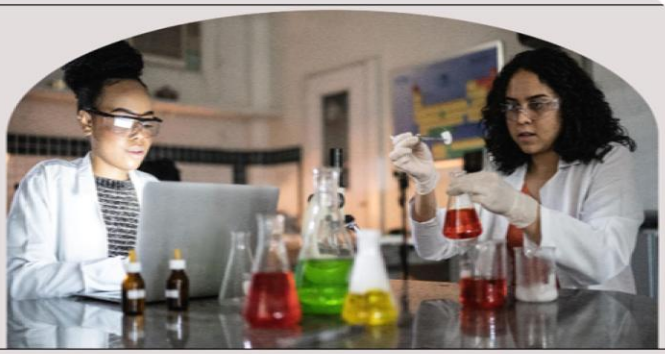
Neutralisation reactions



Answer all the questions below and then check your answers.

1. Potassium chloride can be made in a neutralisation reaction between potassium hydroxide and hydrochloric acid.

a. Write a word and balanced symbolic equation for this reaction. If you are not sure how to work out formula then go to the page on "Finding the formula".

b. Describe in detail a method that can be used to obtain dry crystals of potassium chloride by carrying out a neutralisation reaction using hydrochloric acid and potassium hydroxide. Include the following in your description:
   - Explain how you will ensure the solution you have made by mixing the acid and the alkali is neutral.
   - Explain how you will obtain the crystals and how you will ensure they are dry.

c. A student was expecting to obtain 1.75g of potassium chloride but at the end of the experiment she only managed to obtain 1.25g.

i. Calculate the percentage yield for this reaction.
ii. Suggest why the percentage yield was not 100%.

d. If the student wanted to make sodium sulfate crystals instead of potassium chloride. What acid and alkali should she use?

2. A student wanted to make the salt copper chloride. He decided to neutralise hydrochloric acid using solid copper carbonate. An equation for the reaction is shown below:

$$CuCO_{3(s)} + HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

a. What do the following state symbols means in the above equation:

i. (aq)

ii. (s)

iii. (g)

b. The equation above is not balanced. Balance it.

c. State two observations that would be seen during this reaction.

d. The student used an excess copper carbonate in the above reaction.

i. What does "using an excess mean"? Why did the student use an excess of the copper carbonate?

ii. The student wanted to make 6g of copper chloride. What mass of copper carbonate should he use?

Relative atomic masses (A_r): Cu=63.5 Cl=35.5 O=16 C=12 H=1

iii. The percentage yield for this reaction was 65%. How much copper chloride did the student actually make?

Answers

1. Potassium chloride can be made in a neutralisation reaction between potassium hydroxide and hydrochloric acid.

a. Write a word and balanced symbolic equation for this reaction. If you are not sure how to work out formula then go to the page on "Finding the formula".

Hydrochloric acid + potassium hydroxide → potassium chloride + water

$HCl_{(aq)} + KOH_{(aq)} \longrightarrow KCl_{(aq)} + H_2O_{(l)}$

b. Describe in detail a method that can be used to obtain dry crystals of potassium chloride by carrying out a neutralisation reaction using hydrochloric acid and potassium hydroxide. Include the following in your description:

- Explain how you will ensure the solution you have made by mixing the acid and the alkali is neutral.
- Explain how you will obtain the crystals and how you will ensure they are dry.

- Add equal amounts, 25ml, of hydrochloric acid and potassium hydroxide to a conical flask. Add a few drops of universal indicator. Continue adding acid or alkali drop by drop with constant stirring until the solution with the indicator is green.
- Add a few spatulas of powdered charcoal to the neutral solution to remove the indicator. Warm gently and stir continually.
- Filter to remove the charcoal.
- The solution should be filtered into a clean dry evaporating basin set-up over a water bath. Evaporate most of the solution. Then remove from the water bath and allow the remaining water to evaporate. This will leave solid crystals of potassium chloride.
- Place in a desiccator to dry the crystals.

c. A student was expecting to obtain 1.75g of potassium chloride but at the end of the experiment she only managed to obtain 1.25g.

i. Calculate the percentage yield for this reaction.

$$\% \text{ yield} = \frac{\text{actual mass obtained}}{\text{Theoretical mass}} \times 100\% = \frac{1.25}{1.75} \times 100\% = 71.4\%$$

ii. Suggest why the percentage yield was not 100%.

- Some salt left in evaporating basin or other apparatus.
- Neutralisation was not achieved.
- Weighing error.

d. If the student wanted to make sodium sulfate crystals instead of potassium chloride. What acid and alkali should she use?

Sulfuric acid and sodium hydroxide.

2. A student wanted to make the salt copper chloride. He decided to neutralise hydrochloric acid using solid copper carbonate. An equation for the reaction is shown below:

$$CuCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

a. What do the following state symbols means in the above equation:

i. (aq) – solution

ii. (s) – solid

iii. (g)– gas

b. The equation above is not balanced. Balance it.

c. State two observations that would be seen during this reaction.

- Bubbles of gas released.
- Solid copper carbonate reacts and "disappears".

Must be "something" that you would SEE - its an observation!

d. The student used an excess copper carbonate in the above reaction.

i. What does "using an excess mean"? Why did the student use an excess of the copper carbonate? Excess means too much/used more than was needed. An excess of one reactant is used to ensure that the other reactant(s) are completely used up.

ii. The student wanted to make 6g of copper chloride. What mass of copper carbonate should he use? Try here if you need help with moles calculations!
Relative atomic masses (A_r): Cu=63.5 Cl=35.5 O=16 C=12 H=1

From the balanced symbolic equation we have:

$$CuCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

However we are only interested in the copper carbonate and the copper chloride since this is all the question askes about, so forget about everything else. This leaves:

$$CuCO_{3(s)} \longrightarrow CuCl_{2(aq)}$$

1 mole 1 mole

We can see from the equation that 1 mole of copper carbonate gives 1 mole of copper chloride. So calculate the masses of 1 mole of each.

1 mole of copper carbonate = $CuCO_3$ = 63.5 + 12 + (16x3) = 123.5g

1 mole of copper chloride = $CuCl_2$ = 63.5 + (35.5x2) = 134.5g

So we have :

$CuCO_{3(s)}$ ⟶ $CuCl_{2(aq)}$

1 mole ⟶ 1 mole

123.5g ⟶ 134.5g

Calculate how much copper carbonate is needed to make 1g of copper chloride by dividing both sides by 134.5

$CuCO_{3(s)}$ ⟶ $CuCl_{2(aq)}$

1 mole ⟶ 1 mole

$\frac{123.5g}{134.5g}$ ⟶ $\frac{134.5g}{134.5g}$

= 0.918g ⟶ 1g

So to produce 1g of copper chloride we need 0.918g of copper carbonate. To produce 6g of copper chloride we need 0.918g x 6 = 5.5g.

iii. The percentage yield for this reaction was 65%. How much copper chloride did the student actually make?

The student will get 65% of 6g. That is 6.0g x 0.65 = 3.9g.