

SET-2

Series HFG1E/5



प्रश्न-पत्र कोड  
Q.P. Code 56/5/2

रोल नं.  
Roll No.

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परीक्षार्थी प्रश्न-पत्र कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें।  
Candidates must write the Q.P. Code on the title page of the answer-book.

रसायन विज्ञान (सैद्धांतिक)

CHEMISTRY (Theory)

निर्धारित समय : 3 घण्टे

Time allowed : 3 hours

अधिकतम अंक : 70

Maximum Marks : 70

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ 23 हैं।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए प्रश्न-पत्र कोड को परीक्षार्थी उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में 35 प्रश्न हैं।
- कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, उत्तर-पुस्तिका में प्रश्न का क्रमांक अवश्य लिखें।
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है। प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा। 10.15 बजे से 10.30 बजे तक परीक्षार्थी केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे।
- Please check that this question paper contains 23 printed pages.
- Q.P. Code given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains 35 questions.
- Please write down the serial number of the question in the answer-book before attempting it.
- 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the candidates will read the question paper only and will not write any answer on the answer-book during this period.



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260 B

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P.T.O.

### General Instructions :

Read the following instructions very carefully and follow them :

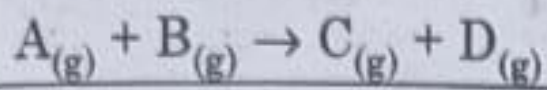
- (i) This question paper contains 35 questions. All questions are compulsory.
- (ii) Question paper is divided into FIVE sections – Section A, B, C, D and E.
- (iii) In section – A : Question Numbers 1 to 18 are Multiple Choice (MCQ) type Questions carrying 1 mark each.
- (iv) In section – B : Question Numbers 19 to 25 are Very Short Answer (VSA) type questions carrying 2 marks each.
- (v) In section – C : Question Numbers 26 to 30 are Short Answer (SA) type questions carrying 3 marks each.
- (vi) In section – D : Question Numbers 31 and 32 are case based questions carrying 4 marks each.
- (vii) In section – E : Question Numbers 33 to 35 are Long Answer (LA) type questions carrying 5 marks each.
- (viii) There is no overall choice. However, an internal choice has been provided in 2 questions in Section – B, 2 questions in Section – C, 2 questions in Section – D and 2 questions in Section – E.
- (ix) Use of calculators is NOT allowed.

### SECTION – A

1. Which one of the following has lowest  $pK_a$  value ? 1  
(a)  $CH_3 - COOH$  (b)  $O_2N - CH_2 - COOH$   
(c)  $Cl - CH_2 - COOH$  (d)  $HCOOH$
2. Which of the following cell was used in Apollo space programme ? 1  
(a) Mercury cell (b) Daniel cell  
(c)  $H_2 - O_2$  Fuel cell (d) Dry cell
3. Consider the following standard electrode potential values : 1  
 $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)} \quad E^\circ = + 0.77 \text{ V}$   
 $MnO_4^-_{(aq)} + 8H^+ + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)} \quad E^\circ = + 1.51 \text{ V}$   
What is the cell potential for the redox reaction ?  
(a)  $- 2.28 \text{ V}$  (b)  $- 0.74 \text{ V}$   
(c)  $+ 0.74 \text{ V}$  (d)  $+ 2.28 \text{ V}$



4. The following experimental rate data were obtained for a reaction carried out at 25 °C :



Initial $[A_{(g)}]/\text{mol dm}^{-3}$	Initial $[B_{(g)}]/\text{mol dm}^{-3}$	Initial rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
$3.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$1.89 \times 10^{-4}$
$3.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$1.89 \times 10^{-4}$
$6.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$7.56 \times 10^{-4}$

What are the orders with respect to  $A_{(g)}$  and  $B_{(g)}$  ?

	Order with respect to $A_{(g)}$	Order with respect to $B_{(g)}$
(a)	Zero	Second
(b)	First	Zero
(c)	Second	Zero
(d)	Second	First

5. The magnetic moment of  $[\text{NiCl}_4]^{2-}$  is :

- (a) 1.82 BM                                      (b) 2.82 BM  
(c) 4.42 BM                                      (d) 5.46 BM

[Atomic number : Ni = 28]

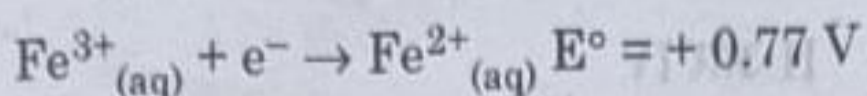
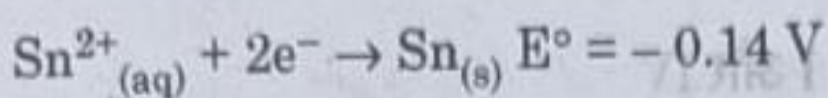
6. Which of the following ions has the electronic configuration  $3d^6$  ? (Atomic number : Mn = 25, Co = 27, Ni = 28)

- (a)  $\text{Ni}^{3+}$                                       (b)  $\text{Co}^{3+}$   
(c)  $\text{Mn}^{2+}$                                       (d)  $\text{Mn}^{3+}$



7. Which of the following aqueous solution will have highest boiling point? 1
- (a) 1.0 M KCl                      (b) 1.0 M K<sub>2</sub>SO<sub>4</sub>  
(c) 2.0 M KCl                      (d) 2.0 M K<sub>2</sub>SO<sub>4</sub>

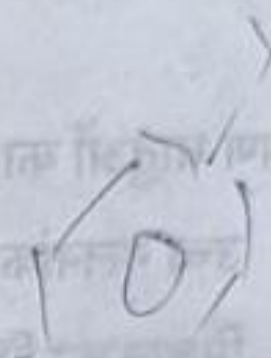
8. A voltaic cell is made by connecting two half cells represented by half equations below :



*no. of moles of solute / val. in kg*

Which statement is correct about this voltaic cell ?

- (a) Fe<sup>2+</sup> is oxidised and the voltage of the cell is -0.91 V.  
(b) Sn is oxidised and the voltage of the cell is 0.91 V.  
(c) Fe<sup>2+</sup> is oxidised and the voltage of the cell is 0.91 V.  
(d) Sn is oxidised and the voltage of the cell is 0.63 V.

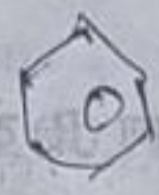


9. Amides can be converted into amines by the reaction named 1

- (a) Hoffmann degradation                      (b) Ammonolysis  
(c) Carbylamine                                      (d) Diazotisation

10. Which of the following statements is not true about glucose? 1

- (a) It is an aldohexose.  
(b) On heating with HI it forms n-hexane.  
(c) It is present in pyranose form.  
(d) It gives 2, 4 DNP test.



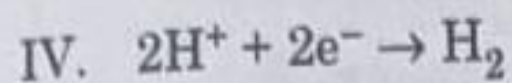
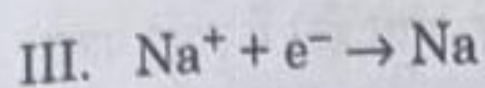
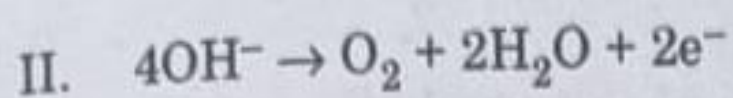
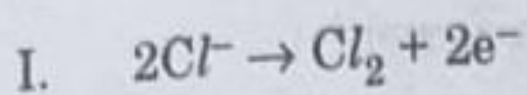
11. Which of the following alcohols will not undergo oxidation? 1

- (a) Butanol    (b) Butan-2-ol  
(c) 2-Methylbutan-2-ol                              (d) 3-Methylbutan-2-ol



12. Four half reactions I to IV are shown below :

1



Which two of these reactions are most likely to occur when concentrated brine is electrolysed ?

(a) I and III

(b) I and IV

(c) II and III

(d) II and IV

13. Which property of transition metals enables them to behave as catalysts ? 1

(a) High melting point

(b) High ionisation enthalpy

(c) Alloy formation

(d) Variable oxidation states

14. Which of the following would not be a good choice for reducing nitrobenzene to aniline ? 1

(a)  $LiAlH_4$

(b)  $H_2/Ni$

(c) Fe and HCl

(d) Sn and HCl

For questions number 15 to 18, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.



15. Assertion (A) : Vitamin C cannot be stored in our body. 1  
Reason (R) : Vitamin C is fat soluble and is excreted from the body in urine.

16. Assertion (A) : The half life of a reaction is the time in which the concentration of the reactant is reduced to one half of its initial concentration. 1

Reason (R) : In first order kinetics when concentration of reactant is doubled, its half life is doubled.

17. Assertion (A) : Bromination of benzoic acid gives m-bromobenzoic acid. 1

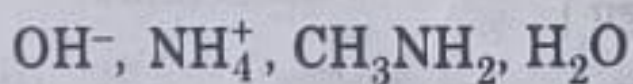
Reason (R) : Carboxyl group increases the electron density at the meta position.

18. Assertion (A) : EDTA is a hexadentate ligand. 1

Reason (R) : EDTA has 2 nitrogen and 4 oxygen donor atoms.

### SECTION - B

19. (a) Which of the following species cannot act as a ligand ? Give reason.



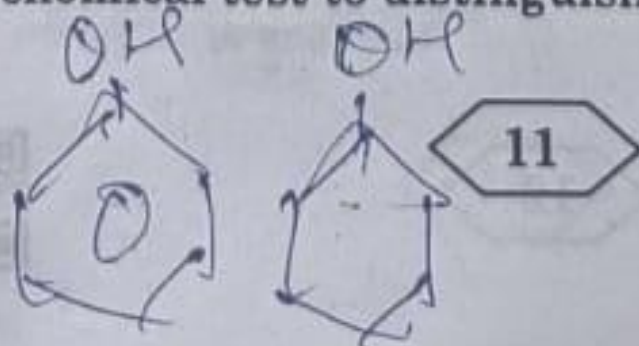
$2 \times 1 = 2$

(b) The complex  $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$  is red in colour. Give IUPAC name of its linkage isomer.

20. For the pair phenol and cyclohexanol, answer the following : 2 \times 1 = 2

(a) Why is phenol more acidic than cyclohexanol ?

(b) Give one chemical test to distinguish between the two.



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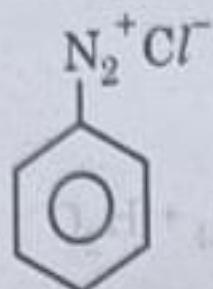


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21. (a) (i) Draw the zwitter ion structure for sulphanic acid.  $2 \times 1 = 2$   
 (ii) How can the activating effect of  $-NH_2$  group in aniline be controlled?

OR

- (b) (i) Complete the reaction with the main product formed:  $2 \times 1 = 2$



- (ii) Convert Bromoethane to Propanamine.

22. Write equations for the following:  $2 \times 1 = 2$

- (a) Oxidation of chloroform by air and light  
 (b) Reaction of chlorobenzene with  $CH_3Cl$  / anhyd.  $AlCl_3$

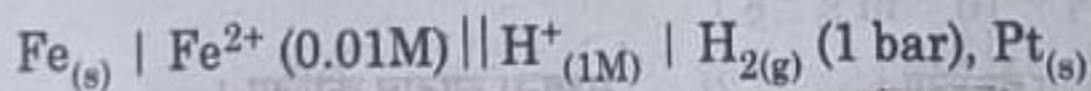
23. What happens to the rate constant  $k$  and activation energy  $E_a$  as the temperature of a chemical reaction is increased? Justify.  $2$

24. (a) (i) What should be the signs (positive/negative) for  $E^\circ_{Cell}$  and  $\Delta G^\circ$  for a spontaneous redox reaction occurring under standard conditions?  $2 \times 1 = 2$

- (ii) State Faraday's first law of electrolysis.

OR

- (b) Calculate the emf of the following cell at 298 K:



Given  $E^\circ_{Cell} = 0.44 \text{ V}$ .  $2$

25. Give the reaction of glucose with acetic anhydride. Presence of which group is confirmed by this reaction?  $2$



SECTION - C

26. (a) (i) Why is the C - O bond length in phenols less than that in methanol? 3 × 1 = 3
- (ii) Arrange the following in order of increasing boiling point :  
Ethoxyethane, Butanal, Butanol, n-butane
- (iii) How can phenol be prepared from anisole? Give reaction.
- OR**
- (b) (i) Give mechanism of the following reaction : 2 + 1 = 3
- $$\text{CH}_3\text{CH}_2\text{OH} \xrightarrow[413\text{ K}]{\text{H}_2\text{SO}_4} \text{CH}_3\text{CH}_2 - \text{O} - \text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$$
- (ii) Illustrate hydroboration - oxidation reaction with an example.
27. (a) On the basis of crystal field theory write the electronic configuration for  $d^5$  ion with a weak ligand for which  $\Delta_0 < P$ . 1 + 2 = 3
- (b) Explain  $[\text{Fe}(\text{CN})_6]^{3-}$  is an inner orbital complex whereas  $[\text{FeF}_6]^{3-}$  is an outer orbital complex.  
[Atomic number : Fe = 26]
28. Give reasons for any 3 of the following observations : 3 × 1 = 3
- (a) Penta-acetate of glucose does not react with hydroxylamine.  
(b) Amino acids behave like salts.  
(c) Water soluble vitamins must be taken regularly in diet.  
(d) The two strands in DNA are complimentary to each other.
29. (a) For the reaction 1 + 2 = 3
- $$2\text{N}_2\text{O}_{5(g)} \rightarrow 4\text{NO}_{2(g)} + \text{O}_{2(g)} \text{ at } 318\text{ K}$$
- calculate the rate of reaction if rate of disappearance of  $\text{N}_2\text{O}_{5(g)}$  is  $1.4 \times 10^{-3} \text{ m s}^{-1}$ .
- (b) For a first order reaction derive the relationship  $t_{99\%} = 2t_{90\%}$
30. (a) Illustrate Sandmeyer's reaction with an equation. 1 + 2 = 3
- (b) Explain, why  $(\text{CH}_3)_2\text{NH}$  is more basic than  $(\text{CH}_3)_3\text{N}$  in aqueous solution.





**SECTION - D**

The following questions are case-based questions. Read the passage carefully and answer the questions that follow :

31. Rahul set-up an experiment to find resistance of aqueous KCl solution for different concentrations at 298 K using a conductivity cell connected to a Wheatstone bridge. He fed the Wheatstone bridge with a.c. power in the audio frequency range 550 to 5000 cycles per second. Once the resistance was calculated from null point he also calculated the conductivity  $K$  and molar conductivity  $\Lambda_m$  and recorded his readings in tabular form.

S.No.	Conc.(M)	$k \text{ S cm}^{-1}$	$\Lambda_m \text{ S cm}^2 \text{ mol}^{-1}$
1.	1.00	$111.3 \times 10^{-3}$	111.3
2.	0.10	$12.9 \times 10^{-3}$	129.0
3.	0.01	$1.41 \times 10^{-3}$	141.0

Answer the following questions :

- (a) Why does conductivity decrease with dilution? 1
- (b) If  $\Lambda_m^\circ$  of KCl is  $150.0 \text{ S cm}^2 \text{ mol}^{-1}$ , calculate the degree of dissociation of 0.01 M KCl. 1
- (c) If Rahul had used HCl instead to KCl then would you expect the  $\Lambda_m$  values to be more or less than those per KCl for a given concentration. Justify. 2 × 1

OR

- (c) Amit a classmate of Rahul repeated the same experiment with  $\text{CH}_3\text{COOH}$  solution instead of KCl solution. Give one point that would be similar and one that would be different in his observations as compared to Rahul. 2 × 1



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## Nucleophilic Substitution

32.

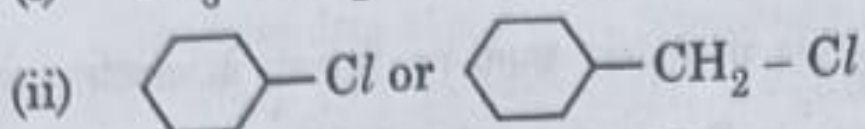
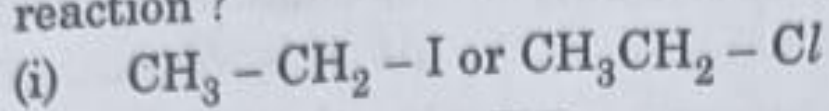
Nucleophilic Substitution reaction of haloalkane can be conducted according to both  $S_N1$  and  $S_N2$  mechanisms.  $S_N1$  is a two step reaction while  $S_N2$  is a single step reaction. For any haloalkane which mechanism is followed depends on factors such as structure of haloalkane, properties of leaving group, nucleophilic reagent and solvent.

Influences of solvent polarity : In  $S_N1$  reaction, the polarity of the system increases from the reactant to the transition state, because a polar solvent has a greater effect on the transition state than the reactant, thereby reducing activation energy and accelerating the reaction. In  $S_N2$  reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slow down the reaction rate. For example, the decomposition rate ( $S_N1$ ) of tertiary chlorobutane at 25 °C in water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate ( $S_N2$ ) of 2-Bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. Hence the level of solvent polarity has influence on both  $S_N1$  and  $S_N2$  reaction, but with different results. Generally speaking weak polar solvent is favourable for  $S_N2$  reaction, while strong polar solvent is favourable for  $S_N1$ . Generally speaking the substitution reaction of tertiary haloalkane is based on  $S_N1$  mechanism in solvents with a strong polarity (for example ethanol containing water).



Answer the following questions :

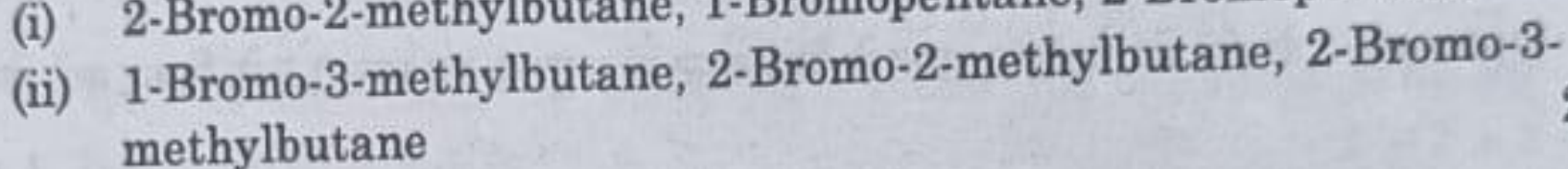
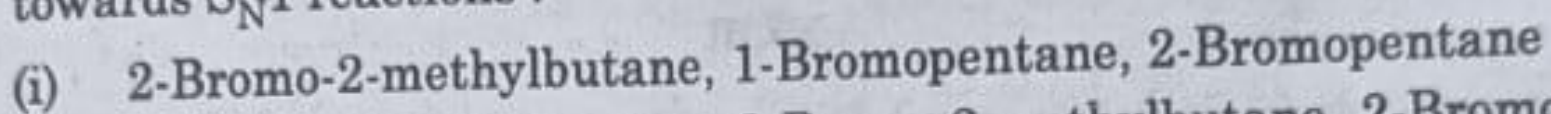
- (a) Why racemisation occurs in  $S_N1$ ? 1  
(b) Why is ethanol less polar than water? 1  
(c) Which one of the following in each pair is more reactive towards  $S_N2$  reaction?



2 × 1

OR

- (c) Arrange the following in the increasing order of their reactivity towards  $S_N1$  reactions :



2 × 1

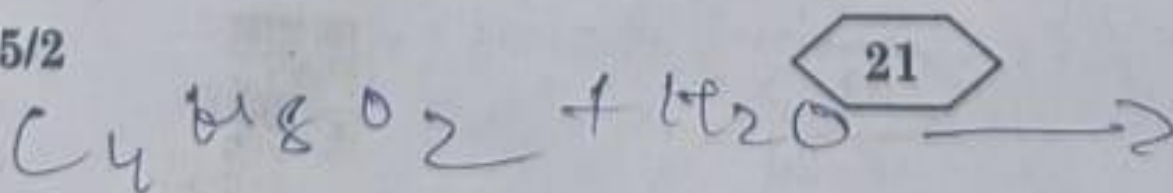
### SECTION - E

33. (a) (i) Write the reaction involved in Cannizaro's reaction. 1 + 1 + 3 = 5  
(ii) Why are the boiling point of aldehydes and ketones lower than that of corresponding carboxylic acids?  
(iii) An organic compound 'A' with molecular formula  $C_5H_8O_2$  is reduced to n-pentane with hydrazine followed by heating with NaOH and Glycol. 'A' forms a dioxime with hydroxylamine and gives a positive Iodoform and Tollen's test. Identify 'A' and give its reaction for Iodoform and Tollen's test.

OR

- (b) (i) Give a chemical test to distinguish between ethanal and ethanoic acid. 1 + 1 + 3 = 5  
(ii) Why is the  $\alpha$ -hydrogens of aldehydes and ketones are acidic in nature?  
(iii) An organic compound 'A' with molecular formula  $C_4H_8O_2$  undergoes acid hydrolysis to form two compounds 'B' and 'C'. Oxidation of 'C' with acidified potassium permanganate also produces 'B'. Sodium salt of 'B' on heating with soda lime gives methane.  
(1) Identify 'A', 'B' and 'C'.  
(2) Out of 'B' and 'C', which will have higher boiling point? Give reason.

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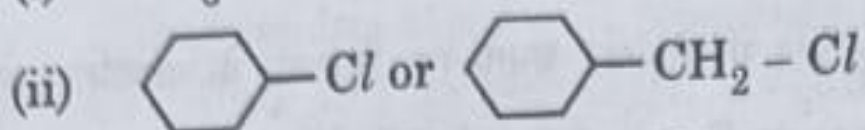
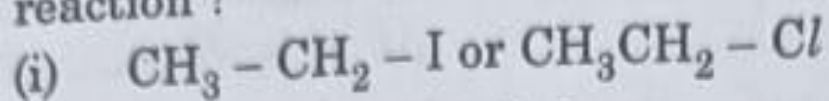


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Answer the following questions :

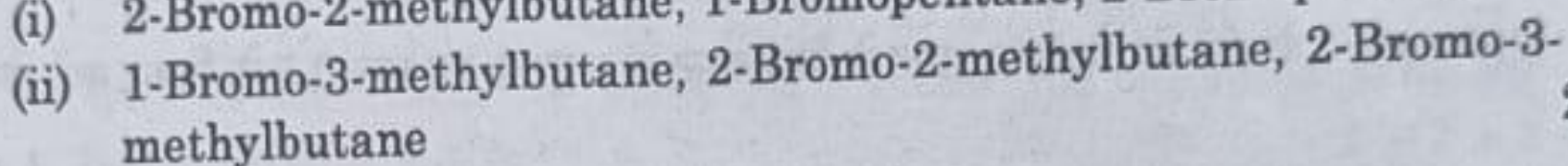
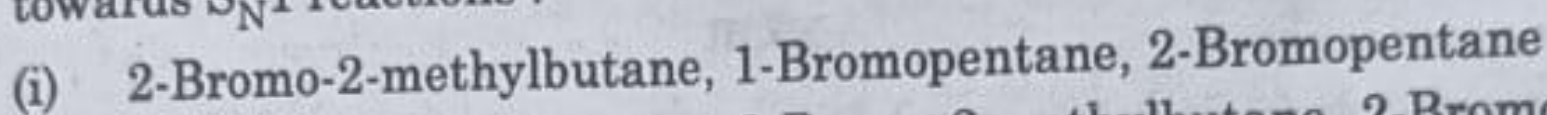
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$2 \times 1$

OR

- (c) Arrange the following in the increasing order of their reactivity towards  $S_N1$  reactions :



$2 \times 1$

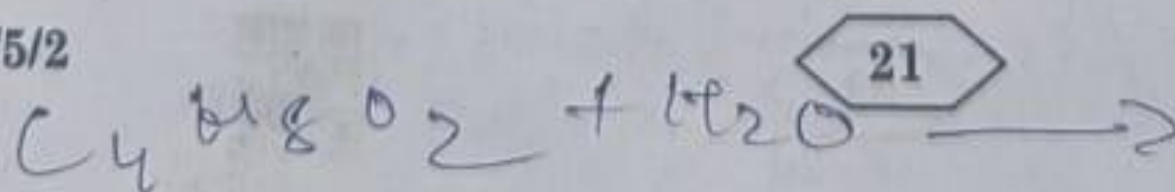
### SECTION - E

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OR

- (b) (i) Give a chemical test to distinguish between ethanal and ethanoic acid.  $1 + 1 + 3 = 5$   
(ii) Why is the  $\alpha$ -hydrogens of aldehydes and ketones are acidic in nature?  
(iii) An organic compound 'A' with molecular formula  $C_4H_8O_2$  undergoes acid hydrolysis to form two compounds 'B' and 'C'. Oxidation of 'C' with acidified potassium permanganate also produces 'B'. Sodium salt of 'B' on heating with soda lime gives methane.  
(1) Identify 'A', 'B' and 'C'.  
(2) Out of 'B' and 'C', which will have higher boiling point? Give reason.

56/5/2



P.T.O.

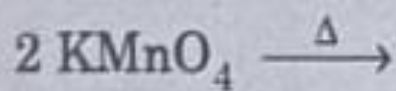
34. (a) (i) Why is boiling point of 1M NaCl solution more than that of 1M glucose solution? 1 + 2 + 2 = 5
- (ii) A non-volatile solute 'X' (molar mass = 50 g mol<sup>-1</sup>) when dissolved in 78g of benzene reduced its vapour pressure to 90%. Calculate the mass of X dissolved in the solution.
- (iii) Calculate the boiling point elevation for a solution prepared by adding 10g of MgCl<sub>2</sub> to 200g of water assuming MgCl<sub>2</sub> is completely dissociated.  
(K<sub>b</sub> for Water = 0.512 K kg mol<sup>-1</sup>, Molar mass MgCl<sub>2</sub> = 95g mol<sup>-1</sup>)

OR

- (b) (i) Why is the value of Van't Hoff factor for ethanoic acid in benzene close to 0.5? 1 + 2 + 2 = 5
- (ii) Determine the osmotic pressure of a solution prepared by dissolving 2.32 × 10<sup>-2</sup>g of K<sub>2</sub>SO<sub>4</sub> in 2L of solution at 25 °C, assuming that K<sub>2</sub>SO<sub>4</sub> is completely dissociated.  
(R = 0.082 L atm K<sup>-1</sup> mol<sup>-1</sup>, Molar mass K<sub>2</sub>SO<sub>4</sub> = 174g mol<sup>-1</sup>)
- (iii) When 25.6g of Sulphur was dissolved in 1000g of benzene, the freezing point lowered by 0.512 K. Calculate the formula of Sulphur (S<sub>x</sub>).  
(K<sub>f</sub> for benzene = 5.12 K kg mol<sup>-1</sup>, Atomic mass of Sulphur = 32g mol<sup>-1</sup>)

35. (a) A transition element X has electronic configuration [Ar] 4s<sup>2</sup> 3d<sup>3</sup>. Predict its likely oxidation states. 1 + 1 + 3 = 5

- (b) Complete the reaction mentioning all the products formed :



- (c) Account for the following :

- (i) In the 3d transition series, zinc has the lowest enthalpy of atomisation.
- (ii) Cu<sup>+</sup> ion is unstable in aqueous solution.
- (iii) Actinoids show more number of oxidation states than lanthanoids.



