

2016

(April)

CHEMISTRY

(Elective/Honours)

SECOND PAPER

(Inorganic, Organic, Physical)

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—I

(Inorganic)

(Marks : 19)

- (a) Define solubility product. The solubility of AgCl in water at 25 °C is 0.00179 g /l. Calculate its solubility product at 25 °C. 2½

(b) How are pK_a and pK_b values related to strength of acids and bases? Among H_3PO_4 , $H_2PO_4^-$ and HPO_4^{2-} , which one is expected to have the highest value of pK_a and which one the least? 3

(2)

- (c) H_2S is used as group reagent in Group II and Group IIIB in the analysis of cations in qualitative inorganic analysis. Why are Group IIIB cations not precipitated in Group II, all precipitates being in form of their sulphides? 2
- (d) How does a primary standard solution differ from a secondary standard solution? Give two examples of secondary standard substances. 2

OR

2. (a) Discuss briefly the solvent system concept of acids and bases. What are its limitations? 2½
- (b) What are acid-base indicators? Give an example. Explain why phenolphthalein cannot be used as an indicator in the titration of aq. NH_3 against dil. HCl. 2½
- (c) What are Lewis acids and bases? Give an example for each. 2
- (d) Explain the levelling effect of acids and bases with appropriate examples. 2½

D16/1439

(Continued)

(3)

3. (a) Describe the process of extraction of copper from its sulphide ore. Write the relevant chemical equation involved. 3
- (b) What is standard electrode potential? Mention two of its applications. 2
- (c) The reaction



occurs in a cell. Write the electrode reactions and calculate the standard e.m.f. of the cell. Given that

$$E^\circ_{Zn^{2+}/Zn} = 0.76 \text{ V and } E^\circ_{Co/Co^{2+}} = 0.28 \text{ V} \quad 2$$

- (d) What are mixed fertilizers? Give example. Explain why NPK is called a complete fertilizer. 2½

OR

4. (a) Explain, in brief, the process of setting of cement. 3
- (b) Describe how urea is manufactured and write the relevant equations involved. 2½

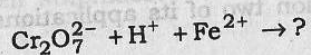
D16/1439

(Turn Over)

(4)

(c) What are paints and pigments? How are they classified? $2\frac{1}{2}$

(d) Complete and balance the following equation by ion-electron method : $1\frac{1}{2}$

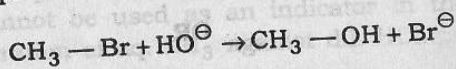


SECTION—II

(Organic)

(Marks : 19)

5. (a) The alkaline hydrolysis of methyl bromide to give methyl alcohol is a typical example of $\text{S}_{\text{N}}2$ reaction



Discuss the mechanism of the reaction and justify why the reaction is designated as $\text{S}_{\text{N}}2$. $1\frac{1}{2} + 1 = 2\frac{1}{2}$

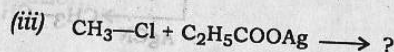
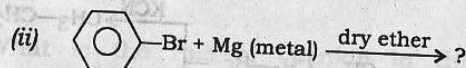
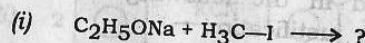
(b) Discuss the effect of solvent on $\text{S}_{\text{N}}1$ reaction rate. $1\frac{1}{2}$

(Continued)

D16/1439

(5)

(c) Complete the following reactions giving correct products : $1 \times 3 = 3$



(d) What is Saytzeff's rule? Considering the reaction between 2-chlorobutane and alcoholic KOH, apply Saytzeff's rule to justify the formation of the major and minor products. $1 + 1\frac{1}{2} = 2\frac{1}{2}$

OR

6. (a) Discuss the mechanism of $\text{E}_{1\text{cB}}$ reaction taking a suitable example. $2\frac{1}{2}$

(b) Why are unsymmetrical alkanes generally not prepared by Wurtz reaction? 2

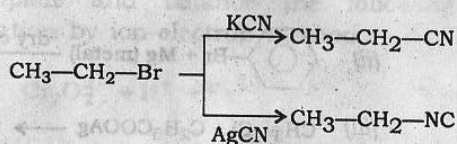
(c) Using the concept of resonance, illustrate why haloarenes are *ortho*- and *para*-directing towards electrophilic substitution reactions. 2

D16/1439

(Turn Over)

(6)

- (d) Explain why different products are formed in the following reaction with proper justification : $1\frac{1}{2}+1\frac{1}{2}=3$



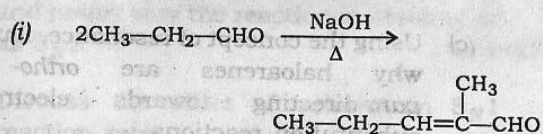
7. (a) Writing appropriate reactions involved, illustrate how you will distinguish among primary, secondary and tertiary alcohols using Victor Meyer's test. 3

- (b) With the help of chemical reactions, show what happens when—

(i) glycerol is treated with three equivalent amount of HI;

(ii) ethylene glycol reacts with HCl at 160°C . $1+1=2$

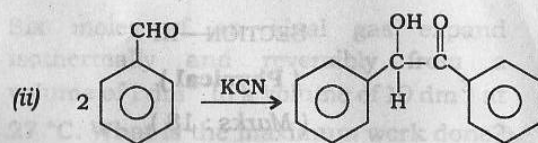
- (c) Write the mechanisms of the following reactions :



D16/1439

(Continued)

(7)



What is the role of cyanide in this reaction? $2+2+\frac{1}{2}=4\frac{1}{2}$

OR

8. (a) Why is phenol more acidic than alcohol? $1\frac{1}{2}$

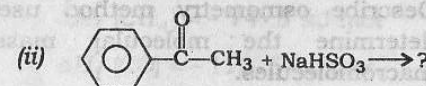
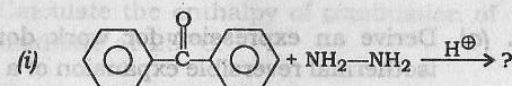
- (b) Write the correct mechanisms of the following name reactions : $2\times 2=4$

(i) Perkin reaction

(ii) Kolbe's reaction of phenol

- (c) How can you convert cumene to phenol? 2

- (d) Write the products of the following reactions : $1\times 2=2$



D16/1439

(Turn Over)

(8)

SECTION—III

(Physical)

(Marks : 18)

9. (a) What are intensive and extensive properties? 1+1=2

(b) Derive the relation

$$C_p - C_v = nR$$

The terms have their usual meanings. 3

(c) Define the following : 1+1=2

(i) Degree of polymerization

(ii) Weight average molecular mass

(d) One mole of an ideal gas is heated at constant pressure from 0 °C to 100 °C. Calculate the work done. 2

OR

10. (a) Derive an expression for work done in isothermal reversible expansion of a gas. 3

(b) Describe osmometry method used to determine the molecular mass of macromolecules. 3

(c) What is Joule-Thomson effect? 1

D16/1439

(Continued)

(9)

(d) Six moles of an ideal gas expand isothermally and reversibly from a volume of 1 dm³ to a volume of 10 dm³ at 27 °C. What is the maximum work done? Express the result in joules. 2

11. (a) State and explain Hess's law of constant heat summation by giving one example. 2+1=3

(b) Derive Langmuir adsorption isotherm. 3

(c) Define the following : 1×3=3

(i) Enthalpy of formation

(ii) Enthalpy of combustion

(iii) Enthalpy of neutralization

OR

12. (a) Derive Kirchhoff's equations. 3

(b) Define physisorption and chemisorption. Give one example of each. 1½+1½=3

(c) Calculate the enthalpy of combustion of methane at 25 °C. 3

Given :

$$\Delta H_f^\circ (\text{CH}_4) = -74.8 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ (\text{CO}) = -110.5 \text{ kJ mol}^{-1}$$

$$\Delta H_f^\circ (\text{H}_2\text{O}) = -288.9 \text{ kJ mol}^{-1}$$

D16—3300/1439

2/EH-23 (ii) (Syllabus-2015)

2/EH-23 (ii) (Syllabus-2015)

2017

(April)

CHEMISTRY

(Elective/Honours)

(General Chemistry—II)

(Inorganic, Organic and Physical)

(Chem-EH-201)

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

SECTION—I

(Inorganic)

(Marks : 19)

1. (a) Define solubility product. The solubility of CaF_2 in water at 18°C is 2.05×10^{-4} mol/l. Calculate its solubility product. 1+1½=2½

(b) How does iodometry differ from iodimetry? 1+1=2

(c) An aqueous solution is prepared by dissolving 4 g of NaOH to give 500 ml of it. Calculate the molarity of the solution. 1

(d) Define acids and bases on the basis of Arrhenius concept. Give an example for each. What is the limitation of this concept? 1+1+1=3

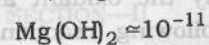
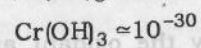
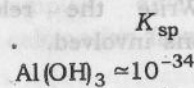
(e) Given the pK_a values for each, which is a strong acid, H_2SO_4 ($pK_a = -1$) or H_2SO_3 ($pK_a = 1.9$). 1

OR

2. (a) What are acid-base indicators? Discuss the action of phenolphthalein as an indicator. 1+2=3

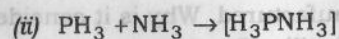
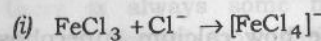
(b) In liquid NH_3 , NH_4Cl and KNH_2 behave as an acid and base respectively. Explain using solvent system concept. 2

(c) The solubility product of the hydroxides of Al, Cr and Mg are as follows :

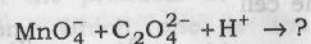


In systematic group separation, explain how you would separate the hydroxides of Al and Cr from that of Mg. 2½

(d) Identify Lewis acid and Lewis bases in the following reactions : 1×2=2



3. (a) Complete and balance the following equation by ion-electron method : 2

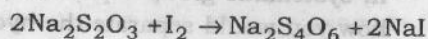


(b) Write down the essential constituents of cement. What is the role of gypsum in the setting of cement? 1½+1=2½

(4)

(c) Discuss in brief the process of extraction of aluminium from its bauxite ore. Write the relevant chemical equations involved. 3

(d) Identify the oxidant and reductant in the following reaction. Calculate the equivalent weight of the oxidant : $1+1=2$



Molecular weight of

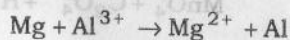
$$\text{Na}_2\text{S}_2\text{O}_3 = 248.2 \text{ g/mol}$$

Molecular weight of $\text{I}_2 = 253.80 \text{ g/mol}$

OR

4. (a) Describe how calcium superphosphate is manufactured. Why is it considered a good fertilizer? $2\frac{1}{2}$

(b) What is electrochemical series? Predict whether the following reaction is feasible or not. Calculate the e.m.f. of the cell $1+2=3$



Given

$$E_{\text{Mg}^{2+}/\text{Mg}}^\circ = -2.37 \text{ V}$$

$$E_{\text{Al}^{3+}/\text{Al}}^\circ = -1.66 \text{ V}$$

D72/1346

(Continued)

(5)

(c) Write down the essential constituents of paints. What are the characteristics of good paints? 2

(d) Giving examples, differentiate the process of calcination from roasting. 2

SECTION—II

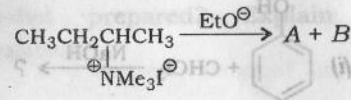
(Organic)

(Marks : 19)

5. (a) Generally $\text{S}_{\text{N}}1$ reactions of optically active substrates are said to be accompanied by racemization, but in actual practice it has been found that there is always some net inversion. Account for this observation. 3

(b) Why does isopropyl amine react faster than triethylamine with isopropyl iodide in an $\text{S}_{\text{N}}2$ reaction? $1\frac{1}{2}$

(c) Predict the products in the following reaction. Which one is the major product and why? $2\frac{1}{2}$



D72/1346

(Turn Over)

(6)

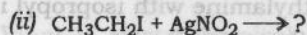
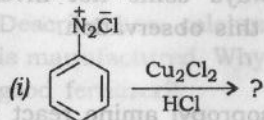
(d) Discuss the mechanistic pathway for the nucleophilic substitution of activated aryl halides. 2½

OR

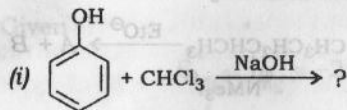
6. (a) What happens when alcohol is treated with thionyl chloride in the presence of pyridine? Explain with appropriate mechanism. 3

(b) Explain the stereospecific nature of E2 reactions by giving suitable examples. 2½

(c) Complete the following reactions with mechanism : 2+2=4



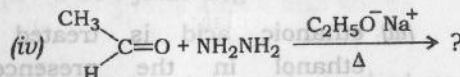
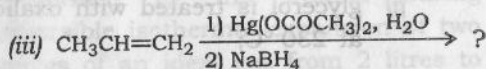
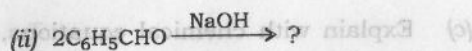
7. (a) Write the product(s) of the following reactions with mechanism (any three) : 3×3=9



D72/1346

(Continued)

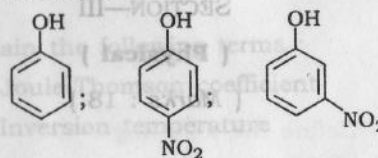
(7)



(b) Which one is more reactive towards nucleophiles, aldehydes or ketones? ½

OR

8. (a) Arrange the following in increasing order of acidity with proper justification : 2



(b) Starting from an alkene, how is a trans-diol prepared? Explain with mechanism. 2½

D72/1346

(Turn Over)

(8)

(c) Explain with chemical equations, what happens when—

(i) glycerol is treated with oxalic acid at 230 °C;

(ii) ethanal is treated with sodium bisulphite;

(iii) ethanoic acid is treated with ethanol in the presence of concentrated H_2SO_4 ;

(iv) glycol is treated with lead-tetraacetate;

(v) phenol is treated with benzene diazonium chloride in alkaline medium.

1×5=5

SECTION—III

(Physical)

(Marks : 18)

9. (a) Define the following terms : 1×3=3

(i) Closed system

(ii) Isolated system

(iii) Isobaric process

D72/1346

(Continued)

(9)

(b) Calculate the pressure-volume work performed by the system during reversible isothermal expansion of two moles of an ideal gas from 2 litres to 10 litres at 20 °C.

[$R = 8.314 \text{ joule degree}^{-1} \text{ mol}^{-1}$]

2

(c) Describe the viscometric method used to determine the molecular mass of macromolecules.

4

OR

10. (a) State the first law of thermodynamics and give its mathematical formulation.

1+2=3

(b) Explain the following terms : 1½×2=3

(i) Joule-Thomson coefficient

(ii) Inversion temperature

(c) Equal numbers of molecules with $M_1 = 10000$ and $M_2 = 100000$ are mixed. Calculate number average molecular mass (\bar{M}_N) and weight average molecular mass (\bar{M}_M).

1½+1½=3

D72/1346

(Turn Over)

(10)

11. (a) Derive Kirchhoff's equation showing the influence of temperature on ΔH and ΔU of a reaction. 4
- (b) The enthalpy of neutralization of a strong acid with a strong base is always the same. Explain why. 2
- (c) Enthalpies of formation of $C_2H_5OH(l)$, $CO_2(g)$ and $H_2O(l)$ are $-277.0 \text{ kJ mol}^{-1}$, $-393.5 \text{ kJ mol}^{-1}$ and $-285.8 \text{ kJ mol}^{-1}$ respectively. Calculate enthalpy change for the reaction at 25°C and 1 atm pressure 3
- $$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

OR

12. (a) Define the following: 1×3=3
- (i) Enthalpy of combustion
- (ii) Enthalpy of formation
- (iii) Enthalpy of solution
- (b) Distinguish between absorption and adsorption. 2

D72/1346

(Continued)

(11)

- (c) Discuss the behaviour of Langmuir isotherm at very high and very low pressure and hence show that at intermediate pressure it reduces to Freundlich isotherm. 4

D72-3600/1346

2/EH-23 (ii) (Syllabus-2015)

2/EH-23 (ii) (Syllabus-2015)

2018

(April)

CHEMISTRY

(Elective/Honours)

(**General Chemistry—II**)

(**Inorganic, Organic and Physical**)

(Chem-EH-201)

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

SECTION—I

(**Inorganic**)

(Marks : 19)

1. (a) How is the concept of solubility product used in the group separation of cations? 4
- (b) What is a primary standard solution? Give two examples. 2
- (c) Which is the strongest Lewis acid in the series of—
- (i) BF_3 , BCl_3 , BI_3 ;
- (ii) BeCl_2 , BCl_3 ?
- Give reasons. 2

8D/1708

(Turn Over)

(2)

- (d) What do you understand by levelling effects of solvents? 1½

OR

2. (a) 20 ml of 0.001 M AgNO₃ solution is added to 1 litre of 0.002 M K₂CrO₄ solution. Will there be any precipitation? *K*_{sp} of Ag₂CrO₄ is 2.4 × 10⁻¹². 2
- (b) The colour change of acid-base indicators are explained on the basis of which theory? Outline the theory. 3½
- (c) Give the conjugate acids of —H₂O, NH₃, Cl⁻ and HSO₄⁻. 2
- (d) Distinguish between iodometry and iodimetry. 2
3. (a) Complete and balance the following equation by ion-electron method : 2
$$\text{Cr}_2\text{O}_7^{2-} + \text{H}^+ + \text{I}^- \rightarrow ?$$
- (b) What do you understand by the electrochemical series? List its applications. 3
- (c) What is 'blister copper'? How is it purified? 2
- (d) What are potash fertilizers? What is NPK fertilizer used for? 2½

8D/1708

(Continued)

(3)

OR

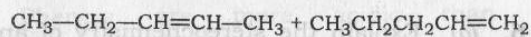
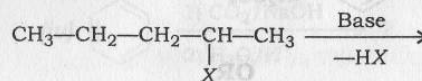
4. (a) The standard electrode potentials of a few metals are given below :
Al (-1.66 V), Cu (+0.34 V), Li (-3.05 V), Ag (+0.80 V) and Zn (-0.76 V)
- Which of the following will behave as the strongest oxidizing agent and which will be the strongest reducing agent? 2
- (b) "All ores are minerals but all minerals are not ores." Explain. 2
- (c) How are paints classified on the basis of the colour of pigments? 3½
- (d) Distinguish between the wet process and dry process of manufacture of cement. 2

SECTION—II

(Organic)

(Marks : 19)

5. (a) Consider the following E2 reaction :



2-pentene 1-pentene

8D/1708

(Turn Over)

(4)

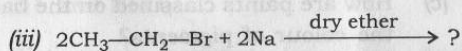
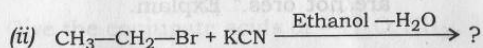
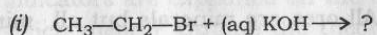
when

X = F	30%	70%
Cl	65%	35%
Br	72%	28%
I	80%	20%

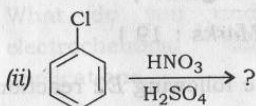
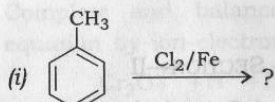
Explain the variations in the proportions of the alkenes obtained. 4

(b) Complete the following reactions :

$$\frac{1}{2} \times 3 = 1\frac{1}{2}$$



(c) Predict the products in the following reactions with mechanism : $2 \times 2 = 4$



OR

6. (a) Explain the stereochemistry of an $\text{S}_{\text{N}}2$ reaction by giving suitable example. 3

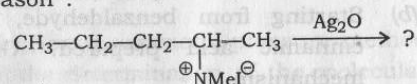
8D/1708

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(5)

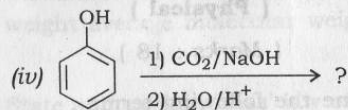
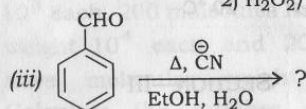
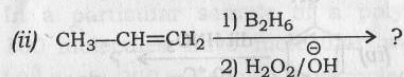
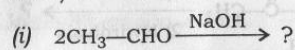
(b) Explain the effect of solvent on the rate of $\text{S}_{\text{N}}1$ reaction. 2

(c) Predict the major product in the following reaction. Explain with proper reason : $2\frac{1}{2}$



(d) How does electron withdrawing substituents affect the reactivity of aryl halide towards nucleophilic substitution reaction? 2

7. (a) Write the product(s) of the following reactions with proper mechanism (any three) : $2\frac{1}{2} \times 3 = 7\frac{1}{2}$



(b) Phenols are more acidic than cyclohexanol. Explain. 2

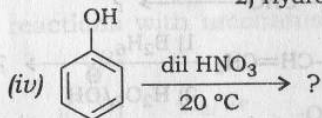
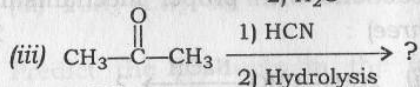
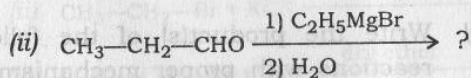
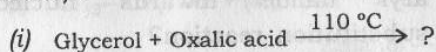
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(Turn Over)

(6)

OR

8. (a) How will you distinguish among primary, secondary and tertiary alcohols by Lucas test? $1\frac{1}{2}$
- (b) Starting from benzaldehyde, how is cinnamic acid prepared? Give the mechanism. 2
- (c) Predict the product(s) in the following reactions with proper mechanism (any three) : $2 \times 3 = 6$



SECTION—III

(Physical)

(Marks : 18)

9. (a) Define the following terms : $1 \times 3 = 3$
- (i) Adiabatic process
- (ii) Extensive property
- (iii) Reversible process

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(-Continued)

(7)

- (b) 10 moles of an ideal gas at the initial pressure of 1 atmosphere at 0°C were expanded reversibly under isothermal conditions to a final pressure of 0.1 atmosphere. Calculate the work done by the gas ($R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$). 2
- (c) Describe the osmotic pressure method for the determination of the molecular mass of macromolecules. 4

OR

10. (a) Deduce the relation between C_P and C_V . Explain why C_P is always greater than C_V . $2+1=3$
- (b) What is Joule-Thomson effect? Describe the experimental setup of the Joule-Thomson effect. $1+2=3$
- (c) In a particular sample of a polymer, 100 molecules have molecular weight 10^3 each, 200 molecules have molecular weight 10^4 each and 200 molecules have molecular weight 10^5 each. Calculate the number average and weight average molecular weights. $1\frac{1}{2}+1\frac{1}{2}=3$

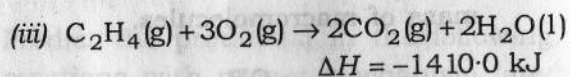
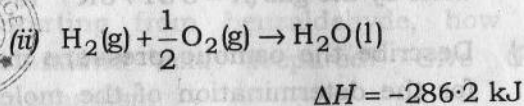
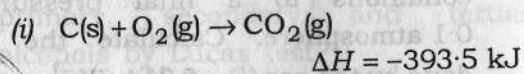
11. (a) State and explain Hess' law of constant heat summation. Explain some of its important applications. $1+2+1=4$

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(Turn Over)

(8)

(b) Calculate the enthalpy of formation of ethylene at 25 °C from the following data :



(c) Derive an expression for work done in an isothermal reversible expansion of a gas.

OR

12. (a) What are exothermic and endothermic reactions? In an exothermic reaction, is the internal energy of the products greater or lesser than internal energy of the reactants? $2 + \frac{1}{2} = 2\frac{1}{2}$

(b) Give five differences between physisorption and chemisorption. $\frac{1}{2} \times 5 = 2\frac{1}{2}$

(c) Deduce the Langmuir adsorption isotherm equation. 4
