SPH4U UNIVERSITY PHYSICS

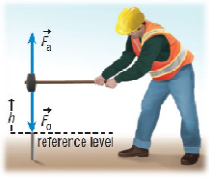
ENERGY & MOMENTUM

☞ Gravitational Potential Energy & Work (P.177-181)

Gravitational Potential Energy

RECALL!

An object positioned above the ground has the ability to fall and gain kinetic energy that could do work. The type of energy possessed by an object because of its position relative to a lower position is called ***gravitational potential energy (E_g)****.*



NOTE!

The greater the height or the mass of the sledgehammer, the greater its gravitational potential energy.

Gravitational Potential Energy

GRAVITATIONAL POTENTIAL ENERGY (E_g)

- energy possessed by an object due to its position relative to Earth

$$E_g = mgh$$

where E_g is the gravitational potential energy (J)
m is the mass (kg)
g is the gravitational field strength (N/kg)
h is the height relative to a reference (m)

NOTE!

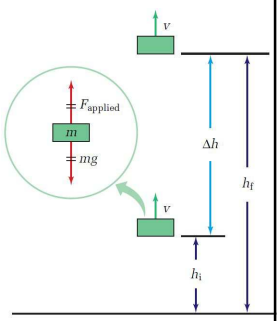
g *is also equal to the acceleration due to gravity (m/s^2) on the planet.*

Gravitational Potential Energy & Work

Now, imagine a mass is being lifted at a constant speed, so there is no change in its kinetic energy. The only energy that the mass will gain will be due to its position in the gravitational field.

since $W = F\Delta d$ & $F = mg$
& $\Delta d = h_f - h_i$

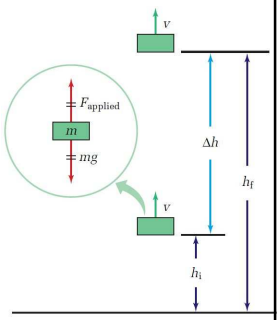
then $W = mg(h_f - h_i)$
$W = mgh_f - mgh_i$
$W = E_{gf} - E_{gi}$



Gravitational Potential Energy & Work

In this case, when the velocity does not change but the object's position changes in height, the work done on an object is equal to the change in the gravitational potential energy of the object. This is another example of the ***work-energy theorem****.*

$W = E_{gf} - E_{gi}$ or $W = \Delta E_g$



Gravitational Potential Energy & Work

WORK-ENERGY THEOREM

$$W = \Delta E_g \quad \text{or} \quad W = E_{gf} - E_{gi} \quad \text{or} \quad W = mg\Delta h$$

where W is the work done (J)
E_g is the gravitational potential energy (J)

NOTE!
As with other equations, i = initial and f = final, and sometimes 1 and 2 are used as the subscripts instead of i and f.

Gravitational Potential Energy & Work

PRACTICE

1. A gas-powered winch on a rescue helicopter does 4200 J of work while lifting a 50 kg swimmer at a constant speed up from the ocean. Through what height was the swimmer lifted?

   $\Delta h = 8.6$ m

Gravitational Potential Energy & Work

PRACTICE

2. A weightlifter raises a loaded barbell 2.2 m. The lift increases the gravitational potential energy of the barbell by 490 J. Determine the mass of the loaded barbell.

   $m = 23$ kg

Gravitational Potential Energy & Work

PRACTICE

3. A 2.5 kg piece of wood falls onto a carpenter's table from a height of 2.0 m above the table.
   (a) Calculate the kinetic energy of the wood as it hits the table?
   (b) Calculate the speed of the wood as it hits the table?

   (a) $E_k = E_g = 49$ J
   (b) $v = 6.3$ m/s

The Work-Energy Theorem

NOTE!

Very few processes involve changes in kinetic energy only or in potential energy only. Real processes usually involve more than one form of energy. For example, if an applied force does work on an object so that both its kinetic energy and its various forms of potential energy change, then the work done by that force equals the total change in both the kinetic energy and the potential energies. In other words:

$$W = \Delta E_k + \Delta E_p$$

✔ Check Your Learning

TEXTBOOK

P.181 Q.2-6 (Review)