Year 12 Chemistry

Assessment 3: Validation Test

Weighting: Practical Work 1%, Validation Test 4%.

Working Time for This Validation Test: 35 minutes

Student Name:_____

Total Marks for validation test _____/ 24

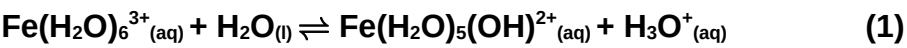
Special note: All equations must be balanced with state symbols.

Note to marker – equations must be totally correct, including balancing, all state symbols and correct type of arrow, otherwise no mark.

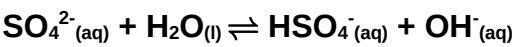
Questions:

1. During the practical part of this assessment you tested the pH of an aqueous solution of iron(III) sulfate by adding a few drops of universal indicator. The universal indicator became red, indicating that iron(III) sulfate is an acidic salt. Explain why iron(III) sulfate is an acidic salt. Include in your answer any hydrolysis reaction/s that occurred.

(3 marks)



(1)



(1)

Iron(III) sulfate is an acidic salt because K_a is greater than K_b or words to that effect e.g. the hydrolysis of iron(III) ions produces more hydronium ions than the hydrolysis of sulfate ions produces hydroxide ions (1).

2. A chemistry student made the statement “If an aqueous solution of a salt solution is tested with universal indicator and the universal indicator stays green then no hydrolysis reaction has occurred”. Explain whether or not this statement is true.

(1 mark)

(**This statement is not true.)**
(It may be that both ions undergo hydrolysis but the resulting solution may be neutral because) $K_a = K_b$ or words to that effect.

3. Explain how you could determine experimentally whether the value of K_b is greater for the ethanoate ion or the nitirite ion. Write appropriate hydrolysis reaction/s to illustrate your answer.

(6 marks)

Test with universal indicator / pH indicator / a pH meter (1)
the pH of solutions of salts containing the ethanoate ion and the nitrite ion (1)
combined with the same cation (1)
(e.g. test the pH of solutions of $NaCH_3COO$ and $NaNO_2$).
K_b is greatest for the ion that produces the highest pH solution (1)

$CH_3COO^-_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COOH_{(aq)} + OH^-_{(aq)}$ (1)

$NO_2^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HNO_{2(aq)} + OH^-_{(aq)}$ (1)

4. Explain how you could determine experimentally whether the value of K_a or K_b is greater for the hydrogen sulfide ion. Write appropriate hydrolysis reaction/s to illustrate your answer.

(6 marks)

Test with universal indicator / pH indicator / a pH meter (1)
the pH of a solution of a salt containing the hydrogen sulfide ion (1)
and a neutral cation (1)
(e.g. NaHS)
If the result is an acidic solution $K_a > K_b$ and if the result is basic $K_b > K_a$ (1)

$HS^-_{(aq)} + H_2O_{(l)} \rightleftharpoons S^{2-}_{(aq)} + H_3O^+_{(aq)}$ (1)

$HS^-_{(aq)} + H_2O_{(l)} \rightleftharpoons H_2S_{(aq)} + OH^-_{(aq)}$ (1)

5. A student made the generalisation “The conjugate bases of weak acids are basic ions”.
   a. Choose one conjugate base of a weak acid and write a hydrolysis reaction to show that the generalisation is true in this case.

(1 mark)

Any correct example e.g.

$CH_3COO^-_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COOH_{(aq)} + OH^-_{(aq)}$

   b. Choose one conjugate base of a weak acid where this generalisation is not true. Write appropriate hydrolysis reaction/s to illustrate this and also explain why the generalisation is not true in this case.

(4 marks)

(The dihydrogen phosphate ion is the conjugate base of phosphoric acid and)
The dihydrogen phosphate ion is amphiprotic / both accepts and donates protons / undergoes hydrolysis to produce both hydronium ions and hydroxide ions (1)
But $K_a > K_b$ / its hydrolysis produces more hydronium ions than hydroxide ions (1)
$H_2PO_4^- + H_2O_{(l)} \rightleftharpoons HPO_4^{2-}{}_{(aq)} + H_3O^+_{(aq)}$ (1)
$H_2PO_4^- + H_2O_{(l)} \rightleftharpoons H_3PO_{4(aq)} + OH^-_{(aq)}$ (1)

6. After completing the practical part of this assessment, you discover that the label has fallen off some of the reagent bottles used in the practical. In one particular bottle is a colourless liquid. You test it with universal indicator and the result is a strong purple colour, indicating it is a basic salt. Suspecting that it is sodium carbonate, you seek to confirm your suspicion by adding hydrochloric acid to the liquid. Upon adding the acid you notice bubbles of a colourless odourless gas. You then conclude that the liquid in the reagent bottle is indeed sodium carbonate.

   Is your reasoning correct? Explain. Also illustrate your answer with appropriate ionic equation/s showing the reaction/s between the contents of the bottle/s and the hydrochloric acid.

   Note: The reagents you used in the practical were the following.

Sodium chloride, Sodium ethanoate, Ammonium chloride, Ammonium sulfate, Calcium nitrate, Iron(III) sulfate, Sodium carbonate, Sodium sulfate, Potassium bromide, Ammonium oxalate, Ammonium ethanoate, Sodium hydrogen carbonate, Sodium dihydrogen phosphate, Sodium monohydrogen phosphate.

   (3 marks)

   (The reasoning is incorrect because)

   The unknown could also contain sodium hydrogen carbonate (1)

   $CO_3^{2-}{}_{(aq)} + 2H^+_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$ (1)

   $HCO_3^-{}_{(aq)} + H^+_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$ (1)

End of Test