Trinity College

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. NH_4CH_3COO
C. $Ca(NO_3)_2$
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. $H_2PO_4^{1-}$
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. $NH_4^+{}_{(aq)} + OH^-{}_{(aq)} \rightarrow NH_{3(aq)} + H_2O_{(l)}$

B. $2NO_3^-{}_{(aq)} + 2H^+{}_{(aq)} + 3H_2O_{2(aq)} \rightarrow 2NO_{(g)} + 3O_{2(g)} + 4H_2O_{(l)}$

C. $2K_{(s)} + 2H_2O_{(l)} \rightarrow 2K^+{}_{(aq)} + 2OH^-{}_{aq} + H_{2(g)}$

D. $Ca^{2+}{}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3\,(s)}$

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

	***K*a in M at 25^{0}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. HN_3 in the azoic acid solution
B. N_3^- 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) $CN^{-1} + H_2O \rightleftarrows HCN + OH^{-1}$

   b) $CH_3COOH + S^{2-} \rightleftarrows CH_3COO^{-1} + HS^{-1}$

[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 25^0C):

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 $NaOH_{(s)}$ is dissolved in 200mL of distilled water and then added to 626mL of 0.15 $mol.L^{-1}$ $H_2SO_{4(aq)}$. 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.

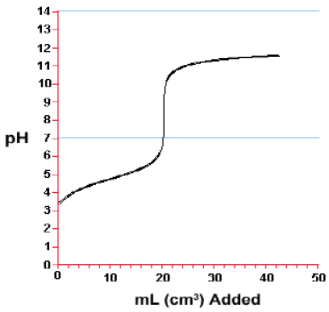
a) On your answer sheet, write down the missing entries *a* to *f* from the table below.

[3 marks]

	Strong Base	Weak Base
Strong Acid	1. pH at end point = *a* Indicator = *b*	3. pH at end point = *e* Indicator = *f*
Weak Acid	2. pH at end point = *c* Indicator = *d*	

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



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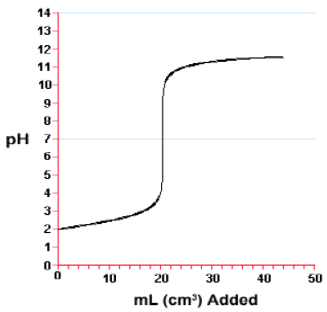
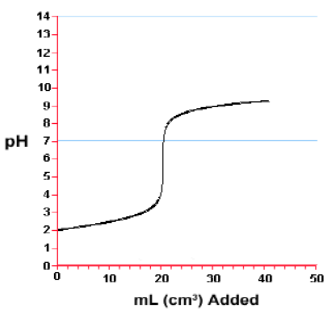


C



[3 marks]

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