CBSE Class 9 Science
Important Questions
Chapter 11
Work and Energy

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1 Marks Questions

1. A lamp consumes 1000 J of electrical energy in 10 s. What is its power?

Ans. P = W/t = 1000J/10s = 100 W

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2. Can there be displacement of an object in the absence of any force acting on it? Think. Discuss this question with your friends and teacher.

Ans. No.

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3. S.I. unit of power is:

(a) J/s

(b) Js

(c) s/J

(d) Js^2

Ans. (a) J/s

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4. If the body starts from rest, then change in its kinetic energy is

(a) positive

(b) Negative

(c) Zero

(d) May be Positive or negative depending upon the mass of the body

Ans. (a) positive

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5. Which of the following quantities have same units?

(a) Power and energy

(b) Power and work

(c) work and energy

(d) None of the above

Ans. (c) work and energy

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6. If a body is stored at a height 'h' then it will posses:

(a) Kinetic energy

(b) Potential energy

(c) Both

(d) None

Ans. (b) Potential energy

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7. If the force applied on the body distances the body in the opposite direction of force applied then work done is

(a) Positive

(b) Negative

(c) Zero

(d) Data incomplete

Ans. (b) Negative

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8. If the force is applied at an angle θ then work done is

(a) $W = FS \cos\theta$ **F = Force**

(b) $W = FS\theta$ **S = Distance**

(c) $W = FS \sin\theta$ **W = work**

(d) None

Ans. (a) W = FS Cos θ F = Force

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9. What is the work done in lifting a body of mass 5Kg vertically through 9m?

(a) 450J

(b) -450J

(c) 45J

(d) 540J

Ans. (a) 450J

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10. How are Joule (J) and ergs (erg) related?

(a) $1J = 10^7 erg$

(b) $1erg = 10^7 J$

(c) $1J = 10^{-7} erg$

(d) None

Ans. (a) $1J = 10^7 erg$

2 Marks Questions

1. When do we say that work is done?

Ans. Work is done when a force acts on an object and displacement occurs in the direction of force.

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2. Write an expression for the work done when a force is acting on an object in the direction of its displacement.

Ans. $Work = Force \times displacement$

$W = F \times d$

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3. Define 1 J of work.

Ans. 1 J is that work which is done when a force of 1 N is applied on an object and it moves a distance of 1 m in the direction of force.

4. A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field?

Ans. Work done $W = F \times d$
$= 140\ N \times 15\ m$ = 2100 J

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5. A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force. Let us take it that the force acts on the object through the displacement. What is the work done in this case?

Ans. Since Work (W)= Force(F)$\times$ displacement(d)
$= 7N \times 8\ m\ = 56\ J$

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6. What is the kinetic energy of an object?

Ans. Kinetic energy of an object is a kind of mechanical energy and it is present in that object due to its state of motion(movement).

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7. Write an expression for the kinetic energy of an object.

Ans. Kinetic energy = $\frac{1}{2}mv^2$

where, m = mass of the object, v = velocity of the object(motion)

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8. What is power?

Ans. Power is the rate of work done. It is denoted by P.

power = work/time

P = W / t

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9. Define 1 watt of power.

Ans. If an agent works at the rate of 1 J/s then the power of that agent is 1 watt (where watt is the unit of power).

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10. An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

Ans. For calculating work done there must be displacement but since in this example vertical displacement is zero (as initial and final points lie on the same horizontal line) so the work done by force of gravity is zero.

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11. A battery lights a bulb. Describe the energy changes involved in the process.

Ans. Chemical energy of battery is changed into heat energy and light energy.

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12. Certain force acting on a 20 kg mass changes its velocity from $5\ \mathrm{m\ s^{-1}}$ to $2\ \mathrm{m\ s^{-1}}$. Calculate the work done by the force.

Ans. Work done by the force = change in kinetic energy

$= \frac{1}{2} \times m\left(v_1^2 - v_2^2\right)$

$= \frac{1}{2} \times 20 \times \left(5^2 - 2^2\right)$

$= 10 \times (25 - 4) = 10 \times 21$

= 210 J

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13. A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer.

Ans. Since work done on the object by gravitational force depends upon change in the vertical height of the object. Vertical height of the object is not changing as the joining A and B is horizontal at the same height hence the work done is zero.

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14. The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?

Ans. It doesn’t violate the law of conservation of energy because the potential energy of a freely falling object decreases progressively since it keeps changing into kinetic energy of the free falling object therefore the total energy to the object remains conserved.

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15. What are the various energy transformations that occur when you are riding a bicycle?

Ans. It is the transformation of our muscular energy into mechanical energy to ride the bicycle.

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16. Does the transfer of energy take place when you push a huge rock with all you might and fail to move it? Where is the energy you spend going?

Ans. While we push a huge rock with all our might(power) but fail to move it no energy transfer occurs as cellular energy simply wastes out in muscle contraction and relaxation even heat generation(sweating).

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17. A certain household has consumed 250 units of energy during month. How much energy is this in joules?

Ans. Energy consumed by a certain household = 250 kWh

since 1 kWh = $3.6 \times 10^6 J$

therefore 250 kWh= $250 \times 3.6 \times 10^6 = 9 \times 10^8 J$

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18. An electric heater is rated 1500 W. How much energy does it use in 10 hours?

Ans. Electric heater's power (p) = 1500 W = 1.5 kW

$Energy = power \times time = 1.5\ kW \times 10h$ = 15 kWh

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19. An object of mass, *m* is moving with a constant velocity, *v*. How much work should be done on the object in order to bring the object to rest?

Ans. In order to bring the object to rest the work done must be equal to the kinetic energy of the moving object = $\frac{1}{2} mv^2$

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20. Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her? Why?

Ans. Yes we agree with her statement. Because when many balanced forces act on the object its displacement becomes zero.

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21. Find the energy in kW h consumed in 10 hours by four devices of power 500 W each.

Ans. Since Energy = power x time

$= 4 \times 500 \times 10$ = 20000 Wh = 20 kWh

22. **A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?**

Ans. A free falling object eventually stops on reaching the ground since on striking the ground its kinetic energy is transmitted to the ground.

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23. **If a huge force acts on an object, but the displacement of the object is zero then what can we say about the work done?**

Ans. Work done on the body is defined as the force applied on the body producing a net displacement on the body.
Work Done = $Force \times Displacement$
If the application of force produces no displacement the work done on the body is zero.

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24. **Differentiate between Potential and kinetic energy?**

Ans.

	Potential energy	Kinetic energy
1)	It is the energy possessed by the body on the virtue of its position.	It is the energy possessed by the body on the virtue of its motion.
2)	Potential energy = Mgh M= Mass g = Acceleration due to gravity h = Height	Kinetic energy = $\frac{1}{2}mv^2$ M = Mass V = velocity
3)	e.g. of potential energy water stored in an upper head tank	e.g. a moving car

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25. **State the law of conservation of energy?**

Ans. According to law of conservation of energy:

1) energy can neither be created nor be destroyed, it can only be changed from one form to another

2) energy of the universe is constant.

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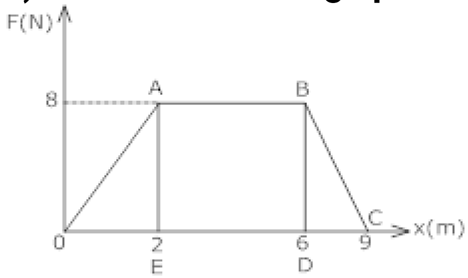
26. **A man of mass 50 Kg runs up a flight of stairs having a rise of 5 m, is 4s.**

a) What is the work done by the man?

b) What is the average power developed by the man?



Ans. Mass of Man = 50 Kg

Distance moved = 5 m

Time Taken = 4s

a) work Done = $Force \times Acceleration$

In this case, Increase in Potential energy =

Work done = Mgh

$= 50 \times 10 \times 5$

= 2500 J

b) Power = $\frac{\text{work Done}}{\text{Time Taken}}$

$= \frac{2500}{4}$

$= 625w$

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27. State the difference between Power and energy?

Ans.

	Power	Energy
1)	It is the rate of doing work or work done per unit time.	It is ability of a body to do work.
2)	S.I. units of Power are Joule/second	S.I. units of energy are Joules.

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28. Write the expression for

a) the potential energy of the body

b) the kinetic energy of the body

Ans. a) Potential energy of = P.E = mgh m = Mass of Body

g = Acceleration due to gravity

h = Height

b) Kinetic energy of = $\frac{1}{2}mv^2$

the body

m = Mass of body

v = Velocity of body

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29. If a 100 J of work was done, when a force of 12.5 N acts, what was the distance moved by the force?

Ans. W = Work = 100 J

Force = F = 12.5 N

Distance Moved

S = Displacement

Since, work done = $Force \times Distance\ moved$

$W = FS$

$100 = 12.5 \times 5$

$\frac{100 \times 10}{12.5} = S$

$\frac{1000}{125} = S$

8 m = S

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30. A 1800 Kg car is moving at 30 m/s. when brakes are applied. If the average force exerted by the brakes is 6000N, find the distance travelled by the car before it comes to rest?

Ans. M = Mass of car = 1800 Kg

V = velocity of car = 30 m/s

F = Force = 6000 N

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

$= \frac{1}{2}1800 \times 900$

K E = 810000 J

K. E of car = work done by the car = $force \times Displacement$

$810000 = 6000 \times Displacement$

$\frac{810000}{6000} = Displacement$

$135m = Displacement$

3 Marks Questions

1. The kinetic energy of an object of mass, m moving with a velocity of 5 m s^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times?

Ans. K.E. of the object = $\frac{1}{2} \times m \times 5^2$

$25 = \frac{1}{2} \times m \times 25$

$m = (25 \times y2)/25$ = 2 kg

If velocity is doubled

$K.E. = \frac{1}{2} \times 2 \times 10^2$ = 200/2 = 100 J i.e. K.E. will become four times

If velocity is increased three times

$K.E. = \frac{1}{2} \times 2 \times 15^2$ = 225 J i.e. K.E. will become nine times

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2. Define average power.

Ans. An agent may not be able to perform same amount of work in a given period of time always. In other words power of that agent may vary with time. Hence we can take average power in such situations. Average power is defined as average amount of work done by a body per unit time (i.e. total energy consumed divided by total time).

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3. Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

- **Suma is swimming in a pond.**
- **A donkey is carrying a load on its back.**
- **A wind-mill is lifting water from a well.**
- **A green plant is carrying out photosynthesis.**
- **An engine is pulling a train.**
- **Food grains are getting dried in the sun.**
- **A sailboat is moving due to wind energy.**

Ans. Work will be done if a force acts on an object and displacement occurs in the direction of force. According to this explanation work is done in following activities:

- Suma is swimming in a pond.
- A donkey is carrying a load on its back.
- A wind-mill is lifting water from a well.
- An engine is pulling a train.
- A sailboat is moving due to wind energy.

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4. An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is half way down.

Ans. Potential energy $(P) = m \times g \times h = 40 \times 5 \times 10$ = 2000 J

When the object is half way down the height of the object is = 2.5 m

initial velocity (u) = 0 (thrown from ground/rest)

$since v^2 = u^2 + 2gh$

$= 0 + 2 \times 10 \times 2.5$

= 50

Kinetic energy $= \frac{1}{2} \times m \times v^2$

$= \frac{1}{2} \times 40 \times 50$ = 1000 J

5. What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.

Ans. The satellite is moving on a round path, displacement in the object is perpendicular to the direction of force. $\theta = 90^\circ$.

$W = F \times s \ Cos\theta$

$= F \times s \ Cos \ 90^0$

$= F \times 0 \ = \ 0$

Therefore, work done is zero.

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6. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Ans. When a person holds a bundle of hay over his head for 30 minutes and gets tired he applies force in upward direction and displacement of bundle of hay is in forward direction which is perpendicular to the direction of force applied therefore displacement is zero

$W = F \times s \ Cos\theta$

$= F \times s \ Cos \ 90^0$

$= F \times 0 \ = \ 0$

No work done.

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7. Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy?

Ans. The bob eventually comes to rest due to the frictional force offered by the air and the rigid support holding the thread.

It is not a violation of the law of conservation of energy since mechanical energy can get converted into another form of energy which cannot be utilised for useful work. This loss of energy is called dissipation of energy.

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8. Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?

Ans. Initial velocity of the car (u) = 60 km/h $= (60\times1000)/60\times60$

$= 50/3\ ms^{-1}$

Final velocity (v) = 0 (object has to be stopped)

Initial kinetic energy = $\frac{1}{2}\times m\times v^2$

$=\frac{1}{2}\times1500\times(50/3)^2$ = 208333.30 J

Final kinetic energy $=\frac{1}{2}\times1500\times0$ = 0

Therefore, work done = change in kinetic energy = 208333.30 — 0 = 208333.30 J

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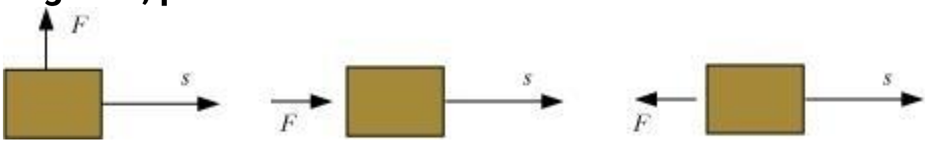
9. In each of the following a force, *F* is acting on an object of mass, *m*. The direction of displacement is from west to east shown by the longer arrow. Observe the diagrams carefully and state whether the work done by the force is negative, positive or zero.



Ans. (i) Since in this diagram displacement is perpendicular to the direction of force, so work done is zero.

(ii) Since in this diagram displacement is in the direction of force, so work done is positive.

(iii) Since in this diagram displacement is in the opposite direction of the force applied hence work done is negative.

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10. In the force - displacement graph, calculate the work done during

a) the interval 0<x<2 m

b) the interval 2<x<6 m

c) the interval 0<x<9 m

Ans. Since area under a force displacement graph gives the work done, hence

a) for 0<x<2

work Done = Area of triangle OAE

$= \frac{1}{2} \times \text{Base} \times \text{Height}$

$= \frac{1}{2} \times OE \times AE$

$= \frac{1}{2} \times 2 \times 8$

= 8J

b) for 2<x<6

work Done = Area of rectangle A BED

$= \text{Length} \times \text{Bneadth}$

$= \text{A B} \times \text{BD}$

$= 4 \times 8$

= 32J

c) for 6<x<9

work Done = Area of triangle DBC

$= \frac{1}{2} \times \text{Base} \times \text{Height}$

$= \frac{1}{2} \times \text{DCBD}$

$= \frac{1}{2} \times 3 \times 8$

= 12J

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11. Derive an expression for the kinetic energy of the body? Calculate the kinetic energy for a body of mass 5 Kg moving a velocity $2.5 \text{m} / \text{s}^2$

Ans. Kinetic energy of the body is defined as the energy possessed by the virtue of motion of the body. Let a body of mass 'm' is at rest.

A force F N acts on it and produces an acceleration of a m / s^2 and it acquires a velocity of v m/s and moves a distance of s m.

Now, from third equation of motion

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

$v^2 = o + 2as$

$o = \frac{v^2}{2s}$

$(u = o \because \text{ body starts from rest})$

From Newton's second law,

$F = ma$

$= \frac{m \times v^2}{2s} = \frac{mv^2}{2s}$

Work Done on the moving Body = Kinetic energy

$= Force \times Dis\tan ce$

$= \frac{mv^2}{2s} \times s = \frac{1}{2}mv^2$

Mass = 5Kg

Velocity = 2.5m/s

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

$= \frac{1}{2} \times 5 \times (2.5)^2$

$= \frac{3125}{2 \times 100}$

$= \frac{1562.5}{100}$

K. E = 15.625J

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12. A stone is thrown vertically upwards with a velocity of 40m/s.

a) At what height will its kinetic energy and potential energy be equal

b) Calculate the P. E. of the body if its mass = 10Kg

Ans. Initial velocity = u = o

Final velocity = v = 40m/s

M = Mass of the body

a) Kinetic energy = K. E. = $\frac{1}{2}mv^2$

Potential energy = P.E= mgh

Now, K. E = P.E

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

$\frac{1}{2}m\times(40)^2 m\times g\times h$

$\frac{1600}{2} = gh$

800 = gh

80m = h

$\frac{800}{10} = h$

b) PE = mgh

$PE = 10\times10\times80$

P.E. = 8000J

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13. A body of mass 5Kg is lifted vertically at a constant velocity of 12m. calculate

a) the force applied

b) work done in lifting the body

c) what happens to the work performed?

Ans. Mass = m = 5Kg

Height = h = 12m.

g = Acceleration due to gravity= $10m/s^2$

a) P.E. = mgh

$= 5\times12\times10$

= 600J

b) Force = ?

Work done = P. E. energy of the Body

$Force \times Distance\ Moved = 600$

$F \times 12 = 600$

F = 50N

c) The work done in lifting the body gets stored as the potential energy.

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14. Derive an expression for the potential energy of the body. Calculate P.E of body of mass 10Kg at a height of 10m.

Ans. Potential energy of a body of mass = m Kg at a height = h m from the ground.

Gravitational force of attraction on the body = mgN

In order to lift this body to B at h m above the ground.

In order to lift this body with a constant velocity, force applied = mg N

Distance moved by force = h m

Work done in lifting the body from a to $B = Force \times Distance$

$= mg \times h$ b= mgh

Energy spent in lifting the body to height 'h'. As energy cannot be destroyed, this energy gets stored in the body as its potential energy

m = 10 Kg

$g = 10\ m/s^2$

h = 10 m

P. E = mgh

P.E= mgh

$= 10 \times 10 \times 10$

= 1000 Joules

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15. Show that total energy is conserved if the ball of mass 'm' is the thrown downwards from a height 'h'

Ans. According to law of conservation of energy, energy is neither created nor be destroyed. It can be only changed from one form to another.

Consider a body of mass ‘m’ at rest at A at an elevation ‘h’ from the ground.

Total energy at A

Potential energy of the body = mgh

As the body is at rest, K. E = O

Total energy of the body at A = PE + KE

= mgh + O

= mgh

Total energy on the ground:

Let the body fall to ground As it strikes the ground, its elevation is O.

∴P. E. w. rt. Ground = O

Let us find its velocity as it strikes the ground at B.

As it falls freely, vo = O

Acceleration $= -gm/s^2$

Distance Travelled = -h

$v^2 = u^2 + 2gh$

$v^2 = 2(-g)(-h)$

$v^2 = 2gh$

$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times m \times 2gh = mgh$

Total energy of the body on ground = KE + PE

= mgh + O

= mgh

Total energy at point C.

Let the ball fall through x and be at C during its fall.

Elevation of the body at c = h - x

Potential energy at C = mg (h - x)

Let the velocity at C be v

$$v^2 = u^2 + 2as$$
$$v^2 = 2(-g)(-x)$$
= 2gx
$$\text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times m \times 2gx = mgx$$

Total energy at C = mg (h - x) + mgx

= mgh

i. e total energy at all point of the fall is always same.

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16. What is Power? Show that power $= \text{Force} \times \text{velocity}$? Calculate power of a body of Mass 10Kg accelerating with $10\text{m}/\text{s}^2$ acquires a velocity of 5m/s?

Ans. Power is the rate at which work is done

Power = $\frac{\text{Work Done}}{\text{Time taken}}$

Unit of Power is watt (w)

$$P = Power = \frac{\text{Work Done(w)}}{\text{Time taken(t)}}$$
$$P = \frac{\text{Force} \times \text{Displacement (F} \times \text{S)}}{\text{Time taken(t)}}$$
$$P = \frac{F \times S}{t}$$

$$\frac{S}{t} = v = velocity$$

Mass = 10 Kg

a = acceleration $= 10m/s^2$

v = 5 m/s

$$P = F \times v$$

P = Fv

$$P = M \times a \times v$$

$$P = 10 \times 10 \times 5$$

P = 500 W

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17. What do you understand by the units of electrical energy? How many joules of energy is consumed if the electrical meter shows 400 units of energy?

Ans. Unit of electrical energy is defined as the energy spent (or used) by electrical appliance at the rate of 1 kw for 1 hr.

$400 units = 144 \times 10^7 J$ or 1 unit = 1 kwh

Now, 1kwh = $1000w \times 3600s$

= 3.6×10^6ws

$$1w = \frac{1 Joule(J)}{1 second(S)}$$

$$1unit = 1Kwh = \frac{3.6 \times 10^6 J \times S}{S} = 3.6 \times 10^6 J$$

So, if 400 units of electrical energy is consumed then,

$$1 Unit = 3.6 \times 10^6 J$$

$$400 Units = \frac{3.6}{10} \times 10^6 \times 400 J$$

$$400 units = 144 \times 10^7 J$$