capacity to do work (?)

what makes things move (?)

What is Energy?

movement of matter (?)

power (?)

force (?)

What is energy?

A very difficult question to answer.

Consider another question:
What is money?

Currency: a means by which we barter.

What two things do we do with money?

1. We spend it (aka transfer it)
2. We save it (aka store it)

Although it is difficult to define precisely what energy is, when we use the concept of energy, it is always in one of two contexts:

→ one object gains and another loses the ability to do work

1. We **transfer** it from one object to a second object.
2. We **store** it within an object.

→ that object neither loses nor gains the ability to do work

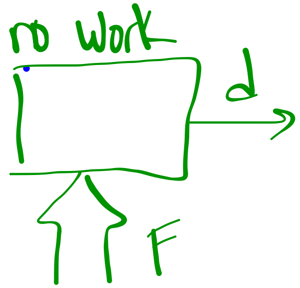
Energy Transfers	Energy Storages
WORK Transmission of the energy of one object to a 2nd object via the application of a force	KINETIC ENERGY $KE = (1/2)\,mv^2$ (energy stored in motion)
HEAT A transfer of internal energy from one object to another	POTENTIAL ENERGY (PE) Gravitational (GPE) Elastic (EPE)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

THIS UNIT IN RED

WORK (In Physics)

When a force is exerted over a displacement.

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



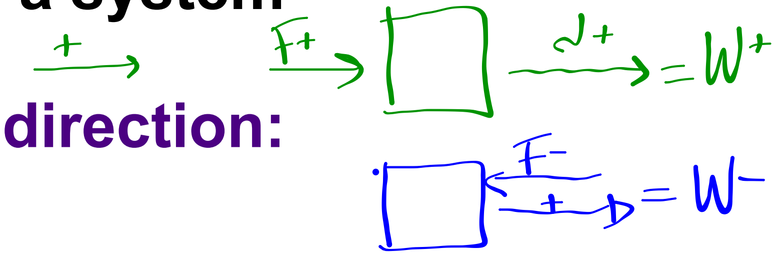
F = an applied force (N)
d = the displacement over which the force is applied (m)

The force must be applied in the direction of the displacement. When these two things are not colinear, the component of the force in the direction of the displacement is multiplied by the displacement to determine the work down by the force.

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

Units for Work (and Energy): N x m = Joule (J)
1 J = .7376 lbs x ft

WORK: transfers into vs. out of a system



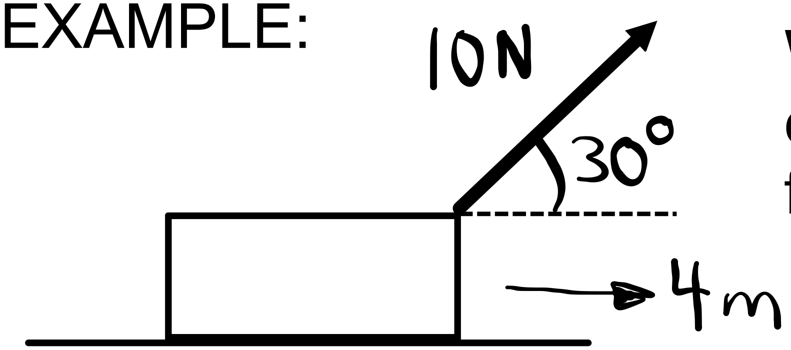
When F and d are in the same direction:

- Work is a positive quantity
- The pusher transfers energy into the object being pushed
- The energy of the pushed object increases (i.e. KE increases)

When F and d are in opposite directions:

- Work is a negative quantity
- The pusher transfers energy out of the object being pushed
- The energy of the pushed object decreases (i.e. KE decreases)

EXAMPLE:

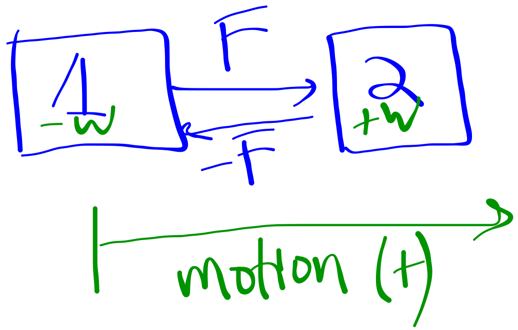


What work does the 10 N force do on this mass? Assume no friction.

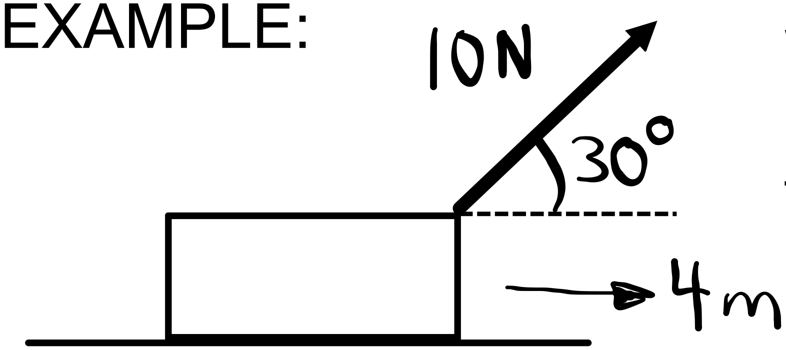
$$W = F \cdot d$$

$$(10\cos 30)(4)$$

$$= 34.6\ J$$



EXAMPLE:



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

$$W = F \cdot d$$

$$= (F\cos 30)(4)$$

$$= (10\cos 30)(4) = \boxed{34.6\,J}$$

The answer is a positive quantity -- the force has transferred energy to the mass; the energy stored in the mass has increased.

BE VERY SPECIFIC WHEN TALKING ABOUT WORK:

All these are different:

- **Work done on an object** (one for 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:

$$\begin{pmatrix}\text{ENERGY TRANSFERRED} \\ \text{TO OR FROM AN} \\ \text{OBJECT}\end{pmatrix} = \begin{pmatrix}\text{CHANGE IN ENERGY} \\ \text{STORED IN THE} \\ \text{OBJECT}\end{pmatrix}$$

$$W = \Delta KE$$

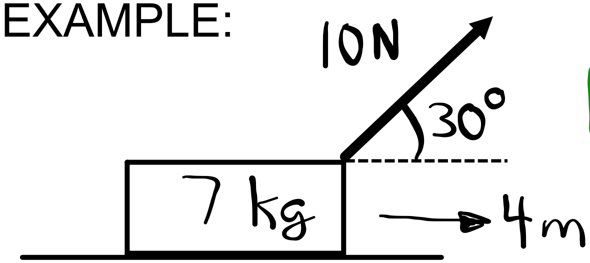
$$W = KE_{FINAL} - KE_{INITIAL}$$

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

KNOWN AS THE

WORK-KE THEOREM

EXAMPLE:



If the mass is initially moving at $\boxed{5\ m/s}$ 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.

$W = 34.6\ J$

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

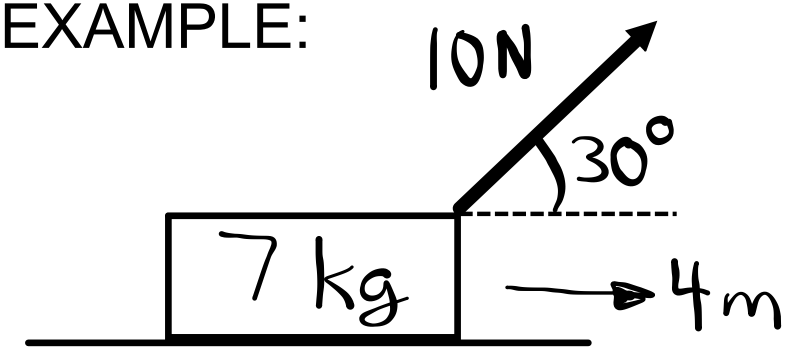
$F_\parallel d = \quad " \quad\quad "$

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

$\sqrt{\frac{34.6}{3.5} + 25} = v$

$v = 5.9\ m/s$

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.

$$W = \Delta KE$$

$$34.6 = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2$$

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

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