**ST. XAVIER'S SENIOR SECONDARY SCHOOL, DELHI – 110 054**

**Std. 11** **Time : 3 hrs.**

**13-2-2024** **Final Examination in PHYSICS** **Max. Marks : 70**

General Instructions:

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

*v)* *There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, all three questions in Section E. You have to attempt only one of the choices in such questions.*

*vi)* *Use of calculators is not allowed.*

## SECTION – A

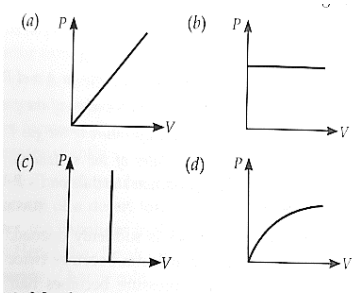
1. A particle executing SHM has an amplitude of 6 cm. Its acceleration at a distance of 2 cm from the mean position is 8cm/s$^2$. The maximum speed of the particle in cm/s is:
(A) 24 (B) 16 (C) 12 (D) 4

2. A steel wire 10m long and $10^{-5}$m$^2$ in cross sectional area elongates by 0.01m under a tension of 2500N.Young's modulus for steel from this data is
(A) $2.5\text{x}10^{7}\text{Nm}^{-2}$ (B) $2.5\text{x}10^{9}\text{Nm}^{-2}$
(C) $2.5\text{x}10^{11}\text{Nm}^{-2}$ (D) $2.5\text{x}10^{-7}\text{Nm}^{-2}$

3. A object is moving through the liquid. The viscous damping force acting on it is proportional to the velocity. The dimensions of constant of proportionality are
(A) $[ML^{-1}T^{-1}]$ (B) $[MLT^{-1}]$ (C) $[M^0L^{-1}T^{-1}]$ (D) $[ML^0T^{-1}]$

4. In determining the temperature of a distant star one makes use of
(A) Kirchhoff's law (B) Stefan's law
(C) Wien's displacement law (D) Newton's law

5. Which of the following graphs between pressure and volume correctly shows isochoric changes?




(A) (a)

(B) (b)

(C) (c)

(D) (d)

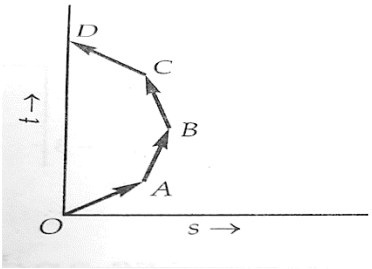
6. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T?
(A) $\frac{3}{2}K_BT$ (B) $\frac{1}{2}K_BT$ (C) $K_BT$ (D) $\frac{2}{3}K_BT$

7. A force ($\mathbf{F} = 3\mathbf{i} + c\mathbf{j} + 2\mathbf{k}$)N acting on a particle causes a displacement $\mathbf{s} = (-4\mathbf{i} + 2\mathbf{j} + 3\mathbf{k})$m direction. If the work done is 6J, then the value of c is
(A) 0 (B) 6 (C) 1 (D) 12

8. A car is moving at a speed of 72km/h. The diameter of its wheels is 0.5m. If the wheels are stopped in 20 rotations by applying brakes, then angular retardation produced by the brakes is
(A) $-25.5\ rad/s^2$ (B) $-33.5\ rad/s^2$
(C) $-29.5\ rad/s^2$ (D) $-45.5\ rad/s^2$

9. The force is given in terms of time t and displacement x by the equation $F = A\cos Bx + C\sin Dt$ The dimensional formula of $\frac{AD}{B}$ is
(A) $[M^0LT^{-1}]$ (B) $[ML^2T^{-3}]$ (C) $[ML^1T^{-2}]$ (D) $[M^2L^2T^{-3}]$

10. Which of the following options is correct for the object having a straight line motion represented by the following graph?




(A) The object moves with constantly increasing velocity from O to A and then it moves with constant velocity.
(B) Velocity of an object increases uniformly.
(C) Average velocity is zero.
(D) The graph shown is not possible.

11. The angle between vectors **A** = (**i** + **j**) and **B** = (**i** - **j**) is
(A) 45° (B) 90° (C) -45° (D) 180°

12. A body of mass 2kg travels according to the law $x(t) = pt + qt^2 + rt^3$ where $p = 3m/s$, $q = 4m/s^2$ and $r = 5m/s^3$. The force acting on the body at t = 2s is
(A) 136N (B) 134N (C) 158N (D) 68N

In the following questions, a statement of assertion is followed by the statement of reason. While answering a question, you are required to choose the correct option out of the given four responses and mark it as
A. if both reason and assertion are true and reason is correct explanation of the assertion.
B. if both reason and assertion are true and reason is not correct explanation of the assertion.
C. if assertion is true, but reason is false.
D. if both assertion and reason are false.

13. **Assertion:** When the height of a tube is less than liquid rise in the capillary tube, the liquid does not overflow.
**Reason:** Product of radius of meniscus and height of liquid in capillary tube remains constant.
(A) A (B) B (C) C (D) D

14. **Assertion:** It is hotter at the top of the fire than at the same distance on the sides.
**Reason:** Air surrounding the fire conducts more heat upwards.
(A) A (B) B (C) C (D) D

15. **Assertion:** A body 'P' having mass M moving with speed u has a head on collision elastically with another body 'Q' having mass m initially at rest. If m<<M, body 'Q' will have maximum speed equal to 2u.
**Reason:** During elastic collision, the momentum and kinetic energy are both conserved.
(A) A (B) B (C) C (D) D

16. **Assertion:** If the dot product and cross product of **P** and **Q** are zero, it implies that one of the vector **P** and **Q** must be null vector.
**Reason:** A null vector is a vector of zero magnitude.
(A) A (B) B (C) C (D) D

## SECTION – B

17. Show that the average kinetic energy of a gas molecule is directly proportional to the temperature of the gas. Hence give the kinetic interpretation of the temperature.

(OR)

Write any two postulates of kinetic theory of gases. Using law of equi partition determine the values of Cp, Cv for a diatomic gas.

18. The radius of earth's orbit is $1.5 \times 10^8$ km and that of Mars is $2.5 \times 10^{11}$ m. In how many years, does the Mars complete its one revolution?

19. Correct the following statements:
    a) In an elastic collision of two bodies, the momentum and energy of each body is conserved.
    b) In an inelastic collision of two bodies, the quantity which does not change after the collision is the total kinetic energy of the system of two bodies.

20. Find the value of 60J per min in a system that has 100g, 100cm and 1 min as the base units.

21. A particle starts from rest and has an acceleration of $2 m/s^2$ for 10 s. After that, the particle travels for 30s with a constant speed and then undergoes a retardation of $4 m/s^2$ and comes back to rest. Find the total distance covered by the particle.

## SECTION – C

22. a) What is an isothermal process? What are the essential conditions for an isothermal process to take place? Derive an expression for the work done during the isothermal process.

(OR)

What is an adiabatic process? What are the essential conditions for an adiabatic process to take place? Derive an expression for the work done during the adiabatic process.

    b) If at 50°C and 75cm of mercury pressure a definite mass of gas is compressed isothermally, then what will be the final pressure and temperature of the gas if the final volume is one fourth of its initial volume?

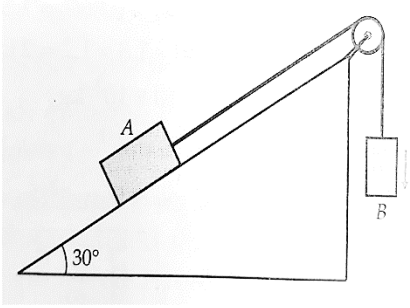
23. a) What is meant by elastic potential energy? Derive an expression for the elastic potential energy of a stretched wire. Prove that its elastic energy density is equal to ½x stress x strain.
    b) A steel wire of 4m is stretched through 2mm. The cross sectional area of the wire is 2 $mm^2$. If the young's modulus of steel is $2 \times 10^{11} Nm^{-2}$. Find the energy density of the wire.

24. Define escape velocity. Obtain an expression for escape velocity of a body from the surface of earth. The escape velocity for a satellite is 11.2km/s. If the satellite is launched at an angle of 60° with the vertical, what will be the escape velocity?

25. Give difference between centre of mass and centre of gravity.
Three masses 3kg, 4kg and 5 kg are located at the corners of an equilateral triangle of side 1m. Locate its centre of mass.

26. Derive the following equation of motion for an object moving with constant acceleration along a straight line $S_{nth} = u + \frac{a}{2}(2n-1)$ where n represents time. Also check the dimensional consistency of this equation.

27. A block 'A' of mass 14kg moves along an inclined plane that makes an angle of 30° with the horizontal. Block 'A' is connected to another block 'B' of mass 14kg by a mass less string that runs around a frictionless pulley. The block 'B' moves downwards with constant velocity. What is (i) magnitude of the frictional force (ii) the coefficient of kinetic friction?



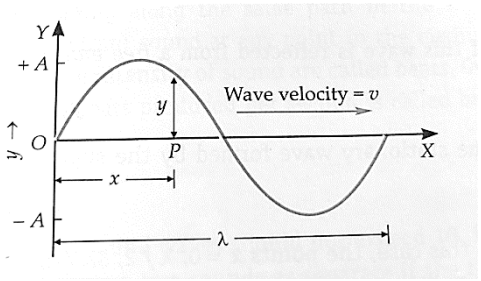

28. a) What do you mean by rectangular components of a vector? Show with the help of proper diagram that walking of a man is an example of resolution of a vector.
b) If **A** = 3**i** + 4**j** and **B** = 7**i** + 24**j**, find a vector having the same magnitude as **B** and is parallel to **A**.

(OR)

a) State and prove parallelogram law of vector addition.
b) If **A** + **B** = **C** and $A^2 + B^2 = C^2$, then prove that **A** and **B** are perpendicular to each other.

## SECTION – D

29. During the propagation of wave through the medium, the particles of the medium vibrate simple harmonically. A simple harmonic wave is shown in the diagram below.




If at t=0, the particle of the origin passes through the mean position, then the displacement at the origin O at any time t is given by y = a sin wt
The wave reaches the point P after the t = $\frac{x}{v}$. Hence displacement of the particle at point P at time t will be y = a sinw(t- $\frac{x}{v}$) = a sin(wt-kx) where k = angular wave number, a = amplitude, w = angular frequency.

29.1 If the equation of a sound wave is y = 0.0015 sin (62.8x + 314t) then the wavelength of the wave is
(A) 0.1 units (B) 0.2 units (C) 0.3 units (D) 2 units

29.2 The equation of progressive wave is y = 5 sin(100πt-0.4πx), where y is in m and t is in s.
(1) The amplitude of the wave is 5m.
(2) The wavelength of the wave is 5m.
(3) The frequency of the wave is 50 Hz.
(4) The velocity of the wave is 250m/s.
Which of the above statements is correct?
(A) (1), (2) and (3) (B) (1) and (4)
(C) All are correct (D) (1), (3) and (4)

29.3 The plane wave is described by the equation y = 3 cos ($\frac{x}{4}$ – 10t – $\frac{\pi}{2}$), where x and y are in m and t is in s. The maximum velocity of the particles of the medium is:
(A) 30m/s (B) ¾ m/s (C) $\frac{3\pi}{2}$m/s (D) 40m/s

29.4 The equation of the wave travelling on a string is y = 4sin{$\frac{\pi}{2}(8t - \frac{x}{8})$} , where x and y are in cm and t in s. The velocity of the wave is
(A) 64cm/s in –x direction (B) 32cm/s in –x direction
(C) 32cm/s in +x direction (D) 64cm/s in +x direction

30. Swati wants to play with swivel chair for having fun in the office during lunch break. She sits on the chair with her arms folded and feet not resting on it i.e. away from the ground. She asked her friend to rotate the chair rapidly. While the chair is rotating with the considerable angular speed, she stretches her arms horizontally. If she brings back her arms closer to the body, the angular speed increases. If the friction is neglected, there is no external torque about the axis of rotation of the chair.

30.1 Planetary motion in the solar system describes
(A) conservation of kinetic energy (B) conservation of angular momentum
(C) conservation of linear momentum (D) none of these.

30.2 If a person is standing on a rotating disc stretches out his hands, the angular speed will
(A) increase (B) decrease (C) remains same (D) none of these.

30.3 A diver in a swimming pool bends his head before diving, because it
(A) increases his linear velocity (B) decreases his angular velocity
(C) increases his moment of inertia (D) decreases his moment of inertia

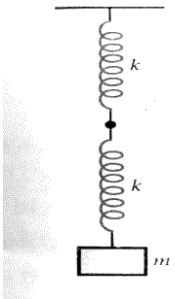
30.4 A child stands at the centre of turntable with his arms stretched out. The turntable is set rotating with an angular speed of 40rpm. The angular speed of the child if he folds his hands back and thereby reducing his moment of inertia to 2/3 times of the initial inertia is
(A) 100rpm (B) 80rpm (C) 60rpm (D) 40rpm

## SECTION – E

31. a) What is an organ pipe? Describe the various modes of vibration for an open organ pipe. Give the supporting diagrams also.
b) What should be the minimum length of open organ pipe for producing a note of 110Hz.? The speed of sound in air is 330m/s.

(OR)

a) Show that for small oscillations the motion of a simple pendulum is simple harmonic. Derive the expression for its time period.
b) Two identical springs, each of spring constant k,are connected in the following way. Deduce the spring factor of the oscillation of the body.




32. State and prove Bernoulli's principle for the flow of non viscous fluids. Give its any two limitations. Why is it advised to stay away from the yellow line when a metro train is approaching the station?

(OR)

a) Show (with proper diagrams) that a pressure difference exists between the two sides of a curved liquid surface. Derive an expression for the excess pressure inside a soap bubble.
b) Define angle of contact. The angle of contact for a solid and liquid is less than 90°. Will the liquid wet the solid? Will the liquid rise in the capillary made up of glass?

33. a) A projectile is fired with a velocity u making an angle Θ with the horizontal. Derive the expressions for A) time of flight B) maximum height of a projectile C) horizontal range.

b) The horizontal range of a projectile is $4\sqrt{3}$ times of its maximum height. What will be the angle of projection?

c) Two bullets are fired simultaneously, horizontally and with different speeds from the same place. Which bullet will hit the ground first?

(OR)

33. a) Define angle of friction. Deduce its relation with the coefficient of friction.

b) Define angle of repose. Show that the angle of repose is equal to the angle of friction.

c) The coefficient of friction between the ground and the wheels of a car moving on the horizontal road is 0.5. If the car starts from rest, what is the maximum distance in which it can acquire a speed of 72km/h?

-x-x-x-x-x-x-x-