

SAMPLE PAPER
CHEMISTRY THEORY (043)

MM:70

Time: 3 Hours

General Instructions:

Read the following instructions carefully.

- a) There are 33 questions in this question paper. All questions are compulsory.
- b) Section A: Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
- c) Section B: Q. No. 17 to 25 are short answer questions and carry 2 marks each.
- d) Section C: Q. No. 26 to 30 are short answer questions and carry 3 marks each.
- e) Section D: Q. No. 31 to 33 are long answer questions carrying 5 marks each.
- f) There is no overall choice. However, internal choices have been provided.
- g) Use of calculators and log tables is not permitted.

SECTION A (OBJECTIVE TYPE)

1. Read the passage given below and answer the following questions: (1x4=4)

Alkene hydration is a catalytic process that involves the addition of water across the double bond of an alkene to produce an alcohol (Figure 1.1). This is the most direct and atom-economical approach to the synthesis of alcohols. Acid-catalyzed alkene hydration is the most well-known hydration process. This process is used industrially with several different acidic species as the catalyst, including zeolites, oxides, solid phosphoric acid and sulfuric acid. There are several major drawbacks with this catalytic process. The first drawback is the acidic environment which is very corrosive and can lead to degradation of reactors or the need to use specially engineered and expensive reactors to resist the acidic conditions. Another drawback is the acidic environment required for hydration is not suitable for alkenes with acid-sensitive functional groups. Thus, this process is typically only used with simple alkenes such as ethylene, propylene and butenes. The final and biggest drawback is the selectivity of the reaction. Acid catalyzed hydration follows Markovnikov's rule which states that the proton will add to the carbon with the most hydrogens attached to it. Therefore, starting with propylene, acid-catalyzed hydration will always be selective for internal alcohols (secondary or tertiary). Except for ethanol, primary alcohols cannot be synthesized by acid-catalyzed hydration. Generally, primary alcohols are the more valuable commodity industrially. Therefore, different synthetic strategies have to be invented for the synthesis of primary alcohols. Figure 1.1

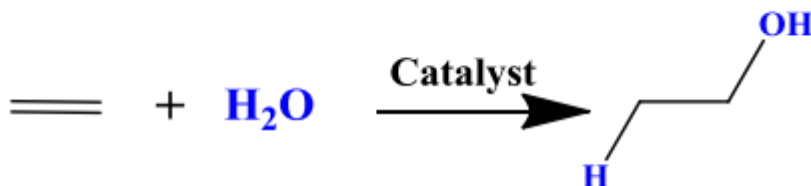


Figure 1.1 Hydration of ethylene

(SOURCE :2013 Investigations into alkene hydration and alkene oxidation catalysis William Schreiter Louisiana State University and Agricultural and Mechanical College, wschre1@lsu.edu)

The following questions are multiple choice questions. Choose the most appropriate answer:

(I) When Propene reacts with water under acidic condition then the product is

- a) Propan-1-ol b) Propan-2-ol c) Propane d) Propanone

(II) Propyne on hydration in the presence of HgSO_4 and Sulphuric acid will produce

- a) Propan-1-ol b) Propan-2-ol c) Propane d) Propanone

OR

2-Methylpropene when it undergoes hydration in the presence of an acid catalyst, the product obtained is

- a) 2-Methylpropan-2-ol b) 2-Methylpropan-1-ol c) Propanone d) Propanal

(III) 1-Methylcyclohexene on hydration under acidic condition will produce

- a) 1-Methylcyclohexan-2-ol b) 1-Methylcyclohexan-1-ol
c) 2-Methylcyclohexan-2-ol d) 2-Methylcyclohexanone

(IV) But-1-ene (P) on acidic condition hydration will produce 'X' compound, which on dehydration produces 'Y'. Acidic condition hydration of 'Y' will produce 'Z'. Then select the incorrect option

- a) X and Y are not isomers b) P and Y are position isomers
c) X and Z are the same c) X on reaction with Na, does not produce H_2 gas

2. Read the passage given below and answer the following questions:

(1x4=4)

Adsorption is a mass transfer process that is a phenomenon of sorption of gases or solutes by solid or liquid surfaces. The adsorption on the solid surface is that the molecules or atoms on the solid surface have residual surface energy due to unbalanced forces. When some substances collide with the solid surface, they are attracted by these unbalanced forces and stay on the solid surface. According to the different adsorption forces, the adsorption process can be divided into two categories: physical adsorption and chemical adsorption. Physical adsorption is produced by the interaction of intermolecular forces (i.e., van der Waals forces), for example, the adsorption of activated carbon for gas. Physical adsorption is generally carried out at a low temperature, and has a fast adsorption rate, low adsorption heat, and is nonselective. As the effect of intermolecular attraction is weak, the structure of the adsorbate molecules hardly changes, the adsorption energy is small, and the adsorbed substance is easily separated again. The adsorption due to the action of chemical bonds is chemical adsorption. Chemical adsorption process includes the formation and destruction of chemical bonds. The absorption or release of adsorption heat is larger, and the activation energy required is also larger. Physical adsorption and chemical adsorption are not isolated and often occur together. In waste water treatment technology, most of the adsorption is the

result of several kinds of adsorption processes. Due to the influence of adsorbents, adsorbates, and other factors, some kind of adsorption may play a leading role.

(SOURCE : Physicochemical technologies for HRP and risk control Haidong Hu, Ke Xu, in High-Risk Pollutants in Wastewater, 2020)

In these questions (Q. No V-VIII), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
- b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
- c) Assertion is correct statement but reason is wrong statement.
- d) Assertion is wrong statement but reason is correct statement.

(V) Assertion : When sorption occur then adsorption also take place.

Reason : Physisorption prefer to take place at low temperature.

(VI) Assertion : Physisorption is reversible in nature.

Reason : Physisorption involves weak vanderwaal forces.

(VII) Assertion : Chemisorption take place generally at higher temperature than Physisorption.

Reason : Low activation energy is involved during Chemisorption.

(VIII) Assertion: During adsorption both physisorption as well chemisorptions can take place

Reason : Adsorption process is exothermic in nature

OR

Assertion : Physisorption required high activation energy than chemisorption.

Reason : Chemisorption involves formation as well as destruction of chemical bond.

Following questions (No. 3 -11) are multiple choice questions carrying 1 mark each

3. Which of the following option has incorrect unit

S.No	Parameter	Unit
1	Resistance	Ohm
2	Cell constant	cm ⁻¹
3	Molar Conductivity	Ohm ⁻¹ cm ² mol ⁻¹
4	Resistivity	Ohm.m ⁻¹

- a) RESISTANCE
- b) CELL CONSTANT
- c) MOLAR CONDUCTIVITY
- d) RESISTIVITY

4. Fructose is :
- a) Non-reducing sugar
 - b) Ketopentose
 - c) Has 2 anomeric forms
 - d) Pyran ring

OR

Sucrose on hydrolysis produces -----number of monosaccharide units:

- a) 0
- b) 1
- c) 2
- d) 3

5. Two beaker 'X' and 'Y' contain aniline and phenol. When the content of 'X' and 'Y' is added to third container 'Z' then
- a) Heat is absorb.
 - b) The resultant volume is more than the sum of individual volume
 - c) The Pressure versus concentration curve for the mixture is a straight line at all the composition.
 - d) The new intermolecular forces are stronger than interaction present in original components.

6. Why Mn shows highest number of oxidation state range in 3d series.

- a) Because it is a transition element.
- b) It contains vacant 3d orbital
- c) It contains maximum 5 unpaired electron in 3d orbital for bonding
- d) It does not have 'f' orbital electrons.

OR

Which of the following is not a diamagnetic ion: (Atomic numbers of Sc, V, Mn, and Zn are 21, 23, 25 and 30 respectively)

- a) V^{2+}
- b) Sc^{3+}
- c) Zn^{2+}
- d) Mn^{7+}

7. Benzamide on reaction with bromine in aqueous NaOH followed by heat gives:

- a) Benzylamine
- b) Aniline
- c) Benzylalcohol
- d) Benzoic acid

OR

IUPAC name of product formed by reaction of methyl magnesium bromide reacts with acetone following by protonation with solvent

- a) 2-Hydroxypropanoic acid
- b) 2-Hydroxy-2-methylpropane
- c) 2-Methylpropane-2-ol
- d) 2-Hydroxybutan-2-ol

8. Ligand 'EDTA' and 'en' have denticity :

- a) 4,6
- b) 6,4
- c) 6,2
- d) 4,2

OR

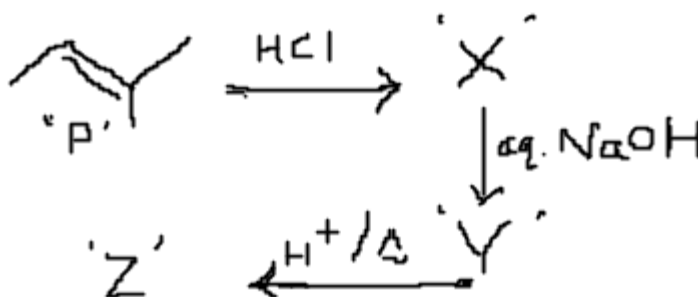
The formula of the coordination compound Iron(III)hexacyanoferrate(II) is

- a) $\text{Fe}[\text{Fe}(\text{CN})_6]_3$
- b) $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
- c) $\text{Fe}[\text{Fe}(\text{CN})_3]_6$
- d) $\text{Fe}_2[\text{Fe}(\text{CN})_6]_3$

9. Which ion do exhibit specific colour? (Atomic number of Sc = 21, Ti = 22, V = 23, Mn = 25, Fe = 26, Ni = 28, Cu = 29 and Zn = 30)

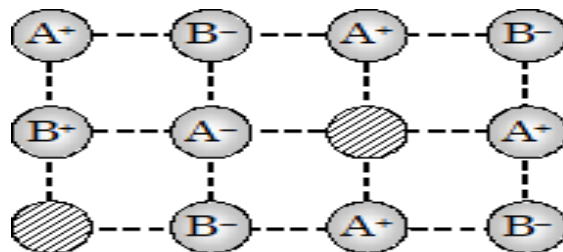
- a) Sc^{3+}
- b) Zn^{2+}
- c) Fe^{3+}
- d) Ti^4

10. Select the incorrect option



- a) Addition of HCl to 'P' is an electrophilic addition reaction.
- b) Addition of NaOH to 'X' will prefer $\text{S}_\text{N}1$ mechanism
- c) 'Z' and 'P' are isomer
- d) Formation of 'Z' from 'Y' involves carbocation as reaction intermediate

11. The crystal 'X' is showing following defect. Select the incorrect option



- a) It is an NaCl crystal b) Density of the crystal get reduced
 b) It is crystalline solid d) This crystal can be of AgBr but not AgCl

In the following questions (Q. No. 12 - 16) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 c) Assertion is correct statement but reason is wrong statement.
 d) Assertion is wrong statement but reason is correct statement.

12. Assertion : Glycine is an optically active amino acid.

Reason : Glycine contain achiral carbon atom.

13. Assertion : 'Marshall Acid' is dibasic acid.

Reason : 'Marshall Acid' contains two O-H bond

14. Assertion : Pickels are prepared in more concentrated salt solution.

Reason : During Osmosis , the net flow of water molecules take place from more concentrated solution to less concentrated solution

OR

Assertion: A mixture of CS₂ and Acetone form a negative deviation mixture.

Reason : In mixture of CS₂ and Acetone the new intermolecular forces are weaker than the intermolecular forces which exist in pure components

15. Assertion: Carboxylic acid are generally more soluble than Phenol in water.

Reason : Extensive hydrogen take place in Carboxylic acid as compare to Phenol.

16. Assertion : Anisole on reaction with HI give Iodobenzene and Methanol

Reason : Aryl Carbon-Oxygen bond is much stronger than Alkyl Carbon-Oxygen bond.

SECTION B

The following questions, Q.No 17 – 25 are short answer type and carry 2 marks each.

17. With the help of resonating structure explain why Chlorobenzene prefer to produce the ortho and para substituted product during electrophilic aromatic substitution reaction, than meta product.

OR

Carry out the following conversions in not more than 2 steps:

- (i) Aniline to Benzene
- (ii) 2-bromopropane to Propan-1-ol

18. Vapour pressure of pure water at 298 K is 23.8 mm Hg. 50 g of urea (NH_2CONH_2) is dissolved in 850 g of water. Calculate the vapour pressure of water, for this solution and its relative lowering.

19.(i) Explain $[\text{Co}(\text{NH}_3)_6]^{3+}$ is an inner orbital complex whereas $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex

(ii) Write the IUPAC name of the coordination complex: $\text{K}_2[\text{Zn}(\text{OH})_4]$

OR

(i) Predict the geometry of $[\text{Ni}(\text{CO})_4]$

(ii) Calculate the spin only magnetic moment of $[\text{NiCl}_4]^{2-}$ ion.

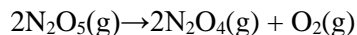
20. For the reaction $2\text{A} + \text{B} \rightarrow \text{A}_2\text{B}$

The rate = $k[\text{A}]^2[\text{B}]$ with rate constant $k = 2.0 \times 10^{-6} \text{ mol}^{-2}\text{L}^2\text{s}^{-1}$. Calculate the initial rate of the reaction when $[\text{A}] = 0.1\text{M}$ and $[\text{B}] = 0.2\text{M}$. Calculate the rate of reaction after $[\text{A}]$ is reduced to 0.04 M

OR

For a first order reaction, show that the time required for 99% completion is twice the time required for the completion of 90% of the reaction.

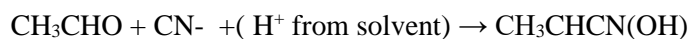
21. The following data were obtained during the first order thermal decomposition of $\text{N}_2\text{O}_5(\text{g})$ at constant volume.



S.N.	TIME/sec	TOTAL PRESSURE/atm
1.	0	0.5
2.	100	0.512

Calculate the rate constant.

22. Explain the mechanism of the following Nucleophilic addition reaction.



23. Draw the structural formula for (A) XeF_6 (B) ClF_3

24. Explain the following reaction with the help of suitable example

A) Reimer Tieman Reaction B) Cross Aldol reaction

25. Atoms of element B form hcp lattice and those of the element A occupy $\frac{2}{3}$ rd of tetrahedral voids ?. What is the formula of the compound formed by the elements 'A' and 'B'?

SECTION C

Q.No 26 -30 are Short Answer Type II carrying 3 mark each.

26. Give reasons for the following:

- Transition elements form alloy.
- Cu(I) undergoes disproportionation reaction
- Why is the highest oxidation state of a transition metal exhibited in its oxide or fluoride only ?.

OR

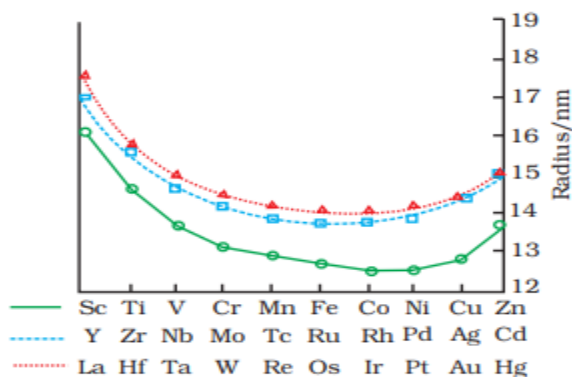


Fig. 8.3: Trends in atomic radii of transition elements

Explain the following observations (Fig-1):

- The general trend shows there is slight increase of atomic radii at the end of the series
- The atomic radii of 4d and 5d series is almost same
- The atomic size of Zr and Hf is almost is same.

27. Arrange the following in increasing order of property specified:

- Aniline, ethanamine, 2-ethylethanamine (Basic character in gaseous phase)
- Formic acid, Benzoic acid, Ethanoic acid (Acidic property)
- Methanamine, N, N- dimethylmethanamine and N- methylmethanamine (Solubility in water)

OR

- Give a chemical test to distinguish between N-methylethanamine and Ethanamine.
- Write the reaction for catalytic reduction of Benzoyl Chloride using Pd/BaSO₄ followed by reaction of product so formed with bromine water.
- Out of butan-1-ol and butan-2-ol, which will be more acidic and why?

28. A metal crystallizes into two cubic system-face centred cubic (fcc) and body centred cubic (bcc) whose unit cell lengths are 4.0 and 2.0 Å respectively. Calculate the ratio of radius (r_{fcc}/r_{bcc}) of the metal in fcc and bcc crystal lattice.

29. Three amino acids are given below:

Alanine $\text{CH}_3\text{CH}(\text{COOH})(\text{NH}_2)$ Aspartic acid $\text{HOOC}-\text{CH}_2\text{CH}(\text{COOH})(\text{NH}_2)$ and Lysine $\text{H}_2\text{N}-(\text{CH}_2)_4-\text{CH}(\text{COOH})(\text{NH}_2)$

- Among the above amino acid select the acidic, basic and neutral amino acid (if any).
 - Represent Alanine in the zwitter ionic form.
- iii) Produced a dipeptide using Alanine and Aspartic Acid
30.
 - Arrange the following in decreasing order of reactivity ICl , F_2 , Cl_2
 - N-N single covalent bond energy less than single P-P covalent bond energy. Explain
 - Sulphur in S_2 form shows paramagnetic nature. Why

SECTION D

Q.No 31 to 33 are long answer type carrying 5 marks each.

31. (i) Answer the following questions: (2+3)

- Write the balanced chemical reaction for reaction of Zn with dilute HNO_3 .
- Draw the shape of BrF_5

(ii) Gas 'X' is produced by thermal decomposition of Ammonium Dichromate. 'X' gas when reacts with hydrogen gas under appropriate condition produced gas 'Y' which on reaction with CuSO_4 solution forms deep blue complex 'Z'. Identify 'X', 'Y' and 'Z'. Write the reaction involved?

OR

(i) Answer the following questions: (2+3)

- Arrange the following in the increasing order of reducing property :
 NH_3 , PH_3 , AsH_3 , SbH_3 , BiH_3
- How you can test a SO_2 gas in lab. using an appropriate reaction.

(ii) A compound 'X' which consists of Hydrogen and element 'Y' as stated by scientist Humphry Davy. When 'X' reacts with Ammonia, it produced a white dense fumes of 'Z'.

Identify 'X', 'Y' and 'Z' and write the reaction involved.

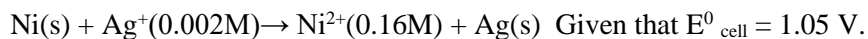
32. A Organic Compound (X) on reaction with PCC produced (Y)-C₄H₈O. Compound 'Y' on reaction with NaOH /I₂ in presence of heat produced a yellow ppt of 'Z'. Compound 'Y' on drastic oxidation with Alkaline KMnO₄ followed by acidification produced an organic compound 'W' which is used in cooking. Identify 'X', 'Y', 'Z' and 'W' and write the reaction involved. (5)

OR

- (i) Write the reaction when Acetaldehyde reacts with 2,4 D.N.P.
- (ii) How will you carry out the following conversions:
 - a) Propane-2-ol to 2-Methylpropan-2-ol
 - b) Propene to Propanone
 - c) Benzene to Phenol

33.(i) Define Limiting molar conductivity. (1+4)

(ii) Calculate the emf of the cell in which the following reaction take place



OR

(a) Why does the conductivity of a solution decreases with dilution (1+4)

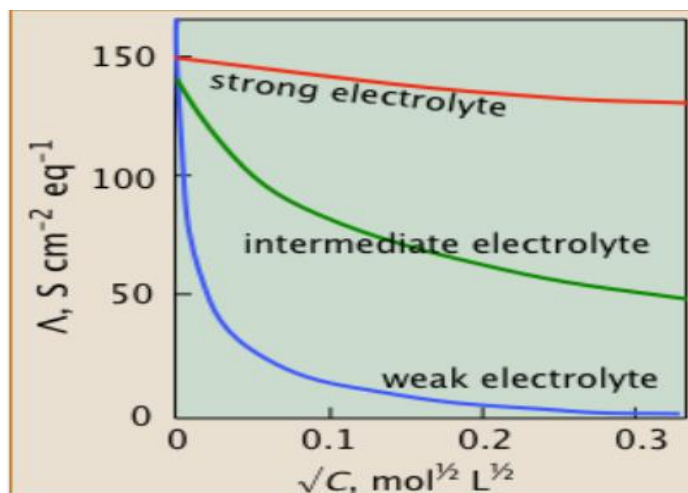


Figure 2

(b)(i) Explain why molar conductivity increases with dilution for electrolyte.

(ii) Why Weak Electrolyte (Blue line curve) has lower molar conductivity than molar conductivity of strong electrolyte (Red Line curve)

(iii) The conductivity of 0.001028 M Acetic Acid is 4.95 × 10⁻⁵ S cm⁻¹. Calculate its dissociation constant if Limiting molar conductivity for acetic acid is 390.5 S cm² mol⁻¹.