Review of Work:

$W = F_{\parallel} \Delta d$

$W = F \Delta d \cos\theta$

maximum work ($\theta = 0^\circ$)
no work ($\theta = 90^\circ$)
negative work ($\theta = 180^\circ$)

W = area under F-d graph

Kinetic Energy

Any moving object has kinetic energy. Kinetic energy depends on the object's mass and its velocity.

Kinetic energy is directly proportional to the object's mass.

$$E_k \propto m$$

Kinetic energy is proportional to the square of the object's velocity

$$E_k \propto v^2$$

combining: $E_k \propto mv^2$

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

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$m = 0.200\,kg$

$v_1 = 0\,m/s$

$v_2 = 27.0\,m/s$

a) $E_{k_1} = ?$

b) $E_{k_2} = ?$

a) $E_{k_1} = 0$ since $v_1 = 0\,m/s$

(any object at rest has no kinetic energy)

b) $E_{k_2} = \frac{1}{2}mv_2^2$

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

$E_{k_2} = \frac{1}{2}(0.200\,kg)(27.0\,\frac{m}{s})^2$

$E_{k_2} = 72.9\,J$

Work and Kinetic Energy

How are they related? Work must be done on an object to transfer kinetic energy to that object.

Recall: $W = F_{\parallel}\Delta d$ and $F_{\parallel} = ma$ (newton's second law)

$W = ma\Delta d$

$W = m\left(\frac{\Delta v}{\Delta t}\right)(v_{ave}\Delta t)$ $v_{ave} = \frac{\Delta d}{\Delta t}$

$W = m(\Delta v)(v_{ave})$

$W = m(v_2 - v_1)\left(\frac{v_1 + v_2}{2}\right)$

$W = \frac{1}{2}m(v_1v_2 + v_2^2 - v_1^2 - v_1v_2)$

$W = \frac{1}{2}m(v_2^2 - v_1^2)$

$W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

$W = E_{k_2} - E_{k_1}$

$W = \Delta E_k$ ← work-energy theorem

In order for an object's kinetic energy to change, work must be done and the amount of work done is equal to the object's change in kinetic energy.

If an object has 20J of kinetic energy and you do 30J of work, then it will have 50J of kinetic energy

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$m = 2.5\,kg$

$F = 4.0\times10^1\,N$

$\Delta d = 1.5\,m$

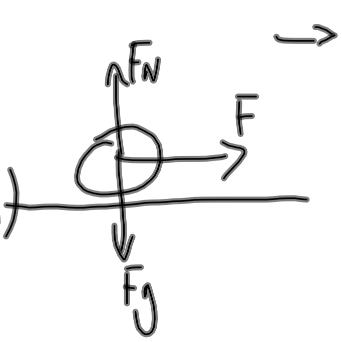
a) $W = ?$

b) $v_2 = ?$ if $v_1 = 0$

a) $W = F_{\parallel}\Delta d$

$W = (4.0\times10^1\,N)(1.5\,m)$

$W = 6.0\times10^1\,J$



b) $W = \Delta E_k$

$W = E_{k_2} - E_{k_1}$ ← $= 0$ since $v_1 = 0$

$W = E_{k_2}$

$W = \frac{1}{2}mv_2^2$

$6.0\times10^1\,J = \frac{1}{2}(2.5\,kg)v_2^2$

$\frac{2(6.0\times10^1\,J)}{2.5\,kg} = v_2^2$

$v_2 = \sqrt{\frac{2(6.0\times10^1\,J)}{2.5\,kg}}$

$v_2 \doteq 6.9\,m/s$

units:

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

$= \sqrt{\frac{m^2}{s^2}}$

$= \frac{m}{s}$

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$m = 75 kg$

$v_1 = 8.0 m/s$

$F_{\parallel} = 2.0 \times 10^2 N$

$\Delta d = 5.0 m$

$E_{k_2} = ?$

$W = \Delta E_k$

$F_{\parallel} \Delta d = E_{k_2} - E_{k_1}$

$E_{k_2} = E_{k_1} + F_{\parallel} \Delta d$

$E_{k_2} = \frac{1}{2} m v_1^2 + F_{\parallel} \Delta d$

$E_{k_2} = \frac{1}{2}(75 kg)(8.0 \frac{m}{s})^2 + (2.0 \times 10^2 N)(5.0 m)$

$E_{k_2} = 2.4 \times 10^3 J + 1.0 \times 10^3 J$

$E_{k_2} = 3.4 \times 10^3 J$

TO DO

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