Analytical Chem

Q 1 - 3 → Calc P_{Ag}

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

: المعطيات

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

$M_{Cl} = 0.02\ M$

$M_{Ag} = 0.01\ M$

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

Q 1. After addition of 25 ml Ag^+

$$Ag^+ + Cl^- \rightleftharpoons AgCl_{(s)} \rightarrow K_{sp} = [Ag][Cl^-]$$

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

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

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

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

$P_{Ag} = 7.44$ (B)

Q 2. At equivalent point

$$Ag^+ + Cl^- \rightleftharpoons AgCl_{(s)}$$

$1\ mol = 1\ mol$

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

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

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

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

$x \rightarrow [Ag]$

$x \rightarrow [Cl]$

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

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

$P_{Ag} = 4.87$ (D)

$Ag\text{-}Cl \rightleftharpoons Ag + Cl$

$- \quad -$

$+x \quad +x$

$K_{sp} = x^2$

Ag^+ [$V = 75$, $M = 0.01$, Cl^- $V = 25$, $M = 0.02$

$m_{Ag^+} = 0.75$

$m_{Cl^-} = 0.05$

$0.75 - 0.05 = \frac{0.25}{1} = \frac{0.25}{100}$

$2.5 * 10^{-3}$

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

$A = 2.60$.

3 أسئلة

Q4. mass sample = 1.50 g

mass Fe_2O_3 = 0.565 g

M.M Fe_2O_3 = 159.6 g/mol

%Fe = ???

M.M Fe = 58.6 g/mol

moles $Fe_2O_3 = \frac{0.565}{159.6} = 3.54 \times 10^{-3}$ moles

$1\ Fe_2O_3 \longrightarrow 2\ Fe^{+3}$

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

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

mass Fe^{+3} = 0.414

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

(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

(AgCl) → M.M = 143.5 g/mol

% NaCl = ???

$NaCl + CaCl_2 = 1\ g$

$NaCl = x$

$\therefore CaCl_2 = (1 - x)\ g$

AgCl : AgCl from NaCl + AgCl from $CaCl_2$ = 2.493 g

$$AgCl: \underbrace{x}_{\text{mass NaCl}} \left[\frac{1}{1} \times \frac{143.5}{58.5} \right] + \underbrace{(1-x)}_{\text{mass } CaCl_2} \left[\underbrace{\frac{2}{1}}_{\text{mole ratio}} \times \frac{143.5}{111} \right] = 2.493\ g$$

(mole ratio; M.M ratio; M.M ratio)

$2.4529x + (1-x)(2.585) = 2.493 \rightarrow 2.4529x + 2.585 - 2.585x = 2.49$

$-0.1321x + 2.585 = 2.493 \rightarrow \frac{-0.1321x}{-0.1321} = \frac{-0.092}{-0.1321}$

$x = 0.6964$

$NaCl \rightarrow x$ $\quad CaCl_2 \rightarrow (1-x)$

↓

mass NaCl = 0.69644

$$\% NaCl = \frac{0.69644}{1} \times 100 = 69.6\% \approx 70\%$$ (B)

Q6. → the answer is : (C)

Q7. → the answer is : (D)

Q8.

$[OH^-] = \sqrt{K_b \times C_{HF}}$ | $[OH^-] = \sqrt{(1.47\times10^{-11}) \times 0.1} = 1.21\times10^{-6}\ M$

$K_b = \frac{K_w}{K_a} = \frac{1\times10^{-14}}{6.8\times10^{-4}} = 1.47\times10^{-11}$ | $pOH = -\log(1.2\times10^{-6}) \rightarrow pOH = 5.91$

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

$C_{HF} = 0.1\ M$

(طريقة حل أخرى)

Q8. NaF → weak ∴ $NaF_{(s)} \rightleftharpoons Na^+ + F^-$

$F^- + H_2O \rightleftharpoons HF + OH^-$

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

$$K_b = \frac{K_w}{K_a} = \frac{1\times10^{-14}}{6.8\times10^{-4}} = 1.47\times10^{-11}$$

	F^-	$+H_2O \rightleftharpoons$	HF	$+OH^-$
i	0.1		0	0
	$-x$		$+x$	$+x$

$$1.47\times10^{-11} = \frac{[HF][OH^-]}{[F^-]} \rightarrow 1.47\times10^{-11} = \frac{x^2}{0.1}$$

$x = 1.21\times10^{-6} \rightarrow [OH^-]$

$pOH = -\log(1.21\times10^{-6}) = 5.91 \rightarrow pH = 14 - 5.91 = \underline{8.08}$

Q9. $Ca(OH)_2 \rightarrow Ca^{+2} + 2OH^-$

0.01 M 1 M 2 M

$2 \times 0.01 = 0.02$

$[OH^-] = 0.02$

$pOH = -\log 0.02 = 1.698$

$pH = 14 - 1.698 = 12.30$

(A)

Q10. $B + H_2O \rightleftharpoons HB^+ + OH^-$

$pH = 9.5$

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

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

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

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

$K_a = \frac{Kw}{K_b} = \frac{1 \times 10^{-14}}{1.99 \times 10^{-8}} = 5 \times 10^{-7}$

(B)

Q#12.

- mmoles NH_4Cl (BH^+) = 200 mmole
- mmoles NH_3 (B) = 150 mmole
- K_a of $(BH^+) = \frac{Kw}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.55 \times 10^{-10}$
- $pKa = -\log(5.55 \times 10^{-10}) = 9.26$
- $pH = pKa + \log \frac{[B]}{[BH^+]} \rightarrow 9.26 + \log \frac{(150 \div 250)}{(200 \div 250)}$
- $pH = 9.13$

(C)

Q11. $CH_3COOH \rightleftharpoons CH_3COO^-$
(HA) (A)

- mmoles HA = 50 x 3 = 150 mmol
- mmoles A^- = 50x4 = 200 mmol

- $pKa = -\log(1.8 \times 10^{-14}) = 4.74$

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

- pH = 4.869 (a)

Q13. acetic acid ← HA ⇌ A^- → sodium acetate

mmoles :	100	100
	+0.02	-0.02
	100.02	99.98

- $pH = pKa + \log \frac{[A^-]}{[HA]}$

- $pH = 4.7 + \log \frac{(99.98)}{(100.02)} = 4.6$ (c)

لما أنو اضافنا HCl ↓
- يزداد الحمض بمقدار تركيز الـ HCl
- يقل القاعده بمقدار تركيز الـ HCl

Q14. The answer is (D)
كيف بنعرف اذا conjugate pair و الحمض هو اللي بضيف H^+ على القاعدة فبزيد عدد الـ H و بنجمع الشحنة +1

Q 15.

NH_3 (B) $\rightleftharpoons$ BH^+ $\longrightarrow$ NH_4Cl

moles $NH_4Cl = \frac{10.7}{52.5} = 0.2$ mol

	0.2	
$+OH$	$-OH$	
OH	$0.2 - OH$	

$pK_a = pK_w - pK_b = 9.23$

$pH = pK_a + \log \frac{base}{acid}$

$9.23 = 9.23 + \log \frac{OH}{0.2-OH} \rightarrow = 1$ عشان $\log 1$ قيمة تكون صفر

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

$OH = 0.2 - OH$

$2OH = 0.2$

$OH = 0.1$ mol

moles $OH^- = 2.5$

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

$V = 0.04\ L \rightarrow 40\ ml$

Q 16. The answer is (D)

Q 17. The answer is (D)

Q 18. mass sample = 0.654 g

precipiate agent (Mn_3O_4) = 0.326 g

M.M = 229 g/mol

% Mn_2O_3 = ???

M.M = 178 g/mol

• moles $Mn_3O_4 = \frac{0.326}{229} = 1.42 \times 10^{-3}$

$$2\ Mn_3O_4 \longrightarrow 3\ Mn_2O_3$$

$1.42 \times 10^{-3} \longrightarrow x$

• moles $Mn_2O_3 = 2.13 \times 10^{-3}$

• mass $Mn_2O_3 = 2.13 \times 10^{-3} \times 178$

$= 0.38$ g

$\% Mn_2O_3 = \frac{0.38}{0.654} \times 100 = 58.11\%$ (A)

Q 19. The answer is (C)

Q 20.

$NaF \rightleftharpoons HF$
$(B) \quad (BH^+)$

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

$$pH = pKa + \log \frac{base}{acid}$$

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

(B)