

2020

CHEMISTRY

(Major)

Course : 201

(**Physical, Inorganic, Organic**)

(New Course)

Full Marks : 80

Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

Write the answers to the separate Sections in separate books

SECTION—I

(**Physical Chemistry**)

(Marks : 26)

1. Choose the correct answer from the following : 1×3=3

(a) Heat of neutralization of NaOH and HCl is $-57.46 \text{ kJ mol}^{-1}$. The heat of ionization of water in kJ mol^{-1} is

(i) -57.46

(ii) $+57.46$

(iii) -114.92

(iv) 114.92

- (b) Intensive property of a system is
- (i) internal energy
 - (ii) enthalpy
 - (iii) viscosity
 - (iv) free energy
- (c) The best indicator for titrating HCl with NH_4OH is
- (i) litmus
 - (ii) phenolphthalein
 - (iii) methyl orange
 - (iv) phenol red

UNIT—I

Answer any *two* questions from the following :

6×2=12

2. (a) Differentiate between extensive property and intensive property with one example of each. 2
- (b) How are the pressure and volume related to each other during the adiabatic expansion of an ideal gas? Deduce the relation. 4
3. (a) What is Joule-Thomson coefficient? Show that Joule-Thomson coefficient is zero for an ideal gas. 1+3=4
- (b) State and explain Hess' law of constant heat summation. 2
4. Calculate the work done when an ideal gas expands—
- (a) isothermally and reversibly from volume V_1 to V_2 ;
 - (b) isothermally and irreversibly from volume V_1 to V_2 .

From these, show that the work done in a reversible process is greater than that in an irreversible process.

2+2+2=6

UNIT—II

Answer any *two* questions from the following :

$5\frac{1}{2} \times 2 = 11$

5. (a) What is a buffer solution? What are the different types of buffer solution? Give one example of each type of buffer solutions. Deduce Henderson equation for acidic buffer solution. What is buffer capacity? $3 + 1\frac{1}{2} + 1 = 5\frac{1}{2}$
- (b) (i) Differentiate between solubility product and ionic product. Establish the relationship between solubility and solubility product of cobalt phosphate. $2 + 2 = 4$
- (ii) Calculate the pH of 1.0×10^{-3} M NaOH solution. $1\frac{1}{2}$
- (c) What is salt hydrolysis? Prove that the aqueous solution of a salt formed by a strong acid and weak base is acidic in nature. $1\frac{1}{2} + 4 = 5\frac{1}{2}$

SECTION—II

(Inorganic Chemistry)

(Marks : 27)

6. Choose the correct answer from the following :

$1 \times 3 = 3$

(a) B_nH_{n+6} belongs to

- (i) *chloso*
- (ii) *nido*
- (iii) *arachno*
- (iv) *hypo*

(b) Zeolite ZSM-5 is used as catalyst in the manufacture of

- (i) *o*-xylene
- (ii) *p*-xylene
- (iii) toluene
- (iv) *m*-xylene

(c) The metal oxide which cannot be reduced by carbon is

- (i) ZnO
- (ii) PbO
- (iii) Fe_2O_3
- (iv) Cr_2O_3

UNIT—I

7. Answer any *three* questions from the following : 3×3=9

- (a) Discuss the formation of B—H—B bridge bond in B_2H_6 molecule. BH_3 does not exist but BF_3 is a stable molecule. Explain. 2+1=3
- (b) How is hydrazine prepared? Discuss its reducing property. 1+2=3
- (c) What are zeolites? Write a note on the use of zeolite as catalyst. 1+2=3
- (d) Explain the structures of XeF_2 and XeF_6 . 1½+1½=3
- (e) Give the structures of the following : 1×3=3
 P_4O_{10} , H_3PO_4 , $\text{H}_4\text{P}_2\text{O}_7$

8. Write short notes on any *two* of the following : 2×2=4

- (a) Inorganic benzene
- (b) Wade's rule
- (c) Buckminsterfullerene

UNIT—II

9. (a) Describe the chemical changes taking place during roasting of a sulphide ore. 2

- (b) Name one metal that is refined by each of the following processes : ½×4=2
 - (i) Vacuum-arc process
 - (ii) Electrolysis
 - (iii) van Arkel process
 - (iv) Zone refining

(c) Describe the extraction of any one of the following :

4

(i) Chromium from chromite ore

(ii) Nickel from pentlandite ore

(d) Give the preparation of any two of the following :

1½×2=3

(i) Potassium permanganate

(ii) Ammonium molybdate

(iii) Vanadium pentoxide

SECTION—III

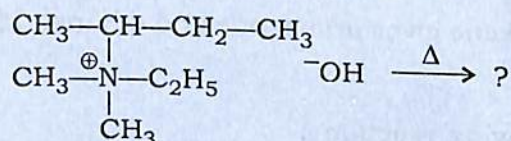
(Organic Chemistry)

(Marks : 27)

10. Choose the correct answer from the following :

1×3=3

(a) The major alkene produced in the reaction



is

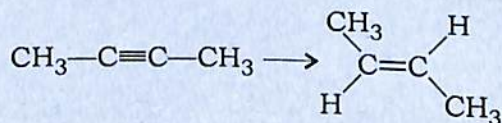
(i) $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$

(ii) $\text{CH}_2=\text{CH}_2$

(iii) $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$

(iv) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

(b) The reagent used for the reaction



is

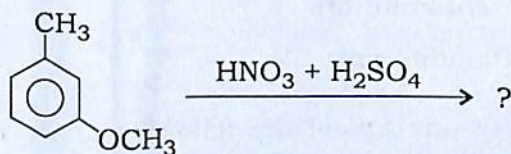
(i) HgO

(ii) $\text{H}_2 + \text{Lindlar cat.}$

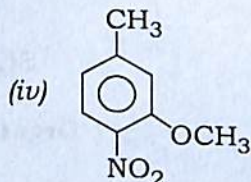
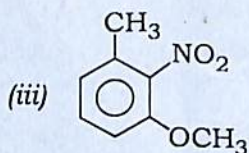
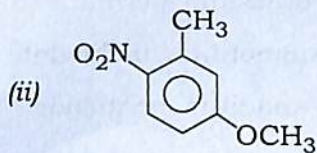
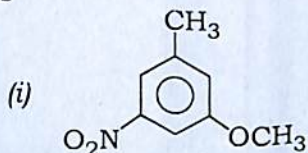
(iii) NaBH_4

(iv) $\text{Na} + \text{NH}_3 (\text{l})$

(c) The major product formed in the reaction



is

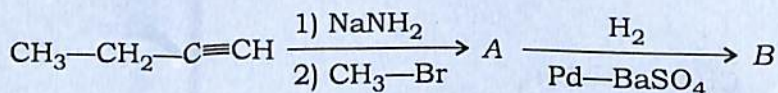


11. Answer any six questions of the following :

2×6=12

(a) Ozonolysis of an alkene gives propanone and ethanal. Identify the alkene.

(b) Complete the following reaction :



(c) Arrange the following alkanes in increasing order of their boiling point :

(i) 2-Methylpentane

(ii) 2,2-Dimethylpropane

(iii) Heptane

(iv) 2,3-Dimethylbutane

(d) What will be the alkane formed when 2-bromopropane is reacted with sodium in dry ether?

(e) How can you distinguish between hex-1-yne and hex-2-yne?

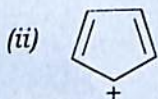
- (f) How will you convert 2-bromopropane to bromopropane?
- (g) How will you synthesize 2-methylbutane by Corey-House synthesis?
- (h) Write a short note on Chugaev reaction.

12. Answer any *two* questions from the following : 3×2=6

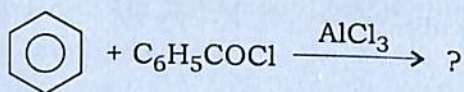
- (a) Draw the Newman conformation of chair and boat form of cyclohexane. Which conformer is more stable and why?
- (b) Discuss Baeyer-Strain theory. What are its limitations?
- (c) Discuss the conformation analysis of butane.

13. Answer any *two* questions from the following : 3×2=6

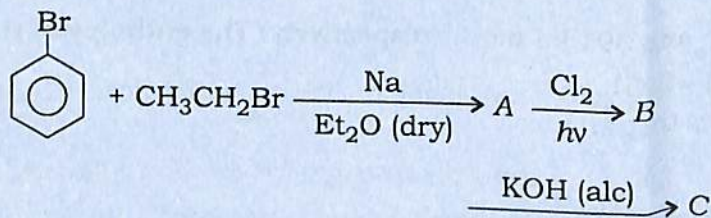
- (a) Apply Hückel's theory to predict aromatic behaviour of the following :



- (b) Complete the following reaction and write the mechanism :



- (c) Complete the following reaction :



(Old Course)

Full Marks : 80

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SECTION—I

(Physical Chemistry)

(Marks : 26)

1. Choose the correct answer from the following :

1×3=3

(a) Heat of neutralization of NaOH and HCl is $-57.46 \text{ kJ mol}^{-1}$. The heat of ionization of water in kJ mol^{-1} is

(i) -57.46

(ii) $+57.46$

(iii) -114.92

(iv) 114.92

(b) The bond energies of $\text{N}\equiv\text{N}$, $\text{H}-\text{H}$ and $\text{N}-\text{H}$ bonds are 945 kJ mol^{-1} , 436 kJ mol^{-1} and 391 kJ mol^{-1} respectively. The enthalpy of the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) = 2\text{NH}_3(\text{g})$ is

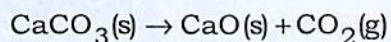
(i) -93 kJ

(ii) 102 kJ

(iii) 80 kJ

(iv) 105 kJ

(c) For the reaction



the correct statement is

(i) $\Delta H = \Delta E$

(ii) $\Delta H > \Delta E$

(iii) $\Delta H < \Delta E$

(iv) $\Delta H = \frac{1}{2}\Delta E$

UNIT—I

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- (b) How are the pressure and volume related to each other during the adiabatic expansion of an ideal gas? Deduce the relation. 4
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- (b) isothermally and irreversibly from volume V_1 to V_2 .
- From these, show that the work done in a reversible process is greater than that in an irreversible process. 2+2+2=6

UNIT—II

Answer any *two* questions from the following :

5½×2=11

5. (a) Deduce an expression for entropy changes associated with the changes in volume and temperature of an ideal gas. 4
- (b) Write the SI unit of entropy. Mention two factors upon which entropy depends. ½+1=1½
6. (a) Deduce an expression showing the variation of Helmholtz free energy with volume at constant temperature for an ideal gas. 2½
- (b) Write the physical significance of Gibbs' free energy. 1
- (c) For the reaction $\text{CO(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$, the standard entropy change is $-0.094 \text{ kJ mol}^{-1} \text{ K}^{-1}$ and standard enthalpy change is $-285.4 \text{ kJ mol}^{-1}$ at 300 K. State whether the reaction is spontaneous or not at this temperature. 2
7. (a) State and explain Nernst heat theorem. 2
- (b) Explain how the third law of thermodynamics can be used for the evaluation of absolute entropy of a substance. 3½

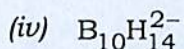
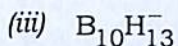
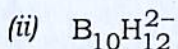
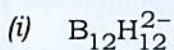
SECTION—II

(Inorganic Chemistry)

(Marks : 27)

8. Choose the correct answer from the following : 1×3=3
- (a) Hybridization involved in the formation of XeOF_4 molecule is sp^3d^2 . The shape of the molecule is
- (i) octahedral
- (ii) trigonal bipyramidal
- (iii) pentagonal bipyramidal
- (iv) square pyramidal

(b) $B_{10}C_2H_{12}$ is isostructural and isoelectronic with



(c) van Arkel method of purification of metals involves converting the metal to a

(i) volatile stable compound

(ii) volatile unstable compound

(iii) non-volatile stable compound

(iv) None of the above

UNIT—I

9. Answer any *three* questions from the following :

3×3=9

(a) What are *closo-*, *nido-* and *arachno-*boranes? Give one example of each.

3

(b) What are silicones? How can they be prepared?

3

(c) Discuss the structures of XeF_6 and XeF_4 .

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

(d) NH_2OH can behave both as oxidizing agent and as reducing agent. Illustrate by giving two examples.

3

(e) Describe the preparation and structure of tetrasulphur tetranitride.

3

10. Discuss the structures and bondings of any *two* of the following :

2×2=4

(a) Borazine

(b) P_4O_{10}

(c) $[NPCl_2]_3$

UNIT—II

11. How will you obtain any *two* of the following? 3×2=6

- (a) Manganese from pyrolusite
- (b) Chromium trioxide from chromite
- (c) Nickel from bessemerized matte

12. Write a note on van Arkel process for purification of metals. 2

13. What is hydrometallurgy? Explain with the help of a suitable example! 1+2=3

Or

Complete any *three* of the following reactions : 1×3=3

- (i) $(\text{NH}_4)_2\text{MoO}_4 \xrightarrow{\text{heated}} ?$
- (ii) $\text{Na}_2\text{CrO}_4 + \text{H}_2\text{SO}_4 \longrightarrow ?$
- (iii) $\text{CoCl}_2 + \text{NaNO}_2 + \text{CH}_3\text{COOH} \longrightarrow ?$
- (iv) $\text{V}_2\text{O}_5 + \text{HCl} \longrightarrow ?$

SECTION—III

(Organic Chemistry)

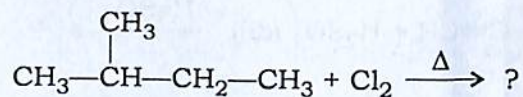
(Marks : 27)

14. Choose the correct answer from the following : 1×3=3

(a) Which of the following compounds will produce white p.p.t. with ammoniacal AgNO_3 ?

- (i) $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$
- (ii) $\text{CH}_3\text{CH}=\text{CH}-\text{CH}_3$
- (iii) $\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_3$
- (iv) $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$

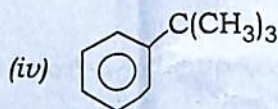
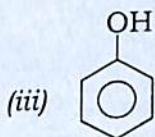
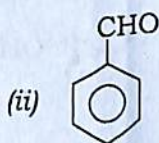
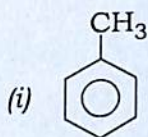
(b) The major chloroalkane produced in the reaction



is

- (i) 1-chloro-2-methylbutane
- (ii) 2-chloro-2-methylbutane
- (iii) 2-chloro-3-methylbutane
- (iv) 1-chloro-3-methylbutane

(c) The compound which will be most reactive towards electrophilic substitution reaction is

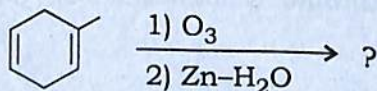


15. Answer any six questions from the following :

2×6=12

(a) How will you distinguish between hex-1-yne and hex-3-yne?

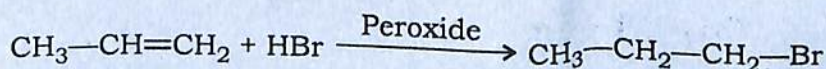
(b) What will be the products of the following reaction?



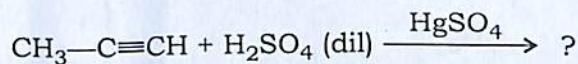
(c) How will you prepare 2-methylbutane by Corey-House synthesis?

(d) What is *syn*-elimination? Give example.

(e) Explain the following mechanism :

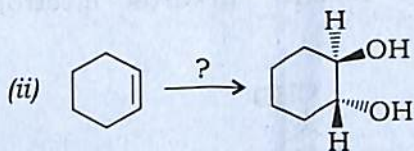
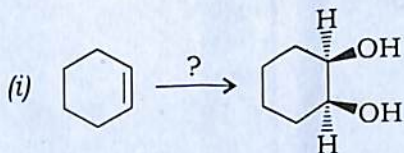


(f) Complete the following reaction and write the mechanism :



(g) How will you convert but-1-ene to but-1-yne?

(h) Write appropriate reagent for the following conversions :



16. Answer any *two* questions from the following :

3×2=6

(a) Draw Newman projection of chair and boat conformer of cyclohexane. Which conformer is more stable and why?

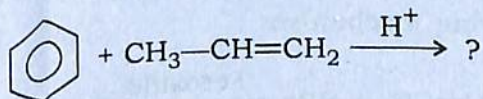
(b) Discuss the conformation analysis of butane.

(c) How can you prepare a suitable cycloalkane from a diester? Give reaction.

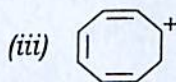
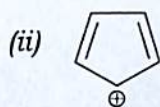
17. Answer any *two* questions from the following :

3×2=6

(a) Complete the following reaction and write down the mechanism :



(b) Apply Hückel rule to determine the aromatic property of any *two* of the following :



(c) Complete the following reaction :

