ITL PUBLIC SCHOOL
ANNUAL EXAMINATION (2023-24)

Date: 12.02.24 **Class: XI**

PHYSICS(042) – SET A

Time:3Hrs **M. M: 70**

General Instructions:

- *All questions are compulsory. There are 33 questions in all.*
- *This question paper has five sections: Section A, Section B, Section C, Section D, Section E*
- *Section A contains twelve very short answer questions and four assertion reason questions of one 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 - based question of four marks each and Section E contains three long questions of five marks each.*

SECTION - A

1 A car travels first half of the distance between two places with a speed of 30 km/h and the remaining half with a speed of 70 km/h. Find the average speed of the car for the whole journey. 1

2 A body is travelling in a straight line with a uniformly increasing speed. Plot its displacement - time and acceleration time graph. 1

3 A constant force $\vec{F} = (-\hat{\imath} + 2\hat{\jmath} + 3\hat{k})$ N acts on an object. Find the work done by the force in displacing the object through 4 m along the z-axis. 1

4 The displacement of a particle is represented by the following equation 1

$s = 2t^3 + 7t^2 + 5t + 8$, where s is in metres and t in seconds. Determine the acceleration of the particle at t = 1s.

5 Find the gravitational potential at the centre of a square of side 'a' if four particles, each of mass 'm', are placed at its vertices. 1

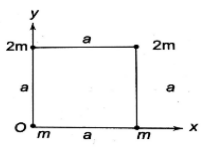
6 Name the physical quantity which is equal to the time rate of change of angular momentum. Is it a vector or scalar? 1

7 Two wires of the same material and same length have diameters in the ratio 1:2. If a load produces an extension of 8 mm in the first wire, then find the extension in the second wire by the same load. 1

8 Two layers of cloth of equal thickness provide warmer covering than a single layer of cloth of double the thickness. Explain why? 1

9 State the Zeroth law in thermodynamics. 1

10 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



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

12 Two streamlines cannot cross each other. Explain why? 1

In question numbers 13 to 16, 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 Assertion (A) and Reason (R) are true and (R) is the correct explanation of (A.)

(B) Both Assertion (A) and Reason (R) are true and (R) is not the correct explanation of (A).

(C) Assertion (A) is true and Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

13 **Assertion (A):** The displacement of a body may be zero when distance travelled by it is not zero. 1

Reason (R): The displacement is longer distance between initial and final positions.

14 **Assertion (A):** Water bottles kept in freezer often burst because water expands when its temperature is decreased from 4^o C to 0^o C. 1

Reason (R): Water has maximum density and minimum volume at 4^o C.

15 **Assertion (A):** The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite. 1

Reason (R): The internal energy of a gas does not change during an isothermal process.

16 **Assertion (A):** When a simple pendulum is made to oscillate on the surface of the Moon, its time period increases. 1

Reason (R): Due to its small mass, the value of g on the surface of the moon is very small.

SECTION – B

17 The displacement- time graphs of two moving particles A and B make angles of 30^0 and 45^0 respectively with the time- axis. What will be the ratio of their velocities? 2

18 The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. 2

(a) What is its angular acceleration, assuming the acceleration to be uniform?
(b) How many revolutions does the engine make during this time?

OR

Calculate the kinetic energy of rotation of a circular disc of mass 1kg and radius 0.2 m rotating about an axis passing through the center and perpendicular to its plane. The disc makes $30/\pi$ rotations per minute.

19 A cricket ball is thrown at a speed of 28m/s in a direction 30^0 above the horizontal. Calculate 2

(a)the maximum height attained

(b)the time taken by the ball to return to the same level.

20 In a system of units in which the unit of mass is α kg, unit of length is β metre and unit of time is γ second, what will be the magnitude of 1 Joule? 2

21 Define orbital velocity. Derive an expression for the orbital velocity of a satellite revolving around a planet. 2

OR

Find the height from the earth's surface where g will become 36% of its value on the surface of the earth (R = 6400 km).

SECTION – C

22 When the velocity of liquid flow exceeds a certain maximum velocity, called as critical velocity v_c, the flow becomes unsteady or disorderly. Given that the critical velocity of a liquid, v_c, depends on its density 'ρ', coefficient of viscosity 'η' and diameter of the pipe 'd', derive a relation for v_c using dimensional considerations. 3

23 Define elastic collision. Prove that bodies of identical masses exchange their velocities after a head- on elastic collision. 3

OR

An elastic spring is compressed by an amount x. Show that its potential energy is $\frac{1}{2}kx^2$ where k is the spring constant.

24 For a particle in uniform circular motion, derive the expression for centripetal acceleration? If the speed is variable in circular path, give the expression for the acceleration. 3

25 Define terminal velocity. Obtain an expression for terminal velocity of a sphere falling through a viscous liquid. 3

OR

State and prove Bernoulli's theorem. State its one limitation.

26 State the first law of thermodynamics and hence derive the relation between the two principal specific heats of a gas (C_p- C_v= R). 3

27 (a) State Newton's Formula for speed of sound in gaseous medium. Why and what correction was applied by Laplace in this formula? 3

(b) Why does sound travel faster in humid air?

28 Discuss the normal modes of oscillations in an air column whose one end is open and the other end is closed. Draw diagrams to depict the first three normal modes. 3

OR

Discuss the normal modes of oscillations of a stretched spring clamped at both the ends. Draw diagrams to depict the first three normal modes.

SECTION – D

29 We know that the earth attracts every object with a certain force and this force depends on the mass (m) of the object and the acceleration due to the gravity (g). The weight of an object is the force with which it is attracted towards the earth. Mathematically 4

Where, W = weight of object

m = mass of object

g = acceleration due to the gravitational force

As the weight of an object is the force with which it is attracted towards the earth, the SI unit of weight is the same as that of force, that is, Newton (N). The weight is a force acting vertically downwards; it has both magnitude and direction. We have learnt that the value of g is constant at a given place. Therefore at a given place, the weight of an object is directly proportional to the mass, say m, of the object, that is, W α m. It is due to this reason that at a given place, we can use the weight of an object as a measure of its mass.

Answer the following questions.

1.State the dimension and unit of Universal Gravitational Constant.

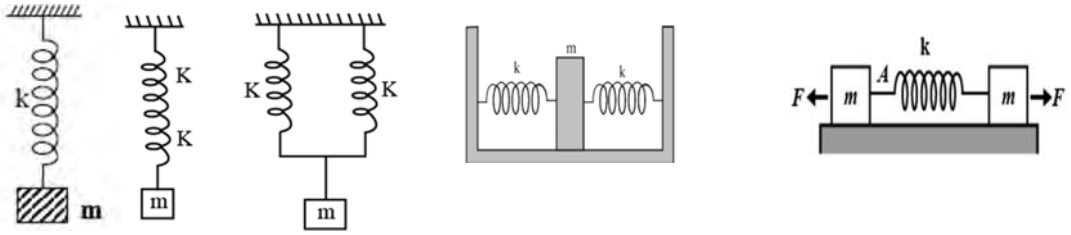
2.What is the force required to produce an acceleration of 9.8m/s^2 in a body of weight 9.8N?

3.Find the percentage decrease in the weight of the body when taken to a height 16 km above the surface of the Earth. (Radius of the Earth is 6400 km)

4.If radius of Earth is R then find the height 'h' at which value of 'g' becomes one- fourth of its value of earth's surface.

30 **<u>Oscillations of springs-</u>** Five figures drawn below show oscillatory motion of mass 'm' connected to massless and elastic springs. 4

All the springs have same spring constant k and same length l.



(i) (ii) (iii) (iv) (v)

1.Find the time period of oscillations of the arrangement shown in figure (i)

2.Find the equivalent spring constant of the combinations given in Fig.(ii) &(iii).

3.A block of mass m is placed on a frictionless horizontal table. Identical springs of spring

constant k are attached on either side as shown in Fig.(iv). The block is displaced a little and released to oscillate, Find the time period of the oscillations.

4. A spring of spring constant k is joined to two identical blocks and the arrangement is placed on a horizontal table. If the arrangement is made to oscillate simple harmonically, find the time period of oscillation.

SECTION – E

31 (a) Define simple harmonic motion. Derive an expression for the potential energy and kinetic energy of a harmonic oscillator. Hence show that the total energy remains conserved in SHM. 5

(b) A simple harmonic oscillator is represented by the equation: y = 0.40 sin (440t +0.61), where y is in metres and t is in seconds. Determine

(i) Amplitude, (ii) angular frequency, (iii) Time period and (iv) Initial phase of the harmonic oscillator.

OR

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

(b) Distinguish between free and forced oscillations. What is resonance?

32 (a) Derive an expression for velocity of a car on a banked circular road having coefficient of friction μ. Write expression for optimum velocity. 5

(b) A cubical block rests on an inclined plane of $\mu = \sqrt{3}$. Determine the angle of inclination when the block just slides down the inclined plane.

OR

(a) State and prove the parallelogram law for finding the magnitude and direction of the resultant of two vectors.

(b) Find a unit vector perpendicular to each of the vectors $\vec{A} = 2\hat{\imath} - 3\hat{\jmath} + \hat{k}$ and $\vec{B} = -\hat{\imath} + 4\hat{\jmath} + 2\hat{k}$.

33 (a) State two essential conditions for an adiabatic process to occur. Derive an expression for the work done during an adiabatic process. 5

(b) An ideal heat engine has an efficiency of 20%. If the engine does 500 J of work every second, find the heat rejected by the engine every second?

OR

(a) 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.

(b) What do you mean by "kinetic interpretation of temperature?"