Unit 2 · Ionic Equilibrium

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

Write True or False in the box beside each sentence. Correct each false sentence. Each carries 0.5 mark.

i. By the Brønsted–Lowry definition, an acid is a proton donor and a base a proton acceptor. ☐

ii. The conjugate base of a strong acid is a strong base. ☐

iii. A Lewis acid accepts a pair of electrons. ☐

iv. The degree of ionization of a weak acid falls as its solution is diluted. ☐

v. At 25 °C, pH + pOH = 14 in any aqueous solution. ☐

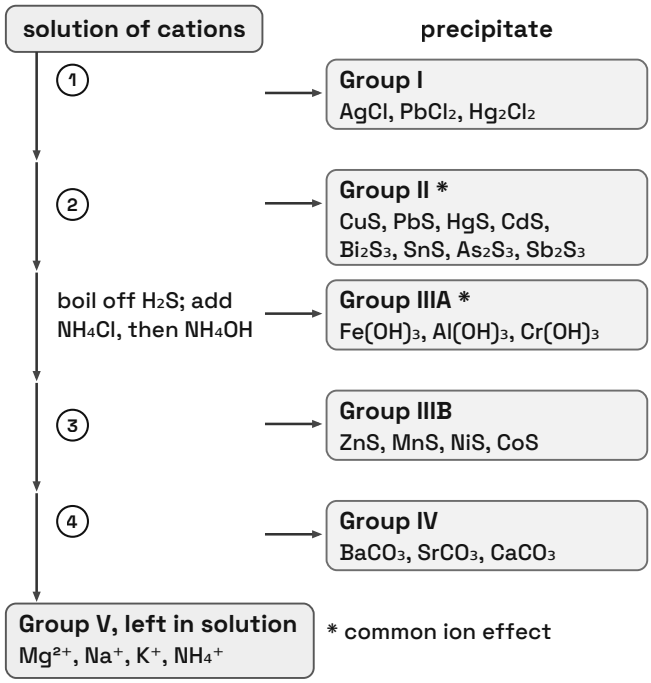
vi. A precipitate forms when the ionic product of a salt is less than its solubility product. ☐

vii. A buffer of a weak acid and its salt has pH = pK_a when the salt and the acid are at equal concentrations. ☐

viii. A solution of sodium acetate in water is neutral. ☐

2 Label the diagram [2]

The chart shows how the cations of a salt are separated into groups. Write the reagent that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The conjugate acid of the hydrogen phosphate ion, HPO_4^{2-}, is: [1]

a. PO_4^{3-} **b.** $H_2PO_4^-$

c. H_3PO_4 **d.** H_3O^+

ii. As the temperature of pure water rises, its ionic product, K_w: [1]

a. increases, because the self-ionization of water is endothermic

b. decreases, because the self-ionization of water is exothermic

c. stays 1.0×10^{-14}, because it is a constant

d. increases, and the water becomes acidic

iii. What is the pH of 0.0050 mol/L barium hydroxide, $Ba(OH)_2$, at 25 °C? [1]

a. 2.0 **b.** 11.7

c. 12.0 **d.** 12.3

iv. Which of these salts gives an acidic solution in water? [1]

a. NaCl **b.** KNO_3

c. CH_3COONa **d.** NH_4Cl

v. A buffer is made with sodium acetate ten times as concentrated as the acetic acid in it. Its pH is (pK_a of acetic acid 4.76): [1]

a. 3.76 **b.** 4.76

c. 5.76 **d.** 14.76

4 Short answers [7]

Write short answers to the following questions.

a. State Ostwald's dilution law. Why does it not apply to hydrochloric acid? [2]

b. Soap is separated from its solution by adding a concentrated solution of common salt. Explain why, with the help of the common ion effect. [2]

c. Write the solubility product of each salt in terms of its ion concentrations, and in terms of its molar solubility s: a. barium fluoride, BaF_2; b. silver phosphate, Ag_3PO_4; c. bismuth sulphide, Bi_2S_3. **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

What is a buffer solution? Explain, with equations, how a mixture of ammonia solution and ammonium chloride resists a change of pH when a little acid or a little base is added. Write the Henderson–Hasselbalch equation for this buffer.

6 Numerical problems **[8]**

Solve the following problems. Show your working. Take K_a of benzoic acid $= 6.3 \times 10^{-5}$, $K_w = 1.0 \times 10^{-14}$ at 25 °C, Mg = 24, F = 19.

a. A solution of benzoic acid, C_6H_5COOH, is 0.040 mol/L at 25 °C. **[4]**

i. Find its degree of ionization, and say whether the shortcut $\alpha = \sqrt{K_a/C}$ is good enough.
ii. Find $[H^+]$.
iii. Find its pH.
iv. Find $[OH^-]$ in the solution.

Answer:

b. The molar solubility of magnesium fluoride, MgF_2, in water at 25 °C is 2.35×10^{-4} mol/L. **[4]**

i. Find its solubility product.
ii. Find its solubility in g/L.
iii. Find its molar solubility in 0.050 mol/L sodium fluoride solution.
iv. How many times less soluble is it there than in pure water? Which effect is this?

Answer: _____

7 Think [3]

Phenolphthalein is the right indicator for titrating acetic acid with sodium hydroxide, but methyl orange is not. Explain why, using the pH at the equivalence point and the steep part of the titration curve.

8 Activity: Acidic, basic or neutral salts? (not marked)

In the laboratory, with goggles on, dissolve a spatula-full of each salt in 20 mL of distilled water and test it with universal indicator paper. Before testing, predict from the acid and the base each salt comes from.

Salt	From acid (strong or weak)	From base (strong or weak)	Predicted	pH found
NaCl				
NH_4Cl				
CH_3COONa				
Na_2CO_3				

Which ion in each acidic or basic solution reacts with water?