Part A: Knowledge and Understanding

NH_3 is basic

1. Multiple choice (12 marks K): please answer all questions on your scantron card in pencil.

2. Write the chemical equation for each of the following ionizing in an aqueous solution: (2 marks K)
   i) trimethylamine, $(CH_3)_3N_{(aq)}$.
   ii) carbonate ion, $CO_3^{2-}{}_{(aq)}$

$(CH_3)_3N$ $(CH_3)_3N_{(aq)} + H_2O_{(l)} \rightarrow H(CH_3)_3N^+_{(aq)} + OH^-_{(aq)}$ ✓

$CO_3^{2-}{}_{(aq)} + H_2O_{(aq)} \rightarrow HCO_3^-{}_{(aq)} + OH^-_{(aq)}$ ✓

4K

   b) Looking at your equations for part a), identify one acid-base conjugate pair and <u>one ion</u> that can act as both an acid and a base (i.e. is amphoteric). (2 marks K)

HCO_3^- can act as both an acid or base ✓ to become CO_3^- or H_2CO_3, therefore it's amphoteric. CO_3^{2-} and HCO_3^- are an acid base conjugate pair. ✓

Part B: Thinking and Investigation & Communication

3. 4.5 mol of HI(g) are injected into a 5.0 L container and the equilibrium below was established. If at equilibrium there was 4.0 mol of HI(g) left, calculate the equilibrium constant, Keq, for this reaction. (4 marks T, 1 mark C)

$2HI(g) \rightleftharpoons H_2(g) + I_2(g) + 65.kJ$

$C = \frac{n}{V} = \frac{4.5}{5} = \frac{9}{10}$

$c = \frac{4}{5} = \frac{8}{10}$ mol/L

	HI	H_2	I_2
I	$\frac{9}{10}$ mol/L	0	0
C	$2x$	$-x$	$-x$
E	$\frac{9}{10} - 2x$	$+x$	$+x$

$\frac{9}{10} - 2x = \frac{8}{10}$

$\frac{1}{10} = +2x$

$x = \frac{1}{20}$

$K_{eq} = \frac{[H_2][I_2]}{[HI]^2}$ ✓ 4T+1C

$= \frac{(\frac{1}{20}M)(\frac{1}{20}M)}{(\frac{8}{10}mol/L)^2}$

$= \frac{0.0025}{0.64}$

$= 3.90625 \times 10^{-3}$

$= \boxed{3.9 \times 10^{-3}}$ ✓

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4. Milk of magnesia is a saturated solution of magnesium hydroxide, $Mg(OH)_2$. At 20C, it's concentration is 9.63mg/100.00mL. What is the pH of milk of magnesia? (4 marks T, 1 mark C)

$\frac{0.009639}{0.1L} = 0.0963\ g/L$

$0.0165\ mol/L$ of $Mg(OH)_2$

There is a 1:2 ratio of $Mg(OH)_2$ to OH

and $[OH^-] = 2(0.0165) = 0.033\ mol/L$

$[OH^-] = 0.033\ mol/L$

$pOH = -\log(0.033\ mol/L) = 1.4814$

$pH = 14 - pOH = 14 - 1.4814 = 12.52$

$= 12.5$

The pH of the solution is 12.5

3½T + 1C

5. A chemistry student prepares a solution of ethanoic acid, $HC_2H_3O_2(aq)$, with a concentration of 0.1000 mol/L. If the percentage ionization of ethanoic acid is 1.3%, what is the acid ionization constant, Ka, for ethanoic acid? (4 marks T, 1 mark C)

$c = 0.1\ mol/L$

$\% = \frac{[HA]_{ionized}}{[HA]_{initial}}$

$0.013 = \frac{[HA]}{0.1\ mol/L} =$

	$HC_2H_3O_2$	$C_2H_3O_2^-$	H_3O^+
I	0.1	0	0
C	x	-x	+x
E	0.1-x	x	x

$[HA]_{ionized} = 1.3\times10^{-3}\ mol/L$ $\quad x = 1.3\times10^{-3}\ mol/L$

$K_a = \frac{(1.3\times10^{-3}\ mol/L)^2}{0.013} = 1.3\times10^{-4}$

$K_a = 1.3\times10^{-4}$

3T + 1C

6. Will an aqueous solution of ~~potassium sulphite~~, FeI_3, be acidic, basic or neutral? Explain your answer. (3 marks T)

$2FeI_3 \rightarrow 2Fe + 3I_2$ weak base

$2Fe + 3H_2O \rightarrow 2Fe(OH)_3 + 6H^+$

$I_2 + H_2O \rightarrow HI + OH^-$

HI: strong acid

Slightly acidic

This is acidic as the iron ion makes H^+ ions when hydrolyzed. Heavy metals like Al^{3+} and Fe^{3+} also are slightly acidic.

3T

Part C: Application

7. Kidney stones form in an equilibrium process where calcium ions, $Ca^{2+}_{(aq)}$, react with oxalate ions, $C_2O_4^{2-}{}_{(aq)}$ (from oxalic acid found in many of the foods we eat), to form solid calcium oxalate, $CaC_2O_{4(s)}$, represented by the equation below. Explain how the formation of calcium oxalate might be prevented, using Le Châtelier's principle. (3 marks A)

Ca^{2+} + $C_2O_4^{2-}$ ⇌ CaC_2O_4

3A

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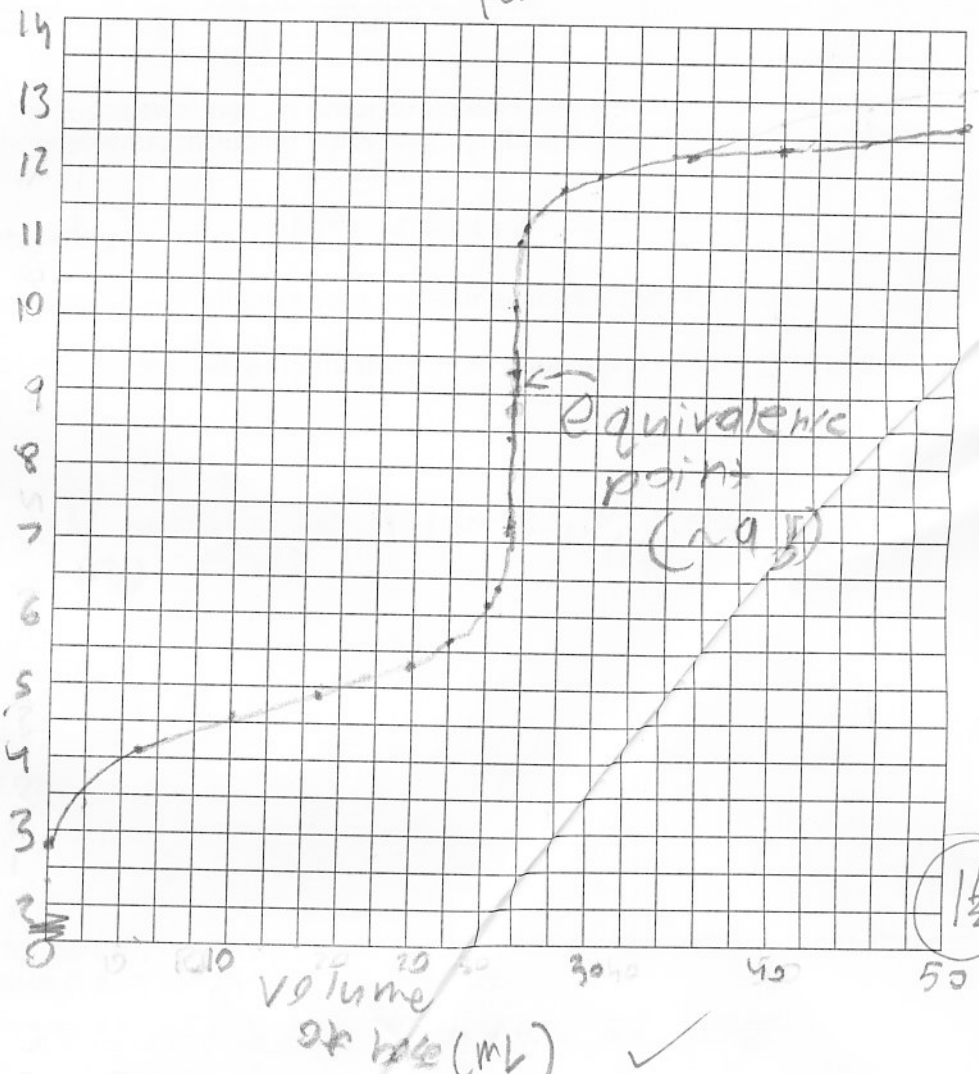
8. The data below was collected during an acid-base titration.

Volume of 0.10 mol/L Base Added (mL)	pH Values of 0.100 mol/L Acid
0	2.87
5.0	4.14
10.0	4.57
15.0	4.92
20.0	5.35
22.0	5.61
24.0	6.13
24.5	6.44
24.9	7.14
25.0	8.72
25.1	10.30
25.5	11.00
26.0	11.29
28.0	11.75
30.0	11.96
35.0	12.22
40.0	12.36
45.0	12.46
50.0	12.52



a) Make a graph of pH versus volume of base added and label both axes. (2 marks A)

b) Mark the location of the equivalence point on your graph and the approximate pH value. (1 mark A)

$\sim \frac{8.72+10.30}{2} = 9.515$ pH = 9.5 1A

c) What kind of acid-base titration was performed? Were the acid and base strong or weak? Explain. (2 marks A)

This was titration of a strong base into a weak acid. since the pH started out not that low at pH 2.87 and the equivalence point was slightly higher than 7. this makes sense as the stronger base will affect the pH more and bring it up. 2A

d) Using the table below, which acid-base indicator would you use to perform this titration? Explain. (2 marks A)

I would use phenolphtaleih as the equivalence point seems to be around ~ 9 and phenolphtaleih is the only one that covers that range, The only other one is cresol red 2A

Common Acid-Base Indicators		
Indicator	**pH Range**	**Colour Change (acid → base)**