

Chapter test

Chapter 2 Acid–base equilibrium system

Name: _____

Class: _____

Time permitted: 50 minutes

	Section	Number of questions	Marks available	Marks achieved
A	Multiple choice	15	15	
B	Short answer	5	15	
	Total	20	30	

Grade: _____

Scale:

A+	29–30	A	26–28	B	23–25	C	19–22	D	15–18	E	9–14	UG	0–8
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Comments:

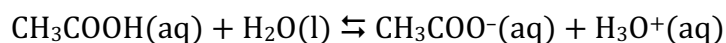
Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

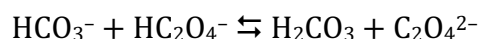
- 1 A safe and accurate way of distinguishing between a strong and weak base is by:
 - A taste.
 - B electrical conductivity.
 - C litmus paper.
 - D addition of acid.
- 2 An Arrhenius acid:
 - A accepts protons.
 - B donates protons.
 - C releases hydrogen ions in solution.
 - D releases hydroxide ions in solution.
- 3 Which is the correct conjugate pairing, in order, of the following?
 $\text{H}_2\text{O}, \text{OH}^-, \text{NH}_3, \text{CO}_3^{2-}$
 - A $\text{OH}^-, \text{H}_2\text{O}, \text{NH}_4^+, \text{CO}_2$
 - B $\text{H}_3\text{O}^+, \text{H}^+, \text{NH}_2, \text{HCO}_3^-$
 - C $\text{H}_3\text{O}^+, \text{H}_2\text{O}, \text{NH}_4^+, \text{HCO}_3^-$
 - D $\text{H}_3\text{O}^+, \text{H}_2\text{O}, \text{NH}_4^+, \text{H}_2\text{CO}_3$
- 4 In which of the following equilibria does water act as a base?
 - i $\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{NH}_3 + \text{H}_3\text{O}^+$,
 - ii $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{OH}^-$
 - iii $\text{HSO}_4^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$
 - iv $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
 - A i, ii and iii
 - B iii and iv
 - C i, iii and iv
 - D i and iv
- 5 What is the pH of a 6 mol L^{-1} solution of HCl?
 - A 12.2
 - B 0.3
 - C 0.8
 - D 1.3

- 6 What is the pH of a 2 mol L⁻¹ solution of Ba(OH)₂?
- A 0.3
 B 0.6
 C 13.4
 D 13.7
- 7 What is the concentration (in M) of H⁺ ions in a solution with pH = 5.3?
- A 5.0 × 10⁻⁶
 B 5.3
 C 1.0 × 10⁻⁷
 D 3.3 × 10³
- 8 What volume of 0.1 mol L⁻¹ HCl will neutralise 100 mL, 0.5 mol L⁻¹ NaOH?
- A 50 mL
 B 100 mL
 C 200 mL
 D 500 mL
- 9 Which one of the following pairs represents a conjugate acid–base pair?
- A CH₃COOH and OH⁻
 B NaOH and H₃O⁺
 C HCl and OH⁻
 D H₂O and OH⁻

- 10 What is the K_a expression for the following weak acid?

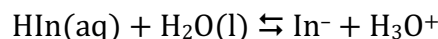


- A $\frac{[\text{CH}_3\text{COOH}][\text{H}_2\text{O}]}{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}$
 B $\frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$
 C $\frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}][\text{H}_2\text{O}]}$
 D $\frac{[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}$
- 11 Identify the correct order of Brønsted–Lowry acids and bases for the following reaction.



- A Base, acid, acid, base
 B Acid, base, base, acid
 C Acid, base, acid, base
 D Base, acid, base, acid

- 12 The K_w of water at 40°C is 2.92×10^{-14} . What is the pH of water at this temperature?
- A 6.8
 B 7.0
 C 7.2
 D 2.9
- 13 what is the ionic equation for the hydrolysis of the salt Na_2CO_3 ?
- A $\text{Na}^+ + \text{H}_2\text{O} \rightleftharpoons \text{NaOH} + \text{H}^+$
 B $\text{CO}_3^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{HCO}_3^- + \text{OH}^-$
 C $\text{CO}_3^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{O}^{2-}$
 D $2\text{Na}^+ + \text{H}_2\text{O} \rightleftharpoons \text{Na}_2\text{O} + 2\text{H}^+$
- 14 When writing the K_a expression for a weak acid, $\text{H}_2\text{O}(\text{l})$ is not included in the expression. Why is this so?
- A $[\text{H}_2\text{O}]$ is considered to be constant.
 B $[\text{H}_2\text{O}]$ does not exist for weak acid equilibria.
 C $[\text{H}_2\text{O}]$ is too large.
 D $[\text{H}_2\text{O}]$ is too small.
- 15 For the following equilibrium involving an indicator, what will the addition of acid on a blue solution cause?



(Reactants are colourless; products are blue.)

- A Equilibrium shifts to the right; solution becomes more blue.
 B Equilibrium shifts to the right; solution becomes less blue.
 C Equilibrium shifts to the left; solution becomes more blue.
 D Equilibrium shifts to the left; solution becomes less blue.

Section B Short answer (15 marks)

Section B consists of five questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

- 1 a Calculate the pH of a 0.2 mol L^{-1} HCl solution.
- b Calculate the pH of a 0.2 mol L^{-1} NaOH solution.
- c Calculate the pH of a 0.2 mol L^{-1} $\text{Ba}(\text{OH})_2$ solution.

(1 + 1 + 1 = 3 marks)

- 2 a Ethanoic acid and the ethanoate ion are an acid base conjugate pair. Using an equation explain the meaning of conjugate pair.
- b Write an ionic equation showing ethanoic acid reacting with water; explain how water acts as a base.
- c Write an ionic equation showing the ethanoate ion with water and explain how water acts as an acid.

(1 + 1 + 1 = 3 marks)

- 3 Swimming pools commonly are cleansed of bacteria by solution containing HOCl, $pK_a(\text{HOCl}) = 7.54$
- a Is the conjugate base of HOCl weak or strong? Show this with a reaction of the base with water.
- b Write the K_a expression for the reaction of HOCl with water.
- c What is the pH of the solution when the concentration of the acid and its conjugate base are equal?

(1 + 1 + 1 = 3 marks)

- 4 a The pH of water at STP is 7.0; explain with the use of an equation the self-ionisation of water.
- b At 60°, the pH of pure water is 6.5. Is the water slightly acidic? Explain.

(1 + 1 = 2 marks)

- 5 A solution of 0.2 mol L^{-1} boric acid, H_3BO_3 , has a pH of 5.45.
- Write an equation for the dissociation of boric acid and write the K_a expression.

 - Calculate the $\text{p}K_a$ of boric acid.

(1 + 3 = 4 marks)