F.E. (Semester – II) (Revised Course 2007-08) Examination, May/June 2014

APPLIED SCIENCE – II
(Physics and Chemistry)

Duration : 3 Hours | Total Marks : 100

***Instructions** : 1) Answer **one** question from **each** Module.*
*2) Answer **two** Sections in **separate** answer books.*
*3) **Draw** diagrams **wherever** necessary.*
*4) **Assume** additional data **if** required.*

Physical constants :

Planck's constant = 6.626×10^{-34} J-s | Electron charge = 1.6×10^{-19} C

Boltzmann constant = 1.38×10^{-23} J/k | Electron mass = 9.1×10^{-31} kg

Rydberg constant = 1.097×10^{7}/m | Velocity of light = 3×10^{8} m/s

SECTION – I
(Physics)

Duration : $1^{1}/_{2}$ Hours | Marks : 50

MODULE – I

1. a) What are step-index and graded index optical fibres ? Draw their R.I. profiles and explain the wave propagation in each fibre. **5**

   b) The state of population inversion is sometimes referred to as negative temperature state. Explain this using Boltzmann's law. **5**

   c) Calculate the maximum diameter allowed for SI fibre having core RI 1.570 and cladding RI 1.565. Fibre has to support only one mode at a wavelength 1.6μm. **5**

   d) Give construction and working of Helium-Neon laser. Draw the necessary diagrams. In what way it differs from Ruby laser (give any two differences). **10**

2. a) Give the characteristic properties of laser. Identify the property of laser which will be useful in welding, surveying, holography and fibre optics communication. 5

   b) Derive the expression for numerical aperture of an optical fibre. 5

   c) Find the relative populations of two states in a ruby laser that produces a light beam of wavelength 6943 A.U.at 330k. 5

   d) Write short note on : 10

      i) Fibrescope

      ii) Ruby laser.

MODULE – II

3. a) Explain the origin of continuous X-ray spectrum. Obtain expression for cutoff wavelength in the spectrum. 5

   b) What are matter waves ? Using the concept of matter waves, obtain Bohr's condition for quantization of angular momentum ? 5

   c) K_α line of tungsten is 0.228 A.U. What is the atomic number of this element. Take screening constant a = 1. 5

   d) What is Compton effect ? Derive an expression for Compton shift. 10

4. a) Explain briefly "Meissner effect" and "Silsbee effect". 5

   b) Write down two industrial, two scientific and one medical application of X-rays. 5

   c) In Compton scattering the energy of an incident X-ray photon is 150 keV and that of scattered photon is 130 keV. Determine angle of scattering and energy of recoiled electron in joules. 5

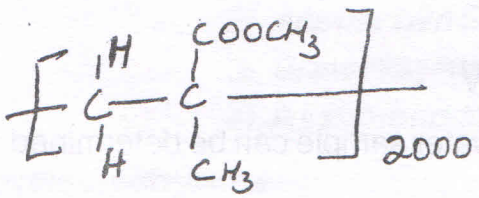
   d) Derive Bragg's equation for reflection of X-rays by crystal plane. Describe Bragg's X-ray spectrometer to verify Bragg's law. 10

SECTION – II
(Chemistry)

Duration : $1^1/_2$ Hours Marks : 50

MODULE – III

5. a) The structural formula of the following polymer is given below : 7



i) Write the structure and name the monomer from which this polymer is prepared.

ii) Determine the molecular weight of the polymer.

iii) Define the term degree of polymerization and find the value for the above polymer.

iv) Explain one method of polymerization by which this polymer can be prepared.

b) With the help of a neat diagram, explain the construction and working of a photovoltaic cell. 7

c) Explain the terms octane number and cetane number of a fuel. How do these ratings help in the selection of a fuel. 6

d) Outline the deficiencies of natural rubber and advantages of synthetic rubber. 5

6. a) Name the ingredients used in the compounding of resin and explain their importance. 7

b) What is solar grade silicon ? Explain the method for production of metallurgical grade silicon and its subsequent purification to obtain solar grade silicon. 7

c) Outline the synthesis of Neoprene; and state any two of its properties and applications. 6

d) Calculate the gross and net calorific value of a coal sample from the following data obtained from bomb calorimeter experiment.

Weight of coal taken = 0.73 g

Weight of water taken in calorimeter = 1500 g

Water equivalent of calorimeter = 470 g

Initial temperature = 25°C

Final temperature = 27.3°C

Percentage of Hydrogen in coal sample = 2.5%

Latent heat of steam = 587 cal/g. **5**

MODULE – IV

7. a) Explain how hardness and alkalinity of a water sample can be determined experimentally. **7**

   b) Explain the molecular arrangement found in a Chiral hematic (cholesteric) liquid crystal and how they can be used for reflection of different colours. **7**

   c) 300 ml of a water sample was treated with 2 ml $MnSO_4$ and 2 ml alkaline KI followed by 2 ml of conc. H_2SO_4 and then titrated against N/50 sodium thiosulphate solution using starch as indicator. The readings were obtained on Day 1 and Day 5.100 ml of the sample gave the following readings :

      i) Day 1 : 35 ml of N/50 $Na_2S_2O_3$

      ii) Day 5 : 2.3 ml of N/50 $Na_2S_2O_3$

      Calculate the D.O. on day 1) and day 5). **6**

   d) Outline the instrumentation and working of a colorimeter. **5**

8. a) Describe the methods used to determine nitrate and chloride contents of water. **7**

   b) Explain how Lyotropic liquid crystals are obtained and outline the different shapes (forms) of arrangement of the mesogens before forming the liquid crystal state. **7**

   c) A sample of water is found to contain 40.5 mg/L $Ca(HCO_3)_2$, 46.5 mg/L, $Mg(HCO_3)_2$, 27.6 mg/L $MgSO_4$, 32.1 mg/L $CaSO_4$ and 22.45 mg/L $CaCl_2$. Calculate temporary and permanent hardness of water.

      Given : (Atomic weights of Ca = 40, Mg = 24, S = 32, O = 16, C = 12, Cl = 35.5, H = 1) **6**

   d) Outline the instrumentation and working of a potentiometer. **5**