Kinetic Energy

Energy is the ability to do work

It exists in many forms such as heat, light, sound, nuclear, chemical

All forms fall into two basic categories:

1. Energy associated with motion called Kinetic energy
2. Energy associated with position called potential energy

Kinetic energy, measured in J, depends on an object's mass and speed according to:

$$\boxed{E_K = \frac{1}{2}mv^2}$$

Example: A 60.0 kg student is running at a uniform speed of 5.70 m/s. What is the kinetic energy of the student?

$$E_K = \frac{1}{2}mv^2$$

$$= \frac{1}{2}60\,kg \cdot \left(\frac{5.70\,m}{s}\right)^2 = \boxed{975\,J}$$

Example: The kinetic energy of a 2.1 kg rotten tomato is 1.00 x 10^3J. How fast is it moving?

$$E_K = \frac{1}{2}mv^2$$

$$v^2 = \frac{2E_K}{m}$$

$$v = \sqrt{\frac{2E_K}{m}} = \sqrt{\frac{2(1000\,J)}{2.1\,kg}} = \boxed{31\,m/s}$$

Work-Energy Theorem: When a net force acts on an object, the object... accelerates!

In other words, the force does work on the object and the object's kinetic energy changes.

$$W = \Delta E_K$$

$$= E_{Kf} - E_{Ki}$$

$$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = \frac{1}{2}m(v_f^2 - v_i^2)$$

Therefore, the total work done on an object by a net force ________________ the change in its kinetic energy.

Therefore, the total work done on an object by a net force equals the change in its kinetic energy.

$$W = \Delta E_k = E_{kf} - E_{ki}$$

Example: A sprinter exerts a net force of 260 N over a distance of 35 m. What is his change in kinetic energy?

$W = \Delta E_k$ so $\Delta E_k = W$
$= F\Delta d$
$= 260\text{ N} \cdot 35\text{ m}$
$\boxed{= 9100\text{ J}}$

Example: How much work must be done to accelerate a 1200 kg truck from 13 to 28 m/s?

$W = \Delta E_k$
$= E_{kf} - E_{ki}$
$= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$= \frac{1}{2}m(v_f^2 - v_i^2)$
$= \frac{1}{2}\,1200\text{ kg}\left(28\frac{\text{m}}{\text{s}}^2 - 13\frac{\text{m}}{\text{s}}^2\right)$
$= 369\,000\text{ J}$
$\boxed{= 3.7\times10^5\text{ J}}$

Example: A student pushes a 25 kg crate which is initially at rest with a force of 160 N over a distance of 15 m. If there is 75 N of friction, what is the final speed of the crate?

Given: $m = 25\text{ kg}$
$v_i = 0$
$F_a = 160\text{ N}$
$\Delta d = 15\text{ m}$
$F_f = 75\text{ N}$

Need: v_f

$F_{net} = F_a - F_f$
$= 160\text{ N} - 75\text{ N}$
85 N

$W = \Delta E_k$
$F_{net}\cdot\Delta d = E_{kf} - E_{ki}$ ← $v_i = 0$
$F_{net}\cdot\Delta d = E_{kf}$
$F_{net}\,\Delta d = \frac{1}{2}mv_f^2$
$v_f^2 = \frac{2F_{net}\Delta d}{m}$
$v = \sqrt{\frac{2(85\text{ N})\cdot 15\text{ m}}{25\text{ kg}}} = 10 = \boxed{1.0\times10^1\text{ m/s}}$