**ACIDS & BASES**

**SUMMARY: Hydrolysis, neutralisation and indicators**

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| **Strong acid + strong base** → neutral salt (aq) + water   * No change in pH   ∴ NO hydrolysis   * Endpoint of the neutralisation reaction pH = 7 * Indicator: **Bromothymol blue** * **Bromothymol blue pH range**: pH 6 – 7,6 * **Bromothymol blue**: yellow to blue (acid to base; green at pH of 7) | **EXAMPLE**  NaOH(aq) + HCl(aq) → NaCl(aq) + H2O(l)   * Strong base and strong acid * NO hydrolysis * pH = 7 * pH at endpoint = 7 |
| **Weak acid + weak base** → neutral salt (aq) + water   * No change in pH   ∴ NO hydrolysis   * Endpoint of the neutralisation reaction pH = 7   Indicator: **Bromothymol blue** | **EXAMPLE**  H2CO3(aq) + NH3(aq) → (NH4)2CO3(aq) + H2O(l)   * Weak acid and weak base * NO hydrolysis * pH = 7 |
| **Strong acid + weak base** → salt (aq) + water   * pH<7   ∴ Hydrolysis occurred – solution becomes acidic   * Endpoint of the neutralisation reaction pH < 7 * Because there will be be more H3O+ * Indicator: **Methyl orange** * **Methyl orange pH range**: pH 3,1 – 4,4 * **Methyl orange**: red to yellow (acid to base) | **EXAMPLE**  NH3(aq) + HCl(aq) → NH4Cl(aq) + H2O(l)   * Strong acid and weak base * Hydrolysis occurred * Acidic solution * pH<7   Hydrolysis reaction:  NH4+(aq) + H2O(l) → NH3(aq) + H3O+(aq)   * pH at endpoint is 3,7 |
| **Weak acid + strong base** → salt (aq) + water   * pH>7   ∴ Hydrolysis occurred – solution becomes basic   * Endpoint of the neutralisation reaction pH > 7 * Because there will be be more OH-   Indicator: **Phenolphthalein**   * **Phenolphthalein pH range**: pH 8,3 – 10 * **Phenolphthalein**: colourless to pink (acid to base) | **EXAMPLE**  NaOH(aq) + H2CO3(aq) → Na2CO3(aq) + H2O(l)   * Weak acid and strong base * Hydrolysis occurred * Basic solution * pH>7   Hydrolysis reaction:  CO32- (aq) + H2O(l) → HCO3- (aq) + OH- (aq)   * pH at endpoint is 9,3 |

* Hydrolysis is a reaction between a salt and water.
* If hydrolysis occurred: the pH of the solution will be altered (changed).
* Neutralisation occurs when the endpoint is reached during a titration.
* During titrations we use a solution with a known concentration to determine the unknown concentration of another solution.

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| --- | --- |
| **Strong acids**   * HCl * HNO3 * H2SO4 * HBr * HI * HClO4 | **Weak acids**   * CH3COOH * (COOH)2 * H2CO3 * H3PO4 |
| **Strong bases**   * KOH * NaOH * LiOH * Ca(OH)2 * RbOH * CsOH | **Weak bases**   * NH3 (Exception, ionises) * CaCO3 * K2CO3 * NaHCO3 * Na2CO3 |

**QUESTION 1 (Adapted from Nov 2014 P2)**

1. Nitric acid (HNO3) is an important acid which is used in the industry. It is classified as a strong acid.

1.1 Give a reason why nitric acid is classified as a strong acid. (2)

1.2 Explain what is meant by the term *ionisation*. (2)

1.3 Explain the difference between a concentrated and diluted acid. (2)

1.4 Write down the FORMULA and NAME of the conjugate base of nitric acid. (2)

1.5 Calculate the pH of a 0,3 mol.dm-3 nitric acid solution. (3) **[11]**

**QUESTION 2 (Adapted from Nov 2014 P2)**

2. Casandra wants to determine the percentage purity of a magnesium oxide sample. She adds 100 cm3 of hydrochloric acid, with a concentration of

2 mol.dm-3, to a 4,5 g sample of the magnesium oxide.

2.1 Calculate the number of moles of hydrochloric acid added to the magnesium oxide. (3)

2.2 Casandra titrates the EXCESS hydrochloric acid in the above reaction against a sodium hydroxide solution.

Diagram of a test tube with text

Description automatically generated

Clamp

B

A

2.2.1 Write down the name of apparatus **A** in the above diagram. (1)

2.2.2 Write down the name of apparatus **B** in the above diagram. (1)

2.2.3 Will sodium hydroxide be classified as a weak base or a strong base? Give a reason for your answer. (3)

2.2.4 The following indicators are available for the titration:

|  |  |
| --- | --- |
| **INDICATOR** | **pH RANGE** |
| A | 3,1 – 4,4 |
| B | 6,0 – 7,6 |
| C | 8,3 – 10,0 |

Which one of the above indicators (A, B or C) is most suitable to indicate the exact endpoint in this titration? Give a reason for your answer. (3)

2.2.5 What is the NAME of the indicator that will most probably be used in this titration? (1)

2.2.6 At the endpoint of the titration, Casandra finds that 21 cm3 of a 0,2 mol.dm-3 sodium hydroxide solution has neutralised the EXCESS hydrochloric acid. Calculate the number of moles of the hydrochloric acid that was in excess. (3)

2.2.7 Did hydrolysis occur during this neutralisation reaction? Write YES or NO. (1)

2.2.8 Give a reason for your answer in QUESTION 2.2.7. (2)

2.2.9 The balanced equation for the reaction between magnesium oxide and hydrochloric acid is:

MgO(s) + 2HCl(aq) → MgCl2(aq) + 2H2O(l)

Calculate the percentage purity of the magnesium oxide. Assume that only the magnesium oxide in the 4,5 g sample reacted with the acid. (5)

2.2.10 Give a reason why hydrochloric acid is referred to as a monoprotic acid. (2)

**[25]**

**QUESTION 3 (Adapted from Nov 2014 Exemplar P2)**

3. During a practical investigation, grade 12 learners decide to determine the percentage of ethanoic acid in a certain bottle of vinegar. They titrate a sample taken from the bottle of vinegar with a standard solution of sodium hydroxide. The equation for the reaction is as follows:

CH3COOH(aq) + NaOH(aq) → CH3COONa(aq) + H2O(l)

3.1 Define the term *standard solution*. (2)

3.2 Classify ethanoic acid as either a strong acid or a weak acid.

Give a reason for your answer. (3)

3.3 Classify sodium hydroxide as either a strong base or a weak base.

Give a reason for your answer. (3)

3.4 Define an acid according to the Arrhenius theory. (2)

3.5 Define an acid according to the Lowry-BrØnsted theory. (2)

3.6 Identify an appropriate indicator for this titration. (1)

3.7 Give a reason for your answer in QUESTION 3.6. (2)

3.8 The learners find that 40 ml of a 0,5 mol.dm-3 sodium hydroxide solution is needed to neutralise 20 ml of the vinegar.

3.8.1 Define a base according to the Arrhenius theory. (2)

3.8.2 Define a base according to the Lowry-BrØnsted theory. (2)

3.8.3 Calculate the pH of the sodium hydroxide solution. (4)

3.8.4 Calculate te percentage of ethanoic acid by mass present in the vinegar.

(Assume that 1 ml of vinegar has a mass of 1 g). (7)

3.9 Does the salt, CH3COONa (sodium ethanoate), that formed during the neutralisation reaction undergo hydrolysis? Write down YES or NO. (1)

**[31]**