BRAIN INTERNATIONAL SCHOOL

MID TERM EXAMINATION (2025-26)

SUBJECT: - PHYSICS (042) (SET-I)

Time: 3 Hr | **Class – XI** | **M.M 70**

General Instructions:

A. **There are 33 questions in all. All questions are compulsory**
B. **This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.**
C. **Section A contains 16 questions, 12 MCQ and 4 assertion reasoning questions of 1 mark each, Section B contains 5 questions of two marks each, Section C contains 7 questions of three marks each, Section D contains two case study-based questions of 4 marks each and section E contains three long questions of five marks each.**
D. **Use of calculators is not allowed.**

SECTION A

1. **If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of density will be**

   (a) $F^2V^{-2}T^6$

   (b) $F^1V^{-2}T^2$

   (c) $F^1V^4T^{-6}$

   (d) $F^1V^{-4}T^{-2}$

2. **Which of the following pairs has the same dimensions?**

   (a) Torque and Energy

   (b) Momentum and Inertia

   (c) Pressure and density

   (d) Angular momentum and torque

3. **A ball dropped from the top of tower falls first half height of tower in 10 s. The total time spend by ball in air is**

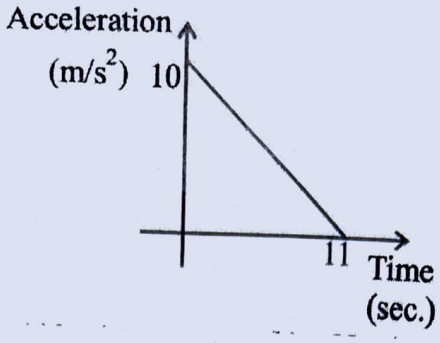
   (a) 14.14 sec

   (b) 10.5 sec

   (c) 5.5 sec

   (d) 6.5 sec

4. **A body starts from rest at time t = 0, the acceleration time graph is shown in the figure. The maximum velocity attained by the body will be**



(a) 60 m/s (b) 55 m/s (c) 65 m/s (d) 550 m/s

5. **The coefficient of static friction between two surfaces depends on**

(a) the nature of surface

(b) the shape of the surface in contact

(c) the area of contact

(d) all of the above

6. **What will be the projection of vector $\vec{A} = \hat{\imath} + \hat{\jmath} + \hat{k}$ on vector $\vec{B} = \hat{\imath} + \hat{\jmath}$**

(a) $\sqrt{2}(\hat{\imath} + \hat{\jmath} + \hat{k})$

(b) $\hat{\imath} + \hat{\jmath}$

(c) $\sqrt{2}(\hat{\imath} + \hat{\jmath})$

(d) $2(\hat{\imath} + \hat{\jmath} + \hat{k})$

7. **The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is**

(a) 60°

(b) 15°

(c) 30°

(d) 45°

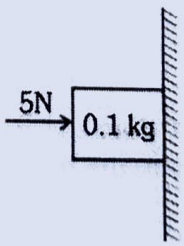
8. **A block of mass 0.1 kg. is pressed against a wall with a horizontal force of 5N as shown in the figure. If the coefficient of friction between the wall and the block is 0.5 then the frictional force acting on the block will be ($g = 9.8\ ms^{-2}$)**

(a) 9.8 N

(b) 2.5 N

(c) 0.98 N

(d) 0.49 N



9. **A 1 kg stationary bomb is exploded in three parts having mass 1: 1: 3 respectively. Parts having same mass move in perpendicular direction with velocity 30 m/s, then the velocity of bigger part will be**

(a) $10\sqrt{2}$

(b) $\frac{10}{\sqrt{2}}$

(c) $15\sqrt{2}$

(d) $\frac{15}{\sqrt{2}}$

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

(a) $t^{1/2}$

(b) t

(c) $t^{3/2}$

(d) t

11. Two bodies with kinetic energies in the ratio of 4: 3 are moving with equal linear momentum. The ratio of their masses is

(a) 4: 3

(b) 1: 1

(c) 1: 4

(d) 3: 4.

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

(a) zero

(b) 1

(c) –1

(d) 2

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(i) Both A and R are true and R is the correct explanation of A

(ii) Both A and R are true but R is not the correct explanation of A.

(iii) A is true but R is false.

(iv) A is false and R is true.

13. Assertion (A): A passenger in a bus moving with constant speed feels pushed backward when the bus suddenly stops.

Reason(R): Due to inertia of rest, the upper part of the passenger's body continues moving forward when the bus stops.

14. Assertion (A): Work done by force of friction in moving a body in any round trip is zero.

Reason(R): Frictional force is a non-conservative force.

15. Assertion (A): Torque on a body can be zero even if there is a net force on it.

Reason(R): Torque and force on a body are always perpendicular.

16. Assertion (A): A body moving at constant speed in a circular path has zero acceleration.

Reason(R): In uniform circular motion, the velocity changes direction but not magnitude.

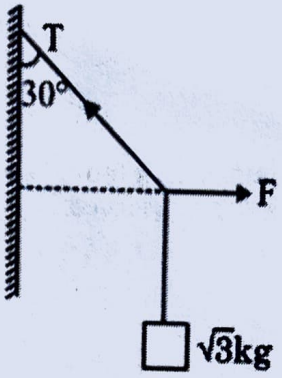
SECTION B

17. A body of mass m is moving in a circle of radius r with angular velocity ω. Find expression for centripetal force acting on it by the method of dimensions.

18. The motion of a particle is described by the equation $x = a + bt^2$ where $a = 15\,cm$ and $b = 3\,cm/s^2$. Find Its instantaneous velocity at time 3 sec.

19. A particle starts from origin at t = 0 with a velocity $5.0\,\hat{\imath}$ m/s and moves in x-y plane under action of a force which produces a constant acceleration of $(3\hat{\imath} + 2\hat{\jmath})$ m/s^2(a) What is the y-coordinate of the particle at the instant its x-coordinate is 84 m? (b) What is the speed of the particle at this time?

20. A block of $\sqrt{3}$kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30^0 with the wall. Find the tension T.



21. A block of mass $m = 1\,kg$, moving on a horizontal surface with speed $v_i = 2\,ms^{-1}$ enters a rough patch ranging from $x = 0.10\,m$ to $x = 2.01\,m$. The retarding force F_r on the block in this range is inversely proportional to x over this range,

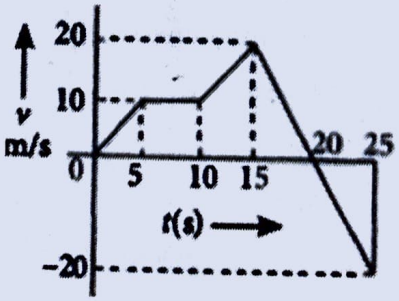
$F_r = \frac{-k}{x}$ for $0.1 < x < 2.01\,m$

$= 0\,for\,x < 0.1m\,and\,x > 2.01\,m$ where k = 0.5 J. What is the final kinetic energy and speed v_f of the block as it crosses this patch? [given ln (20.1) =3]

SECTION C

22. Find the dimensions of b^2/a in the equation: F= $ax^2 + bt^{1/2}$, where F is force, x is distance and t is time.

23. From the v-t graph shown, find the ratio of distance to displacement in 25 sec of motion.



24. Derive an expression for the centripetal acceleration of a body moving in a circular path of radius 'r' with uniform speed 'v'

25. A man of mass 70 kg stands on a weighing scale in a lift which is moving. What would be the readings on the scale in each case?

(a) upwards with a uniform speed of 10 ms^{-1}

(b) downwards with a uniform acceleration of 5 ms^{-2}

(c) What would be the reading if the lift mechanism failed and it hurtled down freely under gravity?

26. Show that in case of one-dimensional elastic collision of two bodies, the coefficient of restitution is equal to one.

27. A rope of negligible mass is wound round a hollow cylinder of mass 3 kg and radius 40 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N? What is the linear acceleration of the rope? Assume that there is no slipping.

28. Derive the relation between angular momentum and torque.

SECTION D

29. This principle is a consequence of Newton's second and third laws of motion. In an isolated system (i.e., a system having no external force), mutual forces (called internal forces) between pairs of particles in the system causes momentum change in individual particles. Let a bomb be at rest, then its momentum will be zero. If the bomb explodes into two equal parts, then the parts fly off in exactly opposite directions with same speed, so that the total momentum is still zero. Here, no external force is applied on the system of particles (bomb).

(i) A shell of mass 10 kg is moving with a velocity of 10 ms^{-1} when it blasts and forms two parts of mass 9 kg and 1 kg respectively. If the first mass is stationary, the velocity of the second is

(a) 1 m/s

(b) 10 m/s

(c) 100 m/s

(d) 1000 m/s

(ii) A bullet of mass 10 g is fired from a gun of mass 1 kg with recoil velocity of gun 5 m/s. The muzzle velocity will be

(a) 30 km/min

(b) 60 km/min

(c) 30 m/s

(d) 500 m/s

(iii) A bullet of mass 0.1 kg is fired with a speed of 100 m/s. The mass of gun being 50 kg, then the velocity of recoil becomes

(a) 0.05 m/s

(b) 0.5 m/s

(c) 0.1 m/s

(d) 0.2 m/s

(iv) A cricketer catches a ball of mass 150 gm in 0.1 sec moving with speed 20 m/s, then he experiences force of

(a) 300 N

(b) 30 N

(c) 3 N

(d) 0.3 N.

30. Conservation of Angular Momentum:

Swati wants to play with swivel chair for having fun in office during lunch break. She sits on a swivel chair with her arms folded and feet not resting on, i.e., away from, the ground. She asked her friend to rotate the chair rapidly. While the chair is rotating with considerable angular speed, she stretches her arms horizontally. If she brings back her arms closer to body, the angular speed increases again. This is a situation where the principle of conservation of angular momentum is applicable. If friction in the rotational mechanism is neglected, there is no external torque about the axis of rotation of the chair and hence angular momentum is conserved.

(i) planetary motion in the solar system describes

(a) conservation of kinetic energy

(b) conservation of angular momentum

(c) conservation of linear momentum

(d) none of these

(ii) if a person standing on a rotating disc stretches out his hands, the angular speed will

(a) decrease

(b) increase

(c) remain same

(d) first increases then decreases

(iii) A diver in a swimming pool bends his head before diving, because it

(a) increases his linear velocity

(b) decreases his angular velocity

(c) increases his moment of inertia

(d) decreases his moment of inertia

(iv) what will be the duration of the day, if earth suddenly shrinks to 1/64 of its original volume, mass remaining the same?

(a) 2.5 hour

(b) 1.5 hour

(c) 3 hours

(d) 4 hours

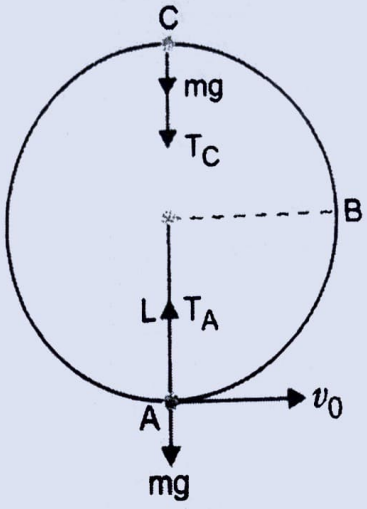
SECTION E

31. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_o at the lowest point A such that it completes a semi-circular trajectory in the vertical plane with the string becoming slack only on reaching the top most point, C. Obtain an expression for

(i) v_o

(ii) the speeds at points B and C;

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



32. (a) Derive an expression for velocity of a car on a banked circular road having coefficient of friction (μ). Hence write the expression for optimum velocity.

(b) A body of mass 0.40 kg moving initially with a constant speed of 10 m/s to the north is subject to a constant force of 8.0 N directed towards the south for 30 s. Take the instant the force is applied to be t = 0, the position of the body at that time to be x = 0, and predict its position at t = –5 s, 25 s, 100 s.

33. (a) A projectile is fired upward at an angle θ with the horizontal with velocity u. Show that its trajectory is a parabola.

(b) A hiker stands on the edge of a cliff 490 m above the ground and throws a stone horizontally with an initial speed of 15 m/s. Neglecting air resistance, find the time taken by the stone to reach the ground, and the speed with which it hits the ground. (Take g = 9.8 m/s^2).