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ANNUAL EXAMINATION 2023-24

SUBJECT : PHYSICS

CLASS : XI

Time : 3hours **Marks :70**

General Instructions:

1) There are 33 questions in all. All the 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 has sixteen questions - twelve MCQ and four Assertion-Reasoning based 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 study-based questions of four marks each and Section E contains three long 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 in 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.

SECTION –A

1. Which of the following pairs have the same dimensions,
   a) Specific heat and latent heat
   b) impulse and momentum
   c) surface tension and force

d) moment of inertia and torque

2. A boy starts from a point A travels to a point B at a distance of 1.5 km and returns to A. If it takes one hour to do so. His average velocity is

a) 3 km/h

b) Zero

c) 1.5 km/h

d) 2 km per hour

3. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?

a) 7.2 J

b) 3.6 J

c) 1.20 J

d) 1200 J

4. Two masses 1 g and 4 g are moving with equal kinetic energy. The ratio of the magnitude of their linear momenta is

a) 4:1

b) 1:2

c) 1:4

d) 1:3

5. Moment of inertia depends on

a) distribution of particles

b) mass

c) position of the axis of rotation

d) All of these

6. A dancer on ice spins faster when she folds her arms. This is due to
   a) increase in energy and increase in angular momentum.
   b) decrease in friction at the states
   c) constant angular momentum and increase in angular velocity
   d) increase in energy and decrease in angular momentum.

7. What will be the weight if a body mass 'm' at a height h=Re (Re – radius of the earth) from the surface of the earth?
   a) mg/4
   b) 0
   c) mg
   d) mg/2

8. In a wire, when elongation is 2 cm energy stored is E. If it is stretched by 10 cm, then energy stored will be
   a) E
   b) 2E
   c) 4E
   d) 25E

9. Emissivity of a perfect black body is
   a) 1
   b) 2
   c) 5
   d) 0

10. A ball is thrown up with a velocity of 2.5m/s. It collides elastically with the ground. Find the frequency of this periodic motion.
   a) 1Hz
   b) 2Hz
   c) 3Hz

d) 0.5Hz

11. If a hole is bored along the diameter of the earth and a stone is dropped into hole

a) The stone reaches the centre of the earth and stops there

b) The stone reaches the other side of the earth and stops there

c) The stone executes simple harmonic motion about the centre of the earth

d) The stone reaches the other side of the earth and escapes into space

12. If a string wave encounters a completely fixed end, what happens to its phase?

a) Stays the same

b) Changes by π

c) Changes by $\pi/2$

d) Waves gets destroyed And other

For Questions 13 to 16, two statements are given - one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below:

a. If both Assertion and Reason are true and the Reason is correct explanation of Assertion.

b. If both Assertion and Reason are true but Reason is not the correct explanation of the Assertion.

c. If assertion is true but reason is false.

d. If the assertion and reason both are false.

13. Assertion : Compression and rarefaction involve changes in density and pressure.

Reason : When particles are compressed, density of medium increases and when they are rarefied, density of medium decreases.

14. Assertion (A) : Specific heat of a gas at constant pressure is greater than itsspecific heat at constant volume.

Reason (R) : At constant pressure, some heat is spent in expansion of the gas.

15. Assertion : Air quickly leaking out of a balloon becomes cool

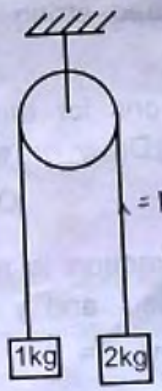
Reason : The leaking air undergoes adiabatic expansion.

16. Assertion : Horizontal range is same for angle of projection θ and $(90 - \theta)$.

Reason : Horizontal range is independent of angle of projection.

SECTION B

17. In the given system, masses are released from rest. The Young's modulus of wire is $10^{11} N/m^2$, length = 1m & radius = 2mm. Find elongation in wire when masses are moving. Assume pulley to be frictionless.



18. The displacement (in metre) of a particle moving along x-axis is given by $x = 18t + 5t^2$. Calculate

(i) The instantaneous velocity at t = 2 s

(ii) Instantaneous acceleration

19. Find the ratio of specific heat capacities of a monoatomic gas using the law of equipartition of energy.

[P.T.O.]

20. What do you mean by static and kinetic friction? Explain how a ball bearing placed between moving parts of a machine reduces friction?

OR

A ball thrown up is caught by the thrower after 4s. How high did it go and with what velocity was it thrown?

21. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontalsurface are tied to the ends of a tight string. A horizontal force F = 600 N is applied to (i) A, (ii) B along the direction of string. What is the tension in the string in each case?

SECTION C

22. Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ The coefficient of static friction between the wheels and the road is μ.

23. Discuss the formation of harmonics in a stretched string. Show that in case of a stretched string, the first four harmonics are in the ratio 1:2:3:4.

24. Derive the expressions for the kinetic and potential energies of a harmonic oscillator. Draw graph for Energy vs. displacement.

OR

A simple harmonic motion is represented by y = 5 cos $(2\pi t + \pi/4)$, where t is in sec. and y is in meters. Calculate

a) Displacement at t = 0

b) Time period

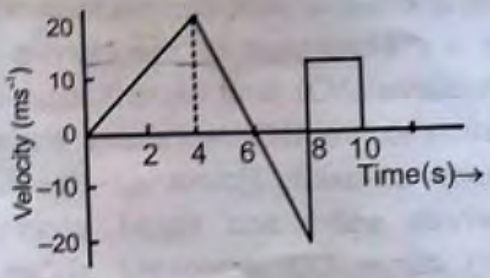
c) Initial velocity

25. The velocity-time graph of an object moving along a straight line is shown in fig. below.

a) Find the net distance covered by the object in time interval between t = 0 to t = 10s.

b) Find the displacement in time 0 to 10s.

c) Find acceleration between t = 0 to t = 4s, t= 6s to t= 8s.



26. (i) Two point masses 2M & M are separated by a distance 'r'. find the position of center of mass of this system.

(ii) Find the torque of a force $7\hat{i}-3\hat{j}-5\hat{k}$ about the origin which acts on aparticle whose position vector is $\hat{i}+\hat{j}-\hat{k}$.

27. Experiments show that the frequency (n) of a tuning fork depends upon the length (l) of the prong, the density (d) and Young's modulus (Y) of its material. From dimensional considerations, find a possible relation for the frequency of a tuning fork.

28. (i) State First law of thermodynamics.

(ii) Derive an expression for the work done during an isothermal process.

$pv = nRT$ $\quad p = \frac{nRT}{v}$ $\quad \int \frac{1}{v}\,dv$ $\quad [\log v]_{v_1}^{v_2}$

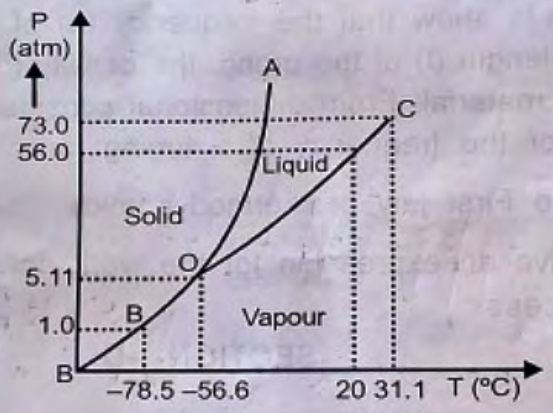
SECTION –D

29. Read the following paragraph and answer the questions that follow:

Change of State: Matter normally exists in three states: solid, liquid and gas. A transition from one of these states to another is called a change of state. The change of state from solid to liquid is called melting and from liquid to solid is called fusion. The change of state from liquid to vapour (or gas) is called vaporisation. The change from solid state to vapour state without passing through the liquid state is called sublimation, and the substance is said to sublime. It is observed that the temperature of a substance remains constant during its change of state. A graph between the temperature T and the Pressure P of the substance is called a phase

[P.T.O.]

diagram or P – T diagram. The following figure shows the phase diagram of water and CO2. Such a phase diagram divides the P – T plane into a solid-region, the vapour-region and the liquid-region. The regions are separated by the curves such as sublimation curve (BO), fusion curve (AO) and vaporisation curve (CO).. The point on the sublimation curve BO represent states in which the solid and vapour phases co-exist. Points on the fusion curve AO represent states in which solid and liquid phase coexist. Points on the vapourisation curve CO represent states in which the liquid and vapour phases coexist. The temperature and pressure at which the fusion curve, the vaporisation curve and the sublimation curve meet and all the three phases of a substance coexist is called the triple point of the substance.



Pressure-temperature phase diagram for CO2

(1) What is the term used to describe the change of state from solid to vapour without passing through the liquid state?

a) Melting
b) Sublimation
c) Fusion
d) Vaporisation

(2) What is the significance of the point on the sublimation curve BO?

a) Solid and liquid phases coexist
b) Solid and vapour phases coexist

c) Liquid and vapour phases coexist
d) liquid, solid and vapour state coexist

(3) What is the common term for the point at which the all the three phases of a substance coexist?
a) Melting point
b) Critical point
c) Triple point
d) Phase equilibrium point

(4) What property of a substance remains constant during its change of state?
a) Volume
b) Pressure
c) Temperature
d) Density

OR

The triple point of CO_2 is
a) -78.5 $^{\circ}C$ at 1 atmosphere
b) -56.6 $^{\circ}C$ at 5.11 atmosphere
c) -20 $^{\circ}C$ at 56 atmosphere
d) 31.1 $^{\circ}K$ at 73 atmosphere

30. Read the following paragraph and answer the questions that follow:

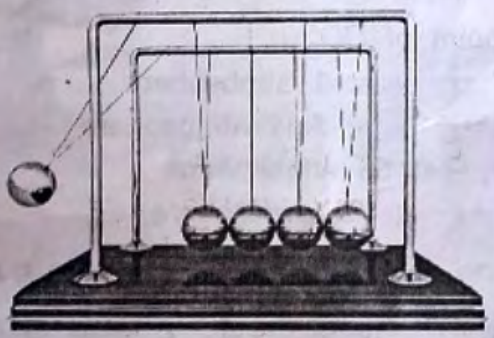
Newton's Cradle: Newton's Cradle consists of a row of five metal balls — positioned to just barely touch one another — suspended from a frame by thin wires. When a ball on one end of the cradle is pulled away from the others and then released, it strikes the next ball in the cradle, which remains motionless. But the ball on the opposite end of the row is thrown into the air, then swings back to strike the other balls, starting the chain reaction again in reverse.

When the first ball of Newton's Cradle collides with the second, the first ball stops, but its momentum isn't lost, just transferred to the second ball, then the third, then the fourth, until it reaches the very last ball. You witness this conservation of momentum as the last ball

[P.T.O.]

swings into the air with nearly the same momentum as the first ball. Thus, if two balls are lifted into the air on one end of the device and released, then two balls on the opposite end will swing in response. Change in direction of motion brings a change in momentum, which cannot happen without the influence of an outside force.

This device illustrates some main principles of Physics also, like- conservation of momentum, conservation of energy. It is to remember that law of conservation only works in a closed system, which is free from any external force. The Newton's Cradle is not a closed system. When the last ball swings out away from the rest of the balls, it is affected by the force of gravity, which brings the ball down.



(1) What principles of Physics does Newton's Cradle demonstrate?
a) Law of conservation of Energy
b) Law of conservation of Momentum
c) Law of conservation of mass
d) Both a and b

(2) According to the passage, why is Newton's Cradle not considered a closed system?
a) It lacks conservation of energy
b) External forces, like gravity, affect it
c) Friction is absent in the system
d) The metal balls are too close to each other

(3) When the first ball of Newton's Cradle collides with the second, what happens to the momentum of the first ball?

a) It is lost
b) It stops completely
c) It is transferred to the second ball
d) It increases exponentially

(4) In a perfectly elastic collision of Newton's Cradle balls, what happens to the kinetic energy?

a) It decreases
b) It remains constant
c) It increases
d) It transforms into potential energy

OR

If four balls are lifted into the air on one end of the device and released, then

a) one ball on the opposite end will swing
b) four balls on the opposite end will swing
c) two balls from each end will swing
d) all the balls remain at rest

SECTION E

31. (i) Show that the trajectory of a projectile is a parabola.

(ii) A projectile is projected at an angle θ with horizontal with initial velocity u. Derive expressions for its

a) Time of flight

b) Maximum height

(iii) Find the value of 'y' so that the vectors $\vec{A} = (2\hat{i} + y\hat{j} + \hat{k})$ and $\vec{B} = (4\hat{i} - 2\hat{j} - 2\hat{k})$ are perpendicular to each other.

OR

(i) Two vectors $\vec{A}$ and $\vec{B}$ are inclined to each other at an angle . Using Parallelogram law of vector addition, find the magnitude and direction of their resultant.

(ii) An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100 s.
(a) What is the angular speed of the motion?
(b) What is its magnitude?

32. (i) Derive expressions for acceleration due to gravity below and above the surface of earth.

(ii) Find the percentage decrease in weight of a body, when taken 16 km below the surface of the earth ?(Given radius of the earth is 6400 km)

OR

(i) Define escape velocity. Derive an expression for the escape velocity of an object from the surface of the earth.

(ii) A particle is projected upward from the surface of the earth (radius R) with a K.E. equal to half the minimum value needed for it to escape. To which height does it rise above the surface of the earth?

33. (i) State and prove Bernoulli's theorem.

(ii) Water flows smoothly in a closed pipe system, with one point having a speed of 3.0 ms^{-1} and another point 1.0 m higher having a speed of 4.0 ms^{-1}. What is the pressure at the upper point if the lower pressure is stated as 20 kPa?

OR

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

(iv) Calculate the work done in blowing a soap bubble from a radius of 2 cm to 3 cm. The surface tension of the soap solution is 30 dyne/cm.

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