B.Tech-1st(A,B,C,K,L,M,N)

Chemistry

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer **all** questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

Any supplementary materials to be provided

1. Answer *all* questions : 2×5

(*a*) What do you understand by the isoelectronic species ? Explain the variation in the size of isoelectronic species.

(*b*) Calculate the free energy change when 4 moles of an ideal gas expands from a pressure of 10 to 1 atm at 25°C.

(*c*) For a solution of camphor in hexane in a 5-cm cell, the absorbance A was found to be 2.59 at 295 nm with $\varepsilon_{max} = 16$. What is the concentration of camphor ?

(*d*) "The chair conformation of cyclohexane is more stable than the of boat conformation" State true or false and justify.

(*e*) How can you form a free redical ? Why triphenylmethyl free radical is most stable ?

2. (*a*) What are the differences between atomic radius and van der Waals radius. How does atomic radius vary in a group and in a period ? 4

(*b*) Mention the general outer electronic configuration of d and f block elements. Explain the general properties of elements belonging to these groups. 4

Or

(*a*) How does ionisation enthalpy vary in a period and in a group ? Explain why the first ionisation enthalpy of potassium is lower than that of calcium but its second ionisation enthalpy is higher than that of calcium. 4

(*b*) What is the difference between the terms electron gain enthalpy and electronegativity. Explain the periodic trends of electronegativity in the periodic table. 4

3. (*a*) What is the physical significance of Van't Hoff isotherm ? Derive an expression for the Van't Hoff reaction isotherm of the general reaction $aA + bB \rightarrow cC + dD$ 4

(*b*) At NTP, 2.8 L of oxygen were mixed with 19.6 L of hydrogen. Calculate the increase in entropy, assuming ideal gas behavior. 4

Or

(*a*) Derive Integrated form of Claypeyron-Clausius equation for liquid-vapor equilibrium. Why the slope of melting curve in phase diagram is negative for water ? Justify. 4

(*b*) Calculate the total entropy change when 5 moles of ice at 0°C and 1 atm is converted into steam at 100°C. The molar heat of fusion of ice and molar heat of vaporisation of water are 1440 and 9720 cal mol^{-1}. The molar heat capacity of water over this temperature range may be taken equal to 18 cal mol^{-1}. 4

4. (*a*) Calculate the theoretical number of vibrational degrees of freedom in
(*i*) Carbon monoxide
(*ii*) Benzene
(*iii*) Water
(*iv*) N_2O 4

(*b*) The internuclear distance (bond length) of carbon monoxide molecule is 1.13 Å. Calculate the energy (in joules and eV) of this molecule in the first excited rotational level. Also calculate the angular velocity of the molecule. Given atomic masses of $^{12}C = 1.99 \times 10^{-26}$ kg; $^{16}O = 2.66 \times 10^{-26}$ kg. 4

Or

(*a*) (*i*) Explain why an aldehyde absorbs at a higher wave number than its corresponding methylketone due to their >C = 0 vibrations.

(*ii*) Explain Hyperchromic shift with respect to UV-visible spectroscopy. 4

(*b*) Calculate the vibrational absorption frequency of the carbonyl (>C=O) group, if the force constant for the double bond is 1×10^6 dynes cm^{-1}. 4

5. (*a*) Which of the following compounds will show optical isomerism ? 4

(*i*) $CH_3CH(I)C_2H_5$

(*ii*) $CH_3CH(SH)COOH$

(*iii*) $CH_3CH(SH)CH_3$

(*iv*) $C_2H_5CD(OH)CH_3$

(*b*) Draw the Newmann projections of all the conformations of butane. Explain their relative stability with the help of the potential energy diagram. 4

Or

(*a*) Determine the number of optical isomers in the following molecules 4

(*i*) 2, 3 dichloropentane and

(*ii*) Tartaric acid (2,3-dihydroxybutane-dioic acid)

(*b*) Define the following terminologies and mention one example (Draw structure) 4

(*i*) Meso compound and

(*ii*) Racemic mixture.

6. (*a*) What is S_N1 reaction ? Explain why S_N1 mechanism leads to the formation of racemic mixture. 4

(*b*) What are the possible hybridizations of carbon in the free radical. What are the various factors influencing the stability of free radicals. 4

Or

(*a*) What are carbanions ? Explain the factors responsible for the stability of the carbaion. 4

(*b*) Both alkenes and carbonyl compounds contain double bonds and undergo

addition reactions. Explain the difference between the addition reactions of alkenes and carbonyls with the help of suitable examples. 4
