1. Define work.

   Answer:

   Work is said to be done, when a force or its component causes displacement in the direction of force.

2. State the mathematical expression for work when displacement is produced in its own direction.

   Answer:

   W = F × S, where, W is the work done, F is the force applied and 'S' is the displacement in the direction of force.

3. Derive a relation between joule and erg.

   Answer:

   $1\text{J} = 1\text{N} \times 1\text{ m}$

   $= \frac{1\text{kgm}}{\text{s}^2} \times \text{m}$

   $= 1000\text{g} \times \frac{100\text{ cm} \times 100\text{cm}}{\text{s}^2}$

   $= 10^7 \frac{\text{gcm}^2}{\text{s}^2}$

   $= 10^7\text{ ergs}$

4. State the condition when the work done by a force is (i) positive, (ii) negative.

   Explain with the help of examples.

Answer:

(i) Positive work is done, when the angle between the direction of force applied and the displacement of body is zero. For example, when a horse pulls a cart or an engine pulls a train, the positive work is done.

(ii) Negative work is done, when the angle between the direction of the force applied and the displacement is 180° i.e., the displacement is in a direction opposite to the force.

For example, when brakes are applied to a moving vehicle, the work done by the applied force is negative. Similarly, when a ball is projected vertically upward, the work done by the force of gravity is negative.

5. In which of the following cases, is the work being done and why?

(i) A man pushing a wall.

(ii) A coolie standing with a load of 12 kgf on his head

(iii) A boy climbing up a staircase

(iv) A boy carrying a box on his head and sliding over a frictionless horizontal surface.

Answer:

In case (iii) work is done, because displacement is produced in the direction of applied force. In cases (i), (ii) and (iv), no work is done as no displacement occurs in the direction of applied force.

6. A boy of mass m climbs up a staircase of vertical height h.

(i) What is the force acting on the boy?

(ii) What is the work done by the boy against the force of gravity? What would have been the work done, if he uses a lift in climbing the same height?

Answer:

(i) Force acting on the boy = mg.

(ii) Work done by the boy against the force of gravity = mgh.

(iii) Work done, if lift is used = mgh.

7. Differentiate between work and power.

Answer:

Work	Power
1. Work is the product of force and displacement in the direction of force.	1. Power is the rate of doing work.
2. Its SI unit is joule.	2. Its SI unit is watt (Js^{-1})

8. (a) Define the term energy.

(b) Define the term potential energy. Give four examples of potential energy.

(c) Define the term kinetic energy. Give four examples of kinetic energy.

Answer:

(a) The capacity of doing work is called energy.

(b) The energy possessed by a body, by virtue of its position or configuration, is called potential energy.

Examples :

(i) A stretched bow and arrow system.

(ii) Wound up spring of a watch.

(iii) Water stored high up in reservoirs.

(iv) A stone lying on the top of the roof.

(c) The energy possessed by a body by virtue of its motion is called kinetic energy.

Examples :

(i) A running horse

(ii) Speeding car

(iii) Flowing water

(iv) Flying bird.

9. Derive an expression for potential energy.

Or

Derive an expression for potential energy of a body of mass m, placed at a height 'h' above the earth's surface.

Answer:

Consider a body of mass 'm', raised vertically upward through a height 'h', to a new position, against the acceleration due to gravity 'g'.

∴ Force acting on body = mg.

∴ Work done or energy spent = Force × displacement = mg × h.

But, work done in raising a body to the new position is called potential energy.

∴ P.E. = mgh.

10. State the energy changes which occur in following cases.

(a) Burning of coal.

(b) Petrol engine of running motor car.

(c) An electric cell in a circuit.

Answer:

(a) The chemical energy of coal, changes into heat energy.

(b) The chemical energy of petrol changes into heat energy. The heat energy changes into kinetic energy and drives the car.

(c) The chemical energy of cell, changes into electric energy.

11. A tennis ball and a table tennis ball have same momentum. Which of the two has more kinetic energy and why?

Answer:

Table tennis ball has more kinetic energy. It is because its mass is very small and hence in order to have same momentum, as tennis ball, it must have more velocity than the tennis ball and consequently more kinetic energy.

Numericals:

1. Two bodies of equal masses are moving with velocities v and 3v respectively. Find the ratio of their kinetic energies.

Answer:

K.E. of 1st body: K.E. of 2nd body = $\frac{1}{2}m(v)^2 : \frac{1}{2}m(3v)^2 = \mathbf{1:9}$

2. A 200 g ball is thrown vertically upward with an initial velocity of 30 ms^{-1}.

i. Draw a velocity-time graph for the motion of the ball.

(Acceleration due to gravity is 10 ms^{-2}).

ii. How long will the ball take to reach highest point?

iii. What will be the kinetic energy of ball, when it returns to starting point?

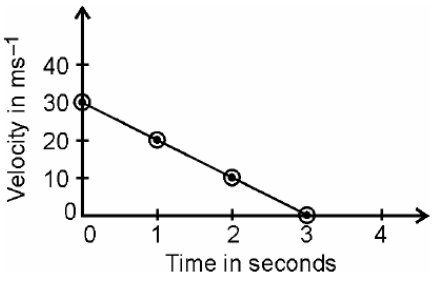
(Ignore air resistance).

iv. What will be the potential energy of ball at highest point?

m = 200 g = 0.200 kg; u = 30 ms^{-1}

Answer:

(a) Shown in the diagram below:



(b) 3 seconds

(c) K. E. = $\frac{1}{2}m(v)^2 = \frac{1}{2} \times 0.200 \times (30)^2 = \mathbf{90J}$

(d) P. E. = K. E. [By the law of conservation of energy] = **90J**

3. A boy of mass 40 kg, runs upstairs and reaches 8 m high first floor, in 5 s. Calculate:

(i) Force of gravity acting on boy,

(ii) Work done by him against gravity,

(iii) Power developed by boy. [g = 10 ms^{-2}]

Answer:

Mass of the boy = 40 kg;

Vertical height through which boy climbs up = 8 m;

Time = 5 seconds

(i) Force of gravity acting on boy

= mg = 40 kg × 10 ms^{-2} = 400 N.

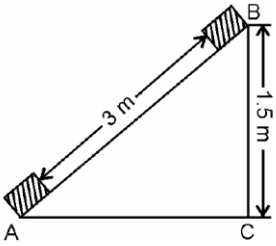
(ii) Work done by boy = Force × displacement

= 400 N × 8 m = 3200 J.

(iii) Power developed by boy = $\frac{W}{t} = \frac{3200J}{5s} = 640W$

4. A block of mass 30 kg is pulled up along a slope, as shown in the diagram with a constant speed, by applying a force of 200 N parallel to slope. A and B are initial and final positions of the block.

(i) Calculate the work done by the force in moving the block from A to B.



(ii) Calculate P.E. gained by block.[g = 10 ms^{-2}]

Answer:

(i) Work done in moving the block from A to B = 200 N × 3 m = 600 J.

(ii) Gain in potential energy = mgh = 30 × 10 × 1.5 = 450 J.

5. A compressed spring is held near a small toy car of mass 0.15 kg. On release of spring, the toy car moves forward with a velocity of 10 ms^{-1}. Find the potential energy of the spring.

Answer:

K.E. of toy car

$\frac{1}{2}mv^2 = \frac{1}{2} \times 0.15\ kg \times (10\ ms^{-1})^2 = 7.5\ J$

∴ Potential energy of the spring

= K.E. of toy car = 7.5 J.