[Time: Three Hours] [Marks: 100]

N. B.: (1) **All** questions are **compulsory**.
(2) **Figures** to the **right** indicate **full** marks.
(3) Draw **neat** diagrams wherever **necessary**.
(5) Symbols have usual meaning unless otherwise stated.
(5) Use of **non-programmable** calculator is allowed.

Q.1. A) Select the correct alternative 12

(i) Modulus of rigidity is shown by _____
a. liquids b. gases
c. solids d. none of the above

(ii) Centrifugal force is _____ force
a. pseudo b. real
c. imaginary d. none of the above

(iii) In the Wedge –Shaped film, alternate dark and bright straight fringes obtained are due to the phenomenon of _____
a. Diffraction b. Scattering
c. Interference d. Polarization

(iv) In Ramsden eyepiece, the lens defect coma is _____
a. Minimum b. Maximum
c. Medium d. none of these

(v) The first law of thermodynamics is based on _____ principle.
a. Conservation of mass b. Action and reaction
c. The entropy-temperature d. Conservation of energy

(vi) A system is in _____ equilibrium if there is no change in pressure at any point of the system with time.
a. Pressure b. Thermal
c. Mechanical d. Phase

B) Answer in one sentence 3

(i) State Hooke's law.
(ii) Define Angular Magnification.
(iii) What is Critical temperature of a gas?

C) Fill in the blanks 5

(i) Lift of air plane is based on the _____ principle
(ii) In equation of continuity, area of pipe and velocity of liquid are _____ proportional.
(iii) The ratio of length of an image to the length of an object measured perpendicular to the axis is called as _____
(iv) The unit of power of lens is a _____
(v) When the heat transfer into a system is more than the work transfer out of the system then the internal energy of the system _____

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Q. 2 A) **Attempt ANY ONE** 8

(i) Derive an expression for Bernoulli's equation for the flow of liquid in a pipe of varying cross section.

(ii) Show that for homogeneous isotropic material $Y = 3K(1 - 2\sigma)$. Symbols have usual meaning.

B) **Attempt ANY ONE** 8

(i) Drive an expression for the moment of a couple required to twist one end of the cylinder when other is fixed.

(ii) Show that the shear strain is equal to compression and extension strains and they are perpendicular to each other.

C) **Attempt ANY ONE** 4

(i) A block of mass 2kg is kept on a horizontal surface. When a horizontal force of 15 N is applied to it the block doesn't slide. Calculate the coefficient of static friction.

(ii) Derive Poisson's ratio equation for homogeneous isotropic material : $\sigma = \frac{3K-2\eta}{6K+2\eta}$; Comment on the limiting value of σ.

Q. 3 A) **Attempt ANY ONE** 8

(i) Discuss the construction and working of Ramsden's eyepiece with the help of ray diagram.

(ii) Derive the condition for the achromatism a) when two lenses are in contact with each other, and b) when two lenses are separated by distance '*D*'.

B) **Attempt ANY ONE** 8

(i) Explain how the concentric circular fringes are formed in the Newton's Rings experiment? Hence show that the radius of n^{th} bright ring is directly proportional to the square root of odd natural numbers.

(ii) Derive the equation for equivalent focal length of lens combinations, if two lenses having focal lengths f_1 and f_2 are separated by the distance '*d*'.

C) **Attempt ANY ONE** 4

(i) A thin Plano convex of focal length 2 m and refractive index 1.5 is used so as to get Newton's Rings. Determine the radius of tenth bright ring by reflection if the wedge shaped air film is illuminated normally by a light of wavelength 589 nm.

(ii) A coaxial system of lenses has two thin convex lenses of same material. If f_1 and f_2 represents the focal lengths of lenses separated by distance '*x*', then equivalent focal length is found to be 60 cm. The combination satisfies the condition of minimum aberrations and no chromatic aberration. Find the focal length of each lens.

Q. 4 A) **Attempt ANY ONE** 8

(i) Derive Van der Waals equation explaining every step.

(ii) Obtain relations between *P*, *V* and *T* in an adiabatic interaction for a perfect gas.

B) **Attempt ANY ONE** 8

(i) Draw a neat diagram showing ($pV - p$) isothermals for a large range of temperatures. Also define Boyle's temperature.

(ii) Prove that, for a real gas,

$$C_P - C_V = \left[\left(\frac{\partial U}{\partial V}\right)_T + P\right]\left(\frac{\partial V}{\partial T}\right)_P$$

where, symbols have their usual meaning.

C) **Attempt ANY ONE** 4

(i) Critical volume of helium is 3.75cm^3/g and a = 1.8 x 10^{-4} Nm^4 mol^{-2}. Calculate P_c and T_c. Given: R = 8.4 JK^{-1} mol^{-1} and Molecular weight of helium = 4.

(ii) One mole of a perfect gas at 200K is isothermally compressed to half of its volume. Calculate the heat rejected by the system, the work done on the system and the change in its internal energy. Given: R = 8.4 JK^{-1} mol^{-1} , 1 cal = 4.2 J

Q. 5 **Attempt ANY FOUR** 20

(i) A wooden block of mass m kg is kept on an incline plane of an angle θ . The angle θ is adjusted such that the block moves downwards with constant speed. Determine the angle θ in terms of coefficient of friction μ_k.

(ii) Write short note on application of Bernoulli's theorem as Venturimeter.

(iii) Derive the expression for Newton's Lens equation.

(iv) Fringe of the same thickness are observed in a thin glass wedge of R. I. 1.67. If the fringe spacing is 2 mm and wavelength of incident light is 5890 A^0, what is the angle of wedge in seconds of an arc?

(v) Discuss the limitations of Van der Waals equation.

(vi) Show that the work done by a perfect gas in an isothermal expansion from volume V_1 to V_2 is given by: $W = nRT \ln\left(\frac{V_2}{V_1}\right)$

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