RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.Sc. SECOND SEMESTER EXAMINATION, MAY 2015

FIRST YEAR

Date : 27/05/2015 **PHYSICS (General)**

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

[Use a separate Answer Book for each group]

Group – A

[*Answer **any two** questions*]

1. a) Prove that the kinetic energy of a perfect gas is proportional to absolute temperature. [3]
   b) Under what physical condition Maxwell's law of distribution of velocities of a perfect gas is applicable? Define most probable velocity in the Maxwell's law of distribution of such a gas. [1+1]
   c) State Van-der-Waal's equation of a real gas. Under what condition this equation reduces to perfect gas equation. [1+1]
   d) Find the critical temperature of helium gas. Given critical pressure = 2·26 atm, critical density = 0·069 gm cm^{-3}, R = 8·31 $J.mol^{-1}.K^{-1}$. [3]

2. a) Write down the mathematical form of first law of thermodynamics and explain the terms used. Define internal energy of a thermodynamic system. [2+1]
   b) Derive the relation between pressure and volume for a perfect gas during an adiabatic change. Compare this relation with isothermal change. Hence explain which one is steeper. [2+1+2]
   c) Calculate the change in internal energy when 25 gm of oxygen is heated from –5°C to 7°C. Given the specific heat of oxygen at constant volume 0·063 cal/gm/°C. [2]

3. a) Define a Carnot engine. Draw an indicator diagram just showing the processes of a carnot cycle without detailed discussion. [1+2]
   b) Distinguish between reversible and irreversible changes. Give examples. [2]
   c) State the physical significance of entropy of a thermodynamic system. State second law of thermodynamics in terms of entropy. [2+1]
   d) The efficiency of a Carnot engine is 40% and the temperature of its heat-sink is 7°C. Find out the temperature of the heat-source of the engine. [2]

4. a) State and explain Stefan's law of black body radiation.
   Sun radiates energy at the rate of $6{\cdot}3 \times 10^{7}$ $Jm^{-2}s^{-1}$. If Stefan's constant is $5{\cdot}669 \times 10^{-8}$ $Wm^{-2}K^{-4}$, calculate the temperature of sun's surface. [2+1]
   b) State Newton's law of cooling and establish the law mathematically. [1+2]
   c) State Wien's displacement law. Explain it with a graph.
   The wavelength of maximum energy in lunar specturm is found to be $14{\cdot}46\times10^{-4}$ cm. Find the effective lunar temperature. Given a black body at 1646 K has peak value of emission at 1·48 micron. [2+2]

Group – B

[*Answer **any three** questions*]

5. a) Define a solenoidal vector. Determine the constant *a* so that the following vector is solenoidal.
   $\vec{V} = (-4x - 6y + 3z)\hat{i} + (-2x + y - 5z)\hat{j} + (5x + 6y + az)\hat{k}$. [1+1]
   b) Show that $\vec{\nabla}\phi$ is a vector perpendicular to the surface $\phi(x, y, z) = c$ where c is constant. [3]
   c) What do you mean by curl of a vector field? State Stoke's theorem. [1+1]
   d) A vector $\vec{S}$ is defined as $\vec{S} = xy\hat{i} + yz\hat{j} + zx\hat{k}$. Find the divergence and curl of $\vec{S}$. [3]

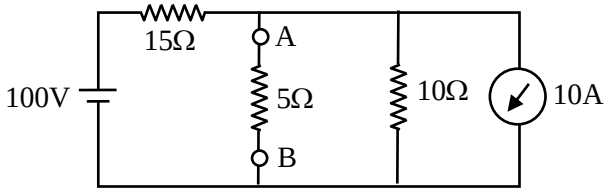
6. a) An electric dipole is placed in a uniform external electric field. Find out the torque experienced by the dipole and also the potential energy of the dipole.
Will an electric dipole experience a net force when placed in a non uniform field? [2+2+1]

b) Explain the term electric intensity $(\vec{E})$, polarisation of dielectric $(\vec{P})$ and established the relationship $\vec{D} = \in_0 \vec{E} + \vec{P}$ where $\vec{D}$ is the electric displacement vector. [1+1+3]

7. a) A battery of emf E is connected in series with a resistance R and a capacitance C. Solve the emf equation to find the growth of charge in the capacitor. What do you mean by time constant of this CR circuit? [3+1]

b) A battery of emf 100V is connected with an inductance of 50mH and a resistance of 20Ω in series. After what time the current will rise to half of its maximum value. [2]

c) Using Nortons' theorem determine the current in the branch AB in the circuit given below. [4]



8. a) What do you mean by electromagnetic induction? State the laws of electromagnetic induction. Hence write the mathematical expression for electromagnetic induction. [1+2+1]

b) What do you mean by self inductance? Find an expression for self inductance for a long solenoid. [1+2]

c) What do you mean by mutual inductance? Find an expression for mutual inductance between two solenoids placed coaxially. [1+2]

9. a) What do you mean by impedance and reactance in any AC circuit? [1+1]

b) An alternating voltage $V(t) = V_0 e^{j\omega t}$ is connected in series with a resistor R, an inductor L and a capacitor C. Solve for the current I(t) flowing through this circuit at any time t. Hence find the condition for resonance. [4+1]

c) A series LCR circuit has a quality factor Q = 5·1 and the resonant frequency f_0 = 100KHz. The power dissipation of the circuit is 100 Watt when it draws a current 1A (rms). Determine the values of R, L and C. [3]

——— × ———