

# TRIBHUVAN UNIVERSITY

2080 (Regular)

Bachelor Level 4 Yrs. Prog. / 1<sup>st</sup> Year / Science & Tech,

Full Marks: 100

CHEM: 101: CHEMISTRY

Time: 3 hrs.

*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

What is Schrodinger's wave equation? what is the significance of the  $\psi$  and  $\psi^2$ ? What are the conditions to be obeyed by proper wave function? Explain the term radial wave function and angular wave function. [1+2+2+2+2]

OR

What is difference between electronegativity and electron affinity? How does electronegativity vary within a group and within a period? Explain why the electron affinity of Cl is quite high? [2+4+3]

### 2. Short Answer Questions

6×4=24

2.1. What are Hund's rule of maximum multiplicity and Pauli exclusion principle? Explain.

2.2. Predict the bond order in  $\text{Ne}_2$ , NO,  $\text{O}_2$  and  $\text{H}_2$  using molecular orbital theory.

2.3. What is lattice energy? Give the Born-Haber cycle for the formation of NaCl and define the terms involved in the cycle.

- 2.4. What are the Lewis acid and bases? Arrange the following in their acid strength  $\text{BCl}_3$ ,  $\text{BI}_3$  and  $\text{BF}_3$  giving suitable explanations.
- 2.5. Define the terms binding energy, half life period and group displacement law.
- 2.6. How does VSEPR theory governs the geometry of molecules? Explain.
- 2.7. Explain why ionic radius of  $\text{K}^+$  is smaller than  $\text{Cl}^-$ ?
- 2.8. The half life period of a certain radioactive substance is 100 seconds. Calculate the disintegration constant. Also calculate the time during which 1g of the substance is reduced to 0.01g.
- 2.9. Define the terms solubility product, common ion effect, gravimetric and volumetric analysis giving their application in analytical chemistry.

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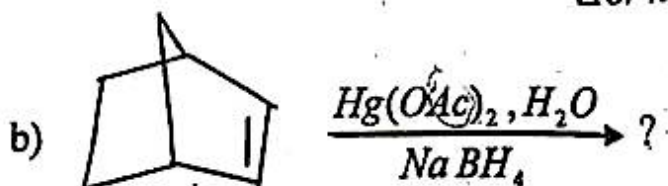
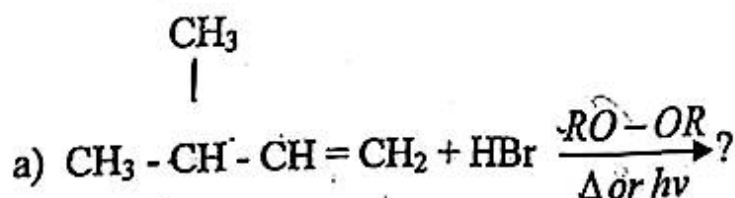
GROUP "B" (ORGANIC)

3. Comprehensive Questions

Alkaline hydrolysis of tertiary butyl bromide and methyl bromide are first order and second order reactions, respectively. Keeping this fact in view, suggest mechanisms of these reactions along with probable transition states. [4+5]

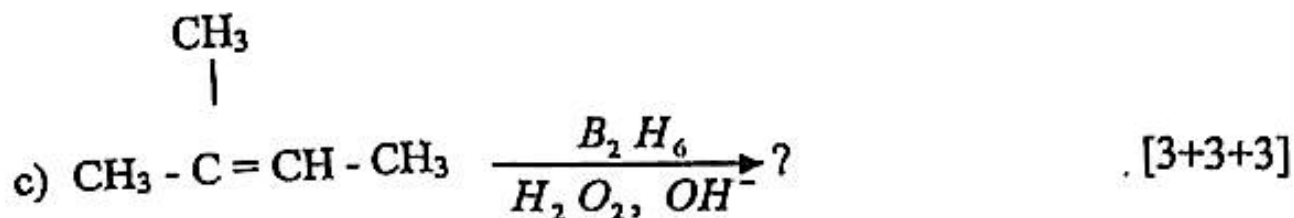
OR

Predict the product and give mechanism of the following reactions...



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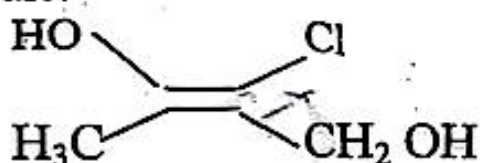
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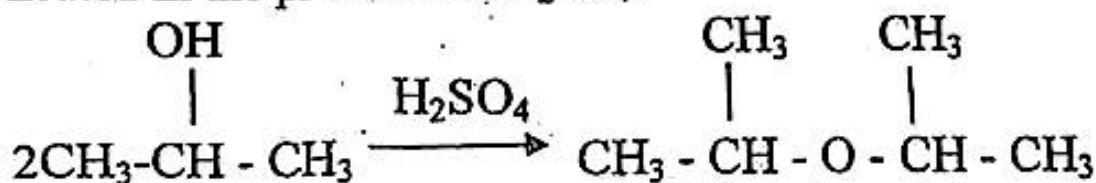
4 Short Answer Questions

6×4=24

- 4.1. Define inductive effect. How does it differ from resonance? Explain why phenol is more acidic than alcohol?
- 4.2. Chlorination of n-butane gives 72% of 2-chlorobutane and 28% of 1-chlorobutane, while bromination gives 98% of 2-bromobutane and 2% of 1-bromobutane. Explain why?
- 4.3. Why water is preferred for preparation of alkane from Grignard reagent? Write the reactions for the preparation of ethane from Grignard reagent-giving mechanism.
- 4.4. What is geometrical isomerism? Why is trans-isomer more stable than cis-isomer? Assign E or Z configuration to following molecule.



- 4.5. Di-isopropyl ether can be obtained when isopropyl alcohol is heated in the presence of  $\text{H}_2\text{SO}_4$ .



Suggest the mechanism for the formation of the products.

- 4.6. Explain:

- a) In  $\text{S}_\text{N}^1$  reaction of (-) - 2 - bromooctane the product is partially racemized.
- b) Rate of  $\text{S}_\text{N}^2$  reaction is affected by steric factors.

- 4.7. Write the mechanism of the reaction of tertiary alkyl halide with  
 a) aq. NaOH and (b) alc. KOH
- 4.8. How does E<sub>1</sub> reaction differ from E<sub>2</sub> in mechanistic and kinetic aspects?
- 4.9. Explain with examples, "Stereoselective reduction of alkynes"

GROUP "C" (PHYSICAL)

5. Comprehensive Question

Define critical constants of gas. Derive the expression for critical constants of gas in terms of van der Waal's constant. [3+3+4]  
 Calculate critical constants for C<sub>2</sub>H<sub>2</sub>(g). (Given  $a = 4.39 \text{ atm L}^2 \text{ mol}^{-2}$  and  $b = 5.13 \times 10^{-2} \text{ L mol}^{-1}$ ).

OR

What is a buffer solution? Give examples. Explain the buffer action of mixture of CH<sub>3</sub>COOH and CH<sub>3</sub>COONa. Derive the Henderson's equation for pH of buffer solution. [2+3+2+3]

Calculate concentration of NH<sub>4</sub>OH and NH<sub>4</sub>Cl required to prepare a buffer solution of pH 9.0 when total concentration of buffering agent is 0.6 mol L<sup>-1</sup>. Given pK<sub>b</sub> for NH<sub>4</sub> OH = 4.7

6. Short Answer Questions

6×4=24

6.1. What is meant by colligative property? Show that elevation of boiling point is a colligative property.

6.2. Define the term coefficient of viscosity. Describe the Ostwald's viscometer method for its determination.

6.3. What is meant by unit cell of crystal sketch the unit cell of body centered cubic lattice and calculate the number of atoms per unit cell.

6.4. Explain the effect of temperature on reaction rate. Calculate the specific reaction rate for a reaction at 300K if activation energy and frequency factor are 105KJ mol<sup>-1</sup> and 2.5×10<sup>15</sup> sec<sup>-1</sup>.

- 6.5. Define half life time for a reaction. Show that half life period of a second order reaction is inversely proportional to initial concentration of reactant.
- 6.6. Define Boyle's temperature three moles of  $\text{NH}_3$  gas are enclosed in 5L flask at  $25^\circ\text{C}$ . Calculate pressure exerted by  $\text{NH}_3$  gas using van der Waal's equation (Given  $a = 4.14 \text{ atm. L}^2 \text{ mol}^{-2}$ ,  $b = 3.7 \times 10^{-2} \text{ L mol}^{-1}$ ).
- 6.7. Calculate enthalpy formation of  $\text{NH}_3(\text{g})$ . Given bond enthalpies of N-H, H-H and  $\text{N} \equiv \text{N}$  are 391, 436 and  $941 \text{ KJ mol}^{-1}$ , respectively.
- 6.8. State Hess's law of constant heat summation and mention its applications.
- 6.9. Define hydrolysis of salt. Calculate pH of 0.4M solution of  $\text{NH}_4\text{Cl}$ . Given  $K_b$  for  $\text{NH}_4 \text{ OH}$   $1.82 \times 10^{-5}$ .

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