PHY 101
CURRENT PAST.Q

FIRST SEMESTER EXAMINATION 2019/2020 SESSION

PHY 101.1: Intro. to Mechanics & Properties of Matter   Time: $1\frac{3}{4}$ hrs

Instruction: Answer All Questions

1. The number of complete oscillations made in one second by a vibrating system is referred t as (a) Period (b) Amplitude (c) Frequency (d) Wavelength
2. The angular momentum of a rotating body is given as (a) $I\omega$ (b) $I\tau\omega$ (c) $I\tau$ (d) $\frac{1}{2}\omega I^2$
3. A source vibrating at a frequency of 100kHz emits a signal of wavelength 0.75km. What is the speed of the signal? (a) $7.5 \times 10^4 kms^{-1}$ (b) $0.13kms^{-1}$ (c) $7.5kms^{-1}$ (d) $75.0kms^{-1}$
4. Frequency and wavelength are (a) directly related (b) not related (c) equal (d) inversely related
5. The wavelength of sound waves traveling with a velocity of 300m/s is 60m. The period of the wave is (a) 60s (b) 0.2s (c) 0.6s (d) 1.67s
6. A car moves from rest with an acceleration of $0.2m/s^2$.What is the velocity when it has moved a distance of 50m? (a) 4.47m/s (b) 2.0m/s (c) $3.5m/s^2$ (d) $1.5m/s^2$
7. A ball is thrown up vertically with a velocity of 40m/s. What is the time taken to reach the ground? (a) 6s (b) 8s (c) 4s (d) 10s
8. What is the equivalent of 30 in radian? (a) $\frac{\pi}{5}$rad (b) 2π rad (c) $\frac{\pi}{6}$ rad (d) $\frac{2\pi}{5}$ rad
9. The taking off of a rocket can be explained by (a) First law of motion (b) Law of conservation of momentum (c) Second law of motion (d) Law of conservation of energy
10. A ball is thrown with a speed of 30m/s in a direction 30° above the horizon. Determine the height to which it rises. (a) 31m (b) 80m (c) 11.5m (d) 20m
11. A football player will throw a football at maximum distance if the angle of protection is (a) 30° (b) 90° (c) 60° (d) 45°
12. A man pushes a lawn mower with a 40N force directed at an angle 20° downward from the horizontal. Find the work done by the man if he cuts a strip of grass 20m long (a) 502J (b) 60.4J (c) 7.52×10^2J (d) 93.2J
13. Work is defined as (a) $F\Delta m$ (b) $F\Delta r$ (c) $F\Delta v$ (d) $F\Delta t$
14. A spring is stretched 10mm by a weight of 2.0N. Calculate the force constant k, (a) 10N/m (b) 500N/m (c) 100N/m (d) 200N/m
15. By the use of a pulley, a man raises a load of 50kg to a height of 15m in 60seconds. Find the average power required. (a) 300W (b) 70W (c) 125W (d) 400W
16. If a rifle fires a bullet of mass 0.01kg with a velocity of 300m/s, find the recoil velocity if the mass of the rifle is 6kg. (a) 2m/s (b) 3.5m/s (c) 0.5m/s (d) 1.5m/s
17. What is the equivalent of 72° in radian? (a) $\frac{2\pi}{5}$ rad (b) 2π (c) $\frac{\pi}{5}$ (d) $\frac{\pi}{6}$ rad
18. From the figure 1, calculate the total distance covered by the particle (a) 300m (b) 150m (c) 50m (d) 112.5m

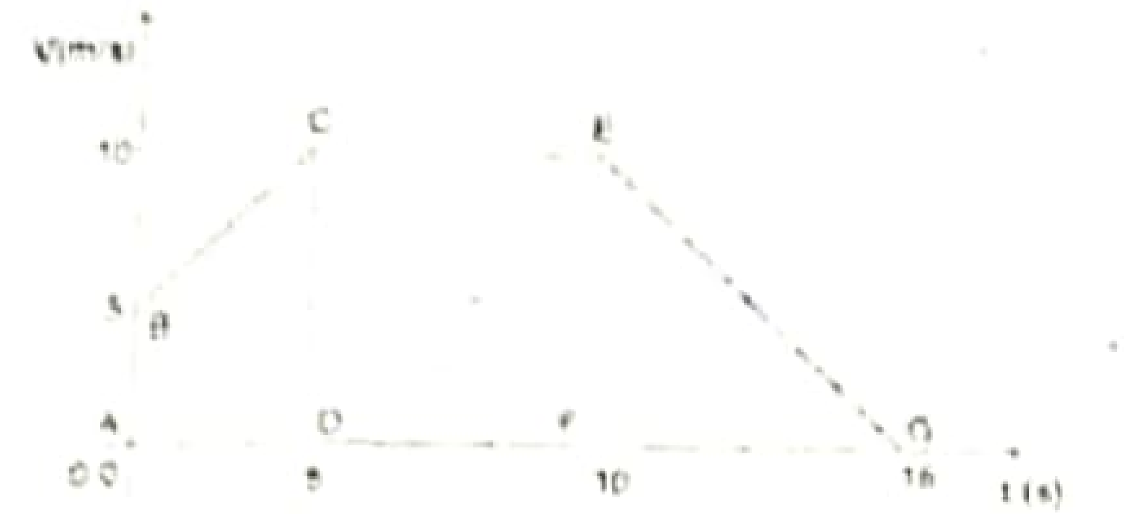


Figure 1: Question 18 Diagram

19. A car is traveling at 60km/h when it begins to accelerate at a rate of $4m/s^2$. How long does it take to travel a distance of 100km? (a) 3.06sec (b) 3.04sec (c) 5.04sec (d) 4.04sec
20. A machine with VR of 5 requires 1000J of work to raise a load of 500N through a vertical distance of 1.5m. find the efficiency. (a) 35% (b) 45% (c) 60% (d) 75%
21. Which of the following gives the relationship between impulse and momentum? (a) $Ft = m(v-u)$ (b) $F = ma$ (c) $F = m(v-u)$ (d) $P = m(v-u)$
22. From the figure 2, if $d_1 = 5m$, $d_2 = 4m$, $d_3 = 7m$; $F_1 = 50N$ and $F_2 = 10N$, find F_3. (a) 50N (b) 60N (c) 30N (d) 20N

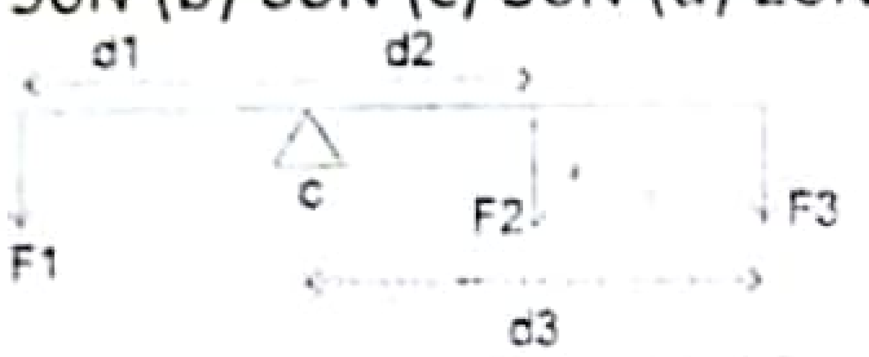


Figure 2: Question 22 diagram

23. A model car moves round a circular track of radius 0.3m at 2 revolutions per second. What is (i) The angular velocity (ii) The period (iii) The speed of the car (a) 3.77π rad/sec, 4s, 5m/s (b) 0.5 π rad/sec, 4s, 3.77m/s (c) 5 π rad/sec, 0.4s, 3.77m/s (d) 4 π rad/sec, 0.5s, 3.77m/s
24. A particle undergoes three consecutive displacements: $d_1 = (2i + 3j - 2k)cm$, $d_2 = (3i - 4j - 4k)$cm, and $d_3 = (-5i + 5j + 3k)cm$. Find the components of the resultant displacement and its magnitude (a) $(3j - 2k)cm$ & 4cm (b) $(5i + 5k)cm$ & 2cm (c) $(3i + 4j)cm$ & 3cm (d) $(4j - 3k)cm$ & 5cm
25. What is the correct dimension for pressure(a)$MM^{-1}T^{-1}$(b)ML^2T^2(c)$ML^{-1}T^{-2}$ (d) MLT^{-1}
26. A ball bearing falls from rest, what will be its velocity after 4seconds? Take $g = 9.8ms^{-2}$ (a) 0m/s (b) 39.2m/s (c) 13.8m/s (d) 5.8m/s
27. A 2kg object is moving horizontally with a speed of 4m/s. How much net force is required to keep the object moving at this speed and in this direction? (a) 0N (b) 8N (c) 2N (d) 10N
28. A 100kg man and 50kg woman on ice skates stand facing each other. If the woman pushes the man backwards so that his final speed is 1m/s, at what speed does she recoil? (a) 2m/s (b) 5m/s (c) 1m/s (d) 0
29. The reading on the Vernier Caliper with a Long Vernier scale (resolution 0.05mm) in Figure 3 is (a) 40.05mm (b) 3.05mm (c) 50.05mm (d) 30.35mm

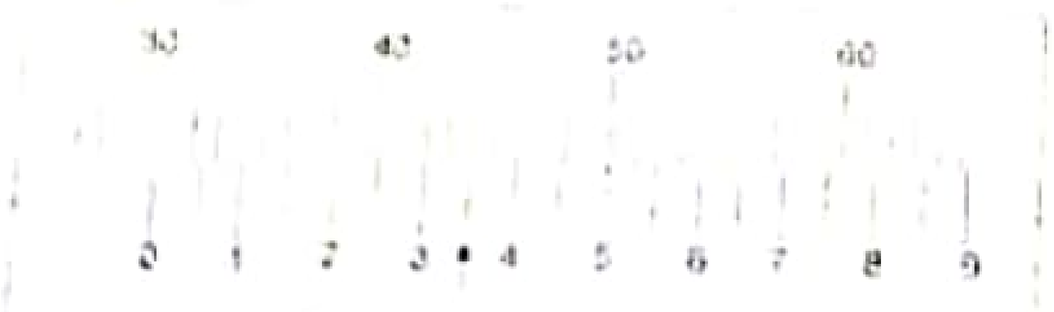


Figure 3: Question 29 Diagram

30. A 6.0N force acts on a 1.50kg mass for 5.0s. Find momentum (a) 30Ns (b) 30N (c) 45N (d) 7.5Ns
31. Find the sum of two vectors A and B lying in the xy plane and given by $A = (10.0i + 15.0j)m$ and $B = (2.0i - 6.0j)m$ (a) $(20i - 90j)m$ (b) $(12i + 9j)m$ (c) $(10i + 90j)m$ (d) $(10i - 15j)m$
32. A rope is used to pull a 200kg car horizontally. If the tension in the string is 2000N and the frictional force is 100N, find the car's acceleration (a) 20m/s² (b) 19m/s² (c) 9.5m/s² (d) 100m/s²
33. Calculate the kinetic energy of 20kg of water (just before it hits the ground) falling from the top of a roof 40m high. (a) 8000J (b) 2000J (c) 200J (d) 4000J
34. A printing machine has its VR as 9. If it requires 20N to overcome a load 90N, calculate its efficiency. (a) 20% (b) 5% (c) 9% (d) 50%
35. A force that causes an object to turn is (a) Pivot 9b) Impulse (c) Moment (d) Torque
36. A constant force of 5kN pulls a crate along a level floor a distance of 15m in 75s. What is the power used? (a) 500W (b) 200W (c) 1000W (d) 250W
37. A bullet weighing 50g moves with a velocity of 108km/h. Calculate the K.E (a) 45J (b) 22.5J (c) 8J (d) 30J
38. When two moments exactly balance each other, the object is said to be in (a) Balance force (b) Constant (c) Equilibrium (d) Inertial
39. A ball is thrown straight upward with an initial speed of 40m/s. How high is the ball at 3s. (a) 120m (b) 70m (c) 80.5m (d) 75.9m
40. A body having a definite shape, and made up of many particles, which are at fixed distance from each other is called (a) Plain body (b) Circular body (c) Rotational body (d) Rigid body
41. A 5kg baseball is thrown upward with a speed of 40m/s. neglecting friction, the maximum height reached by the baseball is approximately? (a) 80.0m (b) 40.0m (c) 200m (d) 100m
42. The magnitude of the momentum of an object is 64kgm/s. If the velocity of the object is doubled, the magnitude of the momentum of the object will be (a) 32kgm/s (b) 128kgm/s (c) 64kgm/s (d) 16kgm/s
43. A 2000kg car travelling at 20m/s collides with a 1000kg car at rest at a stop sign. If the 2000kg car has a velocity of 6.67m/s after the collision, find the velocity of the 1000kg after the collision. (a) 20m/s (b) 26.66m/s (c) 45.2m/s (d) 40m/s
44. A gun of mass 8kg fires a bullet of mass 80g at a speed of 300m/s. With what initial speed does the gun recoil? (a) 4m/s (b) 3m/s (c) 6m/s (d) 8m/s
45. The product of the force and the perpendicular distance of its line of action from the point or axis is? (a) Moment of a force (b) Turning (c) Principle of moment (d) Moment of inertia

46. The velocity of a given sound wave is 250m/s and its frequency is 25Hz. What is the wave number of the sound wave? (a) 0.04rad/m (b) 0.628rad/m (c) 0.2rad/m (d) 0.4rad/m
47. From the fundamental quantities M, L and T derived dimensions of energy and momentum (a) ML^2T^{-2} and MLT^{-1} (b) $ML^{-1}T^{-2}$ and ML^2T^{-1} (c) $ML^{-2}T^{-2}$ and MLT^{-2} (d) MLT^{-1} and $ML^{-2}T^{-2}$
48. A car moving with a speed of 180km/h was brought uniformly to rest by the application of brakes in 20s. How far did the car travel after the brakes were applied? (a) 0.1km (b) 10km (c) 15km (d) 0.5km
49. Find the vector cross product of two vectors $C = 2i - j$ and $D = i + 2j - 3k$. What is the angle between the vectors? (a) 60° (b) 45° (c) 90° (d) 30°
50. A big lump of meat of mass 5kg is hung from a spring balance in an elevator, find the reading of the balance if (i) the elevator is moving with a steady speed (ii) the elevator is moving upwards with acceleration of 0.2m/s² ($g = 10ms^{-2}$) (a) 5N & 1N (b) 50N & 51N (c) 1N & 51N (d) 51N & 50N
51. A body is pulled along by horizontal force of 20N, calculate the work done in moving distance of 40m (a) 60J (b) 800J (c) 40J (d) 400J
52. A 900kg cannon fires 100kg shells with muzzles velocity of 75m/s. Calculate the recoil velocity of the cannon relative to the ground. (a) 8.33m/s (b) 83.3m/s (c) 833m/s (d) 8330m/s
53. It is known that a load with a mass of 200g will stretch a spring 10.0cm. The spring is then stretched an additional 5.0cm and released. Find the spring constant (a) 19.6N/m (b) 96N/m (c) 10N/m (d) 9.6N/m
54. The period of vibration in Q53 (a) 0.635s (b) 1.57s (c) 1.57Hz (d) 0.635Hz
55. The maximum acceleration in Q53 (a) 0.49m/s² (b) 0.9m/s² (c) 9.98m/s² (d) 9.6m/s²
56. The velocity through equilibrium positions in Q53 (a) 0.3m/s (b) 9.89m/s (c) 98m/s (d) 0.495m/s
57. A flywheel of mass 500kg and radius 1m make 500rev/min. Assuming the mass is concentrated along the rim; calculate the energy of the flywheel (a) 685.6J (b) 68.51306J (c) 6.851306J (d) 685130.6J
58. A worker is to paint the walls of a square room 8.00ft high and 12.0ft along each side. What surface area in square meters must she cover? Hint: 1ft = 0.305m (a) 96m² (b) 20m² (c) 80m² (d) 35.27m²
59. The volume of a wallet is 8.50in³. Convert this value to m³, using the definition 1in = 2.54cm (a) 8500m³ (b) 0.0085m³ (c) 1.39×10^{-4}m³ (d) 1390m³
60. An ore loader moves 1200 tons/h from a mine to the surface. Convert the rate to lb/s, using 1ton = 2000lb (a) 6.67lb/s (b) 667lb/s (c) 66.7lb/s (d) 66700lb/s
61. By how much does the volume of a cylinder change if the radius is halved and the height is double? (a) The volume is halved (b) The volume doubles (c) The volume is quartered (d) No change in the volume
62. If the average velocity of an object is zero in some time interval, what can you say about the displacement of the object for that interval? (a) double (b) half (c) zero (d) none of the above
63. You have a mass of 50.0kg and you are standing in an elevator. Your weight is (a) 0

(b) 50N (c) 490N (d) 98N

64. While the elevator is accelerating upward at $1.0m/s^2$ (mass of 50.0kg, in Q63), the net force on you is? (a) zero (b) 98N (c) 490N (d) 50.0N

65. While the elevator is moving upward at a constant speed of 1.0m/s (mass of 50.0kg in Q63), the net force on you is? (a) 50.0N (b) 98N (c) 490N (d) zero

66. The law that states that each planet moves in its own elliptical orbit with the sun at one focus is (a) law of orbit (b) Area Law (c) Period Law (d) Hooke Law

67. A body of mass 20g moves in a circular path with radius of 10m with constant speed of 0.4m/s. What is the centripetal force? (a) 3.8N (b) 0.032N (c) 4.5N (d) 2.0N

68. The construction in Fig. 4 shows (a) $C = B + (-A)$ (b) $C = A + B$ (c) $C = A + (-B)$ (d) $C = A \times B$

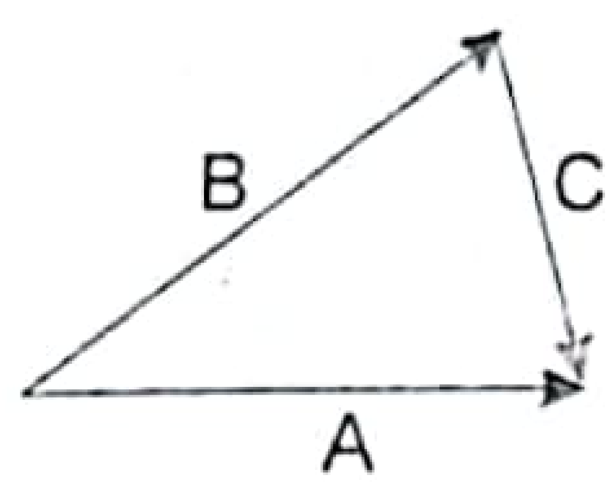


Figure 4: Question 68 Diagram

69. A satellite launched with a $v = \sqrt{\frac{GM_E}{r}}$, its orbit is (a) elliptical (b) linear (c) circular (d) crash onto the earth

70. There are three main types of oscillation except (a) free (b) damped (c) random (d) forced

PHY 101 2019/2020 SOLUTIONS

1. C
2.

Angular momentum L is the rotational analog of linear momentum P.
Since, $P = mv$, where m is mass of body; v is velocity of motion, by relating the linear parameters m and v with their rotational analogs I (moment of inertia) and ω (angular velocity) respectively

$\Rightarrow L = I\omega$

The correct option is A

3.

$f = 100kHz$
$= 100 \times 10^3 Hz = 100000Hz$
$= 100000\ s^{-1}$

$\lambda = 0.75km;\qquad v = ?$

$v = \lambda f$
$= 0.75\ km \times 100000\ s^{-1}$

$v = 75000\ kms^{-1}$

$v = 7.5\times 10^4 kms^{-1}$ A

Note: The units of the given physical quantities are inserted in the formula along with the quantities in the calculation in order to demonstrate the elegance of unit analysis in deducing the correct unit of the final answer.

The correct option is A

4.

From $v = \lambda f$, where λ is wavelength, f is frequency

$\Rightarrow f = \frac{v}{\lambda}$

If v is constant

$\Rightarrow f \propto \frac{1}{\lambda}$

i.e. f is inversely related to λ

The correct option is D

5.

$v = 300m/s;\ \lambda = 60m;\ T = ?$

$f = \frac{v}{\lambda} = \frac{300\ m/s}{60\ m}$

$f = 5\ s^{-1}$

$T = \frac{1}{f} = \frac{1}{5\ s^{-1}}$ B

$T = 0.2$ s

6.

Since the car moves from rest $u = 0\ m/s$, $a = 0.2\ ms^{-2}$, $s = 50m$, $v = ?$

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

$\Rightarrow v^2 = (0)^2 + 2 \times (0.2) \times 50$

$v^2 = 20$ A

$v = \sqrt{20} = 4.47\ m/s$

7.

$u = \frac{40m}{s}$; $g = 10\ ms^{-2}, T = ?$

The time taken to reach the ground is the total time of flight

$$T = \frac{2u}{g}$$

$$= \frac{2\times 40}{10} = 8s$$

8.

$$180^{\circ} = \pi\ rad$$

$$\therefore 30^{\circ} = \frac{30\times\pi}{180}\ rad$$

$$= \frac{\pi}{6}\ rad$$

9. B

10.

$u = \frac{30m}{s}$; $\theta = 30^{\circ}$; $g = 10\ ms^{-2}$; $H = ?$

$$H = \frac{u^2 sin^2\theta}{2g}$$

$$= \frac{(30)^2\times sin^2 30^{\circ}}{2\times 10}$$

$$= \frac{900\times(0.5)^2}{20}$$

$$H = 11.25m$$

11.

Horizontal range $R = \frac{u^2 \sin 2\theta}{g}$

For a maximum range, $R = R_{max}$

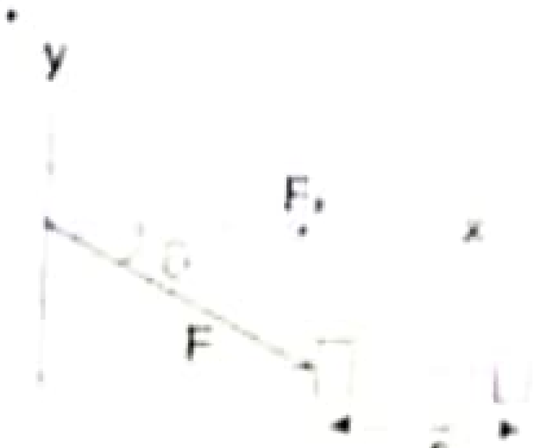
For $R = R_{max}$

$\Longrightarrow \sin 2\theta = 1$

$2\theta = sin^{-1}(-1) = 90^{\circ}$

$\therefore \theta = \frac{90}{2} = 45^{\circ}$

12.



$F = 40N; \theta = 20^{\circ}; s = 20m; W = ?$

The horizontal component of F determines the work done

$$W = F_x\ s$$

$$= (F\cos\theta)s$$

$$= 40\cos 20\times 20 = 752J$$

$$W \cong 7.52\times 10^2\ J$$

13. B

14.

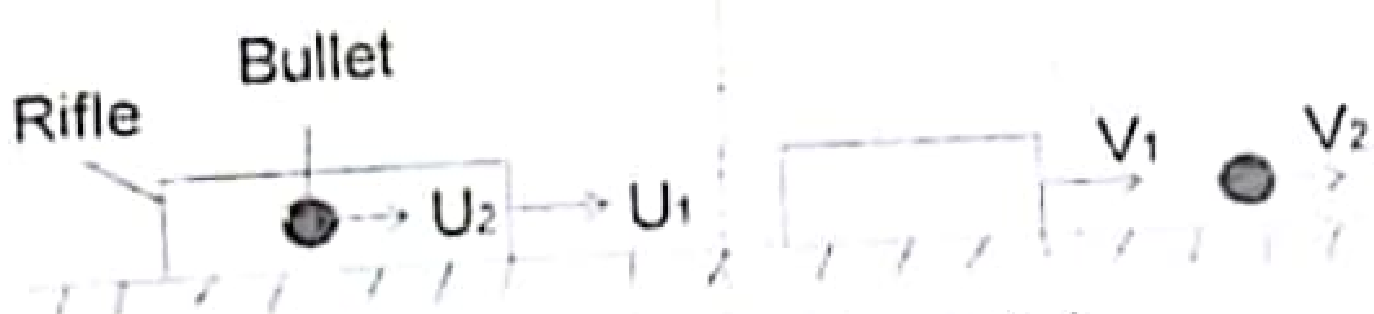
$F = 2.0N$

$e = 10mm = \frac{10}{1000}m = 0.01m$

$k = ?$
From Hooke's law $F = ke$
$k = \frac{F}{e} = \frac{2.0N}{0.01m}$
$k = 200N/m$ D

15.
$m = 50kg$; $h = 15m; t = 60s; g = 10s^{-2}; P = ?$
$F = mg = 50 \times 10 = 500N$
Work done $W = Fh = 500 \times 15 = 7500J$
$Power = \frac{workdone}{time}$
$P = \frac{W}{t} = \frac{7500}{60}$ C
$P = 125W$

16.



Before collision (firing of bullet)

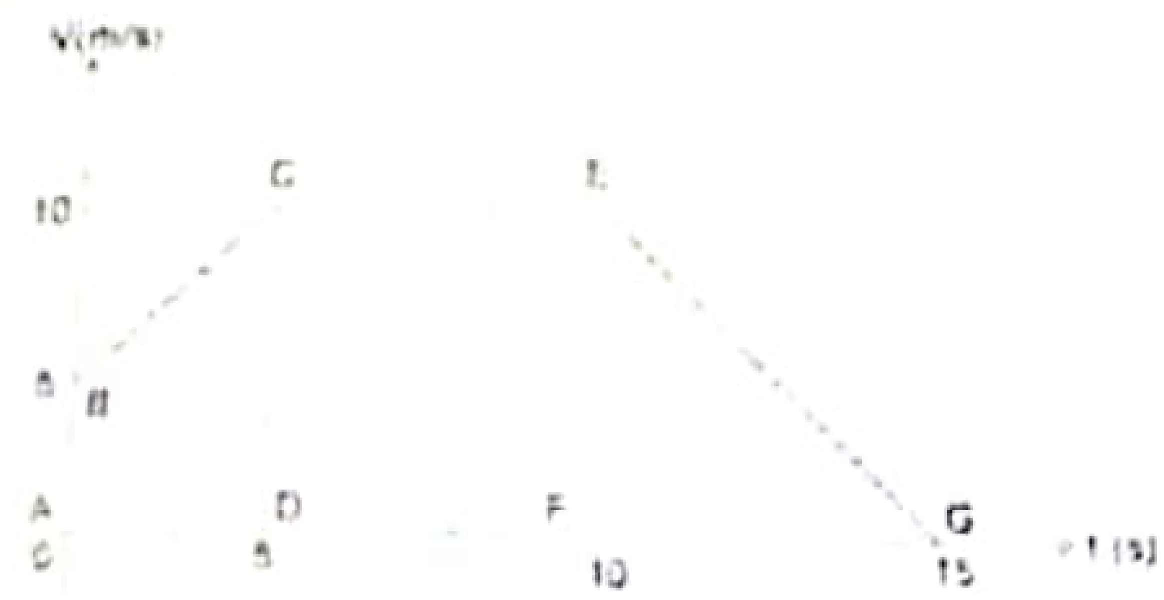
After collision (firing of bullet)

Mass of rifle $m_1 = 6kg$; Initial velocity $u_1 = 0$
Mass of bullet $m_2 = 0.01kg$; initial velocity $u_2 = 0$
Note: Both rifle and bullet are initially at rest before firing, so they have zero initial velocities
Final velocity of rifle = recoil velocity $v_1 = ?$
Final velocity of bullet $v_2 = 300m/s$
From the principle of conservation of momentum
Total momentum before collision = Total momentum after collision
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
$6 \times (0) + 0.01 \times (0) = 6v_1 + 0.01 \times 300$
$0 = 6v_1 + 3$
$6v_1 = -3$
D $v_1 = -\frac{3}{6}$
$v_1 = -0.5\ m/s$
Note: The negative sign implies that the rifle recoils in the opposite direction to the bullet after firing. C

17.
$180° = \pi\ rad$
$72° = \frac{72 \times \pi}{180}\ rad$ A
$= \frac{2\pi}{5}\ rad$

C

18.



Total distance covered = area of trapezium ABCD + area of rectangle CDEF + area of triangle EFG

$$= \left[\tfrac{1}{2}(AB + CD)(AD)\right] + (CD \times DF) + \left[\tfrac{1}{2}(FG) \times EF\right]$$
$$= \left[\tfrac{1}{2}(5 + 10)(5)\right] + [10(10 - 5)] + \left[\tfrac{1}{2}(15 - 10)10\right]$$
$$= \left[\tfrac{1}{2}(15)(5)\right] + [10(10)] + \left[\tfrac{1}{2}(5)(10)\right]$$
$$= 37.5 + 50 + 25 = 112.5m$$

D

19.

$u = 60km/h = \frac{60 \times 1000m}{60 \times 60s} = 16.67m/s$

$a = 4m/s^2$

$s = 100m; \quad t = ?$

Firstly, calculate final velocity v and then time t

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

$\Rightarrow v^2 = (16.67)^2 + 2 \times 4 \times 100$

$= 277.89 + 800$

$v^2 = 1077.89$

$v = \sqrt{1077.89} = 32.83m/s$

From $v = u + at$

$\Rightarrow 32.83 = 16.67 + 4t$

$4t = 32.83 - 16.67$

$4t = 16.16$

$t = \frac{16.16}{4} = 4.04s$

D

20.

$V.R = 5$; work input = 1000J

Load = $500N$; distance load moves = $1.5m$; $\varepsilon = ?$

$\varepsilon = \frac{work\ output}{work\ input} \times 100\%$

$= \frac{load \times distance\ load\ moves}{work\ input} \times 100\%$

$= \frac{500 \times 1.5}{1000} \times 100\%$

$\varepsilon = 75\%$

D

21.

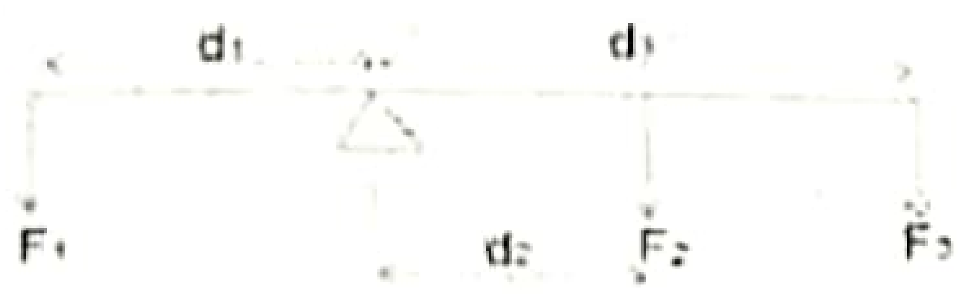
From the impulse-momentum theorem

Impulse = change in momentum

$I = \Delta P$

$Ft = mv - mu$
$Ft = m(v - u)$ A

22.



$F_1 = 50N$; $d_1 = 5m$
$F_2 = 10N$; $d_2 = 4m$
$F_3 = ?$; $d_3 = 7m$
Taking moments about the pivot
Total clockwise moments = Total anticlockwise moments
$F_2d_2 + F_3d_3 = F_1d_1$
$10 \times 4 + F_3 \times 7 = 50 \times 5$
$40 + 7F_3 = 250$
$7F_3 = 250 - 40 = 210$
$F_3 = \frac{210}{7} = 30N$ C

23.
$r = 0.3m$
a) $\omega = \frac{2\ rev}{1\ s} = \frac{2 \times 2\pi\ rad}{1\ s}$ (since 1rev = 2π rad)
$\omega = 4\pi\ rad/s$
b) $T = \frac{2\pi}{\omega} = \frac{2\pi}{4\pi} = \frac{1}{2}$
$T = 0.5s$
c) $v = r\omega$
$= 0.3 \times 4\pi$
$= 0.3 \times 4 \times 3.142$
$v = 3.77\ m/s$ D

24.
$\vec{d_1} = (2i + 3j - 2k)cm$; $\vec{d_2} = (3i - 4j - 4k)cm$; $\vec{d_3} = (-5i + 5j + 3k)cm$
Sum up the individual components to get the resultant displacement in component form
i.e. Resultant displacement $d = \vec{d_1} + \vec{d_2} + \vec{d_3}$
$\vec{d} = (2i + 3j - 2k) + (3i - 4j - 4k) + (-5i + 5j + 3k)$
$\vec{d} = 2i + 3j - 2k + 3i - 4j - 4k - 5i + 5j + 3k$
Collect like terms
$\vec{d} = 2i + 3i - 5i + 3j - 4j + 5j - 2k - 4k + 3k$
$\vec{d} = 4j - 3k$ cm
Magnitude of $\vec{d}$ is
$|d| = \sqrt{(4)^2 + (-3)^2}$
$|d| = \sqrt{25}$
$|d| = 5cm$ D

25.

$$Pressure = \frac{force}{area}$$

$$Dimension = \frac{MLT^{-2}}{L^2}$$

$$= ML^{-1}T^{-2}$$ C

26.

$u = 0m/s$ (balls bearing falls from rest)

$g = 9.8ms^{-2}$; $t = 4s$; $v = ?$

$v = u + gt$

$v = (0) + 9.8 \times 4$

$v = 39.2m/s$ B

27. A · Since the object moves with constant speed, no acceleration, the required net force is zero.

28.

$m_1 = 100kg$; $u_1 = 0$ (man initially at rest)

$m_2 = 50kg$; $u_2 = 0$ (woman initially at rest)

Final speed of man, $v_1 = 1m/s$

Final (recoil) speed of woman, $v_2 = ?$

From conservation of moment

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$100 \times (0) + 50 \times (0) = 100 \times 1 + 50v_2$

$0 = 100 + 50v_2$

$50v_2 = -100$

$v_2 = -\frac{100}{50} = -2m/s$ A

The negative sign shows that the woman recoils in the opposite direction to the man.

29.

30.

$F = 6.0N$; $m = 1.50kg$; $t = 5.00s$

$\Delta P = ?$

$\Delta P = Ft$

$= 6.0N \times 5.00s$

$= 30Ns$ A

31.

$A = (10.0i + 15.0j)m$ $B = (2.0i - 6.0)m$

Sum $= A + B$

$= 10.0i + 15.0j + 2.0i - 6.0j$

$= 12i + 9j\ m$ B

32.

$m = 200kg$; tension $T = 2000N$

Frictional force $f = 100N$; acceleration $a = ?$

The net force $\sum F = ma$

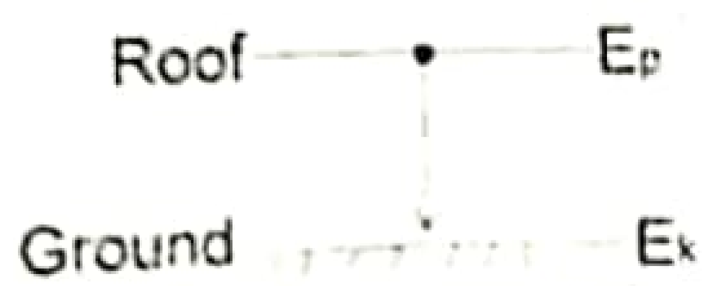
$\Rightarrow T - f = ma$

$2000 - 100 = 200a$

$1900 = 200a$

$a = \frac{1900}{200} = 9.5ms^{-2}$ C

33.



$m = 20kg;\ g = 10ms^{-2};\ h = 40m$

From principle of conversation of energy

Total energy at ground = Total energy at roof

E_k at ground $= E_p$ at roof

$= mgh$

$= 20 \times 10 \times 40$ A

$= 8000J$

34.

V.R = 9 ; load = $90N$; effort = $20N$; $\varepsilon = ?$

M.A $= \frac{load}{effort} = \frac{90N}{20N} = 4.5$

$\varepsilon = \frac{M.A}{V.R} \times 100\%$

$= \frac{4.5}{9} \times 100$ D

$= 50\%$

35. D

36.

$F = 5kN = 5 \times 1000N = 5000N$

$s = 15m;\ t = 75s;\ P = ?$

Power $= \frac{work\ done}{time}$

$P = \frac{Fd}{t} = \frac{5000 \times 15}{75}$ C

$P = 1000W$

37.

$m = 50g = \frac{50}{1000}kg = 0.05kg$

$v = 108km/hr$

$= \frac{108 \times 1000m}{60 \times 60s} = 30m/s$

$E_k = ?$

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

$= \frac{1}{2} \times 0.05 \times (30)^2$ B

$= 22.5J$

38. C

39.

$u = 40m/s$; $t = 3s$

$g = -10ms^{-2}$ (deceleration in upward motion implies negative acceleration)

$h = ?$

$h = ut + \frac{1}{2}gt^2$

$= 40 \times 3 + \frac{1}{2} \times (-10) \times 3^2$

$= 120 - 45 = 75m$ D

40. D

41.

$u = \frac{40m}{s}$; $m = 5kg$; $g = \frac{10}{s^2}$; $H = ?$

$H = \frac{u^2}{2g} = \frac{(40)^2}{2 \times 10}$

$H = 80m$ A

42.

$P_1 = 64kg\ m/s$; $v_2 = 2v_1$; $P_2 = ?$

From $P = mv$

If m is constant, $P \propto v$

$\Rightarrow P = kv$

$\Rightarrow \frac{P}{v} = k$ (where k is constant)

$\Rightarrow \frac{P_1}{v_1} = \frac{P_2}{v_2}$

$\therefore P_2 = \frac{P_1 v_2}{v_1}$

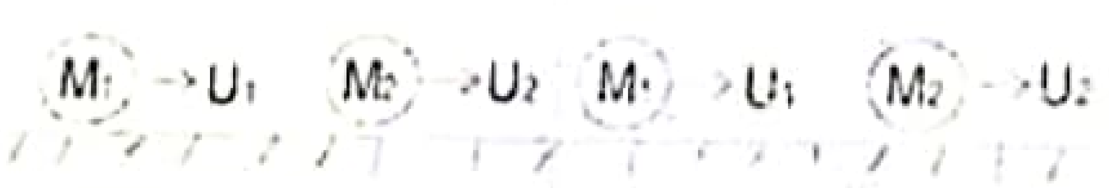
$= \frac{P_1 \times 2v_1}{v_1}$

$P_2 = 2P_1$

$= 2 \times 64kg\ m/s$

$P_2 = 128\ kg\ m/s$ B

43.



Before collision After collision

$m_1 = 2000kg$; $u_1 = 20m/s$

$m_2 = 1000kg$; $u_2 = 0$ (second car initially at rest)

$v_1 = 6.67m/s$; $v_2 = ?$

From momentum conservation

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$200 \times 20 + 1000 \times 0 = 2000 \times 6.67 + 1000 \times v_2$

$40000 = 13340 + 1000v_2$

$1000v_2 = 40000 - 13340 = 26660$

$v_2 = \frac{26660}{1000} = 26.66m/s$ B

44.

$m_1 = 8kg;\ u_1 = 0$ (gun initially at rest)

$m_2 = 80g = \frac{80}{1000}kg = 0.08kg$

$u_2 = 0$ (bullet initially at rest)

$v_1 = ?$ $\quad v_2 = 300m/s$

From momentum conservation

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$8 \times 0 + 0.08 \times 0 = 8v_1 + 0.08 \times 300$

$0 = 8v_1 + 24$

$8v_1 = -24$

$v_1 = -\frac{24}{8} = -3m/s$ B

45. A

46.

$v = 250m/s\ ;\ \ f = 25Hz$

Wave number $k = ?$

From $v = \lambda f$

$\lambda = \frac{v}{f} = \frac{250}{25} = 10m$

$k = \frac{2\pi}{\lambda} = \frac{2\times 3.142\ rad}{10\ m}$

$k = 0.628\ rad/m$ B

47.

Energy = work done = force x distance

Dimension = $MLT^{-2} \times L$

$= ML^2T^{-2}$

Momentum = mass × velocity

Dimension = $M \times LT^{-1}$ A

$= MLT^{-1}$

48.

$u = 180kmh^{-1} = \frac{180\times 1000\ m}{60\times 60\ s}$

$u = 50m/s$

Since the car was brought to rest $v = 0m/s$

$t = 20s\ ;\ \ s = ?$

$s = \frac{1}{2}(u + v)t$

$= \frac{1}{2}(0 + 50) \times 20$

$= 25 \times 20$

$s = 500m = \frac{500}{1000}km$ D

$s = 0.5km$

49.

$\overrightarrow{C} = 2i - j\,;\quad \overrightarrow{D} = i + 2j - 3k$

$$\overrightarrow{C} \times \overrightarrow{D} = \begin{vmatrix} i & j & k \\ 2 & -1 & 0 \\ 1 & 2 & -3 \end{vmatrix}$$

$= i[3 - 0] - j[-6 - 0] + k[4 - (-1)]$

$= i(3) - j(-6) + k(5)$

$\overrightarrow{C} \times \overrightarrow{D} = 3i + 6j + 5k$

$|C \times D| = \sqrt{(3)^2 + (6)^2 + (5)^2} = \sqrt{70}$

$|C| = \sqrt{(2)^2 + (-1)^2} = \sqrt{5}$

$|D| = \sqrt{(1)^2 + (2)^2 + (-3)^2} = \sqrt{14}$

But $|C \times D| = |C||D| \sin\theta$

Where θ is the angle between vectors $\overrightarrow{C}$ and $\overrightarrow{D}$

$\Rightarrow \sqrt{70} = \sqrt{5}\,.\sqrt{14}\,\sin\theta$

$\sqrt{70} = \sqrt{70}\,\sin\theta$

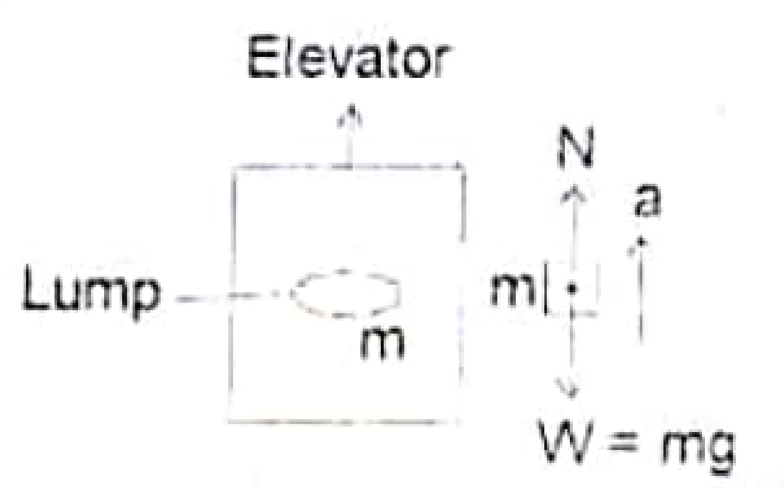
$\sin\theta = \frac{\sqrt{70}}{\sqrt{70}} = 1$

$\theta = sin^{-1}(1)$

$\theta = 90°$

C

50.



$m = 5kg;\quad g = 10ms^{-2}$

Let the reading of the balance be N

i) If the elevator is moving at steady (uniform) speed, $a = 0ms^{-2}$

From Newton's second law of motion, resultant for $F = ma$

$N - W = m(0)$

$N - mg = 0$

$N = mg = 5 \times 10 = 50N$

ii) If $a = 0.2ms^{-2}$

$F = ma$

$N - W = ma$

$N - mg = ma$

$N = mg + ma = m(g + a)$

$N = 5(10 + 0.2)$

$N = 51N$

B

51.

$F = 20\,;\quad s = 40m\,;\quad$ W = ?

$W = F \times s$

$= 20N \times 40m$

$= 800J$

B

52.

$m_1 = 900kg$; $u_1 = 0m/s$ (cannon at rest)
$m_2 = 100kg$; $u_2 = 0m/s$ (shell at rest)
$v_2 = 75m/s$; $v_1 = ?$
Using $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
$\Rightarrow 900 \times 0 + 100 \times 0 = 900 \times v_1 + 100 \times 75$
$0 = 900v_1 + 7500$
$900v_1 = -7500$ A
$v_1 = -\frac{7500}{900} = -8.33m/s$

53.

$m = 200g = \frac{200}{1000}kg = 0.2kg$; $g = 9.8m/s^2$
$F = mg = 0.2 \times 9.8 = 1.96N$
$e = 10.0cm = \frac{10}{100}m = 0.1m$
$k = ?$
From $F = ke$
$\Rightarrow 1.96 = k \times 0.1$ A
$k = \frac{1.96}{0.1} = 19.6N/m$

54.

$T = 2\pi\sqrt{\frac{m}{k}}$
$= 2 \times 3.142 \times \sqrt{\frac{0.2}{19.6}}$ A
$T = 0.635s$

55.

56.

57.

$m = 500kg$; $r = 1m$
$\omega = \frac{500rev}{1min} = \frac{500 \times 2\pi\ rad}{60s}$
$= \frac{500 \times 2 \times 3.142}{60} = 52.367rad/s$
$I = \frac{1}{2}mr^2 = \frac{1}{2} \times 500 \times (1)^2 = 250kgm^2$
$E = \frac{1}{2}I\omega^2 = \frac{1}{2} \times 250 \times (52.367)^2$ No Correct Option
$E = 342787J$

58.

Length $l = 12.0ft = 12ft \times \frac{0.305m}{1ft} = 3.66m$
Breadth $b = 8.0ft = 8.0ft \times \frac{0.305m}{1ft} = 2.44m$
Area $A = lb = 3.66m \times 2.44m = 8.93m^2$ No Correct Option

59.

Volume $= 8.50in^3$
$= 8.50 \times (2.54cm)^3$
$= 8.50 \times (2.54 \times 10^{-2}m)^3$
$= 8.50 \times (2.54)^3 \times (10^{-2})^3 m^3$
$= 8.50 \times 16.387 \times 10^{-6}m^3$
$= 1.392 \times 10^{-4}m^3$ C

60.

To convert 1200 tons/h to lb/s
Using $1ton = 2000lb$

$$1200\ ton/h = \frac{1200tons}{1h} \times \frac{1h}{3600s} \times \frac{2000lb}{1ton}$$

$$= \frac{\frac{1200\times2000}{3600}lb}{s} = 666.67\ lb/s$$ B

61.

Volume of cylinder
$V = \pi r^2 h$
Since π is constant
$V_1 = \pi r_1^2 h_1$ ------------- (1)
$V_2 = \pi r_2^2 h_2$
Given $r_2 = \frac{r_1}{2}$; $h_2 = 2h_1$

$$V_2 = \pi \left(\frac{r_1}{2}\right)^2 (2h_1) = \pi \frac{r_1^2}{4} 2h_1$$

$V_2 = \frac{\pi r_1^2 h_1}{2}$ --------------- (2)

Divide (2) by (1)

$$\frac{V_2}{V_1} = \frac{\frac{\pi r_1^2 h_1}{2}}{\pi r_1^2 h_1}$$

$$= \frac{\pi r_1^2 h_1}{2} \times \frac{1}{\pi r_1^2 h_1}$$

$$\frac{V_2}{V_1} = \frac{1}{2}$$

$$V_2 = \frac{V_1}{2}$$

i.e. the volume is halved A

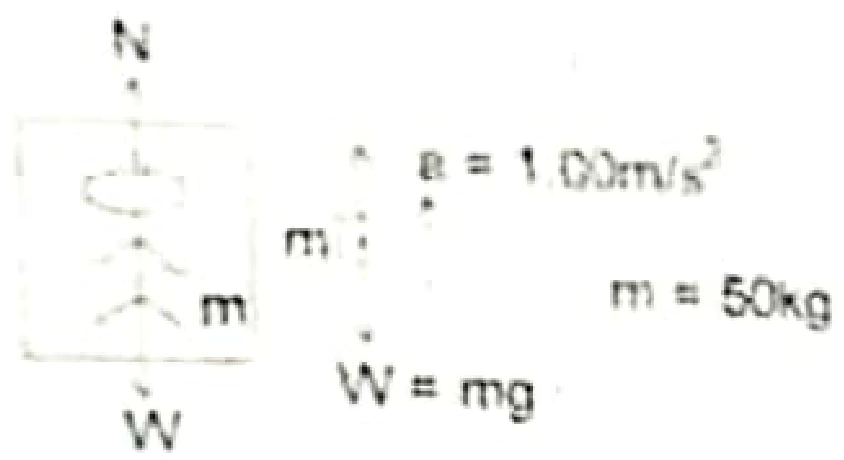
62.

Displacement = average velocity x time
$s = \frac{1}{2}(u + v)t$
If average velocity is zero
$\Rightarrow$ displacement is zero C

63.

$m = 50kg$; $g = 9.8ms^{-2}$
$W = mg = 50 \times 9.8 = 490N$ C

64.



Let apparent weight = N

From Newton's second law, resultant (net) force $F = ma$ **D**

$\Longrightarrow F = 50 \times 1.0 = 50N$

65. **D**

66. **A**

67.

$$m = 20g = \frac{20}{1000}kg = 0.02kg$$

$r = 10m\ ;\quad v = 4.0m/s\ ;\quad F_c = ?$ **B**

$$F_c = \frac{mv^2}{r} = \frac{0.02 \times (4)^2}{10} = 0.032N$$

68. **C**

69. **C**

70. **C**

FIRST SEMESTER EXAMINATION 2020/2021 SESSION

PHY 101.1 INTRODUCTION TO MECHANICS AND PROPERTIES OF MATTER

INSTRUCTIONS: Attempt ALL Questions TzIME: 1HR 30MINS

1. The principle of the conservation of mechanical energy states that in a given or closed system, energy can _____ a.) be created and destroyed b.) Neither be created and destroyed c.) Either created and destroyed d.) neither be created nor destroyed.
2. A bullet of mass 0. 002kg is moving with a velocity of 500m/s. What is its Kinetic Energy? a.) 250J b.) 420J c.) 350J d.) 1.0J
3. A man with mass 60kg works up a flight of stairs 15m high. Calculate how much work is done against gravity. A.) 22.2m, 11.1m b.) 11.1m, 53.3m c.) 20m, 22.2m d.) 10m, 63.3m
4. A box of mass 30kg was pulled along the ground. If the frictional force between the object and the ground is 20N, how much work is done in pulling the box a distance of 50m?. a.) 150J b.) 600J c.) 300J d.) 100J
5. If a gun of mass 4kg fires a bullet of mass 20kg, if the bullet leaves the muzzle of the gun with a velocity of 300.0m/s, what is the velocity of the recoil of a gun? a.) 5m/s b.) 1.5m/s c.) 150m/s d.) 15m/s
6. A ball of mass 0.4kg is released from a height of 30m. What is the potential energy on impact to the ground? (a) $100J$ (b) $70J$ (c) $120J$ (d) $102J$
7. A rocket of mass 40,000kg propelled by a force of 10^6N and requires a speed of 3000m/s,. determine the power expended. (a) $2 \times 10^9 Watts$ (b) $1 \times 10^9 Watts$ (c) $4 \times 10^9 Watts$ (d) $3 \times 10^9 Watts$
8. Convert an angle 60° to radian. (a) $\frac{\pi}{2}$rad (b) $\frac{\pi}{3}$rad (c) 3π rad (d) $\frac{3\pi}{2}$rad
9. The angular displacement of a gear is $\theta = 2t^2 + 9t + 5. If\ t\ is\ in\ seconds, calculate\ the\ angular\ velocity\ at\ t = 4s.$ (a) 20rad/s (b) 22rad/s (c) 30rad/s (d) 25rad/s.
10. Find the angular speed of a 78rev/min turntable in radian per seconds. (a) 2.6rad/s (b) 26rad/s (c) 0.26rad/s (d) 260rad/s
11. A disc starting from rest at t = 0, rotates with a constant angular acceleration of 0.40rad/s^2 counterclockwise. What is angular velocity at t = 30secs? (a) 12 rad/s (b) 0.12rad/s (c) 0.13rad/s (d) 75rad/s
12. If the moment of inertia of a door about its axis is given as I = 8.2kgm^2 and the door is rotating at an angular speed 0.71rad/s. What is its rotational kinetic energy? (a) 0.21J (b) 21J (c) 2.1J (d) 5.8J.
13. A wheel rotating about a fixed axis has a K.E of 29J when its angular speed is 13rad/s. What is the wheel's moment of inertia about its axis of rotation? (a) 0.34kgm^2 (b) 34 kgm^2 (c) 377 kgm^2 (d) 2.2 kgm^2
14. If the radius of a circular orbit is 50cm. Calculate its linear velocity if the angular velocity is 6rad/s. (a) 30m/s (b) 300m/s (c) 3m/s (d) 8.3 kgm^2
15. A body on the circular orbit makes an angular displacement given by $\theta = 4t^3 + 3t^2 - 5$

Calculate its angular acceleration at t = 3sec (a) 78rad/s^2 (b) 72rad/s^2 (c) 126rad/^{2}
(d) 7.8rad/s^2

16. One complete revolution makes (a) 260° (b) 270° (c) 180° (d) 360°
17. Convert 120° to revolutions (a) $\frac{1}{3}$ rev (b) $\frac{1}{5}$ rev (c) 2 rev (d) $\frac{1}{2}$ rev
18. What is the centre of mass of three particles of masses m_1 = 2.0kg, m_2=4.0kg and m_3= 6.0kg located at different points x_1 = 3m, x_2 = -2m and x_3 = 4m respectively along x-axis (a) 3.17m (b) 1.83m (c) 2.4m (d) 18.3m
19. Linear Momentum can be defined as (a) mass × velocity (b) Mass × $distance$ (c) Force × $distace$ (d) mass × $time$
20. What is the unit for linear momentum? (a) kgm/s (b) kg/m/s (c) m/kgs (d) N/m
21. What is the unit for work? (a) $Newton$ (b) $Watts$ (c) $Joules$ (d) $Kilogram - metere$
22. What is the unit for Power? (a) Joules (b) Newton-metre (c) Newton (d) Watts
23. Which of these is not a vector quantity. (a) Weight (b) Energy (c) Displacement (d) Impulse
24. What is the dimensional expression for Power? (a) ML^2/T^3 (b) ML/T^3 (c) ML^2/L^2 (d) $M/T^3 L^2$
25. Find the centre of mass of the system(figure 1), all lying along x- axis. (a) $\frac{12}{13}L$ (b) $\frac{4}{12}L$ (c) $\frac{21}{13}L$

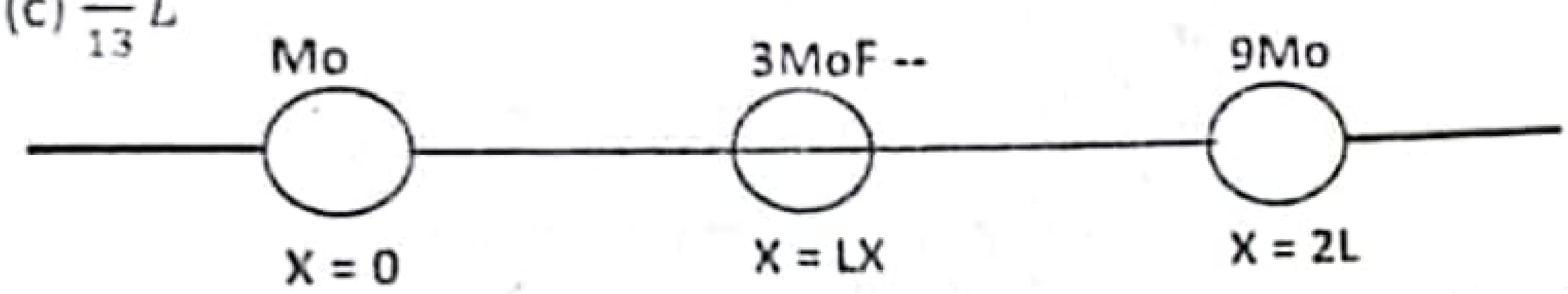


Figure 1

26. A 15g bullet travelling at a velocity of 300m/s strikes and is absorbed by a 75kg object. Find the velocity which the objects moves off. (a) 0.06m/s (b) 6m/s (c) 60m/s (d) 0.6m/s
27. A 5.0kg object travelling at 1.0m/s collides head on with a 10.0kg object initially at rest. If the two objects get stocked and move in the same direction after the collision, what is their velocity?. (a) 3m/s (b) 0.33m/s (c) 3.3m/s (d) 33m/s
28. A body of weight 20N, mass 2kg is moving in a vertical motion with the help of a string of radius 1mand with a velocity of 2m/s. What is the tension in the string at the lowest point?. (a) 28N (b) 20N (c) 8N (d) 115N
29. A motor bike of mass of 200kg started from rest and moves with a speed of 30m/s for 10s. What is the momentum with which the bike is moving? (a) 6kgm/s (b) 60Kgm/s (c) 6000kgm/s (d) 0.6kgm/s
30. What is the force a motor bike of mass of 200kg is moving with if it started from rest and moves with a speed of 30m/s for 10seconds?. (a) 600N (b) 60N (c) 6000N (d) 0.6N
31. A bullet of mass 20g is fired into a 10kg stationary block. As a result of the impact, the block and the bullet moved in the same direction a distance of 45cm in 1 sec. What is velocity with which the bullet was fired? (a) 225.45m/s (b) 22.54m/s (c) 0.22m/s (d) 22545m/s.

32. A car of mass 1000kg is moved by a force of $6.1\times 10^{-3}N$. What is the speed of the car after 8 seconds (a) 15.8m/s (b) 48.8m/s (c) $60m/s$ (d) $80\ m/s$

33. What is the equivalent of 150km/hr in m/s? (a) $150m/s$ (b) $2.5m/s$ (c) $0.41m/s$ (d) $41.67m/s$

34. An object has a mass of 13kg and weight 127N on the earth. Find the object weight on Endor moon, if acceleration due to gravity on Endor moon is 2m/s (a) 254.8N (b) 13Kg (c) 26N (d) 127.4Kg

35. If a = $i + 2j - 3k$ and $b = 2i - 3j + 4k$, then $a \cdot b$ is _ (a) −16 (b) 3i − j + 4k (c) − i − 10j − 7k (d) −i + 5j − 7k

36. Which of these is correct in terms of quantification of units? (a) Pico > Tera (b) Nano > Deka (c) Milli > Deci (d) Giga > Mega

37. The type of mechanics which describes the motion of particles with emphasis on phenomena associated with motion is ______ (a) Kinematics (b) Dynamics (c) Newtonian (d) Rotation

38. An arrow is fired with an initial velocity of 20.0m/s at an angle of 37° with the horizontal. How long does the arrow stay in the air? (a) 1.22sec (b) $3.26sec$ (c) 4.08sec (d) 2.46sec

39. The slope of the plot of velocity-time graph gives the ____. (a) Moment (b) Acceleration (c) Speed (d) Velocity

40. A particle of mass 800kg is lifted up vertically by a force of 10^4N, if the g = 10m/s^2, the upward acceleration of the particle will be (a) 12.5m/s^2 (b) 10m/s^2 (c) 2.5m/s^2 (d) 5m/s^2

41. The tendency of an object to resist a change of its state wither at rest or motion at constant speed along a straight line is called _____ (a) Momentum (b) Dynamics (c) Inertia (d) Friction

42. The acceleration of an object that rolls down a plane inclined at 30° to the horizontal (g= 10m/s^2) is ____(a) 2m/s^2 (b) 3m/s^2 (c) 4m/s^2 (d) 5m/s^2

43. Three particles of masses 2kg, 3kg and 5kg are spaced along a line through x-axis and x = 1cm, x = 2cm and x = 6cm respectively. Find the center of mass (a) $4.1cm$ (b) $4.2cm$ (c) $4.3cm$ (d) $4.4cm$

44. When the net external force acting on a body is zero, which of the following is true about the velocity of the centre of mass will _____ (a) It increases (b) It decreases (c) It remains constant (d) it doubles

45. An object of mass 5kg moving with a velocity of 100m/s makes a head-on collision with another object of equal mass moving with a velocity of 10m/s. If they stick together after collision, calculate their common velocity. (a) 20m/s (b) 25m/s (c) 35m/s (d) 45m/s

46. A force is acting on a body of mass 50kg moving at 50m/s. If the velocity increases to 50m/s, calculate the impulse in the body. (a) $180Ns$ (b) $1800Ns$ (c) $250Ns$ (d) $2500Ns$

47. Which of the following is not true about inelastic collision? (a) *There is deformation* (b) *The objectmove together after collision* (c) *Momentum is conserved* (d) *Kinetic Energy is conserved*

48. An object is moving in a circle of radius 2m with angular velocity of 200rad/s. Calculate the initial velocity. (a) 200m/s (b) 200rad/s (c) 300m/s (d) 300rad/s

49. If a body id travelling in a circle of diameter 10m with velocity 20m/s. Find the angular frequency (a) 4Hz (b) $\frac{1}{4}Hz$(c) 100Hz (d) 5Hz

50. A body moving in a vertical circular motion which of the following does it not experience (a) $Center\ of\ gravity$ (b) $Centripetal\ force$ (c)$Frictional\ force$ (d)$Normalreaction\ force$

51. Calculate the rotational kinetic energy of an object rotating with angular velocity of 20rad/s if the moment of inertia is $12kgm^2$ (a) 240J (b) 2400J (c) 240kJ (d) 2.4J

52. Calculate the radial acceleration of a particle moving round a circular part of radius of 0.5m if the angular velocity is 6rad/s (a) $18m/s^2$ (b) $36m/s^2$ (c) $12m/s^2$ (d) $1.8m/s^2$

53. The center of mass (cm) position R_{cm} $is\ defined\ mathematically\ with\ respect\ to\ a\ fixed\ angle\ for\ \ a\ system\ of\ n\ particles\ as:$ (a) $R_{cm} = \frac{\sum m_i r_i}{\sum m_i}$ (b) $R_{cm} = \frac{\sum m_i}{\sum m_i r_i}$ (c) $R_{cm} = \frac{\sum m_i r_i}{M}$ (d) $R_{cm} = \frac{\sum m_i r}{\sum m_i}$

54. Find the center of mass of particles $m_1 = 2kg$, $m_2 = 3kg$ and $m_3 = 2kg$ where the masses are located at the corner of an equilateral triangle1.0cmon a side. (a) $R_{cm} = \frac{4}{7} + \frac{\sqrt{3}}{7}j$ (b) $R_{cm} = \frac{4}{7}I + \frac{\sqrt{3}}{7}j$ (c) $R_{cm} = \frac{\sqrt{3}}{7} + \frac{4}{7}j$ (d) $R_{cm} = \frac{2}{7} + \frac{\sqrt{3}}{7}j$

55. An Isolated system is one for which ____ (a) The vector sum of the external forces acting on the system is double (b) the vector sum of the external forces acting on the system is zero (c) The algebraic sum of the kinetic energy is equal to $\frac{1}{2}ma$ (d) The algebraic sum of the external forces acting on the system is zero.

56. Based on Newton's 2nd law of motion, the net force on a particle is ____ (a) F = ma (b) F = $\frac{dv}{dt}$ (c) F = $\frac{dt}{dv}$ (d) F = $\frac{1}{2}mv^2$

57. The general motion of a rigid body is a combination of both ____ (a) Kinetic energy and Potential energy (b) Linear and angular momentum (c) Translational and rotational (d) Torque and momentum

58. Based on the associative law of addition in figure 2, the value of x is ____ (a) $x = (-A)$ (b) $A + (B + C)$ (c) $x = A + (-B)$ (d) $x = AB$

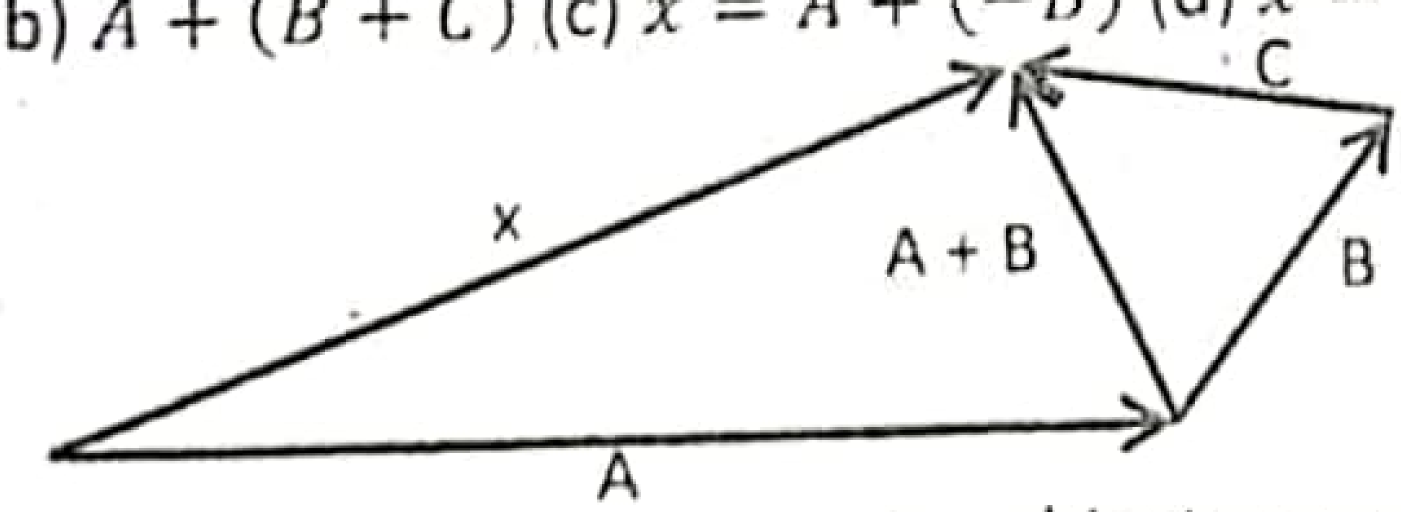


Figure 2

59. If the distance between two objects were doubled, the force of gravitational attraction between two objects would be ___ (a) Same (b) Doubled (c) One Half (d) One quarter of the original force

60. A body of mass 10kg is moving with a velocity of 5m/s in a circle of radius 5m. What is the centripetal acceleration of the body? (a) $5ms^{-2}$ (b) $5ms^{-2}$ (c) $0.5ms^{-2}$ (d) $50ms^{-2}$

61. Two asteroids exert a gravitational force on each other sometime later, the asteroids are now three times as far from each other as before. Which of the following represents the gravitational force at this distance? (a) $\frac{F}{3}$ (b) $\frac{F}{2}$ (c) $\frac{F}{6}$ (d) $\frac{F}{9}$

62. Two Objects of masses M and m sit r distance apart. What will be the effect on the gravitational force between them if the masses are 2M and 3m? (a) It will increase 36 fold (b) It will increase 6 fold (c) It will increase 3 fold (d) It will not change unless r is changed

63. A grindstone has a constant angular acceleration a of rad/s² Find the angular displacement of a line joining a point p to the axis at 0. (a) 6.0rad (b) 7.0rad (c) 5.0 rad (d) 4.0rad

64. Which of the following represents the moment of Inertia I of the rigid body with respect to the particular axis of rotation. (a) $I = \sum m_i r_i^2$ (b) $I = \sum r_i r_i^2$ (c) $I = \sum \frac{1}{2} w^2 r_i^2$ (d) $I = \sum m_i v_i^2$

65. A ball bearing falls from rest with an acceleration, what will be its velocity after 4 seconds? Take g = 9.8m/s² (a) $39.2m/s$ (b) $\frac{0m}{s}$(c) $13.8m/s$ (d) $5.8m/s$

66. Which of the following provides a relation between the moment of inertia I_p *about an axis through an aribrary point* p *and the moment of inertia* I_{cm} *about a parallel axis through the center of mass.* (a) $md^2 = I_p - m_i r_i$ (b) $I_p = I_{cm} + md^2$ (c) $I_p = \frac{4\pi r^2}{I_{cm}}$ (d) $I_p = I_{cm} + 4md^2$

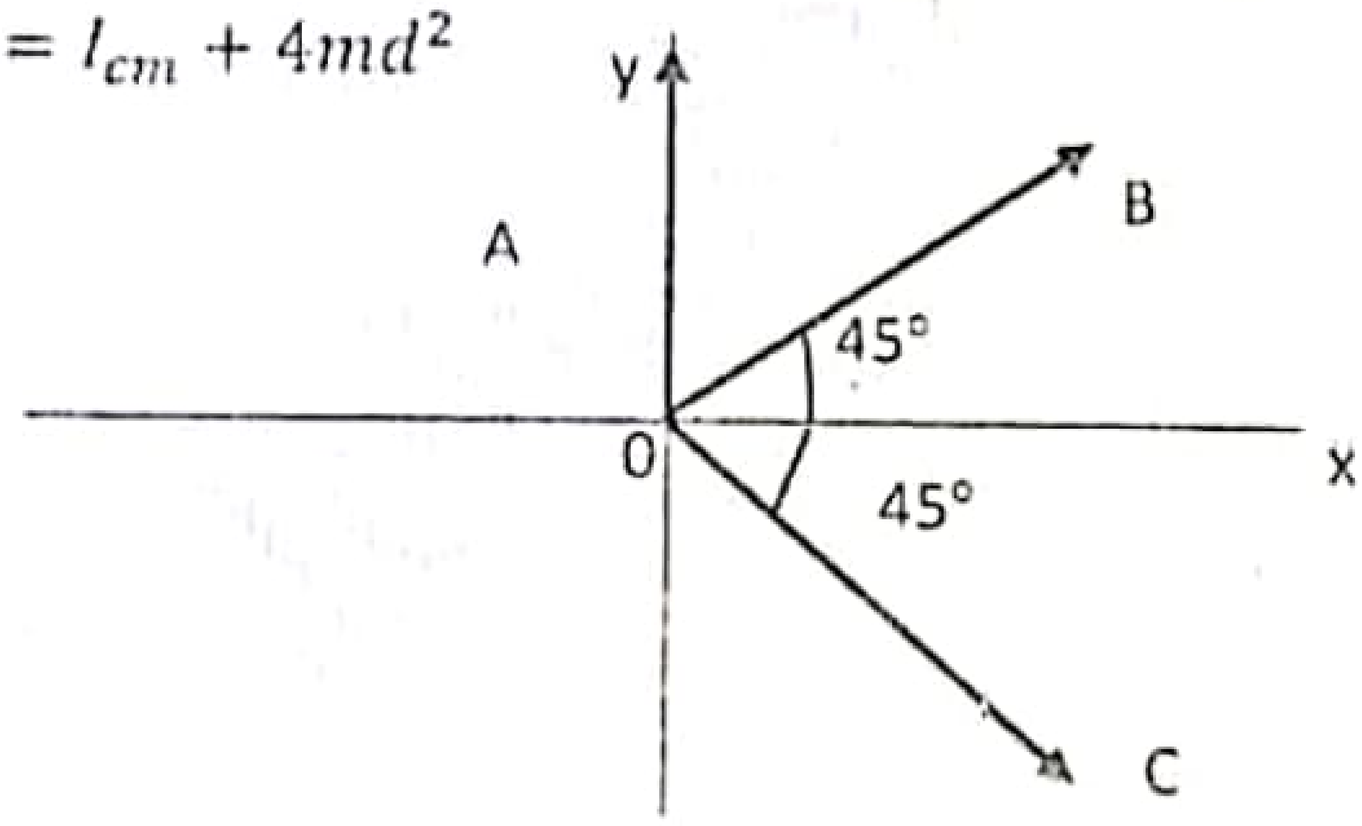


Figure 3

67. In Figure 3, $|A| = 20cm, |B| = 40cm$ and $|C| = 20cm$, Find the magnitude of x and y components of the resultant vector (expressed in unit-vector notation)
(a) R = 29.5i + 47.1J (b) R = 29.5i + 47.1J (c) R = 9.5i + 7.1J (d) R = 49.5i + 27.1J

68. The magnitude and direction of the resultant vector (in Q67) (a) R = 2.5i, $\theta = 7°$ (b) R = 2.5i, $\theta = 7°$ (c) R = 27.5i, $\theta = 28.7°$ (d) R = 49.5i, $\theta = 28.7°$

69. Express 30mi/h in term of m/s (a) 13.4m/s (b) 25 m/s (c) 26.8m/s (d) 5m/s

70. What is the correct dimension for Pressure (a) $ML^{-1}T^{-1}$ (b) $ML2T^2$ (c) $ML^{-1}T^{-2}$ (d) MLT^{-1}

1. D
2.

$m = 0.002kg, \quad v = 500m/s, \ E_k = ?$

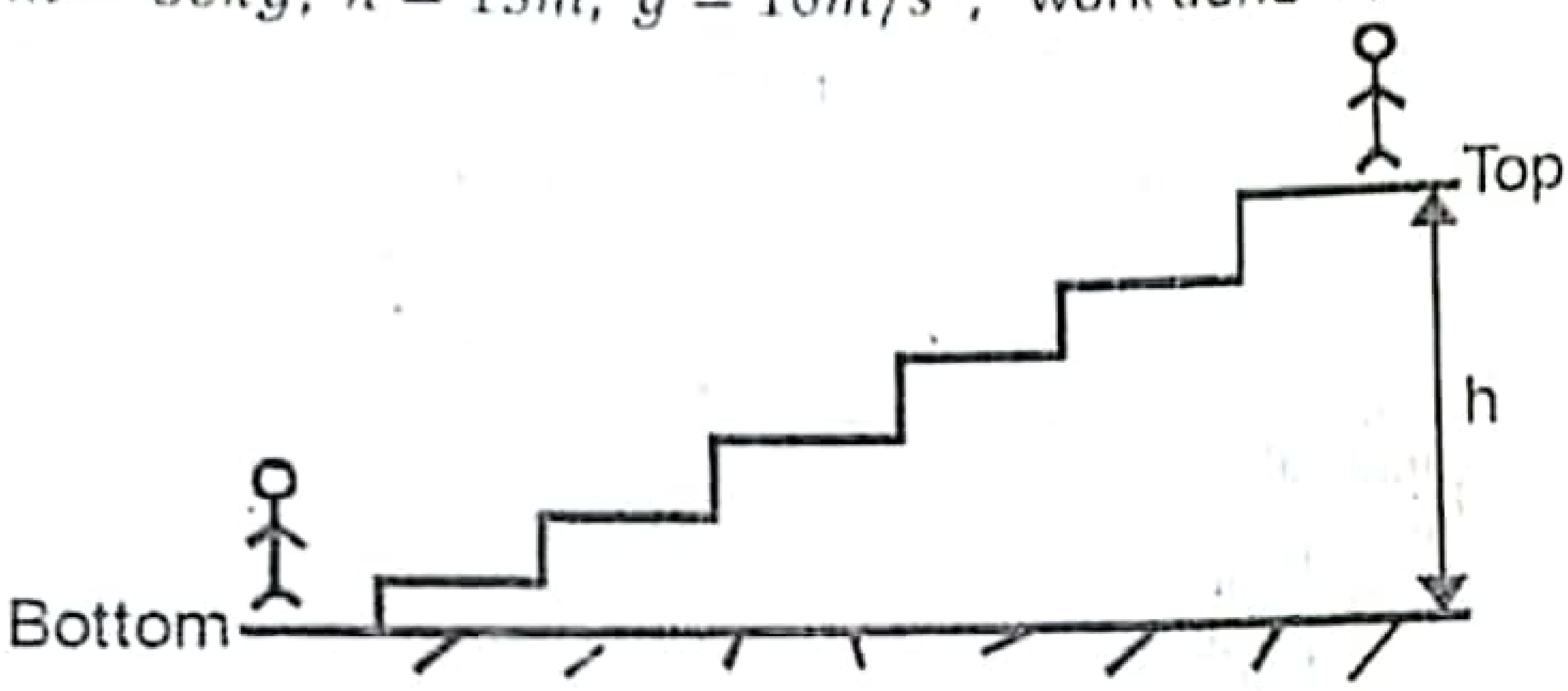
$E_k = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.002 \times 500^2$

$E_k = 250J$ **A**

3.

$m = 60kg, \ h = 15m, \ g = 10m/s^2,$ work done = ?



Having climbed to the top of the staircase, the work the man has done against gravity is equivalent to his potential energy.

Work done = E_p

$= mgh$

$= 60 \times 10 \times 15 = 9000J$ **No Correct Option**

4.

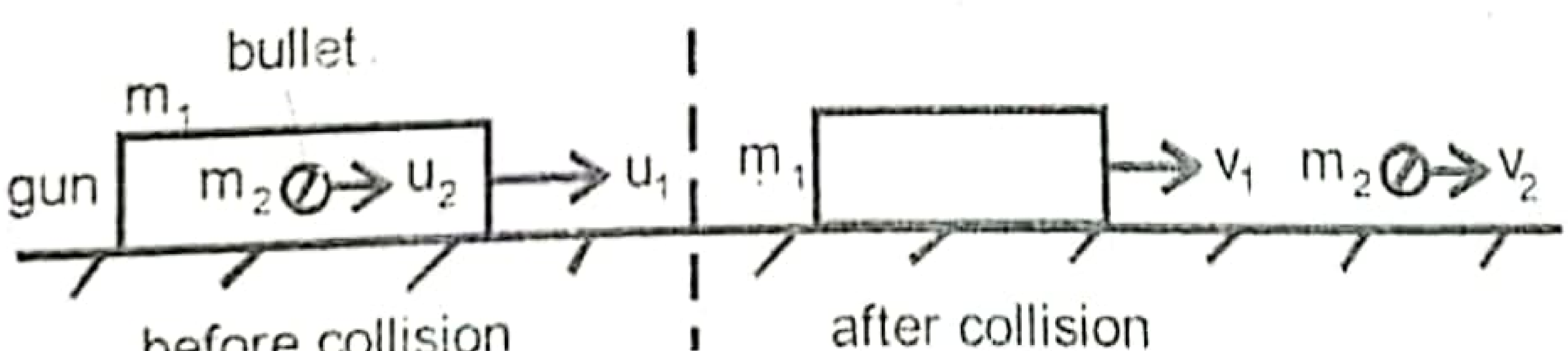
Force overcome = frictional force f = 20N

Distance d = 50m

Work done = f d

$= 20 \times 50 = 1000J$ **No Correct Option**

5.



Gun: $m_1 = 4kg, \ u_1 = 0$ (gun is initially at rest)

Recoil velocity $v_1 = ?$

Bullet: $m_2 = 2.0kg, \ u_2 = 0$ (bullet is initially at rest)

$v_2 = 300m/s$

From principle of conservation of momentum

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$$4 \times (0) + 20 \times (0) = 4v_1 + 2 \times 300$$
$$0 = 4v_1 + 600$$
$$4v_1 = -600$$
$$v_1 = -\frac{600}{4} = -150m/s$$

The negative sign implies that the gun recoils (at 150m/s) in the opposite direction to the bullet after collision (discharge).

The correct option is **C**

6.

$m = 0.4kg,\ h = 30\text{m},\ g = 10m/s^2,\ E_p = ?$

$$E_p = mgh$$
$$= 0.4 \times 10 \times 30$$
$$E_p = 120\text{J}$$

C

7.

$m = 40{,}000kg,\quad F = 1 \times 10^6\text{N},\ v = 3000m/s,\ P = ?$

$$P = Fv$$
$$= 1 \times 10^6 \times 3000$$
$$P = 3 \times 10^9\text{W}$$

D

Note that: power = force x velocity. Hence, the mass of the rocket m is not required for the calculation of power expended.

8.

In order to perform the conversion, use the equivalence relationship between degrees and radians

$180° = \pi$ rad

$\therefore 60° = \frac{60\times\pi}{180}$ rad

$= \frac{\pi}{3}$ rad

B

9.

Angular displacement $\theta = 2t^2 + 9t + 5$

$t = 4s,\ \omega =?$

To obtain angular velocity ω, take the derivative of angular displacement θ with respect to time, t.

That is, angular velocity $\omega = \frac{d\theta}{dt}$

$$\omega = \frac{d}{dt}(2t^2 + 9t + 5)$$
$$\omega = 4t + 9$$

Substitute $t = 4$

$$\Rightarrow \omega = 4 \times 4 + 9$$
$$\omega = 25 \text{ rad/s}$$

D

10.

This solution involves converting from rev/min to rad/s

Use the following equivalence relationships

1rev = 2πrad ; 1min = 60s

$\therefore$ 78rev/min $= \frac{78\text{rev}}{1\text{min}}$

$= \frac{70 \times 2\pi rad}{60s} = 2.6\pi rad/s$ **No Correct Option**

11.

Since the disc starts from rest, initial angular velocity

$\omega_o = 0$ rad/s

$t = 30s, \quad \alpha = 0.4 rad/s^2, \quad \omega = ?$

$\omega = \omega_o + \alpha t$

$\omega = 0 + 0.40 \times 30$

$\omega = 12 rad/s$ **A**

12.

$I = 8.2 kgm^2, \ \omega = 0.71 rad/s, \ E_k = ?$

Note that translational kinetic energy $E_k = \frac{1}{2}mv^2$

By relating mass m and velocity v with their respective rotational equivalents, moment of inertia I and angular velocity ω, we deduce that rotational kinetic energy

$E_k = \frac{1}{2} I\omega^2$

$= \frac{1}{2} \times 8.2 \times (0.71)^2$

$E_k \cong 2.1 J$ **C**

13.

$E_k = 29J, \quad \omega = 13 rad/s \qquad I = ?$

Using $E_k = \frac{1}{2} I\omega^2$

$\Rightarrow 29 = \frac{1}{2} I (13)^2$

$29 = 84.5\, I$

$\therefore I = \frac{29}{84.5}$

$I = 0.34 kgm^2$ **A**

14.

$r = 50cm = \frac{50}{100} m = 0.5m$

$\omega = 6 rad/s, \quad v = ?$

$v = r\omega$

$= 0.5 \times 6$

$v = 3m/s$ **C**

15.

$\theta = 4t^3 + 3t^2 - 5$

$t = 3s, \quad \alpha = ?$

To obtain angular acceleration α, take the derivative of angular velocity ω with respect to time t. That is,

$\alpha = \frac{d\omega}{dt}$

But $\omega = \frac{d\theta}{dt} = \frac{d}{dt}(4t^3 + 3t^2 - 5) = 12t^2 + 6t$

$\therefore \alpha = \frac{d\omega}{dt} = \frac{d}{dt}(12t^2 + 6t)$

$\alpha = 24t + 6$

Substitute t = 3

$\alpha = 24 \times 3 + 6$
$\alpha = 78 rad/s$

16. **D**

17. A 26

To convert from degree to revolution, use the equivalence relationship

$360° = 1$ rev

$\therefore 120° = \frac{120 \times 1}{360}$ rev

$= \frac{1}{3}$ rev

18. A

$m_1 = 2kg \;;\; x_1 = 3m$
$m_2 = 4kg \;;\; x_2 = -2m$
$m_3 = 6kg \;;\; x_3 = 4m$
$X_{cm} = ?$

$X_{cm} = \frac{\sum m_i x_i}{\sum m_i} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$X_{cm} = \frac{2\times3+4\times(-2)+6\times4}{2+4+6} = \frac{6-8+24}{12}$

$X_{cm} = \frac{22}{12}$

$X_{cm} = 1.83m$

B

19. **A**
20. **A**
21. **C**
22. **D**
23. **B**
24.

To obtain the dimensional expression for power, first define it in terms of other known quantities.

$\text{Power} = \frac{\text{work done}}{\text{time}}$

$\text{Power} = \frac{\text{force} \times \text{distance}}{\text{time}}$ -------- (1)

Force $= MLT^{-2}$

Distance $= L$

Time $= T$

By substitution into (1)

$\text{Power} = \frac{M.LT^{-2} \times L}{T} = \frac{ML^2T^{-2}}{T}$

$\text{Power} = ML^2T^{-3}$ or ML^2/T^3

A

Note: By consistent practice, the dimensions of major known physical quantities can be memorized.

25

$m_1 = M_o \;;\; x_1 = 0$
$m_2 = 3M_o \;;\; x_2 = L$
$m_3 = 9M_o \;;\; x_3 = 2L$

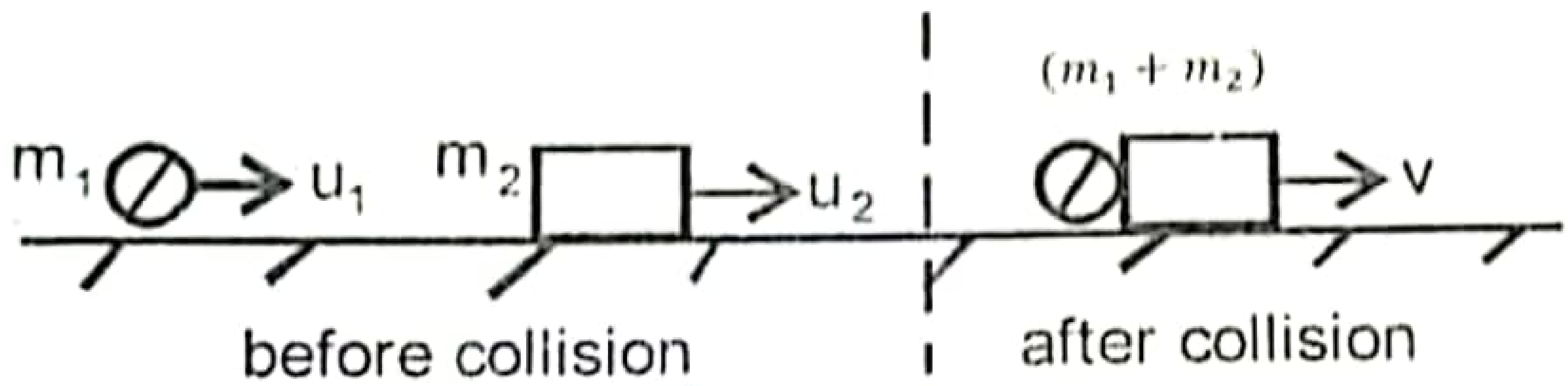
$X_{cm} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$$= \frac{M_0(0) + 3M_0(L) + 9M_0(2L)}{M_0 + 3M_0 + 9M_0}$$

$$= \frac{3M_0L + 18M_0L}{13M_0} = \frac{12M_0L}{13M_0}$$

$$X_{cm} = \frac{21}{13}L$$ C

26



Mass of bullet $m_1 = 15g = \frac{15}{1000}kg = 0.015kg$
Initial velocity $u_1 = 300m/s$
Mass of object $m_2 = 75kg$
Initial velocity $u_2 = 0$ (object initially at rest)
Let the common final velocity of the bodies after collision = v = ?
From the principle of conversation of linear momentum,
Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

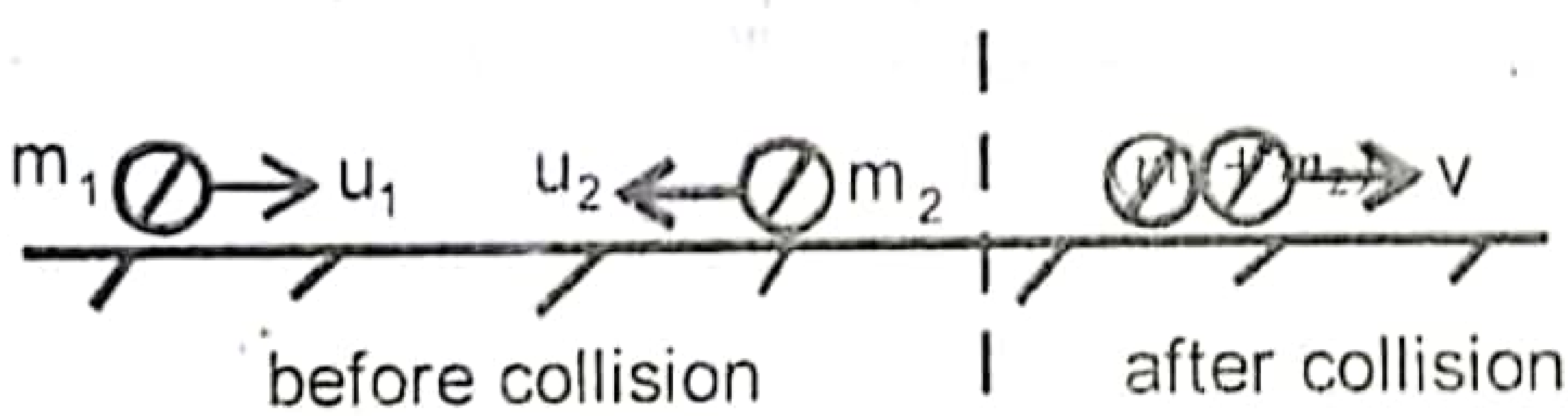
$0.015 \times 300 + 75 \times 0 = (0.015 + 75)v$

$4.5 = 75.015v$

$v = \frac{4.5}{75.015} \approx 0.06m/s$ A

Note, the collision in which the bodies stick together and move with common final velocity after collision is called inelastic collision. Total momentum is conserved but kinetic energy is not conserved.

27



$m_1 = 5kg$; $u_1 = 1m/s$; $m_2 = 10kg$; $u_2 = 0m/s$
Let the common final velocity after collision = v = ?
This is a case of inelastic collision
Applying momentum conservation principle
Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v + m_2v = (m_1 + m_2)v$

$5 \times 1 + 10 \times 0 = (5 + 10)v$

$5 = 15v$

$v = \frac{5}{15} = 0.33m/s$ B

28

$m = 2kg, \quad v = 2m/s, \quad r = 1m, \quad T = ?$

The tension in the string is provided by the centripetal force that constrains the body to move in the vertical circle 33

$T = \frac{mv^2}{r}$

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

$T = 8N$

C

29

$m = 200kg, \quad u = 0, \quad v = 30m/s \quad P = ?$

$P = mv$

$= 200 \times 30$

$P = 6000 kgm/s$

C

30

$m = 200kg, \; u = 0m/s \quad v = 30m/s \quad t = 10s$

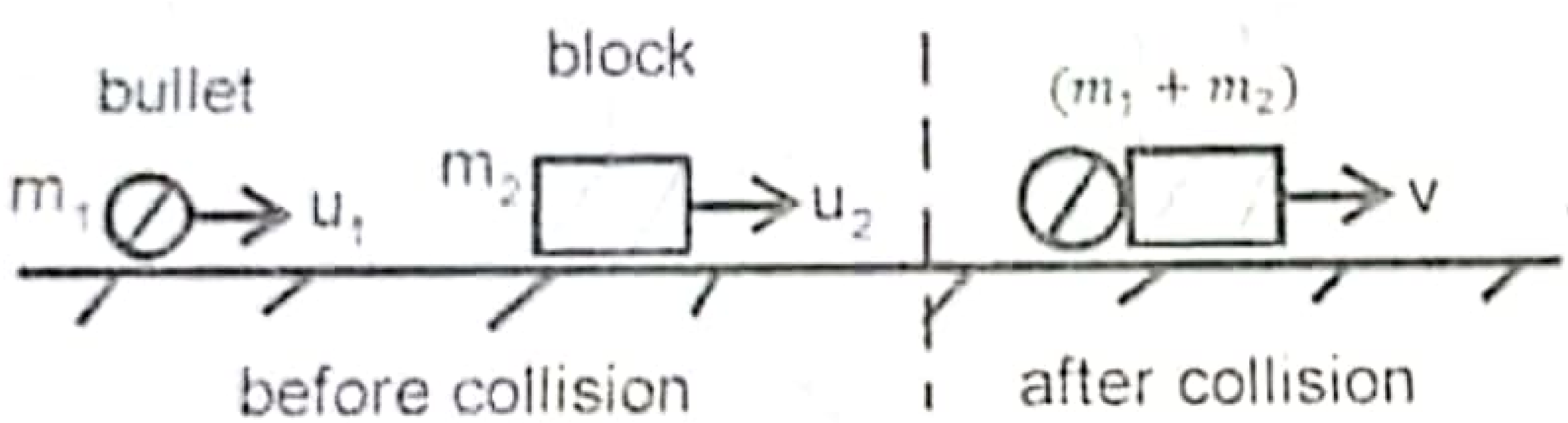
$F = \frac{m(v-u)}{t}$

$= \frac{200(30-0)}{10}$

$F = 600N$

A

31



Bullet: $m_1 = 20g = \frac{20}{1000} kg = 0.02kg \qquad u_1 = ?$

Block: $m_2 = 10kg \quad u_2 = 0m/s$ (block is initially stationary – at rest)

First, calculate the common final velocity v, given

LLdistance $d = 45cm = \frac{45}{100} m = 0.45m \quad ; \qquad t = 1s$

$v = \frac{d}{t} = \frac{0.45}{1} = 0.45m/s$

Then, apply the momentum conservation principle

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v + m_2v = (m_1 + m_2)v$

$0.02 \times u_1 + 10 \times 0 = (0.02 + 10) \times 0.45$

$0.02u_1 = 4.509$

$u_1 = \frac{4.509}{0.02} = 225.45m/s$

A

32

$m = 1000kg \quad ; \quad F = 6.1 \times 10^3 N \quad ; \quad t = 8s$

$u = 0m/s$ (car is initially at rest)

$v = ?$

Using $F = \frac{m(v-u)}{t}$

$$\Rightarrow 6.1 \times 10^3 = \frac{1000(v-0)}{8}$$
$$6.1 \times 10^3 = 125v$$
$$v = \frac{6.1 \times 10^3}{125}$$
$$v = 48.8m/s$$
B

33

Using the equivalence relationships

$1km = 1000m$ and $1hr = 3600s$

To convert 150km/hr to m/s

$$150km/hr = \frac{150km}{1hr}$$
$$= \frac{150 \times 1000m}{3600s}$$
$$= 41.67m/s$$
D

34

$m = 13kg$; $g_{moon} = 2m/s^2$

$$W = mg_{moon}$$
$$= 13 \times 2 = 26kgm/s^2$$
$$W = 26N$$
C

35

$\vec{a} = i + 2j - 3k$; $\vec{b} = 2i - 3j + 4k$

$$\vec{a}.\vec{b} = (i + 2j - 3k).(2i - 3j + 4k)$$

Just multiply corresponding coefficients and sum them up

$$\vec{a}.\vec{b} = (1)(2) + (2)(-3) + (-3)(4)$$
$$= 2 - 6 - 12$$
$$= -16$$
A

36

Pico (p) = 10^{-12}

Tera (T) = 10^{12}

Nano (n) = 10^{-9}

Deka (da) = 10^{1}

Milli (m) = 10^{-3}

Deci (d) = 10^{-1}

Giga (G) = 10^{9}

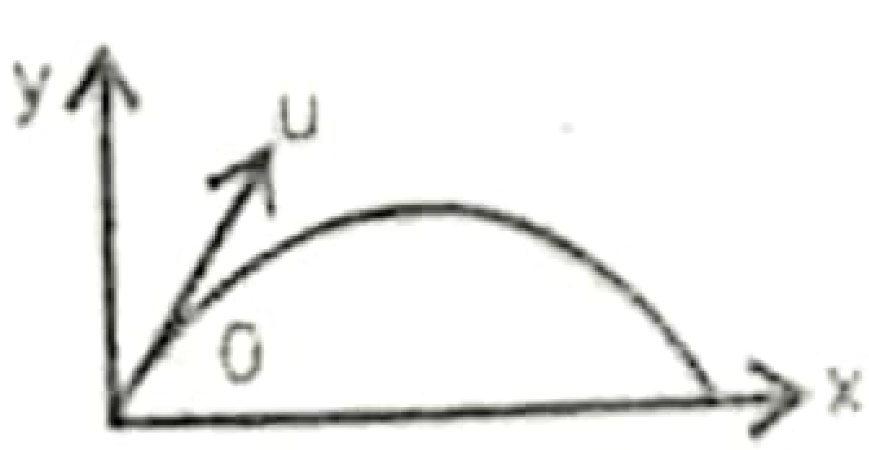
Mega (M) = 10^{6}

Clearly, Giga > Mega

The correct option is D

37,A

38



$u = 20m/s$; $\theta = 37°$; $g = 9.8m/s^2$; $T = ?$

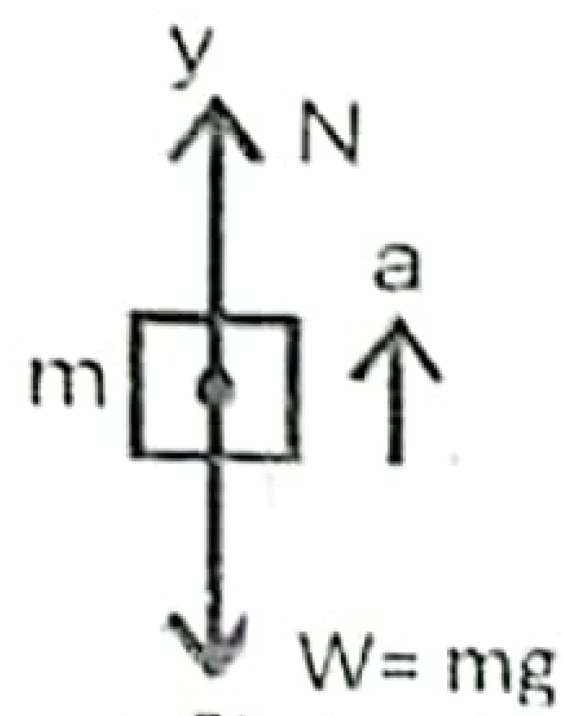
$T = \frac{2u\sin\theta}{g}$

$= \frac{2\times 20\times \sin 37^{\circ}}{9.8}$

$T = 2.46s$ D

39. B

40.



$m = 800kg$; $N = 1\times 10^4 N$; $g = 10m/s^2$; $a = ?$

From Newton's second law of motion

$\sum F_y = ma$

$N - W = ma$

$N - mg = ma$

$1\times 10^4 - 800\times 10 = 800a$

$800a = 2000$

$a = \frac{2000}{800}$

$a = 2.5m/s^2$ C

41. C

42.

$g = 10m/s^2$; $\theta = 30^{\circ}$; $a = ?$

$a = g\sin\theta$

$= 10\times \sin 30^{\circ}$

$a = 5m/s^2$ D

43.

$m_1 = 2kg$; $x_1 = 1cm$

$m_2 = 3kg$; $x_2 = 2cm$

$m_3 = 5kg$; $x_3 = 6cm$

$X_{cm} = ?$

$X_{cm} = \frac{\sum m_i x_i}{\sum m_i}$

$= \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

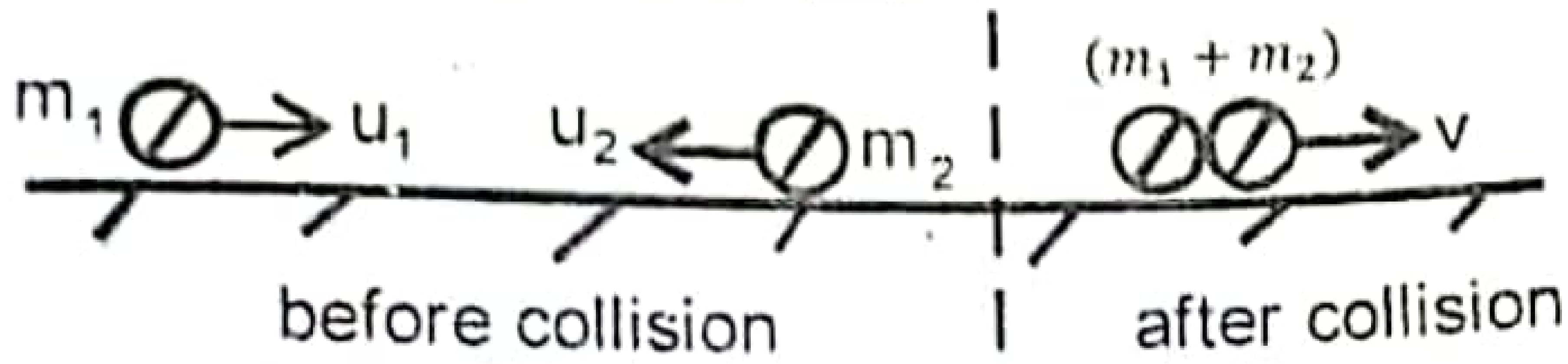
$= \frac{2(1)+3(2)+5(6)}{2+3+5} = \frac{38}{10}$

$X_{cm} = 3.8cm$ No correct option

44. C

45.

Note that this problem is a case of inelastic collision, similar to the problems in Q26 and Q27. But in this case of a head-on collision, the second object is initially moving in opposite direction to the first. Hence, velocity of second object is given negative sign, while that of the first object is positive.



$m_1 = 5kg$; $u_1 = 100m/s$; $m_2 = 5kg$; $u_2 = -10m/s$; $v = ?$

From momentum conservation principle

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$5(100) + 5(-10) = (5 + 5)v$

$500 - 50 = 10v$

$v = \frac{450}{10}$

$v = 45m/s$ D

46.

$m = 50kg$; $u = 5m/s$; $v = 50m/s$; impulse $I = ?$

From the impulse-momentum theorem, the impulse of a net force on a body is equal to the change in momentum of the body.

$I = mv - mu$

$= m(v - u)$

$= 50(50 - 5)$

$I = 2250Ns$ No correct option

47. D

48.

$r = 2m$; $\omega = 200\text{rad/s}$; $v = ?$

$v = r\omega$

$= 2 \times 200 = 400m/s$ No correct option

49.

Diameter $d = 10m$

Radius $r = \frac{d}{2} = \frac{10}{2} = 5m$

$v = 20m/s$

From $v = r\omega$

$\Rightarrow 20 = 5\omega$

$\therefore \omega = \frac{20}{5} = 4\text{rad/s}$

Unit of angular frequency (angular velocity) is rad/s No correct option

50. D

51.

$\omega = 20 rad/s \;\; ; \; I = 12kgm^2$

$E_k = \frac{1}{2} I\omega^2$

$= \frac{1}{2} \times 12 \times 20^2$

$E_k = 2400J$

52. B

Radial acceleration = Centripetal acceleration a_c

$r = 0.5m \;\; ; \;\; \omega = 6 rad/s \;\; ; \;\; a_c = ?$

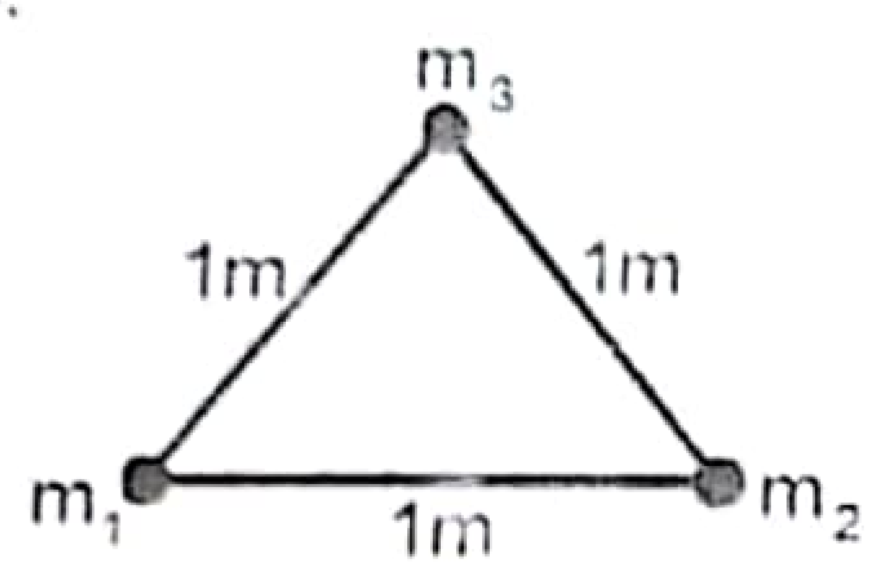
$a_c = r\omega^2$

$= 0.5 \times 6^2$

$a_c = 18m/s^2$ A

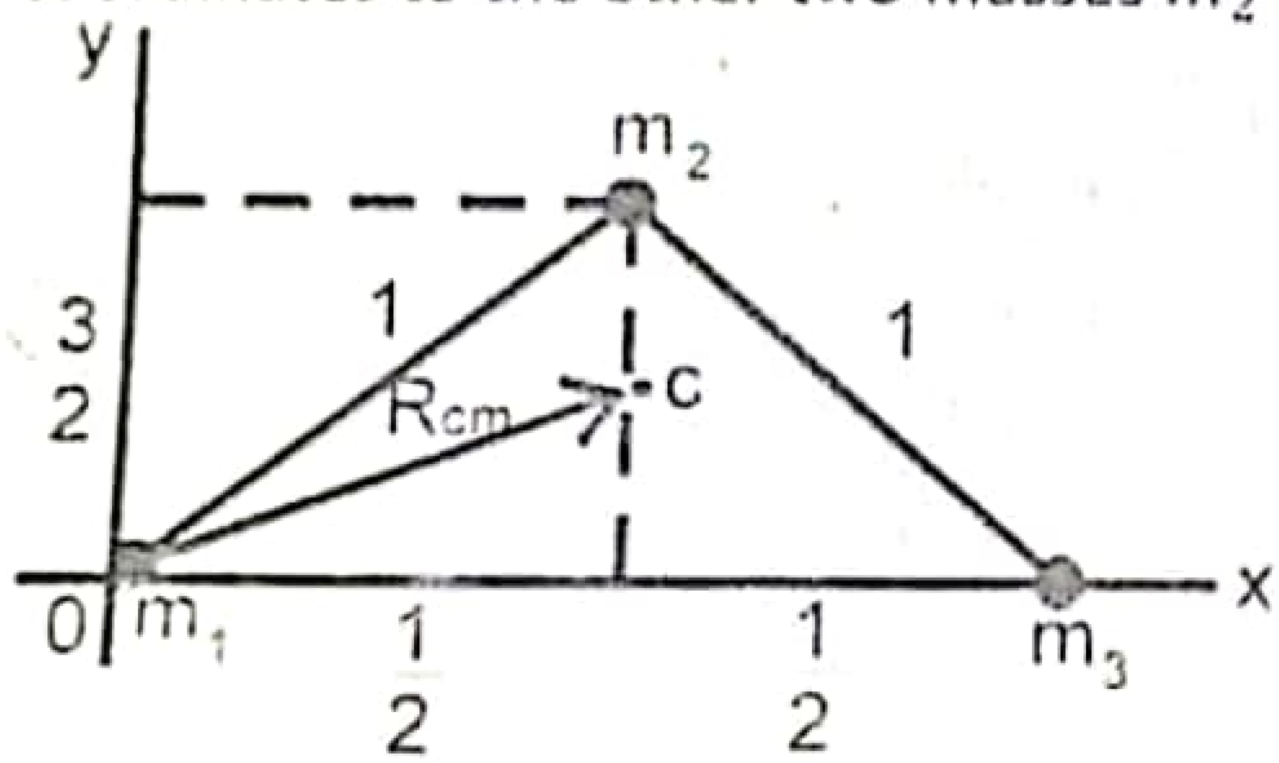
53. A

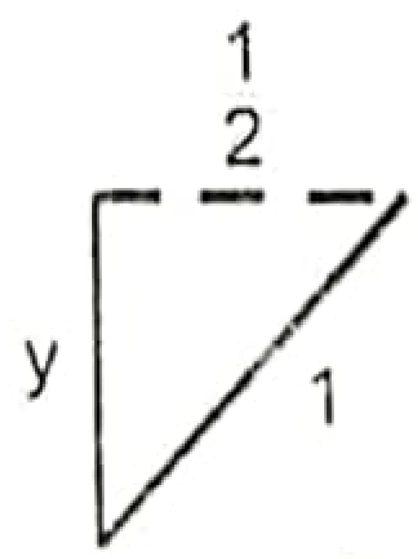
54.



$m_1 = 2kg, \;\; m_2 = 3kg, \;\; m_3 = 2kg$

Place the origin of the x-y plane on the m_1 mass in order to give non-negative position coordinates to the other two masses m_2 and m_3





$y = \sqrt{1^2 - \left(\frac{1}{2}\right)^2}$

$= \sqrt{1 - \frac{1}{4}} = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2}$

$\Rightarrow m_1 = 2kg \;\; ; \;\;\;\; (x_1, y_1) = (0,0)$

$m_2 = 3kg \;\;\;\; ; \;\; (x_2, y_2) = (1,0)$

$m_3 = 2kg \;\;\;\; ; \;\; (x_3, y_3) = \left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$

$X_{cm} = \frac{\sum m_i x_i}{\sum m_i}$

$= \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$X_{cm} = \frac{2(0) + 3(1) + 2\left(\frac{1}{2}\right)}{2+3+2}$

$X_{cm} = \frac{4}{7} m$

$Y_{cm} = \frac{\sum m_i y_i}{\sum m_i}$

$$= \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

$$Y_{cm} = \frac{2(0) + 3(0) + 2\left(\frac{\sqrt{3}}{2}\right)}{2+3+2}$$

$$Y_{cm} = \frac{\sqrt{3}}{7} m$$

$$\vec{R}_{cm} = X_{cm}i + Y_{cm}j$$

$$= \frac{4}{7}i + \frac{\sqrt{3}}{7}j$$

55. B B

56. A

57. C

58. B

59.

$$F \propto \frac{1}{r^2}$$

Where r is the separation distance between the objects and F is the gravitational force between them.

$$F = \frac{k}{r^2}$$

Where k is a constant

$$Fr^2 = k$$

$$F_1r_1^2 = F_2r_2^2$$

$$F_2 = \frac{F_1r_1^2}{r_2^2} = F_1\left(\frac{r_1}{r_2}\right)^2$$

$$F_2 = F_1\left(\frac{r_1}{r_2}\right)^2$$

If distance is doubled, $r_2 = 2r_1$

By substitution

$$F_2 = F_1\left(\frac{r_1}{2r_1}\right)^2 = F_1\left(\frac{1}{2}\right)^2$$

$$F_2 = F_1\left(\frac{1}{4}\right) = \frac{1}{4}F_1$$

The new force is one quarter of the original force. D

60.

$m = 10kg$; $v = 5m/s$; $r = 5m$; $a_c = ?$

$$a_c = \frac{v^2}{r} = \frac{5^2}{5}$$

$$a_c = 5m/s^2$$

A

61.

This problem is similar to that in Q59, but in this case, the new separation distance is three times the original one.

Use $F_2 = F_1\left(\frac{r_1}{r_2}\right)^2$

Substitute $r_2 = 3r_1$

$$\Rightarrow F_2 = F_1\left(\frac{r_1}{3r_1}\right)^2 = F_1\left(\frac{1}{3}\right)^2$$

$$F_2 = \frac{1}{9}F_1$$

D

62.

Case 1: masses M, m ; distance r

Apply Newton's law of Gravitation

$$F_1 = \frac{GMm}{r} \text{ ------------ (1)}$$

Case 2: masses 2M, 3m ; distance r

$$F_2 = \frac{G(2M)(3m)}{r} = \frac{6GMm}{r}$$

$$\Rightarrow F_2 = 6F_1$$

That is, gravitational force will increase 6 fold .

63. Incomplete data

64. A

65.

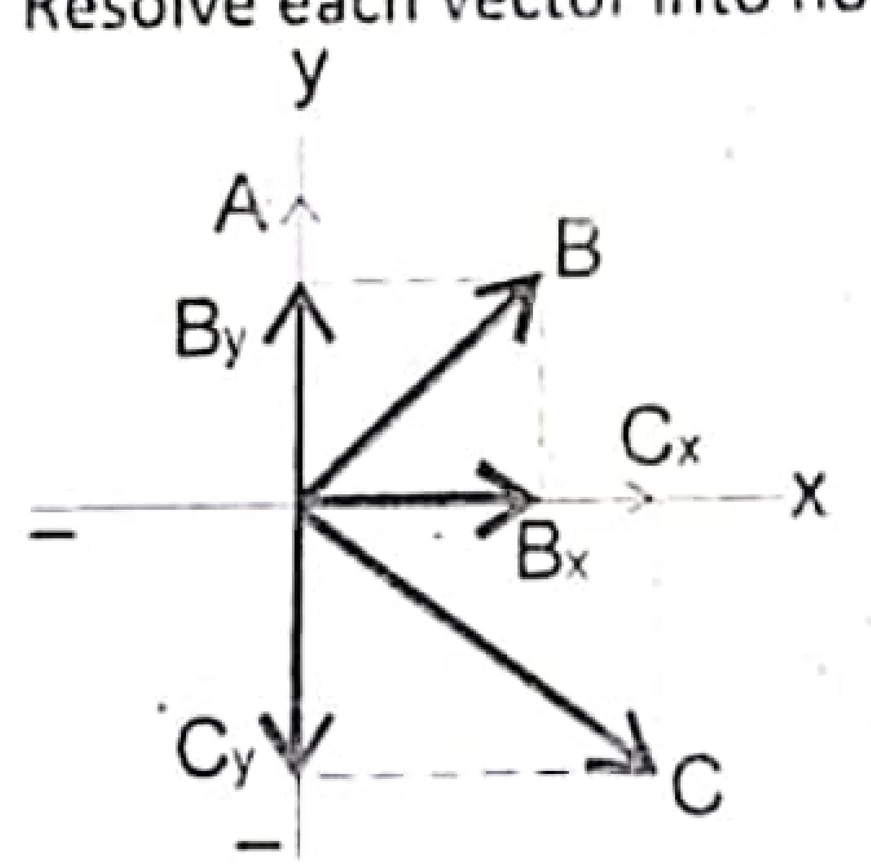
$u = 0m/s$; $t = 4s$; $g = 9.8m/s^2$; $v = ?$

$$v = u + gt$$
$$= 0 + 9.8 \times 4$$
$$v = 39.2m/s$$

66. B – the relationship is the Parallel-axis Theorem

67.

Resolve each vector into horizontal (x) component and vertical (y) component



Vector $\vec{A}$

$$A_x = |A| \cos 90 = 20(0) = 0$$
$$A_y = |A| \sin 90 = 20(1) = 20$$
$$\vec{A} = A_x i + A_y j$$
$$= (0)i + 20j$$
$$\vec{A} = 20j$$

Vector $\vec{B}$

$$B_x = |B| \cos 45 = 40(0.7071) = 28.28$$
$$B_y = |B| \sin 45 = 40(0.7071) = 28.28$$
$$\vec{B} = B_x i + B_y j$$
$$= 28.28i + 28.28j$$

Vector $\vec{C}$

$$C_x = |C| \cos 45 = 20(0.7071) = 14.14$$
$$C_y = -|C| \sin 45 = -20(0.7071) = -14.14$$
$$\vec{C} = C_x i + C_y j$$

$\vec{C} = 14.14i + (-14.14)j = 14.14i - 14.14j$
$\vec{R} = \vec{A} + \vec{B} + \vec{C}$
$= 20j + 28.28i + 28.28j + 14.14i - 14.14j$
Collect like terms in i and j
$\therefore \vec{R} = 42.42i + 34.14j$

No correct option

68.

$|R| = \sqrt{R_x^2 + R_y^2}$
$= \sqrt{(42.42)^2 + (34.14)^2}$
$= \sqrt{1799.4564 + 1165.5396}$
$= \sqrt{2964.996}$
$|R| \approx 54.5$
$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \tan^{-1}\left(\frac{34.14}{42.42}\right)$
$\theta = \tan^{-1}(0.8048)$
$= 38.8°$

No correct option

69.

Use the equivalence relationships
1mi = 1609.344m ; 1hr = 3600s
$30mi/h = \frac{30mi}{1hr}$
$= \frac{30 \times 1609.344m}{3600s}$
$= 13.4m/s$

A

70.

First, define pressure in terms of known quantities and then substitute the dimensions of the known quantities to get the dimension of pressure.

Pressure $= \frac{\text{Force}}{\text{Area}}$
$= \frac{mass \times acceleration}{\text{Area}}$
Dimension $= \frac{M.LT^{-2}}{L^2}$
$= ML^{-1}T^{-2}$

C

FIRST SEMESTER EXAMINATION 2022/2023 SESSION
PHY 101.1: Introduction to Mechanics & Properties of Matter
Instruction: Attempt all questions **Time: 1hr 30mins.**

1. What is the equivalent of 150km/h in meter/seconds? (a) 1.5m (b) 2.5m/s (c) 0.15m/s (d) 41.67m/s
2. Which of these is not a vector quantity? (a) Energy (b) Weight (c) Displacement (d) Impulse
3. Which of the following is the dimension of Power? (a) ML^2/T^3 (b) ML/T^3 (c) MT^2/L^2 (d) M/T^3L^2
4. Which of these is not a derived quantity? (a) Area (b) Temperature (c) Electrical potential (d) Energy
5. If $a = i + 2j - 3k$ and $b = 2i - 3j + 4k$, then a.b = ? (a) -16 (b) $3i - j + k$ (c) $-1 - 10j - 7k$ (d) $-i + 5j - 7k$
6. Which of these is correct in terms of quantification (a) Pico > Tera (b) Nano > Deca (c) Milli > Deci (d) Giga > Mega
7. The type of mechanics which describe the motion of particle with emphasis on associated causative phenomenon is? (a) Kinematics (b) Dynamics (c) Newtonian (d) Rotation
8. Which of the following is not a fundamental force? (a) Electric force (b) Magnetic force (c) Nuclear force (d) Mechanical force
9. An arrow is fired with an initial velocity of 20.0m/s at an angle of 37° with the horizontal. How long does the arrow stay in the air? (a) 1.22sec (b) 3.26sec (c) 4.08sec (d) 2.46sec
10. The slope of the plot of velocity-time graph gives the (a) momentum (b) acceleration (c) Speed (d) time
11. Which of these statements is not correct? (b) a uniform circular motion is an accelerated motion (b) in a projectile motion, the velocity at maximum height is zero (c) the magnitude of instantaneous acceleration specifies how much the speed is changing (d) acceleration due to gravity has the same value for all objects at the same locations
12. If a particle motion is represented by $x(t) = 16 + 12t - 1.2t^2$, its velocity at t = 2.0 seconds is? (a) 12 – 2.4tm/s (b) 2.2m/s (c) 7.2m/s (d) $12t - 1.2t^2$
13. A particle of mass 800kg is lifted up vertically by a force of 10^4N. If the acceleration due to gravity is $10ms^{-2}$, the upward acceleration of the particle will be (a) $12.5m/s^2$ (b) $10m/s^2$ (c) $2.5m/s^2$ (d) $5.0m/s^2$
14. The tendency of an object to resist a change of its state either at rest or motion at constant speed along a straight line is called? (a) momentum (b) dynamics (c) inertia (d) friction
15. The acceleration of an object that rolls on a plane inclined at 30° to the horizontal ($g = 10m/s^2$) is? (a) $2m/s^2$ (b) $1.5m/s^2$ (c) $4m/s^2$ (d) $5m/s^2$
16. An object started from rest and accelerated at the rate of $200m/s^2$ for 1.5 minutes. Calculate the velocity reached. (a) $1.8 \times 10^2 ms^{-1}$ (b) $1.8 \times 10^3 ms^{-1}$ (c) $1.8 \times 10^4 ms^{-1}$ (d) $1.8 \times 10^5 ms^{-1}$
17. Determine the range of an object projected at an angle of 15° to the horizontal with a constant velocity of 30m/s. (Take $g = 10m/s^2$) (a) 45m (b) 50m (c) 55m (d) 60m

18. A ball is thrown vertically upwards from the ground with a velocity of 20m/s. What is the maximum height reached? (Take g = $10m/s^2$) (a) 10m (b) 15m (c) 20m (d) 30m
19. A body has constant velocity unless it is acted upon by a net force. This is a statement of (a) conservation of mass (b) law of inertia (c) law of gravitation (d) conservation of momentum
20. An object is about to slide down a plane inclined at an angle of 60^o to the horizontal. Determine the acceleration down the plane. (a) $5\sqrt{3}ms^{-2}$ (b) $10\sqrt{3}ms^{-1}$ (c) $5\sqrt{2}ms^{-2}$ (d) $10\sqrt{2}ms^{-2}$
21. What is the force a motor bike of mass 200kg is moving with if it started from rest and moves with a speed of 30m/s for 10seconds? (a) 600N (b) 60N (c) 6000N (d) 0.6N
22. A conical pendulum of mass of 6kg with its string inclined at angle 60^o to the vertical at the point of support revolves in a horizontal plant. Determine the tension in the string. (Take g = $10m/s^2$). (a) 60N (b) 80N (c) 100N (d) 120N
23. The Kepler's law which states that all planets move in elliptical orbits with the sun at one focus is referred to as? (a) law of focus (b) law of area (c) law of orbit (d) law of period
24. A 250kg elevator cage descends 100m within a high rise building, what is the work down by gravity on the elevator? (a) $2.5\times 10^5 J$ (b) $4.20\times 10^5 J$ (c) $3.50\times 10^5 J$ (d) $1.0\times 10^5 J$
25. One horse power (hp) is equivalent to ________ watts
26. A 60kg man walks up a flight of stairs 15m high, how much work is done against the force of gravity?
27. Consider that a 5.0kg object is thrown vertically upwards from the ground and rises to a maximum height of 30m. calculate the initial K.E __________
28. A bullet of mass 2g is moving with a velocity of 500m/s what is its K.E __________
29. A ball whose mass is 0.25kg is allowed to fall from a height 5m. after hitting the floor, it bounces back up to a height of 4.5m. Determine the impulse it received from gravity while it was falling ________
30. Two masses $m_1 = 1.0kg$ and $m_2 = 3.0kg$ collide while initially moving in the positive x direction with $u_1 = 16m/s$ and $u_2 = 4m/s$. Determine the velocity of masses if they both moved in the same direction after collision.
31. Three particles of mass 2kg, 3kg and 5kg are spaced along a line through x-axis at $x = 1cm$, $x = 2cm$ and $x = 6cm$ respectively, find the centre of mass.
32. A bullet of mass 15kg is fired into a 10kg wooden block. As a result of the impact, the block and the bullet is moved a distance of 41m in 1sec. Determine the nuzzle velocity of the bullet.
33. A disc starting from rest at t = 0, rotate with a constant angular acceleration of $0.40rad/sec^2$ counterclockwise. What is the angular velocity at t = 30sec?
34. One complete revolution makes ________ degree
35. Convert 120^o to revolutions __________

PHY 101.1 2022/2023 SOLUTIONS

1.

$$150km/h = \frac{150km}{1hr} = \frac{150 \times 1000m}{60 \times 60s}$$
$$= 41.67m/s$$ D

2. A
3.

$$\text{Power} = \frac{\text{work done}}{\text{time}} = \frac{\text{force} \times \text{distance}}{\text{time}}$$
$$\text{Dimension} = \frac{MLT^{-2} \times L}{T} = \frac{ML^2T^{-2}}{T}$$
$$= ML^2T^{-3} = ML^2/T^3$$ A

4. B
5.

$$\vec{a} = i + 2j - 3k, \qquad \vec{b} = 2i - 3j + 4k$$
$$\vec{a}.\vec{b} = (i + 2j - 3k).(2i - 3j + 4k)$$
$$= (1)(2) + (2)(-3) + (-3)(4)$$
$$= 2 - 6 - 12$$
$$= -16$$ A

Note: Dot product is a scalar, whereas cross product is a vector.

6.

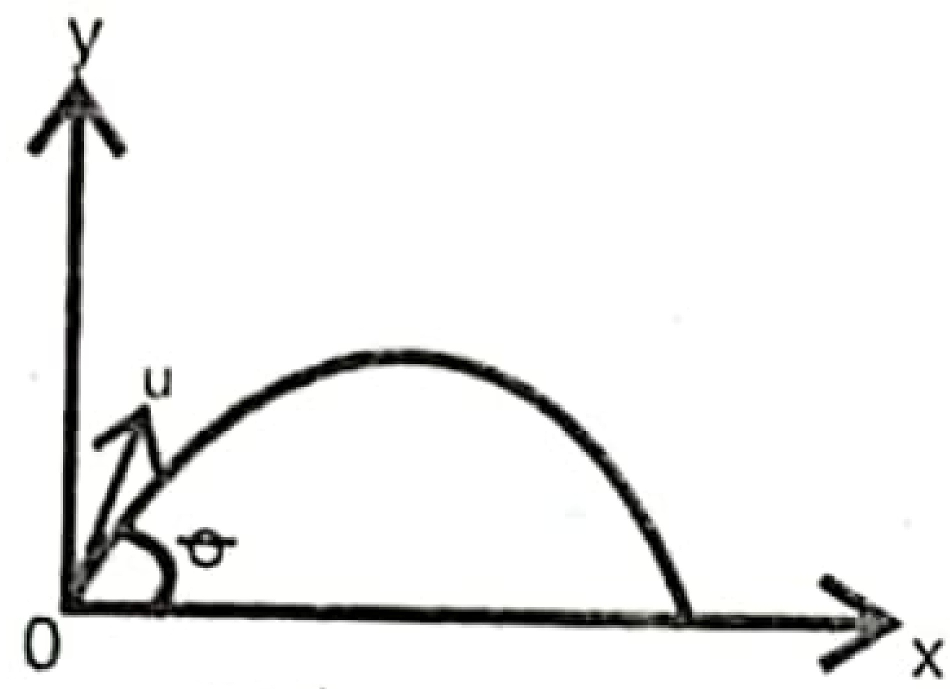
Consider the given prefixes

Tera = 10^{12}
Giga = 10^9
Mega = 10^6
Kilo = 10^3
Deca = 10^1
Deci = 10^{-1}
Centi = 10^{-2}
Milli = 10^{-3}
Micro = 10^{-6}
Nano = 10^{-9}
Pico = 10^{-12}

Decreasing order of magnitude
Giga > Mega
Correct option is **D**

7. B
8. D

9.



$u = 20.0m/s,$ $\theta = 37°$ $g = 9.8m/s^2,$ $T = ?$

$T = \frac{2u\sin\theta}{g}$

$= \frac{2\times20\times\sin 37°}{9.8}$

$= 2.46s$ **D**

10. **B**
11. **C**
12.

$x(t) = 16 + 12t - 1.2t^2$

$v(t) = \frac{dx}{dt}(t) = \frac{d}{dt}(12 + 12t - 1.2t^2)$

$v(t) = 12 - 2(1.2)t$

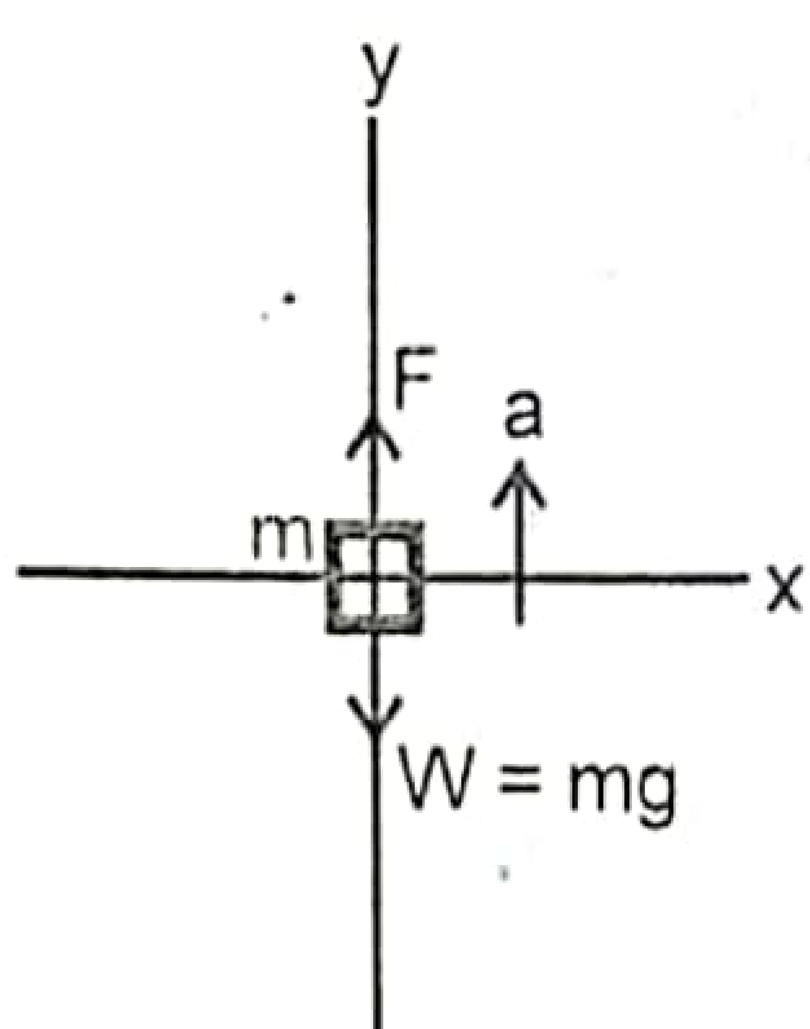
$v(t) = 12 - 2.4t$

Substitute t = 2s

$\Rightarrow v = 12 - 2.4 \times 2$

$= 7.2m/s$ C

13.



Free body diagram (FBD)

Given: m = 800kg, F = 10^4N = 10000N, g = $10m/s^2$, a = ?

Resultant vertical force

$\sum F_y = ma$

$\rightarrow F - W = ma$

$F - mg = ma$

$10000 - 800 \times 10 = 800a$

$2000 = 800a$

$a = \frac{2000}{800} = 2.5m/s^{-2}$ C

14. C

15.

$\theta = 30°$, g = $10m/s^{-2}$, a = ?

Acceleration of object down inclined plane is given by

$a = g \sin\theta$

$= 10 \times \sin 30°$

$= 5m/s^2$ D

16.

$u = 0m/s$ (since object started from rest)

$a = 200m/s^2$

$t = 1.5\text{mins} = 1.5 \times 60s = 90s$

$v = ?$

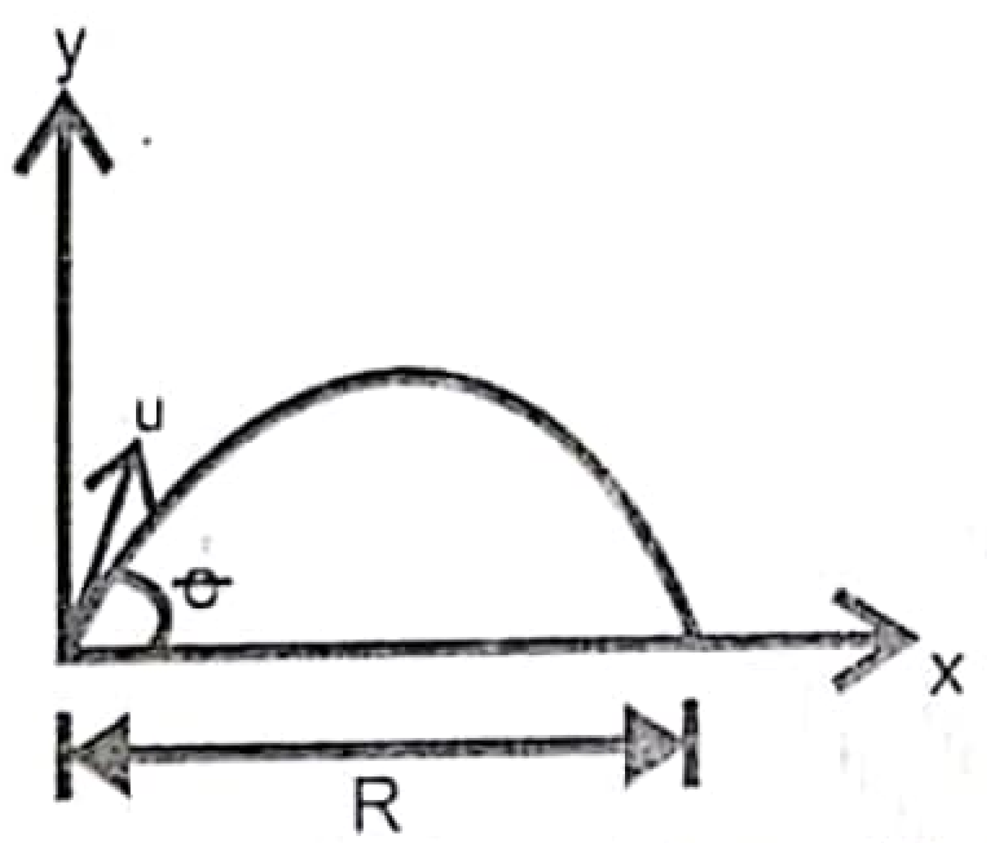
$v = u + at$

$= (0) + 200 \times 90$

$= 18000m/s$

$= 1.8 \times 10^4 m/s$ C

17.



$u = 30m/s, \theta = 15°, g = 10m/s^2$, R = ?

$R = \frac{u^2 \sin 2\theta}{g} = \frac{(30)^2 \sin 2(15)}{10} = \frac{900 \sin 30}{10}$

$R = 45m$ A

18.

$u = 20m/s$, $g = 10m/s^2$, H = ?

$H = \frac{u^2}{2g} = \frac{20^2}{2\times10}$

$H = 20m$ C

19. B

20.

$g = \frac{10m}{s^2}$, $\theta = 60°$, $a = ?$

$a = g \sin\theta$

$= 10 \sin 60°$

$= 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3}m/s^2$ A

21.

$m = 200kg$, $u = 0m/s$ (bike starts from rest)

$v = 30m/s$, $t = 10s$, $F = ?$

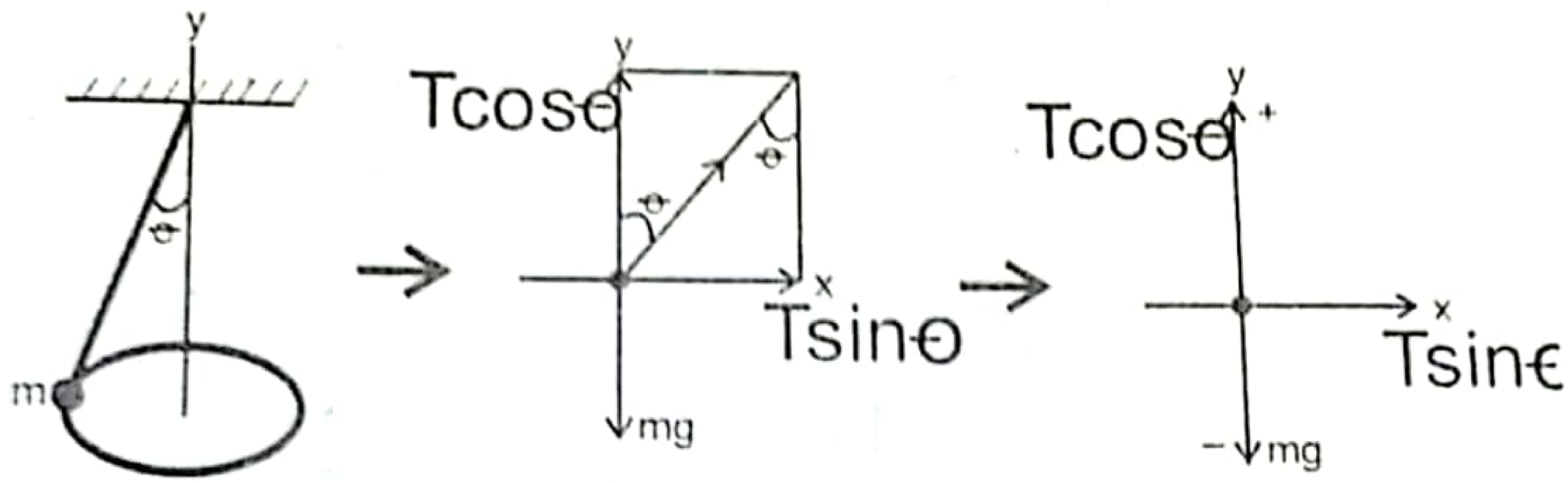
$F = ma$

$= \frac{m(v-u)}{t}$

$= \frac{200(30-0)}{10}$

$F = 600N$

22. A



Free Body Diagram

$m = 6kg.\ \theta = 60°,\quad g = \frac{10m}{s^2},\qquad T = ?$

Since there is only horizontal motion, it implies that there is no motion along y-axis.

$\Rightarrow \sum F_y = 0$

$\Rightarrow T\cos\theta - mg = 0$ (where T is tension in string)

$T\cos 60° - 6 \times 10 = 0$

$0.5T - 60 = 0$

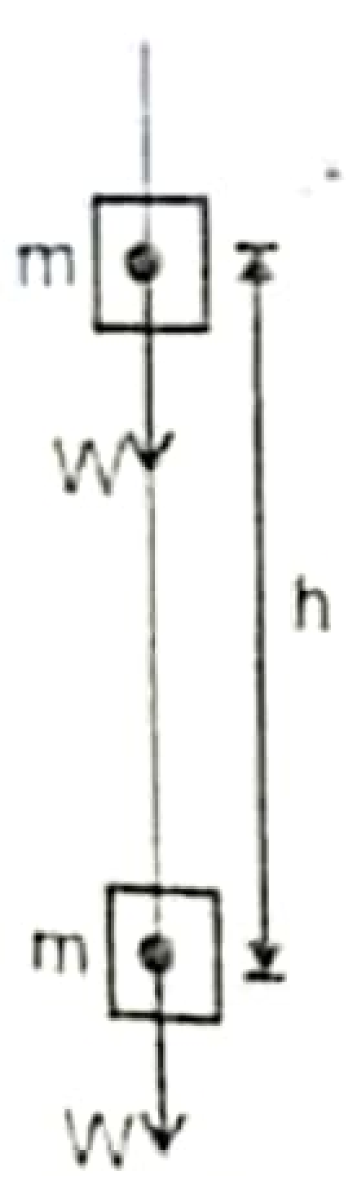
$0.5T = 60$

$T = \frac{60}{0.5} = 120N$ D

Refer to Johnson's PHY 101 GUIDE for more extensive insight into statics and dynamics of bodies

23. **C**

24.



$m = 250kg,\ g = 10m/s^2,\ h = 100m,\quad work = ?$

Work done = force x distance

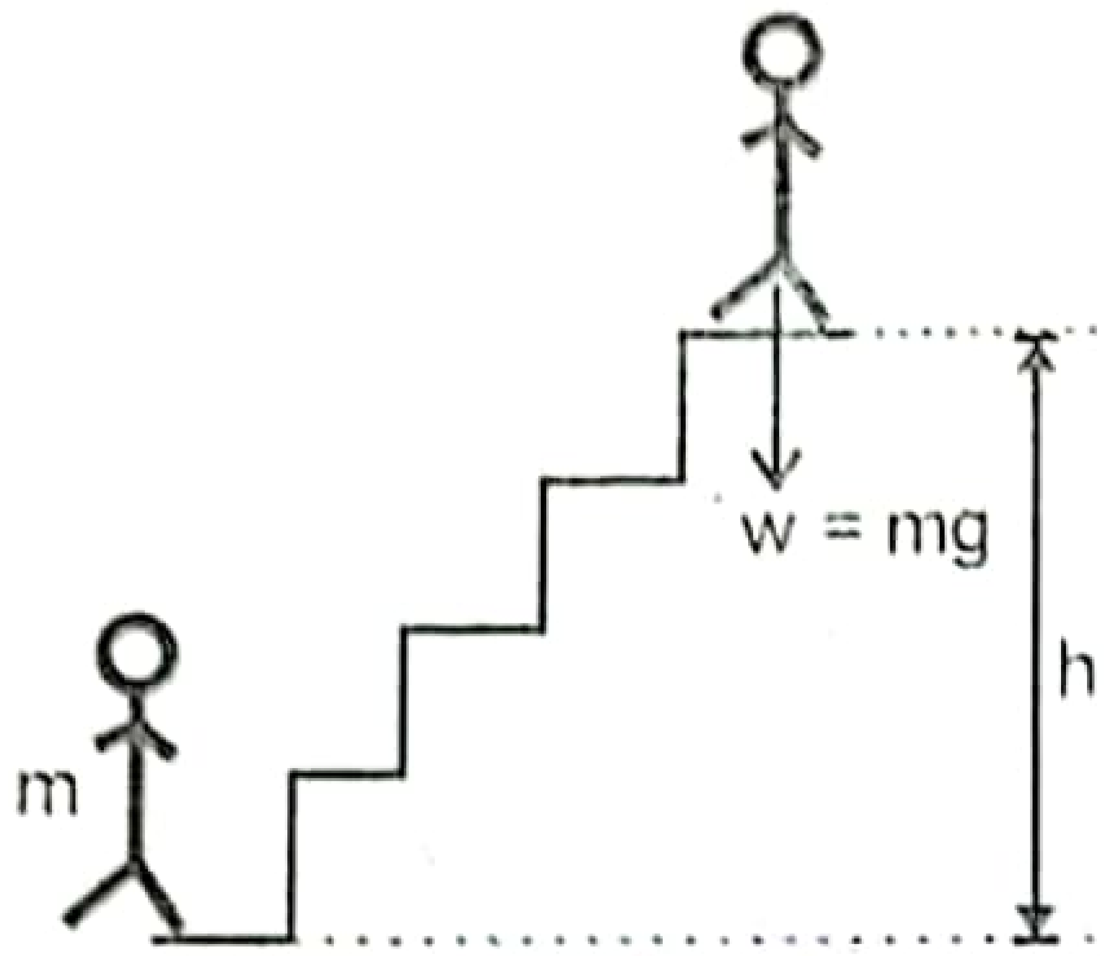
$= W \times h$

$= mg \times h$

$$\text{Work done} = 250 \times 10 \times 100$$
$$= 250000J$$
$$= 2.5 \times 10^5 J$$

25. 746 watts

26.

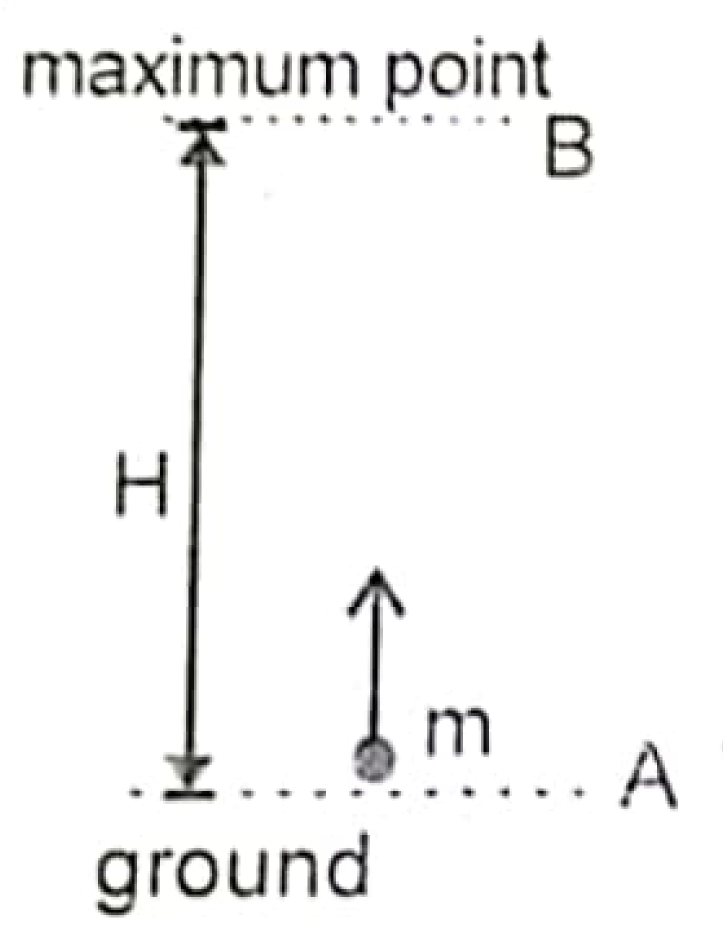


$m = 60kg,\quad h = 15m,\quad g = 10m/s^2$, work = ?

Work done $= E_p$

$$= mgh$$
$$= 60 \times 10 \times 15$$
$$= 9000J$$

27.



$m = 5kg,\quad H = 30m,\quad g = 10m/s^2$

From principle of conservation of energy

Total energy at ground = Total energy at maximum point

Initial K.E = Final P.E at maximum point

$$= mgH$$
$$= 5 \times 10 \times 30$$
$$= 1500J$$

28.

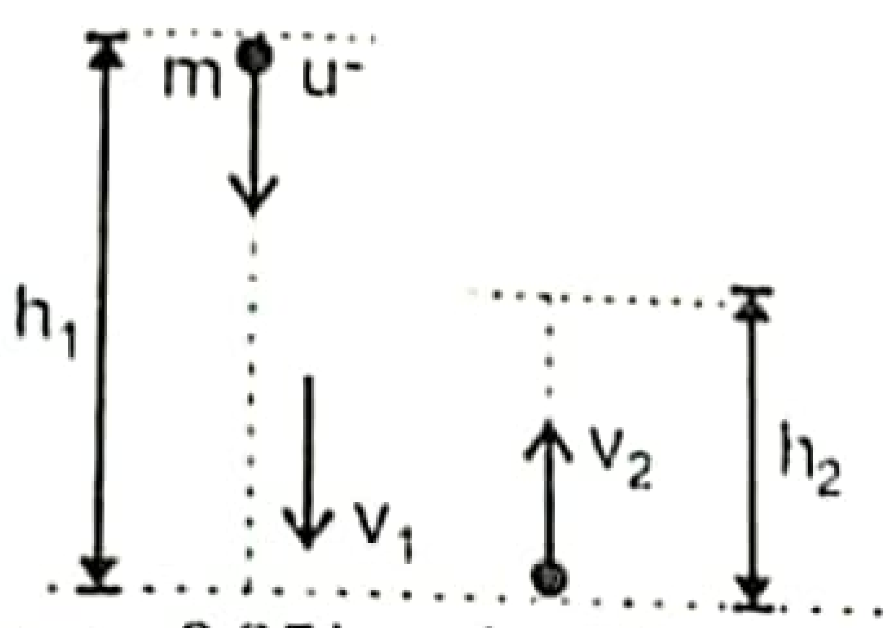
$$m = 2g = \frac{2}{1000}kg = 2 \times 10^{-3}kg$$

$$v = 500m/s$$

$$K.E = \frac{1}{2} \times mv^2$$
$$= \frac{1}{2} \times (2 \times 10^{-3}) \times (500^2)$$

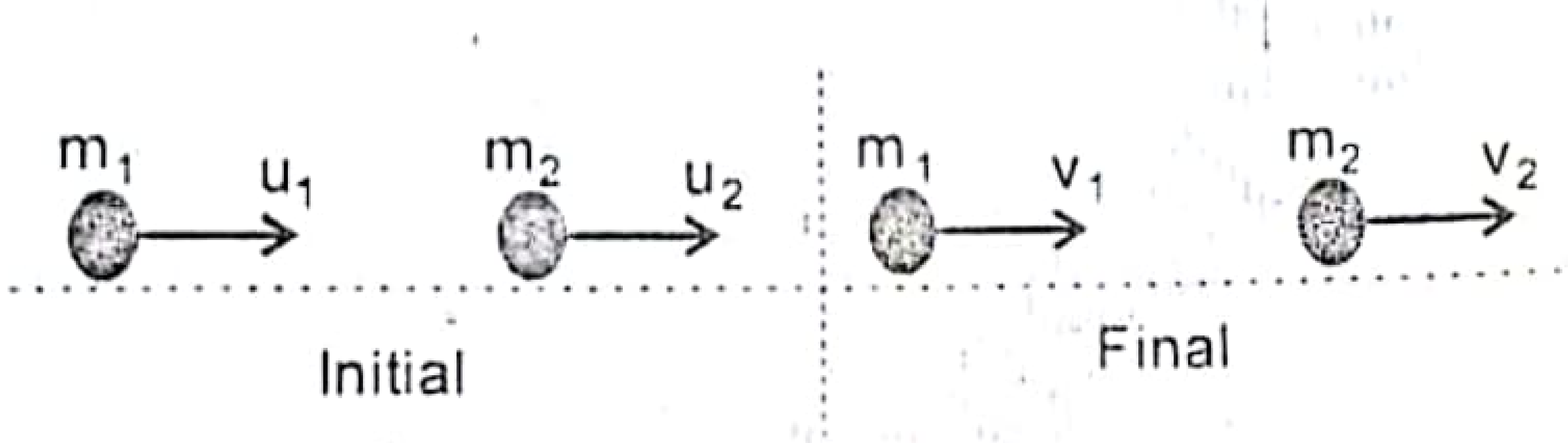
$= 250J$

29.



$m = 0.25kg,\ h_1 = 5m,\quad h_2 = 4.5m,\quad g = 10m/s^2$
$u = 0m/s$ (ball falls from rest)
In the fall, through the height $h_1 = 5m$.
Using $v^2 = u^2 + 2gh$
$\rightarrow v_1^2 = 0^2 + 2gh_1 = 2gh_1$
$v_1 = \sqrt{2gh_1} = \sqrt{2 \times 10 \times 5} = 10m/s$
Impulse received from gravity $I = mv_1 - mu$
$I = m(v_1 - u) = 0.25(10 - 0)$
$I = 2.5kgm/s$

30.



$m_1 = 1kg,\quad u_1 = 16m/s,\ m_2 = 3kg,\quad u_2 = 4m/s,\quad v_1 = ?,\quad v_2 = ?$
From momentum conservation principle,
Total momentum before collision = Total momentum after collision
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
$1 \times 16 + 3 \times 4 = 1 \times v_1 + 3 \times v_2$
$28 = v_1 + 3v_2$
$v_1 + 3v_2 = 28$ --------- (1)
Assume the collision is elastic
From kinetic energy conservation,
Total kinetic energy before collision = Total kinetic energy after collision
$\frac{1}{2}m_1u_1^2 + m_2u_2^2 = \frac{1}{2}m_1v_1^2 + m_2v_2^2$
$\frac{1}{2}(1)(16^2) + \frac{1}{2}(3)(4^2) = \frac{1}{2}(1)v_1^2 + \frac{1}{2}(3)v_2^2$
$256 + 48 = v_1^2 + 3v_2^2$
$v_1^2 + 3v_2^2 = 304$ --------- (2)
Solve equation 1 and 2 simultaneously by substitution method
From (1), $v_1 = 28 - 3v_2$ --------- (3)
Substitute (3) for v_1 in (2)
$(28 - 3v_2)^2 + 3v_2^2 = 304$
$784 - 168v_2 + 9v_2^2 + 3v_2^2 = 304$
$12v_2^2 - 168v_2 + 480 = 0$

Divide both sides by 12

$v_2^2 - 14v_2 + 40 = 0$

Apply Quadratic formula

$v_2 = \frac{-(-14) \pm \sqrt{(-14)^2 - 4 \times 1 \times 40}}{2 \times 1} = \frac{14 \pm 6}{2}$

$\therefore v_2 = \frac{14+6}{2} = 10m/s$ or

$v_2 = \frac{14-6}{2} = 4m/s$

Substitute $v_2 = 10$ into equation (3)

$\rightarrow v_1 = 28 - 3 \times 10 = -2m/s$

Substitute $v_2 = 4$ into equation (3)

$v_1 = 28 - 3 \times 4 = 16m/s$

$\therefore$ Final velocities are $v_1 = -2m/s, \ v_2 = 10m/s$

Or

$v_1 = 16m/s, \ v_2 = 4m/s$

Refer to Johnson's PHY 101 GUIDE for more on momentum and collisions

31.

$m_1 = 2kg, \quad x_1 = 1cm$

$m_2 = 3kg, \quad x_2 = 2cm$

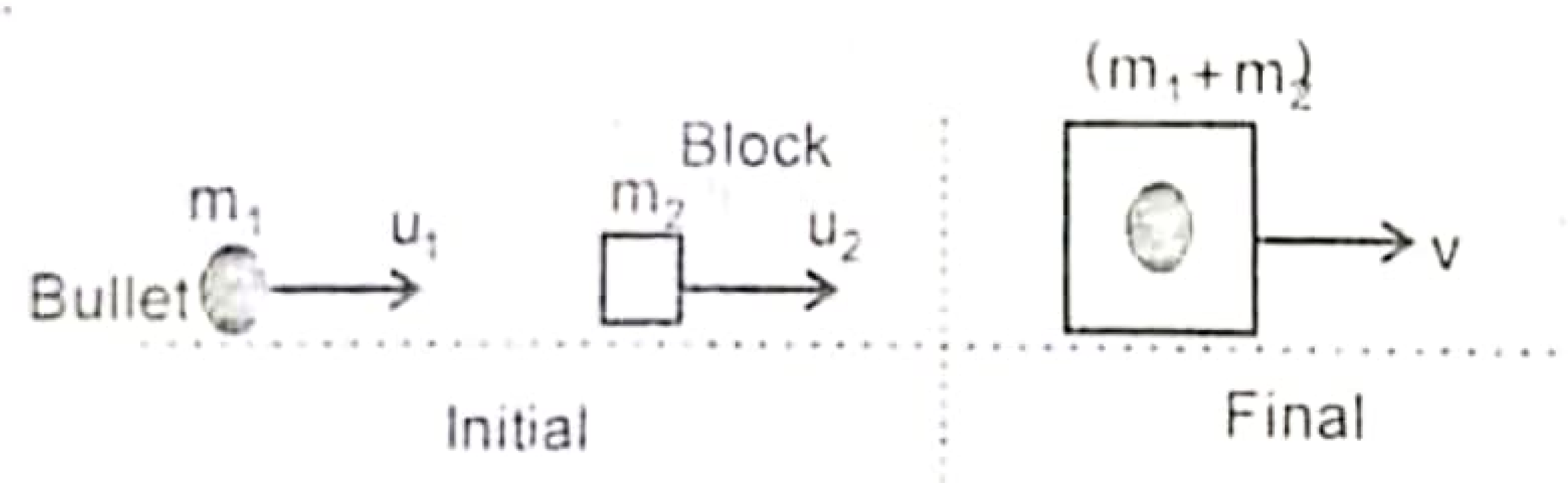
$m_3 = 5kg, \quad x_3 = 6cm$

$x_{cm} = \frac{\sum m_i x_i}{\sum m_i} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$

$= \frac{2 \times 1 + 3 \times 2 + 5 \times 6}{2+3+5} = \frac{38}{10}$

$x_{cm} = 3.8cm$

32.



$m_1 = 15kg.$

Bullet's muzzle velocity $u_1 = ?$

$m_2 = 10kg.$

$u_2 = 0$ (block is initially at rest)

Since block and bullet stick together with a common final velocity v after impact collision is inelastic

$v = \frac{41m}{1s} = 41m/s$

From momentum conservation,

Total momentum before impact = Total momentum after impact

$m_1 u_1 + m_2 u_2 = (m_1 + m_2)v$

$15u_1 + 10(0) = (15 + 10)(41)$

$15u_1 = 1025$

$u_1 = \frac{1025}{15} = 68.3m/s$

33.

$\omega_o = 0\ rad/s$ (disc starts from rest)

$\propto = 0.40 rad/s^2$. $\quad t = 30s$. $\quad \omega = ?$

$\omega = \omega_o + \propto t$

$= 0 + 0.40 \times 30$

$= 12 rad/s$

34. 360°

35.

$360° = 1 rev$

$\therefore 120° = \frac{120 \times 1 rev}{360} = \frac{1}{3} rev$

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