Name:	Teacher:

Level 3 Chemistry

91392 Demonstrate understanding of equilibrium principles in aqueous systems

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of equilibrium principles in aqueous systems	Demonstrate in-depth understanding of equilibrium principles in aqueous systems	Demonstrate comprehensive understanding of equilibrium principles in aqueous systems

You should attempt ALL the questions in this booklet.

A periodic table is provided in the Resource Sheet.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

TOTAL

ASSESSOR'S USE ONLY

QUESTION ONE

(a) Lead hydroxide, $Pb(OH)_2$, is a sparingly soluble, ionic compound.

(i) Write the equation for the dissolving of $Pb(OH)_2$ in water.

(ii) Write the expression for the solubility product, K_s, for $Pb(OH)_2$.

(iii) Calculate the solubility product K_s for $Pb(OH)_2$ given the solubility at 25°C is 3.68×10^{-5} g L^{-1}.

$M(Pb(OH)_2) = 241$ g mol^{-1}

(b) The solubility of lead hydroxide, $Pb(OH)_2$, can be altered.

(i) Use equilibrium principles to explain how the solubility of lead hydroxide will change if added to 50 mL of a 1.00 mol L^{-1} lead nitrate solution, $Pb(NO_3)_2(aq)$. *No calculations are necessary.*

(ii) A change in pH may lead to the formation of complex ions, such as the plumbate ion, $[Pb(OH)_4]^{2-}$.

Use equilibrium principles to explain what happens to the solubility of lead hydroxide when the pH is greater than 10. *No calculations are necessary.*

(c) Predict whether a precipitate of lead sulfate, $PbSO_4$, will form when the following solutions are mixed:

50.0 mL of 0.00560 mol L^{-1} $Pb(NO_3)_2$ and 70.0 mL 0.00200 mol L^{-1} Na_2SO_4.

$K_s(PbSO_4) = 1.82 \times 10^{-8}$

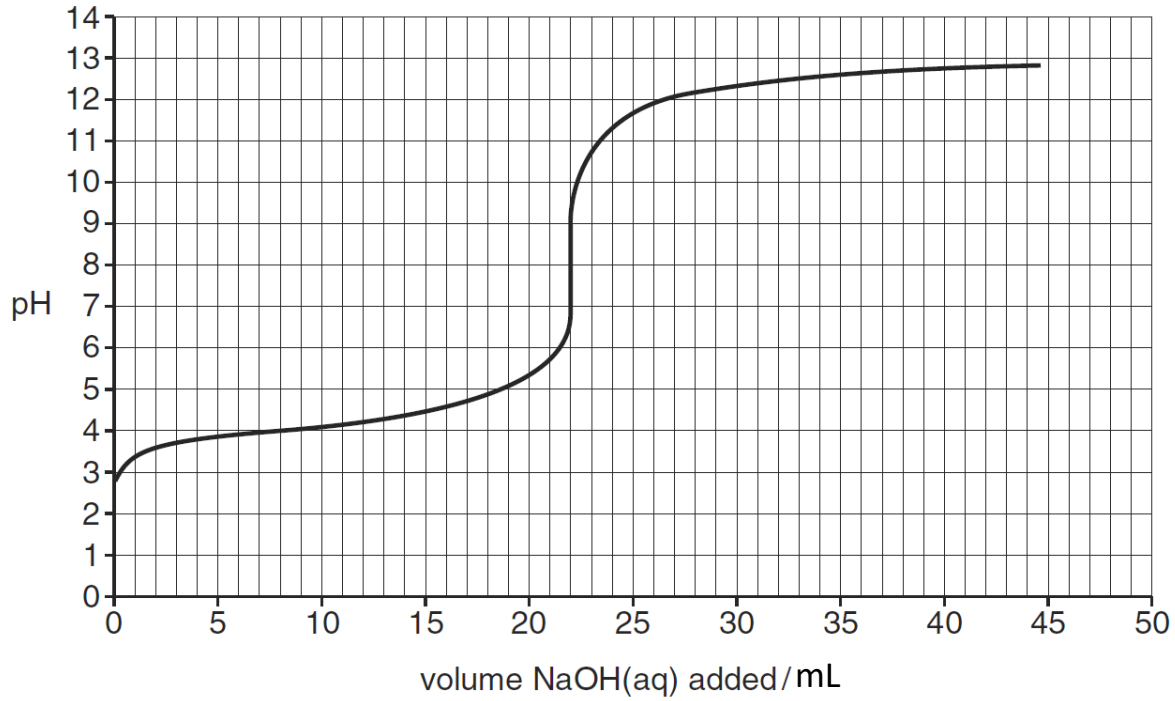
QUESTION TWO

Ethanoic acid, CH_3COOH, is a weak acid. Ka, for ethanoic acid is 1.74×10^{-5}.

(a) What is meant by "ethanoic acid is a weak acid"? Include an equation in your answer.

(b) A student titrated 25.0 mL samples of ethanoic acid with 0.200 L^{-1} sodium hydroxide solution added from a burette. The pH was monitored throughout.

The titration pH curve is shown below.



(i) Show that the concentration of the ethanoic acid is 0.176 mol L^{-1}.

(ii) Calculate the pH of the ethanoic acid before any sodium hydroxide is added.

(iii) List all the species present in at equivalence point, in order of decreasing concentration. Do not include water. Justify the order you have given. Include equations, where necessary.

(c) The pK_a values of three indicators are shown below.

- Cresol purple pKa 8.3
- Bromocresol green pKa 4.7
- Alizarin Yellow pKa 11.0

Discuss your choice of indicator in terms of the composition and function of indicators in acid-base titrations.

(d) Ethanoic acid can be used to make buffer solutions.

- Calculate the pH of the buffer solution formed when 16.0 mL of a 0.250 mol L^{-1} solution of sodium hydroxide is added to 24.0 mL of a 0.200 mol L^{-1} solution of ethanoic acid.
- Evaluate the effectiveness of this solution acts as a buffer. Include equations in your answer.

QUESTION THREE

(a) List all the species in each of the following 1.00 mol L^{-1} solutions in order of decreasing concentration. Do not include water.

1.00 mol L^{-1} solutions	Species formed in order of decreasing concentration
NaCl	
NH_4Cl	

(b) Explain why a 1.00 mol L^{-1} solution of ammonium chloride, NH_4Cl, is a strong electrolyte while a 1.00 mol L^{-1} solution of ammonia, NH_3, is a weak electrolyte.

(c) (i) Calculate the pH of the 0.850 mol L^{-1} ammonium chloride solution.

pK_a (NH_4^+) = 9.25

(ii) Calculate **the change in pH** if the ammonium chloride concentration in part (c)(i) is doubled (100% change) and, by considering the pKa value, explain why the pH change is very small.

Extra paper if required.
Write the question number(s) if applicable