

S'11: 3AN : AN206(1406)

ENGINEERING PHYSICS AND CHEMISTRY

Time : Three hours

Maximum Marks : 100

*Answer FIVE questions, taking ANY TWO from Group A,
ANY TWO from Group B and ALL from Group C.*

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be answered at one place.*

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Figures on the right-hand side margin indicate full marks.

Group A

(Engineering Physics)

1. (a) What are emission and absorption spectra and how do you obtain these ? Write the expressions for Lyman, Balmer, Paschen spectral series and mention their range of electromagnetic spectrum. 3 + 2
- (b) In radio astronomy, hydrogen atoms are observed in which, for example, radiative transitions from $n = 109$ to $n = 108$ occur. What are the frequency and wavelength of the radiation emitted in this transition ? 5
- (c) Mention the law of radioactive decay and define half-life of the radioactive decay. 5
- (d) Write in brief on nuclear fission and fusion. 5

2. (a) Write the basic idea behind Bohr's model of the atom. State the assumptions of Bohr's model. 5
- (b) State Heisenberg uncertainty principle. Determine the de Broglie wavelength of a moving golf ball of mass $m = 0.05$ kg and velocity $v = 40$ m/s. 2 + 3
- (c) What are crystalline and non-crystalline (amorphous) materials? 5
- (d) Iron at 20°C is BCC with atoms of atomic radius 0.124 nm. Calculate the lattice constant, a , for the cube edge of the iron unit cell. 5
3. (a) Calculate the atomic packing factor (APF) for the BCC unit cell, assuming the atoms to be hard spheres. 5
- (b) (i) State the principle of superposition and explain the phenomenon of interference. What do you mean by constructive and interference? 3
- (ii) What is slit spacing required to give a separation of 2 cm between the second and third-order maxima for two slits if $\lambda = 550$ nm and $D = 1.50$ m? 2
- (c) Light of wavelength 580 nm is incident on a slit having a width of 0.3 mm. The viewing screen is 2.00 m from the slit. Find the positions of the first dark fringes and the width of the central bright fringe. 5
- (d) Explain the meaning of spontaneous and stimulated emission and mention the features of these emissions. 5
4. (a) What do you mean by total internal reflection? How is this phenomenon utilized in an optical fiber? 5
- (b) Write the assumption of kinetic theory of gases. 5

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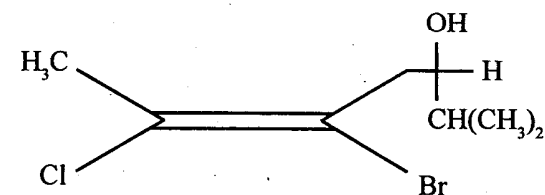
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- (c) What is meant by mechanical, thermal, chemical and thermodynamic equilibrium? State zeroth law of thermodynamics. 5
- (d) Describe p-type and n-type extrinsic semiconductors in detail. 5

Group B

(Engineering Chemistry)

5. (a) What are the causes of environmental pollution? Discuss the toxic effects of CO and cyanide pollutants. What are the sources of sulphur dioxide pollutants in air? How are they controlled? 6
- (b) A precipitate of 0.110 g of calcium oxalate was obtained from 250 ml of a water sample. Explain the calcium content (in ppm). 4
- (c) Assign E/Z and R/S configuration of the following molecule and write its IUPAC name. 4



- (d) Mention appropriate reasons for the following: 3 x 2
- (i) Van der Waal's forces of attractions are responsible for the condensation of inert gases.
- (ii) Chlorine is a diatomic molecule, while helium is a monoatomic molecule.
- (iii) At room temperature, HF is a liquid, whereas HCl, having larger molecular mass, is a gas.

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(Turn Over)

6. (a) Explain, on the basis of molecular orbital theory, about the following : 3 + 2

(i) Br_2 molecule is not stable

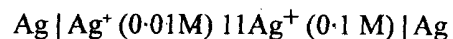
(ii) N_2 has stronger bond than B_2 .

(b) Based on metallic bond, explain why metals are (i) good conductors of electricity, and (ii) malleable and ductile? 3 + 2

(c) What is meant by the term 'temperature coefficient of a reaction'? How would you explain, on the basis of collision theory, the effect of temperature on the rate of reactions? The half life for the homogeneous gaseous reaction $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$, which obeys first order kinetics, is 8 min. How long will it take for the concentration of SO_2Cl_2 to be reduced to 1% of the initial value? 5 + 5

7. (a) What are chemical cells? Differentiate between reversible and irreversible cells. 7

(b) Find the e.m.f. of the following at 25°C : 7



(c) Give appropriate reason why solution of sodium chloride is a good conduction of electricity, but chlorine-water does not conduct electricity. 6

8. (a) What is meant by 'space lattice' of a crystal? Draw a unit cell for space lattices of face-centred cubic. 5

(b) Mention various air pollutants and describe the effects of hydrogen sulphide on environment. 5

(c) What are the important sources of water pollution? Explain the activated sludge process of treatment of wastewater. 5

(d) A first order reaction is 15% complete in 20 min. How long will it take to be 60% complete? 5

Group C

9. (A) Choose the *correct* answer for the following : 5 x 2

(i) Which one of the following is *not* evidence for the wave nature of matter?

(a) The photoelectric effect

(b) The diffraction pattern obtained when electrons pass through a slit

(c) Electron tunneling

(d) The validity of the Heisenberg uncertainty principle

(ii) A hole refers to

(a) a positively charged electron.

(b) an electron that has somehow lost its charge.

(c) a microscopic defect in a solid.

(d) the absence of an electron in an otherwise filled band.

(iii) Polarization experiments provide evidence that light is

(a) a longitudinal wave.

(b) a stream of particles.

(c) a transverse wave.

(d) some type of wave.

(iv) 1 atomic mass unit is about

- (a) 1.66×10^{-31} kg
- (b) 9.11×10^{-31} kg
- (c) 1.66×10^{-27} kg
- (d) 9.11×10^{-27} kg

(v) Photons in a laser beam have the same energy, wavelength, polarization direction, and phase because

- (a) each is produced in an emission that is stimulated by another.
- (b) all come from the same atom.
- (c) the lasing material has only two quantum states.
- (d) all photons are alike, irrespective of their source.

(B) Choose the *correct* answer for the following : 10 x 1

(i) Which one of the following does not conduct electricity ?

- (a) Molten NaCl
- (b) NaCl crystal
- (c) Solution of NaCl in water
- (d) Solution of NaCl in alcohol

(ii) For the first order reaction, half life is 14 s, the time required for the initial concentration to reduce to one-eighth of its value is

- (a) 28 s
- (b) 42 s
- (c) $(14)^3$ s
- (d) $(14)^2$ s

(iii) During electrochemical corrosion in acidic environment,

- (a) oxygen evolution occurs.
- (b) oxygen absorption occurs.
- (c) hydrogen evolution takes place.
- (d) hydrogen absorption takes place.

(iv) Which one of the following is *not* a strong electrolyte ?

- (a) AgNO_3
- (b) NaCl
- (c) NH_4OH
- (d) NaOH

(v) The molecule that has a linear structure is

- (a) CO_2
- (b) NO_2
- (c) SO_2
- (d) SiO_2

(vi) Arrange O_2 , O_2^- , O_2^{2-} , O_2^+ in order of increasing bond length.

(vii) Man dies in the atmosphere of CO, because it

- (a) dries up the blood.
- (b) combines with O_2 present in the body.
- (c) reduces the organic matter of tissues.
- (d) combines with haemoglobin of blood, thereby making the latter incapable of absorbing O_2 .

- (viii) What is the effect of using unleaded petrol in automobiles ?
- (ix) 3-ketobutene ($\text{CH}_2 = \text{CHCOCH}_3$) will exhibit one of the following absorption maxima in UV spectrum :
- (a) one
 - (b) two
 - (c) three
 - (d) four
- (x) Which one of the following can cause depletion of ozone ?
- (a) H_2s
 - (b) NO
 - (c) Smoke
 - (d) Aerosols

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Group A

(Engineering Physics)

1. (a) What are Bohr's assumptions in connection with the structure of hydrogen atom? Explain Balmer series of hydrogen spectra. 3 + 2
- (b) If value of Rydberg constant for hydrogen be 10973700 m^{-1} , find the longest wavelength of the Balmer series. 5
- (c) Write a short note on the properties of α , β and γ rays. 5
- (d) An electron has a speed of 500 m/s with an accuracy of 0.005%. Calculate the uncertainty in the position of the electron. 5

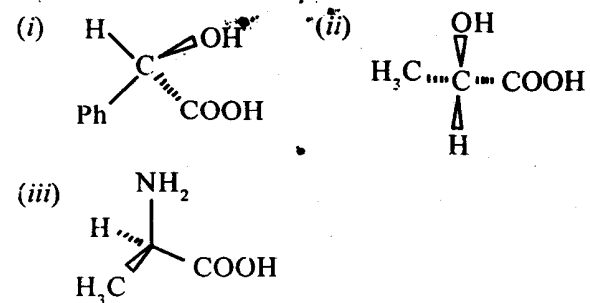
2. (a) Find the relationship between lattice parameter and atomic radius for monoatomic SC, BCC and FCC structures. 5
- (b) An atomic plane in a crystal lattice makes intercept of $6a$, $4b$ and $6c$ with the crystallographic axes, where a , b and c are the dimensions of the unit cell. Find the Miller indices of the atomic plane. 5
- (c) Find the interplanar distance of (110) plane and (111) plane of Nickel crystal. The radius of Nickel atom is 1.245 \AA . The structure of Nickel is FCC. 5
- (d) In a cubic cell, find the angle between normals to the planes (111) and (101). 5
3. (a) What is the difference between diffraction due to double slit and interference pattern due to two sources? 5
- (b) In a Newton's ring experiment, the diameter of a dark ring is 0.32 cm when the wavelength of the monochromatic light is 6000 \AA . What would be the diameter of that ring when the wavelength of light used is 5000 \AA ? 5
- (c) Write the condition for laser action. 5
- (d) Write the applications of optical fiber. 5
4. (a) State the law of equipartition of energy. Find the values of number of degrees of freedom for diatomic and polyatomic gases having $\gamma = 1.40$ and 1.33 , respectively. 2 + 3
- (b) Distinguish among metal, semiconductor and conductor with the help of band theory. 5

- (c) State Meissner effect. Distinguish between type I and type II superconductor. 2 + 3
- (d) Show that the torque exerted on a dipole \vec{p} by a uniform field \vec{E} is given by $\vec{\tau} = \vec{p} \times \vec{E}$. 5

Group B

(Engineering Chemistry)

5. (a) Describe Eajan's rule. Why is HgCl_2 colourless, whereas HgI_2 is red? What is the hybridization and geometry of NH_3 ? 3 + 3 + 2
- (b) Write the M.O. energy levels for N_2 and calculate the bond order. 4 + 2
- (c) Define lattice energy and solvation energy. Write an expression of the lattice energy. What is the value of Madelung constant and Born exponent for sodium chloride. 2 + 2 + 2
6. (a) What is rotational axis of symmetry (C_n)? How many types of rotational axis is/are present in NH_3 ? 2 + 2
- (b) Convert the flying wedge projection into Fisher projection: 3 x 2



- (c) Write the difference between Enantiomers and Diastereo isomers. 2
- (d) Why is potassium permanganate solution used as a secondary standard? What is self-indicator? Give an example. 2 + 2
- (e) Find the symmetry elements present in the following compounds: (i) H_2O , and (ii) $C_2H_2Cl_2$. 2 + 2
7. (a) Derive the rate expression for the reaction: $A + B \rightarrow \text{Product}$ and from this, calculate the expression of $t_{1/2}$. 4 + 2
- (b) State Lambert Beer's law and give the unit of molar extinction coefficient (in S.I. unit). 2 + 1
- (c) What is the significance of activation energy? Write the relation between reaction rates and temperature. 2 + 2
- (d) The half life period of a substance is 50 min at a certain concentration. When the concentration is reduced to one half of the initial concentration $t_{1/2}$ becomes 25 min. Calculate the order of the reaction. 4
- (e) What is greenhouse effect? Give an example of greenhouse gas. 2 + 1
8. (a) Give the two half cell reaction for the following reaction: 3

$$Zn + CuSO_4 \rightleftharpoons ZnSO_4 + Cu$$
- (b) Write the Nernst equation for a cell reaction (for one electron transfer) 3

$$aA + bB \rightleftharpoons cC + dD.$$
- (c) Define specific conductance and give its unit. 2 + 1

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(Continued)

- (d) Given the equivalence conductances of sodium chloride, sodium butyrate and hydrochloric acid as 127, 83, and $426 \text{ ohm}^{-1} \text{ cm}^2$ at 25°C , respectively. Calculate the equivalence conductance of butyric acid at infinite dilution. 4
- (e) Calculate the ionic mobility of the cation in 0.1 molar solution of NaCl at 25°C . Given its transference number as 0.39 and the equivalence conductance at infinite dilution as 127. 4
- (f) Give the difference between lyophilic and lyophobic solution. 3

Group C

(Engineering Physics)

9. (A) Fill in the blanks: 5 × 2
- (i) If a particle of mass ' m ' moving with a velocity ' v ', the de Broglie wavelength of that particle is _____.
- (ii) Plane of vibration is _____ to the plane of polarization.
- (iii) If the number of molecules per unit volume is N and if each has a moment p , then the polarization is equal to _____.
- (iv) Pauli's exclusion principle has been used in _____ statistics.
- (v) The relation between half-life and disintegration constant or decay constant is _____.

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(Turn Over)

(Engineering Chemistry)

(B) Fill in the blanks:

5 × 2

(i) Na(Hg)|Na^+ (C) is a _____ electrode.

(ii) Hybridization of CF_4 is _____.

(iii) The geometry of XeF_2 is _____.

(iv) Any two structures ~~superimposable~~ on each other are called _____.

(v) Benzene has _____ σ_v planes.

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Group A

(Engineering Physics)

1. (a) Write about the Bohr's fundamental postulates for explaining the spectra of hydrogen atom. 5
- (b) The energy of a particular state of an atom is 5.36 eV and the energy of another state is 3.45 eV. Find the wavelength of the light emitted when the atom makes a transition from one state to the other. Given : 5
 $h = 6.626 \times 10^{-34} \text{ JS}$; $c = 3 \times 10^8 \text{ ms}^{-1}$
 $\text{eV} = 1.602 \times 10^{-19} \text{ J}$.

- (c) Write about the properties of α , β and γ rays. 5
- (d) In a thermonuclear reaction, 1.0×10^{-3} kg hydrogen is converted into 0.993×10^{-3} kg helium. Calculate the energy released in joules. Given: $c = 3 \times 10^8 \text{ ms}^{-1}$. 5
2. (a) Explain the differences between ionic, covalent and metallic bonding in solids. 5
- (b) Distinguish between conductors, semiconductors and insulators. 5
- (c) The transition temperature for lead is 7.2 K. However, at 5 K it loses the superconductor property subjected to a magnetic field of 3.3×10^4 A/m. Find the critical magnetic field at 0 K. 5
- (d) Define polarisation in a dielectric. Write about different types of polarisations in solids. 5
3. (a) What are postulates of kinetic theory of gases? Explain. 5
- (b) The r.m.s. velocity of the molecules of a gas at 15°C is $1.8 \times 10^3 \text{ ms}^{-1}$. What will be the r.m.s. velocity at 119°C . 5
- (c) Write about differences between Fresnel and Fraunhofer diffraction. 5
- (d) Explain the principle of the optical fiber as a waveguide for light. 5
4. (a) Draw the unit cell diagram and classify seven crystal systems based on a , b , c and α , β and γ , where the symbols carry usual meanings. 5

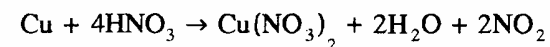
- (b) Write about symmetry elements in a cubic crystal. 5
- (c) Calculate the interplanar spacing for (321) plane in a simple cubic lattice where lattice constant is 4.2×10^{-10} m. 5
- (d) What is piezoelectric effect? Explain. 5

Group B

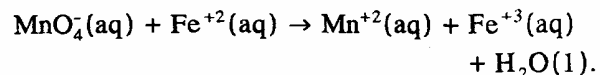
(Engineering Chemistry)

(Data given: $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$, $F = 96,500 \text{ C mol}^{-1}$)

5. (a) Make the distinction between the following:
(i) Galvanic and electrolytic cell, (ii) Frankel and Schottky defects, (iii) Lambert's and Beer's law, and (iv) physical adsorption and chemisorptions. 2×4
- (b) What are the sources of sulphur dioxide pollutants in air? How are they controlled? 4
- (c) If a reaction following first order kinetics undergoes 50% of its decomposition in 69.3 min, how long will it take to 90% of this compound to undergo decomposition? 4
- (d) What are the basic rules for writing the resonance structure of a compound? Write down the resonance structure of CO_3^{2-} . 4
6. (a) Write the rate of reaction in terms of rate of disappearance of the reactants and formation of products for the reaction: 5



(b) Balance the following equation taking place in an acidic medium using half reaction method :



6

(c) What is meant by optical activity and how is it measured ?

5

(d) Arrange the molecular orbitals formed by the overlapping of atomic orbitals in order of increasing energies (up to second shell). Write the molecular orbital structure of N_2 .

4

7. (a) What is Fagan's rule ? Based on this concept , explain how the formation of covalent bond depends on the size of cation and size of anion.

6

(b) Write a short note on intermolecular forces.

4

(c) For the cell at 298 K: $\text{Zn}(\text{s})|\text{Zn}^{+2}(a=0.01)||\text{Fe}^{+2}(a=0.001)|\text{Fe}(\text{s})$.

(i) What are anode reaction, cathode reaction and overall reaction taking place in the cell ?

(ii) If $E^0(\text{Zn}^{+2}/\text{Zn})$ and $E^0(\text{Fe}^{+2}/\text{Fe}) = -0.763 \text{ V}$ and $= -0.44 \text{ V}$, respectively, what is the e.m.f. of the cell ?

6

(d) Write the structure of the following:

(i) Dimethyl ether, and (ii) 2-hydroxypropanoic acid.

4

3. (a) What is close packing of spheres? Explain the formation of tetrahedral and octahedral holes based on this.

4

(b) Explain the mechanism of rusting of iron.

4

(c) Describe the Arc method and double decomposition method for preparation of colloidal solutions.

6

(d) What is the difference between the geometrical and optical isomerism? Discuss this for 1,2 dichloroethene, 2-butene and lactic acid based on which type of isomerism they belong to.

6

Group C

9. (A) Fill in the blanks :

1 × 10

(i) The radius of the first orbit in hydrogen atom is _____.

(ii) In nuclear reactions, we have conservation of _____ and _____ and _____.

(iii) In atom bomb, we use the process called _____.

(iv) The approximate energy band gap in silicon at room temperature is _____ eV.

(v) If a ferroelectric curie temperature is heated to a temperature more than curie temperature, it becomes _____.

(vi) When white light is incident on a diffraction grating, the visible light, that is, most deviated is _____.

- (vii) If a superconductor is heated to a temperature more than ———, then its superconductivity is ———.
- (viii) The transverse nature of light can be demonstrated by observing the phenomenon of ———.
- (ix) The atoms in the amorphous material have ——— range order.
- (x) The number of Bravais space lattices are ——— in number.

(B) Fill in the blanks : 2 × 5

- (i) The strongest hydrogen bond is formed between H and ——— atoms.
- (ii) The electrode at which reduction occurs is called ———.
- (iii) The rate of reaction measured for an infinitesimally small interval of time is called the ———.
- (iv) The enantiomer which rotates the plane polarized light in an anti-clockwise direction is called ———.
- (v) As_2S_3 solution is ——— charged.

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Group A

(Engineering Physics)

1. (a) What is Rutherford's nuclear atomic model? Explain.
In Rutherford scattering experiment, the number of particles observed at an angle of 10° is one million per minute. How many particles per minute will be observed at 90° ? ($\sin 5^\circ = 0.0872$.) 3 + 2
- (b) What are the assumptions of Bohr's theory hydrogen atom? Derive expressions for (i) radius of the orbit, and (ii) velocity of revolving electron.

(Turn Over)

Calculate the radius of the Bohr orbit in the ground state and velocity of electron in the ground state
 $e = 1.6 \times 10^{-19}$ coulomb; $m = 9.1 \times 10^{-31}$ kg,
 $h = 6.6 \times 10^{-34}$ J-sec; $c = 3 \times 10^8$ m/sec
 $\epsilon_0 = 8.86 \times 10^{-12}$ coul²/nt -m². 4 + 1

(c) What are shortcomings of Bohr's theory of hydrogen atom? 5

(d) What is Planck's quantum theory of radiation? Explain. 5

2. (a) Distinguish between properties of solids with ionic, covalent and metallic bonds. 5

(b) Based on band theory and of solids, distinguish between conductors, semiconductors and insulators. Give examples for (i) best two metals at room temperature with lowest resistances, (ii) direct and indirect band gap semiconductors, and (iii) two insulators. 5

(c) What are superconductors? Explain. Mention the name of superconductor which has critical temperature more than 90°. 5

(d) Define polarisation? Write about types of polarisations in solids. A parallel plate capacitor has circular plates of radius 8 cm and plate separation 1 mm. The dielectric medium with relative permittivity of 4.5 is inserted between the plates. Find the capacitance. $\epsilon_0 = 8.86 \times 10^{-12}$ coul²/nt -m². 5

3. (a) Explain on the following: (i) Average velocity, (ii) root mean square velocity, and (iii) most probable velocity of gas molecules. 5

(b) Determine average value of kinetic energy of molecules of an ideal gas at 273 K and at 373 K. What is the kinetic energy per mole of an ideal gas at these temperatures? $K = 1.38 \times 10^{-23}$ J/K. 5

(c) Explain how Newton's rings are formed. In Newton's rings experiment, the diameters of 4th and 12th dark ring are 0.400 cm and 0.700 cm, respectively. Find the diameter of the 20th dark ring. 5

(d) What do you understand by diffraction of light? Distinguish clearly between interference and diffraction of light. 5

4. (a) What is lattice translation operator? Draw the unit cell figure and indicate a , b , c , α , β , γ and classify seven crystal systems. Also, draw the unit cell diagram of NaCl and explain its structure. 5

(b) What are Miller indices of crystalline planes? Explain. Draw (100), (110) and (111) planes in cubic crystalline systems. 5

(c) What is Bragg's law of X-ray diffraction? Explain how you will find crystal structure of a cubic system using powder method of X-ray diffraction. 5

(d) Calculate the planar density of (fcc) Nickel in (100) plane. The radius of Nickel atom is 1.245 Å. 5

Group B

(Engineering Chemistry)

5. (a) Distinguish between the properties of BaCl_2 and CCl_4 in terms of (i) melting point, (ii) boiling point, (iii) equivalent conductance at melting point (at room temperature), (iv) solubility in water (at room temperature), and (v) solubility in ether (at room temperature). 5
- (b) For N_2 molecule, (i) write its molecular orbital configuration, (ii) find out bond order, and (iii) comment on its metallic character. 5
- (c) What are the different methods through which solutions can be prepared? Explain why solutions (not true solutions) exhibit Tyndall effect. 5
- (d) Explain (i) optically active substances, (ii) Lambert Beer's law, (iii) activation energy, (iv) emulsion, and (v) adsorption isotherm. 5
6. (a) What are theories which have been forwarded to explain the metallic bonding. 5
- (b) Differentiate between the primary and secondary pollutants. 4
- (c) Define the following terms while illustrating one example for each type: (i) Optical isomerism, (ii) structural isomerism, and (iii) stereo isomerism. 6

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(Continued)

- (d) For the reaction, $2\text{Fe}^{3+} + 2\text{I}^- \rightleftharpoons 2\text{Fe}^{2+} + \text{I}_2$, taking place at 298 K, find out the equilibrium constant. [Given that : $E^0(\text{Fe}^{3+}/\text{Fe}^{2+}) = 0.771 \text{ V}$; $E^0(\text{I}_2/\text{I}^-) = 0.536 \text{ V}$. (Data provided : $F = 96,500 \text{ C mol}^{-1}$, $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$). 5
7. (a) What is corrosion? Explain the cathodic protection and galvanization methods used for prevention of the corrosion. 5
- (b) Explain (i) order of a reaction, (ii) resonance, (iii) catalyst, (iv) optical density (v) photochemical reactions, and (vi) full name of EDTA. 1×6
- (c) How is ozone formed in the atmosphere? What are the causes of depletion of ozone layer? What are the harmful effects of depletion of the ozone layer? 5
- (d) A compound is made up of elements A and B crystallizing in the cubic structure. The atoms A are located at the corners of a cube, whereas atoms B are present at the centre of each face of the cube. What is the formula of the compound? 4
8. (a) State Fagan's rule. What is its significance? 5
- (b) Write a note on ion exchange catalysis. 5
- (c) Describe schematically the functioning of a galvanic cell. Also, write the cell reaction for this. 5
- (d) The rate constant of a second order $2A \rightarrow \text{Product}$ is $0.05 \text{ mol}^{-1} \text{ dm}^3 \text{ min}^{-1}$. What is the half life, if the initial concentration is $0.005 \text{ mol dm}^{-3}$. 5

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(Turn Over)

Group C

9. (A) Write *true* or *false* in respect of the following statements : 1 × 10

- (i) A fiber communication has large bandwidth, the system is capable of handling a large number of channels. Hence, found wide applications in communication.
- (ii) For re-construction of image from the hologram, a laser beam of lower wavelength (compared to the wavelength of laser used during formation of hologram) is used.
- (iii) In double refraction due to biaxial crystals, the ordinary ray and extraordinary rays travel with different speeds along each one of the axis.
- (iv) One gram of radioactive material, having a half period of two years, is kept in store for a duration of four years. 0.25 gm of the material remains unchanged.
- (v) Nuclear fusion reactions takes place at high temperature because kinetic energy is high enough to overcome repulsion between nuclei.
- (vi) The resistivity of intrinsic semiconductor increases linearly with increase in temperature.

(vii) When an electric field, E_0 , is applied to a parallel plate capacitor and a dielectric material is introduced between two plates, the electric field within the dielectric is greater than E_0 .

(viii) The ionic solids have very high electrical and thermal conductivities.

(ix) The Maxwell-Boltzman's statistics fails to explain the phenomena like black body radiation, specific heat of solids at low temperatures, photoelectric effect, etc.

(x) Amorphous solids have long range order of periodicity of lattice.

(B) Fill-in the blanks : 2 × 5

(i) The migration of colloidal particles, under the electric fields, towards the electrodes is called

(ii) The oxidation half reaction involves of electron(s).

(iii) IUPAC name of the $\text{CH}_3 - \text{CH}(\text{CH}_3) - \text{CH}_2 - \text{CH}_3$ is

(iv) A cell, in which an electric current is used to cause the chemical change, is called electrochemical cell.

(v) In paper chromatography, mobile phase is

W'08 : 3 AN : AN 206 (1406)

ENGINEERING PHYSICS AND CHEMISTRY

Time : Three hours

Maximum Marks : 100

*Answer FIVE questions, taking ANY TWO from Group A,
ANY TWO from Group B and ALL from Group C.*

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Group A

(Engineering Physics)

1. (a) Write about Rutherford's experiment on α particles scattering. 5
- (b) What are the drawbacks of Rutherford's nuclear atom model? 5
- (c) What are spectral series of hydrogen atom? 5
- (d) How many photons of red light ($\lambda = 6 \times 10^{-7} \text{ m}$) have the same energy as one photon of γ -rays ($\lambda = 1.6 \times 10^{-13} \text{ m}$)? 5

2. (a) Write about ionic, covalent and metal crystals. 5
 (b) What are piezoelectric materials? Explain. 5
 (c) Write about ferroelectrics. Explain the structure of barium titanate. 5
 (d) Discuss about the applications of superconductors. 5
3. (a) What are important assumptions/postulates of kinetic theory of gases? 5
 (b) The rms velocities of the molecules of a gas at 15°C is 1.8×10^3 m/s. What will be the rms velocity at 119°C? 5
 (c) What is double refraction of light? Explain in detail about Nicol prism. 10
4. (a) Classify crystal systems and write about Miller indices in crystalline planes. 5
 (b) Draw (100) (110) and (111) planes in cubic crystalline systems. 5
 (c) Explain how structure of a cubic crystal can be determined by X-ray diffraction method. 5
 (d) Lead is a face centered cubic with an atomic radius of 0.1746×10^{-9} m. Find the spacing of (200) planes. 5

Group B

(Engineering Chemistry)

5. (a) Predict the type of hybridisation and geometry (shape) of the following: (i) XeO_3 , (ii) NH_3 , (iii) H_2O , (iv) PCl_5 , and (v) SO_2 . 5

(b) Give reasons in brief:

(i) Aqueous solution of sodium chloride is a good conduction of electricity, but chlorine-water does not conduct electricity. 3

(ii) Chlorine has a diatomic molecules, while helium is a monoatomic molecules. 2

(c) What is the ion-exchange process? What are the advantages of this method over other methods? 5

(d) A metal has a fcc crystal structure. The length of the unit cell is 404 pm. What is the molar mass of metal atoms, if the density of the metal is 2.72 g cm^{-3} . [$N_0 = 6.023 \times 10^{23} \text{ atoms mol}^{-1}$]? 5

6. (a) Write the structural formula of the following: 1 x 5

(i) 1-chloro-2-pentanone

(ii) Methyl-4-oxohexanoate

(iii) 5-Methyl-3-hexen-2-ol

(iv) Methanoic acid

(v) 4-Penten-2-one.

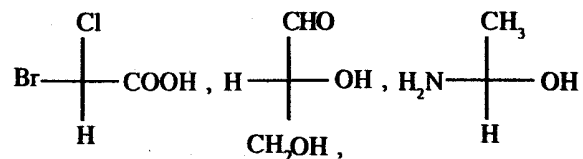
(b) What are chemical cells? Differentiate between reversible and irreversible cells. 5

(c) What is the potential of a half-cell consisting of zinc electrode in 0.01 M ZnSO_4 solution at 25°C? $E^\circ = 0.763 \text{ V}$. 5

(d) Explain the source and harmful effect of the following air pollutants : (i) CO, and (ii) SO₂. 5

7. (a) The half life period of first order reaction is 60 min. Calculate the time for 87.5% completion of the reaction. 5

(b) (i) Assign R/S configuration to the following compounds : 3



(ii) State necessary conditions for a compound to show optical isomerism. Illustrate your answer with examples. 2

(c) Discuss calomel electrode. How is the pH of a solution determined using glass electrode? 5

(d) Differentiate between chemical and electrochemical corrosion with suitable examples. 5

8. (a) Define the term chromatography. What is the principle of gas chromatography? Mention important applications of gas chromatography. 5

(b) What are chromophores? Name some chromophores and explain how you can identify a particular chromophore in a compound. 5

(c) What are the main characteristics of colloidal system and what are their industrial importance? 5

(d) Explain the following on the basis of molecular orbital theory : 5

(i) Br₂ molecule is not stable

(ii) N₂ has a stronger bond than B₂.

Group C

9. (A) Write *true* or *false* in respect of the following statements : 1 × 10

(i) The step index fibers are used only for short distance communication.

(ii) For reconstruction of image from hologram, the laser beam identical to reference laser is used.

(iii) If ferroelectric materials are heated more than critical temperature, they are converted to paraelectric materials.

(iv) Beta rays, emitted by radioactive substances, is an electron emitted by the nucleus as a result of decay of a neutron inside the nucleus.

(v) The high T_C superconductors have critical temperature less than the liquid nitrogen temperature.

(vi) The step index fibers are used for long distance communication.

(vii) For a reconstruction of image from hologram, the laser beam identical to reference laser is not required.

(viii) Dielectric materials acquire polarisation when they are placed in externally applied electric field.

(ix) Alpha rays emitted from a radioactive substance are uncharged particles.

(x) The law of equipartition of energy was postulated by Boltzman.

(B) Write the *correct* answer for the following : 1×10

(i) Specific conductance is the conductance of solution of volume

(a) 1 cm^3

(b) 10 cm^3

(c) 100 cm^3

(d) 1000 cm^3 .

(ii) Corrosion is an example of

(a) oxidation

(b) reduction

(c) electrolysis

(d) erosion.

(iii) Bond orders of N_2 , N_2^+ and N_2^{2-} are in the order

(a) $\text{N}_2^{2-} > \text{N}_2^+ > \text{N}_2$

(b) $\text{N}_2^{2-} > \text{N}_2 > \text{N}_2^+$

(c) $\text{N}_2^+ > \text{N}_2 > \text{N}_2^{2-}$

(d) $\text{N}_2 > \text{N}_2^+ > \text{N}_2^{2-}$.

(iv) Aerobic oxidation takes place in

(a) stale sewage

(b) septic sewage

(c) both of the above

(d) None of the above.

(v) Damage to blood is caused by

(a) Ca

(b) Mg

(c) As

(d) Pb.

(vi) Which one of the following does not represent Arrhenius equation ?

(a) $k = Ae^{-E/RT}$

(b) $\log_e k = \log_e A - E/RT$

(c) $\log_{10} k = \log_{10} A - (E/2.303 RT)$

(d) $k = AE^{E/RT}$.

(vii) Which one of the following techniques is used to detect the steroid consumed by the athletes in international sports competitions :

(a) IR spectroscopy

(b) Gas chromatography

(c) UV spectroscopy

(d) pH measurement .

(viii) The atomic radius for bcc crystal lattice with lattice constant a is

(a) $a/2$

(b) $a\sqrt{3}/4$

(c) a

(d) $a\sqrt{2}/4$.

(ix) Which one of the following is used as external indicator in titration of ferrous ammonium sulphate and $K_2Cr_2O_7$?

(a) $K_4Fe(CN)_6$

(b) $K_3Fe(CN)_6$

(c) N-phenyl anthranilic acid

(d) Starch .

(x) A chemical, which can simultaneously acts as coagulant and softening agent, is

(a) alum .

(b) soda

(c) sodium aluminate

(d) lime .



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ENGINEERING PHYSICS AND CHEMISTRY

Time : Three hours

Maximum Marks : 100

*Answer FIVE questions, taking ANY TWO from Group A,
ANY TWO from Group B and ALL from Group C.*

*All parts of a question (a, b, etc.) should
be answered at one place.*

*Answer should be brief and to-the-point and be supplemented
with neat sketches. Unnecessary long answer may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks.

Important Data

Atomic number : N = 8 ; Atomic weight : C = 12 , O = 16 , S = 32,

R = $8.314 \text{ JK}^{-1} \text{ mol}^{-1}$; $2 \text{ calK}^{-1} \text{ mol}^{-1}$; $h = 6.625 \times 10^{-34} \text{ Js}$;

Velocity of light = $3 \times 10^8 \text{ m sec}^{-1}$;

Charge of an electron = $1.602 \times 10^{-19} \text{ C}$; Mass of an

electron = $9.11 \times 10^{-31} \text{ kg}$; $J = \text{kg m}^2 \text{ sec}^{-2}$;

At 25°C , $(2.303 RT) / F = 0.059$

Group A

(Engineering Physics)

1. Differentiate clearly between the following : 5 x 4

(a) Amorphous and crystalline materials

- (b) Piezo, pyro and ferroelectric materials.
- (c) Wave function and square of the wave function.
- (d) Semiconductors, insulators and superconductors.
2. (a) Draw schematic diagram of Michelson interferometer and explain its working. 5
- (b) Define average velocity, root mean square velocity and most probable velocity of gases. Calculate the most probable velocity of CO_2 at 300 K. 3 + 2
- (c) What are the important applications of adsorption phenomena? 5
- (d) How many α and β particles will be emitted in transformation of ${}^{232}_{90}\text{Ra}$ to most stable isotope of lead, ${}^{208}_{82}\text{Pb}$? 3 + 2
3. (a) Show schematically that there are three rectangular and six diagonal plane of symmetry in the cubic crystal. 2 + 3
- (b) Calculate the deBroglie wavelength of an electron moving with a velocity of $5.90 \times 10^7 \text{ m sec}^{-1}$. 5
- (c) What is hydrogen bonding? How the intermolecular and intramolecular hydrogen bonding does influences physical properties of the compounds. 2 + 3
- (d) Write down the Schrodinger wave equation and explain the terms involved in it. 5

4. (a) What is kinetic gas equation and what are the assumptions involved in the kinetic theory of gases? Deduce the Boyles' law and Charles' law based on this equation. 1 + 2 + 2
- (b) Justify that the number of atoms per unit cell in simple cubic, bcc and fcc are 1, 2, and 4, respectively. 1 + 2 + 2
- (c) The half life of a radioactive element is 6.93 h. How long 10 mg/litre of this nuclide will take to reduce its concentration to 0.1 mg/litre? 5
- (d) Draw a schematic diagram of a nuclear reactor and explain the function of ${}^{235}_{92}\text{U}$, cadmium rods and graphite rods in this reactor? 2 + 1 + 1 + 1

Group B

(Engineering Chemistry)

5. (a) What are salient features for the orbital hybridization? Discuss sp , sp^2 and sp^3 hybridisation by giving one example of each. 2 + 3
- (b) Explain the theory and working of paper chromatography. 2 + 3
- (c) Write a short note on galvanic corrosion. 5
- (d) A solution, when placed in a cell of thickness of 2.5 cm, shows 10% transmittance. Find out its concentration (mol dm^{-3}), if the molar absorption coefficient is $10,000 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$. 5

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(Turn Over)

6. (a) Deduce the first order rate equation for a reaction $A \rightarrow P$, if a is initial concentration at $t = 0$ and x , the amount of A decomposed in time $t = t$. Show that the half life of a first order in reaction is independent of initial concentration of the reactant. 3 + 2

(b) Write down the electronic configuration of N_2 molecule. What is its bond order and magnetic character? 3 + 1 + 1

(c) Describe in details about the gaseous air pollutants and particulate air pollutants. 5

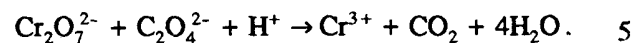
(d) Nickel crystallizes in a face centered cubic lattice. The edge of the unit cell is 3.5 \AA . The atomic weight of the nickel is 58.7 and its density is 8.94 g.cm^{-3} . Calculate the Avogadro's number. 5

7. (a) Distinguish clearly between physical adsorption and chemisorption. 5

(b) For a cell :

$Zn(s) | Zn^{2+} (0.4 M) || Cu^{2+} (0.04 M) | Cu(s)$ at $25^\circ C$, (i) write down the cell reactions, (ii) calculate the e.m.f. of the cell (given that $E^\circ_{Zn^{2+}/Zn} = -0.76 V$, $E^\circ_{Cu^{2+}/Cu} = 0.34 V$). 5

(c) Balance the following equation by half reaction method while mentioning each step for this :



(d) Describe the general method of preparation of solutions. 5

8. (a) Write the structural formula of the following :
(i) Butanoic acid, (ii) 3-Bromopentanal,
(iii) 1-Bromobutane, (iv) 2-Bromo-3-chloro butane, (v) Butan-2-one. 5

(b) What is optical isomerism? Discuss this with respect to the lactic acid and tartaric acid. 2 + 3

(c) Define the following terms: (i) Colloids, (ii) Emulsions, (iii) Peptisation, (iv) Gold number, (v) Electro-osmosis. 1 + 1 + 1 + 1 + 1

(d) How would you analyze nitrogen oxides present in air? Also, write the necessary chemical reactions involved. 2 + 3

Group C

9. (A) Fill in the blanks : 1 x 10

(i) According to Bravais, there are ——— different ways in which similar points can be arranged in three - dimensional space.

(ii) The kinetic energy of one mole of an ideal gas (monoatomic) at 300 K is ——— calories.

(iii) A catalyst does not shift the position of ——— of a reaction.

(iv) Smoke is a dispersion of ——— in ———.

(v) Sigma bond is formed by ——— overlap of atomic orbitals.

(vi) For a cell reaction to occur spontaneously, the e.m.f. of the cell should be ———.

(vii) The ozone layer filters the incoming ——— radiations and affords our natural protection.

(viii) The full form of LASER is ———.

(ix) The Michelson interferometer represents a device that takes advantage of the ——— nature of light.

(x) The oxidation number of Cr in $K_2Cr_2O_7$ is ———.

(B) Choose the *correct* answer of the following : 1×10

(i) Which of the following indicator is used in the titration involving $KMnO_4$?

- (a) Methyl red
- (b) Methyl orange
- (c) Phenolphthalein
- (d) Starch.

(ii) The frequency of a wave of light is $5 \times 10^{18} \text{ sec}^{-1}$. The wavelength associated with this light is

- (a) $6 \times 10^{-5} \text{ m}$
- (b) $6 \times 10^{-4} \text{ m}$
- (c) $6 \times 10^{-6} \text{ m}$
- (d) $6 \times 10^{-7} \text{ m}$.

(iii) Tyndall effect is not observed in

- (a) true solution
- (b) colloidal solutions
- (c) emulsion
- (d) suspensions.

(iv) Which of the following molecule has a high dipole moment?

- (a) H_2S
- (b) CCl_4
- (c) CO_2
- (d) BF_3 .

(v) In a galvanic cell, chemical energy is converted into

- (a) mechanical energy
- (b) electrical energy
- (c) thermal energy
- (d) surface energy.

(vi) Which of the following defects lowers the density of the solid?

- (a) Frenkel defect
- (b) Schottky defect
- (c) Metal excess defect
- (d) Interstitial defect.

(vii) Which of the following compound is optically active ?

- (a) 2-Chloro butane
- (b) 1-propanol
- (c) Isopropyl alcohol
- (d) 2-Methyl propan-2-ol.

(viii) In the standard hydrogen electrode, concentration of acid is

- (a) 1 M
- (b) 0.1 M
- (c) 0.001
- (d) 0.001 M.

(ix) Which of the following is correct ?

- (a) $k = A \exp (E_a / RT)$
- (b) $k = A \exp (- E_a / RT)$
- (c) $k = A \exp (- E_a / R)$
- (d) $k = A \exp (- E_a / RT^2)$

(x) EDTA is an example of

- (a) bidentate ligand
- (b) tridentate ligand
- (c) tetradentate ligand
- (d) hexadentate ligand.

W'07 : 3 AN : AN 206 (1406)

ENGINEERING PHYSICS AND CHEMISTRY

Time : Three hours

Maximum Marks : 100

*Answer FIVE questions, taking ANY TWO from Group A ,
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with neat sketches. Unnecessary long answers may
result in loss of marks.*

*Any missing or wrong data may be assumed suitably giving
proper justification.*

Figures on the right-hand side margin indicate full marks .

Group A

(Engineering Physics)

1. (a) State Bohr's fundamental postulates to explain the spectra of hydrogen atom. Find the expression for energy levels for the same atom. 5
- (b) Derive Bohr's quantum condition from de Broglie's hypothesis. 5
- (c) What are the laws of radioactive disintegration? 5
- (d) Write about the types of nuclear reactions. 5

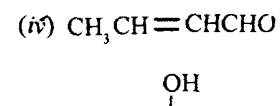
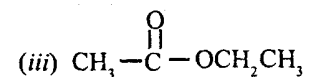
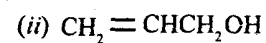
2. (a) In crystals, there is attractive interaction of one kind or the other which is quite appreciable for nearest neighbours. Explain why they do not collapse? 5
- (b) Classify the materials used in conductors, semiconductors, and insulators. 5
- (c) What is superconductor? Write about critical temperature, t_c , critical magnetic field strength, H_c , and Meissner effect. 5
- (d) Write about the types of dielectric polarisations. 5
3. (a) Write about different types of velocities with which gas molecules are associated. 5
- (b) Find the rms velocity of hydrogen molecules at 0°C . Given that the molecular mass of hydrogen is $2 \times 10^{-3} \text{ kg}$ and molar gas constant is $8.3 \text{ J mol}^{-1} \text{ K}^{-1}$. 5
- (c) How will you use Michelson's interferometer to determine the thickness of a thin transparent film or plate? 5
- (d) What is diffraction grating? Derive an expression for resolving power of a grating. 5
4. (a) Write differences between crystalline and amorphous materials. Classify seven crystal systems. 5
- (b) Point out symmetry operations in cubic crystalline system. 5
- (c) What are Bravais lattices in crystalline systems? Draw diagrams of Bravais lattices in cubic crystals and indicate important directions in cubic crystals. 5

- (d) A certain orthorhombic crystal has a ratio of $a : b : c$ of $0.429 : 1 : 0.377$. Find the Miller indices of the face whose intercepts are $0.214 : 1 : 0.183$. 5

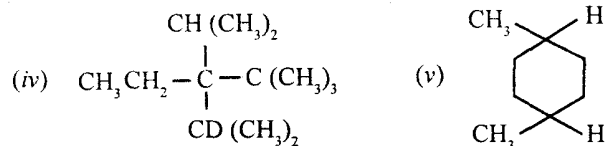
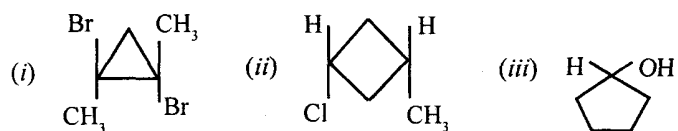
Group B

(Engineering Chemistry)

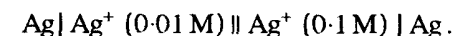
5. (a) Define covalent and electrovalent bond. Explain the formation of 'dative bond', giving examples. 5
- (b) Determine the interplanar spacing between the (220) planes of a cubic lattices of length 450 pm. 5
- (c) State and explain Beer's law. Mention important applications of UV spectroscopy. 5
- (d) What are the major gases responsible for causing greenhouse effect and how are they released into the atmosphere? 5
6. (a) What are lyophobic and lyophilic sols? What are the differences between gels and emulsions? 5
- (b) How is quinhydrone electrode represented? Write the electrode reaction. 5
- (c) Write the IUPAC name for each of the following compounds: 5



- (d) Draw all possible stereoisomers of 4-bromo-4-hexen-3-ol and assign R/S and E/Z configurations. 5
7. (a) What is meant by 'space lattice' of a crystal? Draw a unit cell for space lattices of face-centred cubic. 5
- (b) Mention the various air pollutants and describe the effects of hydrogen sulphide on environment. 5
- (c) What are the important sources of water pollution? Explain the activated sludge process of treatment of waste water. 5
- (d) A first order reaction is 15% complete in 20 min. How long will it take to be 60% complete? 5
8. (a) What are chemical cells? Differentiate between reversible and irreversible cells. 5
- (b) Label the following molecules as chiral or achiral: 5



- (c) Find the e. m. f. of the following at 25°C: 5



- (d) Give reasons for the following in brief: 5

(i) Aqueous solution of sodium chloride is a good conduction of electricity, but chlorine-water does not conduct electricity.

(ii) Chlorine has a diatomic molecule while helium is a monoatomic molecule.

Group C

9. (A) Fill in the blanks: 1 x 10

(i) The experiment, which proves positive charge of the atom, is concentrated within a nucleus of size 10^{-12} cm can approximately is _____.

(ii) No two electrons will have all the four quantum numbers equal. This statement is known as _____.

(iii) If the temperature of the metal increases, its resistance _____.

(iv) If the temperature of superconductor is more than _____, its superconductivity is lost.

(v) The ratio of number of Helium and Neon atoms in the He-Ne laser source is _____.

(vi) Bohr postulated in his model quantisation of _____.

(vii) Lines of Balmer series are emitted by the hydrogen atom when the electron jumps from _____.

(viii) If the semiconductor temperature is increased, its resistance _____.

(ix) If the externally applied magnetic field strength on superconductor is increased more than _____ its superconductivity is lost.

(x) In Ruby laser, the active material is _____ and its outcoming wavelength is _____.

(B) Choose the *correct* answer for the following: 1×10

(i) The presence of which of the following gases in air checks the ultraviolet light from sunlight

(a) SO_2

(b) CO_2

(c) NO

(d) O_3

(ii) Crystalline solids are

(a) supercooled liquids

(b) isotropic

(c) anisotropic

(d) not sharp melting.

(iii) Conductivity of a solution is directly proportional to

(a) dilution

(b) number of ions

(c) current density

(d) volume of the solution.

(iv) The specific conductance of an electrolyte solution on dilution

(a) decreases

(b) increases

(c) remains unchanged

(d) first increases and then decreases.

(v) Corrosion in essence is a process of

(a) reduction

(b) oxidation

(c) electrolysis

(d) extraction of metals.

(vi) Which of the following produces another air pollutant by reacting with oxides of nitrogen in presence of sunlight?

(a) HCl

(b) SO_2

(c) O_3

(d) HCN gas.

- (vii) Which of the following indicator used in the titration of Ca^{2+} and EDTA ?
- (a) Eriochrome black-T
 - (b) Starch
 - (c) Phenolphthalein
 - (d) Methyl blue
- (viii) The second order rate constant is usually expressed as
- (a) mol.lit.sec
 - (b) $\text{mol}^{-1} \cdot \text{lit}^{-1} \cdot \text{sec}^{-1}$
 - (c) $\text{mol} \cdot \text{lit}^{-1} \cdot \text{sec}^{-1}$
 - (d) $\text{mol}^{-1} \cdot \text{lit} \cdot \text{sec}^{-1}$
- (ix) Which of the following methods employs ion-selective membranes ?
- (a) Reverse osmosis
 - (b) Electrodialysis
 - (c) Superfiltration
 - (d) Flash evaporator.
- (x) Colloidal conditioning of boiler is done by using
- (a) calgon
 - (b) EDTA
 - (c) ion-exchangers
 - (d) lignin.