ITL PUBLIC SCHOOL
ANNUAL EXAMINATION (2022-23)

Date: 20.02.2023 **Class: XI**

PHYSICS (042) - SET A

Time: 3 hrs **M. M: 70**

General Instructions:

- *There are 35 questions in all. All questions are compulsory*
- *This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All sections are compulsory.*
- *Section A contains eighteen very short answer questions of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case- study based question of 4 marks each.*
- *There is no overall choice. However, an internal choice has been provided in section B, C, D and E. you have to attempt only one of the choices in such questions.*
- *Use of calculators is not allowed.*

SECTION-A

1 Give the dimensional formula of: 1

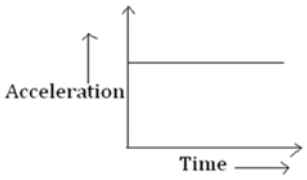
(i) Coefficient of viscosity (ii) Power

2 A man of mass 70 kg stands on a weighing scale in a lift which is moving downwards with a uniform acceleration of 5 ms^{-2}. What is the reading of the weighing scale? 1

3 A particle starts from rest, and its acceleration (a) plotted versus time (t) is shown in the given figure. Plot the corresponding graphs for 1

(i) Velocity (v) versus time (t)

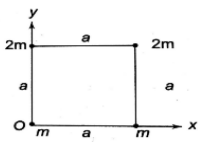
(ii) Displacement (s) versus time (t)



4 Two straight lines drawn on the same velocity – time graph make angles 30° and 60° with the time axis respectively. What is the ratio of the two accelerations? 1

5 If the radius of the earth were increased by a factor of 3, by what factor would its density have to be changed to keep 'g' the same? Justify your answer using required formula. 1

6 Four particles of masses m, m, 2m and 2m are placed at the four corners of a square of side a. Find the centre of mass of the system. 1



7 Two particles of masses 0.5 kg and 0.25 kg moving with velocities 4.0 ms^{-1} and -3.0 ms^{-1} collide head-on in a perfectly inelastic collision. Find the velocity of the composite particle after the collision. 1

8 Draw the graph showing variation of acceleration due to gravity with 1

(i) Height above the earth's surface

(ii) Depth below the earth's surface.

9 What is the angle between two vectors $\vec{A}$ and $\vec{B}$ if the ratio of their dot product to cross product is $\sqrt{3}$. 1

10 A lead sphere acquires a terminal velocity v when it falls in a viscous liquid. What will be the terminal velocity attained by another lead sphere of radius three times in the same liquid? 1

11 The absolute temperature of a gas is increased to four times its original value. How will the rms velocity of its molecules change? 1

12 What will be the change in the time-period of a loaded spring when taken to the moon? 1

13 A tuning fork of unknown frequency gives 4 beats per second when sounded with a tuning fork of frequency 320 Hz. When loaded with a little wax, it gives 3 beats per second. Find the unknown frequency. 1

14 What is the work done by the centripetal force in making a body of mass m move in a semi-circle of radius r with a constant speed v? Justify your answer. 1

15 Two bodies move in two concentric circles of radii R_1 and R_2 in same time. What is the ratio of their angular velocities? 1

For question numbers 16, 17 and 18, two statements are given-one labelled Assertion (A) and the other labelled 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 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

16 **Assertion (A):**For an isothermal process in an ideal gas, the heat absorbed by the gas is entirely used in the work done by the gas. 1

Reason (R): During an isothermal process, the change in internal energy of the ideal gas is zero.

17 **Assertion (A):** In an elastic collision of two bodies, the momentum and kinetic energy of the system is conserved. 1

Reason (R): Momentum and kinetic energy are always conserved during any collision.

18 **Assertion (A):**Young's modulus of steel is greater than that for rubber. 1

Reason (R): Steel is more elastic than rubber.

SECTION-B

19 Using calculus, derive the equation of motion $s = ut + \frac{1}{2} at^2$. 2

20 The position of a particle is given by $\vec{r} = (3t\,\hat{\imath} - 2t^2\hat{\jmath} + 4\,\hat{k})$ m. Find the instantaneous velocity and instantaneous acceleration of the particle at t = 2 s. 2

OR

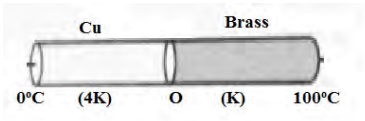
If $\vec{A} = 2\hat{\imath} + \hat{\jmath} - \hat{k}$ and $B = \hat{\imath} + 2\hat{\jmath} + \hat{k}$, find the angle between $\vec{A}$ and $\vec{B}$.

21 State the theorem of perpendicular axes. Calculate the moment of inertia of a disc about a diameter in its plane. Given that the moment of inertia about an axis perpendicular to the plane of the disc and passing through its centre is $\frac{1}{2}MR^2$. 2

22 Draw the stress – strain curve for a metal wire, subjected to an increasing load. On the curve, mark the following points: 2

(i) Proportionality limit (ii) Permanent set (iii) Breaking point.

23 Two rods of copper and brass of the same length and cross-section are joined end to end. The free end of copper rod is kept at 0^o C and the free end of brass rod at 100^0 C. Calculate the temperature at the junction of the two rods at equilibrium. Assume that the thermal conductivity of copper is four times that of brass. 2



OR

Efficiency of a heat engine is 40 % when the temperature of the sink is 300 K. What is the temperature of the source?

24 Show that $x(t) = \sin \omega t + \cos \omega t$ represents a simple harmonic motion. Determine its amplitude and initial phase. 2

25 State and prove the work – energy theorem for a variable force. 2

SECTION-C

26 The period of vibration, T, of a tuning fork depends on the length 'l' of its prong, density 'd', and the Young's modulus 'Y' of its material. Deduce an expression for the period of vibration on the basis of dimensions. 3

27 Define orbital velocity. Derive an expression for the orbital velocity of a satellite revolving around a planet. 3

OR

Derive an expression for gravitational potential energy for a body of mass m lying at distance r from the centre of earth.

28 On the basis of the kinetic theory of gases, derive an expression for the pressure exerted by an ideal gas on the walls of the container. 3

29 State two essential conditions for an adiabatic process to occur. Derive an expression for the work done during an adiabatic process. 3

OR

State the first law of thermodynamics. On its basis establish relation between two principal specific heats of a gas.

30 Prove analytically that in the case of an open organ pipe of length L, the frequencies of vibrating air column are given by f = n (v / 2L), where n is an integer. Draw diagrams to depict the first three normal modes. 3

SECTION-D

31 (a) State and prove Bernoulli's theorem. 5

(b) Why is it dangerous to stand near the edge of the platform when a fast train is crossing it? Explain using Bernoulli's theorem.

OR

(a) What is capillarity? Give two examples of capillarity from daily life.

(b) Derive an expression for the height to which the liquid rises in a capillary tube of radius r.

(c) If a glass capillary tube is dipped in mercury, the level of mercury in the tube is depressed. Explain why?

32 (a) A projectile is fired at an angle θ upward with a horizontal velocity u. 5

Derive expressions for maximum height attained, Time of flight and Horizontal range.

(b) A 15 g ball is projected obliquely from a spring gun whose spring has a force constant of 600 N/m. The spring is compressed by 5 cm. Find the maximum range of the ball.

OR

(a) State Newton's second law of motion. Derive the law of conservation of linear momentum from it.

(b) Why are curved roads generally banked? Derive an expression for the velocity of a car on a banked circular road having coefficient of friction μ.

33 (a) Derive Newton's formula for the speed of sound in a gas. Why and what correction was applied by Laplace in this formula? 5

(b) A transverse harmonic wave travelling on a string is described by
y (x,t) = 3.0 sin (36 t + 0.018 x + $\pi/4$). Here x and yare in cm and t is in seconds. Find:
(i)Amplitude of wave (ii) Direction of propagation
(iii) wave velocity.

OR

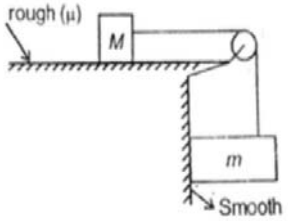
(a) Show that for small oscillations, the motion of a simple pendulum is simple harmonic. Derive an expression for its time-period.

(b) A particle is executing SHM of amplitude A. At what displacement from the mean position, is the energy half kinetic and half potential?

SECTION-E

Question numbers 34 and 35 are case-based questions and have three sub-parts. Parts (a) and (b) are compulsory, while a choice has been provided for part (c).

34 A block A of mass M is placed on a rough horizontal surface. It is connected by means of a light inextensible string passing over a smooth pulley. The other end of the string is connected to a block of mass m. there is no friction between the vertical surface and block m. 4



(a) What is the minimum value of coefficient of friction μ, such that the system remains at rest?

(b) Determine the downward acceleration of the block m, if the coefficient of friction μ is less than the above value.

(c) If the mass of block A is doubled, how will the coefficient of friction change?

OR

Draw a graph showing variation of frictional force with the applied force.

35 **Surface Tension** 4

Surface tension is the tendency of liquid surfaces at rest to shrink into the minimum surface area possible. Surface tension is what allows objects with a higher density than water such as razor blades and insects to float on a water surface without becoming even partly submerged. At liquid – air interfaces, surface tension results from the greater attraction of liquid molecules to each other (due to cohesion) than to the molecules in the air (due to adhesion). It is due to the phenomenon of surface tension that liquid drops are spherical in shape.

If we increase the free surface area of a liquid then work has to be done against the force of surface tension. This work done is stored in the liquid surface as potential energy. This additional potential energy per unit area of free surface of liquid is called **surface energy**.

(a) Water on a clean glass surface tends to spread out, while mercury on the same surface tends to form drops. Explain why?

(b) A spherical liquid drop of radius R breaks into eight equal droplets. If the surface tension is T, then find the work done in the process.

(c) Define surface energy. How is it related to surface tension?

OR

How does the surface tension of water change, if a small amount of detergent is dissolved in it?