Australian Islamic College 2018

ATAR Chemistry Units 3 and 4

Task 4 (Weighting: 3%)

Acids and Bases Test

Test Time: 45 minutes

Please do not turn this page until instructed to do so.

First Name	Surname

Teacher
ANSWERS

Mark / 31	Percentage
	Final percentage rounded down

Equipment allowed: Pens, pencils, erasers, whiteout, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

Special condition: 2 marks will be deducted for failing to write your full name on this test paper.

Teacher help: Your teacher can only help you during your test in one situation.

> If you believe there is a mistake in a question show your teacher and your teacher will tell you whether or not there is a mistake in the question and if appropriate, how to fix that mistake.

Questions must be answered in this booklet, in the spaces provided.

Total marks: 31

1. Write an ionic equation and observations for the following reactions.
   a. Sulfuric acid is added to solid iron(II) sulfite.
      Ionic equation:

      (1 mark)

      $2H^+_{(aq)} + FeSO_{3(s)} \rightarrow SO_{2(g)} + H_2O_{(l)} + Fe^{2+}_{(aq)}$

      Observations:

      (2 marks; ½ each)

      A colourless liquid is added to a pale green solid. The pale green solid disappears, the liquid turns pale green and bubbles of a colourless gas with a choking odour are produced (any 4, ½ each).
   b. Ethanoic acid is added to solid copper(II) oxide.
      Ionic equation:

      (1 mark)

      $2CH_3COOH_{(aq)} + CuO_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2CH_3COO^-_{(aq)} + H_2O_{(l)}$

      Observations:

      (2 marks; ½ each)

      A colourless solution with a vinegar-like odour is added to a black solid. The black solid disappears, the liquid becomes blue and the vinegar-like odour disappears.

2. Complete this table by naming each acid and classifying it as strong or weak. The first one has been done as an example.

   (3 marks, 1 mark per correct row, no half marks)

Formula	**Name**	**Strong or Weak Acid**
HNO_3	**Nitric Acid**	**Strong**
H_3PO_4	***Phosphoric Acid***	***Weak***
H_2SO_3	***Sulfurous acid***	***Weak***
$H_2C_2O_4$	***Oxalic acid***	***Weak***

3. Give the formula of conjugate acid and conjugate base of the HS^- ion.

(2 marks; 1 each)

a. Conjugate acid
H_2S

b. Conjugate base
S^{2-}

4. When dissolved in water, ammonia produces a basic solution.
   a. Explain why ammonia does not fit the Arrhenius definition of a base.

(1 mark)

It does not contain hydroxide ions / OH / OH^- (in its formula).

   b. Explain why ammonia does fit the Brønsted-Lowry definition of a base. State the reaction between ammonia and water to demonstrate this.

(2 marks)

It acts as a proton acceptor. (1 mark)
$NH_{3(aq/g)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ *(1 mark)*
Arrow must be correct.

5. Pure water undergoes self-ionisation to a small extent.
   a. Write the reaction for the self-ionisation of water.

(1 mark)

$H_2O_{(l)} + H_2O_{(l)}$ {or $2H_2O_{(l)}$} $\rightleftharpoons H_3O^+{}_{(aq)} + OH^-{}_{(aq)}$
Arrow must be correct.

   b. Write the equilibrium expression for K_w, the equilibrium constant for the self-ionisation of water.

(1 mark)

$K_w = [H_3O^+]\ [OH^-]$

c. The values of pH at two different temperatures are given below.

pH of pure water at 20°C = 7.083
pH of pure water at 100°C = 6.130

(i) Determine $[H_3O^+]$ at 20°C.

(2 marks)

$[H_3O^+] = 10^{-pH}$
$[H_3O^+] = 10^{-7.083}$ *(1 mark for either this or the above)*
$[H_3O^+] = 8.260 \times 10^{-8}$ mol L^{-1} *(1 mark. ½ off if no unit)*

(ii) Determine the percentage ionisation of pure water at 20°C.

(3 marks)

Water contains 1000 g in 1 L.
$M(H_2O) = 18.106$
$n(H_2O)$ in 1 L = 1000 / 18.016 = 55.5062 mol
$c(H_2O) = 55.5062$ mol L^{-1} (1)
% ionisation = $8.260 \times 10^{-8} \times 100 / 55.5062$ (1)
$= 1.488 \times 10^{-7}$ % (1, ½ off for no/wrong unit)

d. Based on Le Chatelier's Principle and the information provided, is the self-ionisation of water an exothermic or endothermic process?

(1 mark)

Endothermic (1)

6. List these pure substances in order of increasing pH.

(1 mark)

Substance	**Ranking (1 to 7)**
2 M $KOH_{(aq)}$	*7*
$H_2O_{(l)}$	*5*
2 M $H_2SO_{4(aq)}$	*1*
1 M $H_2SO_{4(aq)}$	*2*
1 M $HCl_{(aq)}$	*3*
0.5 M $CH_3COOH_{(aq)}$	*4*
0.5 M $NaOH_{(aq)}$	*6*

7. Nitrous acid is a weak acid.
   a. The pH of a 0.100 M solution of nitrous acid (HNO_2) is 2.200. Determine the K_a of nitrous acid.

(2 marks)

$[H_3O^+] = 10^{-2.200} = 0.0063096$ mol L^{-1} (1)
$K_a = [H_3O^+]^2 / [HNO_2] = (0.0063096)^2 / 0.1 = 3.98 \times 10^{-4}$ (1)

8. Thymol blue is an acid-base indicator that is red in very acidic solution and yellow in basic solution. The K_a of thymol blue is 2×10^{-2}. Determine the pH at which thymol blue changes colour from red to yellow. Show your working.

(3 marks)

$HIn_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + In^-_{(aq)}$ (1)
$K_a = [H_3O^+]\,[In^-] / [HIn]$ (or 1)

Change of colour when $[In^-] / [HIn] = 1$ (or 1)
$K_a = 2 \times 10^{-2} = [H_3O^+]$ (1)
$pH = -\log[H_3O^+] = 2 \times 10^{-2}$
$pH = 1.70 = 2$ (1 sig. fig.) (1)

9. Some $AlCl_3$ is dissolved in water.

   a. Describe the resulting solution.

   (1 mark)

   Colourless.
   (Accept some other answers at teacher's discretion as question is ambiguous).

   b. Will the resulting solution be acidic, basic or neutral? Write a reaction to justify your response.

   (2 marks)

   Acidic (1).
   $Al(H_2O)_6^{3+}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons Al(H_2O)_5(OH)^{2+}{}_{(aq)} + H_3O^+{}_{(aq)}$ (1)

END OF TEST