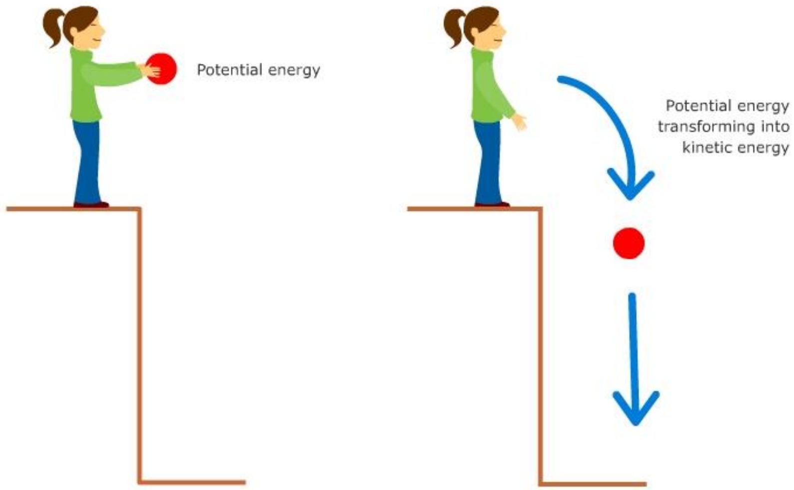
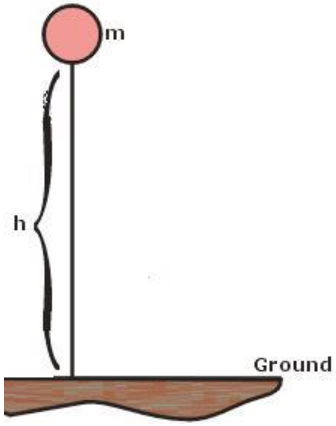
Calculations Involving Potential & Kinetic Energy



Gravitational Potential Energy



- Is the energy possessed by an object due to its height relative to some other surface.
- It is directly proportional to its mass, its height, and gravitational field st

$$E_g = mgh \quad \text{where } m = mass\ (kg)$$

$$g = gravitational\ \ field\ strength\ (9.8N/kg)$$

$$h = height\ (m)$$

Example 1

- A 3.0 kg cat is perched on a 2.0 m high shelf. What is the cat's gravitational potential energy?

$E_g = mgh$

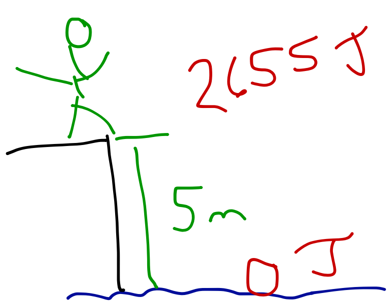
$= (3.0\,kg)(9.8\,m/s^2)(2.0\,m)$

$E_g = 58.8\,J$

$E_g = 59\,J$

Example 2

- A diver on a diving board at a height of 5.0 m dives into the water experiencing a loss in gravitational potential energy of 2655 J. What is the diver's mass?



Given: $E_g = 2655\,J$

$h = 5\,m$

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

Unknown: m = mass

Steps: $E_g = mgh$

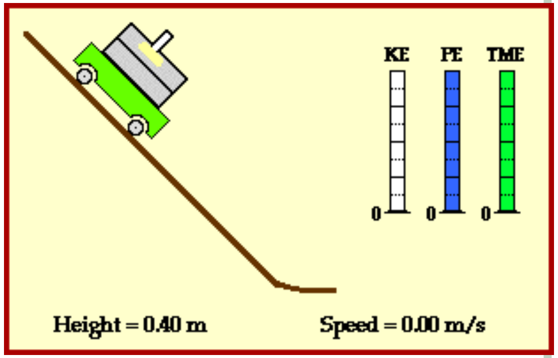
$2655\,J = m\left(9.8\frac{m}{s^2}\right)(5\,m)$

$2655\,J = \left(49\frac{m^2}{s^2}\right)m$

$m = \frac{2655\,kg\frac{m^2}{s^2}}{49\frac{m^2}{s^2}}$

$m = 54\,kg$

Kinetic Energy



- Is the energy possessed by an object in motion
- The amount of kinetic energy possessed by an object proportional to its mass and to the square of its speed

$$E_k = \frac{1}{2}mv^2 \quad where\ m = mass\ (kg)$$

$$v = speed\ (m/s)$$

EXAMPLE 3

- A 2500.0 kg car is travelling at 80.0 km/h (22.222 m/s). What is its kinetic energy?

<u>Given</u>

$m = 2500\ kg$

$V = 22.2\ m/s$

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

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

<u>Unknown:</u>

E_k = Kinetic energy

<u>Steps:</u>

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

$= \frac{(2500kg)(22 m/s)^2}{2}$

$$E_k = \frac{(2500\ kg)\left(493\ \frac{m^2}{s^2}\right)}{2}$$

$$E_k = 616{,}050\ kg\frac{m^3}{s^2}$$

-1J

$$E_k = 616\,000\ J$$

Example 4

- A runner of mass 59 kg possesses a kinetic energy of 1.3 kJ. What is her speed?

Given $E_k = 1.3\,kJ$

$= 1.3 \times 1000\,J$

$= 1300\,J = 1300\,kg\frac{m^2}{s^2}$

$m = 59\,kg$

Unknown $v = speed$

Steps: $E_k = \frac{mv^2}{2}$

$1300\,kg\frac{m^2}{s^2} = \frac{59\,kg\,v^2}{2}$

$$1300\,kg\,\frac{m^2}{s^2} = 29.5\,kg\,v^2$$

$$\frac{1300\,\cancel{kg}\,\frac{m^2}{s^2}}{29.5\,\cancel{kg}} = v^2$$

$$44\,\frac{m^2}{s^2} = v^2$$

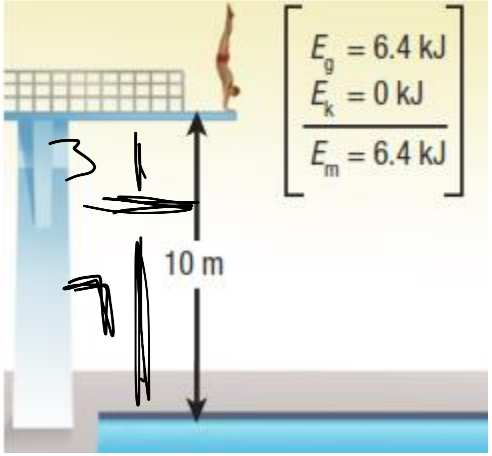
$$v = \sqrt{44\,m^2/s^2}$$

$$v = 6.6\ m/s$$

EXAMPLE #5

- A 65 kg diver performs a handstand dive from a 10.0 m high platform. Determine his speed 3.0m below the platform and his speed when he hits the water.

At top all E_g



$$E_g = mgh$$

$$= (65\,kg)\left(9.8\,\frac{m}{s^2}\right)(10\,m)$$

$$E_g = 6370\,J$$

$$E_k = 0\,J$$

$$E_{mechanical} = 6370\,J + 0\,J$$

$$= 6370\,J$$

3 m below platform

$10 - 3 = 7 \qquad h = 7\,m$

$E_g = (65\,kg)(9.8\,\frac{m}{s^2})(7\,m)$

$E_g = 4459\,J$

$\therefore E_k = 6370\,J - 4459\,J$

$E_k = 1911\,J$

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

$1911 = \frac{65\,v^2}{2}$

$1911 = 32.5\,v^2$

$v^2 = 1911 / 32.5$

$v^2 = 58.8\,m^2/s^2$

$v = 7.7\,m/s$

When he hits water

$$h = 0$$

$$\therefore E_g = 0$$

so $E_k = 6370\ J$

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

$$6370 = \frac{65v^2}{2}$$

$$6370 = 32.5\ v^2$$

$$v^2 = \frac{6370}{32.5}$$

$$v^2 = 196\ m^2/s^2$$

$$v = 14\ m/s$$