Year 11 > 12

KS5 Taster Session

Name: ………………………………………………..

Problem: To determine the concentration of a sodium hydroxide solution using 0.1 mol/dm-3 hydrochloric acid.

Balanced Equation:

NaOH + HCl → NaCl + H2O

**Keywords**

**Acids :** Acids form acidic solutions in water. Acids produce hydrogen ions, H+ in aqueous solution. Acidic solutions have pH values less than 7.

**Alkalis:** Alkalis form alkaline solutions in water. Alkalis produce hydroxide ions, OH- in aqueous solution. Alkaline solutions have pH values greater than 7.

**Neutral solutions:** A neutral solution is neither acidic, nor alkaline. A neutral solution has a pH value of 7.

**Indicators and the pH scale:** The pH scale measures the acidity or alkalinity of a solution. The pH of a solution can be measured using a pH probe, or estimated using universal indicator and a colour chart. Indicators such as phenolphthalein or methyl orange.

**To determine the concentration of a sodium hydroxide solution using 0.1 mol/dm-3 hydrochloric acid.**

This required practical involves using appropriate apparatus to make and record a range of measurements accurately, including volume of liquids. It also involves determining the concentration of one of the solutions in mol/dm3 and g/dm3.

It is important in this practical to:

* make and record accurate measurements
* take account of health and safety considerations

### **Aims**

* To determine the reacting volumes of solutions of an acid and alkali by titration.
* To determine the concentration of one of the solutions in mol/dm3 and g/dm3 (Higher tier only).

The required apparatus is:

* burette
* pipette and filler
* conical flask and white tile

The reagents are:

* an acid (hydrochloric, sulfuric or nitric) of unknown concentration
* sodium hydroxide solution of known concentration
* a suitable indicator, for example methyl orange or phenolphthalein

### **Hazards, risks and precautions**

Identify the hazards and suggest precautions needed to reduce the risk of harm. For example:

| **Hazard** | **Possible harm** | **Precaution** |
| --- | --- | --- |
| Dilute sodium hydroxide solution | Causes skin and serious eye irritation | Wear gloves and eye protection, and use a pipette filler |
| Spilling hydrochloric acid while filling the burette | Causes eye irritation | Fill the burette slowly below eye level, using a funnel |

This table does not include all the possible hazards.

## Carrying out the practical

1. Use the pipette and pipette filler to add 25 cm3 of alkali to a clean conical flask.
2. Add a few drops of indicator and put the conical flask on a white tile.
3. Rinse the burette through with acid. Fill the burette with acid and note the starting volume. Use a funnel to help
4. Slowly add the acid from the burette to the alkali in the conical flask, swirling to mix.
5. Stop adding the acid when the end-point is reached (when the indicator first permanently changes colour). Note the final volume reading.
6. Repeat steps 1 to 5 until you get concordant titres ( results with 0.1cm3 of each other) More accurate results are obtained if acid is added drop by drop near to the end-point.

**Tasks**

Label the equipment

Diagram

Description automatically generated

Complete the steps

|  |
| --- |
| 1. Rinse the burette with acid. Place the burette in the clamp with the\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at the bottom |
| 1. Check the tap is off and fill the b\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with acid using the f\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. |
| 1. Make sure the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is removed from the burette. Record the reading on the \_\_\_\_\_\_\_\_\_\_ |
| 1. Use the \_\_\_\_\_\_\_\_\_\_\_to measure 25cm3 alkali into a conical flask. Add a few drops of \_\_\_\_\_\_\_\_\_\_\_\_\_. |
| 1. Place the \_\_\_\_\_\_\_\_\_\_flask under the burette on a white tile |
| 1. Add a small amount of \_\_\_\_\_\_at a time to the alkali in the conical flask. \_\_\_\_\_\_\_\_\_ the conical flask |
| 1. When the \_\_\_\_\_\_\_\_\_\_\_\_\_ point is nearing, add the acid a \_\_\_\_\_\_\_\_\_\_\_\_ at a time. |
| 1. When the indicator changes colour, stop adding acid and write down the reading on the\_\_\_\_\_\_\_\_\_\_\_\_. |
| 1. Repeat the titration until you have \_\_\_\_\_\_\_\_\_\_\_\_ results (three results that are within 0.1cm3 of each other) |

**Result table:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Run** | **Initial** | **Final** | **Titre** |
| **Rough** |  |  |  |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |
| **Average Titre (cm3)** | | |  |

**Problem:** To determine the concentration of a sodium hydroxide solution using 0.1 mol/dm-3 hydrochloric acid.

**3 steps to work out concentration of sodium hydroxide.**

NaOH **+** HCl → NaCl **+** H2O

**Equation used:** Moles = concentration (mol/dm3) x volume used (dm3)

* 1000cm3 = 1dm3

*example below uses a hypothetical average titre of* ***23.82 cm3****.*

* 23.82 cm3 = 0.02382 dm3

1000

**Step 1: Get moles from burette** (0.1 mol/dm3 HCl solution)

* Moles = concentration **x** volume used (dm3)

substitution

* Moles = 0.1 x 0.02382dm3
* Moles of HCl from burette = **0.002382**

**Step 2: Get moles in flask**

* 1 mol HCl neutralises 1 mol NaOH
* 0.002382 mol NaOH in flask

**Step 3: Get concentration in flask**

* Moles = concentration **x** volume used

rearrange

* Concentration = moles from burette

volume used

substitution

* Concentration = 0.002382

0.025

* Concentration = 0.09528 mol/dm3

**Concentration of NaOH was 0.095 mol/dm3**

**Your turn:**

**Use your results to complete the 3 steps to work out concentration of sodium hydroxide.**

NaOH **+** HCl → NaCl **+** H2O

**Equation used:** Moles **=** concentration (mol/dm3) **x** volume used (dm3)

* 1000cm3 = 1dm3

*Average titre is \_\_\_\_\_\_\_\_\_\_\_\_\_* ***cm3****. Average titre is \_\_\_\_\_\_\_\_\_\_\_\_\_* ***dm3****.*

**Step 1: Get moles from burette** – 0.1 mol/dm3 HCl solution

* Moles = concentration **x** volume used (dm3)
* Moles = 0.1 x ( \_\_\_\_\_\_\_\_\_\_ cm3/1000)
* Moles – 0.1 x ­­­­­­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_dm3
* Moles of HCl from burette = **­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Step 2: Get moles in flask**

* 1 mol HCl neutralises 1 mol NaOH
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol NaOH in flask

**Step 3: Get concentration in flask**

* Concentration = moles from burette

volume used (dm3)

* Concentration = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

0.025

* Concentration = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol/dm3

**Concentration of NaOH was \_\_\_\_\_\_\_\_\_\_ mol/dm3**

**Exam Practice**

This question is about acids and alkalis.

(a)  Which ion do all acids produce in aqueous solution?

Tick (**✓**) **one** box.

|  |  |
| --- | --- |
| H+ |  |
| H− |  |
| O2− |  |
| OH− |  |

**(1)**

(b)  Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

calcium hydroxide + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acid → calcium chloride + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm3 of dilute sulfuric acid.

**Figure 1** shows the apparatus the student uses.

**Figure 1**

**Diagram

Description automatically generated**

Use **Figure 1** to answer parts (c) and (d).

(c)  Name apparatus **A**.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(d)  What is the reading on apparatus **A**?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_cm3

**(1)**

(e)  The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

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**(6)**

**(Total 11 marks)**

**Exam Question**

Sodium hydroxide reacts with hydrochloric acid.

The diagram shows apparatus that can be used to find the volume of sodium hydroxide reacting with 25.0 cm 3 hydrochloric acid.

Diagram, shape, polygon

Description automatically generated

Describe a method to find the exact volume of sodium hydroxide that reacts with 25.0 cm 3 of hydrochloric acid.

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**(6)**