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Level 3 Chemistry, 2017

91392 Demonstrate understanding of equilibrium principles in aqueous systems

2.00 p.m. Wednesday 15 November 2017

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 is provided on the Resource Sheet 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

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QUESTION ONE

(a) Hydrogen fluoride, HF, and hydrogen bromide, HBr, both form acidic solutions when added to water.

(i) Write an equation for the reaction of each acid with water.

Hydrogen fluoride, HF, with water:

Hydrogen bromide, HBr, with water:

(ii) Compare and contrast the electrical conductivity of 0.150 mol L^{-1} solutions of hydrofluoric acid, HF, and hydrobromic acid, HBr.

In your answer, you should:

- include the requirements for a solution to conduct electricity
- identify the species present AND their relative concentrations.

No calculations are necessary.

(b) 40.0 mL of 0.150 mol L⁻¹ HBr solution was added to 25.0 mL of a saturated silver bromide, AgBr, solution.

(i) Write an equation for the equilibrium occurring in a saturated solution of AgBr.

(ii) Explain the changes that occur to the concentrations of the species in the saturated solution of AgBr on the addition of the HBr solution.

(iii) Calculate the concentration of the silver ions, Ag⁺, after the HBr solution has been added.

$$K_s(\text{AgBr}) = 5.00 \times 10^{-13}$$

Assume the concentration of Br⁻ in the original saturated solution of AgBr is insignificant.

QUESTION TWOASSESSOR'S
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(a) Ammonia, NH_3 , is a weak base.

$$pK_a(\text{NH}_4^+) = 9.24 \qquad K_a(\text{NH}_4^+) = 5.75 \times 10^{-10}$$

(i) Calculate the pH of a 0.105 mol L^{-1} NH_3 solution.

(ii) Dilute hydrochloric acid, HCl, is added to the NH_3 solution until the ratio of NH_3 to NH_4^+ in the solution is 5:1.

Determine the pH of this solution, and evaluate its ability to resist a change in pH when small volumes of strong acid or base are added.

- (b) (i) Write the equation for the equilibrium occurring in a saturated solution of copper(II) hydroxide, $\text{Cu}(\text{OH})_2$.

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

- (iii) Calculate the solubility of $\text{Cu}(\text{OH})_2$ in water at 25°C .

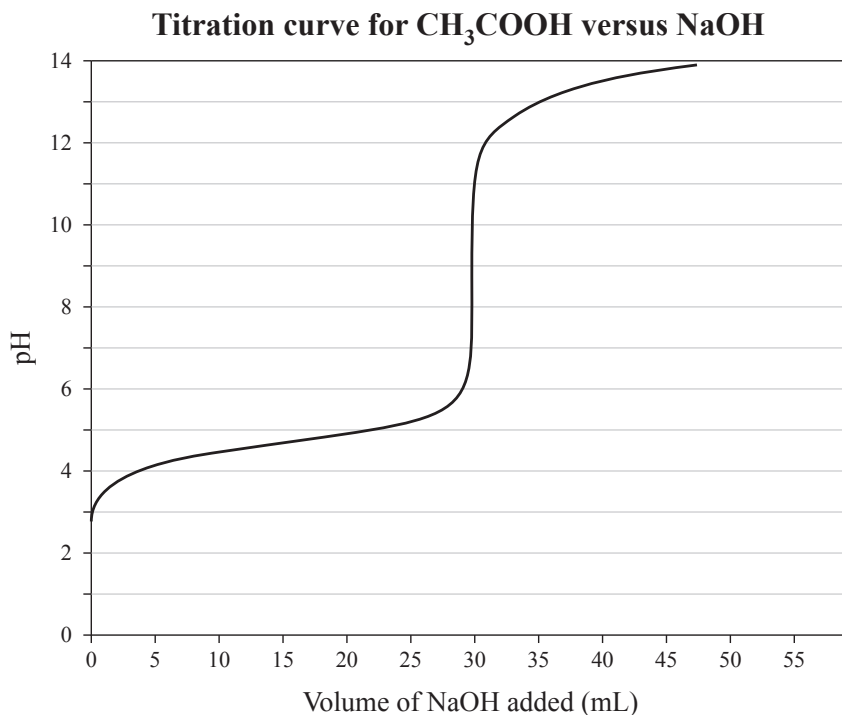
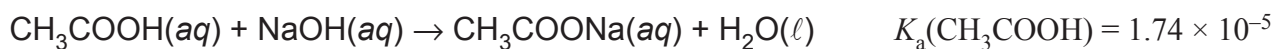
$$K_s(\text{Cu}(\text{OH})_2) = 4.80 \times 10^{-20}$$

- (c) Explain why the solubility of $\text{Cu}(\text{OH})_2$ increases when dilute hydrochloric acid is added.

QUESTION THREE

A titration was carried out by adding 0.112 mol L^{-1} sodium hydroxide solution, $\text{NaOH}(aq)$, to 20.0 mL of ethanoic acid solution, $\text{CH}_3\text{COOH}(aq)$.

The equation for the reaction is:



- (a) With reference to the titration curve above, put a tick next to the indicator most suited to identify the equivalence point.

Indicator	$\text{p}K_a$	Tick ONE box below
Methyl yellow	3.1	
Bromocresol purple	6.3	
Phenolphthalein	9.6	

- (b) (i) The ethanoic acid solution, $\text{CH}_3\text{COOH}(aq)$, has a pH of 2.77 before any NaOH is added.

Show by calculation that the concentration of the CH_3COOH solution is 0.166 mol L^{-1} .

- (ii) Calculate the pH of the solution in the flask after 10.0 mL of 0.112 mol L^{-1} NaOH has been added to 20.0 mL of ethanoic acid solution, $\text{CH}_3\text{COOH}(aq)$.

**Question Three continues
on the following page.**

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

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QUESTION
NUMBER

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