

2022

(February)

PHYSICS

(Elective/Honours)

(Thermal Physics, Optics)

[PHY-03 (T)]

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks
for the questions

Answer any **eight** questions

1. (a) What are the limitations of the perfect gas equation $PV = RT$? 2
- (b) What are the corrections that van der Waals made to the perfect gas equation? Hence deduce the van der Waals gas equation

$$P = \frac{a}{V^2} (V - b) RT \quad 1+4=5$$

2. (a) Define mean free path. Derive the Clausius expression for mean free path (λ) on the basis of kinetic theory of gases. 1+3=4
- (b) Calculate the diameter of a molecule of a gas if the number of molecules per cm^3 in a gas is 3×10^{19} and mean free path is 2×10^{-8} cm. 3
3. (a) Define entropy. Derive an expression for the entropy of an ideal gas in terms of its temperature, pressure and specific heat. 1+4=5
- (b) Calculate the change in entropy when 10 g of ice at 0°C is converted into water at the same temperature. (Latent heat of ice = 80 cal/g). 2
4. (a) What is Joule-Thomson effect? 1
- (b) What is Boyle temperature? Derive the expression for Boyle temperature for a van der Waals gas. $1\frac{1}{2}+2\frac{1}{2}=4$
- (c) Explain the principle of regenerative cooling. 2
5. State the Planck's quantum postulates. Hence derive the Planck's radiation formula. 2+5=7

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6. State and explain Fermat's principle of extremum path. Using the principle, derive Snell's law of refraction at a plane surface. $1+2+4=7$
7. (a) What are the cardinal points of an optical system? With a suitable diagram, establish the relations between distances of principal points and nodal points of a thick lens. $2+3=5$
- (b) Two thin lenses A and B having focal lengths 0.05 m and 0.02 m are placed coaxially and separated by a distance of 0.03 m. Find the equivalent focal length of the combination. 2
8. (a) With the help of a neat diagram, describe the construction of Ramsden's eyepiece and find an expression for the focal length of the eyepiece. $2+2+1=5$
- (b) Give two advantages of Ramsden's eyepiece over Huygens' eyepiece. 2
9. What are Newton's rings? Give the theory of Newton's rings and hence determine the wavelength of monochromatic light used in Newton's rings experiment. $1+3+3=7$

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10. (a) What is a zone plate? How is it constructed? Explain positive zone plate and negative zone plate. $1+2+1=4$
- (b) Explain the theory of plane diffraction grating. 3
11. (a) What is polarization of light? Discuss one method to produce elliptically polarized light. $1+3=4$
- (b) What is a quarter-wave plate? 1
- (c) Calculate the thickness of a half-wave plate for light of wavelength 5000 \AA ; $n_o = 1.544$ and $n_e = 1.533$. 2
12. (a) With a neat diagram, explain how population inversion is achieved in a He-Ne laser. $2+2=4$
- (b) What are normal and anomalous dispersions? $1\frac{1}{2}+1\frac{1}{2}=3$
