ANANDALAYA
PERIODIC TEST - 2
Class : XI

विद्या सर्वार्थि साधिका

Subject: Physics (042) MM : 70
Date : 20-09-2023 Time: 3 Hours

General Instructions:
1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections – Section A, Section B, Section C, Section D and Section E.
3. Section A contains sixteen questions - twelve MCQ and four Assertion Reasoning based - 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
4. There is no overall choice. However an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.
6. You may use the following values of physical constants wherever necessary.
   $c = 3 \times 10^8\ ms^{-1}$ and $g = 10\ ms^{-2}$

SECTION A

1. In the standard equation $s_n = u + \frac{a}{2}(2n - 1)$, u is initial velocity, a is acceleration and n is time. What is the dimensions of s_n? (1)
   (A) $[M^0L^1T^0]$ (B) $[M^0L^{-1}T^1]$ (C) $[M^0L^1T^{-1}]$ (D) $[M^0L^0T^1]$

2. The number of significant figures in 3400 is _____. (1)
   (A) 4 (B) 3 (C) 2 (D) 1

3. Which of the following physical quantity has the dimensional formula is $[ML^2T^{-2}]$? (1)
   (A) Force (B) kinetic energy (C) Power (D) Momentum

4. A stone is dropped from a height. At the same time two more stones are thrown from the same height – one horizontally and another vertically upward. The times taken by three stones to reach the ground are t_1, t_2 and t_3 respectively. Then (1)
   (A) $t_1 = t_2 = t_3$ (B) $t_1 < t_2 < t_3$ (C) $t_1 > t_2 > t_3$ (D) $t_1 = t_2 < t_3$

5. The equation of motion of a point mass is given by $x = 5t + 8\,t^2$ where x is in meters and t is in seconds. This equation represents _____. (1)
   (A) uniform velocity (B) uniform speed
   (C) uniform acceleration (D) non – uniform acceleration

6. The velocity of a mass changes from 8 m/s to 3 m/s in 2 seconds. What is the acceleration? (1)
   (A) 2.5 m/s^2 (B) – 2.5 m/s^2 (C) 5.5 m/s^2 (D) – 5.5 m/s^2

7. For what angle of projection a projectile will have highest range? (1)
   (A) 30° (B) 45° (C) 60° (D) 90°

8. A particle of mass m moving with a velocity v hits another stationary particle of mass 2m. If both masses stick together and move with a velocity v'. The velocity v' will be _____. (1)
   (A) $\frac{v}{2}$ (B) $2v$ (C) $\frac{v}{3}$ (D) $3v$

9. For a body moving with a constant speed in a horizontal circle, which of the following remains constant? (1)
   (A) Velocity (B) Acceleration (C) centripetal force (D) kinetic energy

10. Force F = $(3\,\hat{\imath} + 4\,\hat{\jmath} - 5\hat{k})$ N and displacement d = $(5\hat{\imath} + 4\hat{\jmath} + 3\hat{k})$ m. Find the projection of F on d. (1)
(A) 16 Nm (B) 46 Nm (C) $15\hat{\imath} + 16\hat{\jmath} - 15\hat{k}$ (D) $15\hat{\imath} + 16\hat{\jmath} + 15\hat{k}$.

11. Inelastic collision is the collision between two objects where (1)
(A) both momentum and kinetic energy are conserved
(B) momentum is conserved but not kinetic energy
(C) kinetic energy is conserved but not momentum
(D) both momentum and kinetic energy are not conserved

12. In a two particles system the masses 1 kg and 2 kg are separated by a distance of 1m. The position of centre of mass from 1 kg mass is _____. (1)
(A) 0.66 m (B) 0.33 m (C) 0.50 m (D) 0.70 m

For question numbers 13 to 16, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.
(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion
(B) Both Assertion and Reason are true but Reason is NOT the correct explanation of Assertion.
(C) Assertion is true but Reason is false
(D) Assertion is false and Reason is also false.

13. Assertion: Uniform circular motion is an accelerated motion. (1)
Reason: In uniform circular motion speed of the body remains constant

14. Assertion: The weight of a man standing in a lift which is moving with acceleration 'a' is greater than that when the lift is stationary. (1)
Reason: During the upward motion of the lift the weight of the will be *m(g-a)*.

15. Assertion: Kinetic energy becomes four times when the velocity of the particle becomes two times. (1)
Reason: Kinetic energy is directly proportional to square of the velocity.

16. Assertion: When a bottle is opened, the net force acting on the bottle cap is zero. Still the bottle is opened. (1)
Reason: A couple is torque provided by two equal and opposite forces separated by a distance.

SECTION B

17. The acceleration of a body is $a = 4t$. What is its velocity at t = 2 s, if it starts from rest? (2)

OR

The position of a mass is given by the equation $x = 5t - 6t^2$. Find the velocity at t = 2s?

18. A particle starts from rest and it acceleration (a) plotted against time (t) is shown here. (2)

Plot the corresponding velocity (v) against time (t). Also plot the corresponding position (x) against time (t).

19. A bullet of mass 0.04 kg moving with a speed of 90 m s^{-1} enters a heavy wooden block and is stopped after a distance of 60 cm. What is the average resistive force exerted by the block on the bullet? (2)

20. A mass 1 kg tied to a string of length 40 cm is rotated in a vertical circle. Find the minimum speed of the mass (a) at the highest point and (b) the lowest point of the circle to maintain the circular path. (2)

21. Define cross product of two vectors. Find a vector which is perpendicular to the plane containing $\vec{A} = 2\hat{\imath} + 2\hat{\jmath}$ and $\vec{B} = 3\hat{\imath} + 2\hat{k}$. (2)

SECTION C

22. The time of oscillation T of a small drop of liquid under surface tension depends upon the density ρ, radius r and surface tension σ. Obtain dimensionally that : $T = \sqrt{\frac{\rho r^3}{\sigma}}$ (3)

(Surface tension is defined as the force per unit length acting at right angles on an imaginary line drawn on the surface of the liquid)

23. Derive the following equations of motion for a uniformly accelerated motion from its velocity – time graph. (a) $v = u + at$ (b) $s = ut + \frac{1}{2}a\,t^2$ (3)

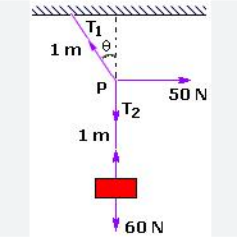
24. A ball is thrown vertically upwards with a velocity of 20 m s^{-1} from the top of a multi-storey building. The height of the point from where the ball is thrown is 25.0 m from the ground. (3)
(a) How high will the ball rise?
(b) How long will it be before the ball hits the ground?

25. Show that there are two values of time for a projectile when it is at the same height. Also show that the sum of these two times is equal to the time of flight. (3)

OR

A body is projected horizontally from the top of a tower of height 20 m. The initial velocity is 10 m/s. Find: (a) the time it will take to reach the ground, (b) horizontal distance from the foot of the tower to where it will strike the ground and (c) vertical velocity with which it will hit the ground.

26. (a) What do you mean by equilibrium of particle? (3)
(b) A mass of 6 kg is suspended by a rope of length 2 m from the ceiling. A force of 50 N in the horizontal direction is applied at the midpoint P of the rope, as shown. What is the angle the rope makes with the vertical in equilibrium? Neglect the mass of the rope.



27. A body of mass 2 kg initially at rest moves under the action of an applied horizontal force of 7 N on a table with coefficient of kinetic friction = 0.1. Compute the (a) work done by the applied force in 10 s, (b) work done by friction in 10 s, and (c) work done by the net force on the body in 10 s. (3)

28. A particle is rotating with an initial angular velocity ω_0. Derive the expression for the angular displacement at a time t if it experiences a constant angular acceleration α. (3)

SECTION D

Question no 29 and 28 are case based questions. Read the paragraph and answer the questions given below.

29. If a body moves in a circle with constant speed, that motion is known as uniform circular motion. In uniform circular motion the angular velocity is constant. But since the direction of the linear velocity changes continuously we can say this is an accelerated motion. The acceleration is directed towards the centre of the circular path and is called centripetal acceleration a_c. The centripetal force is ma_c. (4)

(i) Centripetal acceleration associated with a body in uniform circular motion is _____.
(A) $\frac{v^2}{r}$ (B) $\frac{m^2v^2}{r}$ (C) $\frac{m^2v^2}{r^2}$ (D) $\frac{v}{r}$

(ii) The relation between the speed of the body in a uniform circular motion and its angular velocity is _____.
(A) $v = \omega/r$ (B) $v = r\omega$ (C) $\omega = rv$ (D) $r = v\omega$

(iii) The direction of the acceleration of the body in uniform circular motion is _____
(A) tangential to the circle (B) perpendicular to the plane of the circle

(C) radially outward (D) radially inward

(iv) What is the angular velocity of the tip of second hand of a wall clock?

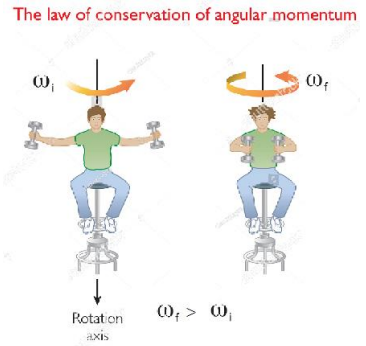
(A) $\frac{\pi}{60}$ rad/s (B) $\frac{\pi}{30}$ rad/s (C) 120π rad/s (D) 60π rad/s

OR

(iv) Two bodies are moving in circular paths of radius r_1 and r_2 taking same time to complete one full rotation. What is the ratio of their angular velocities?

(A) 1:2 (B) 1:1 (C) 2:1 (D) 1:5

30. You may do this experiment with your friend. Sit on a swivel chair (a chair with a seat, free to rotate about a pivot) with your arms folded and feet not resting on, i.e., away from, the ground. Ask your friend to rotate the chair rapidly. While the chair is rotating with considerable angular speed stretch your arms horizontally. What happens? Your angular speed is reduced. If you bring back your arms closer to your body, the angular speed increases again. This is a situation where the principle of conservation of angular momentum is applicable. (4)



(i) State law of conservation of angular momentum.

(ii) Which of the following quantity would be zero when angular momentum is constant?

(A) linear momentum (B) force (C) angular acceleration (D) torque

(iii) A comet revolving around the sun has velocity of 3×10^4 m/s at a distance of 8×10^{15} m from the sun. What will be its velocity at a distance of 12×10^{15} m?

OR

(iii) If earth were to shrink suddenly (keeping the mass constant), what would happen to the length of the day?

SECTION E

31. An object is projected at an angle θ with the horizontal with a velocity 'u'. Show that the path of the projectile is a parabola. Also derive the expression for the maximum height that it can reach. (5)

OR

Find the magnitude and direction of the resultant of two vectors A and B in terms of their magnitudes and angle θ between them.

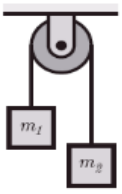
32. A car is travelling on a road of radius r banked at an angle (θ). (a) Find the maximum velocity with which it can negotiate the turn. (b) Also find the optimum speed for which the wear and tear will be minimum. (5)

OR

(a) What is conservative force? Give one example.

(b) Friction is not a conservative force. Justify.

(c) Two masses m_1 = 16 kg and m_2 = 8 kg are hung from a ceiling using a frictionless pulley as shown in the figure. Find the acceleration with which 16 kg mass would move?



33. (a) What do you mean by a completely inelastic collision? (5)

(b) Two equal masses – one moving with velocity u_1 and other one is a stationary mass – collide. Assuming that it is one dimensional completely inelastic collision, obtain the loss in kinetic energy.

OR

(a) What is restoring force (spring force) of a spring?

(b) A spring attached with a mass m is stretched through a distance of x_m. Derive an expression for the potential energy stored in the spring.

(c) Sketch a plot to show the variation of potential and kinetic energies with displacement of mass m from the un-stretched position.