विद्या सर्वार्थि साधिका

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PERIODIC TEST - 2

Class: XI

Subject: Physics (042) MM: 70

Date : 16-09-2025 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 of 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 two questions in Section B, one question in Section C 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.

SECTION A

1. A block is moving on a smooth horizontal surface. The force required to keep it moving with uniform velocity is: (1)
   (A) Equal to its weight (B) Zero
   (C) Equal to the friction (D) Equal to the product of mass and acceleration

2. The horizontal range of a projectile is maximum when the angle of projection is_____. (1)
   (A) 30° (B) 45° (C) 60° (D) 90°

3. The unit vector in the direction of $\vec{A} = 3\hat{\imath} + 4\hat{\jmath}$ is _____. (1)
   (A) $\hat{A} = \frac{3}{5}\hat{\imath} + \frac{4}{5}\hat{\jmath}$ (B) $\hat{A} = \frac{3}{4}\hat{\imath} + \frac{4}{3}\hat{\jmath}$ (C) $\hat{A} = \frac{7}{5}\hat{\imath} + \frac{7}{5}\hat{\jmath}$ (D) $\hat{A} = \hat{\imath} + \hat{\jmath}$

4. The velocity of a particle moving in a circle of radius r with angular velocity ω is _____. (1)
   (A) $r\omega^2$ (B) $\frac{\omega}{r}$ (C) $r\omega$ (D) $\frac{1}{r\omega}$

5. Which of the following is *not* possible? A body having _____. (1)
   (A) zero displacement but non-zero distance (B) constant speed but variable velocity
   (C) zero velocity but non-zero acceleration (D) constant velocity but variable speed

6. A car is moving with velocity 20 m/s. It comes to rest in 5 s with uniform deceleration. The deceleration is _____. (1)
   (A) 2 m/s^2 (B) 4 m/s^2 (C) 5 m/s^2 (D) 10 m/s^2

7. Which of the following graphs is possible for uniform acceleration? (1)
   (A) Curved velocity–time graph (B) Straight line position–time graph
   (C) Straight line velocity–time graph (D) Hyperbolic acceleration–time graph

8. A particle covers first half of the distance with speed v_1 and the second half with speed v_2. Its average speed for the whole journey is _____. (1)
   (A) $\frac{v_1+v_2}{2}$ (B) $\sqrt{v_1 v_2}$ (C) $\frac{2v_1v_2}{v_1+v_2}$ (D) $\frac{v_1^2+v_2^2}{v_1+v_2}$

9. A mass 6 kg is moving with a constant velocity of 4 m/s along a line parallel to the x – axis away from the origin. If the line is 3 m from the x axis, what is the angular momentum with respect to the origin? (1)
(A) 8 Js (B) 2 Js (C) 4.5 Js (D) 72 Js

10. What is the dimensional formula of moment of inertia? (1)
(A) $[M^1L^2T^{-1}]$ (B) $[M^1L^2T^0]$ (C) $[M^1L^1T^{-1}]$ (D) $[M^0L^0T^0]$

11. The sum of the numbers 436.32, 227.2 and 0.301 in appropriate significant figures is _____. (1)
(A) 663.821 (B) 664 (C) 663.8 (D) 663.82

12. The power delivered by a force (F) when a body is moved with a constant velocity (v) is ___. (1)
(A) $F\ v\cos\theta$ (B) $Fv\sin\theta$ (C) $\frac{F}{v\cos\theta}$ (D) $\frac{F\sin\theta}{v}$

For question numbers 13 to 16, select the correct answer from the codes (A), (B), (C) and (D) as given below.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false
(D) (A) is false and (R) is also false.

13. A: The angle projection for maximum height in a projectile is 90°. (1)
R: The maximum height reached is directly proportional to sine of the angle of projection.

14. A: In a uniform circular motion, speed of the body is constant. (1)
R: Centripetal acceleration is always tangential to the circular path.

15. A: If acceleration of a body is zero, the body must be at rest. (1)
R: Acceleration is the rate of change of speed with time.

16. A: Work done by friction is always negative. (1)
R: Friction is not a conservative force.

SECTION B

17. (a) Explain why passengers are advised to wear seat belts in moving vehicles. (2)
(b) A ball moving with velocity u hits a wall perpendicularly and rebounds with the same speed in the opposite direction. What is the change in momentum?

18. A bullet of mass 50 g is fired from a gun of mass 5 kg with a velocity of 400 m/s. Calculate the recoil velocity of the gun. (2)

19. The position of a particle is given by $\vec{r} = 3.0\,t\,\hat{\imath} + 2.0\,t\,\hat{\jmath} + 4.0t^2\,\hat{k}$ m where t is in seconds and the coefficients have the proper units for r to be in metres. What is the magnitude of velocity of the particle at t = 2.0 s? (2)

20. The displacement (S_n) of a uniformly accelerated body in nth second is the displacement in n seconds and that in (n-1) seconds. Find the expression for displacement in nth second. (2)

OR

A truck and a car with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding forces. Find which one of them will come to rest in a shorter distance.

21. When white light travels through glass the refractive index $\mu = \left[\frac{velocity\ of\ light\ in\ air}{velocity\ of\ light\ in\ glass}\right]$ is found to vary with wavelength (λ) as $\mu = A + \frac{B}{\lambda^2}$ where A and B are constants. Using the principle of homogeneity of dimensions, determine the dimensions of A and B. (2)

SECTION C

22. (a) State Newton's second law of motion. (3)
(b) A truck of mass 5000 kg is moving at 15 m/s. If the brakes are applied and the truck stops in 10 s, find: (i) The acceleration and (ii) The braking force

23. Show that for a projectile, two angles θ and (90°−θ) give the same range, but different maximum heights. Derive the relation between the two maximum heights. (3)

24. Derive the equation $x = x_0 + ut + \frac{1}{2}at^2$ using analytical method. (3)

OR

Derive the equations $v = u + at$ and $s = ut + \frac{1}{2}at^2$ using graphical method.

25. (a) Define Torque. (3)
(b) A force $\vec{F} = 3\hat{\imath} - 4\hat{\jmath} + 5\hat{k}$ N is acting on a mass at position $\vec{r} = -2\hat{\imath} + \hat{\jmath} + 3\hat{k}$ m. What is the torque experienced by the mass about the origin?

26. Assuming that the mass (*m*) of the largest stone that can be moved by a flowing river depends only upon the velocity *v*, the density ρ of water and the acceleration due to gravity *g*. Show that m varies, with the sixth power of the velocity of the flow. (3)

27. Define work. A cyclist comes to a skidding stop in 10 m. During this process, the force on the cycle due to the road is 200 N and is directly opposed to the motion. (a) How much work does the road do on the cycle? (b) What is the work done by the friction? (c) How much work does the cycle do on the road? (3)

28. State work-energy theorem. Prove work-energy theorem for a constant force. (3)

SECTION D

29. Static friction opposes impending motion. The term impending motion means motion that would take place (but does not actually take place) under the applied force, if friction were absent. We know from experience that as the applied force exceeds a certain limit, the body begins to move. It is found experimentally that the limiting value of static friction (f s) max is independent of the area of contact and varies with the normal force (N) approximately as: $(f_s)_{max} = \mu_s N$ (4.13) where μ_s is a constant of proportionality depending only on the nature of the surfaces in contact. The constant μ_s is called the coefficient of static friction.

A wooden block of mass 2 kg is placed on a horizontal surface. A force of 6 N is applied to move it. The coefficient of static friction between the block and surface is 0.4, and the coefficient of kinetic friction is 0.3. Take g = 10 m/s^2.
Answer the following questions:
(i) Calculate the maximum static friction. (1)
(ii) (a) Will the block start moving? Justify. (2)

OR

(ii) (b) How can friction be reduced? Give any two points.
(iii) What is the dimensional formula of coefficient of friction? (1)

30. The centre of mass of a body is a point at which the entire mass of body is supposed to be concentrated. The position vector $\vec{r}$ of centre of mass of a system of two particles of mass m_1 and m_2 at positions r_1 and r_2 respectively is given by the equation

$$\vec{r} = \frac{m_1 r_1 + m_2 r_2}{m_1 + m_2}$$

The velocity of centre of mass is constant if there is no external force acting on the system. Under no circumstance, the velocity of centre of mass of an isolated system can undergo a change.

Based on the above information, answer the following:

(i) An electron and a proton in an isolated atom move towards each other with velocities v_1 and v_2 respectively, then the velocity of their centre of mass is (1)

(A) $2v_1$ (B) 0 (C) v_2 (D) $v_1 + v_2$

(1)

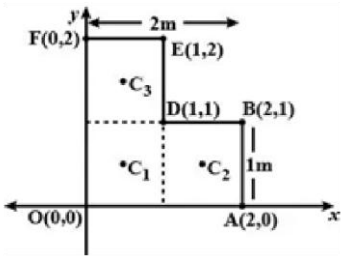
(ii) Two bodies of masses 1 kg and 2 kg are located at (1, 2) and (–1, 3) respectively. The co-ordinate of the centre of mass is

(A) $\left(\frac{1}{3}, \frac{8}{3}\right)$ (B) $\left(-\frac{1}{3}, \frac{8}{3}\right)$ (C) $\left(\frac{1}{3}, -\frac{8}{3}\right)$ (D) $\left(-\frac{1}{3}, -\frac{8}{3}\right)$

(iii) (a) Two blocks of masses 5 kg and 2 kg are placed on a frictionless surface and connected by a spring. An external kick gives a velocity of 14 m/s to the heavier block in the direction of the lighter one. What is the velocity gained by the centre of mass? (2)

OR

(b) Find the centre of mass of a uniform L-shaped lamina (a thin flat plate) with dimensions as shown. The mass of the lamina is 3 kg.



SECTION E

31. (a) Show that the path of a projectile is a parabola. (5)

(b) A particle is projected with velocity 20 m/s at angle 30°. Find:

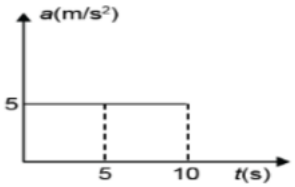
(i) Maximum height (ii) Time of flight (iii) Horizontal range. (g=10 m/s^2)

OR

(a) A mass m is moving in a circular path of radius R with a constant speed v. Obtain the expression for centripetal acceleration.

(b) An aircraft executes a horizontal loop of radius 1.00 km with a steady speed of 900 km/h. Compare its centripetal acceleration with the acceleration due to gravity.

32. Acceleration – Time graph of a moving body is shown in the figure. (5)



(a) Draw position–time graph and velocity- time graph for the motion of the body.

(b) Find the speed of the moving body.

(c) A ball is thrown vertically up with a velocity of 20 m/s. Construct acceleration-time and displacement-time graph.

OR

The speed of a train increases at a constant rate α from zero to v and then remains constant for an interval, and finally decreases to zero at a constant rate β. The total distance described is L. Draw the (v-t) graph and prove that the total time taken is $\frac{L}{v} + \frac{v}{2}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$.

33. (a) What is restoring force in a spring? How does it depend on the expansion of the spring? (5)

(b) Derive the expression for the potential energy of a spring when it is stretched to a distance of x_m.

(c) Draw a graph showing the variation of potential energy of a stretched spring with the expansion/ compression.

OR

(a) What is the difference between elastic and inelastic collisions?

(b) Two equal masses, one travelling with velocity v_0 and other at rest collide head on. If the collision is perfectly inelastic collision, find the loss in the kinetic energy.