SS3

HALF YEARLY EXAMINATION 2024-25

PHYSICS (Set-2)

Time: 3 hours **M. M.: 70**

General Instructions:

i). **There are 33 questions in all. All the questions are compulsory.**

ii). **This question paper has five sections: Section A, Section B, Section C, Section D and Section E.**

iii). **All the sections are compulsory.**

iv). **The section A contains sixteen questions, twelve MCQs and four Assertion Reasoning based questions of one mark each, The Section B contains five questions of two marks each. The section C contains seven questions of three marks each. The section D contains two case study based questions of four marks each and the Section E contains three long answer questions of five marks each.**

v). **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. The use of a calculator is not allowed.**

	SECTION - A	
Q1.	What is the number of significant figures in the measurement of 35.000 m? (a) 2 (b) 5 (c) 3 (d) 4	**(1)**
Q2.	A body travels along the circumference of a circle of radius 2m with a linear velocity of 6m/s. Then its angular velocity is: (a) 6 rad/s (b) 3 rad/s (c) 2 rad/s (d) 4 rad/s	**(1)**
Q3.	The path of a particle is given by the expression $Y = at + bt^2$, where a and b are constants. Y is the displacement at time t, it's velocity at any instant is given by: (a) a + 2bt (b) zero (c) 2bt (d) at	**(1)**
Q4.	If two forces $(6\hat{i} + 8\hat{j})$ N and $(4\hat{i} + 4\hat{j})$ N are acting on a mass of 2kg, then the acceleration produced in the body in m/s^2 will be: (a) $5\hat{i} + 6\hat{j}$ (b) $10\hat{i} + 12\hat{j}$ (c) $6\hat{i} + 12\hat{j}$ (d) $2\hat{i} + 3\hat{j}$	**(1)**
Q5.	A particle is restricted to move on a straight line path. It returns to the starting point after 10s. The total distance covered by the particle during this time is 30m. Which of the following statements about the motion of the particle is TRUE? (a) The displacement of the particle is zero (b) The displacement of the particle is 30m (c) The average speed of the particle is 3m/s (d) Both the options (a) and (c)	**(1)**

Q6.	Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 respectively. Their speeds are such that they make complete circles in the same time t. The ratio of their centripetal accelerations is: (a) $m_1r_1 : m_2r_2$ (b) $m_1 : m_2$ (c) $r_1 : r_2$ (d) 1:1	**(1)**
Q7.	If u_1 and u_2 are the units selected in two systems of measurement and n_1 and n_2 their numerical values, then: (a) $n_1u_1 = n_2u_2$ (b) $n_1u_1 + n_2u_2 = 0$ (c) $n_1n_2 = u_1u_2$ (d) $n_1 + u_1 = n_2 + u_2$	**(1)**
Q8.	A force is inclined at 60° with the horizontal. If it's horizontal rectangular component is 50N, then the vertical component will be: (a) 86.6N (b) 100N (c) 50N (d) 70.7N	**(1)**
Q9.	The interpretation of a velocity-time graph if it is a line parallel to time axis will be: (a) The body is at rest (b) The body is moving with constant velocity (c) The body is moving with uniform acceleration (d) The body is in non-uniform motion	**(1)**
Q10.	The power of a pump, which can pump 200 kg of water to a height of 50m in 10s, will be (Take $g=10m/s^2$): (a) 60×10^3 watt (b) 20×10^3 watt (c) 4×10^3 watt (d) 10×10^3 watt	**(1)**
Q11.	Vinay completes one revolution of a circular path of radius 28m in 22 seconds. The displacement covered by him after 121 seconds is: (a) 936m (b) 56m (c) 0 m (d) 176 m	**(1)**
Q12.	A spring of force constant 800N/m has an extension of 5cm. The work done in extending it from 5cm to 15cm is: (a) 16J (b) 32J (c) 8J (d) 24J	**(1)**

Q. no 13 to 16 are Assertion - Reasoning based questions. These consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

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

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

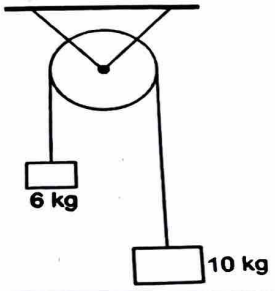
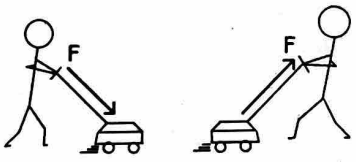
(c) A is true but R is false

(d) Both A and R are false

Q13.	**Assertion:**	When a body is dropped or thrown horizontally from the same height, it would reach the ground at the same time.	**(1)**
	Reason:	The horizontal velocity has no effect on the vertical motion.	
Q14.	**Assertion:**	If the net external force on a body is zero, then its acceleration is zero.	**(1)**
	Reason:	The acceleration does not depend on force applied on the body.	
Q15.	**Assertion:**	For a body moving along a straight horizontal line, work done by the gravitational force is zero.	**(1)**
	Reason:	The angle between the gravitational force and the displacement is 90° in the above case.	

Q16.	**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.	**(1)**

SECTION – B

Q17.	A body is dropped from the top of a tower. If it describes 9/25th of the total height in the fifth second of its motion, then find the height of the tower.	**(2)**
Q18.	The resultant of two forces 3P and 2P is R. If the first force is doubled then the resultant is also doubled. Find the angle between the two forces.	**(2)**
Q19.	If 'v' is velocity and 't' is time, then find the dimensions of (a × d) in the following equation: $v = a + bt + \frac{c}{d-t}$	**(2)**
Q20.	Two masses 6 kg and 10 kg are connected at the two ends of an inextensible and massless string. The string passes over a smooth frictionless pulley. Calculate the acceleration of the two attached masses and the tension in the string. 	**(2)**
Q21.	Which one is easier - PUSH or PULL along a horizontal surface? Justify your answer.  **OR** State and prove the law of conservation of linear momentum .	**(2)**

SECTION - C

Q22.	If a stone is thrown at an angle θ with the horizontal with a speed u, then derive the expressions for the (a) total time of flight, (b) horizontal range and (c) the maximum height attained.	**(3)**
Q23.	A bullet of mass 10g is fired horizontally into a 5 kg wooden block which is at rest on a horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.1. Calculate speed of the bullet striking the block, if the combination moves 20m before coming to rest. (Take $g = 10\ m/s^2$)	**(3)**

	OR Two particles A and B are traveling in the same direction on a smooth surface with speeds 4m/s and 3m/s respectively. They collide directly, and immediately after the collision continue to travel in the same direction with speeds 2m/s and v m/s respectively. Given the coefficient of restitution between A and B is ⅓, find v.	
Q24.	The displacement x as a function of time is given as $x = 3t^4 - 5t^3 + 10$, where x is in m and t in s, then find (a) The displacement at t = 2s (b) The velocity at t = 2s (c) The acceleration at t = 2s	**(3)**
Q25.	Using any method, derive the equation $v^2 - u^2 = 2as$.	**(3)**
Q26.	Define centripetal acceleration. Derive the expression for centripetal acceleration of a particle moving with uniform speed 'v' along a circular path of radius 'r'.	**(3)**
Q27.	(a) State and prove Work-Energy theorem. (b) If the momentum of a body increases by 10%, then by how much percentage will its kinetic energy increase?	**(3)**
Q28.	(a) A light body and a heavy body have the same kinetic energy. Which one will have a greater linear momentum and why? (b) A particle of mass 'm' is moving in a horizontal circle of radius 'r' under the action of a centripetal force equal to $-k/r^2$, where k is a constant. What is the total energy of the particle?	**(3)**
	SECTION - D (CASE BASED QUESTIONS)	
Q29.	The dimensions of a physical quantity may be defined as the powers to which the fundamental quantities must be raised in order to obtain the unit of that quantity and expressed by putting square brackets. The dependence of a physical quantity on two or more fundamental quantities can be expressed with the help of the concept of dimensions. The dimensional analysis has 3 important applications: (i) To check the correctness of a physical equation. (ii) To derive the relation between different physical quantities. (iii) To change from one system of units to another. The principle of homogeneity of dimensions states that a given physical equation is correct if and only if the dimensions of all the terms on the two sides of the equation are one and the same.. (i) The displacement (x) of a particle is given by $x = A\sin^2 kt$ where t denotes the time. The unit of k is: (a) radian/second (b) meter (c) kilogram (d) second (ii) The dimensional formula for work is same as that of: (a) energy (b) gravitational constant (c) power (d) linear momentum	**(4)**

(iii) The checking the correctness of physical equations using the methods of dimensions is based on:

(a) the equality of frame of reference
(b) the type of system of units
(c) the method of measurement
(d) the principle of the homogeneity of dimensions

(iv) The concept of dimensions cannot be used to:

(a) check dimensional correctness of a formula
(b) convert units
(c) find value of the constant of proportionality in an equation
(d) deduce a relation among various physical quantities

OR

The principle of dimensional homogeneity implies that:

(a) Only the variables with the same dimensions may be multiplied
(b) Only the variables with the same dimensions may be divided
(c) Only the variables with the same dimensions may be added or subtracted
(d) Dimensions of the quantities on two sides of the equation may not be the same.

Q30. To drive a nail into a wooden block, we blow a hammer on the nail. When a ball hits a wall, it bounces back. In both of these examples, a large force acts for a very short duration producing a finite change in momentum of the body. Here it is difficult to measure force and time separately. The product of the force and time that produces a finite change of momentum is called impulse. **(4)**

Impulse = Force × time duration = Total change in momentum

(i) A particle is moving in a circle with uniform speed v. In moving from a point to another diametrically opposite point,

(a) the momentum changes by mv
(b) the momentum changes by 2mv
(c) the kinetic energy changes by $\frac{1}{2}mv^2$
(d) the kinetic energy changes by mv^2

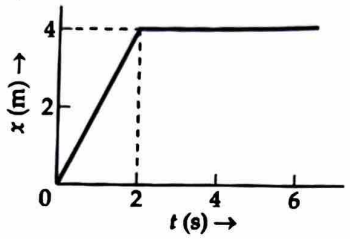
(ii) A bat strikes a ball with velocity v. The ball has mass m and after striking it retraced its path. What is the impulse imparted by the bat?

(a) 3mv (b) mv (c) Zero (d) 2mv

(iii) If two balls, each of mass 0.06kg, moving in opposite directions with speed 4m/s, collide and rebound with same speed, then impulse imparted to each ball due to other is:

(a) 0.48 kg-m/s (b) 0.81 kg-m/s (c) 0.53 kg-m/s (d) 0.92 kg-m/s

(iv) In the figure given, the position-time graph of a particle of mass 0.1kg is shown.

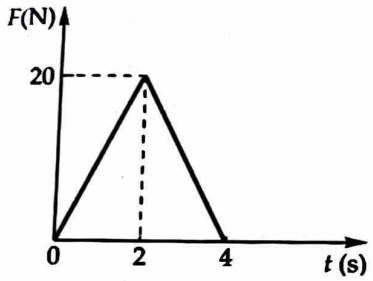


The impulse at t = 2s is:

(a) 0.2 kgm/s (b) -0.2 kgm/s (c) 0.1 kgm/s (d) -0.4 kgm/s

OR

A body is initially at rest on a smooth surface, a force F, whose time variation is shown in the figure, acts on it for a duration of 4s. The momentum of the ball at the end of 4s is:



(a) 10 Ns (b) 20 Ns (c) 30 Ns (d) 40 Ns

SECTION - E

Q31. **(5)**

(a) Find the work done by a force $\vec{F} = \left(2\hat{i} + 3\hat{j} - 3\hat{k}\right) N$ in displacing a particle from point A(3m, 1m, 2m) to another point B(4m, 3m, 6m).

(b) The x and y components of vector $\vec{A}$ are 4m and 6m respectively. The x and y components of vector $(\vec{A} + \vec{B})$ are 10m and 9m respectively. Calculate for vector $\vec{B}$:

(i) its x and y components,

(ii) its magnitude and

(iii) the angle it makes with the x axis.

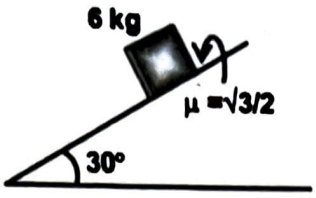
OR

(a) Find a unit vector perpendicular to the vectors $\vec{A} = 4\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{B} = -2\hat{i} + \hat{j} - 2\hat{k}$

(b) If $\vec{A} = \hat{i} + 2\hat{j} + 2\hat{k}$ is perpendicular to $\vec{B} = \left(2\hat{i} + m\hat{j} - 3\hat{k}\right)$, then calculate the value of m.

Q32. (5)

(a) A block of mass 6 kg is kept on a rough surface as shown in figure. Find acceleration and frictional force acting on the block. (Take $g=10m/s^2$)



(b) What is the banking of a road? Derive the expression of the maximum safe velocity of a vehicle on a banked road.

OR

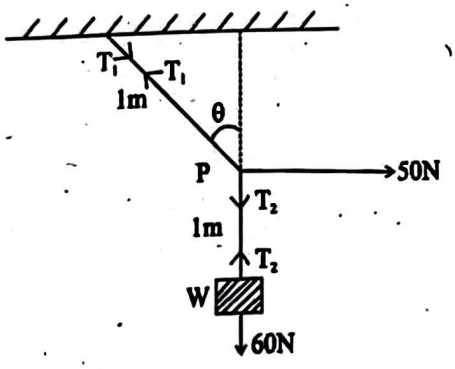
(a) A box of mass 4 kg is placed on a wooden plank of length 1.5m which is lying on the ground. The plank is lifted from one end along its length so that it becomes inclined. It is noted that when the height of the top end of the plank from the ground becomes 0.5m, the box begins to slide. Find the coefficient of friction between the box and the plank.

(b) Define: (i) the angle of repose (ii) the angle of friction.

Q33. (5)

(a) Define concurrent forces and their equilibrium.

(b) As shown in the figure, a mass of 6kg is suspended by a rope of length 2m from the ceiling. A force of 50N in the horizontal direction is applied at the mid point P of the rope. What is the angle the rope makes with the vertical in equilibrium? Also calculate tensions T_1 and T_2 in the string. (Take $g = 10m/s^2$ and neglect mass of the rope).



OR

(a) A person weighs 70 kg. He stands on a weighing machine in a lift which is moving:

(i) upwards with a uniform speed of 10 m/s.

(ii) downwards with a uniform acceleration of 5 m/s^2.

(iii) upwards with a uniform acceleration of 5 m/s^2.

(iv) What would be the reading if the lift falls down freely under gravity ? ($g = 9.8\ m/s^2$)

What would be the reading of the machine in each case?

(b) Define the terms static friction, limiting friction and kinetic friction. Draw the graph between friction and applied force on any object labeling the types of friction on the graph.