ALL SAINTS' COLLEGE

Science Department

Year 12 Chemistry 2018

Acids & Bases Test

Name: _____

Instructions to Students:

Attempt all questions
Write in the spaces provided
Show all working when required
All answers to be in blue or black pen, diagrams in pencil.

Multiple Choice	Short Answer	TOTAL	Final Percentage
/10	/50	/60	

Section 1: Multiple Choice **10 marks**

Use the Multiple Choice Grid provided

1. In which of the following reactions is the underlined species acting as an acid?

   (a) $H_3O^+_{(aq)} + \underline{HPO_4^{2-}}_{(aq)} \rightleftarrows H_2O(l) + H_2PO_4^-{}_{(aq)}$
   (b) $H_2O_{(l)} + \underline{HCO_3^-}_{(aq)} \rightleftarrows H_3O^+_{(aq)} + CO_3^{2-}{}_{(aq)}$
   (c) $H_2O_{(l)} + \underline{PH_3}_{(g)} \rightleftarrows PH_4^+{}_{(aq)} + OH^-_{(aq)}$
   (d) $H_3O^+_{(aq)} + \underline{HS^-}_{(aq)} \rightleftarrows H_2O_{(l)} + H_2S_{(aq)}$

2. Two solutions of equal concentration, A and B, have a pH of 3 and 6 respectively. Which of the following statements about the solutions is/are true?

   (i) They are both acidic.
   (ii) The concentration of H^+ is higher in B than it is in A.
   (iii) B is a weaker acid than A.

   (a) (i) only
   (b) (ii) only
   (c) (i) and (iii) only
   (d) (i), (ii) and (iii)

3. The conjugate base of the ion HCO_3^- is which of the following?

   (a) CO_3^{2-}
   (b) H_2CO_3
   (c) OH^-
   (d) H_2O

4. Which of the following would NOT change the pH of 10.0 mL of a dilute hydrochloric acid solution when it is added to the acid?

   (a) 10.0 mL of pure water.
   (b) 10.0 mL of sodium hydroxide solution.
   (c) 10.0 mL of concentrated hydrochloric acid solution.
   (d) 10.0 mL of the same hydrochloric acid solution.

5. Consider the following:

I	PO_4^{3-}
II	HPO_4^{2-}
III	$H_2PO_4^-$
IV	H_3PO_4

The term amphiprotic can be used to describe

(a) I only.
(b) II and III only.
(c) I, II and III only.
(d) II, III and IV only.

6. Consider the following equilibrium for the self-ionization of water:

$$H_2O \rightleftarrows H_3O^+ + OH^- \qquad \Delta H = \text{positive}$$

When water has a pH of 7.5, the temperature is

(a) less than 25ºC and the solution is basic.
(b) less than 25ºC and the solution is neutral.
(c) greater than 25ºC and the solution is basic.
(d) greater than 25ºC and the solution is neutral.

7. Which one of the following pairs of substances forms a buffer in aqueous solution?

(a) HCl and NaCl
(b) H_2SO_4 and Na_2SO_4
(c) NH_4Cl and $NaNH_2$
(d) HF and NaF

8. Which one of the following describes the acidity/basicity of a solution of the following compounds when dissolved in distilled water?

	Sodium hydrodensulfate	**Potassium carbonate**	**Magnesium chloride**	**Sodium ethanoate**
(a)	acidic	basic	acidic	basic
(b)	acidic	basic	neutral	basic
(c)	basic	acidic	neutral	acidic
(d)	basic	acidic	basic	acidic

9. The concentration of tartaric acid in a sample of diluted wine was determined by titration against a solution of sodium hydroxide. The sodium hydroxide solution was placed in the burette and the diluted wine sample was pipetted into the conical flask.
Which of the following options shows the correct rinsing of glass equipment prior to titration?

	Burette	**Pipette**	**Conical flask**
	Rinsed with		
(a)	Distilled water followed by NaOH solution	Distilled water followed by wine	Distilled water only
(b)	Distilled water followed by NaOH solution	Distilled water only	Distilled water followed by diluted wine
(c)	Distilled water followed by NaOH solution	Distilled water followed by diluted wine	Distilled water only
(d)	Distilled water followed by diluted wine	Distilled water followed by NaOH solution	Distilled water only

10. The properties of a primary standard for use in an acid-base titration include:

(a) reactivity with carbon dioxide in the air and low molar mass
(b) high stability and high purity
(c) low molar mass and low solubility
(d) high purity and ability to absorb water from the air

Section 2: Short Answers **50 Marks**

1. Write balanced net ionic equations (including state symbols) and observations for the following reactions:

(a) A solution of sulfuric acid is added to solid copper (II) oxide. (3)

Equation: _____

_____

Observation: _____

_____

(b) Acetic acid is added to magnesium carbonate solid. (3)

Equation: _____

_____

Observation: _____

_____

2. Carbonic acid, H_2CO_3, is an example of a polyprotic acid.

(a) With the aid of equations, describe what it means that carbonic acid is polyprotic. (4)

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(b) The acid constant, K_a for the first ionisation of carbonic acid is 4.5×10^{-7}, while the K_a constant for the first ionisation of phosphoric acid is 7.5×10^{-3}. If both acids are present at the same concentration, which of the two would have the lower pH based on the first ionisation? Explain your answer. (3)

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3. Consider the following salts: K_3PO_4, NH_4NO_3, Na_2SO_4, KH_2PO_4, $Mg(NO_3)_2$, $CaCl_2$.

(a) Explain what is meant with the term 'salt hydrolysis' and how this affects the pH of an aqueous salt solution. (2)

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(b) Choose two salts from the list above, one which will produce an acidic solution and one that will produce a basic solution.
Write a hydrolysis equation for each.

i) Salt producing acidic solution: _____

Hydrolysis equation:

_____ (2)

ii) Salt producing basic solution: _____

Hydrolysis equation:

_____ (2)

4. Calculate the pH of the resulting solution when 500.0 mL of 0.250 mol L^{-1} HNO_3 is mixed with 550.0 mL of 0.200 mol L^{-1} $Ba(OH)_2$. (9)

5. Buffer solutions are necessary to keep the correct pH for effective bodily functions to be maintained.

In the body, the most common metabolic process involving the production of substances that change the pH of blood is respiration. One of the products of respiration, carbon dioxide, is acidic and lowers the pH of body fluids.

The buffer system that is most important in keeping the pH of blood constant during respiration is the carbonic acid/hydrogencarbonate ion buffer found in blood plasma, which must maintain a pH of between 7.35 and 7.45.

$$CO_{2\,(g)} + H_2O_{\,(l)} \rightleftarrows H_2CO_{3\,(aq)}$$

$$H_2CO_{3\,(aq)} + H_2O_{\,(l)} \rightleftarrows H_3O^+_{\,(aq)} + HCO_3^-{}_{\,(aq)}$$

(a) What is the buffer capacity of a system? (2)

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_____

(b) During strenuous exercise, more carbon dioxide is produced in respiration, causing an increase in the concentration of H_3O^+.
Use Le Chatelier's Principle to predict how the blood plasma buffer would respond to this change.
Use an equation to help illustrate your answer. (3)

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6. A sample of 1.10 g of impure magnesium oxide was dissolved in 25.0 mL of 3.2 mol L^{-1} hydrochloric acid. The resulting solution was diluted to 250 mL in a volumetric flask. From this diluted solution, 20.0 mL aliquots were taken and titrated with the 0.102 mol L^{-1} sodium hydroxide solution to reach the end-point. The results of this titration are shown in the table below:

Trial	Rough	Two	Three	Four	Five
Volume of NaOH(mls)	25.10	24.85	24.65	24.95	24.80

(a) Calculate the average titre volume for the sodium hydroxide solution. (1)

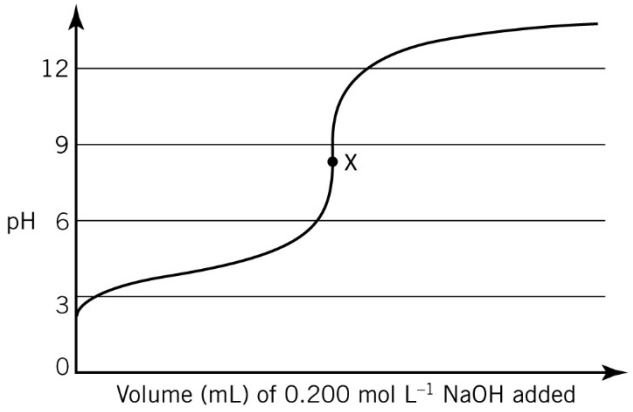
(b) Write a molecular equation for the reaction between magnesium oxide and the hydrochloric acid. (1)

(c) Calculate the mass of magnesium oxide in the original sample. (7)

(d) Calculate the percentage purity of magnesium oxide of the original sample. Quote your result to the appropriate number of significant figures (2)

7. Benzoic acid is a weak acid used as a preservative, for example in soft drinks. In aqueous solution it dissociates according to the equation:

$$C_6H_5COOH(aq) \rightleftharpoons C_6H_5COO^-(aq) + H^+(aq)$$



The graph shows the changes in pH that occur when 20.00 mL of 0.100 mol L^{-1} benzoic acid solution in a conical flask is titrated with 0.200 mol L^{-1} NaOH solution from a burette.

(a) Calculate the volume of the sodium hydroxide that has been added to the conical flask at point X. (3)

(b) For the indicator bromophenol blue, the pH range for the colour change is 3.0 (yellow) to 4.6 (blue).
Would this be a suitable indicator for this titration of benzoic acid with sodium hydroxide? Explain your answer. (3)

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END OF TEST