SECTION-A

1. The cube has a side 7.203 m. Its total surface area to appropriate significant figure is : 1

(a) $311.29\ m^2$ (b) $311.3\ m^2$

(c) $310.3\ m^2$ (d) $311.4\ m^2$

2. If momentum (P), Area (A) and time (T) are taken as fundamental quantities then dimensional formula for energy is : 1

(a) $[PA^{-1}T]$ (b) $[P^2AT]$

(c) $[PA^{-1/2}T]$ (d) $[PA^{1/2}T^{-1}]$

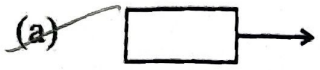
3. The slope of position-time graph represents _____. 1

(a) Velocity (b) Acceleration

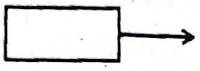
(c) Impulse (d) Momentum

4. Which of the following represents inertial reference frame : 1

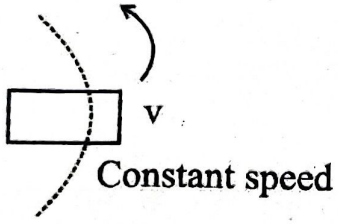
(a) a: acceleration



(b) retarding



(c)



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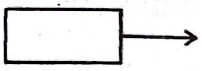
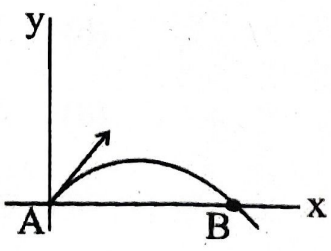


v(constant velocity)

5. A projectile has initial velocity $(2\hat{i}+3\hat{j})$ m/s at A, its velocity in m/s at B will be : 1



(a) $-2\hat{i}-3\hat{j}$ (b) $-2\hat{i}+3\hat{j}$

(c) $2\hat{i}-3\hat{j}$ (d) $2\hat{i}+3\hat{j}$

6. The position vector of a particle changes with time as

$r(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$; its acceleration at t = 1 is : 1

(a) 25 m/s^2 (b) 100 m/s^2

(c) 40 m/s^2 (d) 50 m/s^2

7. Two identical particles are revolving in circular paths of radii r_1 and r_2. They experience the same centripetal force. The ratio of their angular velocities is : 1

(a) $r_2 : r_1$ (b) $r_1^2 : r_2^2$

(c) $\sqrt{r_2} : \sqrt{r_1}$ (d) $r_2^2 : r_1^2$

8. A boy having mass 40 kg is standing in a lift. The force experienced by his feet will be maximum when lift is : 1

(a) stationary

(b) moving downward with velocity 4 m/s

(c) moving down with acceleration 4 m/s^2

(d) moving up with acceleration 4 m/s^2

9. A truck and a car are moving with same kinetic energy. If the weight of truck is 16 times the weight of the car then the ratio of momentums of truck and car is : 1

(a) 1:16 (b) 16:1

(c) 1:4 (d) 4:1

10. A particle is displaced from $\vec{r}_1 = (4\hat{i} + 6\hat{j} + 10\hat{k})$m to $\vec{r}_2 = (6\hat{i} + 9\hat{j} + 15\hat{k})$m on applying a force $(5\hat{i} + 2\hat{j} + 3\hat{k})$ N. The work done is : 1

(a) 31 J (b) 20 J

(c) 60 J (d) 61 J

11. A uniform circular disc having radius R is rotating about a fixed axis passing through its centre and perpendicular to its plane with angular velocity 'W'. The momentum of inertia is I. A heavy particle having mass m is gently placed at the end of the disc. The angular velocity of this system is : 1

(a) $\frac{Iw}{(I+mR)}$ (b) $\frac{(I+mR)}{Iw}$

(c) w (d) $\frac{Iw}{(I+mR^2)}$

12. A disc, a ring, a solid sphere and a hollow sphere have same mass and radius. Which has the greatest moment of inertia for axis of rotation passing through their centre. 1

(a) Ring (b) Disc

(c) Solid sphere (d) Hollow sphere

Note : In question number 13 to 16, two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the code (A), (B), (C) and (D) as given below:

(a) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(b) Both Assertion (A) and Reason (R) are true and (R) is the not correct explanation of Assertion (A).

(c) Assertion (A) is true and Reason (R) is false.

(d) Assertion (A) is false and Reason (R) is also false.

13. Assertion (A) : Slope of momentum-time graph gives acceleration.

Reason (R) : Acceleration is given by rate of change of momentum. 1

14. Assertion (A) : A spring has potential energy, both when it is compressed or stretched.

Reason (R) : In compressing or stretching, work is done on the spring against the restoring force. 1

15. Assertion (A) : The centre of mass of system of n particles is the weighted average of the position vector of the n particles making up the system.

Reason (R) : The position of centre of mass of a system is independent of the coordinate system. 1

16. Assertion (A) : Gravitational potential is maximum at infinity.

Reason (R) : Gravitational potential is the amount of work done to shift a unit mass from infinity to the given point in gravitational attraction force field. 1

SECTION-B

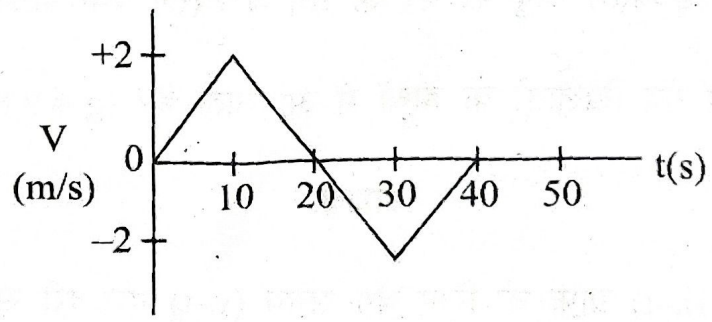
17. Derive an expression for distance travelled in nth second for a body moving in a straight line having constant acceleration a and initial velocity u. 2

OR

From the following velocity-time graph. Find :

(i) Average acceleration between 0 to 10s

(ii) Distance travelled in 40s 2



18. State and prove Work Energy theorem. 2

19. Establish the relation between torque and angular momentum. 2

20. From a uniform disc of radius R, a circular hole of radius R/2 is cut out. The centre of the hole is at R/2 from the centre of the original disc. Locate the centre of mass of the resulting flat body. 2

21. Find the percentage decrease in the weight of a body when taken to a depth of 64 km below the surface of the earth. (Radius of earth = 6400 km) 2

SECTION-C

22. The time period (T) of oscillation of a small liquid drop depends on the density (d) of the liquid, radius (r) of the drop and surface tension (s). Derive by method of dimensions, an expression for the time period (T). 3

23. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t, then calculate :

(i) the maximum velocity attained by the car

(ii) the total distance travelled by the car 3

24. A man throws a ball upwards with a initial speed of 29.4 m/s

(i) What is the direction of acceleration during the upward motion of the ball?

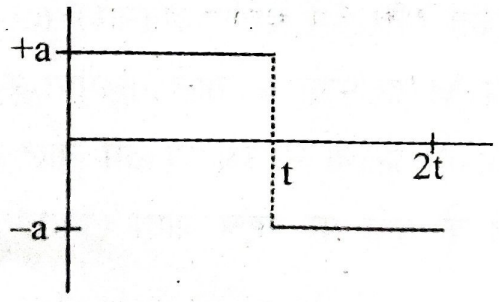
(ii) What is the direction of acceleration during the downward motion of the ball?

(iii) What are the velocity and acceleration of the ball at the highest point of its motion?

(iv) After how long does the ball returns to the player's hand. ($g = 9.8\ m/s^2$) 3

OR

For the given acceleration-time (a-t) graph draw the corresponding velocity-time (v-t) and distance-time (s-t) graphs. The body is moving in a straight line and its initial velocity is zero. 3

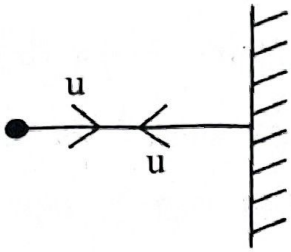


25. Derive the relation for centripetal acceleration. What is the direction of the force producing centripetal acceleration. 3

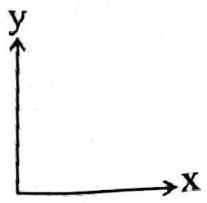
26. Two identical billiard balls strike a rigid wall with the same speed, but at different angles, and gets reflected without any loss of speed as shown in the figure. What is:

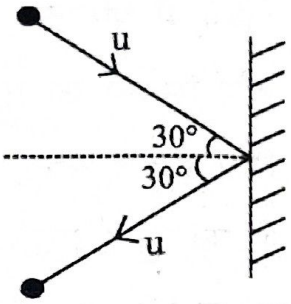
(i) the direction of the force on the wall due to each ball?

(ii) the ratio of magnitudes of the impulses imparted on the two balls by the wall? 3



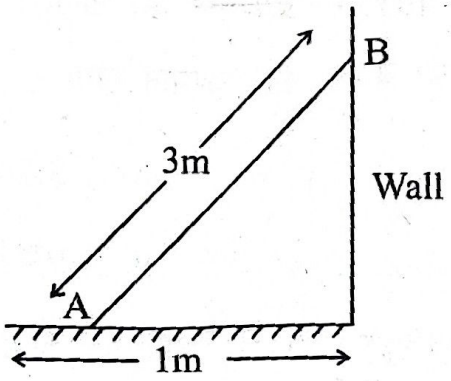
(a)



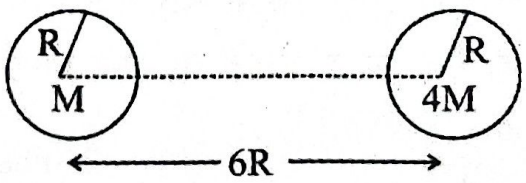


(b)

27. A 3m long ladder (AB) weighing 20 kg leans on a frictionless wall. Its feet rest on the floor 1m from the wall as shown. Find the reaction forces of the wall and the floor. 3



28. Two uniform fixed solid spheres of equal radii R, but mass M and 4M have a centre to centre separation 6R as shown in figure. A projectile of mass m is projected from the surface of the sphere of mass M directly towards the centre of the second sphere. Obtain as expression for the minimum speed V of the projectile so that it reaches the surface of the second sphere. (Neglect any other gravitational effect) 3



SECTION-D

29. In an isolated system of n particles, the mutual forces between pairs of particles in the system cause changes in momenta of individual particles. By third law, the mutual forces between any pair of particles are equal and opposite. By second law, the change in momenta for any pair of particles are $F\Delta t$ and $-F\Delta t$. Thus the momentum changes cancels in pair and the total momentum of the system remains constant. This leads to a fundamental principle of Physics called the law of conservation of linear momentum. This law states that the total linear momentum of an isolated system of interacting particles is conserved. The recoil of a gun on firing, explosion of a bomb into different fragments due to internal forces, the working of rockets and jet planes etc. can be explained on the basis of principle of momentum conservation.

(i) A gun fires a bullet of mass 50g with a velocity of 30 m/s. Because of this, the gun is pushed back with a velocity of 1 m/s. The mass of the gun is : 1

(a) 5.5 kg (b) 3.5 kg

(c) 1.5 kg (d) 0.5 kg

(ii) A body of mass M moving with a velocity V explodes into two equal parts. If one comes to rest and the other part moves with velocity V_1, the value of V_1 is: 1

(a) V (b) $V/\sqrt{2}$

(c) 4V (d) 2V

(iii) The body of mass 0.25 kg is projected with muzzle velocity 100 m/s from a tank of mass 100 kg. What is the recoil velocity of tank? 1

(a) 5 m/s (b) 25 m/s

(c) 0.5 m/s (d) 0.25 m/s

(iv) A bullet is fired from a rifle. If the rifle recoils freely, then the kinetic energy of the rifle is : 1

(a) less than that of the bullet

(b) more than that of the bullet

(c) same as that of the bullet

(d) equal to or less than that of the bullet

OR

(iv) A boy of mass m stands on one end of a wooden plank of length L and mass M. The plank is floating on water. If the boy walks from one end of the plank to the other end it constant speed, the resulting displacement of the plank is given by: 1

(a) $\frac{mL}{M}$

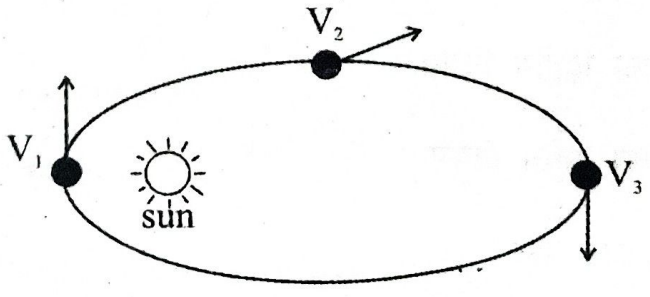
(b) $\frac{ML}{m}$

(c) $\frac{mL}{(m+M)}$

(d) $\frac{mL}{(M-m)}$

30. Aryabhatta gave – the heliocentric model in his treatise in which the sun was the centre around which the planets revolve. Later Kepler analysed the data of Trycho Brache and extract three elegant laws now by the name Kepler's laws.

(i) Figure shows the velocity of a planet revolving around the sun at three times of a year. Then : 1



(a) $|V_2| = 2|V_1|$ and $|V_3| = 3|V_1|$

(b) $|V_3| > |V_2| > |V_1|$

(c) $|V_2| = \frac{|V_1| + |V_3|}{2}$

(d) $|V_1| > |V_2| > |V_3|$

(ii) The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to 3 times its previous value, then approximately new time period of the satellite will be : 1

(a) 40 hours

(b) 36 hours

(c) 30 hours

(d) 25 hours

(iii) According to Kepler's law, which of the following is correct : 1

(a) $T \propto R^{3/2}$

(b) $T \propto R^3$

(c) $T \propto R^{2/3}$

(d) $T \propto R^2$

(iv) Kepler's second law is based on : 1

(a) Law of conservation of energy

(b) Law of conservation of momentum

(c) Law of conservation of angular momentum

(d) Law of conservation of mass

OR

(iv) Which law of Kepler corresponds to Newton's law of gravity. 1

(a) Kepler's first law

(b) Kepler's second law

(c) Kepler's third law

(d) None of these

SECTION-E

31. A projectile is fired at an angle θ upward with the horizontal with velocity u. Obtain expressions for (i) Maximum height obtained (ii) horizontal range. At what value of 'θ' is the range maximum, also give this maximum range? 5

OR

State triangle law of vector addition. Give analytical treatment to find the magnitude and direction of a resultant vector by using this law. 5

32. What is meant by banking of roads? What is the need for banking a road? Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ. The coefficient of friction between the wheels and the road is μ. 5

OR

Define the terms static friction, limiting friction and kinetic friction. Draw the graph between friction and applied force on any object and show static friction, limiting friction and kinetic friction in graph. Using graph show that static friction is a self adjusting force. 5

33. Define elastic collision. Two bodies with masses m_1 and m_2 moving with velocities u_1 and u_2 undergo one dimensional elastic collision. Determine their velocities after the collision. Why heavy water is used in nuclear reactor? 5

OR

A bob of mass m is suspended by a string of length L. It is imparted a horizontal velocity v_0 at the lowest point A such that it completes a semicircular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point, C. This is shown in figure. Obtain the expression for :

(i) v_0

(ii) the speeds at points B and C

(iii) the ratio of kinetic energies (K_B/K_C) at B and C.