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Roll Number: 9



**THE INDIAN SCHOOL**  
**HALF-YEARLY EXAMINATION (2024-25)**  
**PHYSICS (042)**  
**XI**  
**SET-B**

Time allowed: 3 hours

Maximum Marks: 70

No. of printed pages: 08

**General Instructions:**

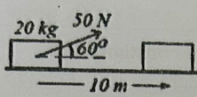
- (i) There are 33 questions in all. All questions are compulsory.
- (ii) This question paper has 5 sections.
- (iii) Section A contains 16 questions, 12 MCQs and 4 Assertions and Reasoning based questions of 1 mark each, Section B contains 5 questions of 2 marks each, Section C contains 7 questions of 3 marks each, Section D contains 2 case study-based questions of 4 marks each and Section E contains 3 questions of 5 marks each.
- (iv) There is no overall choice. However, an internal choice has been provided in 3 questions of 5 marks. You have to attempt only 1 of the choices in such questions.

SECTION-A		
Multiple Choice Questions (16 Marks)		
Q No.	Question	Marks
1	5.74 g of substance occupies 1.2 cm <sup>3</sup> . The density of the substance (in g/cm <sup>3</sup> ) to correct significant figures will be _____.  (a) 4.78                      (b) 4.783                      (c) 4.8                      (d) 4	1
2	Which pair does not have equal dimensions?  (a) Energy and torque                      (c) Angular momentum and Planck's constant (b) Force and impulse                      (d) Elastic modulus and pressure	1
3	A geostationary satellite _____.  (a) falls with gravity towards the earth                      (c) has an equatorial orbit (b) has time period of 24 hours                      (d) all of the above	1



4	A cyclist moves in a way such that he takes a $60^\circ$ turn after every 100 m. What is the displacement when he takes his sixth turn?  (a) 0 (b) 100 (c) $100\sqrt{3}$ (d) 200	1
5	The angle between vectors $A^{\rightarrow} = \hat{i} - \hat{j}$ and $B^{\rightarrow} = \hat{i} + \hat{j}$ is _____.  (a) $45^\circ$ (b) $90^\circ$ (c) $60^\circ$ (d) $180^\circ$	1
6	A body moves a distance of 10m under the action of force 'F' = 10 N. If the work done is 25 J, the angle which the force makes with the direction of motion is _____.  (a) $0^\circ$ (b) $30^\circ$ (c) $60^\circ$ (d) none of these	1
7	A bullet of mass 0.04 kg moving at a speed of 90 m/s enters a wooden block and is stopped after a distance of 60 cm. The average resistive force exerted by the block on the bullet is _____.  (a) 300 N (b) 270 N (c) 400 N (d) 450 N	1
8	A boy of 50 kg is in a lift moving up with an acceleration $9.8 \text{ ms}^{-2}$ . The apparent weight of the body is _____.  (a) 50 N (b) 980 N (c) 98 N (d) 0 N	1
9	A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to _____.  (a) $t^{1/2}$ (b) t (c) $t^{3/2}$ (d) $t^2$	1
10	Angular momentum is _____.  (a) an axial vector (b) a polar vector (c) a scalar (d) none of these	1



	<p>The ratio of gravitational force of attraction between two bodies kept at the same distance apart in air and water will be _____.</p> <p>(a) 1:2                                  (c) 2:1 (b) 1:1                                  (d) 3:1</p>	1
12	<p>Calculate work done if a block placed on a frictionless surface is pulled to the right by force 50 N inclined at 60°, displacing the block by 10 m.</p> <div style="text-align: center;">  </div> <p>(a) 500 J                                  (c) 200 J (b) 1000 J                                (d) 250 J</p>	1
	<p><b>Assertion and Reason</b></p> <p>Directions for questions 13 to 16: In each of the questions given below, there are two statements labelled Assertion (A) and Reason (R). Mark your answer as per the codes provided.</p> <p>(a) Both A and R are true, and R is the correct explanation for A. (b) Both A and R are true, and R is not the correct explanation for A. (c) A is true, but R is false. (d) A is false, but R is true.</p>	1
13	<p>Assertion: Work is a scalar quantity Reason: Work is a vector product of force and displacement</p>	1
14	<p>Assertion: The centre of mass of a body may lie at a point where there is no mass. Reason: The centre of mass of a body is a point, where the whole mass of the body is to be concentrated.</p>	1
15	<p>Assertion: When a body moves along a circular path, no work is done by the centripetal force. Reason: The centripetal force is used in moving the body along the circular path and hence no work is done.</p>	1
16	<p>Assertion : Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis. Reason : In the uniform motion of an object, the velocity increases as the square of time lapsed.</p>	1



SECTION-B (10Marks)		Marks
Q No.	Question	
17	Draw the following graphs (expected nature only) representing the motion of an object under free fall, neglecting air resistance. (i) Variation of position with respect to time. (ii) Variation of acceleration with respect to time.	2
18	State and prove the work-energy theorem for a constant force.	2
19	(i) Can the couple acting on a rigid body produce translatory motion? (ii) Name the physical quantity that corresponds to the moment of force. On what factor does it depend?	2
20	A rubber ball of mass 0.05 kg is thrown against a wall. It strikes the wall normally with a velocity of 25 m/s and rebounds with the same speed in the opposite direction. Calculate the impulse of the force exerted by the wall on the ball.	2
21	A satellite orbits the earth at a height of 400 km above the surface. How much energy can be expended to rocket the satellite out of the earth's gravitational influence? Mass of the satellite = 200 kg, Mass of the earth = $6.0 \times 10^{24}$ kg. Radius of the earth = 6400 km.	2
SECTION-C (21Marks)		Marks
Q No.	Question	
22	Consider a simple pendulum, having a bob attached to a string, that oscillates under the action of the force of gravity. Assume that the period of oscillation of the simple pendulum depends on its length (l), mass of the bob (m) and acceleration due to gravity (g). Derive the expression for its time period using the method of dimensions.	3
23	(i) Find the value of 'a' for which the two vectors, $\vec{A} = 3\hat{i} + 3\hat{j} + 9\hat{k}$ and $\vec{B} = \hat{i} + a\hat{j} + 3\hat{k}$ are parallel. (ii) What is the minimum number of coplanar vectors of different magnitudes which can give a zero resultant?	3
24	Define the orbital velocity of a satellite. Obtain an expression for the orbital velocity of a body from the surface of the earth.	3
25	The position of an object moving along the x-axis is given by $x = a + b t^2$	3



	<p>where <math>a = 8.5 \text{ m}</math>, <math>b = 2.5 \text{ m s}^{-2}</math> and <math>t</math> is measured in seconds.</p> <p>(i) What is its velocity at <math>t = 0 \text{ s}</math> and <math>t = 2.0 \text{ s}</math>?</p> <p>(ii) What is the average velocity between <math>t = 2.0 \text{ s}</math> and <math>t = 4.0 \text{ s}</math>?</p>	
26	<p>(i) Can the magnitude of the rectangular components of a vector be greater than the magnitude of that vector?</p> <p>(ii) To a person moving eastward with a velocity of <math>48 \text{ km h}^{-1}</math>, rain appears to fall vertically downward at a speed of <math>6.6 \text{ km h}^{-1}</math>. Find the actual speed and the direction of the rain.</p>	3
27	<p>A body tied to one end of a string is made to revolve in a vertical circle. Derive an expression for the velocity of the body and tension in the string at any point. Hence find the</p> <p>(i) tension at the top and at the bottom of the circle.</p> <p>(ii) minimum velocity at the lowest point so that it is just able to 'loop the loop'.</p>	3
28	<p>Find the centre of mass of three particles at the vertices of an equilateral triangle. The masses of the particles are <math>100 \text{ g}</math>, <math>150 \text{ g}</math>, and <math>200 \text{ g}</math> respectively. Each side of the equilateral triangle is <math>0.5 \text{ m}</math> long.</p> <p style="text-align: center;">OR</p> <p>In the <math>\text{HCl}</math> molecule, the separation between the nuclei of the two atoms is about <math>1.27 \text{ \AA}</math>. Find the approximate location of the centre of mass of the molecule, given that a chlorine atom is about <math>35.5</math> times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus.</p>	3
<b>SECTION-D (8 Marks)</b>		
<b>Based on your understanding of the case study, answer the questions that follow.</b>		
Q No.	Question	Marks
29	<p><b>UNIFORM CIRCULAR MOTION:</b></p> <p>When an object follows a circular path at a constant speed, the motion of the object is called uniform circular motion. The word 'uniform' refers to the speed, which is uniform (constant) throughout the motion. Suppose an object is moving with uniform speed '<math>v</math>' in a circle of radius '<math>r</math>' as shown in the figure. Since the direction of velocity is changing continuously, the object undergoes acceleration. This acceleration is called centripetal acceleration.</p> <div style="text-align: center;"> </div>	4



<p>30 Variation of acceleration due to gravity 'g': Depending on the location, an object at the surface of the earth falls with an acceleration between 9.76 and 9.83 m/s<sup>2</sup>. The earth is not exactly spherical. It is similar to a "squashed" sphere, with the radius at the equator slightly larger than the radius at the poles. This has the effect of slightly increasing gravitational acceleration at the poles and slightly decreasing it at the equator. Also, because of centripetal acceleration, the acceleration due to gravity is slightly lesser at the equator than at the poles. Gravitational acceleration varies with depth and altitude from the surface as shown below:</p> <div style="text-align: center;"> </div> <p>(i) The value of 'g' is inversely proportional to the square of the _____.</p> <p>(a) diameter of earth (b) radius of earth (c) weight of body (d) area of earth</p>	4



(ii) Which of the following statements is true: -

- (a)  $g$  is less at the earth's surface than at a height above it.
- (b)  $g$  is less at the earth's surface than at a depth below it
- (c)  $g$  has its maximum value at the equator
- (d)  $g$  is greater at the poles than at the equator

(iii) If ' $R$ ' is the radius of the earth, the height at which the weight of the body becomes  $1/4$  th its weight on the surface of earth, is \_\_\_\_\_.

- (a)  $2R$
- (b)  $R/2$
- (c)  $R$
- (d)  $R/4$

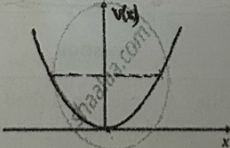
(iv) The weight of a body of mass ' $m$ ' decreases by 1% when it is taken to a height ' $h$ ' above the earth's surface. If the same body is taken to a depth ' $h$ ' below the earth's surface, the change in its weight is a \_\_\_\_\_.

- (a) 1% decrease
- (b) 1% increase
- (c) 0.5% increase
- (d) 0.5% decrease

**SECTION-E (15 Marks)**

Q No.	Question	Marks
31	<p>(a) What do you mean by projectile? A projectile is fired with velocity '<math>u</math>' making an angle '<math>\theta</math>' with the horizontal direction. Find an expression for the maximum height and the horizontal range.</p> <p>(b) A cricket ball is thrown at a speed of 28 m/s in a direction <math>30^\circ</math> above the horizontal direction. Calculate: (i) the maximum height, (ii) the distance from the thrower to the point where the ball returns to the same level.</p> <p style="text-align: center;">OR</p> <p>(a) A projectile is fired at an angle of elevation '<math>\theta</math>' with initial velocity '<math>u</math>'. Obtain expressions for the (i) equation of the trajectory of the projectile and (ii) expression for velocity '<math>v</math>' of the projectile at an instant <math>t</math>.</p> <p>(b) An aeroplane is in level flight at 900 km/h at an altitude of 100 m. How far from the given target should it release a bomb so as to hit the target? Assume <math>g = 10 \text{ m/s}^2</math>.</p>	5



32	<p>(a) Derive an expression for the maximum velocity of a car taking a circular turn on a level circular road having a coefficient of static friction '<math>\mu</math>'.</p> <p>(b) A cyclist speeding at 18 km/h on a level road takes a sharp circular turn of radius 3 m without reducing the speed. The co-efficient of static friction between the tyres and the road is 0.1. Will the cyclist slip while taking the turn?</p> <p style="text-align: center;">OR</p> <p>(a) Why are circular roads banked? Deduce an expression for the angle of banking.</p> <p>(b) A 100 kg car rounds a curve on a flat road of radius 50 m at a speed of 50 km/hr. Will the car make the turn or will it skid if the coefficient of friction is 0.60?</p> <p>(c) Why does a cricket player lower his hands when he catches the ball?</p>	5
33	<p>(a) Deduce an expression for potential energy in the stretched state of a spring. Draw a graph showing the variation of energy with displacement for a spring?</p> <p>(b) The potential energy function for a particle executing linear simple harmonic motion is given by <math>V(x) = kx^2/2</math>, where <math>k</math> is the force constant of the oscillator. For <math>k = 0.5 \text{ N/m}</math>, the graph of <math>V(x)</math> versus <math>x</math> is shown in the figure. Show that a particle of total energy 1 J moving under this potential must 'turn back' when it reaches <math>x = \pm 2 \text{ m}</math>.</p> <div style="text-align: center;">  </div> <p style="text-align: center;">OR</p> <p>(a) Discuss elastic collision between two bodies in one dimension. Calculate the velocities of both the bodies after collision.</p> <p>(b) Show that two bodies of equal mass undergoing elastic collision, just exchange their velocities.</p>	5