Delhi Public School, Howrah

PERIODIC TEST – III (2024-2025)

Class-XI

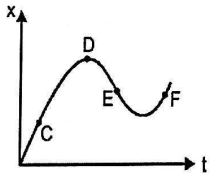
Care must be taken not to write anything on the question paper. All the questions must be attempted in the correct sequence.

SUBJECT: PHYSICS (CODE- 042)

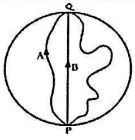
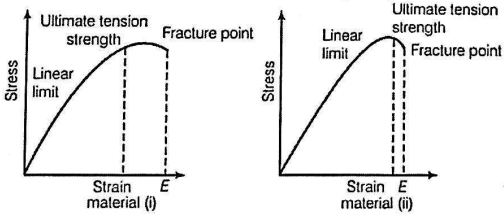
Time:-3 Hours **F.M.-70**

General Instructions:

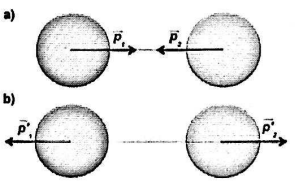
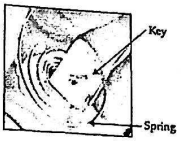
(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark 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. $h = 6.63 \times 10^{-34}$ Js
vi. $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2N^{-1}m^{-2}$
vii. Avogadro's number = 6.023×10^{23} per gram mole

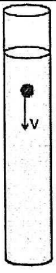
	SECTION - A	
1.	The number of significant figures in 0.06900 is (a) 5 (b) 4 (c) 2 (d) 3	1
2.	If momentum(p), area (A) and time(T) are taken to be fundamental quantities, then the energy has the dimensional formula (a) $[pA^{-1}T^1]$ (b) $[p^2AT]$ (c) $[pA^{-1/2}T]$ (d) $[pA^{1/2}T]$	1
3.	The displacement–time graph of a moving particle is shown below. The instantaneous velocity of the particle is negative at the point:  (a) C (b) D (c) E (d) F	1

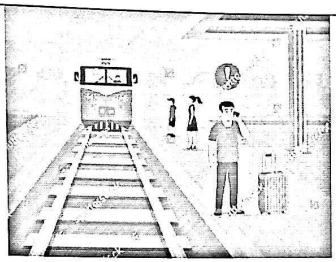
4.	A car, moving with a speed of 50 km/hr, can be stopped by brakes after at least 6m. If the same car is moving at a speed of 100 km/hr, then the minimum stopping distance of the car will be (a) 12m (b) 18m (c) 24m (d) 6m	1
5.	A body is initially at rest. It undergoes one-dimensional motion with constant 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
6.	A body of mass 2kg travels according to the law $x(t) = pt + qt^2 + rt^3$ where, $q = 4\ m/s^2$, $p = 3\ m/s$ and $r = 5\ m/s^3$. The force acting on the body at t=2 s is (a) 136 N (b) 134 N (c) 158 N (d) 68 N	1
7.	For which of the following does the centre of mass lie outside the body? (a) A pencil (b) A shotput (c) A dice (d) A bangle	1
8.	A raindrop is released from a cloud 1000 m above ground. When the drop is about to hit the ground, its speed will be (a) Constant terminal speed (b) Decreasing due to retardation from air drag (c) Increasing due to acceleration due to gravity (d) Cannot be predicted	1
9.	The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at (a) 0.25 seconds (b) 0.5 seconds (c) 2 seconds (d) 1 second	1
10.	Modulus of rigidity of ideal liquids is (a) infinity (b) zero (c)unity (d) some finite small non-zero constant value	1
11.	Gulab jamuns (assumed to be spherical) are to be heated in an oven. They are available in two sizes, one twice bigger (in radius) than the other. Pizzas (assumed to be discs) are also to be heated in oven. They are also in two sizes, one twice bigger (in radius) than the other. All four are put together to be heated in the oven. Choose the correct option from the following. (a) Both size gulab jamuns will get heated in the same time. (b) Smaller gulab jamuns and pizzas are heated before the bigger ones. (c) Smaller pizzas take same time to be heated as the bigger ones. (d) Bigger pizzas are heated before smaller.	1
12.	A black hole is a body from whose surface nothing may ever escape. The escape speed for a uniform spherical mass M to be a black hole should be equal to velocity of light, then the approximate radius of such a black hole if its mass is the same as that of the Earth ($Me = 6.0 \times 10^{24}$ kg) will be (a) 1 cm (b) 2 cm (c) 3 cm (d) 4 cm	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):** Thermodynamics processes in nature are irreversible. **Reason (R):** Dissipative effects cannot be eliminated.	1
14.	**Assertion (A):** Moon travelers tie heavy weight at their back before landing on moon. **Reason (R):** The value of g at the moon is greater than that on the surface of the Earth.	1
15.	**Assertion(A):** A body falling freely under the force of gravity has constant acceleration. **Reason(R):** Earth attracts everybody towards its center by the same force.	1
16.	**Assertion(A):** Work and temperature are two equivalent forms of energy. **Reason(R):** Work is the transfer of mechanical energy irrespective of the temperature difference, whereas heat is the transfer of thermal energy because of temperature difference only.	1
	SECTION - B	
17.	Three girls skating on a circular ice ground of radius 200 m start from a point P on the edge of the ground and reach a point Q diametrically opposite to P following different paths as shown in the figure.  (i) What is the magnitude of the displacement vector for each? (ii) For which girl is this equal to the actual length of the path skated? **OR** A passenger arriving in a new town wishes to go from the station to a hotel located 10 km away on a straight road from the station. A dishonest cabman takes him along a circuitous path 23 km long and reaches the hotel in 28 min. Find (a) the average speed of the taxi. (b) the magnitude of average velocity. Are the two equal?	1+1 1+1
18.	A molecule in a gas container hits a horizontal wall with speed 200 m/s and angle 30° with the normal, and rebounds with the same speed. (i) Is momentum conserved in the collision? Give reason in support of your answer. (ii) Is the collision elastic or inelastic? Justify your answer with appropriate calculation (if necessary).	1+1
19.	A solid cylinder of mass 20 kg rotates about its axis with angular speed 100 rad/s. The radius of the cylinder is 0.25 m. (i) What is the kinetic energy associated with the rotation of the cylinder? (ii) What is the magnitude of angular momentum of the cylinder about its axis? (Given, moment of inertia of the cylinder about its axis $I = mr^2/2$)	1+1
20.	(i) The stress-strain graphs for two materials are shown in figure. (assume same scale)  Which of the two metals is more brittle than the other and why? (ii) What is an elastomer? Give an example.	1+1
21.	(i) How does regelation help in ice skating? (ii) State Wien's displacement law with proper mathematical equation mentioning all the terms.	1+1

	SECTION - C	
22.	(i) A bullet fired at an angle of 30° with the horizontal hits the ground 3.0 km away. By adjusting its angle of projection, can one hope to hit a target 5.0 km away? Assume the muzzle speed to be fixed, and neglect air resistance. Justify your answer with proper calculation and explanation. (ii) A cricketer can throw a ball to a maximum horizontal distance of 100 m. How much high above the ground can the cricketer throw the same ball?	1.5+1.5
23.	(i) Calculate the length of the arc of a circle of radius 31.0 cm which subtends an angle of $\pi/6$ at the centre. (ii) The displacement of a progressive wave is represented by $y = Asin(\omega t - kx)$, where x is distance and t is time. Write the dimensional formula of w and k. (iii) The volume of a liquid flowing out per second of a pipe of length l and radius r is written by a student as $V = \frac{p\pi r^4}{8nl}$ where 'p' is the pressure difference between the two ends of the pipe and 'n' is the coefficient of viscosity of the liquid having dimensional formula $[ML^{-1}T^{-1}]$. Check whether the equation is dimensionally correct.	1+1+1
24.	A child stands at the centre of a turntable with his two arms outstretched. The turntable is set rotating with an angular speed of 40 rev/min. (i) How much is the angular speed of the child if he folds his hands back and thereby reduces his moment of inertia to 2/5 times the initial value? (ii) Assume that the turntable rotates without friction. Show that the child's new kinetic energy of rotation is more than the initial kinetic energy of rotation. (iii) How do you account for this increase in kinetic energy?	1+1+1
25.	(i) Derive the equation for conservation of linear momentum using Newton's third law. (ii) Why are mountain roads generally made winding upwards rather than going straight up?	2+1
26.	(i) Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears cooler than wooden bar if they are both colder than room temperature. (ii) Calculate the temperature which has same numeral value on Celsius and Fahrenheit scale.	1+2
27.	(i) Derive the expression for elastic potential energy. (ii) The average depth of Indian Ocean is about 3000 m. Calculate the fractional compression, $\Delta V/V$, of water at the bottom of the ocean, given that the bulk modulus of water is 2.2×10^9 $N.m^{-2}$. (Take g = 10 $m.s^{-2}$)	2+1
28.	(i) Consider an object of mass 'm' which is falling from a height 'h' under the gravitational force of the earth (ignore air resistance). Show that the total mechanical energy of the falling object at any point during its free fall remains constant. (ii) A person trying to lose weight (dieter) lifts a 10 kg mass, one thousand times, to a height of 0.5 m each time. Assume that the potential energy lost each time she lowers the mass is dissipated. (a) How much work does she do against the gravitational force? (b) Fat supplies 3.8 × 107 J of energy per kilogram which is converted to mechanical energy with a 20% efficiency rate. How much fat will the dieter use up?	1+1+1

	SECTION – D	
29.	**Read the following passage and answer the questions based on that.** The kinetic energy of an object is the energy associated with the object which is under motion. It is defined as "the energy required by a body to accelerate from rest to stated velocity." It is a vector quantity and the momentum of an object is the virtue of its mass. It is defined as the product of mass and velocity. It is a vector quantity. The relation between them is given by $E = \frac{p^2}{2m}$. In case of the elastic collision both of these quantities remain constant.  	
i.	Two masses of 1 gm and 4gm are moving with equal linear momentum. The ratio of their kinetic energy is: (a) 1:2 (b) 4:1 (c) 1:1 (d) 4:2	1
ii.	If the linear momentum is increased by 50%, then K.E will be increased by: (a) 50% (b) 200% (c) 125% (d) 100%	1
iii.	When a body moves with a constant speed along a circle then (a) no acceleration is produced (b) no work is done on it (c) no displacement on it (d) no force acts on it	1
iv.	A heavy object and a light object have the same momentum. Which has the greater speed? (a) both heavy and light object (b) heavy object (c) Moderate object (d) light object **OR** Kinetic energy with any reference must be _____. (a) Change (b) negative (c) zero (d) positive	1
30.	**Read the following passage and answer the questions based on that.** Clockwork refers to the inner workings of mechanical clock or watch (where it is known as "movement") and different types of toys which work using a series of gears driven by a spring. Clockwork device is completely mechanical and its essential parts are:  • A key (or crown) which you wind to add energy • A spiral spring in which the energy is stored • A set of gears through which the spring's energy is released. The gears control how quickly (or slowly) a clockwork machine can do things. Such as in mechanical clock/watch the mechanism is the set of hands that sweep around the dial to tell the time. In a clockwork car toy, the gears drive the wheels. Winding the clockwork with the key means tightening a sturdy metal spring, called the mainspring. It is the process of storing potential energy. Clockwork springs are usually twists of thick steel, so tightening them (forcing the spring to occupy a much smaller space) is actually quite hard work. With each turn of the key, fingers do work and potential energy is stored in the spring. The amount of energy stored depends on the size and tension of the spring. Harder a spring is to turn and longer it is wound, the more energy it stores. While the spring uncoils, the potential energy is converted into kinetic energy through gears, cams, cranks and shafts which allow wheels to move faster or slower. In an	

	ancient clock, gears transform the speed of a rotating shaft so that it drives the second hand at one speed, the minute hand at 1/60 of that speed, and the hour hand at 1/3600 of that speed. Clockwork toy cars often use gears to make themselves race along at surprising speed.	
i.	What is the meaning of movement of old age mechanical clocks? (a) The pendulum of the clock (b) The gears which move the hands of the clock (c) A spring and combination of gears which move the hands of the clock (d) The hands of the clock	1
ii.	What type of energy is stored in the spring while winding it? (a) Potential (b) Heat (c) Both kinetic and potential (d) Kinetic	1
iii.	In clockwork devices, _____ transform the speed of a rotating _____ to drive wheels slower or faster. (a) Shaft, spring (b) shaft, gear (c) Gear, Shaft (d) Spring, gear	1
iv.	When the spring of a clockwork uncoils (a) Kinetic energy is converted into potential energy (b) Potential energy is converted into kinetic (c) Potential energy is converted into heat, light and sound energy (d) Kinetic energy is converted into heat, light and sound energy **OR** More energy is stored in a spring if the (a) Spring is larger, harder and wound fur a longer time (b) Spring is smaller, harder and wound for a shorter time (c) Spring is larger, harder and wound for a shorter time (d) Spring is larger, softer and wound for a shorter time	1
	SECTION - E	
31.	(i) During an experiment in the physics lab it was observed that a spherical metallic ball of radius 'r' is falling through a column of castor oil having coefficient of viscosity 'η', with a terminal velocity 'v'. According to Sir George G. Stokes, the viscous force depends on the velocity of the ball 'v', viscosity coefficient 'η' of the fluid and radius 'r' of the spherical ball. Derive the expression for the viscous force acting on the ball using dimensional analysis. (iii) Why does the spherical ball attain terminal velocity while falling through the liquid? (ii) Use the above expression to derive the equation of terminal velocity in terms of radius and density of the spherical ball, density and coefficient of viscosity of the fluid through which it is falling and the gravitational acceleration acting on the ball.  **OR** (i) Derive Bernoulli's principle with appropriate diagram. (ii) During the school trip to Darjeeling, while boarding the train, Azaan heard the following announcement in the platform. **"Attention to the passengers, a through train will be passing from platform no.5. Please keep safe distance."** Azaan wondered why is it necessary to keep a safe distance from the railway track while a through train is going to pass through it. His friend Aditi explained to him the reason with the help of Bernoulli's principle. What possible explanation Aditi might have given to Azaan?	2+1+2 3+1+1

	 (iii) Known as the **"land of spin,"** India provided cricket with many top-notch spinners. They're legends who ruled the game during their years. Spin bowling plays an important role in India's cricket victories. A spinning ball deviates from its parabolic trajectory as it moves through air. Explain this deviation on the basis of Bernoulli's principle.	
32.	(i) Derive the expression for work done in an isothermal process. (ii) Is it possible to increase the temperature of a gas without adding heat to it? Explain. (iii) If a refrigerator's door is kept open, will the room become cool or hot? Explain. **OR** (i) Derive the expression for work done in an adiabatic process. (ii) A cylinder with a movable piston contains 3 moles of hydrogen at standard temperature and pressure. The walls of the cylinder are made of a heat insulator, and the piston is insulated by having a pile of sand on it. By what factor does the pressure of the gas increase if the gas is compressed to half its original volume?	**3+1+1** **3+2**
33.	(i) State Kepler's third law and derive the expression for the law using the concept of gravity and centripetal force. (ii) A satellite is to be placed in equatorial geostationary orbit around the earth for communication. Calculate the height of such a satellite. Given, Mass of earth = 6×10^{24} kg, Radius of earth =6400 km, T = 24h, G= 6.67×10^{-11} SI unit. **OR** (i) Derive the expression for gravitational acceleration at an altitude 'h_1' over the earth's surface. (ii) Derive the expression for gravitational acceleration at a depth of 'h_2' below the earth's surface. (iii) Draw a graph to show the variation of the gravitational acceleration with altitude and depth.	**3+2** **2+2+1**