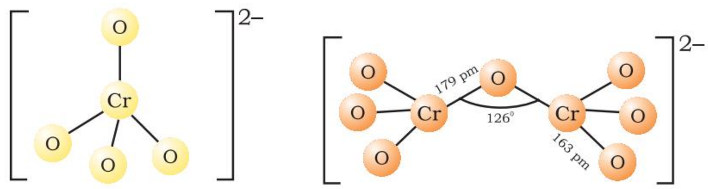
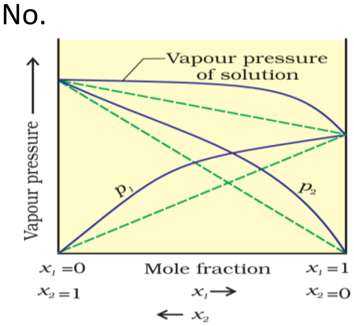
SECOND YEAR HIGHER SECONDARY FIRST TERM EXAMINATION AUGUST 2023
CHEMISTRY - ANSWER KEY

Qn. No.	Sub Qns.	Answer Key/Value Points	Score	Total
		Answer any 4 questions from 1 to 5. Each carry 1 score		
1.		(b) Molality	1	1
2.		96487 C mol^{-1} OR, 96500 C mol^{-1} OR, 1 Faraday	1	1
3.		mol L^{-1} s^{-1} OR M s^{-1} OR atm s^{-1}	1	1
4.		(b) Kohlrausch law	1	1
5.		Scandium (Sc)	1	1
		Answer any 8 questions from 6 to 15. Each carry 2 score		
6.		Primary cell cannot be recharged or reused, while secondary cell can be recharged and reused. In primary cell, the cell reaction cannot be reversed but in secondary cell, the cell reaction can be reversed. ***[Any one difference is required]*** Example for primary cell: Dry cell, mercury cell (button cell) etc. Example for secondary cell: Lead storage cell, Ni-Cd cell (Nicad cell), Lithium ion cell etc. ***[Any one example for each cell is required]***	1 1	2
7.		This is because the fluid inside our blood cell is isotonic with 0.9% (mass/volume) NaCl solution. So osmosis does not occur if we place the blood cells in this solution. OR, If the blood cells are placed in NaCl solution with higher or lower concentrations than 0.9 %, they would shrink or swell.	2	2
8.	a) b)	The rate equation (rate law) is $r = k[A]^2$ Let the initial concentration of A be y. Then the rate law for this reaction is $r = k\,y^2$ When the concentration of A is increased to three times, the final concentration becomes 3y. Now the rate law is $r_1 = k(3y)^2 = 9ky^2$ So $r_1 = 9 \times r$ i.e. the rate formation of B is ***increased by 9 times.***	1 1	2
9.		We know that $\Delta T_f = \frac{1000\,K_f \,.\, w_2}{w_1 \,.\, M_2}$ Here $w_2 = 0.4$ g, $w_1 = 20$g, $\Delta T_f = 0.75$ K, $K_f = 5.12$ K kg/mol, $M_2 = ?$ On substituting in the above equation, we get $0.75 = \frac{1000 \times 5.12 \times 0.4}{20 \times M_2}$ So, $M_2 = \frac{1000 \times 5.12 \times 0.4}{20 \times 0.75} =$ **136.53 g/mol**	1 1	2

10.		 Chromate ion Dichromate ion	2 x 1	2
11.		For a first order reaction, $k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$ When $t = t_{1/2}$, $[R] = [R]_0/2$ Substitute these values in the above equation $k = \frac{2.303}{t_{1/2}} \log \frac{[R]_0}{[R]_0/2}$ Or, $t_{1/2} = \frac{2.303}{k} \log 2 = \frac{2.303 \times 0.3010}{k}$ Or, $t_{1/2} = \frac{0.693}{k}$ Thus for a first order reaction, half-life period is independent of initial concentration of the reacting species.	1 1	2
12.		When a pressure larger than osmotic pressure is applied to the solution side, the direction of osmosis gets reversed (i.e. now the pure solvent flows out of the solution through the semi permeable membrane). This phenomenon is called reverse osmosis. Application: Desalination of sea water OR, Purification of water.	1 1	2
13.		Transition elements act as catalyst due to their: (i) large surface area (ii) ability to form complexes (iii) ability to show variable oxidation state. ***[Any 2 required]***	2 x 1	2
14.		Given $\Lambda^0 m_{(NaCl)} = 126.4$ S cm^{2}mol^{-1}, $\Lambda^0 m_{(HCl)} = 425.9$ S cm^{2}mol^{-1} and $\Lambda^0 m_{(NaAc)} = 91.0$ S cm^{2}mol^{-1} Applying Kohlrausch's law, $\Lambda^0 m_{(HAc)} = \Lambda^0 m_{(NaAc)} + \Lambda^0 m_{(HCl)} - \Lambda^0 m_{(NaCl)}$ = 91.0 + 425.9 – 126.4 = **390.5 S cm^{2}mol^{-1}**	1 1	2
15.		$\Delta_r G^0 = -nFE^0_{cell}$ Here n = 2, F= 96500 C and E^0cell = 1.1 V So $\Delta_r G^0$ = – 2 x 96500 x 1.1 = **– 212300 J/mol** = **– 212.3 kJ/mol**	1 1	2
Answer any 8 questions from 16 to 26. Each carry 3 score				
16.	(i) (ii)	No. 	1 2	3

<table>
<tr><td>17.</td><td></td><td>For Daniel cell, the electrode potentials are given as:
$E_{(Cu^{2+}/Cu)} = E^0_{(Cu^{2+}/Cu)} + \frac{RT}{2F} \ln [Cu^{2+}]$ (For cathode)
$E_{(Zn^{2+}/Zn)} = E^0_{(Zn^{2+}/Zn)} + \frac{RT}{2F} \ln [Zn^{2+}]$ (For anode)
The cell potential, $E_{cell} = E_{(Cu^{2+}/Cu)} - E_{(Zn^{2+}/Zn)}$
$= \{E^0_{(Cu^{2+}/Cu)} + \frac{RT}{2F} \ln [Cu^{2+}]\} - \{E^0_{(Zn^{2+}/Zn)} + \frac{RT}{2F} \ln [Zn^{2+}]\}$
$= [E^0_{(Cu^{2+}/Cu)} - E^0_{(Zn^{2+}/Zn)}] + \frac{RT}{2F} \ln \frac{[Cu^{2+}]}{[Zn^{2+}]}$
Or, $E_{cell} = E^0_{cell} + \frac{RT}{2F} \ln \frac{[Cu^{2+}]}{[Zn^{2+}]}$
On changing the base of logarithm, we get
$E_{cell} = E^0_{cell} + \frac{2.303RT}{2F} \log \frac{[Cu^{2+}]}{[Zn^{2+}]}$
On substituting the values of R (8.314 $JK^{-1} mol^{-1}$), F (96500 C mol^{-1}) at 298K, the above equation becomes,
$E_{cell} = E^0_{cell} + \frac{0.0591}{2} \log \frac{[Cu^{2+}]}{[Zn^{2+}]}$</td><td>1
1
1</td><td>3</td></tr>
<tr><td>18.</td><td>a)
b)</td><td>The molar mass obtained by colligative property measurement becomes incorrect, if there is association or dissociation of particles. Such a molar mass is called abnormal molar mass.
<table><tr><td>Salt</td><td>Van't Hoff factor</td></tr><tr><td>KCl</td><td>2</td></tr><tr><td>$Al(NO_3)_3$</td><td>4</td></tr><tr><td>Na_2SO_4</td><td>3</td></tr><tr><td>$Al_2(SO_4)_3$</td><td>5</td></tr></table></td><td>1
½ x 4 = 2</td><td>3</td></tr>
<tr><td>19.</td><td>(a)
(b)</td><td>Anode reaction: $2 Fe_{(s)} \rightarrow 2 Fe^{2+}_{(aq)} + 4 e^-$
Cathode reaction: $O_{2(g)} + 4 H^+_{(aq)} + 4 e^- \longrightarrow 2 H_2O_{(l)}$
The methods to prevent corrosion of metals are:
a) By giving a non-metallic coating on the surface of iron with paint, varnish etc.
b) By coating the iron surface with electropositive metal like zinc or magnesium.
c) By coating with anti-rust solution.
d) By sacrificial protection. [Any 2 methods required]</td><td>1
1
1</td><td>3</td></tr>
<tr><td>20.</td><td></td><td>Potassium dichromate is generally prepared from chromite ore ($FeCr_2O_4$) by the following three steps.
1. Conversion of chromite ore to sodium chromate by fusing with sodium carbonate in presence of air.
$4 FeCr_2O_4 + 8 Na_2CO_3 + 7 O_2 \rightarrow 8 Na_2CrO_4 + 2 Fe_2O_3 + 8 CO_2$
2. Sodium chromate is acidified with sulphuric acid to form sodium dichromate.
$2Na_2CrO_4 + 2 H^+ \rightarrow Na_2Cr_2O_7 + 2 Na^+ + H_2O$
3. Conversion of sodium dichromate to potassium dichromate by treating with potassium chloride.
$Na_2Cr_2O_7 + 2 KCl \rightarrow K_2Cr_2O_7 + 2 NaCl$</td><td>3 x 1 = 3</td><td>3</td></tr>
</table>

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<tr><td>21.</td><td></td><td>
<table>
<tr><th>Order</th><th>Molecularity</th></tr>
<tr><td>It is the sum of the powers of the concentration terms in the rate law expression</td><td>It is the total number of reactant species collide simultaneously in a chemical reaction</td></tr>
<tr><td>It is an experimental quantity</td><td>It is a theoretical quantity</td></tr>
<tr><td>It can be zero or fractional</td><td>It cannot be zero or fractional</td></tr>
<tr><td>It is applicable to both elementary and complex reactions.</td><td>It is applicable to only elementary reactions.</td></tr>
</table>
[Any 3 differences required]</td><td>3 x 1
= 3</td><td>3</td></tr>
<tr><td>22.</td><td>(a)

(b)</td><td>Standard Hydrogen Electrode (SHE) consists of a platinum electrode coated with platinum black. The electrode is dipped in 1 molar acidic solution. Pure hydrogen gas at 1 bar pressure and 298K is bubbled through it. It is represented as $Pt(s)/H_2(g)/H^+(aq)$. By convention, the electrode potential of SHE is taken as zero.
OR, the labelled diagram of SHE.
We know that $E^0_{cell} = E^0_R – E^0_L$ [Here SHE is the negative electrode, i.e. anode]
i.e. $1.37 = E^0_R – 0$
So, $E^0_R = 1.37$ V
So the std. electrode potential of the given electrode = <u>1.37 V</u></td><td>2

1</td><td>3</td></tr>
<tr><td>23.</td><td></td><td>We know that, $\log k_2/k_1 = \frac{E_a}{2.303\,R}\,\frac{[T_2 - T_1]}{T_1.T_2}$
Here T_1 = 293 K, k_1 = x, T_2 = 313 K, k_2 = 4x and R = 8.314 J K^{-1} mol^{-1}
$\log \frac{4x}{x} = \frac{E_a}{2.303 \times 8.314}\,\frac{[313 – 293]}{293 \times 313}$
So, $E_a = \frac{(2.303 \times 8.314 \times 293 \times 313 \times \log 4)}{20}$ = 52854 J/mol = <u>52.854 kJ/mol</u></td><td>1

1

1</td><td>3</td></tr>
<tr><td>24.</td><td></td><td>Electronic configuration of Fe^{2+} : [Ar] $3d^6$
Sc^{3+} : [Ar] $3d^0$
Ni^{2+}: [Ar]$3d^8$
Cu^+: [Ar] $3d^{10}$
Coloured ions are Fe^{2+}, Ni^{2+}
This is because of the presence of partially filled d-orbitals in these ions.
OR, in Sc^{3+} and Cu^+, there are no partially filled d-orbitals. So they are colourless.</td><td>1

1
1</td><td>3</td></tr>
<tr><td>25.</td><td>a)
b)</td><td>Paramagnetism, Diamagnetism and ferromagnetism [Any 2 required]
The electronic configuration of M^{2+} ion with atomic number 27 is $3d^7$.
[↑↓][↑↓][↑][↑][↑]
So there are 3 unpaired electrons.
The spin-only magnetic moment, μ s = √3(3+2) = √15 = 3.87 BM</td><td>1
1

1</td><td>3</td></tr>
<tr><td>26.</td><td>a)

b)</td><td>Reactions which appears to follow higher order but actually follows first order kinetics are called pseudo first order reactions.
E.g.: Hydrolysis of ester OR, Inversion of cane sugar OR, any hydrolysis reaction.

Zero order reaction</td><td>1
1

1</td><td>3</td></tr>
</table>

Answer any 4 questions from 27 to 31. Each carry 4 score.				
27.	a)	These are properties of dilute solutions, which depend only on the number of solute particles and not on their nature.	2	4
	b)	The important colligative properties: (i) Relative lowering of vapour pressure (ii) Elevation of boiling point (iii) Depression of freezing point (iv) Osmotic pressure. ***[Any 2 Required]***	1	
	c)	Osmotic pressure	1	
28.	a)	Fuel cells are galvanic cells which convert the energy of combustion of fuels like hydrogen, methane, methanol etc. directly into electrical energy.	1	4
	b)	Anode reaction: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$	1	
		Cathode reaction: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	1	
	c)	The advantages of fuel cell are: i) The cell works continuously as long as the reactants are supplied. ii) It has higher efficiency as compared to other conventional cells. iii) It is eco-friendly (i.e. pollution free) since water is the only product formed. iv) Water obtained from $H_2 - O_2$ fuel cell can be used for drinking. ***[Any 1 required]***	1	
29.	(a)	Azeotropes are binary liquid mixtures having same composition in liquid phase and vapour phase and boils at a constant temperature.	1	4
	(b)	Let $CHCl_3$ be the component 1 and CH_2Cl_2 be the component 2. Then vapour pressure of pure chloroform (P_1^0) = 200 mm of Hg and vapour pressure of pure CH_2Cl_2 (P_2^0) = 415 mm of Hg. Mass of Chloroform (w_1) = 24 g Molar mass of Chloroform, $CHCl_3$ (M_1) = 12 + 1 + 3 x 35.5 = 119.5 g/mol		
		No. of moles of Chloroform (n_1) = w_1/M_1 = 24/119.5 = 0.2 mol	½	
		Mass of dichloromethane (w_2) = 17 g Molar mass of dichloromethane, CH_2Cl_2 (M_2) = 12 + 2 x 1 + 2 x 35.5 = 85 g/mol		
		No. of moles of CH_2Cl_2 (n_2) = w_2/M_2 = 17/85 = 0.2 mol	½	
		Mole fraction of CH_2Cl_2 (χ_2) = $n_2/(n_1+n_2)$ = 0.2/(0.2+0.2) = 0.5	1	
		Total pressure of the solution = $P_1^0 + (P_2^0 - P_1^0)\chi_2$ = 200 + (415-200) x 0.5 = **<u>307.5 mm of Hg</u>**	1	
		[Or, find out χ_1 also and then calculate P_1 ($P_1 = P_1^0\chi_1$), P_2 ($P_2 = P_2^0\chi_2$) & $P_{Total} = P_1 + P_2$]		
30.	a)	Arrhenius equation is $k = A.e^{-Ea/RT}$ OR, $\ln k = \ln A - \frac{E_a}{RT}$ OR, $\log k = \log A - \frac{E_a}{2.303RT}$	1	4
	b)	Where k – rate constant, A – Arrhenius parameter (frequency factor or pre-exponential factor), E_a – Activation energy, R- universal gas constant and T – absolute temperature.	1	
		For a first order reaction, $k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$	1	

		For 90% completion, $[R]_0$ = 100 and [R] = 100 – 90 = 10 So $t = \frac{2.303}{k} \log \frac{[R]_0}{[R]}$ $= \frac{2.303}{0.2303} \times \log \frac{100}{10}$ = **10 s**	1	
31.	a)	The regular decrease in the atomic and ionic radii along lanthanide series is known as lanthanoid contraction. It is due to the poor shielding effect of f – electrons and increase in nuclear charge.	1 1	
	b)	Consequences of lanthanoid contraction are: (i) the 2^{nd} and 3^{rd} row transition series elements have similar atomic and ionic radii. (ii) Lanthanides have similar physical properties and they occur together in nature. So their isolation is difficult. (iii) The basicity of hydroxides of lanthanides decreases from lanthanum to lutetium. ***[Any 2 required]***	2	4

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