§6-2 Kinetic Energy + the Work-Energy Theorem

Any moving object has kinetic energy.
Kinetic enery depends both the mass and the speed of the object.

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

where E_k is the kinetic energy (J)
m is the mass (kg)
v is the speed (m/s)

Note: E_k is a scalar quantity

UNITS: $1\,kg \cdot \frac{m^2}{s^2} = 1\,J$

mP/237

$m = 0.200\,kg$
$v_1 = 0$
$v_2 = 27.0\,m/s$

a) $E_k = ?$ (at rest)
b) $E_k = ?$ (moving at 27.0 m/s)

a) $E_k = 0\,J$ (when at rest)

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

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

$E_k = 72.9\,J$

The hockey puck's original kinetic energy was zero and now it has 72.9J of kinetic energy. Where did that energy come from?

WORK!

Work was done on the hockey puck!

A force acted on the hockey puck over a given distance causing the hockey puck to accelerate and increase its speed and therefore increase its kinetic energy.

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

$W = ma\Delta d$ $\quad (F_{net} = ma)$

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

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

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

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

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

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

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

$\boxed{W = \Delta E_k}$ ← Work-Energy Theorem

The work done on an object is equal to the change in its kinetic energy.

If there is an increase in KE, positive work is done.

If there is a decrease in KE, negative work is done

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$m = 2.5\,kg$

$F_a = 40\,N$

$v_1 = 0$

$\Delta d = 1.5\,m$

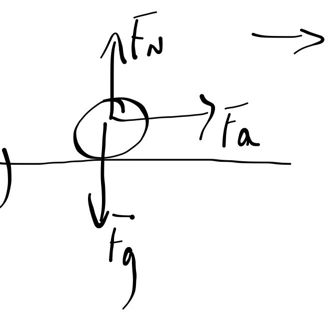
a) $W = ?$

b) $v_2 = ?$

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 Theorem)

$W = E_{k_2} - \cancel{E_{k_1}}^{\,0}$

$W = E_{k_2}$

$W = \frac{1}{2} m v_2^2$

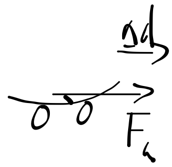
$v_2^2 = \frac{2W}{m}$

$v_2 = \sqrt{\frac{2W}{m}}$

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

$\boxed{v_2 = 6.9\,m/s}$

The curling stone was given 60 J of kinetic energy and its final velocity was 6.9 m/s.



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$m = 75\,kg$

$F_a = 2.0 \times 10^2\,N$

$\Delta d = 5.0\,m$

$v_1 = 8.0\,m/s$

$E_{k_2} = ?$

$$W = \Delta E_k$$

$$F_{\parallel}\Delta d = E_{k2} - E_{k1}$$

$$E_{k_2} = \underbrace{F_{\parallel}\Delta d}_{\text{work}} + \underbrace{E_{k_1}}_{\text{original energy}}$$

$$E_{k_2} = F_{\parallel}\Delta d + \tfrac{1}{2}mv_1^2$$

$$E_{k_2} = (2.0\times10^2\,N)(5.0\,m) + \tfrac{1}{2}(75\,kg)(8.0\,m/s)^2$$

work done + original energy.

$$E_{k_2} = 1.0\times10^3\,J + 2.4\times10^3\,J$$

$$E_{k_2} = 3.4\times10^3\,J$$

TO DO

1. PP|238
2. PP|245-246