4 Work, Energy and Power

Work :

- Work = Force × displacement in the direction of force

or

Work = effective component of displacement × force in direction displacement

Work done by constant force

$W = \vec{F} \cdot \vec{d} = Fd\cos\theta$

- $0 \le \theta < 90°$: W = +
- $\theta = 90°$: W = 0
- $90° < \theta \le 180°$: W = –

Work done by variable force

$W = \int_A^B \vec{F} \cdot d\vec{r}$

- Area enclosed by graph of Foce ($\vec{F}$) → displacement ($\vec{r}$) = work.
- Work :

  MKS – Unit = joule

  CGS – Unit = erg

  Dimensional formula = $M^1L^2T^{-2}$

  1 joule = 10^7 erg

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(1) A person pull trolly bag with 24 N force and displacement 10 m. If work done in this case is 120 J. Find the angle of trolly bag with vertical direction.

(A) 0° (B) 30° (C) 45° (D) 60°

(2) Two students kept their bag on a table at a height of 1 m. Mass of their bag are equal and time to kept on a table for student - 1 is three times than student - 2. The ratio of work done by them is .....

(A) 1:3 (B) 3:1 (C) 9:1 (D) 1:1

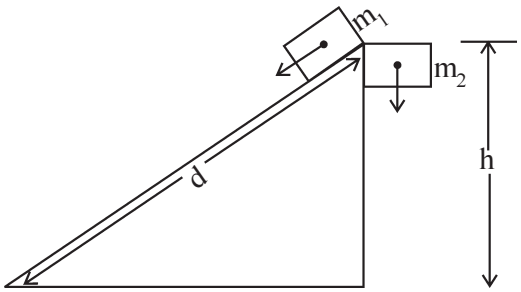
(3) A car of mass 2000 kg is moving with speed 108 kmh^{-1}, when brake applies suddenly it stops after travelling a distance of 15 m. Find the work done on a wheel of a car.

(A) 900 KJ (B) – 900 KJ (C) 300 KJ (D) – 300 KJ

(4) In a cricket ground, player A throws a ball of 150 g in horizontal direction up to 15 m and player B throws a ball of 300 g in vertical direction up to same distance. Find the ratio of work done on a ball by gravitational forces in both the cases ?

(A) 1:2 (B) 2:1 (C) 1.1 (D) 0

(5) As shown in figure, two blocks of mass m_1 and m_2 are given motion under the effect of gravitational field. If the ratio of mass are $m_1 : m_2 = 2:3$. Find the ratio of work done.



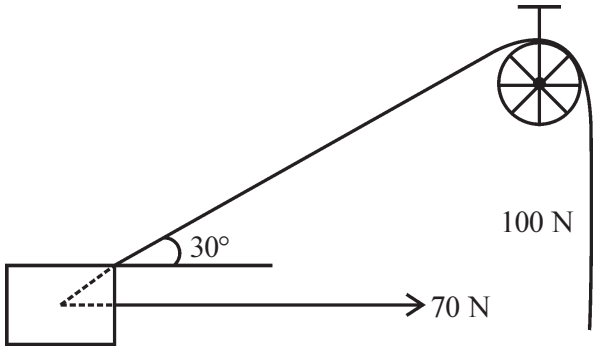
(A) 1 : 1 (B) 2 : 3

(C) 3 : 2 (D) 2 : 1

(6) Ramesh tied 1 kg stone at the end of 3 m long string and gives circular motion in a horizontal plane. How much work is done on a stone by string and gravitational force ?

(A) 4 N, 0 N (B) 0 N, 4 N (C) 4 N, 4 N (D) 0 N, 0 N

(7)



Two forces are acting on a 10 kg block as shown in figure, so block attains velocity of $\sqrt{14.66}$ ms^{-1} after travelling some distance. If block performs motion only in horizontal direction and kinetic friction of surface is 0.2. Find the work done on a block by resultant force during this motion.

(A) 96.6 J (B) 48.3 J (C) 73.3 J (D) 35 J

(8) Acceleration of 6 kg mass changes according to distance as $a(x) = (9x^2 + 6x - 3)$ ms^{-2}. What is the work done when body travels a distance of 3 m ?

(A) 33 J (B) 99 J (C) 198 J (D) 594 J

(9) Force acting on a 2 kg mass in x-y plane changes according to $\vec{F} = \{(3x^2 + 2x)\,\vec{i} + (6y^2 + 2)\,\vec{j}\}$ N. Find the work done on this body when it displaces from pt. P (0, 2) to Q (2, 0).

(A) –12 J (B) –8 J (C) +8 J (D) 12 J

(10)

Particle lying at origin 0 performs motion from 0 to A under the influence of force $F = kx^2$ and work done in this case is W_1. When it travels from B to D work done is W_2 then $\frac{W_1}{W_2}$ = ...

(A) 3 : 2 (B) 3 : 1 (C) 19 : 8 (D) 8 : 19

(11) Displacement of a body having mass 2 kg under variable force changes according to $S = \left(\frac{t^3}{3} + \frac{t^2}{2} + 5\right)$ m. What is the work done on a body by this force in first two second ?

(A) 12 J (B) 18 J (C) 24 J (D) 36 J

(12) A chain of 3m length is kept on a table in such a way so that its 1 m part hanging downward from the edge of table. The whole mass of chain is 9 kg. How much work is done to bring hanging part completely on a table ?

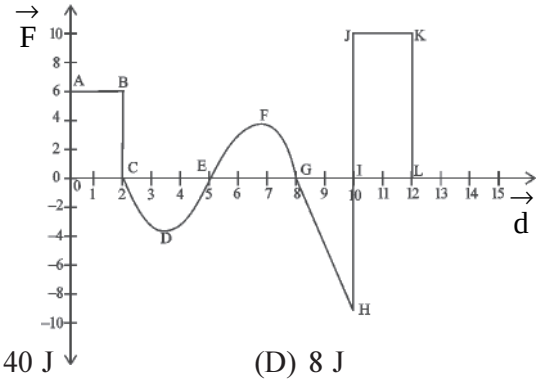
(A) 270 J (B) 100 J (C) 30 J (D) 15 J

(13) A particle performs motion in two dimension under the influence of force $\vec{F} = (3x^2\,\hat{i} + 4\,\hat{j})$ N. What would be the work done to move a particle from point (2, 3) m to (3, 0) m ?

(A) 0 (B) +7 J

(C) 12 J (D) +19 J

(14) The graph of Force $\left(\vec{F}\right)$ → distance $\left(\vec{d}\right)$ for a particle moving along X- axis is as shown in figure. Find the work done, when particle travels first 12 m distance.



(A) 26 J (B) 24 J (C) 40 J (D) 8 J

Ans : 1 (B), 2 (D), 3 (B), 4 (D), 5 (B), 6 (D), 7 (C), 8 (D), 9 (B), 10 (D), 11 (D), 12 (D), 13 (B), 14 (B)

Energy

The ability to do work

Kinetic energy

The ability to do work due to its motion is called kinetic energy

Formula

$K = \frac{1}{2}mv^2 = \frac{p^2}{2m} = \frac{1}{2}pv$

$W = \Delta k \Rightarrow$ Work – energy – theorem

Potential energy

The ability to do work due to position or configuration is called potential energy

Potential energy due to position

Gravitational potential energy : $U = mgh$

h = height from the reference surface of the earth

Potential energy due to configuration

Elastic potential energy in the spring $U = \frac{1}{2}kx^2$

x = compression of the spring

k = force constant of the spring

Total energy

- (mechanical energy) : $E = U + K$
- **Conservation of mechanical energy :**

  For isolated system under the effect of conservative force, $E = U + K$ = constant

  $\therefore \Delta E = \Delta U + \Delta K = 0$
- **Different form of energy :** (1) Mechanical energy (2) Internal energy (3) Heat energy (4) Electrical energy (5) Chemical energy (6) Nuclear energy.
- **Energy - mass equivalence :**

  According to Einstein's theory of relativity, $E = \Delta mc^2$

  Δm = change in mass, E = Energy, c = velocity of light = $3 \times 10^8\ ms^{-1}$

  E = energy equivalent to Δm

- MKS unit of energy = joule
- CGS unit of energy = erg
- Dimensional formula of energy = $M^1L^2T^{-2}$
- Traditional unit of energy = calorie, 1 calorie, = 4.186 joule
- Unit of energy in terms of power = 1 kWh = 3.6×10^6 J = 1 Unit

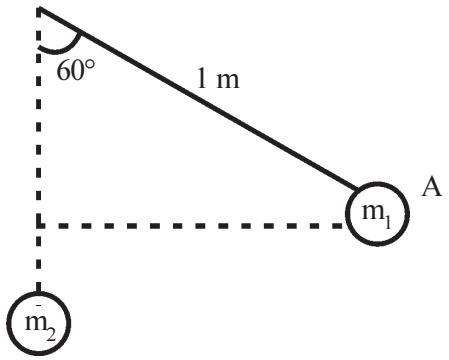
(15) A ball is thrown with velocity 'v' in vertical direction. At the same time a block having same mass is projected at an angle of 30°. Find the ratio of their potential energy at the points on maximum height on their paths of motion.

(A) 1 : 1 (B) 2 : 1 (C) 4 : 1 (D) 8 : 1

(16) Two objects with mass 16 kg and 4 kg is moving with acceleration of 2 ms^{-2} and 8 ms^{-2} respectively from the steady state. After a respective time interval t_1 and t_2 their kinetic energy equals to K J. Find the ratio $\frac{t_1}{t_2}$.

(A) 2 : 1 (B) 1 : 2 (C) 1 : 4 (D) 4 : 1

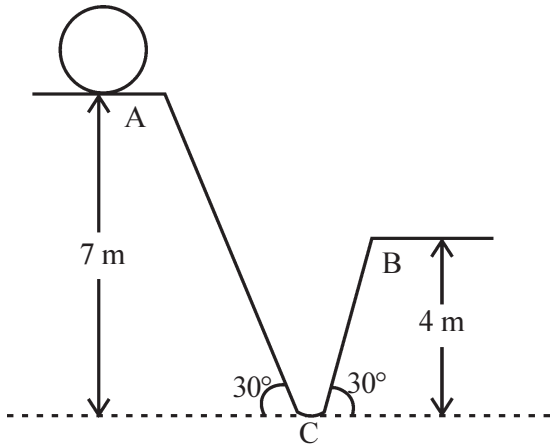
(17) As shown in figure a sphere of simple pendulum having mass m_1 releases from position A, becomes steady after a collision with a sphere having mass $m_2 = 2m_1$ at mid position of its path of motion. Hence a sphere of m_2 mass attains kinetic energy of 4 J, then m_2 = ...



(A) 2 kg (B) 3.2 kg

(C) 6.3 kg (D) 8.2 kg

(18)



As shown in figure a sphere of mass 1 kg given a motion from steady position at point A, which rolls down to point B. Energy loss of 0.5 J per $\frac{1}{2}$ m length on the slope. Find the kinetic energy at point 'B'.

(A) 40 J (B) 19 J

(C) 8 J (D) 0 J

(19) A stationary bomb of mass 20 kg suddenly explodes in two fragments in proportion of 1:4. If kinetic energy of small fragment is 360 J, find the kinetic energy of larger fragment.

(A) 360 J (B) 180 J (C) 90 J (D) 0 J

(20) A body of mass 800 g freely falls from height of 50 m. When this body comes on the surface of the earth, potential energy completely converts in to kinetic energy. Find the loss of potential energy of a body.

(A) 0 J (B) 200 J (C) 300 J (D) 400 J

(21) An object is moving on a straight path, when its speed increases by 2 ms^{-1}, its kinetic energy doubles. What is the original speed of an object ?

(A) 2 ms^{-1} (B) $2 \pm \sqrt{8}$ ms^{-1} (C) 8 ms^{-1} (D) $2 \pm \sqrt{2}$ ms^{-1}

(22) 15 J energy is paid by a person to pull an object of mass 3 kg from depth 'h' in empty well. 40 % energy is wasted due to friction. When this object reach to the edge of well suddenly rope breaks and object goes to bottom of well. if its velocity at bottom is 3 ms^{-1}, find the depth of well.

(A) 6 m (B) 2 m (C) 1 m (D) 0.45 m

(23) Two balls A and B freely falls from the same height. Ratio of their mass are 1:4, when potential energy of A is three times than potential energy of B. Find the ratio of travelled distance by them.

(A) 1:12 (B) 12:1 (C) 1:6 (D) 6:1

(24) An object of mass 2 kg freely falls from a height of 60 m collides with the surface of the earth and reflect upto height 40 m. Loss of energy during this collision is how much part of its original energy ?

(A) one third (B) Half (C) one fourth (D) one sixth

(25) In diatomic molecule, potential energy between two atoms is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$. How much energy is required to separate these two atom from stable position ?

(A) $\frac{b^2}{2a}$ (B) $\frac{b^2}{6a}$ (C) $\frac{b^2}{4a}$ (D) $\frac{b^2}{12a}$

(26) A rope of length 'L' is tied with balloon. When a person tries to climb in a ballon with the help of rope, it descends by distance 'd'. If mass of ballon is M, then what is the ratio of change of potential energy of a person and ballon ?

(A) $\frac{L}{d}\left(\frac{M}{m}\right)$ (B) $\frac{L-d}{d}\left(\frac{m}{M}\right)$ (C) $\frac{d}{L-d}\left(\frac{M}{m}\right)$ (D) $L - d\left(\frac{M}{m}\right)$

(27) The force required to pull the spring upto 6 cm is 120 N. What is the required work to pull a spring another 6 cm ?

(A) 5 J (B) 8.4 J (C) 10.8 J (D) 12.4 J

(28) The ratio of stored potential energy of two spring pulled by same force having force constant 600 Nm^{-1} and 1200 Nm^{-1} is 'a' and the ratio of stored potential energy when they pulled to same length is 'b' then $a \cdot b$ = ...

(A) 1 (B) 2 (C) 3 (D) 4

(29) A sphere of mass 0.1 kg is moving with velocity of 10 ms^{-1} collides with a spring which is at a distance 2 m from the initial point, which compresses the spring and becomes steady. Find the compression of the spring. [Force constant of spring is 6 Nm^{-1} and co-efficient of friction between sphere and surface is 0.2]

(A) 1 m (B) 2 m (C) 3 m (D) 4 m

(30) When a spring pulled by 2 mm, 36 J energy stored in it. Find the work done to pull a spring further 2 mm length.

(A) 36 J (B) 72 J (C) 108 J (D) 144 J

(31) A spring is arranged vertical, whose end is connected with horizontal surface. A block of mass 'm' falls on a spring from height 'h' so, spring compresses to distance 'd'. If the force constant of spring is 'k', what is the total work done ?

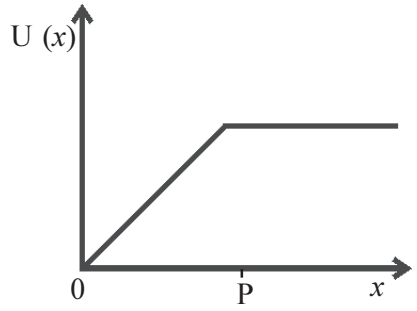
(A) $mg(h + d) + \frac{1}{2} kd^2$ (B) $mg(h + d) - \frac{1}{2} kd^2$

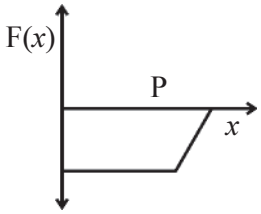
(C) $mg(h - d) - \frac{1}{2} kd^2$ (D) $mg(h - d) + \frac{1}{2} kd^2$

(32) A block of mass 2 kg is moving with velocity of 4 ms^{-1} collides with a spring and compresses it. Find the compression of the spring if friction force is 16 N and force constant of the spring is 10 kNm^{-1}.

(A) 8.5 cm (B) 2.5 cm (C) 5.5 cm (D) 11.0 cm

(33) The graph of potential energy → distance is as shown in figure. Which graph of Force → distance is suitable ?



(A)


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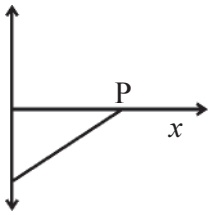

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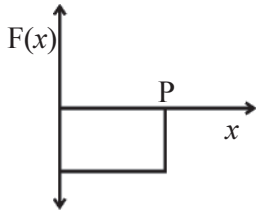

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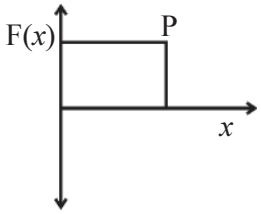
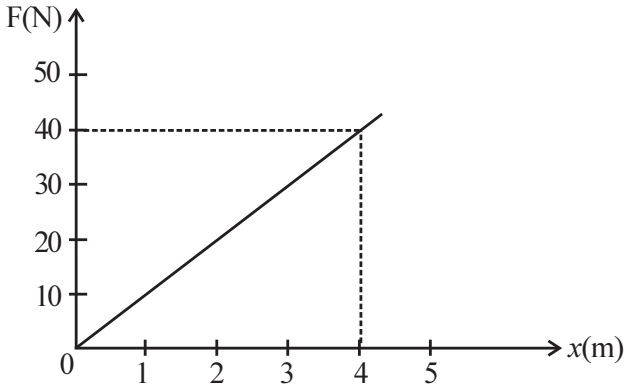
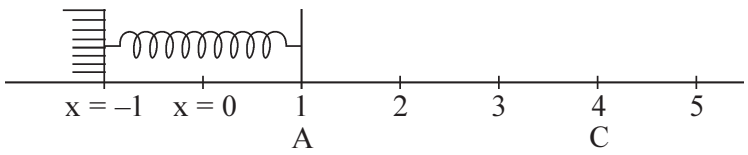


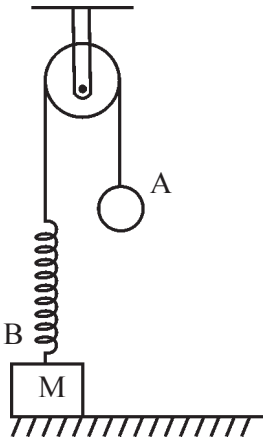
(34) An elastic spring is arranged along the x-axis as shown in figure. The graph of $F \rightarrow x$ is as shown in figure. find the work done to bring end of spring from $x = A$ to $x = C$.





(A) 40 J (B) 80 J (C) 120 J (D) 160 J

(35) A spring is in its normal condition as shown in figure. What should be the minimum mass of A so that B is on the verge to loose a contact with surface ?



(A) $\frac{M}{2}$ (B) M

(C) 2 M (D) 3 M

Ans. : 15 (C), 16 (A), 17 (B), 18 (B), 19 (C), 20 (D), 21 (B), 22 (D), 23 (B), 24 (A), 25 (C), 26 (B), 27 (C), 28 (A), 29 (A), 30 (D), 31 (B), 32 (C), 33 (C), 34 (B), 35 (A)

Power :

Time - rate to do work is called power.

$\langle P \rangle = \frac{\Delta W}{\Delta t}$ (average power)

Instantaneous power $P = \frac{\Delta W}{\Delta t} = \vec{F} \cdot \vec{v}$

- **Different units of power :**

(i) Js^{-1} (ii) watt (W) (iii) horse power (hp), 1 hp ≅ 746 W

Dimensional of power = $M^1L^2T^{-3}$

(36) The force 'F' is acting on a car having mass 'm' and moving on a horizontal road in such a way so that its velocity changes from v_2 to v_1 when it travelled a distance 'd'. If produced power by engine of car (P) is constant then v_2 = ...

(A) $\left(\frac{Pd}{2m}+v_1^2\right)^{\frac{1}{2}}$ (B) $\left(\frac{Pd}{2m}+v_1^2\right)^{\frac{1}{3}}$ (C) $\left(\frac{3Pd}{m}+v_1^3\right)^{\frac{1}{2}}$ (D) $\left(\frac{3Pd}{m}+v_1^3\right)^{\frac{1}{3}}$

(37) Water is falling on turbine of A. C. generator from 80 m height with the rate of 20 kgs^{-1}. 20 % energy from the total energy is converted into electrical energy then what is the electrical energy ?

(A) 3.2 kW (B) 2.4 kW (C) 4.2 kW (D) 6.8 kW

(38) Water tank of size 3m × 3m × 1m is kept on a terrace of 10 m high building. How much time is taken to fill the water in this tank with the help of motor of power 10 kW and efficiency 40 % ?

(A) 6.23 min (B) 3.75 min (C) 4.24 min (D) 8.52 min

(39) What is the power of a body of mass 3 kg projected at an angle of 30° with the horizontal, with velocity of 40 ms^{-1} ?

(A) 75 W (B) 200 W (C) 300 W (D) 400 W

(40) When a rail of mass 12×10^6 kg pulled by engine, its velocity increases from 3 ms^{-1} to 5 ms^{-1} in two minutes What is the power of engine ?

(A) 200 kW (B) 400 kW (C) 600 kW (D) 800 kW

(41) Vehicle of mass 2000 kg and 3000 kg taken time 8 s and 6 s respectively to travel on a slope. The rario of their power of engine is .....

(A) 1 : 2 (B) 2 : 3 (C) 3 : 2 (D) 2 : 1

(42) Force acting on a body of mass 'm' is $(2\hat{i} - 3\hat{j} + 4\hat{k})$ N and displacement in t s is $3t^2\hat{i} + 4t\hat{j} + 6t^3\hat{k}$. Power of body at t = 2 s, is .....

(A) 324 W (B) 300 W (C) Zero (D) 200 W

(43) A soldier fires bullets of mass 20 g with speed 360 kmh^{-1} at the rate of 180 bullet/min. What is power of machine-gun ?

(A) 600 W (B) 400 W (C) 200 W (D) 100 W

(44) Heart of an animal pushes 1 cc blood in 1 sec with pressure of 23,000 Nm^{-2}. Find the essential power.

(A) 0 (B) 0.32 W (C) 0.023 W (D) 0.042 W

(45) An electric motor of 0.5 hp moving with speed of 600 rpm. If the efficiency of motor is 70 %, what is the work done by motor during one rotation ?

(A) 3.46 J (B) 5.12 J (C) 4.19 J (D) 2.6 J

Ans. : 36 (D), 37 (A), 38 (B), 39 (C), 40 (D), 41 (A), 42 (B), 43 (A), 44 (C), 45 (D)

Collision :

- During the collision, if momentum, total energy and kinetic energy is conserved then it is called elastic collision.
- During the collision, If momentum and total energy is conserved but kinetic energy is not conserved then it is called inelastic collision.

Collision in one dimension

- An object of mass m_1 is moving with velocity v_1 along + x axis and collides with an object of mass m_2 moving with velocity v_2 in the same direction.
  After collision velocities of mass m_1 and m_2 are v'_1 and v'_2 respectively

$$v'_1 = \frac{m_1 - em_2}{m_1 + m_2} v_1 + \frac{(1+e)m_2}{m_1 + m_2} v_2 \text{ and } v'_2 = \frac{m_2 - em_1}{m_1 + m_2} v_2 + \frac{(1+e)m_1}{m_1 + m_2} v_1$$

Where e = restitution co-efficient = $\frac{v'_2 - v'_1}{v_1 - v_2}$

For, complete elastic collision, e = 1

Complete inelastic collision, e = 0

and For other cases, $0 < e < 1$

- For complete elastic collision (e = 1)

$$\therefore v'_1 = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2 \text{ and } v'_2 = \frac{m_2 - m_1}{m_1 + m_2} v_2 + \frac{2m_1}{m_1 + m_2} v_1$$

- Two objects with mass m_1 and m_2 moving with velocity v_1 and v_2 respectively suffers perfect elastic collision. If their velocities after collision are v'_1 and v'_2 respectively.

	$v'_1 = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2$	$v'_2 = \frac{m_2 - m_1}{m_1 + m_2} v_2 + \frac{2m_1}{m_1 + m_2} v_1$
$m_1 >> m_2$	$v'_1 = v_1$	$v'_2 = -v_2 + 2v_1$
$m_1 << m_2$	$v'_1 = -v_1 + 2v_2$	$v'_2 = v_2$
$m_1 = m_2$	$v'_1 = v_2$	$v'_2 = v_1$

- **Inelastic collision :**

  A body of mass m_1 is moving with velocity v_1 collides with other body of mass m_2 moving with velocity v_2. If the collision is total inelastic then combined velocity after collision,

  $$v = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

- A body of mass 'm' moving with velocity 'v' collides inelastically with stationary body of mass 'm' then after collision,
  - velocity of first body, $v'_1 = \frac{v}{2}(1 - e)$
  - velocity of second body, $v'_2 = \frac{v}{2}(1 + e)$
  - Decrease of energy during collision, $\Delta K = \frac{1}{2}\left(\frac{m_1 m_2}{m_1 + m_2}\right)(1 - e^2)(v_1 - v_2)^2$
  - Body falls from height 'h' collides on the surface, height achieved by body after n - collision is, $h_n = e^{2n} h$
  - Distance travelled by body before it becomes steady, $d = h\left(\frac{1+e^2}{1-e^2}\right)$
  - time taken by body to become stationary, $t = \left(\frac{1+e}{1-e}\right)\sqrt{\frac{2h}{g}}$

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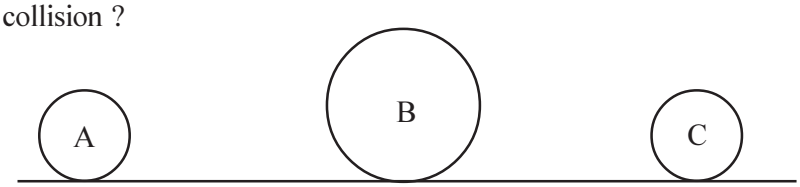
(46) Three stationary spheres of mass 3 kg, 6 kg and 3 kg are kept on a horizontal frictionless surface. At t = 0 time sphere A moving with velocity 9 ms^{-1} collides elastically with sphere B. Then after perfect inelastic collision occurs between B and C. What is the velocity of sphere C after collision ?



(A) 9 ms^{-1} (B) 4 ms^{-1} (C) 1 ms^{-1} (D) Zero

(47) Two spheres of mass m_1 and m_2 ($m_2 = 2m_1$) moving in opposite direction collides with each other. They become stationary after collision. If velocity of sphere having mass m_1 is 12 ms^{-1}, then what is the velocity of a sphere having mass m_2 ?

(A) 12 ms^{-1} (B) 9 ms^{-1} (C) 6 ms^{-1} (D) 3 ms^{-1}

(48) A bomb projected at an angle of 60° with velocity of 200 ms^{-1} explodes in to three equal fragments, at maximum height. First fragment is moving with a speed of 100 ms^{-1} in vertical upword direction, second fragment moving with the same speed in downward direction. If the total mass of bomb is 3 kg, find the kinetic energy of the third fragment.

(A) 300 J (B) 15 kJ (C) 30 kJ (D) 45 kJ

(49) Nucleus of $_{92}U^{238}$ is moving with a speed 'v', emits α - particle which is moving with speed '$3v$' in the same direction. What is the velocity of remaining nucleus ?

(A) $\frac{4v}{238}$ (B) $\frac{113}{117}v$ (C) $\frac{119}{117}v$ (D) Zero

(50) A sphere of mass 8 kg moving in east direction with velocity 8 ms^{-1} collides with strong and a big wall. Calculate the velocity and kinetic energy of a sphere after collision. Consider collision as a perfect elastic.

(A) 8 ms^{-1}, 256 J (B) 4 ms^{-1}, 128 J (C) 0, 256 J (D) 0, 256 J

(51) Two block P and Q having same mass 'm' is moving with velocities 3 ms^{-1} and –5 ms^{-1} respectively on a frictionless horizontal surface collides elastically. What is the ratio of their momentum after collision ?

(A) 3 : 5 (B) 5 : 3 (C) 9 : 25 (D) 25 : 9

(52) Ramesh throws a ball from 16.8 m high tower in downward direction, after collision with surface it reflects back upto 4.2 m height. Find the percentage decrement in a velocity of ball.

(A) 100 % (B) 75 % (C) 50 % (D) 25 %

(53) A bomb explodes in two fragments of equal mass after release from a helicopter which is steady at a certain height, one of the fragment attains horizontal velocity of 15 ms^{-1}. After how much time the vectors connected two fragment with initial point becomes perpendicular ? ($g = 10\ ms^{-2}$)

(A) 15 s (B) 9 s (C) 6 s (D) 3 s

(54) A ball freely falls from 30 m height. If elastic co-efficient during collision is e, then upto how much hight ball would be reflect after second collision ?

(A) 15 e m (B) 60 e m (C) 30 e m (D) 30 e^4 m

(55) An object with mass 'm' thrown in upward direction with a velocity 200 ms^{-1} After 4 sec object divides into two fragments having ratio of mass 1:3. If smaller fragment is moving with a velocity 400 ms^{-1} in upward direction. Find the velocity of larger fragment.

(A) 200 ms^{-1} (B) 100 ms^{-1} (C) 80 ms^{-1} (D) 0

(56) A ball thrown in downward direction from a height 15 m, collides with the surface and losses 50 % energy, reflects back to height of 10 m, then what is its initial speed ?

(A) 5 ms^{-1} (B) 10 ms^{-1} (C) 80 ms^{-1} (D) 00 ms^{-1}

(57) An object falls from height 'h' on the horizontal surface, suffers frequent collision and frequent reflection. If co-efficient of restitution is 'e', then find the travelled distance by object before it becomes steady.

(A) $h\left(\frac{1+e^2}{1-e^2}\right)$ (B) $h\left(\frac{1-e^2}{1+e^2}\right)$ (C) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$ (D) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

(58) A body of mass 4 kg, moving with velocity 12 ms^{-1} collides with a body of mass 6 kg and stick to it. Find the decrease in its kinetic energy.

(A) Zero (B) 288 J (C) 172.8 J (D) 144 J

Ans. : 46 (B), 47 (C), 48 (D), 49 (B), 50 (A), 51 (B), 52 (C), 53 (D), 54 (D), 55 (C), 56 (D), 57 (A), 58 (C)

Assertion - Reason type Question :

Instruction : Read assertion and reason carefully, select proper option from given below.

(a) Both assertion and reason are true and reason explains the assertion.

(b) Both assertion and reason are true but reason does not explain the assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false and reason is true.

(59) **Assertion :** For a body only mass or only energy should not be conserved but mass - energy combinely conserved.

Reason : According to Einstein's equation $E = \Delta mc^2$

(A) a (B) b (C) c (D) d

(60) **Assertion :** When momentum of lighter and heavy body are same, their kinetic energies are always equal.

Reason : Kinetic energy does not depend on mass of body.

(A) a (B) b (C) c (D) d

(61) **Assertion :** Roads on the mountain are curved instead of Straight.

Reason : Slope on the mountains are more so possibility of sliding vehicle is more.

(A) a (B) b (C) c (D) d

(62) **Assertion :** If a spring is extended or compressed for equal length, equal potential energy is stored in both the cases.

Reason : Potential energy of the spring is directly proportional to force constant.

(A) a (B) b (C) c (D) d

(63) **Assertion :** Power of machine-gun P = nK where n = no. of bullets fired per second and K = Kinetic energy of bullet.

Reason : Power of machine-gun $P = \frac{\text{work done by machine-gun}}{\text{time}}$

(A) a (B) b (C) c (D) d

(64) **Assertion :** Work done by damping force is zero, for a body moving under the effect of damping force.

Reason : Work depends on an angle between force and displacement.

(A) a (B) b (C) c (D) d

(65) **Assertion :** If velocity of a sphere moving in horizontal direction becomes double, its kinetic energy becomes four times.

Reason : Kinetic energy is directly proportional to square of velocity.

(A) a (B) b (C) c (D) d

(66) **Assertion :** The graph of potential energy stored in the spring → restoring force is straight line.

Reason : Potential energy stored in the spring is given by $U = \frac{1}{2} kx^2$, where x = compression or expansion of a spring.

(A) a (B) b (C) c (D) d

(67) **Assertion :** During the elastic collision of two body total momentum and total kinetic energy conserved.

Reason : During the collision, if two body sticks with each other, called elastic collision.

(A) a (B) b (C) c (D) d

(68) **Assertion :** The work done to come upto bottom for a body having mass 'm' on the sloped friction less surface making an angle θ and the work done for the same body to move downward from the same height are always equal.

Reason : In both the cases gravitational forces are equal.

(A) a (B) b (C) c (D) d

Ans. : 59 (A), 60 (D), 61 (A), 62 (B), 63 (A), 64 (D), 65 (A), 66 (D), 67 (C), 68 (B)

Match the columns :

(69) Match the column - 1 with column - 2 :

Column-1		Column-2	
(i)	Perfect elastic collision	(P)	losses some kinetic energy
(ii)	Perfect inelastic collision	(Q)	$0 < e < 1$
(iii)	Partial elastic collision	(R)	$e = 1$
(iv)	Partial inelastic collision	(S)	$e = 0$

(A) i → Q ii → R, Q iii → P, S iv → Q, S
(B) i → R ii → P, S iii → R, Q iv → P, R
(C) i → P ii → R, S iii → P, Q iv → S, Q
(D) i → R ii → S iii → P, Q iv → P, Q

(70) Match the columms :

Column-1		Column-2	
(i)	Kinetic energy of a body never be a negative	(P)	Kinetic energy increases by 100 %
(ii)	For uniform circular motion	(Q)	Kinetic energy increases
(iii)	When a bomb explodes from tank	(R)	Kinetic energy remains constant
(iv)	Momentum of a body increases by 50 %	(S)	Statement is true.

(A) i → P ii → R iii → S iv → Q
(B) i → S ii → R iii → Q iv → P
(C) i → S ii → R iii → P iv → Q
(D) i → R ii → Q iii → P iv → S

Ans. : 69 (D), 70 (B)

Comprehension Type Questions :

The relation between potential energy, kinetic energy and total energy is given as below :

$U = mgh$, $K = \frac{1}{2}mv^2$, $E = U + K$ and $\Delta E = \Delta U + \Delta K = 0$

(71) When a body of mass 2 kg freely falls from a tower, what is its kinetic energy at t = 5 s ?

(A) 5000 J (B) 2500 J (C) 2000 J (D) Zero

(72) What is the momentum of a body at that time in above question ?

(A) 100 NS (B) 2500 NS (C) 300 NS (D) Zero

(73) What is the potential energy at that time in above question if total energy is 5000 J ?

(A) 100 J (B) 2500 J (C) 5000 J (D) Zero

(74) What is the change of total energy of a body at a given time ?

(A) 1000 J (B) 2500 J (C) 5000 J (D) Zero

Ans. : 71 (B), 72 (A), 73 (B), 74 (D)

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