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Level 3 Chemistry, 2019

91392 Demonstrate understanding of equilibrium principles in aqueous systems

2.00 p.m. Thursday 14 November 2019
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.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and relevant formulae are provided in the Resource Booklet L3–CHEMR.

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 2–11 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) (i) Write the equation for the equilibrium occurring in a saturated solution of zinc hydroxide, Zn(OH)_2 .

- (ii) Write the expression for $K_s(\text{Zn(OH)}_2)$.

- (iii) Calculate the solubility of Zn(OH)_2 in water at 25°C , and give the $[\text{Zn}^{2+}]$ and $[\text{OH}^-]$ in the solution.

$$K_s(\text{Zn(OH)}_2) = 3.80 \times 10^{-17}$$

- (iv) The presence of a common ion decreases the solubility of a sparingly soluble solid, such as Zn(OH)_2 .

Calculate the concentration of the hydroxide ions, OH^- , in solution after 25.0 mL of 0.210 mol L^{-1} zinc chloride, ZnCl_2 , solution was added to 25.0 mL of a saturated Zn(OH)_2 solution.

- (b) Use equilibrium principles to explain why the solubility of Zn(OH)_2 increases when an excess of dilute sodium hydroxide, NaOH , is added.

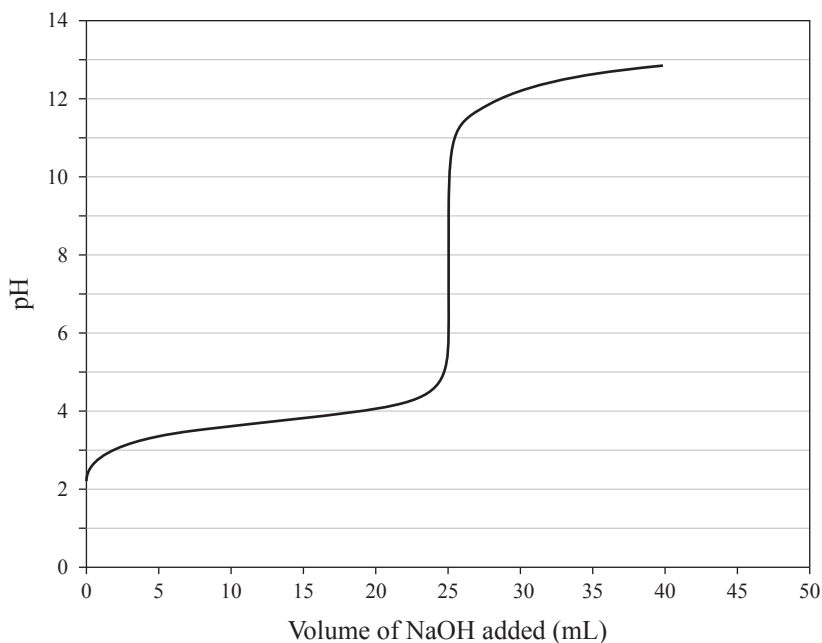
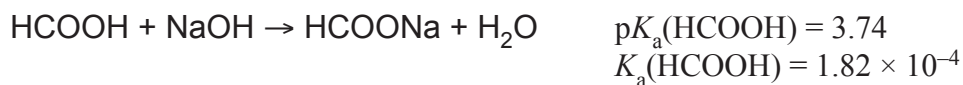
Include relevant equation(s) in your answer.

- (c) Determine whether a precipitate of Zn(OH)_2 will form when 30.0 mL of sodium hydroxide solution, NaOH , at pH 13.1 is added to 20.0 mL of $0.0242 \text{ mol L}^{-1}$ zinc nitrate, $\text{Zn(NO}_3)_2$.

QUESTION TWO

A titration was carried out by adding 0.140 mol L^{-1} sodium hydroxide, NaOH, to 20.0 mL of 0.175 mol L^{-1} methanoic acid, HCOOH.

The equation for the reaction is:



- (a) (i) List ALL the species in solution after 12.5 mL of NaOH solution has been added.
Do not include water.

- (ii) After 12.5 mL of NaOH has been added, the solution has a pH of 3.74.

Explain the significance of this pH with reference to the relative concentrations of the species present.

No calculations are necessary.

- (iii) The ethanoic acid solution has a $[\text{H}_3\text{O}^+]$ of $1.78 \times 10^{-3} \text{ mol L}^{-1}$.

Calculate the concentration of the ethanoic acid solution.

- (b) (i) Dilute hydrochloric acid, HCl, is added to a solution of sodium ethanoate, CH_3COONa , until the ratio of CH_3COONa to ethanoic acid, CH_3COOH , in the solution is two to five (2:5).

Calculate the pH of this buffer solution.

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