Work and Energy

Changing the motion of an object over a distance

What is necessary to do work

What is energy?

We often refer to energy as "the ability to do work".

No one really knows WHAT it is ... but it is useful and it can be:

1. Stored (in one object or entity)
2. Transferred (to another object or entity)

Energy Transfers	**Energy Storages**
WORK Transmission of the energy of one object to a 2nd object via the application of a force	KINETIC ENERGY KE = (1/2) mv^2 $= \frac{1}{2} mv^2$ (energy stored in motion)
HEAT A transfer of internal energy from one object to another	POTENTIAL ENERGY (PE) Gravitational (GPE) Elastic (EPE) → SPRINGS Chemical Nuclear
ELECTROMAGNETIC RADIATION	INTERNAL ENERGY Energy associated with the motion of an object's molecules, not its bulk motion.
SOUND	
CHEMICAL REACTIONS	
ELKTRICAL CIRCUITS	

WORK (In Physics)

The energy transferred from one object to another when there is a force between the objects that exists while the objects are moving relative to each other.

$$\boxed{\text{WORK} = W = F \times d}$$

Work = Force x distance

parallel to the direction of motion

F = an applied force (N)
d = the displacement over which the force is applied (m)

The force must be applied in the direction of the displacement. When these two things are not colinear, it is only important to consider the component of the force parallel to movement.

Units for Work (and Energy): $\boxed{N}$ x m = Joule (J)
1 J = .7376 lbs x ft

$F = ma$

$N = kg \cdot \frac{m}{s^2}$

$W = F \cdot d$

$\boxed{J} = kg \cdot \frac{m}{s^2} \cdot m$

$kg \cdot \frac{m^2}{s^2}$

WORK: energy is transferred FROM one object TO another ...

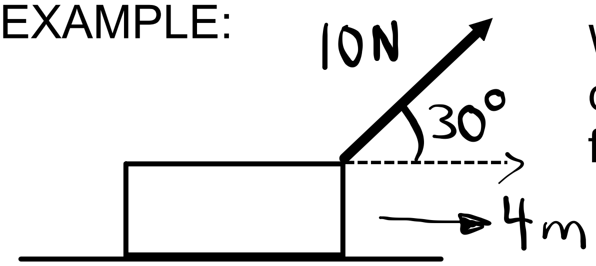
When an object experiences a force in the same direction as its motion:

- Work is done TO the object
- Work will be a positive quantity
- Energy is being transferred into the object (i.e. its KE increases)

When an object experiences a force in the opposite direction as its motion:

- Work is done BY the object
- Work will be a negative quantity
- The object transfers energy into something else (i.e. its KE decreases)

EXAMPLE:



What work does the 10 N force do on this mass? Assume no friction.

$$W = F \cdot d$$
$$= (10 \cos 30)\,4$$
$$= 34.6\ J$$

BE VERY SPECIFIC WHEN TALKING ABOUT WORK:

All these are different:

- **Work done on an object** (work is potentially done by each force acting on an object)
- **Work done by an object** (on something else)
- **Net work done on an object** (by all forces acting on the object)
- **Total work done on an object** (aka net work)

If work is done on an object, we should expect the energy stored in the object to change:

$$\left(\begin{array}{c}\text{ENERGY TRANSFERRED}\\ \text{TO OR FROM AN}\\ \text{OBJECT}\end{array}\right) = \left(\begin{array}{c}\text{CHANGE IN ENERGY}\\ \text{STORED IN THE}\\ \text{OBJECT}\end{array}\right)$$

$$W = \Delta KE$$

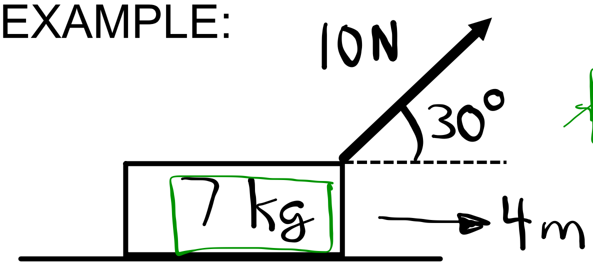
$$W = KE_{FINAL} - KE_{INITIAL}$$

$$\boxed{W = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2}$$

KNOWN AS THE

WORK-KE THEOREM

EXAMPLE:



If the mass is initially moving at 5 m/s to the right as the 10 N force acts on this mass, how fast is it moving when it has travelled the four meters? Assume no friction.

$$W = 34.6\ J$$

$$W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_o^2$$

$$34.6 = \frac{1}{2}(7)v^2 - \frac{1}{2}(7)(5)^2$$

$$\boxed{v = 5.9\ m/s}$$