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CHANDIGARH REGION

CLASS-XI

SUBJECT-PHYSICS

Chapter -6

Work, Energy and Power

INDEX

Gist of the Lesson

Introduction:

Work is said to be done when a force applied on the body displaces the body through a certain distance in the direction of force.

Work Done by a Constant Force:

Let a constant force F be applied on the body such that it makes an angle θ with the horizontal and body is displaced through a distance *s*.

Then work done by the force in displacing the body through a distance *s* is given by:

$W = (F \cos\theta)\, s = Fs \cos\theta \Rightarrow W = (F \cos\theta)\, s = Fs\cos\theta$

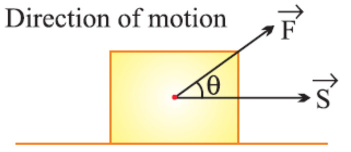
$W = \vec{F}.\vec{s}$

Nature of Work Done:

Positive work:

Positive work means that force (or its component) is parallel to displacement.

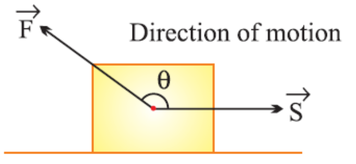
Angle between force and displacement (θ): ($0^o \leq \theta < 90^o$).



Negative Work:

Negative work means that force (or its component) is opposite to displacement.

Angle between force and displacement (θ): ($90^o < \theta \leq 180^o$).



Zero Work:

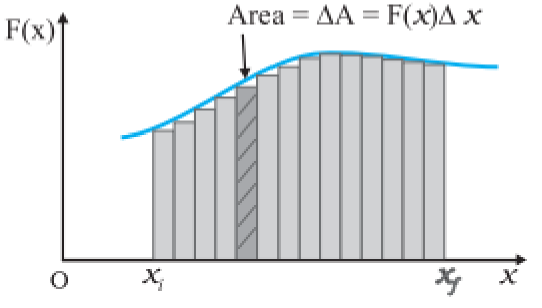
Zero work means that force is perpendicular to displacement.

Angle between force and displacement $\theta = 90^o$.

Work Done by a Variable Force:

When the magnitude and direction of a force varies with position, the work done by such a force for an infinite small displacement is given by:

$dW = \vec{F}.\overrightarrow{ds}$



The total work done in going from initial position A to final position B: $W = \int_A^B \vec{F}.\overrightarrow{ds} = \int_A^B F\ ds \cos\theta$

The area under force displacement curve with proper algebraic sign represents the work done by the variable force.

Energy: The energy of a body is defined as its capacity for doing work.

(1) It is a scalar quantity. (2) Dimensions: $[ML^2 T^{-2}]$. It is same as that of work or torque.

(3) Units: Joule [S.I.], erg [C.G.S.]

Practical units: electron volt (eV), kilowatt hour (kWh), calories (cal)

Relation between Different Units:

1 joule = 10^7 erg, 1 eV = 1.6×10^{-19} joule

1 kWh = 3.6×10^6 joule, 1 calorie = 4.18 joule

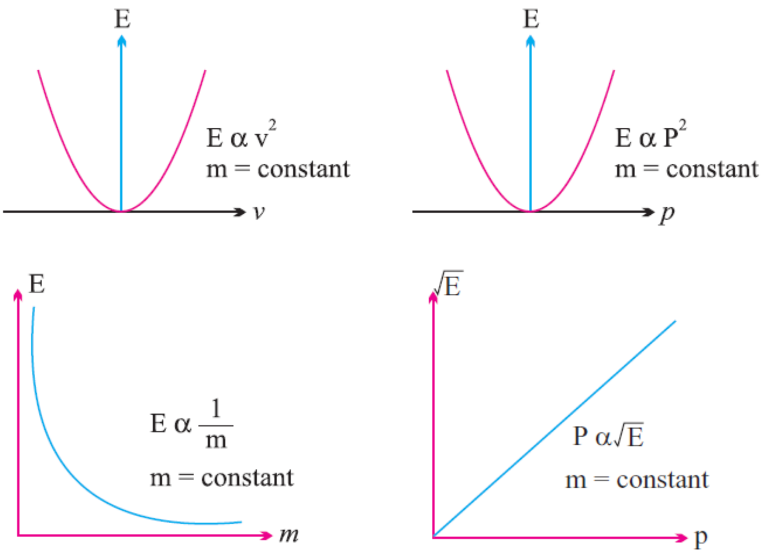
Kinetic Energy: The energy possessed by a body by virtue of its motion is called kinetic energy. Let m = mass of the body, v = velocity of the body then K.E. = ½ mv^2

Work-Energy Theorem: It states that the work done by force acting on a body is equal to the change produced in the kinetic energy of the body. $W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Relation of Kinetic Energy (E) with Linear Momentum (p):

$$\boldsymbol{E = \frac{p^2}{2m}}, \qquad \boldsymbol{p = \sqrt{2\,m\,E}}.$$

Various graphs of Kinetic Energy:



Potential Energy: Potential energy is defined only for conservative forces.

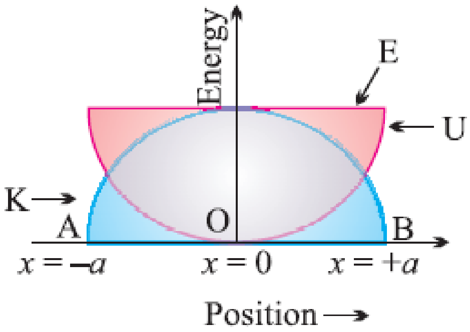
In the space occupied by conservative forces, every point is associated with certain energy which is called the energy of position or potential energy.

Elastic Potential Energy:

Restoring force and spring constant: When a spring is stretched or compressed from its normal position ($x = 0$) by a small distance x, a restoring force is produced in the spring to bring it to the normal position.

According to Hooke's law, this restoring force is proportional to the displacement x and its direction is always opposite to the displacement.

$F \propto x \quad OR \quad F = -k\,x$



Expression for Elastic Potential Energy:

$$\boldsymbol{U = \frac{1}{2}kx^2 = \frac{1}{2}F.x = \frac{F^2}{2k}}$$

If spring is stretched from initial position x_i to final position x_f then work done is equal to increase in elastic potential energy. $\boldsymbol{W = \Delta U = \frac{1}{2}k(x_f^2 - x_i^2)}$.

Power: The rate of doing work is called power.

Average Power: $P_{av} = \frac{dW}{dt} = \frac{W}{t}$.

Instantaneous Power $\boldsymbol{(P_{inst.}) = \frac{dW}{dt} = \frac{\vec{F}.\,\vec{ds}}{dt} = \vec{F}.\,\vec{v}}$

Power is equal to the scalar product of force and velocity.

Dimensions of Power: [P] = $[ML^2T^{-3}]$.

SI unit of Power: watt (W) or joule/second (J/s).

Other units of Power are kilowatt (kW), Mega watt (MW), horse power (hp).

1 kW = 10^3 W, 1 MW = 10^6 W, 1 hp = 746 W, 1 watt = 1 joule/second = 10^7 erg/s

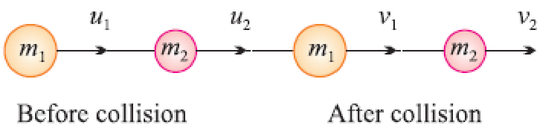
Law of Conservation of Energy: For an isolated system or body in presence of conservative forces, the sum of kinetic and potential energies at any point remains constant throughout the motion. It does not depend upon time. This is known as the law of conservation of mechanical energy.

Law of Conservation of Total Energy:

If the forces are conservative and non-conservative both, it is not the mechanical energy alone which is conserved, but it is the total energy, may be heat, light, sound or mechanical etc., which is conserved.

Collision:

Collision is an isolated event in which a strong force acts between two or more bodies for a short time as a result of which the energy and momentum of the interacting particle change.



In collision particles may or may not come in real touch.

Types of Collision:

Perfectly Elastic Collision:

If in a collision, kinetic energy after collision is equal to kinetic energy before collision, the collision is said to be perfectly elastic collision.

The coefficient of restitution $e = 1$

Inelastic collision:

If in a collision kinetic energy after collision is not equal to kinetic energy before collision, the collision is said to be inelastic.

The coefficient of restitution $0 < e < 1$

Perfectly inelastic Collision:

If in a collision two bodies stick together or move with same velocity after the collision, the collision is said to be perfectly inelastic.

The coefficient of restitution $e = 0$

***Linear momentum is conserved both in elastic and inelastic collision.**

Perfectly Elastic Head on Collision:

Let two bodies of masses m_1 and m_2 moving initial velocities u_1 and u_2 in the same direction they collide such that after collision their final velocities are v_1 and v_2 respectively.

According to law of conservation of momentum and kinetic energy:

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

Velocity of approach = Velocity of Separation, $u_1 - u_2 = v_2 - v_1$

Coefficient of Restitution: The ratio of magnitude of their relative velocity after collision to magnitude of their relative velocity before collision. $\boldsymbol{e} = \frac{|v_1 - v_2|}{|u_1 - u_2|}$

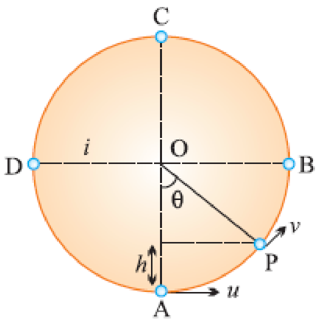
For perfectly elastic collision: e = 1

For perfectly inelastic collision: e = 0

For other inelastic collisions: 0 $< e < 1$

For a ball rebounding from a floor, $\boldsymbol{e} = \frac{v}{u}$

Motion in Vertical Circle: This is an example of non-uniform circular motion.



In this motion, body is under the influence of gravity of earth.

Velocity at any point on vertical loop: If *u* is the initial velocity imparted to body at lowest point then, velocity of the body at height *h* is given by:

$$v = \sqrt{u^2 - 2gh} = \sqrt{u^2 - 2gl\,(1 - \cos\theta)}$$

Tension at any point P on the Vertical Loop:

$$T = mg\cos\theta + \frac{mv^2}{l}$$

Velocity at the Lowest Point A	Condition
$u_A > \sqrt{5\,gl}$	Tension in string will not be 0 at any point & body will continue in circular motion
$u_A = \sqrt{5\,gl}$	Tension at Highest point C will be 0 & body will just complete the circle.
$\sqrt{2gl} < u_A < \sqrt{5gl}$	Body will not follow circular motion. Tension in string become 0 some where between B & C. Velocity remain positive. Body will follow parabolic path.
$u_A = \sqrt{2gl}$	Velocity & Tension become 0 at B and Body will oscillate in semi-circular path.
$u_A < \sqrt{2gl}$	Velocity become 0 between A & B but Tension will not be 0. Body will oscillate about point A.

Formulas

Work done by a Constant Force:

1. $W = \vec{F}.\vec{s} = F\, s \cos\theta = F_x\, s_x + F_y\, s_y + F_z\, s_z$
2. If a body of mass m is raised through height h then work done w = mgh
3. 1 J = 10^7 erg

Work done by a Variable Force: $W = \sum_i \vec{F_i} \,.\, \vec{s_i} = \int_{s_i}^{s_i} \vec{F} \,.\, \overrightarrow{ds}$

The area under force displacement curve with proper algebraic sign represents the work done by the variable force.

Kinetic Energy: $K = \frac{1}{2} m v^2$

Work Energy Theorem: $W = K_f - K_i = \frac{1}{2} m v^2 - \frac{1}{2} m u^2$

Relation of Kinetic Energy (E) with Linear Momentum (p):

$$\boldsymbol{E = \frac{p^2}{2m}}, \qquad \boldsymbol{p = \sqrt{2\, m\, E}}.$$

Gravitational Potential Energy: U = mgh

For a Conservative Force: $F = -\frac{dU}{dx}$

$$\Delta U = U_f - U_i = -W = -\int_{s_i}^{s_i} \vec{F} \,.\, \overrightarrow{ds}$$

For a Conservative Force: K.E. + P.E. = Constant

Potential Energy of a spring: $\boldsymbol{U = W = \frac{1}{2} k x^2}$

Hooke's Law: $F = -k\, x$

Force Constant: $k = \frac{F}{x}$

Mass-Energy Equivalence: $\boldsymbol{E = m\, c^2}$

1 eV = 1.6 X 10^{-19} J, 1 MeV = 1.6 X 10^{-13} J, 1 amu = 931 MeV

Power: $\boldsymbol{P = \frac{W}{t} = \frac{dW}{dt} = \vec{F} \,.\, \vec{v}}$

1 kW = 10^3 W, 1 MW = 10^6 W, 1 hp = 746 W, 1 watt = 1 joule/second = 10^7 erg/s

Collision:

Linear momentum is conserved both in elastic and inelastic collision.

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Kinetic Energy is conserved in elastic collision.

$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

In one dimensional elastic collision, velocities after collision:

$$\boldsymbol{v_1 = \frac{m_1 - m_2}{m_1 + m_2}.u_1 + \frac{2\,m_2}{m_1 + m_2}.u_2}$$

$$\boldsymbol{v_2 = \frac{m_2 - m_1}{m_1 + m_2}.u_2 + \frac{2\,m_1}{m_1 + m_2}.u_1}$$

Perfectly Elastic Head on Collision:

Velocity of approach = Velocity of Separation.

$u_1 - u_2 = v_2 - v_1$

Coefficient of Restitution: $\boldsymbol{e = \frac{|v_1 - v_2|}{|u_1 - u_2|}}$

For perfectly elastic collision: e = 1

For perfectly inelastic collision: e = 0

For other inelastic collisions: 0 $< e < 1$

For a ball rebounding from a floor, $\boldsymbol{e = \frac{v}{u}}$

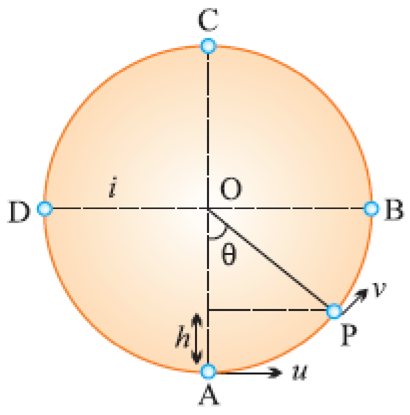
Motion in Vertical Circle:

Velocity at any point on vertical loop:

$v = \sqrt{u^2 - 2gh} = \sqrt{u^2 - 2gl\,(1 - \cos\theta)}$

Tension at any point P on the Vertical Loop:

$T = mg\,cos\,\theta + \frac{mv^2}{l}$



Velocity at the Lowest Point A	**Condition**
$u_A > \sqrt{5\,gl}$	Tension in string will not be 0 at any point & body will continue in circular motion
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$\sqrt{2gl} < u_A < \sqrt{5gl}$	Body will not follow circular motion. Tension in string become 0 some where between B & C. Velocity remain positive. Body will follow parabolic path.
$u_A = \sqrt{2gl}$	Velocity & Tension become 0 at B and Body will oscillate in semi-circular path.
$u_A < \sqrt{2gl}$	Velocity become 0 between A & B but Tension will not be 0. Body will oscillate about point A.

MCQs

1. A man of 60 kg weight is standing at rest on a platform. He jumps up vertically a distance of 1 m and the platform at the same instant moves horizontally forward with the result that the man lands 1 meter behind the point on the platform where they took the jump, the total work done by the man at the instant he lands is:

(a) 300 J (b) 150 J (c) 600 J (d) zero

2. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?

(a) 7.2 J (b) 3.6 J (c) 120 J (d) 1200 J

3. A body of mass 20 kg is initially at a height of 3 m above the ground. It is lifted to a height of 2 m from that position. Its increase in potential energy is:

(a) 100 J (b) 392 J (c) 60 J (d) -100 J

4. A body of mass 10 kg is travelling with uniform speed of 5 m/s. Its kinetic energy is:

(a) 25 J (b) 125 J (c) 1250 J (d) 1000 J

5. A ball is dropped from a height of 1 m. If the coefficient of restitution between the surface and ball is 0.6, the ball rebounds to a height of:

(a) 0.6 m (b) 0.4 m (c) 1 m (d) 0.36 m

6. A quantity of work of 1000 J is done in 2 seconds. The power utilised is:

(a) 998 W (b) 1002 W (c) 2000 W (d) 500 W

7. When the linear momentum of a particle is increased by 1%, its kinetic energy increases by x%. When the kinetic energy of the particle is increased by 300%, its linear momentum increases by y%. The ratio of y to x is:

(a) 300 (b) 150 (c) 100 (d) 50

8. The kinetic energy acquired by a mass m in travelling distance d, the starting from the rest under the action of a constant force, is directly proportional to:

(a) m (b) m^o (c) $\sqrt{m}$ (d) $1/\sqrt{m}$

9. A body of mass 10 kg moving at a height of 2 m, with uniform speed of 2 m/s. Its total energy is:

(a) 316 J (b) 216 J (c) 116 J (d) 392 J

10. Two masses 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their linear momenta is:

(a) 4 : 1 (b) 1 : 2 (c) 0 : 1 (d) 1 : 6

11. A body of mass 10 kg is initially at a height of 20 m above the ground. It falls to a height of 5 m above the ground. Its potential energy in the new position is:

(a) 490 J (b) 50 J (c) 100 J (d) 300 J

12. A man of 60 kg weight is standing at rest on a platform. He jumps up vertically a distance of 1 m and the platform at the same instant moves horizontally forward with the result that the man lands 1 meter behind the point on the plate form where they took the jump the total work done by the man at the instant he lands is:

(a) 300 J (b) 150 J (c) 600 J (d) zero

13. A marble moving with some velocity collides perfectly elastically head-on with another marble at rest having mass 1.5 times the mass of the colliding marble. The percentage of kinetic energy by the colliding marble after the collision is:

(a) zero (b) 50% (c) 100% (d) 60%

14. A body of mass 100 kg falls from a height of 10 m. Its increase in kinetic energy is:

(a) 9800 J (b) 1000 J (c) 5000 J (d) 3000 J

15. An isolated particle of mass m is moving in a horizontal plane (x-y), along the x-axis, at a certain height above the ground. It suddenly explodes into two fragments of masses m/4 and 3m/4. An instant later, the smaller fragment is at y = + 15 cm. The larger fragment at this instant is at:

(a) y = -5 cm (b) y = +20 cm (c) y = +5 cm (d) y = -20 cm

16. Match the Column – I with Column – II:

	Column – I	**Column – II**
(i)	Work done by constant force	(1) Mass X height X acceleration due to gravity
(ii)	Work done by variable force	(2) Work / time
(iii)	Kinetic energy of a moving body	(3) $\int_{x_i}^{x_f} F(x)dx$
(iv)	Potential Energy of a body	(4) Force X displacement
(v)	Power	(5) ½ mv^2

(a) (i)-(4), (ii)-(3), (iii)-(5), (iv)-(1), (v)-(2)
(b) (i)-(2), (ii)-(3), (iii)-(5), (iv)-(1), (v)-(4)
(c) (i)-(4), (ii)-(5), (iii)-(3), (iv)-(1), (v)-(2)
(d) (i)-(5), (ii)-(3), (iii)-(1), (iv)-(4), (v)-(2)

17. During the perfectly elastic collision, which of the following is conserved?

(a) Linear momentum of the each body is conserved.

(b) Kinetic energy of the each body is conserved.

(c) Linear momentum of the system is conserved.

(d) None of the above.

(a) 100 J (b) 392 J (c) 60 J (d) -100 J

18. A body of mass 10 kg is moved parallel to the ground, through a distance of 2 m. The work done against gravitational force is:

(a) 196 J (b) -196 J (c) 20 J (d) zero

19. A ball is dropped from a height of 1 m. If the coefficient of restitution between the surface and ball is 0.6, the ball rebounds to a height of:

(a) 0.6 m (b) 0.4 m (c) 1 m (d) 0.36 m

20. An electric heater of rating 1000 W is used for 5 hrs per day for 20 days. The electrical energy utilised is:

(a) 150 kWh (b) 200 kWh (c) 100 kWh (d) 300 kWh

21. Find the angle between force $\vec{F} = (3\hat{\imath} + 4\hat{\jmath} + 5\hat{k})$ unit and displacement $\vec{d} = (5\hat{\imath} + 4\hat{\jmath} + 3\hat{k}$ unit.

(a) $\cos^{-1}(23/25)$ (b) $\cos^{-1}(21/29)$ (c) $\sin^{-1}(1/2)$ (d) $\sin^{-1}(2/5)$

22. It is well known that a raindrop falls under the influence of the downward gravitational force and the opposing resistive force. The latter is known to be proportional to the speed of the drop but is otherwise undetermined. Consider a drop of mass 1.00 g falling from a height 1.00 km. It hits the ground with a speed of 50.0 ms^{-1}. What is the work done by the unknown resistive force?

(a) − 8.75 J (b) − 4.75 J (c) − 0.75 J (d) − 18.75 J

23. A cyclist comes to a skidding stop in 10 m. During this process, the force on the cycle due to the road is 200 N and is directly opposed to the motion. (a) How much work does the road do on the cycle?

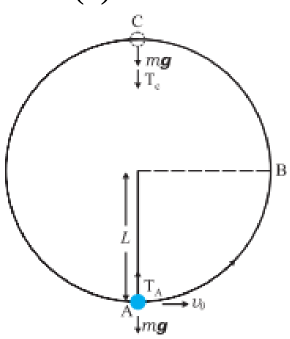
(a) – 2000 J (b) – 200 J (c) – 20 J (d) – 2 J

24. A police officer fires a bullet of mass 50 g with speed 200 ms^{-1} on soft plywood of thickness 2 cm. The bullet emerges with only 10% of its initial kinetic energy. What is the emergent speed of the bullet?

(a) 63.2 ms^{-1} (b) 34.5 ms^{-1} (c) 23.6 ms^{-1} (d) 50.0 ms^{-1}

25. A woman pushes a trunk on a railway platform which has a rough surface. She applies a force of 100 N over a distance of 10 m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50 N. The total distance through which the trunk has been moved is 20 m. Calculate the work done by the two forces over 20 m.

(a) 1750 J (b) 0 J (c) 50 J (d) 1000 J

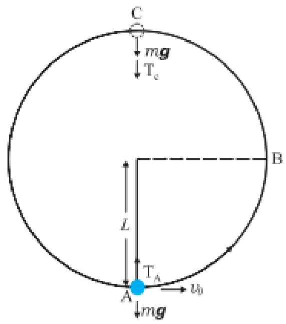


26. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_o at the lowest point A such that it completes a semi-circular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point, C as shown in Figure. What is the formula of v_o?

(a) $\sqrt{5gL}$ (b) $\sqrt{3gL}$

(c) $\sqrt{2gL}$ (d) $\sqrt{gL}$

27. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_o at the lowest point as shown in Figure. What is the formula of v_o at A such that bob oscillates in semi-circle?



(a) $\sqrt{5gL}$ (b) $\sqrt{3gL}$

(c) $\sqrt{2gL}$ (d) $\sqrt{gL}$

28. Consider a typical simulation with a car of mass 1000 kg moving with a speed 18.0 km/h on a smooth road and colliding with a horizontally mounted spring of spring constant 6.25×10^3 Nm^{-1}. What is the maximum compression of the spring?

(a) 2.00 m (b) 3.25 m (c) 4.00 m (d) 9.25 m

29. An elevator can carry a maximum load of 1800 kg (elevator + passengers) is moving up with a constant speed of 2 ms^{-1}. The frictional force opposing the motion is 4000 N. Determine the minimum power delivered by the motor to the elevator in kilowatts.

(a) 44 (b) 44000 (c) 440 (d) 22000

30. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to:

(a) $t^{1/2}$ (b) t (c) $t^{3/2}$ (d) t^2

31. A body is moving unidirectionally under the influence of a source of constant power. Its displacement in time t is proportional to:

(a) $t^{1/2}$ (b) t (c) $t^{3/2}$ (d) t^2

32. A pump on the ground floor of a building can pump up water to fill a tank of volume 30 m^3 in 15 min. If the tank is 40 m above the ground, and the efficiency of the pump is 30%, how much electric power is consumed by the pump?

(a) 43.6 kW (b) 43.6 W (c) 4360 kW (d) 436.60 W

33. A force ($F = 15 + 0.50\,x$) acts on a particle in the x-direction, where F is in newton and x in metre. Find the work done by this force during a displacement from x = 0 to x = 2.0 m.

(a) 31 J (b) 0 J (c) 21 J (d) 50 J

34. A shell in flight explodes into four unequal parts. Which of the following is conserved?

(a) Potential energy (b) Linear Momentum

(c) Kinetic Energy (d) Both (a) and (c)

35. A moving body of mass m and velocity 3 km per hour collides with a rest body of mass 2m and strikes to it. Now the combined mass starts to move. What will be the combined velocity?

(a) 1 km/h (b) 3 km/h (c) 5 km/h (d) 0 km/h

36. On a frictionless surface, a block of mass m moving at speed v collides elastically with another block of mass m which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed v/3. The second block's speed after the collision is:

(a) $\frac{\sqrt{3}\ v}{2}$ (b) $\frac{2\sqrt{2}\ v}{3}$ (c) $\frac{3\ v}{4}$ (d) $\frac{3\ v}{\sqrt{2}}$

37. A gardener pushes a lawn roller through a distance of 20 m. If he applies a force of 20 kg with in a direction in blind at an angle 60 degree to the ground find the work done by the gardener.

(a) 1960 J (b) 1000 J (c) 0 J (d) 60 J

38. A person is holding a bucket by applying a force of 10 Newton. He moves a horizontal distance of 5 m and then climbs up a vertical distance of 10 m. Find the total work done by him.

(a) 100 J (b) 2000 J (c) 50 J (d) 60 J

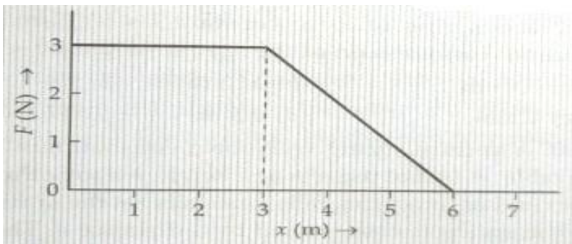
39. If force $\vec{F} = (\hat{\imath} + 5\hat{\jmath} + 7\hat{k})$ acts on a particle and displaces it through $\vec{d} = (6\hat{\imath} + 9\hat{k})$. Calculate the work done if the force is in newton and displacement is in metre.

(a) 69 J (b) 90 J (c) 50 J (d) 60 J

40. A uniform chain of length 2 metre is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table? Take g = 10 ms^{-2}.

(a) 12 N (b) 112 N (c) 22 N (d) 32 N

41. A force F acting on an object varies with distance x as shown in figure. The force is in newton and distance x is in metre. The work done



by the force in moving the object from x = 0 to x = 6 m is:

(a) 12.2 J (b) 13.5 J

(c) 9.5 J (d) 0 J

42. A stationary particle explodes into two particles of masses M_1 and M_2 which move in opposite directions with velocities V_1 and V_2. The relation of their Kinetic energies E_1 & E_2 is:

(a) $E_1 < E_2$ (b) $E_1 > E_2$ (c) $E_1 = E_2$ (d) $E_1/E_2 = M_1/M_2$

43. Two springs A and B having spring constants K_A and K_B ($K_A = 2K_B$) are stretched by applying force of equal magnitude. If energy stored in spring A is E_A then energy stored in spring B will be:

(a) 2 E_A (b) E_A / 4 (c) E_A / 2 (d) 4 E_A

44. A child is sitting on a swing, its minimum and maximum heights from the ground is 0.75 m and 2 m respectively. Its maximum speed will be (in m/s):

(a) 10 (b) 5 (c) 8 (d) 15

45. The heart of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6 X 10^3 kg/m^3 and g = 10 m/s^2 then power of the heart in watt is:

(a) 1.50 (b) 1.70 (c) 2.35 (d) 3.0

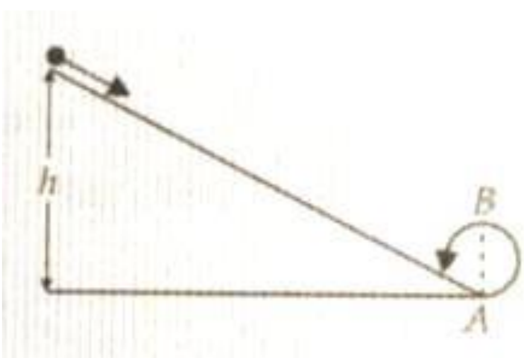
46. A ball moving with velocity 2 metre per second collides head on with another stationary ball of double mass. If the coefficient of restitution is 0.5 then their velocities after collision will be (in m/s):

(a) 0,1 (b) 1,1 (c) 1,0.5 (d) 0,2

47. The coefficient of restitution e for a perfectly elastic collision is:

(a) 1 (b) 0 (c) ∞ (d) -1

48. A body initially at rest and sliding along a frictionless track from a height h (as shown in figure) just completes a vertical circle of diameter AB = D. The height h is equal to:



(a) 3D/2 (b) 5D/4

(c) 7D/5 (d) D

49. A body projected vertically from the Earth reaches a height equal to Earth's radius before returning to the earth. The power exerted by the gravitational force is the greatest:

(a) At the highest position of the body. (b) At the instant just before the body hits the earth.

(c) It remains constant throughout its path. (d) At the instant just after the body is projected.

50. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm the potential energy stored in it is:

(a) U/4 (b) 4 U (c) 8 U (d) 16 U

Assertions and Reasons

In the following questions, statement of assertion (A) is followed by a statement of reason (R): Mark the correct choice as:

(a) If assertion and reason are true and reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

1. **Assertion:** When a body moves along a circular path, no work is done by the centripetal force.
   Reason: The centripetal force is used in moving the body along the circular path and hence no work is done.

2. **Assertion:** Mass and energy are not conserved separately, but they are conserved as a single entity called mass-energy.
   Reason: Mass and energy are inter-convertible in accordance with Einstein's relation: $E = mc^2$.

3. **Assertion:** A chemical reaction is basically a rearrangement of atoms. If the total energy of the reactants is more than the products of the reaction, heat is released and the reaction is said to be an exothermic reaction.
   Reason: Energy spent against friction does not follow the law of conservation of energy.

4. **Assertion:** If momentum of a body increases by 50% its kinetic energy will increase by 125%.
   Reason: Kinetic energy is proportional to square of velocity.

5. **Assertion:** When a ball collides elastically with a floor, it rebounds with the same velocity as with its strikes.
   Reason: Momentum of earth plus ball system remains constant.

6. **Assertion:** In an elastic collision between two bodies, the energy of each body is conserved.
   Reason: The total energy of an isolated system is conserved.

7. **Assertion:** In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.
   Reason: In an elastic collision, the linear momentum of the system is conserved.

8. **Assertion:** A quick collision between two bodies is more violent than a slow collision even when the initial and final velocities are identical.
   Reason: The rate of change of momentum is greater in the first case.

9. **Assertion:** Kinetic energy is conserved at every instant of elastic collision.
   Reason: No deformation of matter occurs in elastic collision.

10. **Assertion:** A particle strikes head on with another stationary particle such that the first particle comes to rest after collision. The collision should necessarily be elastic.
    Reason: In elastic collision, there is a loss of momentum of the system of particles.

11. **Assertion:** Work done in moving a body over a closed loop is zero for every force in nature.
    Reason: Work done does not depend on nature of force.

12. **Assertion:** The potential energy stored in the spring is positive, when it is compassed and negative, when stretched.
    Reason: It is in accordance with the sign conversions for positive and negative work.

13. **Assertion:** The kinetic energy, with any reference, must be positive. **Reason:** In the expression for kinetic energy, the velocity appears with power of 2.

14. **Assertion:** The change in kinetic energy of a particle is equal to the work done on it by the net force.
    Reason: Change in kinetic energy of particle is equal to the work done in case of a system of one particle.

15. **Assertion:** The kinetic energy of the body of mass 2 kg and momentum of 2 Ns is 1 J.
    Reason: The kinetic energy of a body in relation to its linear momentum is given by: $K = \frac{P^2}{2m}$.

16. **Assertion:** The earth moving around the sun in a circular orbit is acted upon by a force and hence work must be done on the earth by this force.
    Reason: It is necessary that the work done in the motion of a body over a closed loop is zero for every force in nature.

17. **Assertion:** A body is moving along a circular path. No work is done by the centripetal force.
    Reason: Chemical gravitational and nuclear energies are nothing but potential energies for different types of forces in nature.

18. **Assertion:** Work done by a body against friction results in a loss of its potential energy.
    Reason: In an elastic collision of two bodies the momentum and energy of each body is conserved.

19. **Assertion:** In an elastic collision of two billiard balls, the total kinetic energy is not conserved during the short time of collision of the balls i.e. when they are in contact.
    Reason: The relative velocity of two particles in a head on collision remains unchanged both in magnitude and direction.

20. **Assertion:** Work Energy theorem is an integral form of Newton’s second law.
    Reason: Work-energy theorem involves an integral over an interval of time.

CASE STUDY BASED QUESTIONS

1. Work energy theorem states that – change in kinetic energy of a body is equal to the work done by the net force. In deriving the theorem, it is assumed that force is effective only in changing the KE. When the force and displacement are in same direction, KE increases and work done is positive. When the force and displacement are in opposite direction, KE decreases and work done is negative. When the body is in uniform motion, KE does not change and work done by centripetal force is zero.

Questions

(i) A body of mass 10 kg initially at rest, acquires a velocity of 10 m/s. The work done is:

(a) -500J (b) 500J (c) 50J (d) - 50J

(ii) How much work must be done by a force on 50 kg body in order to accelerate from rest to 20 m/s in 10 sec?

(a) 10^3 J (b) 10^4 J (c) $2X10^3$ (d) $4X10^4$ J

(iii) A gun of mass M fires a bullet of mass m with maximum speed v. The KE of gun will be?

(a) ½ mv^2 (b) 1/2 Mv^2 (c) more than ½ mv^2 (d) less than½ mv^2

(iv) An unloaded car moving with velocity v on a frictionless road can be stopped in a distance s. If the passengers add 40% to its weight and breaking force remains the same then the stopping distance will be:

(a) 1.4 s (b) 1.5 s (c) 1.6 s (d) 1.8 s

(v) A block of mass 10 kg is moving in x direction with a constant speed of 10 m/s. It is subjected to a retarding force F = - 0.1 xj/m during its travel from x=20m to x=30m. Final KE will be

(a) 250J (b) 275J (c) 450J (d) 475J

Q2. A force is conservative. (i) if the work done by the force in displacing the body is independent of the path followed by the particle and (ii) if the work done by the force in moving a particle around any closed path is zero. Gravitational force, electrostatic force and elastic force are conservative forces A force is if it can be defined from the scalar potential energy function U (x) by the relation: F (x) = du(X)/dx

If the work done by the force in displacing the body, depend S on the path followed by the particle, then the force is non conservative force . Force of friction and viscosity are non conservative forces

Questions-

(i) A particle moves along a curve of unknown shape but magnitude of force F is constant and always act along the tangent to the curve, then

(a) F may be conservative (b) F must be conservative

(c) F may be non conservative. (d) F must be non conservative.

(ii) Which of the following is not a conservative force?

(a) Gravitational force (b) electrostatic force (c) Force of friction (d) magnetic force

(iii) The potential energy of a body is given by $U= A-Bx^2$, x is displacement. The magnitude of the force acting on the particle is:

(a) Constant (b) proportional to x

(c) proportional to x^2 (d)inversely proportional to x

(iv) The potential energy of a system increases if work is done:

(a) upon the system by a non-conservative force (b) by system against the conservative force

(c) by the system against non-conservative (d) upon the system by a conservative force

(v) A particle is moving in a circular path of radius a under the action of attractive potential Energy: $U= k/2r^2$. Its total energy is:

(a) k/2 (b) 2k (c) zero (d) k/4a

Q3. In all collisions, total linear momentum is conserved, while the total KE of the system is not necessarily conserved. If there is no loss of KE during a collision it is called an elastic collision. The collision between atoms and sub atomic particles are truly elastic. If there is a loss of KE during a collision it is called inelastic collision. During collision, a part of kinetic energy may convert into heat and sound. When two bodies stick together after a collision, the collision is perfectly inelastic.

QUESTIONS:

(i) A particle of mass m_1 moves with velocity v_1, collides with another particle at rest of equal mass. The velocity of second particle after collision is

(a) $2v_1$ (b) v_1 (c) $-v_1$ (d) zero

(ii) A body moving with a velocity v, breaks up into two equal parts. One of the parts retraces back with a velocity v. The velocity of other part is

(a) v in forward direction (b) 3v in forward direction

(c) v in backward direction (d) 3v in backward direction

(iii) When a body is moves with constant speed in a circular path, then

(a) Work done will be zero (b) acceleration will be zero

(c) Force acting on body is zero (d) velocity is constant

(iv) In an inelastic collision, what is conserved?

(a) Kinetic energy (b) linear momentum (c) both (a) and (b) (d) neither (a) nor (b)

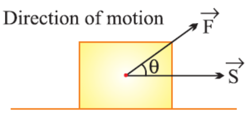
(v) A body of mass m_1, collides elastically with another body of mass m_2, at rest. There is maximum transfer of energy when

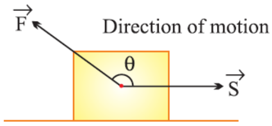
(a) $m_1 > m_2$ (b) $m_1 < m_2$ (c) $m_1 = m_2$ (d) same for all values of m_1 and m_2

Q4.Work is said to be done when a force applied on the body and the body displaces through a certain distance in the direction of force Let a constant force F be applied on the body such that it makes an angle θ with the horizontal and body is displaced through a distance *s*. Then work done by the force in displacing the body through a distance *s* is given by:

$W = (F\cos\theta)\, s = Fs\cos\theta \Rightarrow W = (F\cos\theta)\, s = Fs\cos\theta$ or $W = \vec{F}\cdot\vec{s}$

Positive work means that force (or its component) is parallel to displacement $0^\circ \le \theta < 90^\circ$ and negative work means that force (or its component) is opposite to displacement $90^\circ < \theta \le 180^\circ$





Questions

(i) A body displaces through a distance of 20m on applying a force of 20 newton in a direction inclined at 60 degree to the ground. The work done is:

(a) 100J (b) 200J (c) 300J (d) 400J

(ii) A person holding a bucket by applying a force of 10N. He moves a horizontal distance of 5m and then climbs up a distance of 10m. The total work done by the person is:

(a) zero (b) 10J (c) 50J (d) 100J

(iii) A ball moves on frictionless inclined table without slipping. The work done by the table surface on the ball is:

(a) positive (b) negative (c) zero (d) none of these

(iv) A body moves through a distance of 10m when a force of 10 N is applied on it. If he work done is 25 J, then the angle between the force and direction of motion is

(a) 30^0 (b) 45^0 (c) 60^0 (d) none of these

(v) The work done by a force:

(a) may be positive (b) may be negative (c) may be zero (d) all of these

Q5. When the magnitude and direction of a force varies with position, the work done by such a force for an infinitesimal displacement is given by: $dW=\vec{F}.\vec{s}$

The total work done in going from A to B is: $W=\int_A^B \vec{F}.\vec{ds}=\int_A^B (F\cos\theta)\,ds$

Area under force displacement curve with proper algebraic sign represents work done by the force. Work done depends on magnitude of force, displacement and the angle between direction of force and direction of motion.

Questions:

(i) No work is done if

(a) Displacement is zero (b) Force is zero

(c) Force and displacement are mutually perpendicular (d) All of these

(ii) The magnitude of work done by a force

(a) Depends on frame of reference (b) Does not depend on frame of reference

(c) Cannot be calculated in non-inertial frames (d) Both (a) and (b)

(iii) In which of the following work is being not done?

(a) Shopping in the supermarket (b) Standing with a basket of fruit on the head

(c) Climbing a tree (d) Pushing a wheel barrow

(iv) A particle moves under a force F = CX from X = 0 to X = X_1. The work done is:

(a) $C(X_1)^2$ (b) $C(X_1)^3$ (c) ½ $C(X_1)^2$ (d) zero

(v) The work done by an applied force $F = x + x^3$ from x = 0 m to x = 2 m, where x is displacement is:

(a) 6J (b) 8J (c)10J (d) 12J

Q6. When a force is applied on a body and the body is displaced in the direction of force, then the kinetic energy of the body changes. This change in the kinetic energy of the body is measured in terms of work, i.e. the change in kinetic energy of the body must be equal to work done. It is also known as work energy theorem. If m is the mass of body, u is initial velocity of body, v is final velocity of body then Work done = Change in kinetic energy, $W= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Questions:

(i) The kinetic energy of a body of mass 2kg and momentum 2N

(a) 1J (b) 2J (c) 3J (d) 4 J

(ii) Two bodies of mass m and 4m have equal kinetic energies. Ratio of their linear momenta is:

(a) 1:4 (b)1:2 (c) 1:1 (d) 2:1

(iii) If the momentum is increase by 20% , then the KE is increases by:

(a) 48% (b) 40 % (c) 44 % (d) 35 %

(iv) Which of the following must be known in order to determine the power output of an automobile?

(a) Final velocity and height (b) Mass and amount of work performed

(c) Force exerted and distance of motion (d) Work performed and elapsed time of work

(v) When a force is applied on a body of mass 20kg, it changes its velocity from 5m/s to 10 m/s. The work done by the force is:

(a) 550J (b) 650J (c) 750J (d) 850J

Q7. Potential energy is defined only for conservative forces. In the space occupied by conservative forces every point is associated with certain energy which is called the energy of position or potential energy When a spring is stretched or compressed from its normal position ($x = 0$) by a small distance x, a restoring force is produced in spring to bring it to the normal position. According to Hooke's law this restoring force is proportional to the displacement x and its direction is always opposite to displacement. Then potential energy of spring is given by: $U = 1/2\ kx^2$. If spring is stretched from initial position x_1 to final position x_2 then work done = Increment in elastic potential energy = $\frac{1}{2} k (x_2^2 - x_1^2)$

Questions:

(i) If two particles are brought near one another, the potential energy of the system will

(a) Increase (b) Decrease (c) Remains the same (d) Equal to the K.E.

(ii)If stretch in a spring of force constant k is doubled then the ratio of elastic potential energy in the two cases will be:

(a) 4:1 (b)1:4 (c)2:1 (d)1:2

(iii) The energy stored in wounded spring watch is:

(a) Kinetic (b) Potential (c) Heat (d) Chemical

(iv) A spring of force constant 800N/m has an extension of 5cm. The work done in extending it from 5cm to 15 cm is:

(a) 4J (b) 8J (c) 12J (d) 16J

(v) When a spring is stretched by 2cm, it stores 100 J of energy. If it is stretched further by 2cm, the stored energy will be increased by:

(a) 100J (b) 200J (c) 300J (d) 400J

Q8. In everyday life, the term work is used to refer to any form of activity that requires the exertion of mental or muscular efforts. In physics, work is said to be done by a force or against the direction of the force, when the point of application of the force moves towards or against the direction of the force. If no displacement takes place, no work is said to be done.

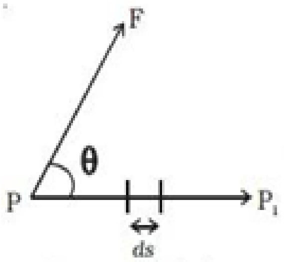


Fig. Work done by a force

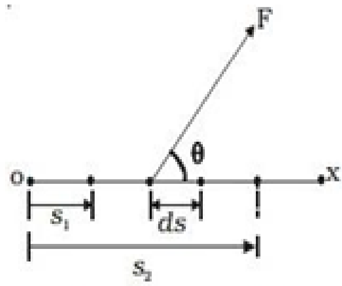


Fig. Work done by a constant force

Questions:

(i) A box is pushed through 4.0 m across a floor offering 100 N force. How much work is done by the applied force?

(a) 100J (b) 200 J (c) 300 J (d) 400 J

(ii) What is work done in holding a 15 kg suitcase while waiting for 15 minutes?

(a)22.5 J (b)225 J (c) zero (d) 150 J

(iii) Frictional forces are:

(a) conservative forces (b) non- conservative forces (c) buoyant force (d) none of these

(iv) When the body moves in circular motion, net 'work' done is:

(a) positive (b) negative (c) zero (d) none of these

(v) Force of 4N is applied on a body of mass 20 kg. The work done in 3rd second is:

(a) 2J (b)4J (c) 6J (d) 8J

Q9. In physics, we come across many examples of collisions. The molecules of a gas collide with one another and with the container. The collisions of a neutron with an atom is well known. In a nuclear reactor, fast neutrons produced in the fission of uranium atom have to be slowed down. They are, therefore, made to collide with hydrogen atom. The term collision does not necessarily mean that a particle or a body must actually strike another. In fact, two particles may not even touch each other and yet they are said to collide if one particle influences the motion of the other. When two bodies collide, each body exerts an equal and opposite force on the other. The fundamental conservation law of physics are used to determine the velocities of the bodies after the collision. Collision may be elastic or inelastic. Thus a collision may be defined as an event in which two or more bodies exert relatively strong forces on each other for a relatively short time. The forces that the bodies exert on each other are internal to the system. Almost all the knowledge about the sub-atomic particles such as electrons, protons, neutrons, muons, quarks, etc. is obtained from the experiments involving collisions. There are certain collisions called nuclear reactions in which new particles are formed. For example, when a slow neutron collides with a U235 nucleus, new nuclei barium-141 and Kr92 are formed. This collision is called nuclear fission. In nuclear fusion, two nuclei deuterium and tritium collide (or fuse) to form a helium nucleus with the emission of a neutron.

QUESTIONS -

Q.1 Which one of the following collisions is not elastic?

(a) A hard steel ball dropped on a hard concrete floor and rebounding to its original height.

(b) Two balls moving in the same direction collide and stick to each other

(c) Collision between molecules of an ideal gas.

(d) Collisions of fast neutrons with hydrogen atoms in a fission reactor.

(ii) Which one of the following statements is true about inelastic collision?

(a)The total kinetic energy of the particles after collision is equal to that before collision.

(b) The total kinetic energy of the particle after collision is less than that before collision.

(c) The total momentum of the particles after collision is less than that before collision.

(d) Kinetic energy and momentum are both conserved in the collision.

(iii) In elastic collision:

(a) Only energy is conserved. (b) Only momentum is conserved.

(c) Neither energy nor momentum is conserved.

(d) Both energy and momentum are conserved.

Q10 Work is said to be done by the force acting on a body, provided the body is displaced actually in any direction except in a direction perpendicular to the direction of force. Mathematically,

W = $\vec{F} \cdot \vec{S}$ = F S cos Θ. Here energy is the capacity of a body to do the work;

Power is the rate at which the body can do the work. P = $\frac{W}{t} = \frac{\vec{F} \cdot \vec{S}}{t} = \vec{F} \cdot \vec{v}$

Both work and energy are measured in joule and power is measured in watt.

QUESTIONS -

(i) A box is pushed through 4.0 m across a floor offering 100N resistance. Work done by the applied force is:

(a) 400J (b) -400J (c) 25J (d) 0.04J

(ii) In the above question, work done by the resisting force is:

(a) 400J (b) -400J (c) 25J (d) -25J

(iii) In the above question, work done by gravity is

(a) 400J (b) -400J (c) zero (d) -25J

(iv) A truck draws a tractor of mass 1000kg at a steady rate of $20ms^{-1}$ on a level road. The tension in the coupling is 2000N. Power spent on the tractor is:

(a) 40W (b) 20W (c) 20kW (d) 40kW

Q11.Potential energy of a body is the energy possessed by the body by virtue of its position P.E. = m g h where the symbols have their usual meaning. Kinetic energy of a body is the energy possessed by the body by virtue of its velocity. K.E. = $\frac{1}{2}mv^2$ Energy can neither be created nor be destroyed. However energy can be changed from one form to the other, such that energy appearing in one form is equal to the energy disappearing in other form.

QUESTIONS

(i) A body of mass 1kg is allowed to fall freely under gravity. The momentum of the body 5 second after it starts falling is:

(a) 100 $kgms^{-1}$ (b) 50 $kgms^{-1}$ (c) 150 $kgms^{-1}$ (d) 200 $kgms^{-1}$

(ii) Kinetic energy of the body at the same time is

(a) 1250 J (b) 2500 J (c) 625 J (d) 2500 J

(iii) The body will attain this K.E. when it fall freely from a height of

(a) 125m (b) 250m (c) 1250m (d) 2500m

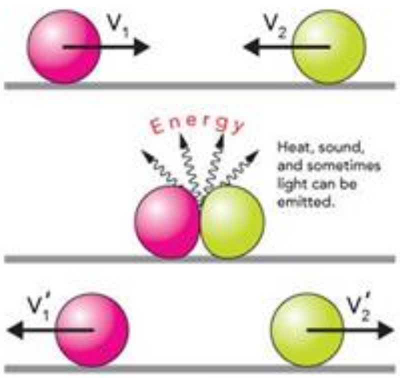
(iv) Velocity of the body on striking the ground will be:

(a) 25m/s (b) 12.5m/s (c) 50m/s (d) 100m/s

(v) The ratio of P.E. to K.E. at a height of 62.5 m above the ground is

(a) 2 (b) 1 (c) 3 (d) 4

Q12. An elastic collision is a collision in which there is no net loss in kinetic energy in the system as a result of the collision. Both momentum and kinetic energy are conserved quantities in elastic collisions.



QUESTIONS

(i) In which motion, momentum changes but K.E does not?

(a) Circular motion (b) Parabolic motion (c) Straight line motion (d) None of these

(ii) The coefficient of restitution for elastic collision is:

(a) 0 (b) 1 (c) -1 (d) infinite

(iii)Two balls at the same temperature collide. What is conserved?

(a) momentum (b) velocity (c) kinetic energy (d) none of these

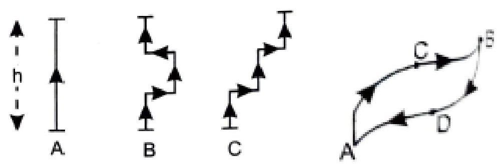
(iv) Momenta of two objects moving with same speed but in opposite direction upon collision is:

(a) Increased (b) decrease (c) Zero (d) none of these

(v) In elastic collision, the relative speed of approach and separation is:

(a) Equal (b)unequal (c)zero (d) infinite

Q13. In nature we have various types of forces. A force is said to be a conservative force if work done by (or against) the force for moving an object from one position to another position depends on these two initial and final) points but is independent of other factors like the nature of path followed or velocity of object. It is also found that work done on an object against the conservative force present there gets stored up as the potential energy of the object. When external constraints are removed, the stored potential energy manifests itself as kinetic energy. lf above mentioned conditions are not fulfilled then force is called a non-conservative force.



(a) Give two examples of conservative forces.

(b) Three girls of same mass climb through a certain height h' following different paths shown as A, B and C in the figure. In which case is the work done against gravity maximum and in which case it is minimum?

(c) An object is taken from position A to B via a path ACB and then brought back to position A via another path BDA. If the force involved is a conservative force, then show that net work done for entire closed path is zero.

(d) What is a non conservative force? Give two examples

(e) Under which condition is the principle of conservation of mechanical energy valid?

ANSWER KEY MCQs

1. (c) 600 J 2. (b) 3.6 J 3. (b) 392 J 4. (b) 125 J 5. (d) 0.36 m

6. (d) 500 W 7. (d) 50 8. (b) m^o 9. (b) 216 J 10. (b) 1 : 2

11. (a) 490 J 12. (c) 600 J 13. (a) zero 14. (a) 9800 J 15. (a) y = -5 cm

16. (a) (i)-(4), (ii)-(3), (iii)-(5), (iv)-(1), (v)-(2) 17. (c) Linear momentum of the system is conserved. 18. (d) zero 19. (d) 0.36 m 20. (c) 100 kWh

21. (a) $\cos^{-1}(23/25)$ 22. (a) − 8.75 J 23. (a) – 2000 J 24. (a) 63.2 ms^{-1}

25. (a) 1750 J 26. (a) $\sqrt{5gL}$ 27. (c) $\sqrt{2gL}$ 28. (a) 2.00 m

29. (a) 44 30. (b) t 31. (c) $t^{3/2}$ 32. (a) 43.6 kW

33. (a) 31 J 34. (b) Linear Momentum 35. (a) 1 km/h

36. (b) $\frac{2\sqrt{2}\ v}{3}$ 37. (a) 1960 J 38. (a) 100 J 39. (a) 69 J 40. (a) 12 N

41. (b) 13.5 J 42. (a) $E_1 < E_2$ 43. (a) 2 E_A 44. (b) 5 m/s 45. (b) 1.70 W

46. (a) 0,1 47. (a) 1 48. (b) 5D/4

49. (b) At the instant just before the body hits the earth. As P = F.v Both F & v are maximum at the instant just before the body hits the earth.

50. (d) 16 U

Answer Key (Assertions and Reasons)

1. (c)	2. (a)	3. (c)	4. (a)	5. (b)	6. (d)	7. (d)
8. (a)	9. (a)	10. (d)	11. (d)	12. (a)	13.(a)	14.(C)
15. (a)	16. (d)	17. (b)	18. (d)	19. (C)	20. (a)	

ANSWER KEY (CASE STUDY BASED QUESTIONS)

Q1. (i) a	(ii) b	(iii) d	(iv) a	(v) d
Q2. (i) d	(ii) c	(iii) b	(iv) b	(v) c
Q3. (i) c	(ii) b	(iii) a	(iv) b	(v) c
Q4. (i) b	(ii) d	(iii) c	(iv) d	(v) d
Q5. (i) d	(ii) a	(iii) c	(iv)c	(v) c
Q6. (i) a	(ii) b	(iii) c	(iv) d	(v) c

Q7. (i) a (ii) a (iii) b (iv) b (v) c

Q8. (i) d (ii) c (iii) b (iv) c (v) a

Q9. (i) b (ii) b (iii)d

Q10. (i) a (ii) b (iii) c (iv) d

Q11. (i) b (ii) a (iii) a (iv) c (v) b

Q12. (i) a (ii) b (iii) a (iv) c (v) a

Q13. (a) Gravitational force, force of gravity and elastic force in a spring are example of Conservative forces.

(b) Work done by all the three girls is exactly the same (w = mgh), because the force of gravity is a conservative force So work done does not depend on the nature of the path

(c)Work done to take an object from position A to B via path ACB and path ADB will be exactly the same if the force involved is a conservative force. $W_{ACB} = W_{ADB}$

It is also clear that work done to take the object from position B to position A via path BDA will be: $W_{BDA} = -W_{ADB}$. Total work done for entire closed path BDA

$W = W_{ACB} + W_{BDA} = W_{ADB} - W_{ADB} = \text{ZERO}$

(d) A force is said to be non-conservative if work done by/against it for moving an object from one position to another depends on the nature of path followed besides the two positions. Moreover, work done against a non-conservative force is never stored as potential energy but is dissipated as heat energy. Friction and viscous force are examples of non conservative forces.

(e) The principle of conservation of mechanical energy is valid only when conservative forces are present in the system.