



Christ Church
Grammar School

Year 12 Chemistry

Acids and Bases Test 2019

Time allowed:

45 minutes

Name: _____

Mark =/ 45

Teacher:

CEM

DGM

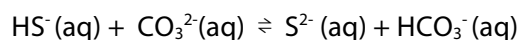
JJF

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Section 1 Multiple Choice

10 marks

1. Consider the following Brønsted- Lowry equation:

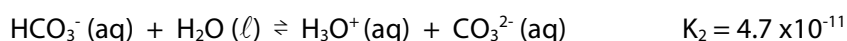
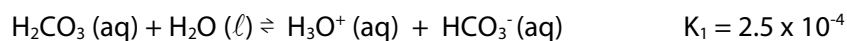


Which of the following is **not** true of this equation?

- A. HCO_3^{-} is acting as an acid.
- B. CO_3^{2-} is acting as a base.
- C. HS^{-} is acting as a base.
- D. CO_3^{2-} accepts a proton from HS^{-}
2. What is the conjugate base of $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$?
- A. $[\text{Al}(\text{HO})_6]^{2+}$
- B. $[\text{Al}(\text{H}_2\text{O})_5(\text{OH})]^{4+}$
- C. $[\text{Al}(\text{H}_2\text{O})_5(\text{OH})]^{2+}$
- D. $[\text{Al}(\text{OH})_6]^{3+}$
3. Which of the following combinations of substances would **not** result in a visible reaction?
- A. Hydrochloric acid and sodium carbonate solution
- B. Sulfuric acid and barium hydroxide solution
- C. Ethanoic acid and magnesium
- D. Nitric acid and potassium hydroxide solution
4. Which of these solutions would be the most effective buffer solution?
- A. 100 mL of 1.0 molL^{-1} NaOH (aq) mixed with 100 mL of 1.0 molL^{-1} CH_3COOH (aq)
- B. 100 mL of 1.0 molL^{-1} HCl (aq) mixed with 50 mL of 1.0 molL^{-1} NaCH_3COO (aq)
- C. 100 mL of 1.0 molL^{-1} NaOH (aq) mixed with 200 mL of 1.0 molL^{-1} CH_3COOH (aq)
- D. 50 mL of 1.0 molL^{-1} NaOH (aq) mixed with 100 mL of 1.0 molL^{-1} NaCH_3COO (aq)

5. Which of the following best describes the change taking place when ethanoic acid reacts with potassium hydroxide solution?
- A. $\text{KOH (aq)} + \text{CH}_3\text{COOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{KCH}_3\text{COO (aq)}$
 - B. $\text{OH}^- \text{(aq)} + \text{CH}_3\text{COOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{CH}_3\text{COO}^- \text{(aq)}$
 - C. $\text{OH}^- \text{(aq)} + \text{H}_3\text{O}^+ \text{(aq)} \rightarrow 2\text{H}_2\text{O (l)}$
 - D. $\text{K}^+ \text{(aq)} + \text{CH}_3\text{COO}^- \text{(aq)} \rightarrow \text{KCH}_3\text{COO (aq)}$
6. Which of the following statements is true about equal volumes of hydrochloric acid and ethanoic acid of the same concentration?
- A. Each contains the same number of H_3O^+ ions in solution.
 - B. When added to magnesium metal, each will produce hydrogen gas at the same rate.
 - C. Each will require the same amount of sodium hydroxide in order to react completely.
 - D. When each is reacted to completion with sodium hydroxide, the pH of the resulting solutions are the same.
7. Which of the following solutions has a pH less than 7?
- A. 0.001 molL^{-1} potassium carbonate
 - B. 0.001 molL^{-1} magnesium nitrate
 - C. 0.001 molL^{-1} sodium hydrogensulfate
 - D. 0.001 molL^{-1} sodium ethanoate (acetate)

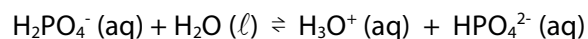
8. When carbonic acid is added to water, it ionises according to the following series of reactions:



Which of the following lists correctly ranks the species present in order of decreasing abundance.

- A. $\text{CO}_3^{2-} \text{ (aq)}$, $\text{HCO}_3^- \text{ (aq)}$, $\text{H}_3\text{O}^+ \text{ (aq)}$, $\text{H}_2\text{CO}_3 \text{ (aq)}$
- B. $\text{H}_3\text{O}^+ \text{ (aq)}$, $\text{HCO}_3^- \text{ (aq)}$, $\text{H}_2\text{CO}_3 \text{ (aq)}$, $\text{CO}_3^{2-} \text{ (aq)}$
- C. $\text{H}_3\text{O}^+ \text{ (aq)}$, $\text{H}_2\text{CO}_3 \text{ (aq)}$, $\text{CO}_3^{2-} \text{ (aq)}$, $\text{HCO}_3^- \text{ (aq)}$
- D. $\text{H}_2\text{CO}_3 \text{ (aq)}$, $\text{H}_3\text{O}^+ \text{ (aq)}$, $\text{HCO}_3^- \text{ (aq)}$, $\text{CO}_3^{2-} \text{ (aq)}$

9. Several drops of concentrated NaOH are added to the following buffer system, containing equimolar amounts of H_2PO_4^- and HPO_4^{2-} ions.



Which of the following statements about the effect of adding NaOH is true?

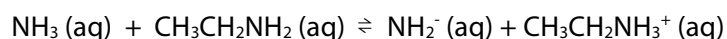
- A. The concentration of H_3O^+ increases
 - B. The concentration of OH^- decreases
 - C. The concentration of H_2PO_4^- increases
 - D. The concentration of HPO_4^{2-} increases
10. Which of the following correctly assigns pH values to the four 0.01 molL^{-1} solutions listed in the table below.

	H_2SO_4	NH_4Cl	NaNO_3
A.	1.6	5.6	9
B.	1.6	5.6	7
C.	1.9	7	9
D.	1.9	5.6	7

Section 2 Short answer

34 marks

11. a) Identify the acid/base conjugate pairs in the following Brønsted- Lowry equation.



Pair 1: Acid _____ Conjugate Base _____

Pair 2: Acid _____ Conjugate Base _____

- b) Given the K_c value of the reaction in part a) is greater than 1, identify the strongest base present in the reaction.

Strongest base: _____

(3 marks)

12. Write an equation and an observation to describe the reaction between solid ammonium nitrate and potassium hydroxide solution.

Equation:

Observations:

(4 marks)

14. Information about several weak acids and their K_a values are listed in the table below:

Acid	K_a value (25°)
Methanoic acid (CHOOH)	1.8×10^{-4}
Hydrocyanic acid (HCN)	6.2×10^{-10}
Hypochlorous acid (HClO)	3.5×10^{-8}
Oxalic acid (H ₂ C ₂ O ₄)	5.8×10^{-2}

- a) Write an ionic equation to show the ionisation of hydrocyanic acid in water. Include state symbols.

(2 marks)

- b) Complete the following table, indicating whether the following statements are true or false.

Statement	True/False
Methanoic acid is a stronger acid than oxalic acid	
$0.1 \text{ mol L}^{-1} \text{ NaClO (aq)}$ has a higher pH than $0.1 \text{ mol L}^{-1} \text{ KCN (aq)}$	
In a hypochlorous acid solution, $[\text{HClO}] > [\text{ClO}^-]$	
The conjugate base of oxalic acid (H ₂ C ₂ O ₄) is C ₂ O ₄ ²⁻	

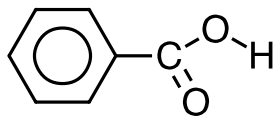
(4 marks)

- c) Explain why a solution of potassium methanoate (KCHOO) is basic. Use equations to illustrate your answer.

(3 marks)

15. Benzoic acid, drawn below, is a monoprotic weak acid.

Benzoic acid (C_6H_5COOH)



A buffer was produced by mixing 100 mL of 0.5 mol L^{-1} benzoic acid with 100 mL of 0.5 mol L^{-1} sodium benzoate (NaC_6H_5COO) solution.

- a) Write an equation to show the equilibrium system that is established in this buffer solution.

(1 mark)

- b) When a single drop of concentrated sodium hydroxide is added to the benzoic acid buffer solution, the pH increases only minimally. Account for this observation, using an equation(s) to illustrate your answer. Note, a detailed collision theory response is not required.

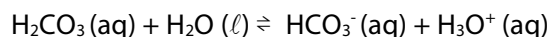
(3 marks)

- c) When the same drop of concentrated sodium hydroxide is added to water, the pH increases significantly. Account for this observation.

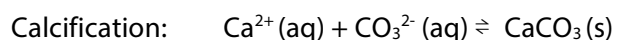
(2 marks)

16. The acidification of the world's oceans as a result of increased atmospheric carbon is causing damage to marine ecosystems.

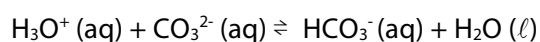
When CO_2 (g) dissolves in water, it produces carbonic acid (H_2CO_3), which then ionises in water to produce H_3O^+ ions, decreasing the pH of the water as shown below.



One major concern due to the increased acidity of the oceans its effect on calcification, the process by which marine organisms build their shells using carbonate ions.



Carbonate ions can also react with hydronium ions present in the ocean.



- a) Hence, or otherwise, complete the following table, describing the effects on the concentration or mass of various species in the oceans due to the increased levels of atmospheric CO_2 .

Species	Effect (increase/decrease/no change)
$[\text{HCO}_3^-]$	
$[\text{CO}_3^{2-}]$	
Mass of CaCO_3	

(3 marks)

End of test