RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SECOND SEMESTER EXAMINATION, MAY 2016
FIRST YEAR [BATCH 2015-18]

Date : 25/05/2016   **PHYSICS (General)**

Time : 11 am – 1 pm   **Paper : II**   Full Marks : 50

[Use a separate Answer Book for each group]

Group – A

Answer <u>any two</u> questions from question nos. <u>1 to 4</u> :   [2×10]

1. a) Deduce an expression for pressure exerted by an ideal gas using kinetic theory.   5

   b) Derive an expression for average kinetic energy of a nitrogen molecule.   3

   c) What do you mean by most probable velocity of a gas molecule?   2

2. a) Write down the van der Waals equation of state for a real gas and explain the significance of the correction terms. Obtain expressions for the critical constants in terms of van der Waals constants.   5

   b) Define isothermal and adiabatic processes. Show that the slope of an adiabatic curve of a perfect gas is γ times the slope of the isothermal curve on P-V diagram, where the symbol have its usual meaning.   5

3. a) Draw the indicator diagram of Carnot-cycle and from it find the efficiency of a Carnot engine.   6

   b) Using the first law of thermodynamics, establish the following relation: 4

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

   the symbols having their usual significance.

4. a) Define entropy. Show that entropy remains constant in the reversible process but increases in an irreversible process.   4

   b) State Newton's law of cooling of a body. The temperature of a body falls from 40ºC to 30ºC in 10 minutes. The temperature of the surroundings is 15ºC. What is the temperature of the body after another 5 minutes.   6

Group – B

Answer <u>any three</u> questions from question nos. <u>5 to 9</u> :   [3×10]

5. a) What do mean by Curl of a vector field? Give a physical example.   2+1

   b) Find the constants a, b, c so that

   $$\vec{F} = (x + 2y + az)\hat{i} + (bx - 3y - z)\hat{j} + (4x + cy + 2z)\hat{k}$$

   is irrotational and hence find function ϕ such that $\vec{F} = \vec{\nabla}\phi$.   3+4

6. a) Find torque on a dipole in a uniform electric field. What will be its energy?
   If the electric field is not uniform what extra physical property will be experienced by the dipole?   4+1

   b) State Gauss's theorem in case of electric field. Calculate the electric field at a point near to the surface of a uniformly charged hollow sphere.   2+3

7. a) Derive an expression for the magnetic induction ($\vec{B}$) at a distance r from the centre of a circular coil of radius a and carrying current I.
   From the relation show that it acts as a magnetic dipole when $r \gg a$.   2+3
   b) What do you mean by mutual inductance? Calculate the mutual inductance of solenoid of 1m length having 1000 turns in primary and 200 turns in secondary. The cross-sectional area of solenoid is 5 cm^2. ($\mu_0 = 4\pi \times 10^{-7}$ H/m).   2+3

8. a) Deduce equation of continuity.   3
   b) State and prove maximum power transfer theorem.   2
   c) A battery of emf E is connected in series with a capacitor C and a resistance R. Solving the emf equation find an expression for charge accumulated in the capacitor at any time assuming initially there was no charge in the capacitor.   3
   d) A capacitor is charged through a resistance of 2MΩ by a battery. It takes 0.5 second for the charge to reach three quarter of its final value. What is the capacitance of the capacitor?   2

9. a) A sinusoidal voltage is applied to a series LCR circuit. Find an expression of current at any time. What is the phase difference between current and voltage?   3+1
   b) What is the condition of resonance in series LCR circuit? Plot the frequency response of current and phase difference. Define Q-factor of a resonant circuit. What do you mean by bandwidth and how will it related to Q-factor?   1+1+1+1
   c) A source of alternating emf supplies 10 Volts (rms) at 100 Cycles/Sec. It is applied to a circuit containing a capacitor of capacitance 20μF in series with a resistor of 100Ω. Calculate the impedance and the phase angle.   2

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