SAMPLE PAPER (2024 -25)

CHEMISTRY THEORY (043)

Max. Marks:70 **Time: 3 hours**

GENERAL INSTRUCTIONS:

Read the following instructions carefully.

(a) There are **33** questions in this question paper with internal choice.
(b) SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
(c) SECTION B consists of 5 short answer questions carrying 2 marks each.
(d) SECTION C consists of 7 short answer questions carrying 3 marks each.
(e) SECTION D consists of 2 case-based questions carrying 4 marks each.
(f) SECTION E consists of 3 long answer questions carrying 5 marks each.
(g) All questions are compulsory.
(h) Use of log tables and calculators is not allowed.

SECTION A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1 Ammonolysis of ethyl chloride followed by reaction of the amine so formed with 1 mole of methyl chloride gives an amine that 1

a. reacts with Hinsberg reagent to form a product soluble in an alkali.
b. on reaction with Nitrous acid, produced nitrogen gas.
c. reacts with Benzenesulphonyl chloride to form a product that is insoluble in alkali.
d. does not react with Hinsberg reagent.

2 Which one of the following has the highest dipole moment? 1

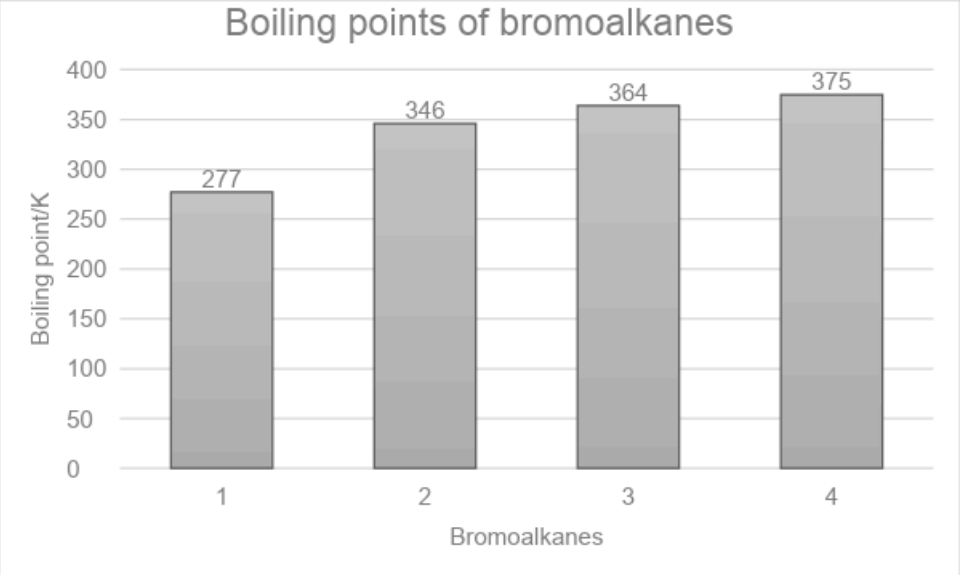
a. CH_3F
b. CH_3Cl
c. CH_3I
d. CH_3Br

3 Match the properties given in column I with the metals in column II 1

Column I	Column II
(i) Actinoid having configuration [Rn] $5f^7 6d^1 7s^2$	(A) Ce
(ii) Lanthanoid which has $4f^{14}$ electronic configuration in +3 oxidation state.	(B) Lu
(iii) Lanthanoid which show +4 Oxidation state	(C) Cm

a. (i)-(C), (ii)-(B), (iii)-(A)
b. (i)-(C), (ii)-(A), (iii)-(B)
c. (i)-(A), (ii)-(B), (iii)-(C)
d. (i)-(B), (ii)-(A), (iii)-(C)

4 Study the graph showing the boiling points of bromoalkanes and identify the compounds. 1



a. 1 = Bromomethane, 2= 2-Bromobutane, 3= 1-Bromobutane, 4= 2-Bromo-2-methylpropane

b. 1 =1-Bromobutane, 2= 2-Bromo-2-methylpropane, 3= 2-Bromobutane, 4= Bromomethane

c. 1 = Bromomethane, 2=1-Bromobutane, 3= 2-Bromo-2-methylpropane, 4= 2-Bromobutane,

d. 1 =Bromomethane, 2= 2-Bromo-2-methylpropane, 3=2- Bromobutane, 4= 1-Bromobutane

(for visually challenged learners)
Which of the following haloalkanes has the highest boiling point?
a. 2-Bromo-2-methylpropane
b. 2-Bromobutane
c. Bromomethane
d. 1-Bromobutane

5 The initial concentration of R in the reaction R□P is 4.62 x 10^{-2} mol/L. What is the half life for the reaction if k = 2.31x 10^{-2} $molL^{-1}s^{-1}$ 1

a. 30 s
b. 3 s
c. 1 s
d. 10 s

6 When $C_6H_5COOCOCH_3$ is treated with H_2O , the product obtained is : 1

a. Benzoic acid and ethanol
b. Benzoic acid and ethanoic acid
c. Acetic Acid and phenol
d. Benzoic anhydride and methanol

7 1

Formulation of Cobalt(III) Chloride-Ammonia Complexes

Colour	Formula	Solution conductivity corresponds to
Yellow	$[Co(NH_3)_6]^{3+}3Cl^-$	Y
Purple	$[CoCl(NH_3)_5]^{2+}2Cl^-$	1:2 electrolyte
Green	X	1:1 electrolyte

'X' and 'Y' in the above table are:

a. X=$[Co(NH_3)_6]^{2+}3Cl^-$, Y= 1:3
b. X= $[Co(NH_3)_4Cl_2]^+Cl^-$, Y= 1:3
c. X=$[Co(NH_3)_4Cl_2]^+Cl^-$, Y= 1:1
d. X=$[Co(NH_3)_4Cl_2]^{3+}3Cl^-$, Y= 1:1

8 Which of the following contains only β-D- glucose as its monosaccharide unit: 1

a. Sucrose
b. Cellulose
c. Starch
d. Maltose

9 Which one of the following sets correctly represents the increase in the paramagnetic property of the ions? 1

a. $Ti^{3+} < Fe^{2+} < Cr^{3+} < Mn^{2+}$
b. $Ti^{3+} < Mn^{2+} < Fe^{2+} < Cr^{3+}$
c. $Mn^{2+} < Fe^{2+} < Cr^{3+} < Ti^{3+}$
d. $Ti^{3+} < Cr^{3+} < Fe^{2+} < Mn^{2+}$

10 A first-order reaction is found to have a rate constant, $k = 5.5 \times 10^{-1}4\ s^{-1}$. The time taken for completion of the reaction is: 1

a. 1.26×10^{13} s
b. 2.52×10^{13} s
c. 0.63×10^{13} s
d. It never goes to completion

11 A student was preparing aniline in the lab. She took a compound "X" and reduced it in the presence of Ni as a catalyst. What could be the compound "X" 1

a. Nitrobenzene
b. 1-Nitrohexane
c. Benzonitrile
d. 1-Hexanenitrile

12 Which of the following compound gives an oxime with hydroxylamine: 1

a. CH_3COCH_3
b. CH_3COOH
c. $(CH_3CO)_2O$
d. CH_3COCl

13 **Assertion (A):** $[Mn(CN)_6]^{3-}$ has a magnetic moment of two unpaired electrons while $[MnCl_6]^{3-}$ has a paramagnetic moment of four unpaired electrons. 1
Reason (R): $[Mn(CN)_6]^{3-}$ is inner orbital complexes involving d^2sp^3 hybridisation,on the other hand, $[MnCl_6]^{3-}$ is outer orbital complexes involving sp^3d^2 hybridisation.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

14 **Assertion (A)**: For strong electrolytes, there is a slow increase in molar conductivity with dilution and can be represented by the equation 1

$$\Lambda_m^\circ = \Lambda_m - A\ c^{½}$$

Reason (R): The value of the constant '*A*' for NaCl, $CaCl_2$, and $MgSO_4$ in a given solvent and at a given temperature is different.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

15 **Assertion (A)** Glucose does not form the hydrogensulphite addition product with $NaHSO_3$. 1
Reason (R): Glucose exists in a six-membered cyclic structure called pyranose structure.

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

16 **Assertion (A):** The half- life for a zero order reaction is independent of the initial concentration of the reactant. 1
Reason (R): For a zero order reaction, Rate = k

Select the most appropriate answer from the options given below:
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not the correct explanation of A.
c. A is true but R is false.
d. A is false but R is true.

SECTION B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17 a. Nitrogen gas is soluble in water. At temperature 293 K, the value of K_H is 76.48 kbar . How would the solubility of nitrogen vary (increase, decrease or remain the same) at a temperature above 293 K , if the value of K_H rises to 88.8 kbar. 1

b. Chloroform (b.p. 61.2°C) and acetone (b.p. 56°C) are mixed to form an azeotrope. The mole fraction of acetone in this mixture is 0.339. Predict whether the boiling point of the azeotrope formed will be (i) 60°C (ii)64.5 °C or (iii)54 °C. Defend your answer with reason. 1

OR

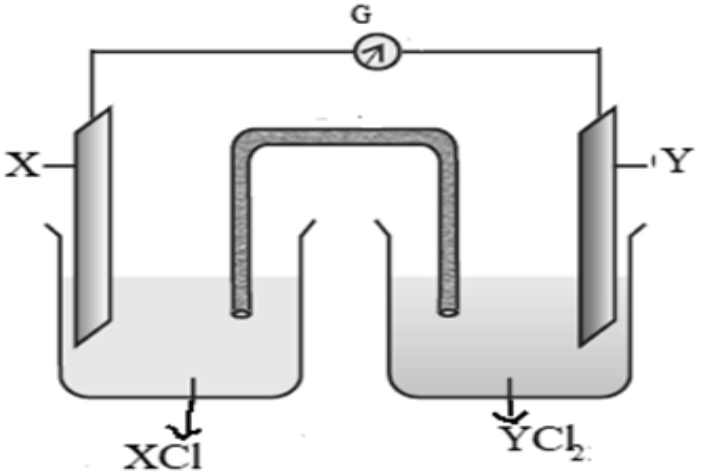
a. A soda bottle will go flat (loose its fizz) faster in Srinagar than in Delhi. Is this statement correct? Why or why not? 1

b. How does sugar help in increasing the shelf life of the product? 1

18 a. Write the IUPAC name of the following complex: $K[Cr(H_2O)_2(C_2O_4)_2]H_2O$ 1

b. Name the metal present in the complex compound of
(i) Haemoglobin (ii) Vitamin B-12 ½+½

19 Observe the following cell and answer the questions that follow:



a. Represent the cell shown in the figure. 1
b. Name the carriers of the current in the salt bridge ½
c. Write the reaction taking place at the anode. ½

(for visually challenged learners)
For the cell represented as:

$Mg(s)/Mg^{2+}(aq)//Ag^{+}(aq)/Ag(s)$
a. Identify the cathode and the anode 1
b. Write the overall reaction 1

20 Complete the following reactions by writing the major and minor product in each case (any 2)

a. $CH_3CH_2Br + KCN \rightarrow$ 1

b. $CH_3CH_2CH = CH_2 + HBr$ □ 1

c. $(CH_3)_2CHCHClCH_3$ + alc KOH → 1

21 The presence of Carbonyl group in glucose is confirmed by its reaction with hydroxylamine. Identify the type of carbonyl group present and its position. Give a chemical reaction in support of your answer. 1 1

SECTION C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22 a. Write down the reaction occurring on two inert electrodes when electrolysis of copper chloride is done. What will happen if a concentrated solution of copper sulphate is replaced with copper chloride? 2

b. Write an expression for the molar conductivity of aluminium sulphate at infinite dilution according to Kohlrausch law. 1

23 Account for the following:

a. The lowest oxide of transition metal is basic, and the highest is acidic. 1
b. Chromium is a hard metal while mercury is a liquid metal 1
c. The ionisation energy of elements of the 3d series does not vary much with increasing atomic number. 1

24 a. Give the chemical reaction involved when p-nitrotoluene undergoes Etard reaction. 1
b. Why does Benzoic acid exist as a dimer in an aprotic solvent? 1
c. Benzene on reaction with methylchloride in the presence of anhydrous $AlCl_3$ forms toluene. What is the expected outcome if benzene is replaced by benzoic acid? Give a reason for your answer. 1

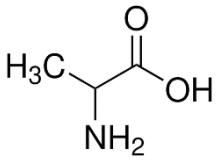
OR

An organic compound 'X', does not undergo aldol condensation. However 'X' with compound 'Y' in the presence of a strong base react to give the compound 1,3-diphenylprop-2-en-1-one.

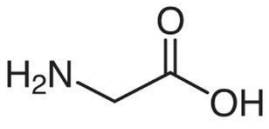
a. Identify 'X' and 'Y' 1
b. Write the chemical reaction involved. 1
c.Give one chemical test to distinguish between X and Y. 1

25 a. Give the structure of all the possible dipeptides formed when the following two amino acids form a peptide bond. 2

Alanine



Glycine



b. Keratin, insulin, and myosin are a few examples of proteins present in the human body. Identify which type of protein is keratin and insulin and differentiate between them based on their physical properties. 1

26 Neeta was experimenting in the lab to study the chemical reactivity of alcohols. She carried out a dehydration reaction of propanol at 140°C to 180°C. Different products were obtained at these two temperatures.

a. Identify the major product formed at 140°C and the mechanism followed in this case. 1+½ 1+½

b. Identify the major product formed at 180°C

27 Various isomeric haloalkanes with the general formula C_4H_9Cl undergo hydrolysis reaction. Among them, compound "A" is the most reactive through S_N1 mechanism. Identify "A" citing the reason for your choice. Write the mechanism for the reaction. 3

28 The equilibrium constant of cell reaction :

$Sn^{4+}(.aq) + Al(s) \rightarrow Al^{3+} + Sn^{2+}(aq)$ is 4.617×10^{184}, at 25 °C

a. Calculate the standard emf of the cell. 2
(Given: log 4.617×10^{184} = 184.6644)

b. What will be the E^o of the half cell Al^{3+}/Al , if E^o of half cell Sn^{4+}/Sn^{2+} is 0.15 V. 1

SECTION D

The following questions are case-based questions. Each question has an internal choice and carries 4 (2+1+1) marks each. Read the passage carefully and answer the questions that follow.

29 Dependence of the rate of reaction on the concentration of reactants, temperature, and other factors is the most general method for weeding out unsuitable reaction mechanisms. The term mechanism means all the individual collisional or elementary processes involving molecules (atoms, radicals, and ions included) that take place simultaneously or consecutively to produce the observed overall reaction. For example, when hydrogen gas reacts with bromine, the rate of the reaction was found to be proportional to the concentration of H_2 and to the square root of the concentration of Br_2. Furthermore, the rate was inhibited by increasing the concentration of HBr as the reaction proceeded. These observations are not consistent with a mechanism involving bimolecular collisions of a single molecule of each kind. The currently accepted mechanism is considerably more complicated, involving the dissociation of bromine molecules into atoms followed by reactions between atoms and molecules:

It is clear from this example that the mechanism cannot be predicted from the

overall stoichiometry.

(source: Moore, J. W., & Pearson, R. G. (1981). *Kinetics and mechanism*. John Wiley & Sons.)

a. Predict the expression for the rate of reaction and order for the following:

$H_2 + Br_2 \square 2\ HBr$ 1

What are the units of rate constant for the above reaction? 1

b. How will the rate of reaction be affected if the concentration of Br_2 is tripled? 1

OR

What change in the concentration of H_2 will triple the rate of reaction?

c. Suppose a reaction between A and B, was experimentally found to be first order with respect to both A and B. So the rate equation is: 1

Rate = k[A][B]

Which of these two mechanisms is consistent with this experimental finding? Why?

Mechanism 1

A → C + D (slow)

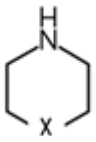
B + C → E (fast)

Mechanism 2

A + B → C + D (slow)

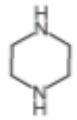
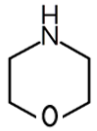
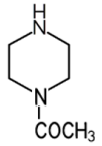
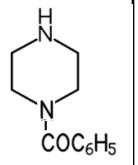
C → E (fast)

30 Amines are basic in nature. The pK_b value is a measure of the basic strength of an amine. Lower the value of pK_b, more basic is the amine. The effect of substituent on the basic strength of amines in aqueous solution was determined using titrations. The substituent "X" replaced "-CH_2" group in piperidine (compound 1) and propylamine $CH_3CH_2CH_2NH_2$, (compound 2).

Compound 1: 

Compound 2: $HXCH_2CH_2NH_2$

The experimental data is tabulated below:

Substituent "X"	**Electro-negativity of X**	**substituted piperidine compound**	**pK_a**	**Substituted propylamine compound**	**pK_a**
CH_2	2.55		11.13	$CH_3CH_2CH_2NH_2$	10.67
NH	3.12		9.81	$NH_2CH_2CH_2NH_2$	10.08
O	3.44		8.36	$HOCH_2CH_2NH_2$	9.45
CH_3CON	3.6		7.94	$CH_3CONHCH_2CH_2NH_2$	9.28
C_6H_5CON	3.7		7.78	$C_6H_5CONHCH_2CH_2NH_2$	___

(source: Hall Jr, H. K. (1956). Field and inductive effects on the base strengths of amines. *Journal of the American Chemical Society*, *78*(11), 2570-2572.)

Study the above data and answer the following questions:

a. Plot a graph between the electronegativity of the substituent vs pK_b value of the corresponding substituted propyl amine (given that $pK_a + pK_b = 14$). Is there any relation between the electronegativity of the substituent and its basic strength? 2

b. The electronegativity of the substituent "C_6H_5CON" is 3.7, what is the expected pKa value of compound $C_6H_5CONHCH_2CH_2NH_2$? 1

10

(i) 9.9 (ii) 9.5 (iii) 9.3 (iv) 9.1

c. The pKa value of the substituted piperidine formed with substituent "X" is found to be 8.28. What is the expected electronegativity of "X" 1

(i)3.5 (ii)3.4 (iii)3.8 (iv) 3.1

OR

What is the most suitable pKa value of the substituted propylamine formed with substituent "X" with electronegativity 3.0

(i)10.67 (ii)10.08 (iii)10.15 (iv)11.10

(for visually challenged learners)

a.How does the electronegativity of the substituent affect the pK_b value and the basic strength of the substituted propyl amine (given that $pK_a + pK_b = 14$).? Give a reason to support your answer. 2

b. The electronegativity of the substituent "C_6H_5CON" is 3.7, what is the expected pKa value of compound $C_6H_5CONHCH_2CH_2NH_2$? 1

(i) 9.9 (ii) 9.5 (iii) 9.3 (iv) 9.1

c. The pKa value of the substituted piperidine (compound 1) formed with substituent "X" is found to be 8.28. What is the expected electronegativity of "X" 1

(i)3.5 (ii)3.4 (iii)3.8 (iv) 3.1

OR

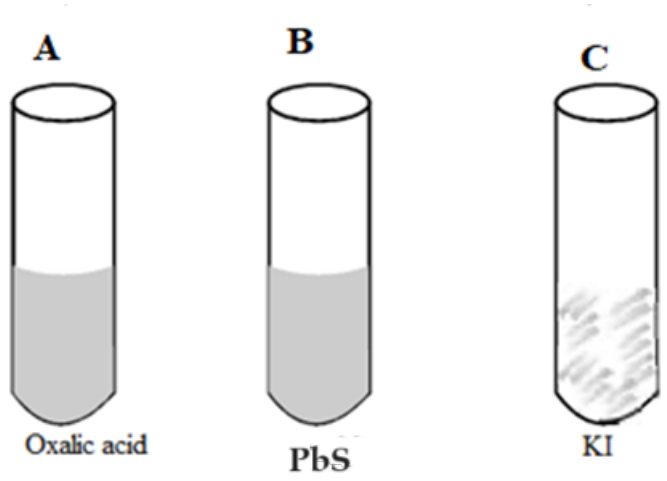
What is the most suitable pKa value of the substituted propylamine formed with substituent "X" with electronegativity 3.0

(i)10.67 (ii)10.08 (iii)10.15 (iv)11.10

SECTION E

The following questions are long answer types and carry 5 marks each. All questions have an internal choice.

31 a. A purple colour compound A, which is a strong oxidising agent and used for bleaching of wool, cotton, silk and other textile fibres was added to each of the three test tubes along with H_2SO_4. It was followed by strong heating.



In which of the above test tubes; A,B or C:

(i) Violet vapours will be formed 1

(ii) The bubbles of gas evolved will extinguish a burning matchstick. Write an equation for each of the above observations. 1

b. A metal ion M^{n+} of the first transition series having d^5 configuration combines with three didentate ligands. Assuming $\Delta_0 < P$:

(i) Draw the crystal field energy level diagram for the 3d orbital of this complex. 1

(ii) What is the hybridisation of M^{n+} in this complex and why? 1

(iii) Name the type of isomerism exhibited by this complex. 1

OR

a. Using, Valence Bond Theory identify A, B, C, D, E and F in the following table

S.No	Complex	central metal ion	configuration of metal ion	Hybridization of Metal ion	Geometry of the Complex	Number Of Unpaired Electron	Magnetic Behaviour
i	$[CoF_4]^{2-}$	**A**	$3d^7$	sp^3	tetrahedral	**B**	Paramagnetic
ii	$[Cr(H_2O)_2C_2O_4)_2]$	Cr^{3+}	$3d^3$	**C**	octahedral	3	**D**
iii	$[Ni(CO)_4]$	Ni	$3d^84s^2$	**E**	**F**	0	Diamagnetic

3

b. Write the ionic equations for the reaction of acidified $K_2Cr_2O_7$ with (i)H_2S and (ii)$FeSO_4$ 2

32 a. Give reasons for the following:

(i)The reaction of ethanol with acetyl chloride is carried out in the presence of pyridine . 1

(ii) Cresols are less acidic than phenol. 1

b. Williamson's process is used for the preparation of ethers from alkyl halide. Identify the alkyl bromide and sodium alkoxide used for the preparation of 2- Ethoxy-3-methylpentane 1

c. Convert:

(i) Toluene to 3-nitrobenzoic acid. 1

(ii) Benzene to m-nitroacetophenone. 1

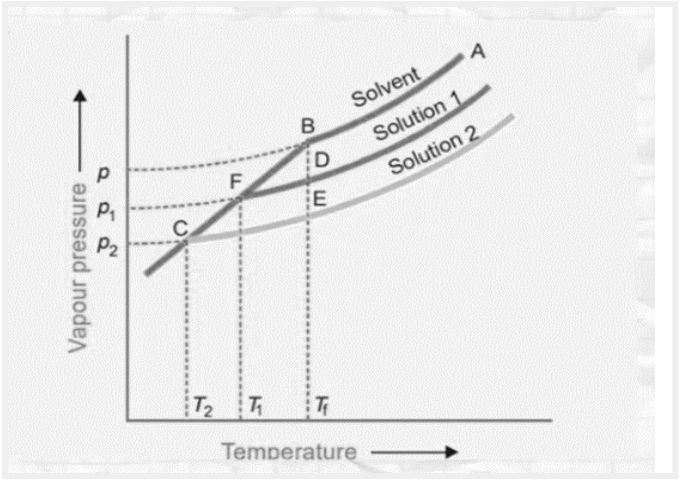
OR

a. Out of formic acid and acetic acid, which one will give the HVZ reaction? Give a suitable reason in support of your answer and write the chemical reaction involved. 2

b. Alcohols are acidic but they are weaker acids than water. Arrange various isomers of butanol in the increasing order of their acidic nature. Give a reason for the same. 1

c. An organic compound A which is a Grignard reagent is used to obtain 2-methylbutan-2-ol on reaction with a carbonyl compound 'B' . Identify A' and 'B'. Write the equation for the reaction between A and B. 2

33 a. An experiment was carried out in the laboratory, to study depression in freezing point. 1M aqueous solution of $Al(NO_3)_3$ and 1 M aqueous solution of glucose were taken. From the given figure identify solution 1 and solution 2. Give a plausible reason for your answer. 2



b. The osmotic pressure of a solution of cane sugar was found to be 2.46 atm at 300 K. If the solution was diluted five times, calculate the osmotic pressure at the same temperature. 3

How can the osmotic pressure of the given cane sugar solution be decreased without changing its volume? Give a reason for your answer.

OR

a. While giving intravenous injections to the patients, the doctors take utmost care of the concentration of the solution used. Why is it necessary to check the concentration of the solution? 2

b. A solution of phenol was obtained by dissolving 2X 10^{-2} kg of phenol in 1 kg of benzene. Experimentally it was found to be 73 % associated. Calculate the depression in the freezing point recorded. 3

(for visually challenged learners)

a. Which of the two solutions : 1M aqueous solution of $Al(NO_3)_3$ or 1M aqueous solution of glucose will show a greater depression in freezing point? Give a plausible reason for your answer. 2

b. The osmotic pressure of a solution of cane sugar was found to be 2.46 atm at 300 K. If the solution was diluted five times, calculate the osmotic pressure at the same temperature. 3

How can the osmotic pressure of the given cane sugar solution be decreased without changing its volume? Give a reason for your answer.

OR

a. While giving intravenous injections to the patients, the doctors take utmost care of the concentration of the solution used. Why is it necessary to check the concentration of the solution? 2

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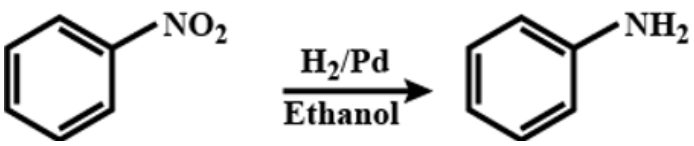
MARKING SCHEME

SAMPLE PAPER (2024 -25)

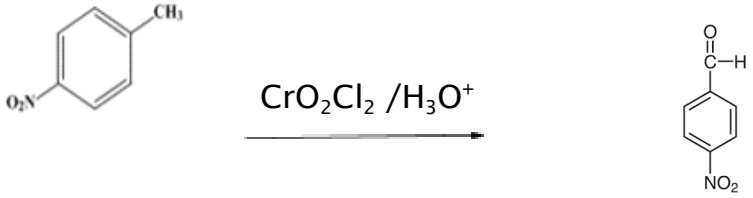
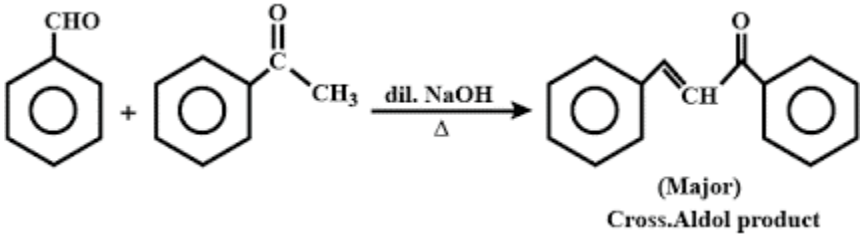
CHEMISTRY THEORY

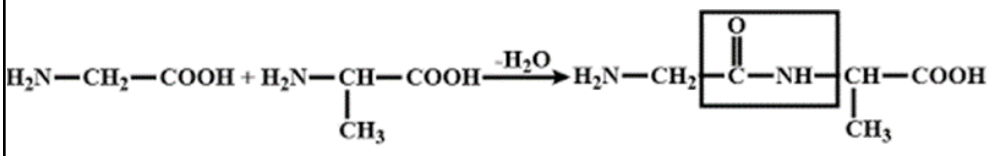
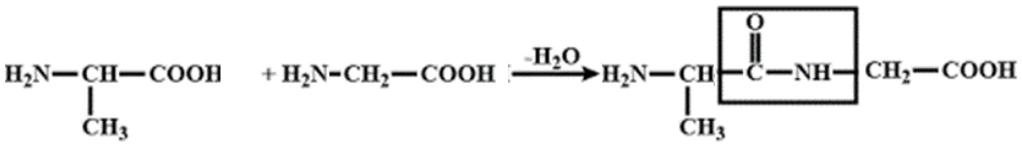
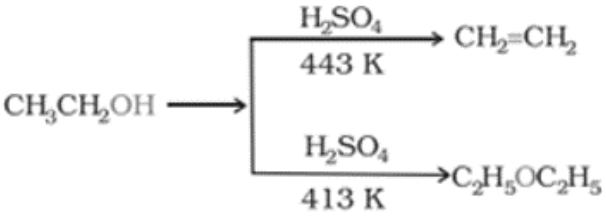
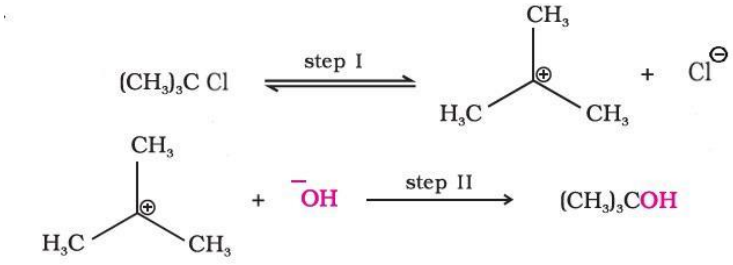
(043)

SECTION A		
1	(c) reacts with Benzenesulphonyl chloride to form a product that is insoluble in alkali	1
2	(b)CH_3Cl The order followed is this $CH_3I<CH_3Br<CH_3F< CH_3Cl$, though F is most electronegative, the bond length is small as compared to C-Cl. Dipole moment is the product of the charge and the bond length.	1
3	(a) (i)-(C), (ii)-(B), (iii)-(A)	1
4	(d) 1 =Bromomethane, 2= 2-Bromo-2-methylpropane, 3=2-Bromobutane, 4= 1-Bromobutane ***(for visually challenged learners)*** d. 1-Bromobutane	1 1
5	(c) the order of reaction is zero as the unit of k is $molL^{-1}s^{-1}$. Thus half life = $[R]_o$ / 2k = 4.62 x 10^{-2} /2 x 2.31 x 10^{-2}	1
6	(b) Benzoic acid and ethanoic acid $C_6H_5COOCOCH_3 \xrightarrow{H_2O} C_6H_5COOH + CH_3COOH$	1
7	(b) X=$[Co(NH_3)_4Cl_2]^+Cl^-$, Y= 1:3	1
8	(b) Cellulose Starch contains only α glucose, sucrose contains α-D-glucose and β-D-fructose glucose, maltose contains α-D-glucose and cellulose is a polymer of β-D-glucose.	1
9	(d) $Ti^{3+}< Cr^{3+}< Fe^{2+} < Mn^{2+}$ No. of unpaired electrons : Ti^{3+} (1), Cr^{3+} (3), Fe^{2+} (4) and Mn^{2+} (5) Paramagnetism depends on the number of unpaired electrons	1
10	(d) It never goes to completion First order reaction [R] = [Ro] e^{-kt} If [R]=0 then	1

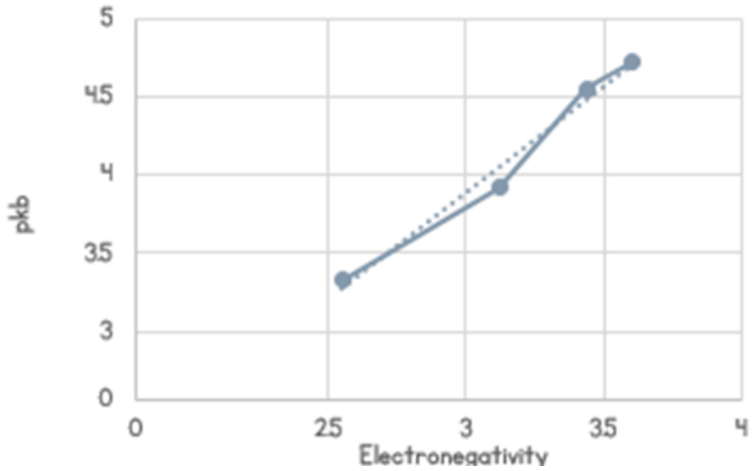
	e^{-kt} = 0, which is not possible for any finite value of t. Here, t is ∞.	
11	(a) Nitrobenzene 	1
12	(a)CH_3COCH_3 Aldehyde and ketones give nucleophilic addition reactions. Other carbonyl compounds do not give nucleophilic addition reactions.	1
13	(a) Both A and R are true and R is the correct explanation of A	1
14	(d) A is false but R is true. $\Lambda_m^\circ = \Lambda_m - A\ c^{½}$ is an incorrect equation, the correct equation is $\Lambda_m = \Lambda_m^\circ - A\ c^{½}$	1
15	(b) Both A and R are true but R is not the correct explanation of A. Due to the absence of a free aldehydic group, it does not give a reaction with $NaHSO_3$.	1
16	(d)A is false but R is true. The half- life for a zero order reaction $t_{1/2}$ = [Ro]/2k where [Ro] is the initial concentration of the reactant.	1
	SECTION B	
17	(a) Solubility of gas is inversely proportional to the value of Henry's constant K_H. On increasing temperature nitrogen gas becomes less soluble because its K_H value increases. (b) (ii)64.5 °C Chloroform and acetone mixture show negative deviation from Raoult's law therefore, they form maximum boiling azeotrope at a specific composition. The boiling point of the mixture so obtained will be higher than the individual components. **OR** (a) At higher altitudes i.e. in Srinagar the atmospheric pressure is	½ ½ ½ ½ 1

	lower. The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas over the solution, therefore, the carbon dioxide dissolved in water will be lesser at Srinagar making the soda go flat faster. (b)Preservation of fruits by adding sugar/salt protects against bacterial action. Through osmosis, a bacterium on canned fruit loses water, shrivels and dies.	 1
18	(a) Potassium diaquadioxalatochromate(III) hydrate (b) (i) Haemoglobin: Iron (ii) Vitamin B-12: Cobalt	1 1
19	(a) $Y(s)\|Y^{2+(}aq) \| \| X^{+}(aq)\| X(s)$ (b) ions are carrier of current in salt bridge (c) $Y(s) \rightarrow Y^{2+(}aq) + 2e^{-}$ ***(for visually challenged learners)*** a. Cathode: silver , Anode: Magnesium b. $Mg + 2Ag^{+} \square Mg^{2+} + 2Ag$	1 ½ ½
20	(a)CH_3CH_2CN (major), CH_3CH_2NC (minor) (b) $CH_3CH_2CHBrCH_3$ (major) $CH_3CH_2CH_2CH_2Br$ (minor) (c) $(CH_3)_2C{=}CHCH_3$ (major) $(CH_3)_2CHCHCH_2$ (minor)	½+½ ½+½ ½+½
21	The carbonyl group present in glucose is aldehyde and the C_1 atom . Glucose gets oxidised to six-carbon carboxylic acid (gluconic acid) with COOH group at the C1 atom on reaction with a mild oxidising agent like bromine water. This indicates that the carbonyl group is present as an aldehydic group	½ ,½ 1
SECTION C		
22	<u>(a) Product of electrolysis of Copper Chloride</u> Cathode(-) $Cu^{2+} + 2e^{-} \rightarrow Cu(s)$ anode(+) $2Cl^{-} \rightarrow Cl_2 + 2e^{-}$ <u>Product of electrolysis of concentrated Copper Sulphate</u> Anode(+) $SO_4^{2-} \rightarrow S_2O_8 + 2e^{-}$ Cathode (-) $Cu^{2+} + 2e^{-} \rightarrow Cu(s)$ (b) $\Lambda^0_m[Al_2(SO_4)_3] = 2\,\lambda^0_m(Al^{3+}) + 3\,\lambda^0_m(SO_4^{2-})$	 1 1 1
23	(a) In the case of a lower oxide of a transition metal, the metal atom has some electrons present in the valence shell of the metal atom that are not involved in bonding. As a result, it can donate electrons and behave as a base whereas in higher oxide of a transition metal,	1

	the metal atom does not have an electron in the valence shell for donation. As a result, it can accept electrons and behave as an acid. (b) Chromium has unpaired electrons which result in strong metallic bonding which results in it being a hard solid and the absence of unpaired electrons in Hg results in it being a liquid. (c) The increase in effective nuclear charge responsible for steady increase in ionisation energy is counterbalanced by shielding effect of (n-1)d electrons	1 1
24	(a)  (b) Benzoic acid undergoes extensive intermolecular hydrogen bonding , leading to the formation of dimer . (c) Benzoic acid does not undergo reaction with CH_3Cl i.e Friedel Craft reaction because the carboxyl group is deactivating and the catalyst aluminium chloride (Lewis acid) gets bonded to the carboxyl group **OR** Compound 'X' = Benzaldehyde , Compound Y = Acetophenone  **(Major)** **Cross.Aldol product** Chemical test to distinguish between X and Y is the Tollen Test . Benzaldehyde undergoes SIlver mirror test with Tollen reagent and forms silver mirror . However Acetophenone does not react with Tollen Reagent .	1 1 1 ½,½ 1 1

25	(a)  (Glycine) (Alanine)  (Alanine) (Glycine) (b) (i) Keratin is a fibrous protein. fibre- like structure is formed. Such proteins are generally insoluble in water. (ii)Insulin is a globular protein . This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water.	1 1 ½ ½
26	(a) Ethanol undergoes a dehydration reaction. At 140°C, diethyl ether is formed. The formation of ether is a nucleophilic substitution bimolecular reaction S_N2 (b) When the temperature exceeds 170°C, ethene is the major product. Elimination, E1 reaction 	1+½ 1+½
27	"A" is $(CH_3)_3CCl$, the carbocation intermediate obtained in tertiary alkyl halide is most stable, making A most reactive of all possible isomers. 	½ +½ 1 1

28	$E_{Cell} = E^{o}_{Cell} - \frac{2.303RT}{nF} \log Kc$ At 298 K $E_{Cell} = E^{o}_{Cell} - \frac{0.0591}{n} \log Kc$	½
	At equilibrium Ecell =0, n= 6	½
	$E^{o}_{Cell} = \frac{0.0591}{n} \log Kc$	½
	=0.059/6 log 4.617×10^{184} = 0.00983 x 184.6644 = 1.8152	½
	(ii) $E^{o}_{cell} = E^{0}_{Sn4+/Sn2+} - E^{0}_{Al3+/Al}$ 1.81 = -0.15- $E^{0}_{Al3+/Al}$ $E^{0}_{Al3+/Al}$ = -1.66 V	½ ½
	SECTION D	
29	a. Rate = k $[H_2]$ $[Br_2]^{1/2}$ order = 3/2	½ ½
	units of k = $\frac{molL^{-1}s^{-1}}{mol^{3/2}L^{-3/2}}$ = $mol^{-1/2}L^{1/2}s^{-1}$	1
	b. Rate = k $[H_2]$ $[Br_2]^{1/2}$ If conc of Br_2 is tripled Rate' = k $[H_2]$ $[3Br_2]^{1/2}$ Rate' = √3 k $[H_2]$ $[Br_2]^{1/2}$ Rate' = √3 Rate	1
	OR	
	Rate = k $[H_2]$ $[Br_2]^{1/2}$ If conc of Br_2 is tripled Rate' = 3 Rate= k $[xH_2]$ $[Br_2]^{1/2}$ 3 Rate = k $[x\ H_2]$ $[Br_2]^{1/2}$ x = 3, the concentration of H_2 is tripled	1

	c. The slowest step is the rate-determining step. From mechanism 2, Rate = k [A] [B] while from mechanism 1 Rate = k [A] Therefore mechanism 2, is consistent with the experimental finding	1
30	a  ……. Is the line of best fit The pKb increases with an increase in the electronegativity of the substituent, therefore the basic strength decreases with an increase in the electronegativity of the substituent b. (iv) 9.1 c. (i) 3.5 **OR** (iii) 10.15 ***(for visually challenged learners)*** The pKb increases with an increase in the electronegativity of the substituent, therefore the basic strength decreases with an increase in the electronegativity of the substituent	1½ ½ 1 1 1 1

Substituent "X"	Electro-negativity of X	Compound	pKa	pKb

CH_2	2.55	$CH_3CH_2CH_2NH_2$	10.67	3.33	
NH	3.12	$NH_2CH_2CH_2NH_2$	10.08	3.2	1
O	3.44	$HOCH_2CH_2NH_2$	9.45	4.55	
CH_3CON	3.6	$CH_3CONHCH_2CH_2NH_2$	9.28	4.72	

b. (iv) 9.1 — 1

c. (i) 3.5 — 1

OR

(iii) 10.15 — 1

SECTION E

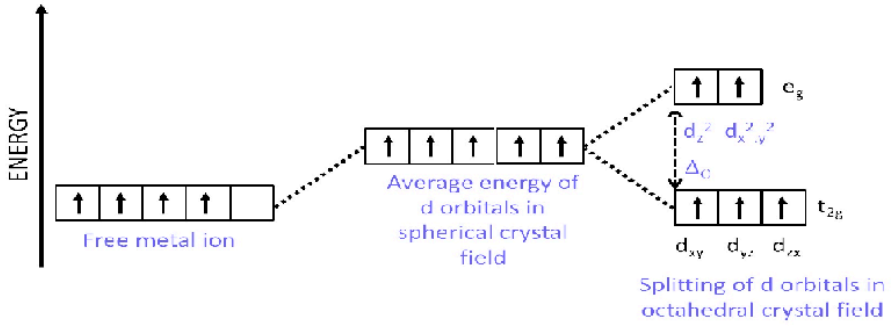
31 (a) (i) Test tube C — 1

$10I^- + MnO_4^- + 16\ H^+ \rightarrow 5I_2 + 2Mn^{2+} + 8\ H_2O$

(ii) Test tube A — 1

$C_2O_4^{2-} + 2MnO_4^- + 16\ H^+ \rightarrow 10CO_2 + 2Mn^{2+} + 8\ H_2O$

(b) (i)



2

(ii) Sp^3d^2 , Since Δ_0 > P it will form an outer orbital complex as the electrons in the 3d orbital will not pair up. — ½

(iii) Optical isomerism. — ½

OR

a. A = Co^{2+} — ½

B = 3 — ½

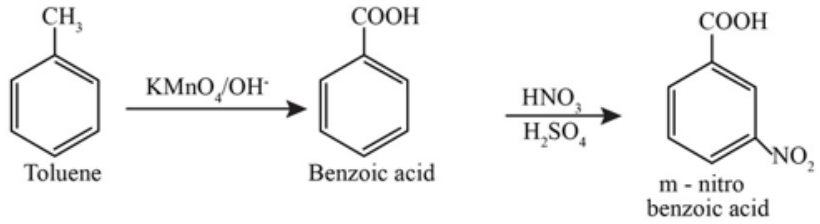
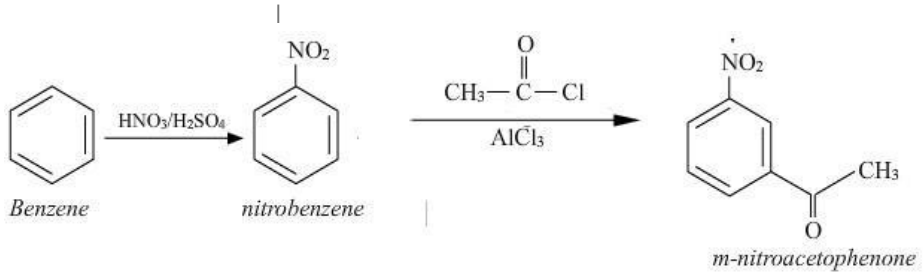
C = d^2sp^3 — ½

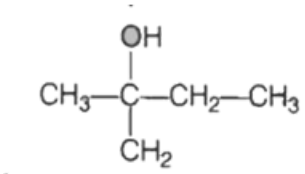
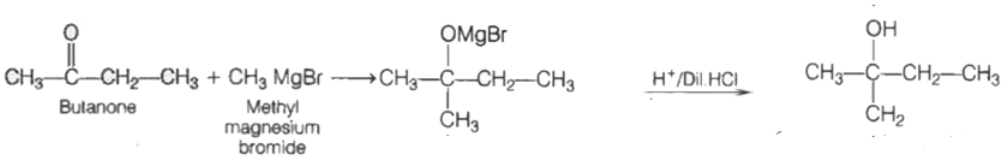
D = Paramagnetic — ½

E= sp^3 — ½

F = tetrahedral — ½

b.

	(i) $Cr_2O_7^{2-} + 8\,H^+ + 3\,H_2S \rightarrow 2\,Cr^{3+} + 3S + 7\,H_2O$ (ii) $Cr_2O_7^{2-} + 14\,H^+ + 6\,Fe^{2+} \rightarrow 2\,Cr^{3+} + 6\,Fe^{3+} + 7\,H_2O$.	1 1
32	a. (i) The reaction of ethanol with acetyl chloride is carried out in the presence of pyridine . Pyridine is a strong organic base .The function of pyridine is to remove HCl formed in the reaction. (ii) The electron releasing groups, such as alkyl groups, in general, do not favour the formation of phenoxide ion resulting in decrease in acid strength. Cresols, for example, are less acidic than phenol. b. C_2H_5Br and $CH_3CH_2CH(CH_3)CH_2CH_2ONa$ yields 2-ethoxy-3-methylpentane c. (i)  (ii)  **OR** a. Acetic acid will give HVZ reaction. Carboxylic acids having an α-hydrogen are halogenated at the α-position on treatment with chlorine or bromine in the presence of a small amount of red phosphorus to give α-halo carboxylic acids. $CH_3COOH \xrightarrow{Br_2/red\ P} CH_2BrCOOH$ b. Isomers of butanol are: Butan-1-ol , butan-2-ol , 2-methylpropanol , 2-methylpropan-2-ol . Acidic strength in isomeric alcohols varies as follows : R R	1 1 1 1 ½ 1 ½

		½
	The acidic character of alcohols is due to the polar nature of O–H bond. An electron-releasing group (–CH_3 , –C_2H_5) increases electron density on oxygen tending to decrease the polarity of O-H bond 2-methylpropan-2-ol< 2-methylpropanol < butan-2-ol <Butan-1-ol	½
	c. An organic compound A is a Grignard reagent : RMgX B is a ketone RCOR'	
	A + B □  (2-methylbutan-2-ol)	
	Ketones lead to the formation of tertiary alcohol ,so the compound B is a ketone B – Butan-2-one and A ' is CH_3 MgBr	½ + ½
	 Butanone Methyl magnesium bromide	1
33	a. Depression in the freezing point is a colligative property. In dilute solutions the depression of freezing point (ΔTf) is directly proportional to the molal concentration of the solute in a solution. From the graph it is interpreted that Solution 2 shows more depression in freezing point	1 ½
	1 M $Al(NO)_3$ has higher i value (i=3) than 1 M glucose (i=1) 1 M $Al(NO)_3$ will have higher depression , hence solution 2 is $Al(NO)_3$ solution and solution 1 is glucose solution.	½
	(for visually challenged learners) a. 1 M $Al(NO)_3$ shows greater depression in freezing point 1 M $Al(NO)_3$ has higher i value (i=3) than 1 M glucose (i=1) and we know that $\Delta T_f = iK_f m$	1 1
	b. $\pi = (n_2/V) RT$ Given π = 2.64 atm	½

	Let V_1= V V_2= 5V (On dilution by 5 times) $\frac{\pi 1}{\pi 2} = \frac{(n/V_1)}{(n/V_2)}$ $\frac{2.64}{\pi 2} = \frac{(n/V)}{(n/5V)}$ $\pi 2 = 0.528$ atm Osmotic pressure is directly proportional to temperature. The osmotic pressure of cane sugar can be decreased by decreasing the temperature. **OR** a. While giving intravenous injection to the patients , utmost care of concentration of the solution is to be taken . The solution must have same concentration as that of blood cells . If the solution becomes more concentrated than the concentration of the blood it will lead to the shrinking of blood cells and fluid will start flowing out because of endosmosis. If concentration is less concentrated than the concentration of the blood it will lead to swelling of blood cells will take place. Both situations are life-threatening. b. $2C_6H_5OH \longrightarrow (C_6H_5OH)_2$ Initial concentration : C 0 Final concentration C (1-α) Cα/n, where α is degree of association . Experimentally, phenol is 73 % associated . Hence α = 0.73 . Relation between i (vant hoff factor) and α is given as : α=(1-i)/ (1-n) , where n for phenol = ½ as phenol acts as dimer , association is taking place Substituting the values : 0.73=(1-i)/(-0.5)	1 ½ ½ ½ 1 1 ½ ½

	i=1- 0.73/2 i= 0.635	½
	Depression in freezing point can be calculated as: $\Delta T_f = iK_f\, m$ $= iK_f\, (w_b / M_b \times w_a)$ $K_f = 5.12$ K Kg/mol, $w_b = 2 \times 10^{-2}$ kg = 20 g, $w_a = 1$ kg $M_b = 94$ $\Delta T_f = (0.635 \times 5.12 \times 20 / (94)$ = 0.691 K	1 ½
	_____	