$$

# Percent Review

Percent

literally per (over) cent (100)

number out of 100

$$50\% = 50/100$$