WORK AND ENERGY

COMMERCIAL UNIT OF ENERGY

Commercial unit of energy

Kilowatt-hour (kwh)

One kilowatt hour is the amount of energy consumed (or work done) by an agent in one hour working at a constant rate of one kilowatt.

Is kWh a unit of power or energy? The answer is energy.

We can write 1 kWh as 1 kW × 1h.

Now, since $P = \frac{E}{t}$ $\quad E = p \times t$

If power is in kW (kilowatt) and time in hour, then the unit of energy is kWh. The unit kWh is important because this is a commercial unit of energy used by electricity boards. If you enquire from your parents what was the last electricity bill? If the answer is 600 units, it means that you have used 600 kWh of energy during the duration of bill. Thus, you pay for the electrical energy that you use.

Relation between kWh and Joule

1 kWh = 1000 Wh [1 kW = 1000 W]

Now, 1 W = 1 Js^{-1} and 1 h = 60 × 60 s = 3600 s

$\therefore$ 1kWh = 1000 Js^{-1} × 3600 s = 3600000 J = 3.6 × 10^6 J

$\therefore$ 1 kWh = 3.6 × 10^6 J = 3.6 MJ

Note:

An energy of 1 kWh is equivalent to using a bulb of 1 kW for 1 hour.

Relationship between kinetic energy and linear momentum:

Relationship between kinetic energy and linear momentum: $K.E = \frac{1}{2}mv^2$

we can conclude as follows:

When the velocity of a body is kept constant, the kinetic energy is directly proportional to the mass of the body, K.E. $\propto$ m

Thus,

If the mass of a body is doubled (v remaining constant), the kinetic energy of the body also gets doubled.

If the mass of the body is reduced to half (v remaining constant), the kinetic energy of the body also gets halved.

The kinetic energy of a body is directly proportional to the square of its velocity (or speed) i.e., K.E. $\propto v^2$

So, (m is constant)

If the velocity of a body is doubled, then its kinetic energy increases four times.

If the velocity of a body is reduced to half, then its kinetic energy gets to one-fourth.

How is the kinetic energy of a body related to its momentum:

Let us consider a body of mass m having a velocity v. Then

Momentum of the body p = Mass × velocity = m × v

This gives, $v = \frac{p}{m}$ ... (1)

From definition,

Kinetic energy (K.E.) of the body $= \frac{1}{2}mv^2$ ... (2)

Substituting the value of v from Equation (1) into Equation (2) we can write,

$$K.E = \frac{1}{2}m \times \frac{p^2}{m^2} = \frac{1}{2} \times \frac{p^2}{m^2}$$

Then, we can write, $p^2 = 2m \times K.E.$

$$p = \sqrt{2m \times K.E}$$

$$Momentum = \sqrt{2 \times mass \times kinetic\ energy}$$

Newton's Thought

A light body and a heavy body have same kinetic energy. Which one of the two has greater momentum?

Explanation

Firstly, we will find the relationship between kinetic energy and linear momentum. Kinetic energy $E_k = \frac{1}{2}mv^2 = \frac{1}{2}mv^2 \times \frac{m}{m} = \frac{(mv)^2}{2m}$

Or $E_k = \frac{p^2}{2_M}$ (p = mv = linear momentum)

Or $p^2 = 2mE_k$ $p = \sqrt{2mE_k}$

This means, if kinetic energy (E) is constant for both the bodies, then, k p $\propto \sqrt{m}$

Thus, heavier body will have greater momentum than the lighter body