



Year 12 Chemistry
Test : Acids and Bases 2009

Part One: Multiple Choice

(15 questions, 15 marks)

Please answer these questions on the separate multiple choice answer sheet provided.

1. Which one of the following substances is the most suitable as an indicator for strong acid-weak base titrations?

- (a) Universal indicator
- (b) Litmus
- (c) Methyl orange
- (d) Phenolphthalein

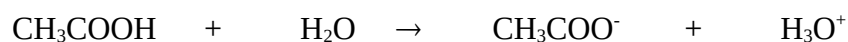
2. Bromocresol green produces the following colours when added to solutions of known pH.

pH	Colour
1	Yellow
2	Yellow
3	Blue
4	Blue

Bromocresol green is added to 0.1 mol L^{-1} solutions of acetic acid, carbonic acid and nitric acid. Which one of the following correctly identifies the colours the indicator will produce in each solution?

	Acetic acid	Carbonic acid	Nitric acid
(a)	Yellow	Yellow	Yellow
(b)	Yellow	Yellow	Blue
(c)	Blue	Blue	Blue
(d)	Blue	Blue	Yellow

3. Ionisation of acetic acid can be represented by the following equation



Which one of the following would increase the concentration of acetate ions?

- (a) addition of a strong base
- (b) addition of a strong acid
- (c) addition of a weak acid
- (d) dilution with water

4. The water in a seriously neglected dam is tested and found to have a pH of 9. By what factor must the hydrogen ion concentration be changed to decrease the water pH to 7?

- (a) decrease the hydrogen ion concentration by 100 times
- (b) double the hydrogen ion concentration
- (c) halve the hydrogen ion concentration
- (d) increase the hydrogen ion concentration by 100 times

5. Which one of the following cannot act as both a Bronsted-Lowry acid and base?

- (a) HPO_4^{2-}
- (b) HCO_3^-
- (c) HSO_4^-
- (d) SO_4^{2-}

6. What is the pH of a 0.05 mol L^{-1} solution of barium hydroxide?

- (a) 1.3
- (b) 7.0
- (c) 12.7
- (d) 13.0

7. Oxalic acid is a weaker acid than sulfuric acid. Which of the following best explains this?

- (a) Oxalic acid is found in plant material and sulfuric acid isn't.
- (b) Sulfuric acid has two hydrogen ions available for ionisation per mole and oxalic acid has one.
- (c) Oxalic acid is less soluble in water than sulfuric acid.
- (d) Oxalic acid ionises to a lesser extent than sulfuric acid.

8. Which of the following correctly identifies the acidity of the listed salts when dissolved in water?

	Sodium chloride	Sodium acetate	Ammonium acetate	Potassium hydrogencarbonate
(a)	Neutral	Acidic	Acidic	Basic
(b)	Acidic	Acidic	Acidic	Acidic
(c)	Neutral	Neutral	Neutral	Basic
(d)	Neutral	Basic	Neutral	Basic

9. In which of the following reactions is water behaving as a base?

- a) $\text{H}_2\text{O} + \text{C} \rightarrow \text{H}_2 + \text{CO}$
- b) $\text{H}_2\text{O} + \text{NH}_3 \rightarrow \text{NH}_4^+ + \text{OH}^-$
- c) $\text{H}_2\text{O} + \text{HCl} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$
- d) $\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 + \text{OH}^-$

10. What volume of sodium hydroxide of pH 12 would be needed to neutralise 10 mL of hydrochloric acid of pH 1?

- a) 100 mL
- b) 10 mL
- c) 1 mL
- d) 10×10^{12} mL

11. Which of the following is not a property of sulfuric acid?
- a) The dilute acid will react with copper to produce hydrogen gas.
 - b) The concentrated acid is an oxidising agent.
 - c) The dilute acid will react with magnesium.
 - d) The dilute acid absorbs water and may be used as a drying agent.
12. Which of the following oxides dissolve in water to give an acidic solution?
- | | |
|-----|---------------------------|
| I | Na_2O |
| II | Al_2O_3 |
| III | P_4O_{10} |
| IV | SO_2 |
- (a) I and III only
 - (b) II and III only
 - (c) II, III and IV only
 - (d) III and IV only
13. An acetic acid (ethanoic acid) solution is titrated with sodium hydroxide solution (in the burette), using methyl orange as the indicator. Which one of the following statements about this titration is **true**?
- (a) The end point and equivalence point occur at the same time.
 - (b) The end point occurs after the equivalence point.
 - (c) The end point occurs before the equivalence point.
 - (d) Whether the end point or equivalence point occurs first depends on the relative concentrations of acid and base.
14. The value of K_w at 35°C is 2.09×10^{-14} . This means that
- (a) the pH of water at 35°C is 13.7 and it is basic.
 - (b) the pH of water at 35°C is 6.3 and it is acidic.
 - (c) the pH of water at 35°C is 6.3 and it is neutral.
 - (d) the pH of water at 35°C is 13.7 and it is neutral.

15. Which of the following statements about aqueous solutions of weak acids is true?

- (a) A weak acid is a concentrated acid that has been diluted.
- (b) A 1.00 mol L^{-1} solution of a weak acid contains more molecules of acid than ions.
- (c) Less than 1.0 mol of sodium hydroxide is needed to react completely with 1.0 mol of a monoprotic weak acid.
- (d) The salt produced through the neutralisation of a weak acid by a strong base is slightly acidic.



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Name _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
b	b	b	b	b	b	b	b	b	b	b	b	b	b	b
c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
d	d	d	d	d	d	d	d	d	d	d	d	d	d	d

Please answer these questions in the spaces provided.

1. Calculate the pH of a solution containing 25.0 mL of 2.0 mol L⁻¹ sodium hydroxide and 49.5 mL of 1.0 mol L⁻¹ hydrochloric acid.

(4 marks)

2. Write equations for any reactions that occur in the following procedures. If no reaction occurs write 'no reaction'.
In each case describe what you would observe, including any: colours, gases evolved, odours and precipitates.
If no change is observed you must state this as the observation.

(a) A solution of phosphoric acid is added to a solution of sodium hydroxide.

Equation

Observation

(b) Potassium hydroxide solution is added to solid zinc hydroxide.

Equation

Observation

(c) Dilute hydrochloric acid solution is added to chromium (III) sulfide solid.

Equation

Observation

(d) Ammonium chloride and sodium hydroxide solutions are mixed and gently warmed.

Equation

Observation

(12 marks)

3. A student was required to standardise a solution of sulfuric acid by titrating it with a sodium carbonate solution made up from an accurately weighed mass of pure sodium carbonate. The sulfuric acid was placed in the burette. The sodium carbonate solution was pipetted into the conical flask with a few drops of methyl orange indicator added.

(a) Explain why sodium carbonate was chosen for this experiment.

(2 marks)

(b) Explain why methyl orange was chosen as the indicator.

(2 marks)

4. Answer the following questions about terms used in volumetric analysis.

a) What does the word 'standardise' mean?

b) Why is a primary standard often needed for volumetric analysis?

c) What is meant by the term 'end point'?

d) What is meant by the term 'equivalence point'?

(4 marks)

5. 3.12 g of washing soda, $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$, was dissolved in water and the solution made up to a volume of 200.0 mL in a volumetric flask. 18.18 mL of $0.0600 \text{ mol L}^{-1} \text{ H}_2\text{SO}_4$ neutralised 20.0 mL of the solution. Calculate the percentage, by mass, of Na_2CO_3 in the washing soda.

(6 marks)

6. Using your knowledge of Bronsted-Lowry theory, the properties of water and the pH scale, discuss the pH values in the table below. All solutions are 0.1 mol L^{-1} .

Solution 0.1 mol L^{-1}	pH
HNO_3	1.0
HClO	4.2
NH_4NO_3	5.1
KNO_3	7.0

(8 marks)



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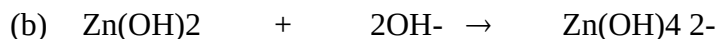
Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C	D	A	D	D	D	D	D	C	A	A	D	C	C	C

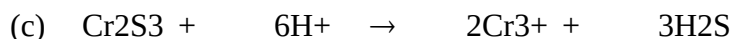
1. $n(\text{OH}) = 0.025 \times 2.0 = 0.050 \text{ mol}$
 $n(\text{H}) = 0.0495 \times 1.0 = 0.0495 \text{ mol}$
 $n(\text{XS OH}) = 0.0005 \text{ mol}$
 $[\text{OH}] = 0.005 / 0.0745 = 6.71 \times 10^{-3} \text{ mol L}^{-1}$
 $\text{pOH} = -\log [\text{OH}] = 2.17$
 $\text{pH} = 14 - 2.17 = 11.83$



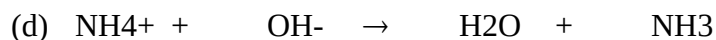
no visible change



white solid dissolves in a colourless solution to form a colourless solution.



green solid dissolves in a colourless solution to form a green solution and a colourless gas with an unpleasant smell.



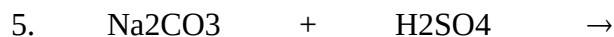
two colourless solutions form a colourless solution and a colourless gas with a pungent smell.

- 3(a) sodium carbonate solution is basic. It is neither deliquescent nor efflorescent and does not absorb gases from the air. The solid has a high molar mass and may be obtained in pure form.

- (b) methyl orange has an end point colour change in the same pH range as the equivalence point of the reaction between sodium carbonate and sulfuric acid.

- 4.(a) Standardise means, determine the exact concentration of.

- (b) Many substances may only be obtained in an impure form, hence the concentration of their solutions may only be approximately known.
- (c) The end point of a titration occurs when the indicator changes colour.
- (d) The equivalence point of a titration occurs when there are chemically equivalent amounts of both reactants present in the conical flask.



$$n = cV = 0.001091 \text{ mol}$$

$n = 0.001091$ in 20 mL therefore 0.001091×10 in 200 mL.

$$m = nM = 1.156 \text{ g}$$

$$\% = 1.156 / 3.12 = 37.1\%$$

6. 2 marks per compound, if pH explained fully.

HNO_3 strong acid $\rightarrow [\text{H}^+]$ same as the acid, 0.1M.

HClO weak acid $\rightarrow [\text{H}^+]$ much less than 0.1M so pH higher than 1.

NH_4NO_3 is a salt and totally dissociates in water. The NH_4^+ ion hydrolyses with water forming the H_3O^+ ion which makes the salt solution acidic.

KNO_3 is a salt. The dissociated ions are both strong species and so do not hydrolyse with water. The $[\text{H}^+]$ is 1×10^{-7} and the pH is 7