Class 9 Science Chapter 2 Work and Energy Textbook Questions and Answers

1. Write detailed answers?

a. Explain the difference between potential energy and kinetic energy.

Answer:

Kinetic Energy	Potential Energy
(i) Kinetic energy is the energy possessed by the body due to its motion.	(i) Potential energy is the energy possessed by the body because of its shape or position.
(ii) K.E = 1/2 mv^2	(ii) P.E = mgh
(iii) e.g., flowing water, such as when falling from a waterfall.	(iii) e.g., water at the top of a waterfall, before the drop.

b. Derive the formula for the kinetic energy of an object of mass m, moving with velocity v.

Answer:

Suppose a stationary object of mass 'm' moves because of an applied force. Let 'u' be its initial velocity (here u = 0). Let the applied force be 'F'. This generates an acceleration a in the object, and after time T, the velocity of the object becomes equal to 'v'. The displacement during this time is s. The work done on the object is

W = F x s ..... (1)

Using Newton's 2nd law of motion,

F = ma ..... (2)

Using Newton's 2nd equation of motion

$s = ut + \frac{1}{2}at^2$

However, as initial velocity is zero, u = 0

$\therefore \quad s = 0 + \frac{1}{2}at^2$

$\therefore \quad s = \frac{1}{2}at^2$ ..... (3)

$\therefore \quad W = ma \times \frac{1}{2}at^2$ ..... Using equations (2) and (3) in (1)

$\therefore \quad W = \frac{1}{2}m \times (at)^2$ ..... (4)

Using Newton's first equation of motion

$v = u + at$

$\therefore \quad v = 0 + at$

$\therefore \quad v = at$

$\therefore \quad v^2 = a^2t^2 = (at)^2$ ..... (5)

$\therefore \quad W = \frac{1}{2}mv^2$ ..... using equations (4) and (5)

The kinetic energy gained by an object is the amount of work done on the object.

$\therefore \quad K.E = W$

$\therefore \quad K.E = \frac{1}{2}mv^2$

c. Prove that the kinetic energy of a freely falling object on reaching the ground is nothing but the transformation of its initial potential energy.

Answer:

Let us look at the kinetic and potential energies of an object of mass (m), falling freely from height (h), when the object is at different heights.

As shown in the figure, the point A is at a height (h) from the ground. Let the point B be at a distance V, vertically below A. Let the point C be on the ground directly below A and B. Let us calculate the energies of the object at A, B and C.

(1) Let the velocity of the object be v_B when it reaches point B, having fallen through a distance x.

$u = 0, s = x, a = g$

$v^2 = u^2 + 2as$

$v_B^2 = 0 + 2gx$

$v_B^2 = 2gx$

$\therefore$ K.E $= \frac{1}{2} mv^2 = \frac{1}{2} m(2gx)$

K.E $= mgx$

Height of the object when at B = h-x

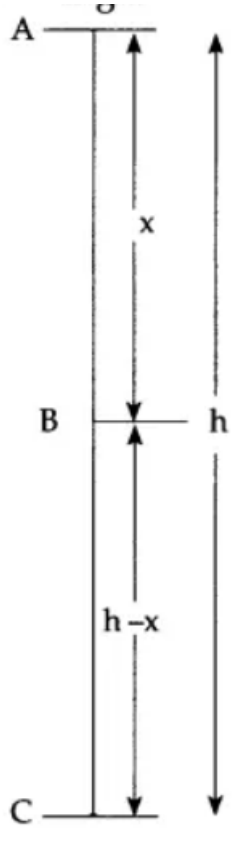
$\therefore$ P.E $= mg(h-x)$

P.E $= mgh - mgx$

$\therefore$ Total Energy T.E. = K.E + P.E

$= mgx + mgh - mgx$

$\therefore$ T.E. $= mgh$ .....(i)



$\therefore$ K.E = 1/2 mass x velocity2

$= \frac{1}{2} mu^2$

K.E $= 0$

P.E $= mgh$

$\therefore$ Total energy $= K.E + P.E$

$= 0 + mgh$

Total Energy $= mgh.$

(2) When the object is stationary at A, its initial velocity is u = 0

∴ K.E = 1/2 mass x velocity2

$$= \frac{1}{2} mu^2$$

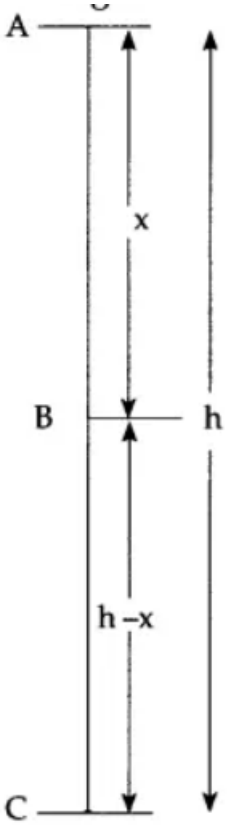
$$K.E = 0$$

$$P.E = mgh$$

$$\therefore \quad \text{Total energy} = K.E + P.E$$

$$= 0 + mgh$$

$$\text{Total Energy} = mgh. \qquad \text{..... (ii)}$$



d. Determine the amount of work done when an object is displaced at an angle of 300 with respect to the direction of the applied force.

Answer:

When an object is displaced by displacement 's' and by applying force 'F' at an 'angle' 30°. work done can be given as

$$W = Fs \cos\theta$$

$$\therefore \quad W = Fs \cos 30 \quad (\because \theta = 30°)$$

$$\therefore \quad W = Fs \left(\frac{\sqrt{3}}{2}\right) \quad \left(\because \cos 30 = \frac{\sqrt{3}}{2}\right)$$

e. If an object has 0 momenta, does it have kinetic energy? Explain your answer.

Answer:

- No, it does not have kinetic energy if it does not have momentum.
- Momentum is the product of mass and velocity. If it is zero, it implies that v = 0 (since mass can never be zero).
- Now K.E = ~ mv2, So if v = 0 then K.E also will be zero.
- Thus, if an object has no momentum then it cannot possess kinetic energy.

f. Why is the work done on an object moving with uniform circular motion zero?

Answer:

- In uniform circular motion, the force acting on an object is along the radius of the circle.
- Its displacement is along the tangent to the circle. Thus, they are perpendicular to each other.
  Hence θ = 90° and cos 90 = θ
  ∴ W = Fs cos θ = 0

a. The potential energy of your body is least when you are .....

(i) sitting on a chair

(ii) sitting on the ground

(iii) sleeping on the ground

(iv) standing on the ground

Answer:

(iii) sleeping on the ground

b. The total energy of an object falling freely towards the ground ..

(i) decreases

(ii) remains unchanged

(iii) increases

(iv) increases in the beginning and then decreases

Answer:

(iii) increases

c. If we increase the velocity of a car moving on a flat surface to four times its original speed, its potential energy ....

(i) will be twice its original energy

(ii) will not change

(iii) will be 4 times its original energy

(iv) will be 16 times its original energy.

Answer:

(ii) will not change

d. The work done on an object does not depend on ....

(i) displacement

(ii) applied force

(iii) initial velocity of the object

(iv) the angle between force and displacement.

Answer:

(iii) initial velocity of the object

1. Take two aluminium channels of different lengths.
2. Place the lower ends of the channels on the floor and hold their upper ends at the same height.
3. Now take two balls of the same size and weight and release them from the top end of the channels. They will roll down and cover the same distance.

Questions

1. At the moment of releasing the balls, which energy do the balls have?
2. As the balls roll down which energy is converted into which other form of energy?
3. Why do the balls cover the same distance on rolling down?
4. What is the form of the eventual total energy of the balls?
5. Which law related to energy does the above activity demonstrate? Explain.

Answer:

1. At the moment of releasing the ball they possess Potential energy as they are at a height above the ground.
2. As the balls roll down, the Potential energy is converted into Kinetic energy since they are now in motion.
3. Since they have been released from the same height, they will cover the same distance.
4. The eventual form of the total energy of the balls is "Mechanical Energy" i.e, a combination of Potential energy and Kinetic energy
5. The above activity demonstrates the "Law of Conservation of Energy"

5. Solve the following examples.

a. An electric pump has 2 kW power. How much water will the pump lift every minute to a height of 10 m? (Ans : 1224.5 kg)

Answer:

Given:

Power (P) = 2 kW = 2000 W

Height (h) = 10 m

Time (t) = 1 min = 60 s

Acceleration due to gravity (g) = 9.8 m/s^2

To Find:

Mass of water (m)= ?

Formula:

$$P = \frac{mgh}{t}$$

Solution:

$$P = \frac{mgh}{t}$$

$$m = \frac{Pt}{gh}$$

$$= \frac{2000 \times 60}{9.8 \times 10}$$

$$= \frac{120000}{98}$$

$$m = 1224.5 \text{ kg}$$

Water lifted by the pump is 1224.5 kg

b. If the energy of a ball falling from a height of 10 metres is reduced by 40%, how high will it rebound? (Ans : 6 m)

Answer:

Given: Initial height (h_1) = 10m

Let Initial ($P.E_1$) = 100

Final ($P.E_2$) = 100 – 40

= 60

To Find:

Final height (h_2) = ?

Formula:

P.E. = mgh

Solution:

$P.E_1 = mgh_1$ ..... (i)

$P.E_2 = mgh_2$ ..... (ii)

Dividing (ii) by (i)

$$\frac{P.E_2}{P.E_1} = \frac{mgh_2}{mgh_1}$$

$$\frac{60}{100} = \frac{h_2}{10}$$

$$\frac{60}{100} \times 10 = h_2$$

$h_2 = 6\ m$

The ball will rebound by 6 m.

---

d. The velocity of a car increase from 54 km/hr to 72 km/hr. How much is the work done if the mass of the car is 1500 kg? (Ans. : 131250 J)

Answer:

Given: Mass (m) = 1500 kg

Initial velocity (u) = 54 km/hr

$= 54 \times \frac{5}{18}$

= 15 m/s

Final velocity (v) = 72 km/hr

$= 72 \times \frac{5}{18}$

= 20m/s

To Find:

Work done to increase the velocity = ?

Formula:

Work done to increase velocity = Change in K.E

Change in K.E $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Solution:

Change in K.E $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

e. Ravi applied a force of 10 N and moved a book 30 cm in the direction of the force. How much was the work done by Ravi? (Ans: 3 J)

Answer:

Given:

Force (F) = 10 N

θ = 0°, (Since force and displacement are in same direction)

Displacement (s) = 30 cm = 30/100 m

To Find:

Work (W) = ?

Formula:

W = Fs cos θ

Solution:

W = Fs cos θ

Solution:

The work done by Ravi is 3J

$$= 10 \times \frac{30}{100} \times \cos 0 \quad \ldots\ldots (\cos 0 = 1)$$

$$= 3\,J$$