

TRIBHUVAN UNIVERSITY

2081 (Regular)

Bachelor Level 4 Yrs. Prog./1st Year/Science & Tech.

Full Marks: 100

Time: 3 hrs.

CHEM: 101: CHEMISTRY

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

Use separate answer-book for each group.

The Comprehensive Question of each group is compulsory.

Attempt SIX questions of Short Answer Questions of each Group.

GROUP "A" (INORGANIC)

1. Comprehensive Question

Give any two shortcomings of Bohr's theory of structure of hydrogen atom. Derive an expression for the energy of an electron in the hydrogen atom. [3+6]

OR

What are bonding and antibonding molecular orbitals? Draw the molecular orbital energy level diagram for O₂ molecule and also give the bond order and magnetic property. [3+4+1+1]

2. Short Answer Questions

6×4=24

2.1. Explain Hund's rule of maximum multiplicity with an example.

2.2. What is meant by mass defect and binding energy?

2.3. What are the merits and demerits of IUPAC classification of periodic table?

2.4. Explain HSAB principle with examples.

2.5. What is the importance of solubility product and common ion effect in qualitative inorganic analysis.

2.6. How does Schottky defect differ from Frenkel defect? Explain.

(1)

- 2.7. What are the main assumptions of VSEPR theory?
- 2.8. Explain the physical significance of wave function.
- 2.9. Draw and explain the CsCl structure

□

GROUP "B" (ORGANIC)

3. Comprehensive Questions

- a) Define the term conformation. Using Newmann projection formula, draw the different conformations of n-butane and arrange them in order of their increasing stability. Give reason for their order of stability. [1+2+3]
- b) Justify the statement "the more stable the free radical, the more easily it is formed" with reference to halogenations of alkanes. [3]

OR

How does E2 reaction differ from E1 reaction in mechanistic and kinetic aspects? The peroxide initiated addition of HBr to an unsymmetrical alkene takes place against Markovnikov's rule. Justify this fact with its mechanism. [5+4]

4. Short Answer Questions

6×4=24

- 4.1. What is hyperconjugation effect? Write the hyperconjugation structures of n-propyl and isopropyl carbocations. Which one of them is more stable and why? Explain.
- 4.2. Explain with a labelled potential energy diagrams of endothermic and exothermic reactions. Indicate the value of ΔH in each case.
- 4.3. Write all the necessary sequence of reactions to prepare 2-methylbutane by coupling of an alkyl halide with lithium dialkylcopper.
- 4.4. Justify the statement that the "Presence of chiral carbon is necessary but not sufficient condition to show the optical activity".

- 4.5. In general, S_N1 reaction of optical active compound is accompanied by racemisation. But in actual practice, there is always some net inversion. How would you justify this observation?
- 4.6. Usually, oxidation of primary alcohols results carboxylic acids. How would you accomplish chemoselective oxidation of primary alcohols to the aldehydes? Explain it by providing an example.
- 4.7. Why cleavage of ether linkage by acids is accomplished only after protonation? Explain this justification with reference to the reaction of methoxyethane and cold solution of HI.
- 4.8. What product will be formed when propene is treated with diborane followed by oxidation with alkaline H_2O_2 ? Explain orientation and mechanism of the reaction.
- 4.9. Describe the stereochemistry of reduction of alkynes to alkenes.

GROUP "C" (PHYSICAL)

5. Comprehensive Question

Derive an expression for the pressure of an ideal gas from kinetic theory of gas. Show that kinetic energy of the molecules in one mole of an ideal gas is equal to $\frac{3}{2}RT$.

Calculate the root mean square velocity of oxygen molecules at $27^\circ C$. [5+3+2]

OR

For a general reaction, $2A \rightarrow B$, the differential rate law is given as $-\frac{d(A)}{dt} = K[A]^2$

Obtain the expression for rate constant (K) by integrating above equation. How do you determine value of K graphically. The rate constant of a reaction is $1.2 \times 10^{-3} S^{-1}$ at 303 K. Calculate rate constant at 323 K provided that activation energy is $54.2 kJ mol^{-1}$. [4+3+3]

Short Answer Questions

- 6.1. What are Miller indices? Determine the Miller indices for a plane which cut through axes 2a, 3b and 2c.
- 6.2. State Raoult's law. How do you determine molecular mass of solute from relative lowering of vapour pressure.
- 6.3. What do you mean by calorific value of fuels? The enthalpy of combustion of methane and ethane are -890.3 and -1560 KJ mol⁻¹. Compare the calorific value of methane and ethane, which has better fuel efficiency.
- 6.4. Calculate enthalpy of formation of NH₃. Given enthalpies of H - H, N≡N and N - H bond are 436, 941 and 391 kJ mol⁻¹, respectively.
- 6.5. The equilibrium constant for a reaction $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ is 32 at 298 K if 10 g of hydrogen and 760 g of iodine is kept at closed vessel at this temperature to attain equilibrium, calculate mass of HI formed.
- 6.6. Define buffer capacity and buffer range. Calculate pH of mixture formed by mixing 200 mL of $\frac{N}{2}$ CH₃COOH and 200 mL of $\frac{M}{4}$ NaOH solution. Given K_a for CH₃COOH = 1.74×10^{-5} .
- 6.7. What is the effect of temperature, pressure and concentration with reference to law of mass action?
- 6.8. Explain the term collision frequency, collision diameter and mean free path.
- 6.9. Define surface tension of liquid. How do you determine surface tension by drop weight method?

