Delhi Public School, Howrah

PERIODIC TEST – II (2024-2025)

Class-XI

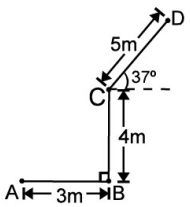
Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.

SUBJECT: PHYSICS (CODE- 042)

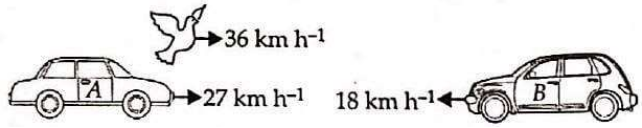
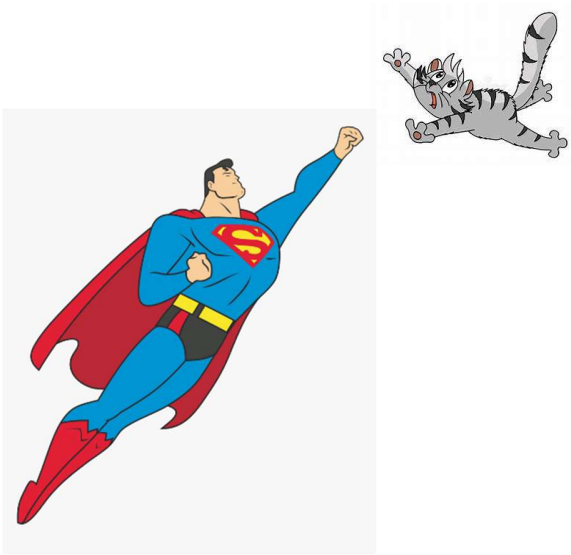
Time:-3 Hours **F.M.-70**

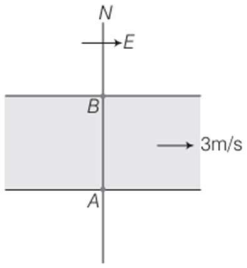
General Instructions:

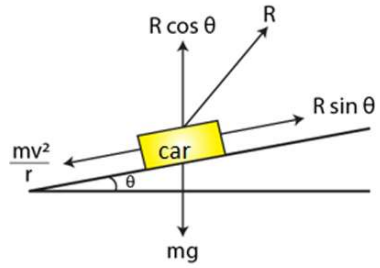
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark 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.
(5) 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.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary.
i. $c = 3 \times 10^8$ m/s
ii. m_e = 9.1 x10-31 kg
iii. $e = 1.6 \times 10^{-19}$ C
iv. $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}
v. h = 6.63 x10^{-34} Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}\ C^2 N^{-1} m^{-2}$
vii. Avogadro's number = 6.023 X 10^{23} per gram mole

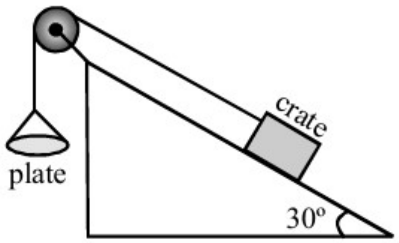
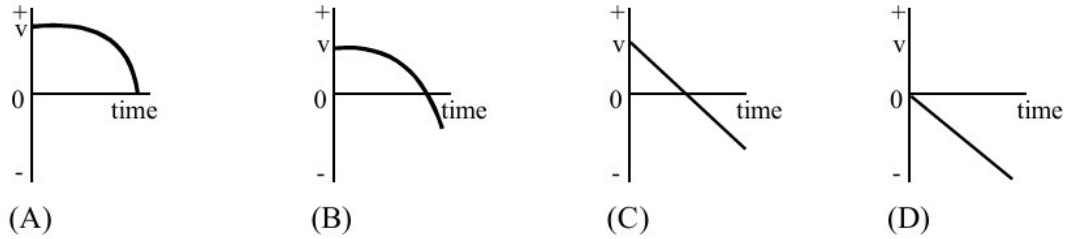
	SECTION - A	
1.	Force F is given in terms of time t and distance x by: F = A sin Ct + B cos Dx Then the dimensions of A/B and C/D are given by (A) $MLT^{-2}, M^0L^0T^{-1}$ (B) $MLT^{-2}, M^0L^{-1}T^0$ (C) $M^0L^0T^0, M^0L^1T^{-1}$ (D) $M^0L^1T^{-1}, M^0L^0T^0$	1
2.	The van-der Waals equation is, $\left(P + \frac{a}{V^2}\right)(V - nb) = RT$ where P is pressure, V is molar volume and T is the temperature of the given sample of gas. R is called molar gas constant, a and b are called van-der Walls constants. The dimensional formula for a is same as that for (A) V^2 (B) P (C) PV^2 (D) RT	1
3.	A particle moves along a path ABCD as shown in the figure. 	1

	Then the magnitude of net displacement of the particle from position A to D is: (A) 10 m (B) $5\sqrt{2}$ m (C) 9 m (D) $7\sqrt{2}$ m	
4.	A clock has a minute-hand 10 cm long. Find the average velocity between 6.00 AM to 6.30 AM for the tip of minute-hand. (A) 22/21 cm/min (B) 2/21 cm/min (C) 12/21 cm/min (D) 2/3 cm/min	1
5.	The displacement of a body is given by $2s = gt^2$ where g is a constant. The velocity of the body at any time t is: (A) gt (B) gt/2 (C) $gt^2/2$ (D) $gt^3/6$	1
6.	If $\vec{A} = \vec{B} + \vec{C}$ and the magnitudes of $\vec{A}, \vec{B}$ and $\vec{C}$ are 5,4 and 3 units respectively, the angle between $\vec{B}$ and $\vec{C}$ is (A) $\cos^{-1}(3/5)$ (B) $\cos^{-1}(4/5)$ (C) π/2 (D)$\sin^{-1}(3/4)$	1
7.	A thief is running away on a straight road in a jeep moving with a speed of 9 m s^{-1}. A police man chases him on a motor cycle moving at a speed of 10 m s^{-1}. If the instantaneous separation of the jeep from the motorcycle is 100m, how long will it take for the police man to catch the thief? (A) 1s (B) 19s (C) 90s (D) 100s	1
8.	A body of mass 0.1 kg is moving on circular path of diameter 1.0 m at the rate of 10 revolutions per 31.4 seconds. The centripetal force acting on the body is (A) 0.2 N (B) 0.4 N (C) 2 N (D) 4 N	1
9.	A block of mass 10 kg is suspended through two light spring balances as shown in the figure. Choose the correct statement from the following options.  (A) Both the scales will read 10 kg (B) Both the scales will read 5 kg (C) The upper scale will read 10 kg and the lower zero (D) The readings may be anything but their sum will be 10 kg	1
10.	A body of mass 4 kg initially at rest is subjected to a force 16 N. The kinetic energy acquired by the body at the end of 10 seconds is (A) 1600 J (B) 3200 J (C) 800 J (D) 1000 J	1
11.	If the kinetic energy of a body increases by 21%, the momentum of a body increases by (A) 10 % (B) 11 % (C) 9 % (D) 12 %	1
12.	Two particles of mass 1 kg and 0.5 kg are moving in the same direction with speed of 2 m/s and 6 m/s respectively on a smooth horizontal surface. The speed of centre of mass of the system is (A) 3.33 m/s (B) 4 m/s (C) 5.5 m/s (D) 5 m/s	1

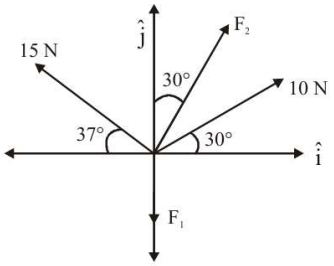
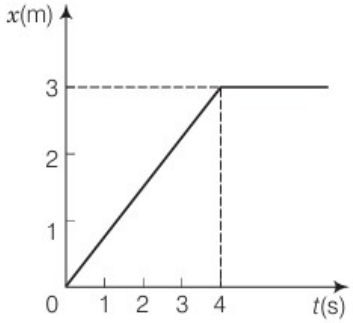
	For question numbers 13 to 16, two statements are given- one labeled as Assertion (A) and the other labeled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below. **(a) Both A and R are true and R is the correct explanation of the A** **(b) Both 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 true** **(e) Both A and R is false**	
13.	**Assertion(A):** Work done by static friction may be positive. **Reason(R):** Static friction may acts along the direction of motion of an object.	1
14.	**Assertion (A):** Horizontal component of velocity is constant in a projectile motion. **Reason (R)**: Acceleration is along the vertical direction in projectile motion.	1
15.	**Assertion(A):** It is easier to pull a heavy object than to push it on a level ground. **Reason(R):** The magnitude of frictional force depends on the nature of the two surfaces in contact.	1
16.	**Assertion(A):** If all particles of a system lie in a cube, the centre of mass would necessarily be in the cube. **Reason(R):** For a uniform, symmetric body, the centre of mass is necessarily within the matter of the body.	1
	SECTION - B	
17.	A bird is tossing (flying to and fro) between two cars moving towards each other on a straight road. One car has a speed of 27 km/h while the other has the speed of 18 km/h. The bird starts moving from first car towards the other and is moving with the speed of 36 km/h and when the two cars were separated by 36 km. What is the total distance covered by the bird?  **OR** A cat jumps off a sky scraper 320 m high and falls freely (zero initial velocity). 5 second later, superman arrives at the scene and dives off the roof to save the cat. What must be superman's initial velocity in order that he catches the cat just before reaching the ground?  [Assume that the superman's acceleration is that of any freely falling body.] (g = 10 m/s^2)	2

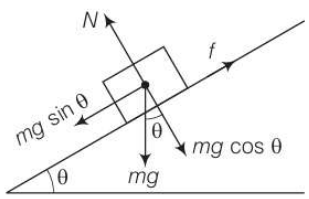
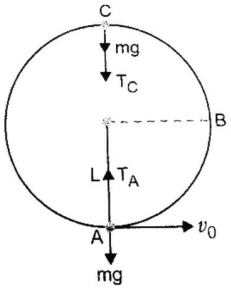
18.	A girl riding a bicycle along a straight road with a speed of 5 m/s throws a stone of mass 0.5 kg which has a speed of 15 m/s with respect to the ground along her direction of motion. The mass of the girl and bicycle is 50kg. Does the speed of the bicycle change after the stone is thrown? What is the change in speed, if so?	2
19.	An electron and a proton are detected in a cosmic ray experiment, the first with kinetic energy 10 keV, and the second with 100 keV. Which is faster, the electron or the proton? Obtain the ratio of their speeds. (Given, electron mass = 9.11×10^{-31} kg, proton mass = 1.67×10^{-27} kg, 1 eV = 1.6×10^{-19} J).	1+1
20.	Three particles of masses 1.0 kg, 2.0 kg and 3.0 kg are placed at the corners A, B and C respectively of an equilateral triangle ABC of edge 1 m. Locate the center of mass of the system.	2
21.	Mr. Verma (50 kg) and Mr. Mathur (60 kg) are sitting at the two extremes of a 4 m long boat (40 kg) Standing still in water. To discuss a mechanics problem, they come to the middle of the boat. Neglecting friction with water, how far does the boat move on the water during the process?	2
	SECTION - C	
22.	The frequency of vibration (f) of a string depends on the length (L) between the nodes, the tension (F) in the string and its mass per unit length (m). Find the expression for its frequency from dimensional analysis.	3
23.	It is a common observation that rain clouds can be at about a kilometer altitude above the ground. (a) If a rain drop falls from such a height freely under gravity, what will be its speed? ($g=10 m/s^2$). (b)A typical raindrop is about 4 mm in diameter. Estimate its momentum when it hits the ground. (c) Estimate how much force such a drop would exert on you.	1+1+1
24.	A river is flowing due east with a speed of 3m/s. A swimmer can swim in still water at a speed of 4m/s(figure).  (a) If swimmer starts swimming due north, what will be his resultant velocity (magnitude and direction)? (b) If he wants to start from point A on south bank and reach opposite point B on north bank, (i)which direction should he swim? (ii)what will be his resultant speed? (c) From two different cases as mentioned in (a) and (b) above, in which case will he reach opposite bank in shorter time?	1+1+1
25.	(a) State the conservation of linear momentum with appropriate mathematical equation mentioning all the terms. (b) Derive the expression for Newton's third law using the conservation of linear momentum.	1+2
26.	(a) Suppose you are talking by interplanetary telephone to your friend, who lives on the moon. He tells you that he has just won a piece of gold weighing one newton in a contest. Excitedly, you tell him that you entered the Earth version of the same contest and also won a newton of gold? Who's richer? (b) A scooter weighing 150 kg together with its rider moving at 36 km/hr is to take a turn of radius 30 m. What horizontal force on the scooter is needed to make the turn possible?	1+1+1

	(c) If the horizontal force needed for the turn in the previous problem is to be supplied by the normal force by the road, what should be the proper angle of banking?  	
27.	A rain drop of radius 2 mm falls from a height of 500 m above the ground. It falls with decreasing acceleration (due to viscous resistance of the air) until it reaches half of its original height. Then it attains its maximum (terminal) speed and moves with uniform speed thereafter. (a) What is the work done by the gravitational force on the drop in the first and second half of its journey? (b) What is the work done by the resistive force in the entire journey if its speed on reaching the ground is 10 m/s?	2+1
28.	(a)During a chase, tom and jerry collides with each other and after the collision they stick together and remain motionless. Mass of jerry is 0.50 kg and he was moving at a speed of 5.0 m/s while mass of tom is 1.0 kg. What was tom's velocity before the collision?  (b) A neutron initially at rest, decays into a proton, an electron and an antineutrino. The ejected electron has a momentum of 1.4×10^{-26} kg-m/s and the antineutrino has a momentum of 6.4×10^{-27} kg-m/s. Find the recoil speed of the proton (i) If the electron and the antineutrino are ejected along the same direction. (ii) If they are ejected along perpendicular directions. (Mass of the proton = $1.67 \times X\ 10^{-27}$ kg.)	1+1+1
	SECTION – D	
29.	**Read the following passage and answer the questions based on that.** A moving company uses the pulley system in figure 1 to lift heavy crates up a ramp. The ramp is coated with rollers that make the crate's motion essentially frictionless. A worker piles cinder blocks onto the plant until the plate moves down, pulling the crate up the ramp. Each cinder block has mass 10kg. The plate has mass 5kg. The rope is nearly massless, and the pulley is essentially frictionless. The ramp makes a 30° and with the ground. The crate has mass 100kg. Let W_1 denote the combined weight of the plate and the cinder blocks piled on the plate. Let T denote the tension in the rope. And let W_2 denote the crate's weight.	

		
i.	What is the smallest number of cinder blocks that need to be placed on the plate in order to lift the crate up the ramp? (A) 3 (B) 5 (C) 7 (D) 10	1
ii.	Ten cinder blocks are placed on the plate. As a result, the crate accelerates up the ramp. Which of the following is true? (A) $W_1 = T = W_2 \sin 30^\circ$ (B) $W_1 = T > W_2 \sin 30^\circ$ (C) $W_1 > T = W_2 \sin 30^\circ$ (D) $W_1 > T > W_2 \sin 30^\circ$	1
iii.	The ramp exerts a 'normal' force on the crate, directed perpendicular to the ramp's surface. This normal force has magnitude: (A) W_2 (B) $W_2 \sin 30°$ (C) $W_2 \cos 30°$ (D) $W_2 (\sin 30° + \cos 30°)$	1
iv.	The net force on the crate has magnitude: (A) $W_1 - W_2 \sin 30°$ (B) $W_1 - W_2$ (C) $T - W_2 \sin 30°$ (D) $T - W_2$ **OR** After the crate is already moving, the cinder blocks suddenly fall of the plate. Which of the following graphs best shows the subsequent velocity of the crate, after the cinder blocks have fallen off the plate? (Up the-rope is positive direction.) 	1
30.	**Read the following passage and answer the questions based on that.** Certain collisions are referred to as elastic collisions. Elastic collisions are collisions in which both momentum and kinetic energy are conserved. The total kinetic energy of the system before the collision equals the total system kinetic energy after the collision. If total kinetic energy is not conserved, then the collision is referred to as an inelastic collision. The coefficient of restitution, denoted by (e), is the measure of degree of elasticity of collision. It is defined as the ratio of the final to initial relative speed between two objects after they collide. It normally ranges from 0 to 1. In real life most of the collisions are neither perfectly elastic nor perfectly inelastic.	
i.	The following are the data of a collision between a truck and a car. Mass of the car = 1000 kg, Mass of the truck = 3000 kg, **Before collision:** Speed of the car = 20 m/s, Momentum of the car = 20000 kg m/s, Speed of the truck = 20 m/s Momentum of the truck = 60000 kg m/s	1

	After collision: Speed of the car = 40 m/s in the opposite direction Momentum of the car = 40000 kg m/s in the opposite direction Speed of the truck = 0 Momentum of the truck = 0 The collision is (A) Both elastic since kinetic energy and momentum is conserved (B) Elastic since momentum is conserved (C) Inelastic since kinetic energy is conserved (D) Elastic since kinetic energy is conserved	
ii.	The coefficient of restitution is the measure of (A) Malleability of a substance (B) Conductivity of a substance (C) Degree of elasticity of collision (D) Elasticity of a substance	1
iii.	Coefficient of restitution is defined as (A) Relative velocity before collision / Relative velocity after collision (B) Relative velocity after collision X Relative velocity before collision (C) None of these (D) Relative velocity after collision / Relative velocity before collision	1
iv.	In real life most of the collisions are (A) Range of coefficient of restitution is $0 < e < 1$ (B) Both neither perfectly nor perfectly inelastic and range of coefficient of restitution is $0 < e < 1$ (C) Neither perfectly elastic nor perfectly inelastic (D) Perfectly inelastic **OR** For perfectly elastic and perfectly inelastic collision, the value of coefficient of restitution are respectively (A) +1, -1 (B) 0, 1 (C) 0, -1 (D) 1, 0	1
	SECTION - E	
31.	(a) Four friends Baman, Roy, Adi and Manav were escaping from the Goa police through a short cut in a dense forest. They found a broken bridge in their way. Adi gave an idea of jumping the car over the bridge. He estimated that the distance between the two ends of the bridge is approximately 3m for which they might need to drive the car at a speed of 90 km/hour and the angle to jump over the bridge should be 45°. Consider Adi's estimation and comment whether they can successfully jump over the bridge? Justify your answer with proper calculation. (Take g = 10 m/s^2) 	2+2+1

	(b) In order to demonstrate the process Adi took a stone and threw it on the bridge. Due to which a portion of the bridge collapses. Now they need to estimate the new speed of the car. The new distance between the two ends of the bridge is 6m. Help Adi to decide the new speed of the car considering the angle to be 45° so that they can successfully jump the car over the bridge. (c) Find out the horizontal acceleration of the car after jumping off that bridge and landing to the ground if the stopping distance is 12 m. **OR** (a) **Neeraj Chopra** etched his name in the history books once again, becoming only the second Indian male athlete to secure two Olympic medals. Competing in the men's javelin throw final, Neeraj delivered an impressive 89.45m throw to claim the silver medal.  Considering the angle of projection to be 30°, find the velocity of projection. (b) If the four forces as shown are in equilibrium,  Express $\overrightarrow{F_1}$ and $\overrightarrow{F_2}$ in unit vector form. (c) Find the value of p for which the vectors $\vec{a} = 3\hat{i} + 2\hat{j} + 9\hat{k}$ and $\vec{b} = \hat{i} + p\hat{j} + 3\hat{k}$ are (i) perpendicular (ii) parallel.	1+2+2
32.	(a) The position-time graph of a body of mass 2 kg is as given in figure.  What is the impulse on the body at t=0 s and t=4 s? (b) Why are porcelain objects wrapped in paper or straw before packing for transportation? (c) A rectangular box lies on a rough inclined surface. The coefficient of friction between the surface and the box is μ. Let the mass of the box be m. At what angle of inclination θ of the plane to the horizontal surface will the box just start to slide down the plane?	2+1+2

	 **OR** (a) An astronaut accidentally gets separated out of his small spaceship accelerating in inter stellar space at a constant rate of 100 m s^{-2}. What is the acceleration of the astronaut at the instant after he is outside the spaceship? (Assume that there are no nearby stars to exert gravitational force on him.) (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? (c) A circular racetrack of radius 300 m is banked at an angle of 15°. If the coefficient of friction between the wheels of a race-car and the road is 0.2, what is the (i) optimum speed of the race car to avoid wear and tear on its tyres, and (ii) maximum permissible speed to avoid slipping?	1+2+2
33.	(a) State and prove the work energy theorem for a variable force. (b) In a ballistics demonstration a police officer fires a bullet of mass 50.0 g with speed 200 m s^{-1} on soft plywood of thickness 2.00 cm. The bullet emerges with only 10% of its initial kinetic energy. What is the emergent speed of the bullet? (c) A woman pushes a trunk on a railway platform which has a rough surface. She applies a force of 100 N over a distance of 10 m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50 N. The total distance through which the trunk has been moved is 20 m. Plot the force applied by the woman and the frictional force, which is 50 N versus displacement. Calculate the work done by the two forces over 20 m. **OR** 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 topmost point, C.  Obtain an expression for (i) v_o. (ii) the speed of the bob at the points B and C. (iii) the ratio of the kinetic energy of the bob at the points B and C(K_B /K_C).	2+1+2 1+2+2