Christ Church
Grammar School

Year 12 Chemistry

Acids and Bases Test
2016

NO READING TIME ALLOWED

Time allowed: **45 minutes**

Name: V. T.

Teacher:_____**(for CAP)**_____**/46**

Note that in this test you may assume that the temperature in all questions is 25°C, unless indicated otherwise

SECTION 1. Multiple Choice (10 marks)

1. Which of the following are Bronsted-Lowry acid/base reactions?

I. $2H_2O_2 \rightarrow 2H_2O + O_2$
II. $2H_2O \rightarrow H_3O^+ + OH^-$
III. $O^{2-} + H_2O \rightarrow 2OH^-$
IV. $2O^{2-} + 2H^+ \rightarrow H_2O + O_2$

A. II, and III only
B. I, II and III only
C. I, II and IV only
D. II, III and IV only

2. Which of the following is a possible pH of a 0.001molL-1 monoprotic weak acid

A. 3 exactly
B. 2.9
C. 3.1
D. 6.9

both answers accepted.

3. Consider the reaction

$HNO_3 + H_2SO_4 \rightleftharpoons H_2NO_3^+ + HSO_4^-$

Which of the following statements is true from the information given

A. the nitric acid is acting as a base
B. the hydrogensulfate ion is acting as an acid
C. the acids must both be strong and concentrated
D. the $H_2NO_3^+$ ion is acting as a base

4. Both ammonia and phosphine (PH_3) are weak bases. The pH of equimolar solutions were measured and it was found that the pH of the ammonia solution was higher. From this we can conclude that

A. Phosphine is a stronger base than ammonia
B. The ammonium ion is a weaker acid than the PH_4^+ ion
C. Ammonia must be able to accept more than one proton
D. The degree of ionisation of phosphine is greater than that of ammonia

5. Which of the following could **not** form an effective buffer solution

A. a mixture of NH_3 and NH_4NO_3
B. a mixture of HCOOH and HCOONa
C. H_2NCH_2COOH
D. a mixture of HCl and NaCl

6. A $0.01 mol L^{-1}$ solution of which of the following would you expect to have the lowest pH?

A sodium nitrate
B sodium ethanoate
C potassium chloride
D ammonium chloride

7. The pH of water at 25^0C is 7.0 and at 30^oC is 6.9. From this we can conclude that

A the ionisation of water is exothermic
B the water at 30^oC is slightly acidic
C both solutions are neutral
D the $[H+]$ at 30^oC is greater than the $[OH^-]$

8. Which one of the following species acts as an **acid** when ammonia gas is bubbled through an aqueous solution of potassium chloride?

A H_2O
B Cl^-
C NH_3
D K^+

9. Which of the following solutions will have the lowest pH?

A $0.1 mol L^{-1}$ H_2SO_4
B $0.2 mol L^{-1}$ CH_3COOH
C $0.2 mol L^{-1}$ HNO_3
D $0.1 mol L^{-1}$ HCl

10. Which of the following equations best represents the change taking place when ethanoic acid reacts with lithium hydroxide solution?

A. $LiOH(aq) + CH_3COOH(aq) \rightarrow H_2O(l) + CH_3COOLi(aq$
B. $OH^-(aq) + CH_3COOH(aq) \rightarrow H_2O(l) + CH_3COO^-(aq)$
C. $OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$
D. $Li^+(aq) + CH_3COO^-(aq) \rightarrow CH_3COOLi(aq)$

SECTION 2. Short Answers (36 marks)

Question 11 (2 marks)

Write ionic Bronsted-Lowry equations to show how

(i) The hypochlorite (ClO^-) ion can act as a base in water

$ClO^- + H_2O \rightleftharpoons HClO + OH^-$

(1 marks)

(ii) The hydrazinium ($N_2H_5^+$) ion can act as an acid in water

$N_2H_5^+ + H_2O \rightleftharpoons N_2H_4 + H_3O^+$

+ $N_2H_5^+ \rightleftharpoons N_2H_4 + H^+$ = 0 mark

(1 marks)

Question 12 (4 marks)

Write ionic equations to show the reaction between

(i) Ammonium nitrate and sodium hydroxide

$NH_4^+ + OH^- \rightleftharpoons NH_3 + H_2O$

(2 marks)

(ii) Ethanoic acid and magnesium oxide

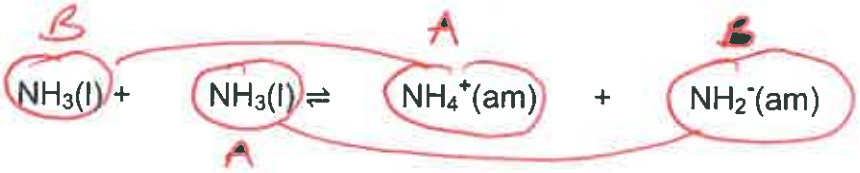
$2\,CH_3COOH + MgO \rightarrow 2\,CH_3COO^- + Mg^{2+} + H_2O$

(2 marks)

* 1 mark for $2H^+ + MgO \rightarrow Mg^{2+} + H_2O$
* 1 mark if MgO considered to be (aq), tho' in WACE you have to assume solid unless told otherwise.

Question 13 (10 marks)

Like water, liquid ammonia is able to react with itself and self-ionise. The equaton for this reaction is shown below, with (am) meaning 'dissolved in ammonia'.



(i) Use arrows to link the conjugate acid/base pairs in the above reaction, clearly identifying the acids and bases.

(2 marks)

The value of the equilibrium constant (at 25°C) for this reaction is about 1.0×10^{-30}.

(ii) What do think will be a better conductor of electricity, water or liquid ammonia. Explain your reasoning

H_2O ..... will be the better conductor of electricity

(1 mark)

Explanation

larger K ⇒ higher [ions]

⇒ better conductor

(2 marks)

(iii) Calculate the concentration of ammonium ions in liquid ammonia at 25°C.

$[NH_4^+] = \sqrt{K}$ ✓

$= 1 \times 10^{-15}$ ✓

(2 marks)

It is found that, as the temperature of the ammonia is increased, both the electrical conductivity and the value of K also increase.

(iv) Is the ionisation of ammonia endothermic or exothermic? Explain your reasoning.

The ionisation of ammonia is an endo ..... reaction

(1 mark)

Explanation

As T ↑, LCP favours endothermic reaction

⇒ eqm shift to right hand side and K increases.

(2 marks)

Question 14 (6 marks)

Even though they can be formed as a product of neutralisation reactions, solutions of salts need not themselves be neutral. They may be acidic, basic or neutral. For the following salts, identify (by circling the correct answer) the nature of the salt and write an ionic Bronsted-Lowry equation to support your answer.

(i) Ammonium nitrate

Acidic *Neutral* *Basic*

Equation

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

(ii) Lithium phosphate

Acidic *Neutral* *Basic*

Equation

$PO_4^{3-} + H_2O \rightleftharpoons HPO_4^{2-} + OH^-$

(iii) Potassium hydrogensulfate

Acidic *Neutral* *Basic*

Equation

$HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$

(3x2=6 marks)

NB if Arrhenius eqns given in (i) and (iii), only deduct one mark.

Question 15 (8 marks)

A buffer solution contains 0.100molL^{-1} CH_3COOH and 0.100molL^{-1} CH_3COONa and is found to have a pH of 4.76.

(i) Explain, with the aid of relevant equation, how this buffer can withstand the addition of acid.

* As H^+ is added,
* $CH_3COO^- + H^+ \rightarrow CH_3COOH$
* H^+ is removed
* Increase in $[H^+]$ and decrease in pH minimised

(3 marks)

(II) After the addition of the acid, circle the correct answer to describe what will have happened to the following values

The $[CH_3COOH]$ will have	*increased*	*decreased*	*stayed the same*
The $[CH_3COO^-]$ will have	*increased*	*decreased*	*stayed the same*
The pH will have	*increased*	*decreased*	*stayed the same*
The $[OH^-]$ will have	*increased*	*decreased*	*stayed the same*
The value of K_w will have	*increased*	*decreased*	*stayed the same*

(5 marks)

TEST CONTINUES ON NEXT PAGE

Question 16 (6 marks)

17.2mL of sodium hydroxide is added to 25.0mL of 0.100molL^{-1} hydrochloric acid and the pH of the resultant solution was found to be 1.65. Calculate the concentration of the sodium hydroxide solution.

(6 marks)

$pH_{(final)} = 1.65$

$\Rightarrow [H^+]_{final} = 10^{-1.65}$

$\Rightarrow [H^+]_{final} = 0.0224 \text{ mol L}^{-1}$ ✓

$\Rightarrow n(H^+)_{final} = (0.0224)(0.0422)$

$= 0.000945$ ✓

$n(H^+)_{initial} = (0.100)(0.025)$

$= 0.0025$ ✓

$\Rightarrow n(H^+)_{react} = n_{init} - n_{final}$

$= 0.0025 - 0.000945$

$= 0.00156$ ✓

$\Rightarrow H^+ + OH^- \rightarrow H_2O$

$\Rightarrow n(OH^-)_{react} = n(H^+)_{react}$

$= 0.00156$ ✓

$\Rightarrow [OH^-] = \frac{0.00156}{0.0172}$

$= 0.0904 \text{ mol L}^{-1}$ ✓