Mock Test 3

(Based on Complete Syllabus)

Instructions

1. This question paper contains of 30 Questions of Chemistry, divided into two Sections :
   Section A Objective Type Questions and **Section B** Numerical Type Questions.
2. Section A contains 20 Objective questions and all Questions are compulsory (**Marking Scheme** : Correct +4, Incorrect −1).
3. Section B contains 10 Numerical value questions out of which only 5 questions are to be attempted (**Marking Scheme** : Correct +4, Incorrect 0).

Section A : Objective Type Questions

1 100 mL each of two sols of AgI, one obtained by adding $AgNO_3$, to slight excess of KI and another obtained by adding KI to slight excess of $AgNO_3$ are mixed together. Then,

(a) the two sols will stabilise each other
(b) the sol particles will acquire more electric charge
(c) the sols will coagulate each other mutually
(d) a true solution will be obtained

2 Alkali metals dissolve in liquid NH_3, then which of the following statements about the solution obtained is incorrect?

(a) Solution has high electrical conductivity due to ammoniated electrons
(b) Solution imparts blue colour due to greater polarisation of metal ion
(c) Solution is quite stable, which is considered as a dilute metal
(d) On the addition of substance like iron oxide, solution decomposes and releases hydrogen gas

3 Which of the following does not represent the correct order of properties indicated ?

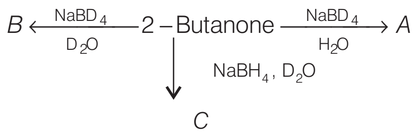
(a) $NH_3 < PH_3 < AsH_3$ (acidic character)
(b) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$ (unpaired electrons)
(c) $Al_2O_3 < MgO < Na_2O < K_2O$ (basic nature)
(d) $Li < Be < B < C$ (IE_1)

4 **Assertion** (A) Addition reaction of water to but-1-ene in acidic medium yields butan-1-ol.

Reason (R) Addition of water in acidic medium proceeds through the formation of primary carbocation.

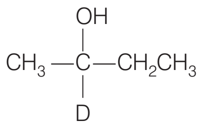
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion
(c) Assertion is true but Reason is false
(d) Both Assertion and Reason are false

5 Consider the reduction of 2-butanone.

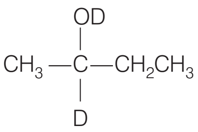


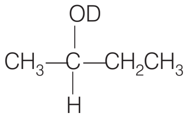
Which of the following statements are true about the products?

(a) Compound (A) is



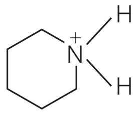
$CH_3-\underset{D}{\overset{OH}{C}}-CH_2CH_3$

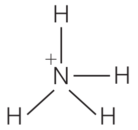
(b) Compound *B* is 
$CH_3-C(OD)(D)-CH_2CH_3$

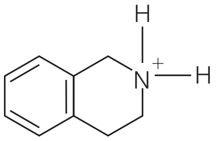
(c) Compound *C* is 
$CH_3-C(OD)(H)-CH_2CH_3$

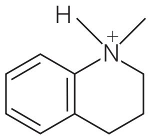
(d) All of the above

6 Which of the following is the strong acid ?

(a) 

(b) 

(c) 

(d) 

7 '*A*' is a blue coloured hydrated salt giving white ppt '*B*' with $BaCl_2$. 2.495 g of '*A*' gave 2.33 g of white ppt '*B*'. '*A*' gives deep reddish-brown solution on reaction with KI but after addition of hypo, reddish-brown solution appears in the form of white ppt '*C*'. '*B*' and '*C*' respectively are

(a) $BaSO_4, CuCN$
(b) $CuSO_4, Cu_2I_2$
(c) $BaSO_4, Cu_2I_2$
(d) $BaSO_4, CuI_2$

8 Match the polymers (given in Column I) with the type of linkage present in them (given in Column II) and choose the correct option from the codes given below.

	Column I		Column II
A.	Terylene	1.	Glycosidic linkage
B.	Nylon	2.	Ester linkage
C.	Cellulose	3.	Phosphodiester linkage
D.	RNA	4.	Amide linkage

Codes

	A	B	C	D		A	B	C	D
(a)	4	1	3	2	(b)	2	4	1	3
(c)	1	3	2	4	(d)	4	3	1	2

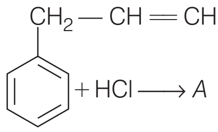
9 A dark brown solid (*X*) reacts with NH_3 to form a mild explosive which decomposes to give a violet coloured gas. (*X*) also reacts with H_2 to give an acid (*Y*). (*Y*) can also be prepared by heating its salt with H_3PO_4. *X* and *Y* are

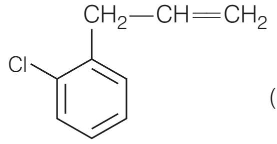
(a) Cl_2, HCl
(b) SO_2, H_2SO_4
(c) Br_2, HBr
(d) I_2, HI

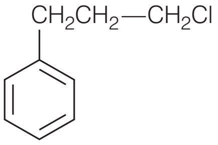
10 Compound *A* and *B* are treated with dil. HCl separately. The gases liberated are *Y* and *Z* respectively. *Y* turns acidified dichromate paper green while *Z* turns lead acetate paper black. The compound *A* and *B* respectively are

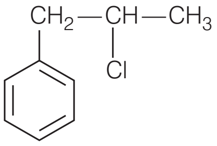
(a) Na_2SO_3 and Na_2S
(b) NaCl and Na_2CO_3
(c) Na_2S and Na_2SO_3
(d) Na_2SO_3 and Na_2SO_4

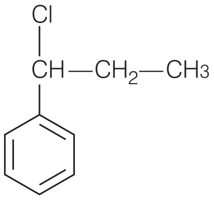
11 Identify *A* in the following reaction. [NCERT Exemplar]



(a) 

(b) 

(c) 

(d) 

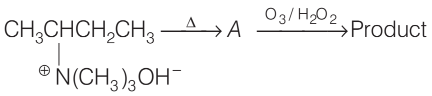
12 Which of the following statements is wrong?

(a) van der Waals' radius of iodine is more than its covalent radius
(b) All isoelectronic ions belong to same period of the periodic table
(c) IE_1 of N is higher than that of O while IE_2 of O is higher than that of N
(d) The electron gain enthalpy of N is zero while that of P is 74.3 kJ mol^{-1}

13 A compound obtained by the hydrolysis of the substance *A*, on reduction forms 2-hexanol. Hence, the substance *A* is

(a) 3,3-dichlorohexane
(b) 2,3-dichlorohexane
(c) 2,2-dichlorohexane
(d) 1,1-dichlorohexane

14 A major alkene '*A*' obtained in the following reaction undergoes ozonolysis to give the product.



$$CH_3\underset{\overset{|}{\oplus N(CH_3)_3OH^-}}{CH}CH_2CH_3 \xrightarrow{\Delta} A \xrightarrow{O_3/H_2O_2} \text{Product}$$

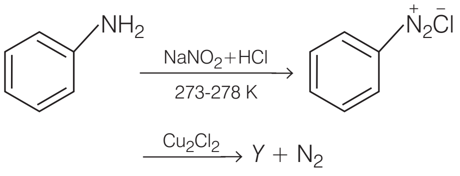
The product obtained is/are identified as

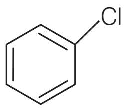
(a) ethanal
(b) methanal and propanal
(c) methanal and acetone
(d) acetone

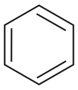
15 Which of the following is correct comparison of the stability of the molecules ?

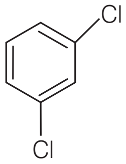
(a) $CN < O_2^+$ (b) $CN^+ = N_2$ (c) $N_2 < O_2$ (d) $H_2^+ > He_2^+$

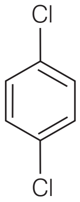
16 Identify the compound *Y* in the following reaction.



(a) 

(b) 

(c) 

(d) 

17 **Assertion** (A) Photochemical smog is produced by nitrogen oxides.

Reason (R) Vehicular pollution is a major source of nitrogen oxides.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion
(c) Assertion is true but Reason is false
(d) Both Assertion and Reason are false

18 In a solid 'AB' having the NaCl structure, 'A' atoms occupy the corners of the cubic unit cell. If all the face-centred atoms along one of the axis are removed then the resultant stoichiometry of the solid is

(a) AB_2 (b) A_2B (c) A_3B_4 (d) A_4B_3

19 The hybridisation states of the central atom of $ClF_3, IF_7, PF_4^+, ClO_3^-$ respectively, are

(a) $sp^3d, sp^3d^3, sp^3, sp^3$ (b) $sp^3d, sp^3d^2, sp^3d, sp^3$
(c) $sp^3, sp^3d, sp^3d, sp^3d^2$ (d) $sp^3d^2, sp^3d^3, sp^3, sp^3$

20 **Statement I** NF_3 is a weaker ligand than $N(CH_3)_3$.
Statement II NF_3 ionises to give F^- ions in aqueous solution.

(a) Statement I is false but Statement II is true.
(b) Statement I is true but Statement II is false.
(c) Both Statement I and Statement II are false.
(d) Both Statement I and Statement II are true.

Section B : Numerical Type Questions

21 One gram of a monobasic acid when dissolved in 100 g of water lowers the freezing point by 0.186°C. Now, 0.25 g of the same acid are dissolved and titrated with 15.1 mL of $N/10$ alkali. The degree of dissociation of the acid is ……… $[K_f(H_2O) = 1.86]$

22 The radius ratio of Cs^+ to Cl^- is 0.90 Å. If the radius of Cl^- ion is 1.80 Å, the distance between Cs^+ ion and Cl^- ion is …… Å.

23 The most abundant element dissolved in sea water is chlorine at a concentration of 19 g/L of sea water. The volume of earth's ocean is 1.4×10^{21} L. Gram-atoms of chlorine are potentially available from the oceans are …… $\times 10^{20}$ (density of sea water is 1 g / cc).

24 When the concentration of 'A' is 0.1M, it decomposes to give 'X' by a first order process with a rate constant of $6.93 \times 10^{-2} \text{min}^{-1}$. The reactant '$A$' in the presence of catalyst gives 'Y' by a second order mechanism with a rate constant of 0.2 min^{-1} M^{-1}. In order that half-life of both the processes is 10 min, one should start with an initial concentration of 'A' as …… M.

25 4.5 g of PCl_5 was completely vaporised at 252°C, vapour occupying 1700 mL at 1.0 atm. The degree of dissociation is …… % (Given $V_\infty = 104.175$)

26 When 1 mole of crystalline NaCl is obtained from sodium and chlorine gas, 410 kJ of heat is released. The heat of sublimation of Na metal is 108 kJ mol^{-1} and Cl—Cl bond enthalpy is 242 kJ mol^{-1}. If the ionisation energy of Na is 493.0 kJ mol^{-1} and the electron affinity of chlorine is 368 kJ mol^{-1}, the lattice energy of NaCl is …… kJ mol^{-1}.

27 A galvanic cell : $Cu|Cu^{2+}||Ag^+|Ag$ initially contains 1 M Ag^+ and 1 M Cu^{2+} ions. The cell potential after the passage of 9.65 A of current for 1 h will be … V.

28 Given, $Fe^{3+} + e^- \longrightarrow Fe^{2+}, E° = 0.77$ V

$$\frac{1}{2}I_2 + e^- \longrightarrow I^-, \quad E° = 0.54 \text{ V}$$

Thus, equilibrium constant for the reaction in terms of $\log k$ is

$$2Fe^{3+} + 3I^- \rightleftharpoons 2Fe^{2+} + I_3^-$$

29 K_1 and K_2 for carbonic acid (H_2CO_3) are 4.3×10^{-7} and 5.6×10^{-11} respectively. The pH of 0.01 M $NaHCO_3$ solution will be

30 Two first order reactions have half-lives in the ratio 8 : 1. The ratio of time intervals $t_1 : t_2$ is …… .
The time t_1 and t_2 are the time period for (1/4)th and (3/4)th completion.

ANSWERS

1. (c)	**2.** (b)	**3.** (d)	**4.** (d)	**5.** (d)	**6.** (d)	**7.** (c)	**8.** (b)	**9.** (d)	**10.** (a)
11. (c)	**12.** (b)	**13.** (c)	**14.** (b)	**15.** (d)	**16.** (a)	**17.** (d)	**18.** (c)	**19.** (a)	**20.** (b)
21. (0.67)	**22.** (3.42)	**23.** (7.6)	**24.** (0.5)	**25.** (83)	**26.** (–764)	**27.** (0.01)	**28.** (7.78)	**29.** (9.19)	**30.** (1:0.602)

Hints and Explanations

1. The sols obtained in the two cases will be oppositely charged, thus coagulate each other mutually.

2. $$\underset{\text{Alkali metal}}{M} + \underset{\text{Solution}}{(x+y)NH_3} \longrightarrow \underset{\substack{\text{Ammoniated}\\\text{metal cation}}}{[M(NH_3)_x]^+} + \underset{\substack{\text{Ammoniated}\\\text{electron (blue)}}}{[e(NH_3)_y]^-}$$

It imparts blue colour due to the presence of solvated electrons, not due to polarisation. On addition of iron oxide, solution decomposes as follows

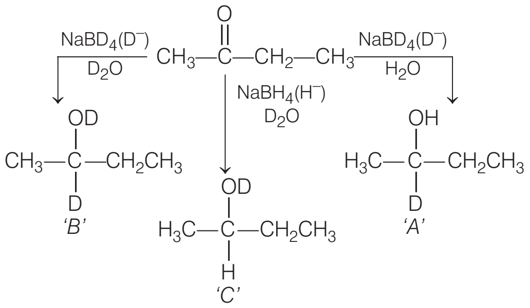
$$2Na + 2NH_3 \xrightarrow{Fe_2O_3} 2NaNH_2 + H_2\uparrow$$

3. Generally, IE increases in a period from left to right but IE of group 2 is greater than group 3 due to stable electronic configuration of group 2.

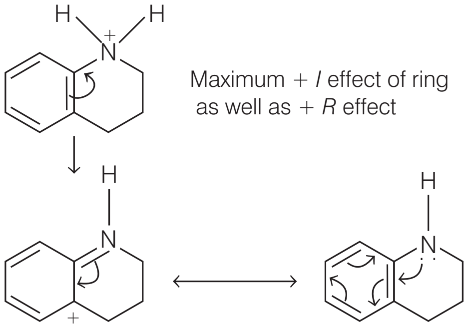
4. Addition of water to but-1-ene in acidic medium yields butan-2-ol.

Addition of water in acidic medium proceeds through the formation of secondary carbocation.

5.



6.



7. $$\underset{'A'}{CuSO_4\cdot 5H_2O} + BaCl_2 \longrightarrow \underset{'B'}{BaSO_4} + CuCl_2$$

$$2CuSO_4 + 4KI \longrightarrow \underset{\text{White ppt}}{2CuI\downarrow} + I_2$$

$$I_2 + KI \rightleftharpoons \underset{\text{Reddish brown}}{KI_3}$$

On adding hypo, I_2 is reduced to I^- and white ppt of Cu_2I_2 (CuI) appears.

8. $A \to 2; B \to 4; C \to 1; D \to 3$

9. $X = I_2$, $Y = HI$

$$\underset{(X)}{3I_2} + 2NH_3 \longrightarrow \underset{\text{(explosive)}}{NH_3\cdot NI_3}$$

$$8NI_3\cdot NH_3 \longrightarrow 5N_2 + I_2 + 6NH_4I$$

$$\underset{(X)}{I_2} + H_2 \longrightarrow \underset{(Y)}{2HI}$$

$$3NaI + H_3PO_4 \xrightarrow{\Delta} Na_3PO_4 + 3HI$$

10. Gas (Y) is SO_2 obtained from Na_2SO_3 (A) and gas Z is H_2S obtained from Na_2S (B).

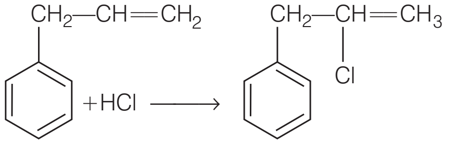
$$\underset{'A'}{Na_2SO_3} + \underset{\text{Dil.}}{2HCl} \longrightarrow 2NaCl + \underset{Y}{SO_2(g)} + H_2O$$

$$\underset{'B'}{Na_2S} + \underset{\text{Dil.}}{2HCl} \longrightarrow 2NaCl + \underset{'Z'}{H_2S(g)}$$

$$K_2Cr_2O_7 + H_2SO_4 + \underset{'Y'}{3SO_2(g)} \longrightarrow K_2SO_4 + \underset{\text{Green}}{Cr_2(SO_4)_3} + H_2O$$

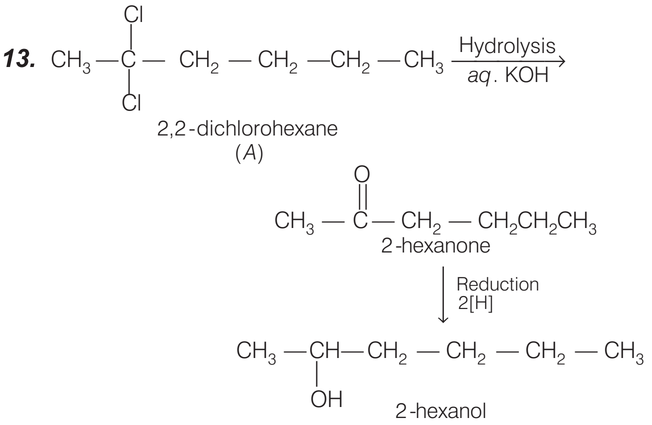
$$(CH_3COO)_2Pb + \underset{'Z'}{H_2S(g)} \longrightarrow \underset{\text{Black}}{PbS\downarrow} + 2CH_3COOH$$

11. Product is in accordance to Markownikoff's rule.



12. In the isoelectronic series, all isoelectronic anions belong to the same period and cations to the next period.

13.



$$CH_3-\underset{Cl}{\overset{Cl}{C}}-CH_2-CH_2-CH_2-CH_3 \xrightarrow[aq.\ KOH]{\text{Hydrolysis}}$$

2,2-dichlorohexane (A)

$$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_2CH_2CH_3$$

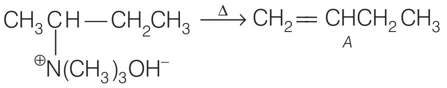
2-hexanone

$$\Big\downarrow \text{Reduction } 2[H]$$

$$CH_3-\underset{OH}{CH}-CH_2-CH_2-CH_2-CH_3$$

2-hexanol

14.



$$CH_3\underset{\overset{\oplus}{N}(CH_3)_3OH^-}{CH}-CH_2CH_3 \xrightarrow{\Delta} \underset{A}{CH_2{=}CHCH_2CH_3}$$

$$+ (CH_3)_3N + H_2O$$

In elimination reaction of alkyl tri-methyl ammonium hydroxide, less substituted alkenes are obtained.

$$CH_2{=}CHCH_2CH_3 \xrightarrow{O_3/H_2O_2} \underset{\text{Methanal}}{HCHO} + \underset{\text{Propanal}}{CH_3CH_2CHO}$$

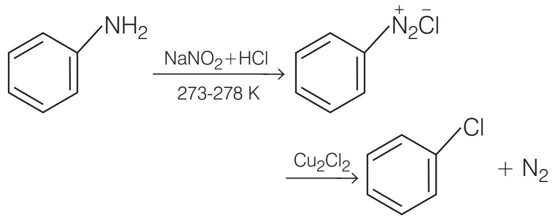
15. Bond order ∝ stability. When the bond order of two molecules are same, the molecule with least number of antibonding electrons is more stable. Thus,

$$H_2^+(1) = \sigma 1s^1;\ BO = \frac{1-0}{2} = 0.5$$

$$He_2^+(3) = \sigma 1s^2, \sigma^* 1s^1,$$

$$BO = \frac{2-1}{2} = 0.5$$

$\therefore$ Stability of H_2^+ > Stability of He_2^+.

16. 

Y

17. Photochemical smog is produced by nitrogen oxides and it is also fact that vehicular pollution is a major source of nitrogen oxide.

18. There are 6 A atoms on the face centres. Removing face centred atoms along one of the axis means removal of 2 A atoms.

Now, number of A atoms per unit cell

$$= \underset{\text{(corners)}}{8 \times \frac{1}{8}} + \underset{\text{(face-centred)}}{4 \times \frac{1}{2}} = 3$$

Number of B-atoms per unit cell

$$= \underset{\text{(edge centred)}}{12 \times \frac{1}{4}} + \underset{\text{(body centred)}}{1} = 4$$

Hence, the resultant stoichiometry is A_3B_4.

19. Hybridisation in $ClF_3 = sp^3d$

$$IF_7 = sp^3d^3$$

$$PF_4^+ = sp^3$$

$$ClO_3^- = sp^3$$

20. Fluorine is highly electronegative, hence it withdraws electrons from nitrogen atom and therefore, the lone pair of electrons on nitrogen atom cannot be ligated. While $N(CH_3)_3$ is a strong ligand because — CH_3 is a electron releasing group.

21. $w = \frac{ENV}{1000}$ [For monobasic acid $E = M$]

$$0.25 = \frac{M \times 1 \times 15.1}{1000 \times 10} \Rightarrow M = 165.56$$

$$\text{Molality } (m) = \frac{1 \times 1000}{165.56 \times 100} = 0.060$$

$$\Delta T_f = K_f \times m = 1.86 \times 0.060 = 0.1116$$

$$i = \frac{[\Delta T_f]_{\text{obs}}}{[\Delta T_f]_{\text{normal}}} = \frac{0.186}{0.1116} = 1.67$$

$$\underset{1-x}{\overset{}{\underset{1}{HA}}} \rightleftharpoons \underset{x}{\underset{0}{H^+}} + \underset{x}{\underset{0}{A^-}}$$

$$1.67 = \frac{(1-x) + x + x}{1}$$

$$x = 0.67$$

22. $\because$ $(r_{Cs^+/Cl^-} = 0.90$ Å,

$\therefore$ $r_{Cs^+} = 0.90 \times r_{Cl^-} = 0.90 \times 1.80 = 1.62$ Å

For precise fitting of the cubic voids, $\frac{r_{Cs^+}}{r_{Cl^-}}$ must be 0.732.

$$0.732 < 0.90$$

Hence, cubic packing of Cl^- ions is loose to some extent.

The distance between Cs^+ and Cl^-

$$= r_{Cs^+} + r_{Cl^-} = 1.62 \text{ Å} + 1.80 \text{ Å} = 3.42 \text{ Å}$$

23. Total weight of ocean = volume of earth ocean

$\times$ density of sea water

$$= 1.4 \times 10^{21} \times 1 \times 10^3 = 1.4 \times 10^{24} \text{ g water}$$

$$[Cl^-] = \frac{19 \text{ g } Cl^-}{1000 \text{ g water}}$$

Total weight of chloride

$$= 1.4 \times 10^{24} \text{ g water} \times 19 \times 10^{-3} \frac{gCl^-}{\text{gwater}} = 2.7 \times 10^{22} \text{ g } Cl^-$$

$$\text{Number of gram atoms} = \frac{2.7 \times 10^{22}}{35.5} = 7.6 \times 10^{20} \text{ g-atoms}$$

24. $A \xrightarrow{k_1} X; k_1 = 6.93 \times 10^{-2} \text{ min}^{-1}$

$A \xrightarrow{k_2} Y; \quad k_2 = 0.2 \text{ min}^{-1} \text{ M}^{-1}$

$$, \quad t_{1/2} = \frac{0.693}{k_1}$$

$$t_{1/2} = \frac{0.693}{6.93 \times 10^{-2}} = 10 \text{ min}$$

and independent of initial concentration.

$$, \quad t_{1/2} = \frac{1}{k_2 a}; \quad a = \frac{1}{k_2 \cdot t_{1/2}} = \frac{1}{0.2 \times 10} = 0.5 \text{ M}$$

25. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$; $pV = \frac{m}{M}RT$

$$\text{Molecular weight } (M) = \frac{mRT}{pV} = \frac{4.5 \times 0.082 \times (273 + 252)}{1.0 \times 1700/1000}$$

$$= 113.96$$

$$\text{Observed vapour density} = \frac{113.95}{2} = 56.98$$

$$\alpha = \frac{V_\infty - V_0}{(n-1)V_0} = \frac{104.175 - 56.98}{(2-1) \times 56.9} = \frac{47.195}{56.98} = 0.828 \approx 0.83$$

Degree of dissociation = 83%

26. $Na(s) + \frac{1}{2}Cl_2(g) \longrightarrow NaCl(s), \quad \Delta H = -410$ kJ

$$\Delta H_{\text{sub}}(Na) + IE(Na(g)) + \frac{1}{2}\Delta H_{Cl-Cl}$$

$$- EA_{(Cl)} + \Delta H_{\text{lattice}}(NaCl) = -410$$

$$108 + 493 + \frac{1}{2} \times 242 - 368 + \Delta H_{\text{lattice}}(NaCl) = -410$$

$$\Delta H_{\text{lattice}}(NaCl) = -764 \text{ kJ mol}^{-1}$$

27. $Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{2} \log \frac{[Cu^{2+}]}{[Ag^+]^2}$$

On the passage of 9.65A for 1h (9.65 × 60 × 60 C) externally cell reaction is reversed, now Cu^{2+} will be discharging

(conc. of Cu^{2+} will decrease) and Ag will be ionising (conc. of Ag^+ will increase).

$$\text{Final mole of } Ag^+ = \frac{9.65 \times 60 \times 60}{96500}$$

$$= 0.36 \text{ g-equivalent} = 0.36 \text{ mol}$$

$$\text{Final moles of } Cu^{2+} = \frac{9.65 \times 60 \times 60}{96500}$$

$$= 0.36 \text{ g-equivalent} = 0.18 \text{ mol}$$

$$[Ag^+] = 1 + 0.36 = 1.36 \text{ M}$$

$$[CH^{2+}] = 1 - 0.18 = 0.82 \text{ M}$$

$$\text{Hence, } E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{2} \log \frac{[0.82]}{[1.36]^2}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} + 0.010 \text{ V}$$

28. $2 \times \quad [Fe^{3+} + e^- \longrightarrow Fe^{2+}, E^\circ_{\text{red}} = 0.77 \text{ V}$

$$2I^- \longrightarrow I_2 + 2e^-, E_{\text{ox}} = -0.54 \text{ V}$$

$$I_2 + I^- \rightleftharpoons I_3^-$$

$$\underline{\overline{2Fe^{3+} + 3I^- \rightleftharpoons 2Fe^{2+} + I_3^-}}, \quad E^\circ_{\text{cell}} = 0.23 \text{ V}$$

$$\therefore \quad E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0591}{2} \log K_{\text{eq}}$$

$$E_{\text{cell}} = 0.00 \text{ V at equilibrium}$$

$$K_{\text{eq}} = \frac{[Fe^{2+}]^2 [I_3^-]}{[Fe^{3+}]^2 [I^-]^3}$$

$$\therefore \quad E^\circ_{\text{cell}} = \frac{0.0591}{2} \log K_{eq} \Rightarrow \frac{0.23 \times 2}{0.0591} = \log K_{\text{eq}}$$

$$\therefore \quad \log K_{\text{eq}} = 7.78$$

29. $NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$

or $\quad HCO_3^- + H_2O \rightleftharpoons OH^- + H_2CO_3$

For anion hydrolysis degree of hydrolysis

$$K_h = \frac{K_w}{K_a} = \frac{K_w}{K_1} = \frac{1 \times 10^{-14}}{4.3 \times 10^{-7}} = 2.33 \times 10^{-8}$$

$$[K_2 <<< K_h, [H^+] <<<< [OH^-]]$$

$$K_h = Ch^2$$

$$[OH^-] = Ch$$

$$[OH^-] = \sqrt{C^2 h^2} = \sqrt{C \times Ch^2}$$

$$= \sqrt{C \times K_h} = \sqrt{0.01 \times 2.33 \times 10^{-8}}$$

$$= 1.53 \times 10^{-5}$$

$$[H^+] = \frac{1 \times 10^{-14}}{1.53 \times 10^{-5}} = 6.53 \times 10^{-10}$$

$$pH = -\log [H^+]$$

$$= -\log (6.53 \times 10^{-10}) = 9.19$$

30. $t_1 = \dfrac{2.303\ (t_{1/2})_1}{0.693} \log \left(\dfrac{1}{1 - (1/4)} \right)$

and $\quad t_2 = \dfrac{2.303\ (t_{1/2})_2}{0.693} \log \left(\dfrac{1}{1 - (3/4)} \right)$

$$\frac{t_1}{t_2} = \frac{8}{1} \times \frac{\log (4/3)}{\log 4}$$

$$= \frac{8 \times 0.125}{0.602} = 1 : 0.602$$