

CHEMISTRY

PAPER-1

(Three hours)

(Candidates are allowed additional 15 minutes for **only** reading the paper
They must NOT start writing during this time)

All questions are compulsory

Question 1 is of twenty marks having four sub parts all of which are compulsory.
Question numbers 2 to 8 carry 2 marks with two questions having internal choice.
Question numbers 9 to 15 carry 3 marks with two questions having internal choice.
Question numbers 16 to 18 carry 5 marks each. Each question has an internal choice.

The intended marks for questions or parts of questions are given in []
Balanced equations must be given wherever possible and diagrams where they are helpful. When
solving numerical problems, all essential working must be shown.

In working out the problems, use the following data:

Gas constant $R = 1.987 \text{ cal deg}^{-1} \text{ mol}^{-1} = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$

$1 \text{ L atm} = 1 \text{ dm}^3 \text{ atm} = 101.3 \text{ J}$ Avogadro's number = 6.023×10^{23}

PART I

Answer all questions.

Question 1

- (a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets : [4x1]

[methanal, propanone, weak, propanal, zero, more, dependent, + I, independent, -I, less, + M, ethanal, strong, -M]

- (i) Molality is _____ of temperature, whereas, molarity is _____ of temperature.
- (ii) Chloroacetic acid is _____ acidic than acetic acid due to _____ effect.
- (iii) An acidic buffer is prepared by taking equimolar solution of _____ acid and its salt with a _____ base.
- (iv) Ozonolysis of 2-methyl pent-2-ene shall give _____ and _____.

- (b) Complete the following by selecting the correct alternatives from the choices given: [4x1]

- (i) The permissible set of all four quantum numbers for an electron are:

- (a) $n=2$ $l=1$ $m=0$, $s=0$
- (b) $n=3$ $l=2$ $m=+3$ $s=+1/2$
- (c) $n=3$ $l=0$ $m=0$ $s=-1/2$
- (d) $n=2$ $l=3$ $m=+2$ $s=+1/2$
-

- (ii) The order of electron gain enthalpy for halogens is:
- $F > Cl > Br > I$
 - $I > Br > Cl > F$
 - $I > Cl > Br > F$
 - $Cl > F > Br > I$
- (iii) Which of the following conditions will favour the formation of ammonia in the reaction $N_2 + 3H_2 \rightarrow 2NH_3$ $\Delta H = -ve$.
- Increase in temperature
 - Decrease in temperature
 - Decrease in pressure
 - Addition of ammonia in the reaction vessel
- (iv) The rate of reaction gets doubled in the reaction $R-X + OH^-(aq) \rightarrow ROH + X^-$ when the concentration of alkyl halide is doubled, but remains same when the concentration of the base is doubled. The alkyl halide is:
- 2-chloro-2-methyl propane
 - 2-chloropropane
 - Methyl chloride
 - 1-chloropropane

(c) Match the following:

[4x1]

- | | |
|-------------------------|-------------------|
| (i) Octahedral | Organic peroxides |
| (ii) Diffusion of gases | SF_6 |
| (iii) Kjeldahl's method | Graham |
| (iv) Kharasch effect | Nitrogen |

(d) Answer the following questions:

[4x2]

- State Heisenberg's Uncertainty Principle.
 - Write the electronic configuration of Cr [$Z = 24$]. What is the reason for abnormal electronic configuration of Cr?
- Explain the following:
 - Potassium carbonate cannot be prepared by Solvay's method.
 - $MgCO_3$ is more soluble in water than $BaCO_3$.
- Calculate the pH value of 2.1×10^{-3} M NaOH at 298 K.
 - Calculate the oxidation number of the following underlined elements:
 - $\underline{S}_2O_3^{2-}$
 - $H_2\underline{O}_2$
- Explain why but-1-ene does not exhibit geometrical isomerism.
 - Draw the optical isomers of 2-chlorobutane.

PART II

Question 2

[2]

Write the electronic configuration of following elements /ions using aufbau's principle:

- (i) Fe^{2+} [$Z=26$]
- (ii) Hg [$Z=80$]
- (iii) I [$Z=53$]
- (iv) Sr [$Z=38$]

OR

What is the maximum number of electrons that can be accommodated in the subshell represented by following set of quantum numbers:

- (i) $n=2, l=1$
- (ii) $n=5, l=3$
- (iii) $n=3, l=2$
- (iv) $n=6, l=0$

Question 3

[2]

The first ionization enthalpy (ΔH_1), the second ionization enthalpy (ΔH_2) and the electron gain enthalpy (ΔH_{eg}) of a few elements is given below:

Element	(ΔH_1) (KJ mol ⁻¹)	(ΔH_2) (KJ mol ⁻¹)	(ΔH_{eg}) (KJ mol ⁻¹)
A	525	7300	+50
B	1642	3374	-328
C	924	1846	-295
D	2520	5251	-600

Which of the above elements is likely to be:

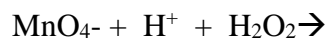
- (a) An alkali metal (Group I element)
- (b) A halogen (Group 17 element)

Justify your answer in (a) and (b) above.

Question 4

[2]

- (a) Complete and balance the following equation:



- (b) Draw the structure of H_2O_2 in gaseous state.

Question 5

[2]

The heat of formation of CO_2 and H_2O is -395 kJ mol^{-1} and -285 kJ mol^{-1} respectively. The heat of combustion of glucose is $-2900 \text{ kJ mol}^{-1}$. Calculate the heat of formation of glucose.

Question 6

[2]

Calculate the temperature at which 28 grams of N_2 will occupy a volume of 10 L at 2.46 atm [at wt of N = 14].

Question 7

[2]

- (a) State *any two* uses of Plaster of Paris.
- (b) *The melting point of LiF is more than LiI.* Explain.

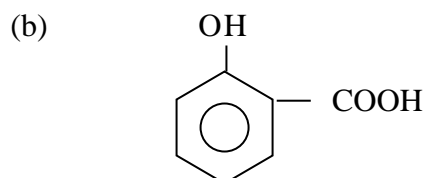
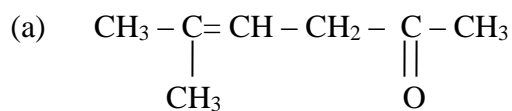
OR

How is sodium hydroxide prepared commercially by Castner-Kellner cell?

Question 8

[2]

Write the IUPAC name of the following:



Question 9**[3]**

- (a) Identify the limiting reagent in the following:
- (i) 5 moles of N_2 reacts with 10 moles of H_2 in Habers Process.
 - (ii) 20 moles of SO_2 reacts with 15 moles of O_2 in Contact Process.
- (b) What mass of MnO_2 is required to react with 250 ml of 0.5 M HCl in the reaction given below;

**OR**

Commercially prepared HCl is 38 % percent by mass. Density is 1.19 g cm^{-3} .

Calculate the following:

- (i) Molality of HCl solution
- (ii) Molarity of HCl solution
- (iii) Mole fraction of HCl in the solution

[at wt of Cl = 35.5, H=1]

Question 10**[3]**

The enthalpy change (ΔH) and entropy (ΔS) change for a reaction are $30.54 \text{ kJ mol}^{-1}$ and 0.06 kJmol^{-1} respectively. Calculate the temperature at equilibrium. Also predict the spontaneity below the temperature at which Gibb's free energy is zero. Justify your answer with valid reason.

Question 11**[3]**

Write balanced equations for the following conversions.

- (a) Propene to 2- bromopropane.
- (b) Phenol to toluene.
- (c) Methyl chloride to ethane.

Question 12**[3]**

- (a) List *any two* gases responsible for greenhouse effect.
- (b) List *any two* green chemistry approaches to reduce waste generation.
- (c) List *any two* gasses which cause acid rain.

Question 13**[3]**

Draw a pair of possible isomers and mention the type of isomerism for each of the following:

- (a) $C_3H_6O_2$
- (b) C_4H_6
- (c) C_2H_4O

OR

Write the type of attacking reagent and the type of reaction for the following :

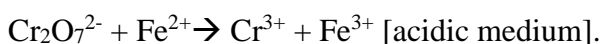
- (a) Nitration of benzene to give nitrobenzene.
- (b) HCN reacted with acetaldehyde to form acetaldehyde cyanohydrin.
- (c) Ethyl bromide with alcoholic KOH.

Question 14**[3]**

- (a) The solubility product of silver chloride is 1.0×10^{-10} at $25^\circ C$. Calculate the solubility of silver chloride in:
 - (i) pure water
 - (ii) 0.2 M sodium chloride
- (b) 10 moles of N_2 is mixed with 14 moles of H_2 in 6 L cylinder. 4.2 moles of ammonia is formed. Calculate Kc for the equation : $N_2 + 3H_2 \rightleftharpoons 2 NH_3$

Question 15**[3]**

Balance the equation given below by ion-electron method. Justify your answer by suitable half cell equation:

**Question 16****[5]**

- (a) Answer the following :
 - (i) Mention the hybridisation of underlined Carbon atom:
 $CH_3\underline{C}HO, \underline{C}H_3COOH$
 - (ii) Show the coordinate bonding in perchloric acid ($HClO_4$) with a suitable diagram.

- (b) Explain why the bond angle of ammonia is less than that of methane although both are sp^3 hybridised.
- (c) (i) Draw the molecular orbital diagram for O_2^+ .
(ii) Explain the reason for O_2^+ being more reactive than O_2 .

OR

- (a) Mention the hybridisation of central atom of the following molecules. Draw the structures showing the lone pair also.
- (i) ClF_3
(ii) XeF_4
- (b) Explain the following:-
- (i) Bond enthalpy of $C=C$ is not double than that of $C - C$ bond.
(ii) Despite being an organic covalent compound, ethyl alcohol is highly soluble in water.
- (c) Calculate the number of sigma and pi bonds in the compound 2,3 dimethyl but-2-ene.

Question 17

[5]

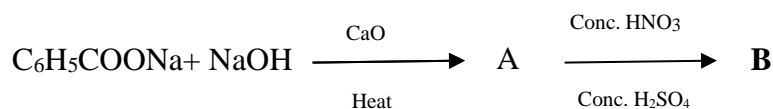
- (a) Explain the following:
- (i) Though carbon and lead belong to the same family, carbon forms CCl_4 whereas in case of lead, $PbCl_2$ is more stable than $PbCl_4$.
(ii) $AlCl_3$ is a Lewis acid.
- (b) How is boric acid (H_3BO_3) prepared from borax?
- (c) State the types of hybridisation of carbon in diamond and graphite.
- (d) State the number of six membered and five membered rings in C_{60} (Buckminster fullerene).

OR

- (a) Explain the following:
- (i) Catenation is maximum in carbon as compared to other group 14 elements.
(ii) Graphite is used as a lubricant.
(iii) Inhaling CO is poisonous.
- (b) How is silicon carbide (SiC) prepared from silica (SiO_2)?
- (c) Why is CO_2 a gas while SiO_2 a solid? Explain.

Question 18**[5]**

- (a) Mention a good chemical test used to distinguish between the following pairs of compounds:
- (i) But-1-yne and but-2-yne
 - (ii) Ethene and ethane
- (b) Write balanced equation for Friedel-Craft acylation.
- (c) Identify the compounds **A** and **B**

**OR**

- (a) How will you convert acetylene to but-2-yne.
- (b) Which is the major product obtained when 2-bromo butane is treated with alcoholic KOH? State the rule involved.
- (c) Draw the resonating structures of phenol and explain why it influences the incoming electrophile to attack at ortho and para positions.
- (d) Why is Corey-House reaction preferred for the preparation of propane as compared to the Wurtz reaction ?