# Section A

**1** A projectile is fired at an angle of $45^\circ$ with the horizontal. The elevation angle $\alpha$ of the projectile at its highest point, as seen from the point of projection is:
1. $60^\circ$
2. $tan^{-1}\left(\frac{1}{2}\right)$
3. $tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$
4. $45^\circ$

**2** Each side of a cube is measured to be $7.203$ m. What are the total surface area and the volume respectively of the cube to appropriate significant figures?

| | |
|---|---|
| 1. | $373.7$ m$^3$ and $311.3$ m$^2$ |
| 2. | $311.3$ m$^2$ and $373.7$ m$^3$ |
| 3. | $311.2992$ m$^2$ and $373.7147$ m$^3$ |
| 4. | $373.7147$ m$^3$ and $311.2992$ m$^2$ |

**3** Given below are two statements:

| | |
|---|---|
| **Assertion (A):** | Two similar trains are moving along the equator at the same speed but in opposite directions. They will exert equal pressure on the rails. |
| **Reason (R):** | In uniform circular motion, the magnitude of acceleration remains constant but the direction continuously changes. |

| | |
|---|---|
| 1. | Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**. |
| 2. | Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**. |
| 3. | **(A)** is true but **(R)** is false. |
| 4. | **(A)** is false but **(R)** is true. |

**4** The width of river is 1 km. The velocity of boat is 5 km/hr. The boat covered the width of river with the shortest possible path in 15 min. Then the velocity of the river stream is:
1. 3 km/hr
2. 4 km/hr
3. $\sqrt{29}$ km/hr
4. $\sqrt{41}$ km/hr

**5** Starting from the origin at time $t=0$, with an initial velocity $5\hat{j}$ ms$^{-1}$, a particle moves in the x-y plane with a constant acceleration of $10\hat{i}+4\hat{j}$ ms$^{-2}$. At time $t$, its coordinates are $(20\text{ m}, y_0\text{ m})$. The value of $t$ is:
1. 2 s
2. 4 s
3. 6 s
4. 8 s

**6** A person standing on the floor of an elevator drops a coin. The coin reaches the floor of the elevator in a time $t_1$ if the elevator is stationary and in time $t_2$ if it is moving uniformly. Then:

| | |
|---|---|
| 1. | $t_1=t_2$ |
| 2. | $t_1<t_2$ |
| 3. | $t_1>t_2$ |
| 4. | $t_1<t_2$ or $t_1>t_2$ depending on whether the lift is going up or down |

**7** A person travelling on a straight line moves with a uniform velocity $v_1$, for some time and with uniform velocity $v_2$ for the next equal time. The average velocity $v$ is given by:
1. $v=\frac{v_1+v_2}{2}$
2. $v=\sqrt{v_1v_2}$
3. $\frac{2}{v}=\frac{1}{v_1}+\frac{1}{v_2}$
4. $\frac{1}{v}=\frac{1}{v_1}+\frac{1}{v_2}$

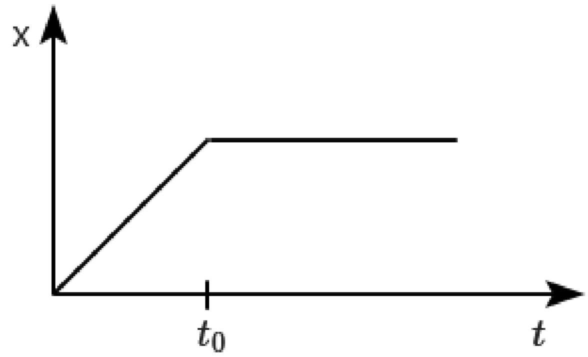
**8** A particle is projected, making an angle of $45^\circ$ with the horizontal and having kinetic energy $K$. The kinetic energy at the highest point will be:
1. $\frac{K}{\sqrt{2}}$
2. $\frac{K}{2}$
3. $2K$
4. $K$

**9** $\hat{i}$ and $\hat{j}$ are unit vectors along the x- and y-axis respectively. What is the magnitude and direction of the vector $\hat{i}-\hat{j}$?
1. $\sqrt{2}$, $45^{\circ}$ with the x-axis.
2. $\sqrt{2}$, $-45^{\circ}$ with the x-axis.
3. $\frac{1}{\sqrt{2}}$, $60^{\circ}$ with the x-axis.
4. $\frac{1}{\sqrt{2}}$, $-60^{\circ}$ with the x-axis.

**10** The main scale of a vernier calliper has $n$ divisions/cm. $n$ divisions of the vernier scale coincide with $(n-1)$ divisions of the main scale. The least count of the vernier calliper is:
1. $\frac{1}{(n+1)(n-1)}$ cm
2. $\frac{1}{n}$ cm
3. $\frac{1}{n^2}$ cm
4. $\frac{1}{(n)(n+1)}$ cm

**11** The position of a particle with respect to time $t$ along the x-axis is given by $9t^2-t^3$ where x is in metre and $t$ in second. What will be the position of this particle when it achieves maximum speed along the +x direction?
1. 32 m
2. 54 m
3. 81 m
4. 24 m

**12** The figure shows the displacement-time graph of a particle moving on the x-axis




| | |
|---|---|
| 1. | the particle is continuously going in a positive x-direction |
| 2. | the particle is at rest |
| 3. | the velocity increases up to a time $t_0$, and then becomes constant |
| 4. | the particle moves at a constant velocity up to a time $t_0$, and then stops. |

**13** The following are four different relations about displacement, velocity, and acceleration for the motion of a particle in general. Choose the incorrect statement(s):

| | |
|---|---|
| a. | $v_{avg}=\frac{1}{2}[v(t_1)+v(t_2)]$ |
| b. | $v_{avg}=\frac{r(t_2)-r(t_1)}{t_2-t_1}$ |
| c. | $r=\frac{1}{2}[v(t_2)-v(t_1)](t_2-t_1)$ |
| d. | $a_{avg}=\frac{v(t_2)-v(t_1)}{t_2-t_1}$ |

| | |
|---|---|
| 1. | (a), (d) |
| 2. | (a), (c) |
| 3. | (b), (c) |
| 4. | (a), (b) |

**14** If the error in the measurement of mass is 0.8% and in volume it is 0.4%, then the error in the measurement of density is:
1. 1.2%
2. 0.4%
3. 0.8%
4. 1%

**15** A particle starts from the origin at $t=0$ and moves in the $x-y$ plane with constant acceleration $a$ in the $y-$ direction. Its equation of motion is, $y=bx^2$. The $x$ component of its velocity is:
1. variable
2. $\sqrt{\frac{2a}{b}}$
3. $\frac{a}{2b}$
4. $\sqrt{\frac{a}{2b}}$

**16** The dimensions of $[ML^{-1}T^{-2}]$ may correspond to:

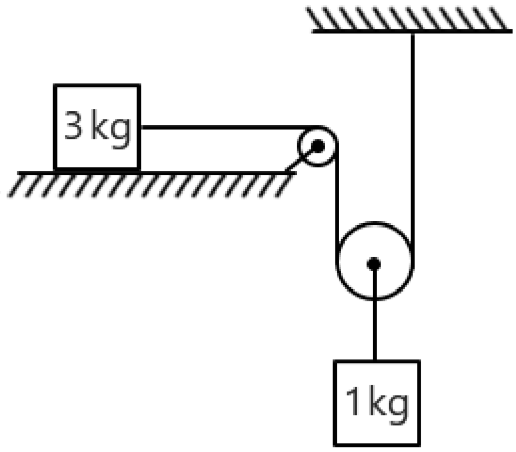
| | |
|---|---|
| a. | work done by a force |
| b. | linear momentum |
| c. | pressure |
| d. | energy per unit volume |

Choose the correct option:

| | |
|---|---|
| 1. | (a) and (b) |
| 2. | (b) and (c) |
| 3. | (c) and (d) |
| 4. | none of the above |

**17** A boy throws a ball straight up the side of a building and receives it after 4 s. On the other hand, if he throws it so that it strikes a ledge on its way up, it returns to him after 3 s. The ledge is at a distance $d$ below the highest point, where $d=?$ (take acceleration due to gravity, $g=10$ m/s$^2$)
1. 5 m
2. 2.5 m
3. 1.25 m
4. 10 m

**18** In the figure shown the horizontal surface is smooth and the strings are inextensible and the massless pulleys are light. If the acceleration of block 1 kg is a, then acceleration of 3 kg is:




1. zero
2. $2a$
3. $\frac{a}{2}$
4. $\frac{a}{4}$

**19** If the kinetic energy of a body is increased by 300%, then the percentage change in momentum will be:
1. 100%
2. 150%
3. 265%
4. 73.2%

**20** If the tension in the cable supporting an elevator is equal to the weight of the elevator, the elevator may be:

| | |
|---|---|
| (a) | going up with increasing speed |
| (b) | going down with increasing speed |
| (c) | going up with uniform speed |
| (d) | going down with uniform speed |

Choose the correct option:

| | |
|---|---|
| 1. | (a) and (b) |
| 2. | (b) and (c) |
| 3. | (c) and (d) |
| 4. | All of these |

**21** A car is negotiating a curved road of radius $R$. The road is banked at an angle $\theta$. The coefficient of friction between the tyre of the car and the road is $\mu_s$. The maximum safe velocity on this road is:

1. $\sqrt{gR\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$
2. $\sqrt{\frac{g}{R}\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$
3. $\sqrt{\frac{g}{R^2}\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$
4. $\sqrt{gR^2\left(\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}\right)}$

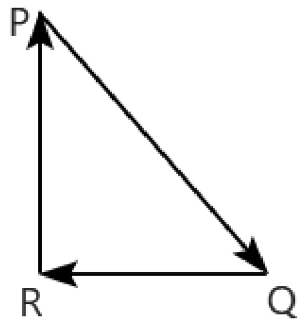
**22** When a heavy mass and lighter mass of a certain material is placed on a surface, then compared to lighter mass, the coefficient of friction between the heavy mass and the surface will:

1. increase
2. decrease
3. remain unchanged
4. become zero

**23** One end of the string of length $l$ is connected to a particle of mass $m$ and the other end is connected to a small peg on a smooth horizontal table. If the particle moves in a circle with speed $v$, the net force on the particle (directed towards the center) will be: ($T$ represents the tension in the string)

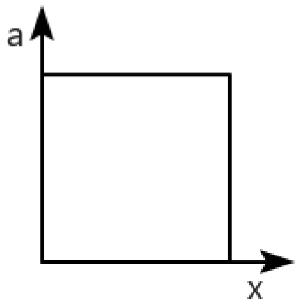
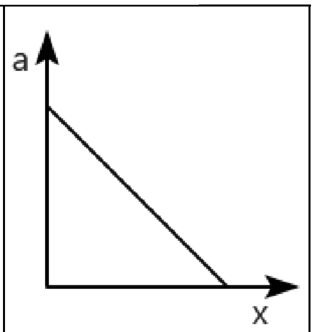
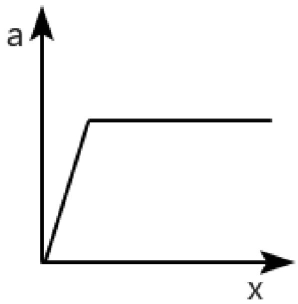
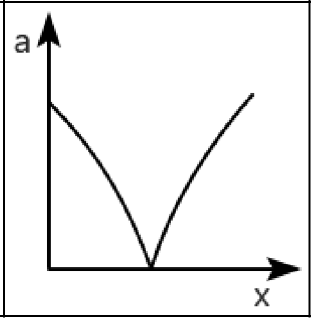
1. $T+\frac{mv^2}{l}$
2. $T-\frac{mv^2}{l}$
3. zero
4. $T$

**24** A particle moving with velocity $\vec{v}$ is acted by three forces shown by the vector triangle PQR. The velocity of the particle will:




| | |
|---|---|
| 1. | change according to the smallest force $\vec{QR}$ |
| 2. | increase |
| 3. | decrease |
| 4. | remain constant |

**25** A light spring is compressed and placed horizontally between a vertical fixed wall and a toy car-free to slide over a smooth horizontal table. If the system is released from rest, which graph best represents acceleration '$a$' and distance '$x$' covered by the car?


| | | | |
|---|---|---|---|
| 1. |  | 2. |  |
| 3. |  | 4. |  |

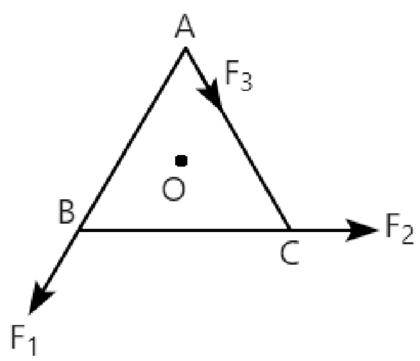
**26** A solid cylinder of mass 3 kg is rolling on a horizontal surface with a velocity of 4 ms$^{-1}$. It collides with a horizontal spring of force constant 200 Nm$^{-1}$. The maximum compression produced in the spring will be:
1. 0.5 m
2. 0.6 m
3. 0.7 m
4. 0.2 m

**27** An engine pumps water continuously through a hose. Water leaves the hose with a velocity $v$ and $m$ is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water?
1. $\frac{1}{2}mv^3$
2. $mv^3$
3. $\frac{1}{2}mv^2$
4. $\frac{1}{2}m^2v^2$

**28** The potential energy of a system increases if work is done:

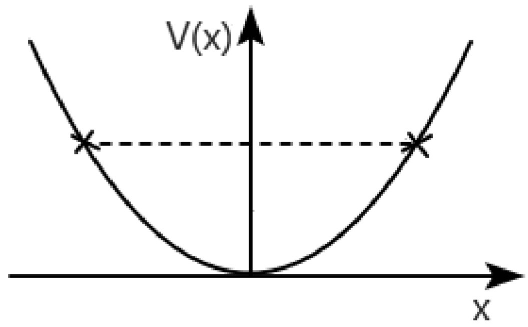
| | |
|---|---|
| 1. | by the system against a conservative force |
| 2. | by the system against a non-conservative force |
| 3. | upon the system by a conservative force |
| 4. | upon the system by a non-conservative force |

**29** ABC is an equilateral triangle with $O$ as its centre. $F_1$, $F_2$, and $F_3$ represent three forces acting along the sides AB, BC and AC respectively. If the total torque about O is zero, then the magnitude of $F_3$ is:




1. $F_1 + F_2$
2. $F_1 - F_2$
3. $\frac{F_1+F_2}{2}$
4. $2F_1 + F_2$

**30** The potential energy function for a particle executing linear simple harmonic motion is given by $V(x) = \frac{kx^2}{2}$, where $k$ is the force constant of the oscillator. For $k = 0.5$ N/m, the graph of $V(x)$ versus $x$ is shown in the figure. A particle of total energy 1 J moving under this potential must turn back when it reaches:




1. x $= \pm 1$ m
2. x $= \pm 2$ m
3. x $= \pm 3$ m
4. x $= \pm 4$ m

**31** What is the minimum velocity with which a body of mass $m$ must enter a vertical loop of radius $R$ so that it can complete the loop?
1. $\sqrt{2gR}$
2. $\sqrt{3gR}$
3. $\sqrt{5gR}$
4. $\sqrt{gR}$

**32** When a mass is rotating in a plane about a fixed point, its angular momentum is directed along:

| | |
|---|---|
| 1. | a line perpendicular to the plane of rotation |
| 2. | the line making an angle of 45° to the plane of rotation |
| 3. | the radius |
| 4. | the tangent to the orbit |

**33** A stone is dropped from a height $h$. It hits the ground with a certain momentum $P$. If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by:
1. 41%
2. 200%
3. 100%
4. 68%

**34** Two similar springs $P$ and $Q$ have spring constants $k_P$ and $k_Q$, such that $k_P > k_Q$. They are stretched, first by the same amount (case a), then by the same force (case b). The work done by the springs $W_P$ and $W_Q$ are related as, in case (a) and case (b), respectively:
1. $W_P = W_Q;\ W_P > W_Q$
2. $W_P = W_Q;\ W_P = W_Q$
3. $W_P > W_Q;\ W_P < W_Q$
4. $W_P < W_Q;\ W_P < W_Q$

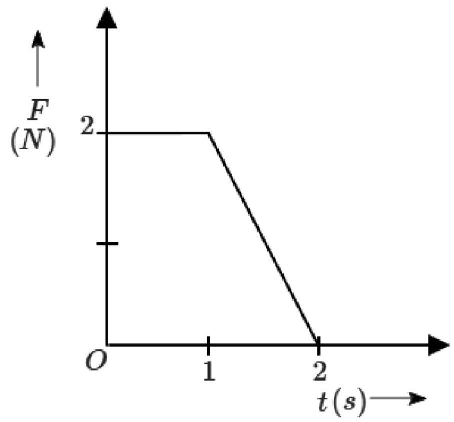
**35** The moment of inertia of a thin uniform rod of mass $M$ and length $L$ about an axis passing through its mid-point and perpendicular to its length is $I_0$. Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is:
1. $I_0 + \frac{ML^2}{4}$
2. $I_0 + 2ML^2$
3. $I_0 + ML^2$
4. $I_0 + \frac{ML^2}{2}$

## Section B

**36** A uniform cylinder of mass $m$ can rotate freely about its axis which is kept horizontal. A particle of mass $m_0$ hangs from the end of a light string wound round the cylinder. When the system is allowed to move, the acceleration with which the particle descends is:
1. $\frac{mm_0g}{m+2m_0}$
2. $\frac{2m_0g}{m+2m_0}$
3. $\frac{m_0g}{m+m_0}$
4. $\frac{2mm_0g}{m+2m_0}$

**37** A bullet of mass 10 g moving horizontal with a velocity of 400 m/s strikes a wood block of mass 2 kg which is suspended by light inextensible string of length 5 m. As result, the centre of gravity of the block is found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges horizontally from the block will be:
1. 100 m/s
2. 80 m/s
3. 120 m/s
4. 160 m/s

**38** A horizontal force $F$ acts on a 2 kg block placed on a smooth horizontal plane. It varies with time $t$ as shown in the figure. The block is initially at rest.



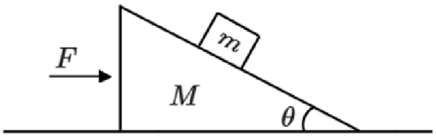

The work done by the force until $t = 2$ s, equals:
1. 6.25 J
2. 4.5 J
3. 2.25 J
4. 1.5 J

**39** Given below are two statements:

| | |
|---|---|
| **Assertion (A):** | According to the law of conservation of mechanical energy change in potential energy is equal and opposite to the change in kinetic energy. |
| **Reason (R):** | Mechanical energy is not a conserved quantity. |

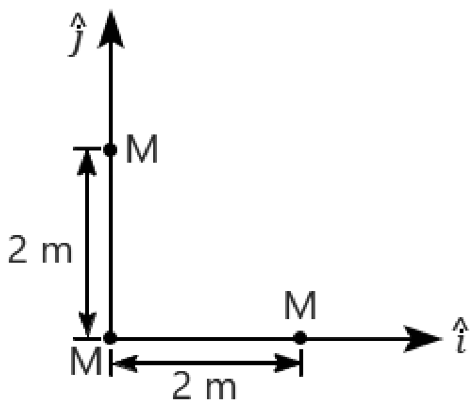
| | |
|---|---|
| 1. | Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**. |
| 2. | Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**. |
| 3. | **(A)** is true but **(R)** is false. |
| 4. | **(A)** is false but **(R)** is true. |

**40** A small block of mass $m$ lies on a frictionless wedge of mass $M$, which is pushed horizontally to the right by means of a constant force $F$. There is no relative motion between block and the wedge. Let the work done by $F$ on $M$ be $W_F$. The work done by the normal force (between $M$ & $m$) on $m$ be $W_m$. Both are measured for the same time interval.




1. $\frac{W_F}{M} = \frac{W_m}{m}$
2. $W_F \cdot M = W_m \cdot m$
3. $\frac{W_F}{M+m} = \frac{W_m}{m}$
4. $\frac{W_F}{M} = \frac{W_m}{m+M}$

**41** Three identical spheres, each of mass $M$, are placed at the corners of a right-angle triangle with mutually perpendicular sides equal to 2 m (see figure). Taking the point of intersection of the two mutually perpendicular sides as the origin, find the position vector of the centre of mass.




1. $2(\hat{i} + \hat{j})$
2. $\hat{i} + \hat{j}$
3. $\frac{2}{3}(\hat{i} + \hat{j})$
4. $\frac{4}{3}(\hat{i} + \hat{j})$

**42** A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on the axis is:

| | |
|---|---|
| 1. | vertical |
| 2. | horizontal and skew with the axis |
| 3. | horizontal and intersecting the axis |
| 4. | none of these |

**43** A particle of mass $5m$ at rest suddenly breaks on its own into three fragments. Two fragments of mass $m$ each move along mutually perpendicular directions with speed $v$ each. The energy released during the process is:

1. $\frac{3}{5}mv^2$
2. $\frac{5}{3}mv^2$
3. $\frac{3}{3}mv^2$
4. $\frac{4}{3}mv^2$

**44**

Four identical thin rods, each of mass $M$ and length $l$, form a square frame. The moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is:

1. $\frac{4}{3}Ml^2$
2. $\frac{2}{3}Ml^2$
3. $\frac{13}{3}Ml^2$
4. $\frac{1}{3}Ml^2$

**45** A uniform circular disc of radius 50 cm at rest is free to turn about an axis that is perpendicular to its plane and passes through its centre. It is subjected to a torque that produces a constant angular acceleration of 2.0 rad $s^{-2}$. Its net acceleration in $ms^{-2}$ at the end of 2.0 s is approximately:

1. 7
2. 6
3. 3
4. 8

**46** A solid cylinder and a hollow cylinder both of the same mass and same external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first:

| | |
|---|---|
| 1. | both together |
| 2. | hollow cylinder |
| 3. | solid cylinder |
| 4. | both together only when angle of inclination of plane is $45^\circ$ |

**47**
A small object of uniform density rolls up a curved surface with an initial velocity $v$. It reaches up to a maximum height $\frac{3v^2}{4g}$ with respect to the initial position. The object is:
1. solid sphere
2. hollow sphere
3. disc
4. ring

**48** A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of $\alpha$ for which angular momentum about the origin is conserved is:
1. -1
2. 2
3. zero
4. 1

**49** Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water, the center of mass of the system shifts by:
1. 3.0 m
2. 2.3 m
3. zero
4. 0.75 m

**50** A solid cylinder of mass 2 kg and radius 4 cm is rotating about its axis at the rate of 3 rpm. The torque required to stop after $2\pi$ revolutions is:
1. $2 \times 10^{6}$ N-m
2. $2 \times 10^{-6}$ N-m
3. $2 \times 10^{-3}$ N-m
4. $12 \times 10^{-4}$ N-m

## Fill OMR Sheet*

*If above link doesn't work, please go to test link from where you got the pdf and fill OMR from there. After filling the OMR, you would get answers and explanations for the questions in the test.