

# CHEMISTRY

## PAPER – 1

### (THEORY)

(Maximum marks: 70)

(Time allowed: Three hours)

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

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*All questions are compulsory*

*Question 1 is of 20 marks having four sub parts, all of which are compulsory.*

*Question numbers 2 to 8 carry 2 marks each, with any two questions having internal choice.*

*Question numbers 9 to 15 carry 3 marks each, with any two questions having an internal choice.*

*Question numbers 16 to 18 carry 5 marks each, with an internal choice.*

*All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.*

*The intended marks for questions or parts of questions are given in brackets [ ].*

*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 problems, use the following data:*

*Gas constant  $R = 1.987 \text{ cal deg}^{-1} \text{ mol}^{-1} = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0821 \text{ dm}^3 \text{ atm K}^{-1} \text{ mol}^{-1}$*

*$1 \text{ l atm} = 1 \text{ dm}^3 \text{ atm} = 101.3 \text{ J}$ .  $1 \text{ Faraday} = 96500 \text{ coulombs}$ .*

*Avogadro's number =  $6.023 \times 10^{23}$ .*

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### Question 1

(a) Fill in the blanks by choosing the appropriate word/words from those given in the brackets [4×1]

(square pyramidal, electrical, 74, 26,  $sp^3d^2$ ,  $sp^3d$ , chemical, 68, 32, tetrahedral, yellow, white, iodoform, Lucas)

- (i) A Galvanic cell converts \_\_\_\_\_ energy into \_\_\_\_\_ energy.
  - (ii) The percentage of unoccupied spaces in bcc and fcc arrangements are \_\_\_\_\_ and \_\_\_\_\_ respectively.
  - (iii) Propan-2-ol on reaction with iodine and sodium hydroxide gives \_\_\_\_\_ precipitate and the reaction is called \_\_\_\_\_ test.
  - (iv) The geometry of  $\text{XeOF}_4$  molecule is \_\_\_\_\_ and the hybridisation of xenon atom in the molecule is \_\_\_\_\_.
-

(b) Complete the following statements by selecting the correct alternative from the choices given: [4×1]

(i) During the course of an  $S_N1$  reaction, the intermediate species formed is:

- (1) a carbocation
- (2) a free radical
- (3) a carbanion
- (4) an intermediate complex

(ii) Purification of aluminium by electrolytic refining is called:

- (1) Serpeck's process
- (2) Hoopé's process
- (3) Hall's process
- (4) Baeyer's process

(iii) An aqueous solution of urea freezes at  $-0.186^\circ\text{C}$ ,  $K_f$  for water =  $1.86 \text{ K kg mol}^{-1}$ ,  $K_b$  for water =  $0.512 \text{ K kg mol}^{-1}$ . The boiling point of urea solution will be:

- (1)  $373.065 \text{ K}$
- (2)  $373.186 \text{ K}$
- (3)  $373.512 \text{ K}$
- (4)  $373.0512 \text{ K}$

(iv) In the dehydration of alcohols to alkenes by heating with concentrated sulphuric acid, the initiation step is:

- (1) formation of carbocation
- (2) formation of an ester
- (3) protonation of alcohol molecule
- (4) elimination of water

(c) Match the following:

[4×1]

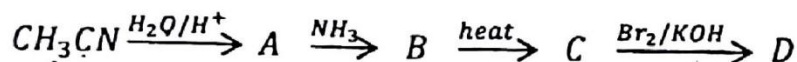
- |                               |                        |
|-------------------------------|------------------------|
| (i) Rate constant             | (a) Dialysis           |
| (ii) Biodegradable polymer    | (b) Glycine            |
| (iii) Zwitter ion             | (c) Arrhenius equation |
| (iv) Purification of colloids | (d) PHBV               |
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(d) Answer the following questions:

[4×2]

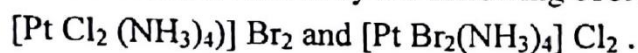
- (i) (1) Why does the density of transition elements increase from Titanium to Copper? (at. no. Ti = 22, Cu = 29)  
(2) Why is zinc not regarded as a transition element?  
(at. no. Zn = 30)

(ii) Identify the compounds A, B, C and D.



(iii) Calculate the osmotic pressure of a solution prepared by dissolving 0.025g of  $\text{K}_2\text{SO}_4$  in 2.0 litres of water at  $25^\circ\text{C}$  assuming that  $\text{K}_2\text{SO}_4$  is completely dissociated. (mol. wt. of  $\text{K}_2\text{SO}_4 = 174 \text{ g mol}^{-1}$ )

(iv) What type of isomerism is shown by the following coordination compounds:



Write their IUPAC names.

### Question 2

[2]

- (a) (i) Write the rate law expression for the reaction  $\text{A} + \text{B} + \text{C} \rightarrow \text{D} + \text{E}$ , if the order of reaction is first, second and zero with respect to A, B and C, respectively.  
(ii) How many times the rate of reaction will increase if the concentration of A, B and C are doubled in the equation given in (i) above?

OR

- (b) The rate of reaction becomes four times when the temperature changes from 293 K to 313 K. Calculate the energy of activation ( $E_a$ ) of the reaction assuming that it does not change with temperature. ( $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ )

### Question 3

[2]

- (a) How do antiseptics differ from disinfectants?  
(b) State the role of the following chemicals in the food industry:  
(i) Sodium benzoate  
(ii) Aspartame

### Question 4

[2]

An aromatic organic compound [A] on heating with  $\text{NH}_3$  and  $\text{Cu}_2\text{O}$  at high pressure gives [B]. The compound [B] on treatment with ice cold solution of  $\text{NaNO}_2$  and  $\text{HCl}$  gives [C], which on heating with  $\text{Cu}/\text{HCl}$  gives compound [A] again. Identify the compounds [A], [B] and [C]. Write the name of the reaction for the conversion of [B] to [C].

**Question 5****[2]**

Write the names of the monomers for each of the following polymers:

- (a) Bakelite
- (b) Nylon – 2 – nylon – 6

**Question 6****[2]**

Name the purine bases and pyrimidine bases present in RNA and DNA.

**Question 7****[2]**

- (a) How will you obtain the following? (Give balanced equation.)
  - (i) Picric acid from phenol.
  - (ii) Ethyl chloride from diethyl ether.

**OR**

- (b) How will you obtain the following? (Give balanced equation.)
  - (i) Anisole from phenol
  - (ii) Ethyl acetate from ethanol.

**Question 8****[2]**

40% of a first order reaction is completed in 50 minutes. How much time will it take for the completion of 80% of this reaction?

**Question 9****[3]**

- (a) The freezing point of a solution containing 5.85g of NaCl in 100g of water is  $-3.348^{\circ}\text{C}$ . Calculate van't Hoff factor 'i' for this solution. What will be the experimental molecular weight of NaCl?

( $K_f$  for water =  $1.86 \text{ K kg mol}^{-1}$ , at. wt. Na = 23, Cl = 35.5)

**OR**

- (b) An aqueous solution containing 12.48g of barium chloride ( $\text{BaCl}_2$ ) in 1000g of water, boils at  $100.0832^{\circ}\text{C}$ . Calculate the degree of dissociation of barium chloride. ( $K_b$  for water =  $0.52 \text{ K kg mol}^{-1}$ , at. wt. Ba = 137, Cl = 35.5)

**Question 10**

[3]

Examine the defective crystal given below and answer the question that follows:

$A^+$	$B^-$	$A^+$	$B^-$	$A^+$
$B^-$		$B^-$	$A^+$	$B^-$
$A^+$	$B^-$	$A^+$		$A^+$
$B^-$	$A^+$	$B^-$	$A^+$	$B^-$

State if the above defect is stoichiometric or non-stoichiometric. How does this defect affect the density of the crystal? Also, write the term used for this type of defect.

**Question 11**

[3]

Give reason for each of the following:

- For ferric hydroxide sol the coagulating power of phosphate ion is more than chloride ion.
- Medicines are more effective in their colloidal form.
- Gelatin is added to ice creams.

**Question 12**

[3]

- For the complex ion  $[Fe(CN)_6]^{3-}$ , state:
  - the type of hybridisation.
  - the magnetic behaviour.
  - the oxidation number of the central metal atom.
- Write the IUPAC name of  $[Co(en)_2Cl_2]^+$  ion and draw the structures of its geometrical isomers.

**Question 13**

[3]

- Explain why:
  - $Mn^{2+}$  is more stable than  $Fe^{2+}$  towards oxidation to +3 state.  
(At. no. of Mn = 25, Fe = 26)
  - Transition elements usually form coloured ions.
  - Zr and Hf exhibit similar properties.  
(At. no. of Zr = 40, Hf = 72)

**OR**

(b) Complete and balance the following chemical equations:



**Question 14**

[3]

(a) Arrange the following in the increasing order of their basic strength:



(b) Give a balanced chemical equation to convert methyl cyanide to ethyl alcohol.

(c) What happens when benzene diazonium chloride reacts with phenol in weak alkaline medium? (Give balanced equation).

**Question 15**

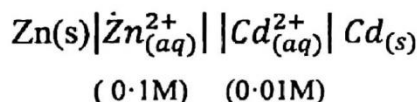
[3]

Name the sulphide ore of Copper. Describe how pure copper is extracted from this ore.

**Question 16**

[5]

(a) (i) Calculate the emf and  $\Delta G^\circ$  for the cell reaction at  $25^\circ\text{C}$ :



Given  $E^\circ \text{Zn}^{2+}/\text{Zn} = -0.763$  and  $E^\circ \text{Cd}^{2+}/\text{Cd} = -0.403\text{V}$

(ii) Define the following terms:

(1) Equivalent conductivity

(2) Corrosion of metals

**OR**

(b) (i) The specific conductivity of a solution containing 5 g of anhydrous  $\text{BaCl}_2$  (mol. wt. = 208) in  $1000 \text{ cm}^3$  of a solution is found to be  $0.0058 \text{ ohm}^{-1}\text{cm}^{-1}$ . Calculate the molar and equivalent conductivity of the solution.

(ii) What is an electrochemical series? How is it useful in predicting whether a metal can liberate hydrogen from acid or not?

**Question 17****[5]**

- (a) (i) Explain why:
- (1) Nitrogen does not form pentahalides.
  - (2) Helium is used for filling weather balloons.
  - (3) ICl is more reactive than I<sub>2</sub>.
- (ii) Draw the structures of the following:
- (1) HClO<sub>4</sub>
  - (2) H<sub>3</sub>PO<sub>3</sub>

**OR**

- (b) (i) Explain why:
- (1) Mercury loses its meniscus in contact with ozone.
  - (2) Halogens are coloured and the colour deepens on moving down in the group from fluorine to iodine.
  - (3) Hydride of sulphur is a gas while hydride of oxygen is a liquid.
- (ii) Complete and balance the following reactions:
- (1)  $\text{NaCl} + \text{MnO}_2 + \text{H}_2\text{SO}_4 \rightarrow \underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}}$
  - (2)  $\text{KMnO}_4 + \text{SO}_2 + \text{H}_2\text{O} \rightarrow \underline{\hspace{2cm}} + \underline{\hspace{2cm}} + \underline{\hspace{2cm}}$

**Question 18****[5]**

- (a) (i) Give balanced equations for the following reactions:
- (1) Benzaldehyde reacts with hydrazine.
  - (2) Acetic acid reacts with phosphorous pentachloride.
  - (3) Acetone reacts with sodium bisulphite.
- (ii) Give one chemical test each to distinguish between the following pairs of compounds:
- (1) Ethanol and acetic acid
  - (2) Acetaldehyde and benzaldehyde

**OR**

- (b) (i) Write chemical equations to illustrate the following name reactions:
- (1) Clemmensen's reduction
  - (2) Rosenmund's reduction
  - (3) HVZ reaction

(ii) Explain why:

- (1) Acetaldehyde undergoes aldol condensation, but formaldehyde does not.
- (2) Acetic acid is a weaker acid as compared to formic acid.