*Candidates are allowed **additional 15 minutes** for **only** reading the paper.*
*(They must **NOT** start writing during this time.)*

*This paper is divided into **four** sections – A, B, C and D. Answer **all** questions. **Section A** consists of **one** question **having sub-parts** of **one** mark each. **Section B** consists of **seven** questions of **two** marks each. **Section C** consists of **nine** questions of **three** marks each, and **Section D** consists of **three** questions of **five** marks each. **Internal choices have been provided in two questions each in Section B, Section C and Section D**.The intended marks for questions are given in brackets[ ]. All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer. Answers to sub parts of the same question must be given in one place only. A simple scientific calculator without a programmable memory may be used for calculations.*

SECTION A - 14 MARKS

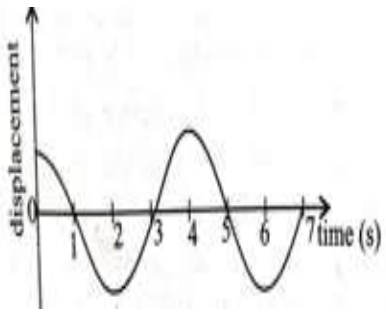
Question 1

(A) In questions (i) to (vii) given below, choose the correct alternative (a),(b),(c) or (d) for each of the questions.

(i) The dimensional formula for the surface tension is : **[1]**

(a) $[M^1L^1T^{-2}]$ (b) $[M^1L^2T^{-2}]$ (c) $[M^1L^0T^{-2}]$ (d) $[M^1L^1T^1]$

(ii) The displacement vs time curve for a particle executing SHM is shown in the figure below. Choose the correct statements. **[1]**



(a) Phase of the oscillator is same at t = 0 s and t = 2 s

(b) Phase of the oscillator is same at t = 2 s and t = 6 s

(c) Phase of the oscillator is same at t = 1 s and t = 7 s

(d) Phase of the oscillator is same at t = 1 s and t = 3 s

(iii) Kepler's third law related to the planetary motion is : **[1]**

(a) $T \alpha r$ (b) $T \alpha r^2$ (c) $T \alpha r^3$ (d) $T \alpha r^{3/2}$

(iv) Two balls A and B of equal mass are thrown at angles 30° and 60° with velocity v **[1]** Find the ratio of their time of flight :

(a) 1:√3 (b) √3:1 (c) 1:3 (d) 1:1

(v) Wien's displacement law of radiation is : **[1]**

(a) $\lambda_m T = b$ (b) $\lambda_m T^{-1} = b$ (c) $\lambda_m T^{-2} = b$. (d) $\lambda_m^{-1} T = b$

(vi) **Assertion (A):** The energy of a body undergoing simple harmonic motion is purely kinetic at its mean position. **[1]**

Reason(R): The energy of a body undergoing simple harmonic motion is purely potential at its mean position.

(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, R is false. (d) A is false, R is true.

(vii) **Assertion (A):** The force on the roof of house due to a gale is directed upwards. **[1]**

Reason (R): This can be explained on the basis of equation of continuity.

(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, R is false. (d) A is false, R is true.

(B) Answer the following **briefly**.

(i) The Newton's law of gravitation is $F = Gm_1m_2 \div r^2$, where F is the magnitude of force of attraction between two masses m_1 and m_2 at a distance r apart. Derive the unit for the gravitational constant G in term of the fundamental Sl units. **[1]**

(ii) State Stefan's law. **[1]**

(iii) In projectile motion, at what point on the trajectory, its speed will be (a) minimum (b) maximum? **[1]**

(iv) How is the path difference related to phase difference? **[1]**

(v) State the first law of thermodynamics. **[1]**

(vi) From a radio station, the frequency of waves is 15 megacycles/second. Calculate their wavelength. **[1]**

(vii) State Newton's universal law of gravitation. **[1]**

SECTION B - 14 MARKS

Question 2

(i) An oil drop falls through air with a terminal velocity 5×10^{-4} ms-^{1}. Calculate radius of the drop. Given: density of oil = 900 kg m^{-3} and viscosity of air = 1.8×10^{-5} Ns m^{-2}. Neglect density of air in comparison to density of oil. **[2]**

OR

(ii) The tube of a mercury barometer is 3.00 mm in diameter. What error is introduced into the reading because of surface tension? Angle of contact for mercury is 128° and its surface tension is 0.647 N/m. Take density of mercury as 13500 kg/m^3. **[2]**

Question 3

Using an indicator diagram, differentiate between the isochoric and isobaric **[2]**

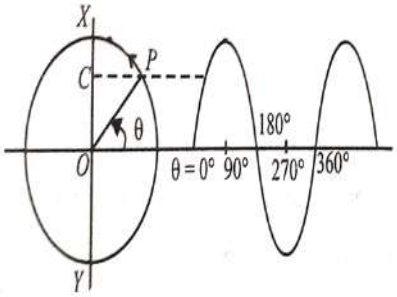
processes.

Question 4

Write the coefficient of thermal conductivity of a perfect heat conductor and that of a perfect heat insulator. **[2]**

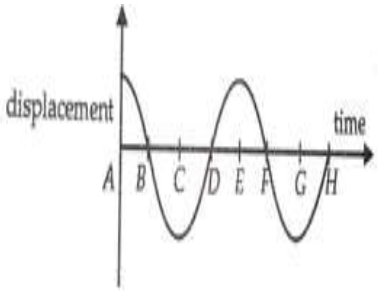
Question 5

(i) Observe the figure below. A particle P is moving in anti-clockwise direction, is shown at an instant when angle traversed by the radius vector is Ø. C is the point of projection of P on X-Y line. Copy the diagram and mark the position of the point C when Ø is:(a) 90° and (b) 270°. **[2]**



OR

(ii) Displacement versus time curve for a particle executing SHM is shown in the figure below. Identify the points marked at which (a) displacement of the oscillator is maximum (b) speed of oscillator is maximum. **[2]**



Question 6

What is meant by: **[2]**

(i) surface film? (ii) molecular range?

Question 7

Calculate the work done in stretching a uniform metal wire of area of cross-section 10^{-6} m^2 and length 1.5 m through 4 x 10^{-3} m. Given Y = 2 x 10^{11} N/m^2 **[2]**

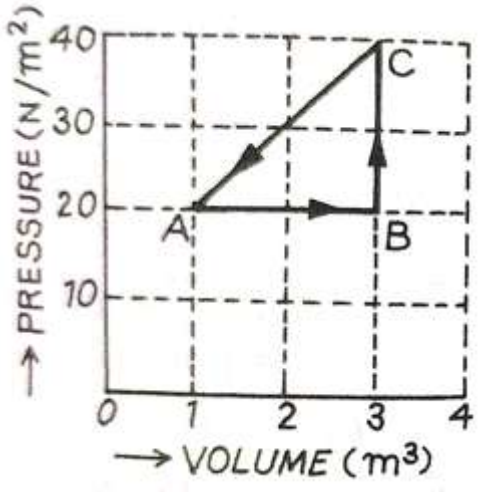
Question 8

Two sitar strings A and B playing the note 'Ga' are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduced and the beat frequency is found to be reduced to 3 Hz. If the original frequency of B is 318 Hz, what is the frequency of A? **[2]**

SECTION C - 27 MARKS

Question 9

The diagram given below shows the changes taking place in a thermodynamic system in going from the initial state **A** to the states **B** and **C** and finally returning to the state **A.** Calculate the work done by/on the system in each of these changes, A to B, B to C and C to A . **[3]**



Question 10

(i) (a) Write the expression for the time of flight of a projectile.(No derivation) **[3]**

(b) Two bombs of 5 kg and 10 kg are thrown from a cannon in the same direction. Which bomb will reach the ground first when they are thrown with (1) the same velocity? (2) the different velocities? Explain.

OR

(ii) A projectile is fired with velocity **U** making an angle **Ø** with the horizontal. Obtain an expression for it's trajectory. **[3]**

Question 11

Write Mayer's relation and prove it. **[3]**

Question 12

The velocity of a longitudinal wave through a gaseous medium depends on the pressure and density of the medium. Using dimensional analysis, derive an expression for the velocity of sound through gas. **[3]**

Question 13

(i) Prove that the motion of a simple pendulum is SHM. Obtain the expression for its time period. **[3]**

OR

(ii) Obtain an expression for the time period of vibrations of a mass-less loaded spring in horizontal alignment. **[3]**

Question 14

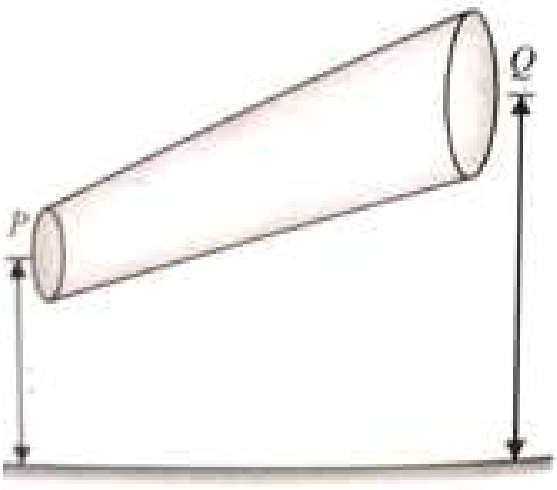
What is meant by temperature gradient? Is it a scalar or a vector? Give it's unit. **[3]**

Question 15

A body describes simple harmonic motion with an amplitude of 5 cm and a period of 0.2 s. Find the acceleration and velocity of the body when the displacement is (a) 5 cm (b) 3 cm and (c) 0 cm. **[3]**

Question 16

An incompressible and non-viscous liquid is flowing in streamlined motion through the tube PQ. Prove that the total energy at the points P and Q are equal. **[3]**



Question 17

The figure below shows a man is sitting on a revolving table carrying dumbbells in his stretched hands. The man is also revolving along with the table. Which of these cases the speed of the man will be greater? Why? State the law used to identify it. **[3]**

SECTION D - 15 MARKS

Question 18

(i) Describe Carnot's reversible heat engine and obtain an expression for its efficiency. **[5]**

OR

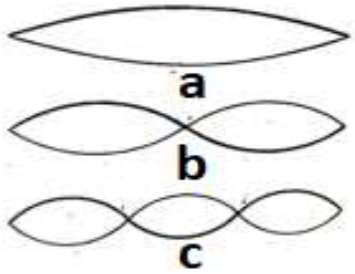
(ii) (a) Derive an expression for the work done during an isothermal expansion. **[5]**

(b) A gas is suddenly compressed to half of its original volume. Calculate the rise in temperature, the original temperature being 300 K, and $C_p/C_v = 1.5$

Question 19

(i) Copy the diagram given below and locate their nodes and antinodes. Identify the **[5]**

mode of vibrations and the harmonics shown in each diagram.



OR

(ii) With the help of diagrams, show the standing waves formed in a closed organ pipe for the first three modes of its vibration. Also prove that only odd harmonics can be produced in it. **[5]**

Question 20

Ritu was playing with a rubber band. She was asking about the elongation of the rubber band to her elder brother Somu. He explained the elastic behaviour of the substance with the help of a stress-strain graph. **[5]**

(i) Draw the labelled stress-strain graph of an elastic substance.

(ii) State Hooke's law and show that up to what point on the curve is Hooke's law obeyed.

(iii) Up to what stress can the wire be subjected without fracturing?

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