RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

SECOND YEAR

B.A./B.SC. FOURTH SEMESTER (January – June), 2012

Mid-Semester Examination, March 2012

Date : 19/03/2012 **PHYSICS (Honours)**

Time : 2 pm – 4 pm Paper : IV Full Marks : 50

[Use separate Answer Books for each Section]

Section-A [Thermal Physics]

Answer **any two** questions.

1. a)Establish the following TdS equation:

$TdS = C_P dT - \delta VTdP$, where δ is the volume expansivity**.** [2]

b) Find the heat transferred when the pressure on 20 gm of water at 0^oC**,** is increased reversibly from 0 to 500 atmosphere. Is heat absorbed or given out?

Volume expansivity of water $= -67 \times 10^{-6}\ ^oC^{-1}$**;** 1 atmosphere $= 1.013 \times 10^5$ Pascal [3+1]

c) Find out an expression of $(C_P - C_V)$ in terms of isothermal compressibility (①) and volume coefficient of expansion (α). [4]

2.a) What are the characteristic features of a first order phase transition ? Show that at phase transition point $g_1 = g_2$, where g_1 and g_2 are specific Gibb's free energy of two phases. [1+3]

b) Write down the differential equation of the vapourisation curve [i.e., Clapeyron eqn.]. Solve the differential equation with reasonable assumptions.

Given that molar latent heat of the substance L(T) = a - bT , where a and b are positive constants. [4]

c) State Gibbs phase rule.

Using Gibbs phase rule, justify the use of Triple point of water as thermometric fixed point. [1+1]

3.a)With the help of a rough sketch, show the nature of intermolecular interaction for molecules of a real gas. On the same graph draw the model potential corresponding to van der Waals' equation of state. [2]

b) Expand the Van der Waal's equation of state in the following virial form:

$$PV = RT[1 + \frac{B}{V} + \frac{C}{V^2} + ...]$$

Find out the value of second virial coefficient (B) and the Boyle temperature. What is the significance of Boyle temperature? [1+1+1+1]

c) Define critical temperature and critical volume of a gas. Find out the expression of critical volume of a van der Waals' gas. [1+3]

4.a) What do you mean by the inversion temperature of a gas undergoing J-T effect? Find out the inversion temperature for a gas obeying the following equation of state:

$$P(V-b) = RT\exp(-\frac{a}{RVT})$$

where a and b are positive constants. [1+5]

b) Critically compare the cooling generated by adiabatic expansion and J-T expansion. [4]

Section-B [Physical Optics + E. M. Theory]

Answer **<u>any one</u>** question.

5.a) A plane EM wave falls obliquely on the interface between two dielectrics with electric field parallel to the plane of incidence. Obtain an expression for the reflection and transmission coefficients. [6]

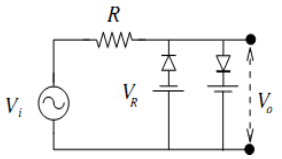
b) Find the angle of incident wave falling between the two dielectrics media, at which the reflected beam became completely polarized. [4]

6.a) State the conditions for an observable interference pattern of light. Show that the shapes of the interference fringes formed in Young's experiment is hyperbolic in two dimensions. [2+5]
b) A film of oil (r.i.=1.7) is formed between a glass plate and an equi-convex lens (r.i. of both may be taken as 1.5). The focal length of the lens is 1 m. Find the radius of the 10^{th} dark ring when light of wavelength 600 nm falls normally on the combination. [3]

Section-C [Electronics]

Answer **any one** question.

7.a) Draw the i-v characteristics of a p-n diode under forward bias and reverse bias. Explain the nature of the curves. [1+2]
b) Does the dynamic resistance of a p-n diode depends on temperature and bias voltage? Explain. [3]
c) In the following circuit, $V_R = 5V$, and $v_i = 20sin\omega t$. Taking $R = 1K\Omega$ and the diode as an ideal one, sketch the voltage wave of v_o. What is the maximum and minimum diode current ?



[2+2]

8.a) Draw circuit diagram for a bridge rectifier with capacitor filter. Explain the action of bridge rectifier and the operation of capacitor filter. [1+1+3]

b) Calculate the ripple factor of the capacitor filter operating at 50 Hz line frequency. Up to what value of R_L , ripple factor does not change? Given $C = 330\mu F$, $R_L = 500\Omega$. [3]

c) Distinguish between avalanche breakdown and Zener breakdown. [2]

Section-D [A.C. + Transient current]

Answer **any one** question

9. a) A series LCR circuit is driven by a sinusoidal voltage. Find the instanteneous current and also the value of the current at resonance. Draw and explain the phasor diagram corresponding to resonance. [3+1+2]
b) The current in a L-R circuit is 5 mA after a long time the potential is first applied. The time taken for it to reach 1 mA is 0.06 sec. Find the initial rate of growth of the current in the circuit. What time is taken for the current to reach 4 mA ? [2+2]

10.a) Show by calculation how the primary current of a transformer is affected by increase of load in the secondary. Derive the necessary formula. [6]
b) A capacitor and inductor have equal reactances at 750 Hz. What is the ratio of their respective reactances at 59 Hz ? [2]
c) What is parallel resonance circuit? Why is it called a rejector circuit? [2]