



Chemistry ATAR 3+4

Acids & Bases Test

TOTAL = 54 Marks

DO NOT MARK THIS PAPER

Please use the Multiple answer sheet for part 1 and the answer booklet for part 2.

PART 1 : Multiple Choice (10 Marks)

Q1. Which of the following volumes of a 0.040 mol L^{-1} potassium hydroxide solution is required to react exactly with 20.0 mL of a 0.010 mol L^{-1} diprotic acid?

- A. 1.0 mL
- B. 5.0 mL
- C. 10.0 mL
- D. 20.0 mL

Q2. Which of these salts will give a basic solution when added to water?

- A. NH_4NO_3
- B. $\text{NH}_4\text{CH}_3\text{COO}$
- C. $\text{Ca}(\text{NO}_3)_2$
- D. CaS

Q3. Which of the following is most **UNLIKELY** to act as both a Brönsted - Lowry acid or base?

- A. OH^-
- B. HPO_4^{2-}
- C. HS^-
- D. NH_4^+

Q4. Which statement best describes the equivalence point in a titration between a strong acid and a strong base?

- A. The point at which the first sign of a colour change occurs
- B. The point at which equal moles of acid and base have been added together
- C. The point at which equal moles of H^+ ions and OH^- ions have been added together
- D. The point at which the rate of the forward reaction equals the rate of the reverse reaction

Q5. All the following are amphoteric except:

- A. HSO_4^{1-}
- B. HPO_4^{2-}
- C. $\text{H}_2\text{PO}_4^{1-}$
- D. PO_4^{3-}

Q6. Sulfuric acid (H_2SO_4) and nitric acid (HNO_3) are both strong acids. Ethanoic acid (CH_3COOH) is a weak acid.

20.00 mL solutions of 0.10 M concentration of each of these three acids were separately titrated with a 0.10 M solution of sodium hydroxide (NaOH),

In order to reach a pH 7 neutralisation reading.

- A. all three acids would require the same amount of NaOH .
- B. HNO_3 would require more NaOH than CH_3COOH but less than H_2SO_4 .
- C. H_2SO_4 and HNO_3 would require the same amount of NaOH but CH_3COOH would require less.
- D. CH_3COOH and HNO_3 would require the same amount of NaOH but H_2SO_4 would require more.

Q7. Which of the following examples represents an acid-base reaction?

- A. $\text{NH}_4^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})} \rightarrow \text{NH}_{3(\text{aq})} + \text{H}_2\text{O}_{(\text{l})}$
- B. $2\text{NO}_3^-_{(\text{aq})} + 2\text{H}^+_{(\text{aq})} + 3\text{H}_2\text{O}_{2(\text{aq})} \rightarrow 2\text{NO}_{(\text{g})} + 3\text{O}_{2(\text{g})} + 4\text{H}_2\text{O}_{(\text{l})}$
- C. $2\text{K}_{(\text{s})} + 2\text{H}_2\text{O}_{(\text{l})} \rightarrow 2\text{K}^+_{(\text{aq})} + 2\text{OH}^-_{(\text{aq})} + \text{H}_{2(\text{g})}$
- D. $\text{Ca}^{2+}_{(\text{aq})} + \text{CO}_3^{2-}_{(\text{aq})} \rightarrow \text{CaCO}_{3(\text{s})}$

Q8. Methanoic acid and azoic acid are both weak acids with the following acidity constants (equilibrium constants).

| | K_a in M at 25°C |
|-------------------------------|-----------------------------------|
| methanoic acid (HCOOH) | 1.82×10^{-4} |
| azoic acid (HN ₃) | 1.91×10^{-5} |

Two separate solutions were prepared, one of 0.1 M methanoic acid and the other of 0.1 M azoic acid.

Which one of the following would be present in the highest concentration at 25°C?

- A. HN₃ in the azoic acid solution
- B. N₃⁻ in the azoic acid solution
- C. HCOOH in the methanoic acid solution
- D. HCOO⁻ in the methanoic acid solution

Q9. Acid X is 0.1 mol L⁻¹ hydrochloric acid. Acid Y is 1.0 mol L⁻¹ ethanoic acid. How does acid X compare with acid Y?

- A. X is weaker and more dilute than Y.
- B. X is stronger and more dilute than Y.
- C. X is weaker and more concentrated than Y.
- D. X is stronger and more concentrated than Y.

Q10. Pure water undergoes self-ionisation. The equilibrium constant for the reaction at 95°C is 4.8×10^{-13} . This corresponds to a pH of 6.2. Which of the following statements is true?

- A. At 95°C the water is acidic.
- B. At 95°C the water is neutral.
- C. At 95°C the water is basic.
- D. The pH has been worked out incorrectly.

PART 2 : Short Answers (44 Marks)

1. Write **net IONIC** equations for any reaction that occurs in the following making sure to **include phases** in your answer: Also write **full observations**.

NB: If no reaction occurs you must state this.

- a) Calcium hydroxide solid and sulphuric acid.
- b) Strontium oxide powder and phosphoric acid.
- c) Nitric acid and copper carbonate solution.
- d) Acetic acid solution and magnesium metal.

[12 marks]

2. Rewrite the following equations labelling the acids and bases with either an "A" or a "B" and show proton donation and acceptance with **an arrow** for both the forward and reverse reaction. State the conjugate acid/base pair and conjugate base/acid pair for each reaction:

- a) $\text{CN}^{-1} + \text{H}_2\text{O} \rightleftharpoons \text{HCN} + \text{OH}^{-1}$
- b) $\text{CH}_3\text{COOH} + \text{S}^{2-} \rightleftharpoons \text{CH}_3\text{COO}^{-1} + \text{HS}^{-1}$

[4 marks]

3. Is a lithium oxalate solution acid, basic or neutral? Explain with the aid of a hydrolysis equation.

[2 marks]

4. The K_a values for two acids are given in the table below:

| Acid | K_a @ 25°C |
|-------------|----------------------|
| $H_2C_2O_4$ | 5.4×10^{-5} |
| H_3PO_4 | 7.1×10^{-3} |

NB: These are the K values for the 1st ionisation only! i.e. K_{a1}

- a) Of the two acids which is the strongest? Justify your answer using the K_a values.
- b) Write equations to represent the first ionisation of each acid.

[4 marks]

5. Calculate the pH of (assume 25°C):

- a) A solution of 0.320 grams of HCl in 250mL of water.

[3 marks]

- b) 75ml of 0.15M NaOH is mixed with 2.5g of powdered $Ba(OH)_2$

[6 marks]

6. A 4.65g sample of pure $\text{NaOH}_{(s)}$ is dissolved in 200mL of distilled water and then added to 626mL of $0.15 \text{ mol.L}^{-1} \text{ H}_2\text{SO}_{4(aq)}$. Determine the pH of the mixture when the reaction is complete. Also state the limiting reagent.

[7 marks]

7. Titrations are a very important analytical technique in Chemistry. Unfortunately, acids, bases and salts are generally all clear and colourless in solution, so the end point of a titration cannot be signified by a colour change as in a redox titration. We need to select an indicator which changes colour for us. However, the selection of the correct indicator is based on a few factors.

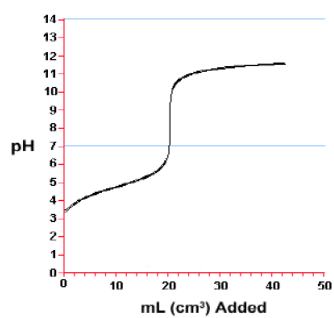
- a) On your answer sheet, write down the missing entries *a* to *f* from the table below.

[3 marks]

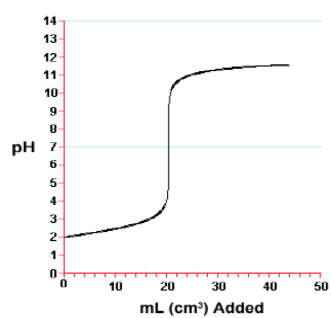
| | Strong Base | Weak Base |
|-------------|---|---|
| Strong Acid | 1. pH at end point = <i>a</i> Indicator = <i>b</i> | 3. pH at end point = <i>e</i> Indicator = <i>f</i> |
| Weak Acid | 2. pH at end point = <i>c</i> Indicator = <i>d</i> | |

- b) The following titration curves are drawn for titrations 1,2 and 3 above. Match the titration to the correct curve. Write your answer in the form "1A" or "1B"etc.

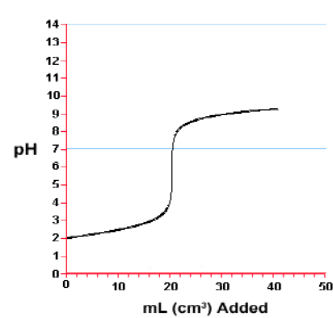
A



B



C



[3 marks]

END of PAPER