DAY THIRTY EIGHT

Mock Test 1

(Based on Complete Syllabus)

Instructions

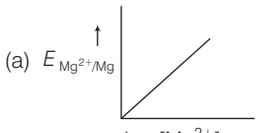
1. This question paper contains of 30 Questions of Chemistry, divided into two Sections :
   Section A Objective Type Questions and **Section B** Numerical Type Questions.
2. Section A contains 20 Objective questions and all Questions are compulsory (**Marking Scheme** : Correct +4, Incorrect –1).
3.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

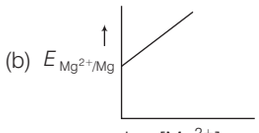
Section A : Objective Type Questions

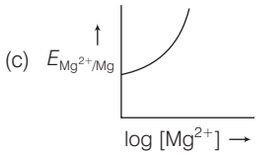
1 Electrode potential for Mg electrode varies according to the equation

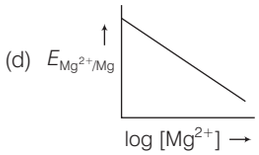
$$E_{Mg^{2+}/Mg} = E^{\ominus}_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$$

The correct graphical representation is

(a) 

(b) 

(c) 

(d) 

2 Consider the reactions

(i) $CO(g) + H_2O(g) \overset{K_1}{\rightleftharpoons} CO_2(g) + H_2(g)$

(ii) $CH_4(g) + H_2O(g) \overset{K_2}{\rightleftharpoons} CO(g) + 3H_2(g)$

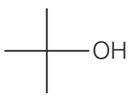
(iii) $CH_4(g) + 2H_2O(g) \overset{K_3}{\rightleftharpoons} CO_2(g) + 4H_2(g)$

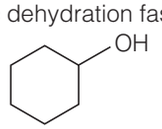
Which of the following is correct relation?

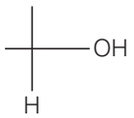
(a) $K_3 = K_1/K_2$ (b) $K_3 = K_1^2/K_2^3$

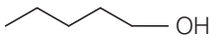
(c) $K_3 = K_1 \cdot K_2$ (d) $K_3 = K_1 \cdot \sqrt{K_2}$

3 Which of the following will undergo dehydration fast?

(a) 

(b) 

(c) 

(d) 

4 The alcohol, having molecular formula C_4H_9OH, when shaken with a mixture of anhydrous and conc. HCl gives an oily layer product after five minutes. The alcohol is

(a) $H_3C—(CH_2)_3—OH$
(b) $(CH_3)_2CHCH_2—OH$
(c) $(CH_3)_3C—OH$
(d) $H_3C—CH(OH)CH_2CH_3$

5 How many moles of $MgIn_2S_4$ can be produced when 1.00 g of magnesium (atomic mass = 24), 1.00 g of indium (atomic mass = 114.8) and 1.00 g of sulphur (atomic mass = 32) react?

(a) 6.74×10^{-4}s (b) 3.1×10^{-2}
(c) 4.17×10^{-2} (d) 8.7×10^{-3}

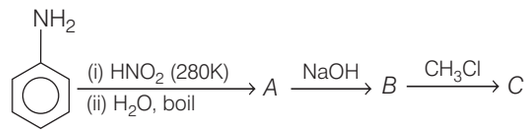
6 **Assertion** (A) Deoxyribose, $C_5H_{10}O_4$ is a carbohydrate.
Reason (R) Carbohydrates are hydrates of carbon so compounds which follow $C_x(H_2O)_y$ formula are carbohydrates.

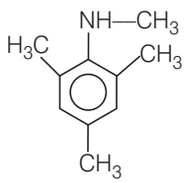
(a) (A) is false but (R) is true.
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false.
(d) Both (A) and (R) are true and (R) is the correct explanation of (A).

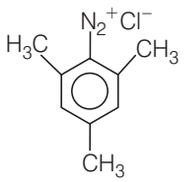
7 Which of the following complexes formed by Cu^{2+} ions is most stable?

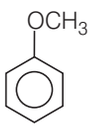
(a) $Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}$; $\log k = 11.6$
(b) $Cu^{2+} + 4CN^- \rightleftharpoons [Cu(CN)_4]^{2-}$; $\log k = 27.3$
(c) $Cu^{2+} + 2en \rightleftharpoons [Cu(en)_2]^{2+}$; $\log k = 15.4$
(d) $Cu^{2+} + 4H_2O \rightleftharpoons [Cu(H_2O)_4]^{2+}$; $\log k = 8.9$

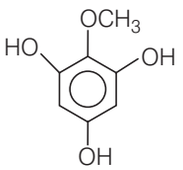
8 Identify *C* in the following sequence of reactions,



(a) 

(b) 

(c) 

(d) 

9 Bromine is added to cold dilute aqueous solution of sodium hydroxide. The mixture is boiled. Which of the following statements is not true ?

(a) During the reaction bromine is present in four different oxidation states
(b) The greatest difference between the various oxidation states of bromine is 5
(c) On acidification of the final mixture, bromine is formed
(d) Disproportionation of bromine occurs during the reaction

10 The correct order of increasing N—N bond stability of N_2^{2-}, N_2, $N_2^{\oplus}$, N_2^- is

(a) $N_2^{2-} > N_2 > N_2^{\ominus} > N_2^{\oplus}$ (b) $N_2 > N_2^{\oplus} = N_2^{\ominus} > N_2^{2-}$
(c) $N_2^{2-} > N_2^{\ominus} = N_2^{\oplus} > N_2$ (d) $N_2^{2-} > N_2 > N_2^{\ominus} = N_2^{\oplus}$

11 Given below are two statements.
Statement I Fe^{2+} givens brown colour with ammonium thiocyanate.
Statement II Fe^{3+} gives red colour with potassium ferrocyanide.
In the light of the above statements, choose the most appropriate answer from the options given below.

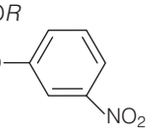
(a) Statement I is false but Statement II is true.
(b) Statement I is true but Statement II is false.
(c) Both Statement I and Statement II are false.
(d) Both Statement I and Statement II are true.

12 Sulphur is converted into Na_2S in Lassaigne's fusion test. Na_2S can be detected by

(I) $(CH_3COO)_2Pb$ (II) CH_3COOH (III) $Na_2[Fe(CN)_5NO]$
Correct codes are

(a) I and II (b) I and III (c) Only III (d) All of these

13 Which of the following species can act as the strongest base?

(a) ^-OH (b) ^-OR
(c) $^-OC_6H_6$ (d) 

14 An aqueous solution of colourless metal sulphate *M* gives a white precipitate with NH_4OH. This was soluble in excess of NH_4OH. On passing H_2S through this solution a white ppt is formed. The metal *M* in the salt is

(a) Ca (b) Ba (c) Al (d) Zn

15 Match the vitamins given in Column I with the deficiency disease they cause given in Column II.

	Column I (Vitamins)		**Column II** (Diseases)
A.	Vitamin B_1	1.	Muscular weakness
B.	Vitamin C	2.	Beri-Beri
C.	Vitamin E	3.	Increased blood clotting time
D.	Vitamin K	4.	Bleeding gums

Codes

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

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

16 The emf of the following cell
$Zn|Zn^{2+}(0.004) \,||\, Cd^{2+}(0.2)|\,Cd$ is given by
[$E^\circ_{(Zn^{2+}/Zn)} = -0.763$ V and
$E^\circ_{(Cd^{2+}/Cd)} = -0.403$ V]

(a) $E = -0.36 + \frac{0.059}{2} \log 2 \times 10^{-2}$

(b) $E = -0.36 - \frac{0.059}{2} \log 50$

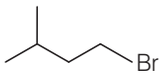
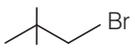
(c) $E = +0.36 - \frac{0.059}{2} \log 2 \times 10^{-2}$

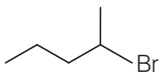
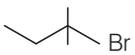
(d) $E = -0.36 + \frac{0.059}{2} \log 50$

17 Which electrolyte is most effective in causing coagulation of ferric hydroxide sol?

(a) KBr (b) K_2SO_4 (c) K_2CrO_4 (d) $K_3[Fe(CN)_6]$

18 Potassium phthalimide on reaction with compound *A* followed by hydrolysis forms *neo*-pentyl amine. Compound *A* is

(a)  (b) 

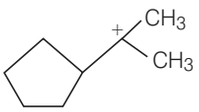
(c)  (d) 

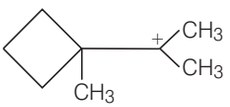
19 Calculate the pressure of O_2 (in atm) over a sample of NiO at 25°C if $\Delta G° = 212$ kJ for the reaction.

$$NiO(s) \rightleftharpoons Ni(s) + \frac{1}{2}O_2(g)$$

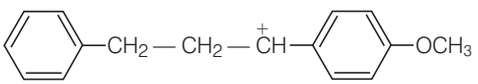
(a) 4.9×10^{-75} atm (b) 7×10^{-38} atm
(c) 4.9×10^{-38} atm (d) 7×10^{-75} atm

20 Identify the intermediate for which the rearrangement is not possible.

(a) 

(b) 

(c) $(CH_3)_3C - \overset{+}{C}H - C(CH_3)_3$

(d) 

Section B : Numerical Type Questions

21 An ideal solution of benzene and toluene boils at 1 atmospheric pressure at 90°C. At 90°C, benzene has a vapour pressure of 1022 mm and toluene has a vapour pressure of 406 mm. The mole fraction of benzene in the solution is …… .

22 If the cell-edge length for CsCl is 0.4123 nm and the ionic radius of a Cl^- ion is 0.181 nm, the ionic radius of a Cs^+ ion is …… nm.

23 0.0005 mole of strong electrolyte, $Ca(OH)_2$ is dissolved to form 100 mL of a saturated aqueous solution. The pH of this solution is

24 An electron in H-atom in its ground state absorbs 1.50 times as much as energy as the minimum energy required for its escape (13.6 eV) from the atom. Thus, kinetic energy given to emitted electron is …… eV

25 For a cell reaction, $Zn + Cu^{2+} \rightleftharpoons Cu + Zn^{2+}$ entropy changes $\Delta S°$ is 96.5 J $mol^{-1}K^{-1}$ then temperature coefficient of the emf of a cell is …… $\times 10^{-4}$ VK^{-1}

26 The degree of hydrolysis in hydraulic equilibrium

$$A^-(aq) + H_2O(l) \rightleftharpoons HA(aq) + OH^-(aq)$$

at salt concentration 0.0001 M is …… $\times 10^{-2}$
($K_a = 1.0 \times 10^{-6}$)

27 The pH of 0.5 L of 1.0 M NaCl after the electrolysis for 965 s using 5.0A current (100 % efficiency) is

28 An organic liquid, *A* is immiscible with water. When boiled together with water, the boiling point is 90°C at which the partial pressure of water is 526 mm Hg. The atmospheric pressure is 736 mm Hg. The weight ratio of the liquid and water collected is 2.5 : 1. The molecular weight of the liquid is …

29 0.15 mole of CO taken in a 2.5 L flask is maintained at 750 K along with a catalyst so that the following reaction can take place.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Hydrogen is introduced until the total pressure of the system is 8.5 atm at equilibrium and 0.08 mole of CH_3OH are formed. The value of K_c is …… $mol^{-2}L^{-2}$ (Assigning ideal behaviour).

30 A reaction proceeds 5 times more at 60°C as it does at 30°C. Its energy of activation is …… Kcal mol^{-1}.

ANSWERS

1 (b)	**2** (c)	**3** (a)	**4** (d)	**5** (d)	**6** (c)	**7** (b)	**8** (c)	**9** (c)	**10** (b)
11 (c)	**12** (b)	**13** (b)	**14** (d)	**15** (b)	**16** (c)	**17** (d)	**18** (b)	**19** (a)	**20** (d)
21 (0.574)	**22** (0.176)	**23** (12)	**24** (20.4)	**25** (5)	**26** (1)	**27** (13)	**28** (112.7)	**29** (187.85)	**30** (10.75)

Hints and Explanations

1. It is known that, $E = E° + \frac{0.059}{2}\log[Mg^{2+}]$. This suggests that the plot of E *vs* $\log[Mg^{2+}]$ would be linear with positive slope having an intercept of $E°$.

2. For the given reaction,

$$K_1 = \frac{[CO_2]\,[H_2]}{[CO]\,[H_2O]},$$

$$K_2 = \frac{[CO]\,[H_2]^3}{[CH_4]\,[H_2O]}$$

$$K_3 = \frac{[CO_2]\,[H_2]^4}{[CH_4]\,[H_2O]^2}$$

$$\frac{K_1 \times K_2}{K_3} = 1$$

$$K_1 \times K_2 = K_3$$

3. In the dehydration of these compounds, intermediate is a carbocation, thus more stable carbocation (3° carbocation) giving compound undergo dehydration fast, i.e. compound.

4. Secondary alcohol, on reaction with anhydrous $ZnCl_2$ and conc. HCl (Lucas reagent) gives an oil layer product after five minutes.

$$\underset{\text{Sec– alcohol}}{H_3C—CH(OH)—CH_2CH_3} \xrightarrow{\text{Lucas reagent}} \text{oil layer}$$

product (turbidity) after 5 min

5.

	Mg	+ 2In	+ 4S	⟶ $MgIn_2S_4$
Moles	$\frac{1}{24}$	$\frac{1}{114.8}$	$\frac{1}{32}$	
	= 0.0417	= 0.0087	= 0.031	

The number of moles of limiting reagent (In) is 0.0087 or 8.7×10^{-3}, hence 8.7×10^{-3} moles of $MgIn_2S_4$ are produced.

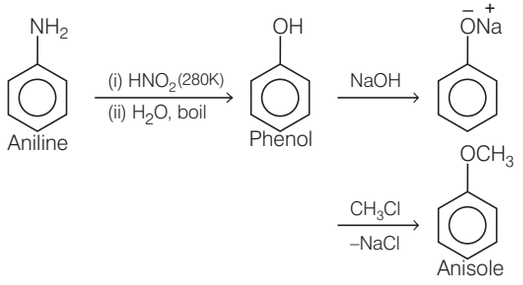
6. **Correct Assertion** Deoxyribose is a carbohydrate.

Correct Reason Carbohydrates are optically active, polyhydroxy aldehydes or polyhydroxy ketones or substances which give these on hydrolysis.

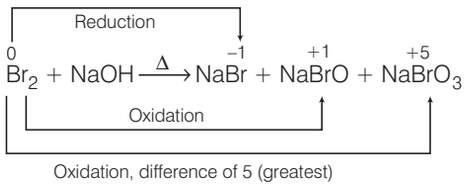
7. Higher the value of log k, larger is the stability of the complex.

So, $[Cu(CN)_4]^{2-}$ is the most stable complex.

8.



9. Bromine on reaction with cold dilute aq. solution of sodium hydroxide undergoes disproportionation. In this reaction, bromine is present in four oxidation state



10. $N_2^{2-}(16) : \sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2,$

$\sigma 2p_z^2, \pi 2p_x^2 \approx \pi 2p_y^2, \overset{*}{\pi} 2p_x^1 \approx \overset{*}{\pi} 2p_y^1$

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{10 - 6}{2} = 2$$

In N_2 (14), bond order = 3

In N_2^- (15), bond order = 2.5

In N_2^+ (13), bond order = 2.5

Bond order ∝ stability

Thus, $N_2 > N_2^{\oplus} = N_2^{\ominus} > N_2^{2-}$

11. The blue precipitate of Fe^{2+} ions with potassium ferricyanide is due to the formation of Turnbull's blue $K\overset{II}{Fe}[\overset{III}{Fe}(CN)_6]$.

$$\underset{\text{Potassium ferricyanide}}{Fe^{2+} + K_3[Fe(CN)_6]} \longrightarrow \underset{\text{Turnbull's blue}}{K\overset{II}{Fe}[\overset{III}{Fe}(CN)_6]} + 2K^+$$

Fe^{3+} ion gives white precipitate that will become blue.

$$FeCl_3 + K_4[Fe(CN)_6] \rightarrow KFe[Fe(CN)_6] + 3KCl$$

12. $Na_2S + Na_2[Fe(CN)_5NO] \longrightarrow \underset{\text{Deep violet}}{Na_4[Fe(CN)_5NOS]}$

$$Na_2S + (CH_3COO)_2Pb \xrightarrow{CH_3COOH} \underset{\text{Black ppt.}}{PbS\downarrow} + 2CH_3COO^-Na^+$$

13. Weakest acid has the strongest conjugate base. Since, ROH is the weakest acid, therefore, RO^- is the strongest base.

14. All the given metals form white ppt with NH_4OH but only ppt of Zn is soluble in excess of NH_4OH and on passing H_2S it gives white ppt of ZnS, so the metal is Zn and reactions takes place are as follows

$$Zn^{2+} + 2NH_4OH \longrightarrow \underset{\text{White ppt.}}{Zn(OH)_2\downarrow} + 2NH_4^+$$

$$Zn(OH)_2 + 2NH_4OH \longrightarrow \underset{\text{Soluble}}{(NH_4)_2ZnO_2} + 2H_2O$$

$$(NH_4)_2ZnO_2 + H_2S \longrightarrow \underset{\text{White ppt.}}{ZnS\downarrow} + 2NH_4OH$$

15. A → 2, B → 4, C → 1, D → 3.

Vitamin-B_1 causes Beri-Beri

Vitamin-C causes bleeding gums

Vitamin-E causes muscular weakness

Vitamin-K causees increased blood clotting time.

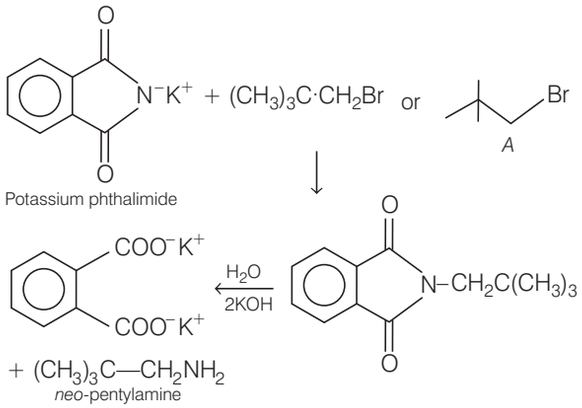
16. $$E = E°_{cell} - \frac{0.059}{n}\log\frac{[\text{oxidised state}]}{[\text{reduced state}]}$$

n = number of electrons taken part in the reaction = 2

$$E = [E^\circ_{Zn/Zn^{2+}} - E^\circ_{Cd^{2+}/Cd}] - \frac{0.059}{2}\log\frac{0.004}{0.2}$$
$$= [0.763 - 0.403] - \frac{0.059}{2}\log\frac{1}{50}$$
$$= 0.36 - \frac{0.059}{2}\log 2\times 10^{-2}$$

17. Ferric hydroxide is a positive sol, thus coagulated by negative ions (like Br^-, SO_4^{2-}, CrO_4^{2-} and $[Fe(CN)_6]^{3-}$). More is the valency of negative ion, more is the coagulating power.

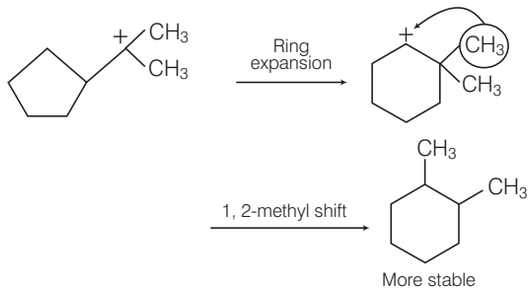
18.



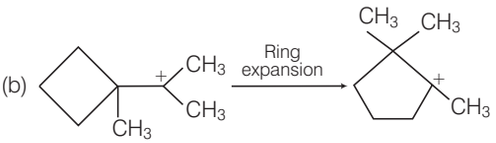
19. $NiO(s) \rightleftharpoons Ni(s) + \frac{1}{2}O_2(g)$

$$k_p = p_{O_2}^{1/2}$$
$$\Delta G^\circ = 212\,kJ = 212000\,J$$
$$\Delta G = -2.303RT\log k_p$$
$$\therefore \quad 212000 = -2.303\times 8.314\times 298\log K_p$$
$$\log k_p = -37.155$$
$$k_p = 7\times 10^{-38}$$
$$\sqrt{p_{O_2}} = 7\times 10^{-38}$$
$$p_{O_2} = 4.9\times 10^{-75}\ atm$$

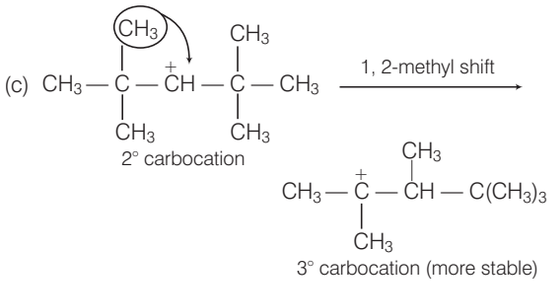
20. (a)



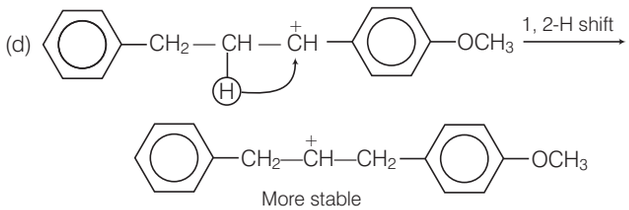
(b)



(c)



(d)



21. $p^\circ_B\chi_B + p^\circ_T\chi_T = p_{total}$

$$1022\chi_B + 406(1-\chi_B) = 1\ atm$$
$$= 760\ mm\ Hg \qquad [\chi_B + \chi_T = 1]$$
$$\chi_B = 0.574$$

22. CsCl has a bcc lattice, so

$$d = a\sqrt{3}$$
$$= 0.4123\times\sqrt{3}$$
$$= 0.7141\,nm$$
$$r_{Cs^+} + r_{Cl^-} = \frac{d}{2} = \frac{0.7141}{2}$$
$$= 0.3571\ nm$$
$$r_{Cs^+} + 0.181 = 0.3571\,nm$$
$$r_{Cs^+} = 0.176\,nm$$

23. Concentration of $Ca(OH)_2 = \frac{0.0005\times 1000}{100}$

$$= 0.005\ mol\ L^{-1}$$

$$Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$$

Initially	1	2
	0.005	$0.005\times 2 = 0.01$

$$pOH = -\log[OH^-]$$
$$= -\log[0.01] = 2$$
$$pH = 14 - 2 = 12$$

24. Energy in ground state = 13.6 eV

Energy absorbed = $1.5\times 13.6 = 20.4$ eV

Energy in higher level = 34.0 eV

Energy emitted = 34.0 eV – 13.6 eV = 20.4 eV

25. $\Delta G = \Delta H - nFT\left(\frac{dE}{dT}\right)_p$ ...(i)

$$\Delta G = \Delta H - T\Delta S \quad ...(ii)$$

On comparing Eq. (i) and (ii)

$$\frac{96.5}{2 \times 96500} = \left(\frac{dE}{dT}\right)_p$$

$$\therefore \quad \left(\frac{dE_{cell}}{dT}\right)_p = \frac{1 \times 10^{-3}}{2} \text{ VK}^{-1} = 5 \times 10^{-4} \text{ VK}^{-1}$$

26. $K_h = \dfrac{K_w}{K_a} = \dfrac{10^{-14}}{10^{-6}} = 10^{-8}$

$$A^- + H_2O \rightleftharpoons HA + OH^-$$

$$K_h = \frac{[HA]\,[OH^-]}{[A^-]}$$

$$K_h = \frac{(0.0001 \times h)\,(0.0001 \times h)}{0.0001\,(1-h)}$$

$$10^{-8} = 0.0001\,h^2 \qquad [\because (1-h) \approx 1]$$

$$10^{-4} = h^2$$

$$\therefore \quad h = 10^{-2}$$

27. **At cathode** $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$

At anode $2Cl^- \longrightarrow Cl_2 + 2e^-$

Moles of OH^- formed = zit $= \dfrac{1 \times 5 \times 965}{96500}$

$= 0.05$ mol

$$[OH^-] = \frac{0.05}{0.5} = 1 \times 10^{-1}$$

$$[H^+] = 1.0 \times 10^{-13} \quad \text{and} \quad \text{pH} = 13$$

28. Initial pressure of mixture,

$p_{mixture} = 736$mm Hg and at 90°C (boiling point),

$p'_{H_2O} = 526$mm Hg

$p'_{liquid} = 736 - 526$

$= 210$mm Hg

Also, $p' = p_{mixture} \times$ mole fraction in vapour phase .... (i)

Let a g of liquid and water is collected or this is the amount of vapours at equilibrium, thus weight of liquid vapours $= \dfrac{2.5 \times a}{3.5}$

and weight of water vapours $= \dfrac{1 \times a}{3.5}$

Now for liquid from Eq. (i)

$$210 = 736 \times \frac{\frac{2.5a}{3.5 \times m}}{\frac{a}{3.5 \times 18} + \frac{2.5a}{3.5 \times m}} \qquad \text{.... (ii)}$$

[here m = molar mass of liquid]

For water, from Eq. (i)

$$526 = 736 \times \frac{\frac{a}{3.5 \times 18}}{\frac{a}{3.5 \times 18} + \frac{2.5a}{3.5 \times m}} \qquad \text{.... (iii)}$$

Thus, from Eqs. (ii) and (iii), we get

$$\frac{210}{526} = \frac{18 \times 2.5}{m}$$

$$\therefore \quad m = 112.7$$

29. $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

Initial mol	0.15	a	0
Moles at equilibrium	$(0.15 - x)$	$(a - 2x)$	(x)

Given, $x = 0.08$ mol

$\therefore$ Total moles at equilibrium

$= 0.15 - x + a - 2x + x$

$= a - 0.01$ mol

Total moles at equilibrium from ideal gas equation

$$n = \frac{pV}{RT} = \frac{8.5 \times 2.5}{0.0821 \times 750}$$

$= 0.345$

Hence, $a - 0.01 = 0.345$

or $a = 0.355$

At equilibrium,

moles of CO = $0.15 - 0.08 = 0.07$

moles of $H_2 = 0.355 - 0.16 = 0.195$

and moles of $CH_3OH = 0.08$

$$\therefore K_C = \frac{[CH_3OH]}{[H_2]^2[CO]} = \frac{0.08/2.5}{[0.195/2.5]^2 \times [0.07/2.5]}$$

$$= 187.85 \text{ mol}^{-2}\ \text{L}^{-2}$$

30. Given, $T_1 = 303\text{K}, T_2 = 33\text{K}$ and $R = 1.987 \times 10^{-3}$ kcal

$\because$ Rate $= k\left[\dfrac{\text{products}}{\text{reactants}}\right]^n$

$\therefore \dfrac{r_2}{r_1} = \dfrac{k_2}{k_1}$ for a given reaction at different temperature.

$\because \quad \dfrac{r_2}{r_1} = 5$

$\because \quad \dfrac{k_2}{k_1} = 5$

$$\because \quad 2.303 \log \frac{k_2}{k_1} = \frac{E_a}{R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$\because \quad 2.303 \log 5 = \frac{E_a}{1.987 \times 10^{-3}}\left[\frac{333 - 303}{333 \times 303}\right]$$

$$\therefore \quad E_a = 10.75 \text{ kcal mol}^{-1}$$