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 2–9 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

Strontium carbonate, $SrCO_3$, is a sparingly soluble salt. It is widely used in the ceramics industry as an ingredient in glazes.

$K_s(SrCO_3) = 1.10 \times 10^{-10}$ at 25°C. $M(SrCO_3) = 148$ g mol^{-1}.

(a) Write the solubility product expression, K_s, for strontium carbonate.

(b) (i) Calculate the solubility of strontium carbonate, $SrCO_3$, at this temperature.

(ii) Calculate the mass of strontium carbonate that will dissolve in 150 mL of water to make a saturated solution at 25°C.

(c) Explain how the solubility of strontium carbonate, $SrCO_3$, will change if added to 150 mL of a 1.00 mol L^{-1} hydrochloric acid solution, HCl.
Support your answer with balanced equations.
No calculations are necessary.

(d) A maximum of 0.600 g $Pb(NO_3)_2$ can be added to 1.50 L of sodium bromide solution, NaBr(aq) without forming a precipitate of lead bromide, $PbBr_2$.

K_s ($PbBr_2$) = 6.60×10^{-6} at 25°C. $M(Pb(NO_3)_2)$ = 331 g mol L^{-1}.

Calculate the concentration of the sodium bromide solution.

Question Two

(a) Sodium propanoate, C_2H_5COONa dissolves in water to form a weakly basic solution. pK_a (C_2H_5COOH) is 4.87.

(i) Write an equation for when sodium propanoate dissolves in water.

(ii) Write an equation to show the reaction occurring in an aqueous solution of C_2H_5COONa.

(iii) List all the species present in an aqueous solution of C_2H_5COONa, in order of decreasing concentration. Do not include water.

(b) Calculate the pH of 0.0175 mol L^{-1} C_2H_5COONa solution.

(c) What is meant by the term buffer solution?

(d) When a solution of propanoic acid is partially neutralised using sodium hydroxide a buffer solution is made.

$$C_2H_5COOH + NaOH \rightarrow C_2H_5COONa + H_2O$$

Calculate the pH of the buffer solution formed when 15.0 mL of a 0.250 mol L^{-1} solution of sodium hydroxide is added to 25.0 mL of a 0.200 mol L^{-1} solution of propanoic acid.

Question Three

In a titration, 24.0 mL of sodium hydroxide solution was added, in 1 mL portions, to 20.0 mL of methanoic acid solution, HCOOH.

pK_a(HCOOH) = 3.75

After the addition of each 1 mL, the pH was measured and recorded using a pH meter.

- The concentration of the methanoic acid solution was 0.400 mol L^{-1}.
- The concentration of the sodium hydroxide solution was 0.500 mol L^{-1}.

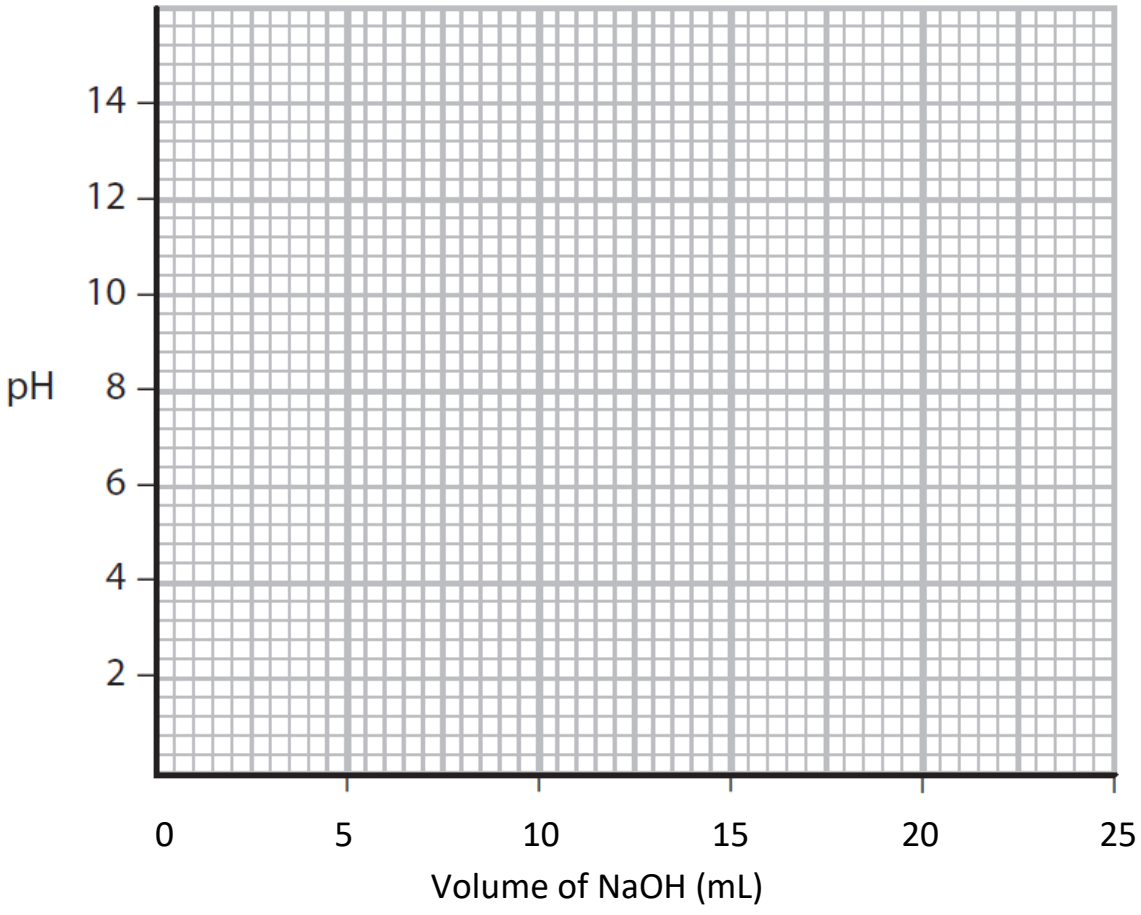
(a) (i) Write the K_a expression for methanoic acid.

(ii) Calculate the pH of the 0.400 mol L^{-1} methanoic acid solution before the titration starts.

(b) Show that the volume of sodium hydroxide solution required to reach the end point is 16.0 mL

(c) By considering the amount of excess alkali remaining, calculate the pH of the solution after 24.0 mL of sodium hydroxide is added.

(d) (i) Sketch a graph to show how the pH changes during the titration.



(ii) Using your sketch graph, justify why bromocresol green indicator (p*K*a = 4.7) *would or would not* be a suitable indicator for this titration.

Extra paper if required.

Write the question number(s) if applicable