

Analytical Chem

المسألة الأولى

Q 1 - 3

Calc P_{Ag}

NOTE: $P_{Ag} = \log [Ag]$

: المعطى

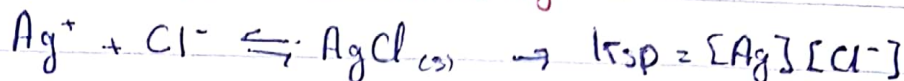
$$V_{Cl^-} = 25 \text{ ml}$$

$$M_{Cl^-} = 0.02 \text{ M}$$

$$M_{Ag^+} = 0.01 \text{ M}$$

$$K_{sp} AgCl = 1.8 \times 10^{-10}$$

Q 1. After addition of 25 ml Ag^+



$$[Ag] = \frac{K_{sp}}{[Cl^-]}$$

$$[Cl^-] = \frac{\text{moles } Cl^- - \text{moles } Ag^+}{V_{Cl^-} + V_{Ag^+}}$$

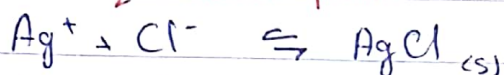
$$[Cl^-] = \frac{(0.025 \times 0.02) - (0.025 \times 0.01)}{0.025 + 0.025} = 0.005 \text{ M}$$

$$[Ag^+] = \frac{1.8 \times 10^{-10}}{0.005} = 3.6 \times 10^{-8} \rightarrow P_{Ag} = \log (3.6 \times 10^{-8})$$

$$P_{Ag} = 7.44$$

(B)

Q 2. At equivalent point



$$1 \text{ mol} = 1 \text{ mol}$$

$$V_{Ag} M_{Ag} = V_{Cl^-} M_{Cl^-}$$

$$V_{Ag} \times 0.01 = 0.025 \times 0.02 \rightarrow V_{Ag} = 0.05 \text{ L}$$

$$K_{sp} = [Ag][Cl]$$

$$\sqrt{x^2} = \sqrt{1.8 \times 10^{-10}}$$

$$x \rightarrow [Ag]$$

$$x \rightarrow [Cl]$$

$$x = 1.34 \times 10^{-5} \rightarrow [Ag]$$

$$P_{Ag} = -\log (1.34 \times 10^{-5})$$

$$P_{Ag} = 4.87$$

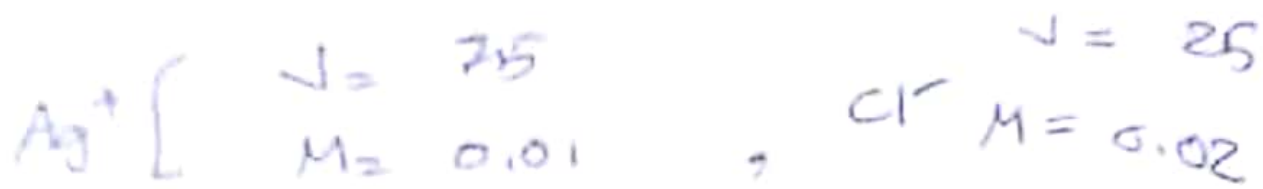


$$-x \quad -x$$

$$K_{sp} = x^2$$

(D)

1320



$$m_{\text{Ag}^+} = 0.75$$

$$m_{\text{Cl}^-} = 0.05$$

$$0.75 - 0.05 = \frac{0.25}{100} = 2.5 \times 10^{-3}$$

$$P_{\text{Ag}^+} = -\log(2.5 \times 10^{-3})$$

$$A = 2.60$$

3 سوال

Q4. mass sample = 1.50 g
 mass $\text{Fe}_2\text{O}_3 = 0.565 \text{ g}$
 M.M $\text{Fe}_2\text{O}_3 = 159.6 \text{ g/mol}$
 $\% \text{Fe} = ???$
 M.M $\text{Fe} = 55.8 \text{ g/mol}$

$$\text{moles } \text{Fe}_2\text{O}_3 = \frac{0.565}{159.6} = 3.54 \times 10^{-3} \text{ moles}$$



$$4.54 \times 10^{-3} \rightarrow x$$

$$\text{moles } \text{Fe}^{+3} = 7.08 \times 10^{-3} \text{ moles}$$

$$\text{mass } \text{Fe}^{+3} = 0.414$$

$$\% \text{Fe}^{+3} = \frac{0.414}{1.50} \times 100 = 27.65\%$$

(C)

Q5. mass mixture = 1 g
 NaCl M.M = 58.5 g/mol
 CaCl_2 M.M = 111 g/mol
 precipitating agent = 2.493 g
 $(\text{AgCl}) \rightarrow$ M.M = 143.5 g/mol
 $\% \text{NaCl} = ???$

~~mass of NaCl = 0.493 g~~



\downarrow
 x

$$\therefore \text{CaCl}_2 = (1-x) \text{ g}$$

$\text{AgCl} : \text{AgCl}$ From $\text{NaCl} + \text{AgCl}$ From $\text{CaCl}_2 = 2.493 \text{ g}$

$$\text{AgCl} : x \left[\frac{1}{1} \times \frac{143.5}{58.5} \right] + (1-x) \left[\frac{2}{1} \times \frac{143.5}{111} \right] = 2.493 \text{ g}$$

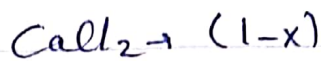
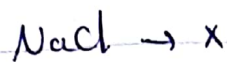
\downarrow mass NaCl \downarrow M.M ratio \downarrow mass CaCl_2 \downarrow mole ratio

$$2.4529x + (1-x)(2.585) = 2.493 \rightarrow 2.4529x + 2.585 - 2.585x = 2.493$$

$$-0.1321x + 2.585 = 2.493 \rightarrow -0.1321x = -0.092$$

$$\frac{-0.1321x}{-0.1321} = \frac{-0.092}{-0.1321}$$

$$x = 0.6964$$



$$\text{mass NaCl} = 0.69644$$

$$\% \text{ NaCl} = \frac{0.69644}{1} \times 100 = 69.6\% \approx 70\%$$

(B)

Q6. → the answer is : (C)

Q7. → the answer is : (D)

Q8.

$$[\text{OH}^-] = \sqrt{K_b \times C_{\text{HF}}}$$

$$[\text{OH}^-] = \sqrt{(1.47 \times 10^{-11}) \times 0.1} = 1.21 \times 10^{-6} \text{ M}$$

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{6.8 \times 10^{-4}} = 1.47 \times 10^{-11}$$

$$\text{pOH} = -\log(1.2 \times 10^{-6}) \rightarrow \text{pOH} = 5.91$$

$$\text{pH} = 14 - \text{pOH} \rightarrow \text{pH} = \underline{\underline{8.08}}$$

$$C_{\text{HF}} = 0.1 \text{ M}$$

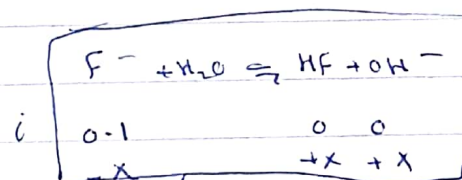
(طريقة حل أخرى)

Q8. $\text{NaF} \rightarrow \text{weak}$



$$K_b = \frac{[\text{HF}][\text{OH}^-]}{[\text{F}^-]}$$

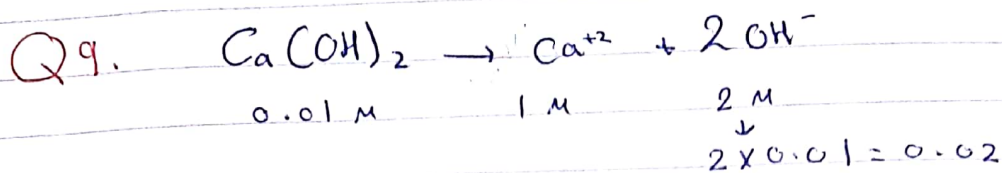
$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{6.8 \times 10^{-4}} = 1.47 \times 10^{-11}$$



$$1.47 \times 10^{-11} = \frac{[\text{HF}][\text{OH}^-]}{[\text{F}^-]} \rightarrow 1.47 \times 10^{-11} = \frac{x^2}{0.1}$$

$$x = 1.21 \times 10^{-6} \rightarrow [\text{OH}^-]$$

$$\text{pOH} = -\log(1.21 \times 10^{-6}) = 5.91 \rightarrow \text{pH} = 14 - 5.91 = \underline{\underline{8.08}}$$

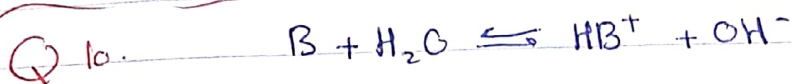


$[\text{OH}^-] = 0.02$

$\text{pOH} = -\log 0.02 = 1.698$

$\text{pH} = 14 - 1.698 = 12.30$

(A)



$\text{pH} = 9.5$

$[\text{H}^+] = 10^{-9.5} = 3.16 \times 10^{-10}$

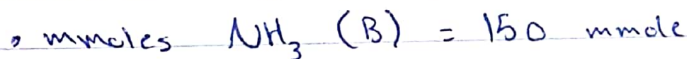
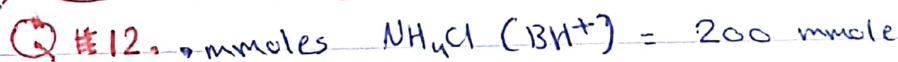
$[\text{OH}^-] = \frac{K_w}{[\text{H}^+]} = \frac{1 \times 10^{-14}}{3.16 \times 10^{-10}} = 3.16 \times 10^{-5} \text{ M}$

$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]} = \frac{x^2}{0.05 - x} = \frac{(3.16 \times 10^{-5})^2}{0.05 - (3.16 \times 10^{-5})}$

$K_b = 1.99 \times 10^{-8}$

$K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.49 \times 10^{-8}} = 5 \times 10^{-7}$

(B)



• $K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.55 \times 10^{-10}$

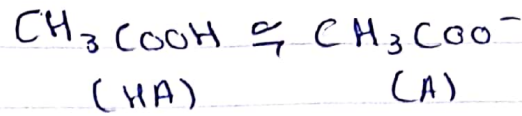
• $\text{p}K_a = -\log (5.55 \times 10^{-10}) = 9.26$

• $\text{pH} = \text{p}K_a + \log \frac{[\text{B}]}{[\text{BH}^+]} \rightarrow 9.26 + \log \frac{(150 \div 250)}{(200 \div 250)}$

• $\text{pH} = 9.13$

(C)

Q11.



• mmols HA = $50 \times 3 = 150 \text{ mmol}$

• mmols $\text{A}^- = 50 \times 4 = 200 \text{ mmol}$

• $\text{pK}_a = -\log(1.8 \times 10^{-4}) = 4.74$

• $\text{pH} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}]} = 4.74 + \log \frac{200 \div 250}{150 \div 250}$

• $\text{pH} = 4.869$

(a)



mmoles :	100	100
	+ 0.02	- 0.02
	<u>100.02</u>	<u>99.98</u>

كما أنه إضافة HCl

• يزداد الحمض بمقدار تركيز HCl

• يقل القاعد بمقدار تركيز HCl

• $\text{pH} = \text{pK}_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$

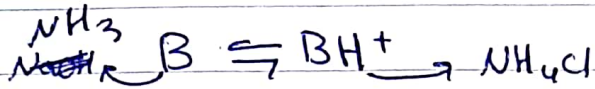
• $\text{pH} = 4.7 + \log \frac{(99.98)}{(100.02)} = 4.6$

(c)

Q14. The answer is (D)

كيف يتغير إذا conjugate pair زوج، المحف هو كما تضيف H^+ على القاعدة فيزيد عدد HCl و يتجمع للشحنة +

Q 15.



$$\frac{+0.1}{0.1} \quad \frac{-0.1}{0.2-0.1}$$

$$\text{moles NH}_4\text{Cl} = \frac{10.7}{53.5} = 0.2 \text{ mol}$$

$$\text{pK}_a = \text{pK}_w - \text{pK}_b = 9.23$$

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}}$$

$$9.23 = 9.23 + \log \left(\frac{0.1}{0.2-0.1} \right) - 2 = 1$$

عنوان 8
قوله ل log تكون 1

$$\frac{0.1}{0.2-0.1} = 1$$

$$0.1 = 0.2 - 0.1$$

$$2 \times 0.1 = 0.2$$

$$\boxed{0.1 = 0.1} \text{ mol}$$

$$\text{moles OH}^- = 2.5$$

$$\frac{0.1}{2.5} = V$$

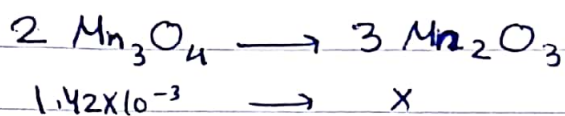
$$V = 0.04 \text{ L} \rightarrow 40 \text{ ml}$$

Q 16. The answer is (D)

Q 17. The answer is (D)

Q 18. mass sample = 0.654 g
precipitate agent (Mn_3O_4) = 0.326 g
M.M = 229 g/mol
% Mn_2O_3 = ???
M.M = 178 g/mol

$$\bullet \text{ moles } \text{Mn}_3\text{O}_4 = \frac{0.326}{229} = 1.42 \times 10^{-3}$$



$$\bullet \text{ moles } \text{Mn}_2\text{O}_3 = 2.13 \times 10^{-3}$$

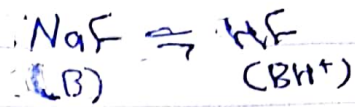
$$\begin{aligned} \bullet \text{ mass } \text{Mn}_2\text{O}_3 &= 2.13 \times 10^{-3} \times 178 \\ &= 0.38 \text{ g} \end{aligned}$$

$$\% \text{Mn}_2\text{O}_3 = \frac{0.38}{0.654} \times 100 = 58.11\%$$

(A)

Q 19. The answer is (C)

Q 20.



- mmols BH⁺ (HF) = mmole HCl = $10 \times 0.5 = 5$ mmole
- mmols B (NaF) = mmole NaF initial - mmole HCl
 $= \left(\frac{0.42}{42} \right) - 5 = 4.99$

$$\text{pH} = \text{pK}_a + \log \frac{\text{base}}{\text{acid}}$$

$$\text{pH} = 3.16 + \log \frac{4.99 \div 100}{5 \div 100} = 3.169$$

(B)