Intermediate 1

Int 1 Chemistry

Section 4

Acids & Alkalis

4LO Section 4: Learning Outcomes

Intermediate 1 Chemistry Unit 1: Chemistry In Action

Section 4: Acids and Alkalis

LO	Lesson	Text Book	Learning Outcome	Int 1 Only
1	4.1	p41	The pH scale ranges from below 0 to above 14.	
2	4.1	p41	Universal indicator, pH paper or a pH meter can be used to find the pH of solutions.	
3	4.7 4.7 4.7	p41	a) acids have a pH of less than 7 b) pure water and neutral solutions have a pH equal to 7 c) alkalis have a pH of more than 7.	
4	4.6 4.6	p42	a) The lower the pH of an acid, the greater the acidity b) the higher the pH of an alkali, the greater the alkalinity.	
5	4.4 4.5	p42	a) Diluting acids decreases the acidity. b) Diluting alkalis decreases the alkalinity.	
6	4.1	p45	Acids and alkalis are in common use in the home and the laboratory.	
7	4.2	p45	Common laboratory acids include hydrochloric acid, sulphuric acid and nitric acid.	
8	4.2	p46	Common laboratory alkalis include sodium hydroxide, lime water and ammonia solution.	
9	4.2	p46	Common household acids include vinegar, lemonade, soda water and coke.	
10	4.2	p47	Common household alkalis include baking soda, oven cleaner, dishwashing powder and bleach.	
11	4.9	p48	Alkalis neutralise acids (and vice versa) to form water and a salt.	
12	4.8	p49	Neutralisation moves the pH of the acid up towards 7.	
13	4.8	p49	Neutralisation moves the pH of the alkali down towards 7.	
14	4.10	p51	**When neutralised, hydrochloric acid forms chloride salts, sulphuric acid forms sulphate salts and nitric acid forms nitrate salts.**	**Int1**
15	4.12	p53	**Metal carbonates neutralise acids producing water, a salt and carbon dioxide gas.**	**Int1**
16	4.10	p51	**The salts contain the metal from the neutraliser.**	**Int1**
17	4.15 4.15 4.11	p54 p54 p54	Everyday examples of neutralisation include: a) reducing soil acidity, b) reducing acidity in lakes c) treatment of indigestion.	
18	4.15 4.15 4.15	p55 p55 p56	a) Carbon reacts with oxygen to produce carbon dioxide. b) Sulphur reacts with oxygen to produce sulphur dioxide. c) Nitrogen reacts with oxygen to produce nitrogen dioxide.	
19	4.15	p55 P57	Carbon dioxide, sulphur dioxide and nitrogen dioxide dissolve in water to form acidic solutions.	
20	4.15 4.15	p56 p57	a) Sulphur dioxide is produced by the burning of fossil fuels and dissolves in water in the atmosphere to produce acid rain b) Nitrogen dioxide is produced by the sparking of air in car engines and dissolves in water in the atmosphere to produce acid rain	
21	4.15	p57	Acid rain has damaging effects on buildings made from carbonate rock, structures made of iron or steel, soils and plant and animal life.	

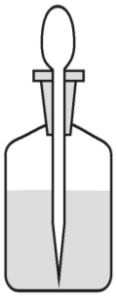
4.1 Acids and Alkalis

a) **Copy** and **complete** the following passage into your jotter.

Acids and alkalis are very common substances in a science lab and at home. The pH scale measures the acidity and alkalinity of a substance in a solution. (The substances must be dissolved in water)

There are different pieces of equipment for measuring the pH of a substance.

b) **Copy** the following diagrams carefully into your jotter and use the word bank to **label** the diagrams.



wordbank
pH meter
Universal indicator
pH paper

....

c) **Copy** the following diagram into your jotter.

The pH Scale

The pH scale ranges from 0 to 14.

0	1	2	3	4	5	6	**7**	8	9	10	11	12	13	14

INCREASING ACIDITY ← NEUTRAL → INCREASING ALKALINITY

pH below 7 (acid) ← pH = 7 (neutral) → pH above 7 (alkali)

[NB It is possible to get a pH below 0 and above 14]

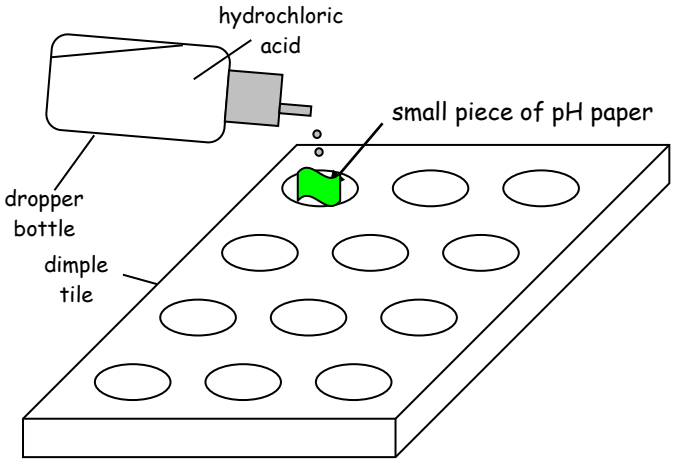
4.2 Measuring pH of Substances

a) **Copy** the following table into your jotter.

Name of Substance	Laboratory or Household	Colour of pH paper	pH number	Acid, Alkali or Neutral
hydrochloric acid				
sodium hydroxide				
vinegar				
baking soda				
nitric acid				
ammonia solution				
pure water				
soda water				
dishwasher powder				
lime water				
cola				
lemon juice				
sulphuric acid				
oven cleaner				
lemonade				
salt water				
bleach				

b) **Carry out** the following experiment.

1. Place a small piece of pH paper into a dimple of a dimple tile
2. Collect a dropper bottle and carefully squeeze the dropper bottle to transfer a few drops of the liquid onto the pH paper.
3. Record the colour of the pH paper in your table and use the conversion chart to calculate the pH of the test substance.



4. Repeat the experiment for all the substances in the table above, being careful to dispose of all used bits of pH paper carefully. [Do not leave the bits of paper in the sink, transfer the bits onto a paper towel before washing the dimple tile]

4.3 pH of Substances

a) **Answer** the following questions, in sentences, in your jotter.

1. What scale is used to measure the acidity (or alkalinity) of a solution?

2. What is the usual range of the pH scale?

3. Describe three pieces of equipment used to measure the pH of a solution.

4. Name the type of solutions have a pH below 7?

5. Name the type of solutions have a pH above 7?

6. What is the pH of water and neutral solutions?

b) **Copy** and **complete** the following table

Common Household Acids	Common Household Alkalis

c) **Copy** and **complete** the following table

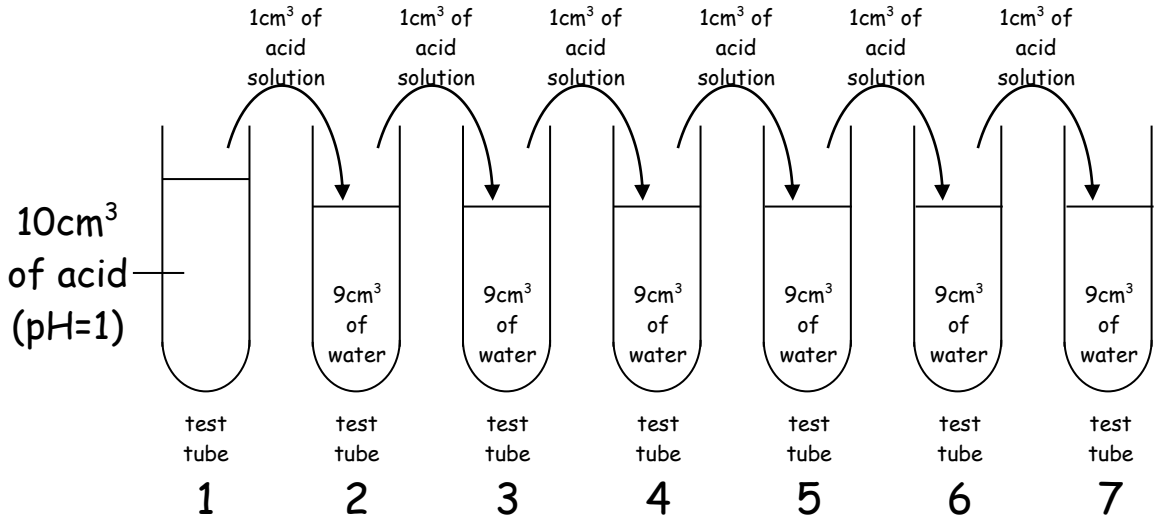
Laboratory Acids	Laboratory Alkalis

4.4 Dilution of Acids

a) **Copy** the following passage into your jotter.

Acids have a pH value, which can be measured by pH paper or universal indicator. What happens to the pH number of an acid if water is added to it?

b) **Copy** the following diagram into your jotter.



c) **Read** the following instructions and then **carry out** the experiment.

1. Working in a group of 4, collect 8 test tubes, one stopper, a 10cm^3 measuring cylinder and a test tube rack
2. Measure 10 cm^3 of the acid into your 1st test tube using the measuring cylinder
3. Rinse the measuring cylinder with water and then measure 1cm^3 of the acid solution in test tube 1 into the measuring cylinder.
4. Add 9cm^3 of water to the test tube using the measuring cylinder.
5. After putting the stopper into the test tube, shake the test tube gently to mix the liquid in the test tube.
6. Repeat the process until you have diluted the acid a further 5 times.
7. Once all the test tubes have been filled, add a small squirt of universal indicator to each test tube and observe the colour.

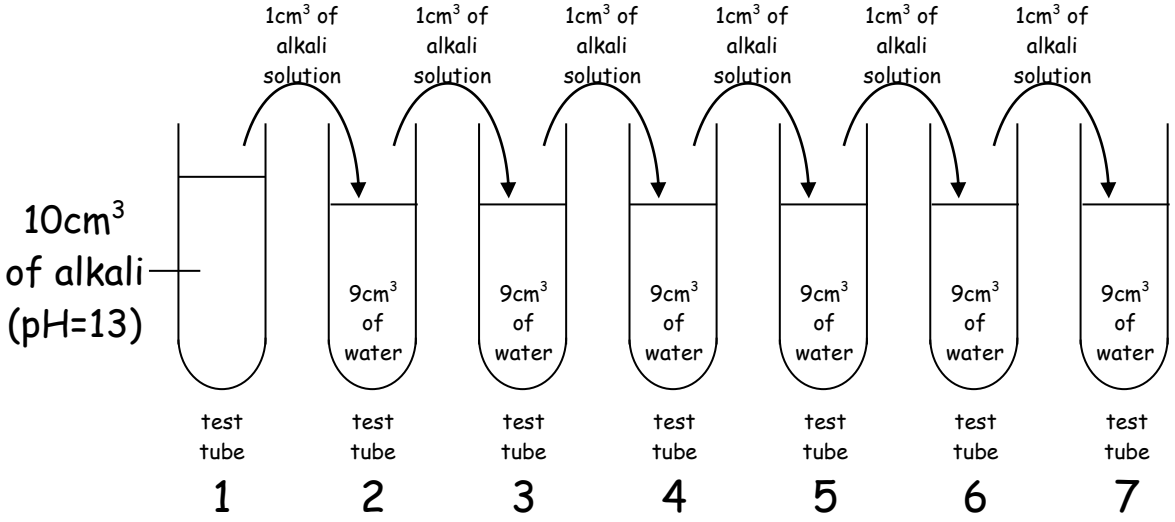
4.5 Dilution of Alkalis

a) **Copy** the following passage into your jotter.

Dilution of acids reduces the acidity of the acid. The pH number of acids increases until it reaches 7 (neutral).

Dilution of alkalis reduces the alkalinity of an alkali. The pH number of alkalis decreases until it reaches 7 (neutral).

b) Look at the following diagram. Use it to perform a dilution of alkali.



b) **Read** the following instructions and then **carry out** the experiment.

1. Working in a group of 4, collect 8 test tubes, one stopper, a 10cm^3 measuring cylinder and a test tube rack
2. Measure 10 cm^3 of the alkali into your 1st test tube using the measuring cylinder
3. Rinse the measuring cylinder with water and then measure 1cm^3 of the alkali solution in test tube 1 into the measuring cylinder.
4. Add 9cm^3 of water to the test tube using the measuring cylinder.
5. After putting the stopper into the test tube, shake the test tube gently to mix the liquid in the test tube.
6. Repeat the process until you have diluted the acid a further 5 times.
7. Once all the test tubes have been filled, add a small squirt of universal indicator to each test tube and observe the colour.

4.6 Dilution and pH

a) **Complete** the following statements in your jotter.

1. As acid solution is diluted, the pH *decreases* / *increases*

2. As the acid solution is diluted, the acidity *decreases* / *increases*.

3. Diluting acid eventually makes the pH of the acid equal to *1* / *7* / *14*

4. The starting acid was the *most* / *least* acidic of all the acids.

5. As alkali solution is diluted, the pH *decreases* / *increases*

6. As alkali solution is diluted, the acidity *decreases* / *increases*.

7. Diluting alkali eventually makes the pH of the acid equal to *1* /*7* /*14*

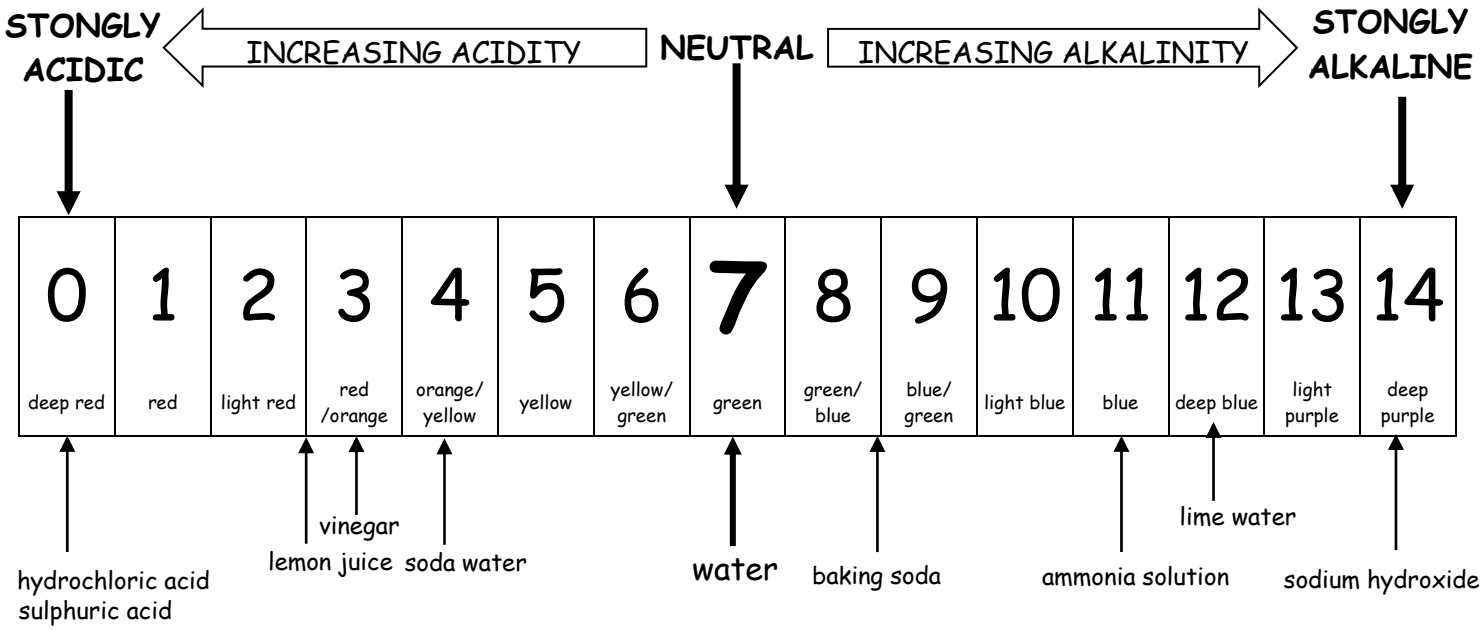
8. The starting alkali was the *most* / *least* alkaline of all the alkalis.

4.7 Summary of Acids, Alkalis & the pH Scale

a) **Collect** a copy of the following diagram

b) Use glue to **stick** it into your jotter (over 2 pages)

c) **Complete** the diagram using the following information



d) **Copy** the following summary into your jotter below your pH table.

- Acids have a pH less than 7
    - The lower the pH, the greater the acidity
- Alkalis have a pH greater than 7
    - The higher the pH the greater the alkalinity
- Neutral substances have a pH = 7
    - Pure water is an example of a neutral substance

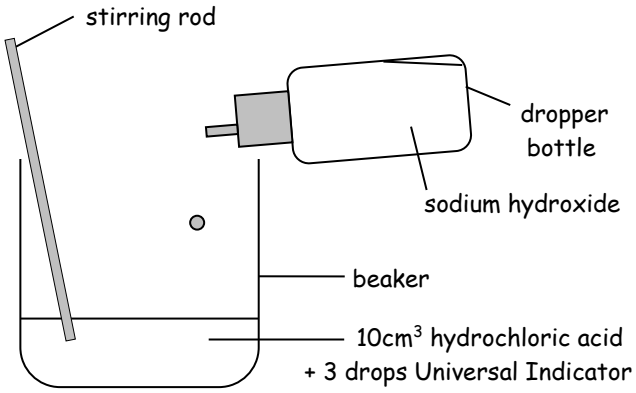
e) **Colour in** your pH chart and try to achieve the colours shown above with the pencils available.

4.8 Adding Acids to Alkali

a) **Copy** the following passage into your jotter.

Acids have a pH below 7 and alkalis have a pH above 7. What happens to the pH if acids and alkalis are added together?

b) **Draw** the following diagram into your jotter



If you have time, try this experiment again but start with sodium hydroxide in the beaker and add small quantities of hydrochloric acid from a dropper bottle

c) **Carry out** the following experiment

1. Using a measuring cylinder, measure 10cm^3 of hydrochloric acid and pour it into your beaker.
2. Add 3 drops of Universal Indicator to the beaker.
3. Collect a dropper bottle of sodium hydroxide
4. Add three drops of this alkali to the beaker and stir the beaker.
5. Repeat the process until the solution turns green
6. If the solution turns blue, add a dropperful of hydrochloric acid to your beaker. After stirring this should make your solution red again.
7. Start adding sodium hydroxide drop by drop to your beaker until the solution turns green.

d) **Copy** the following passage into your jotter.

When acids and alkalis are added together, a neutral solution is formed.

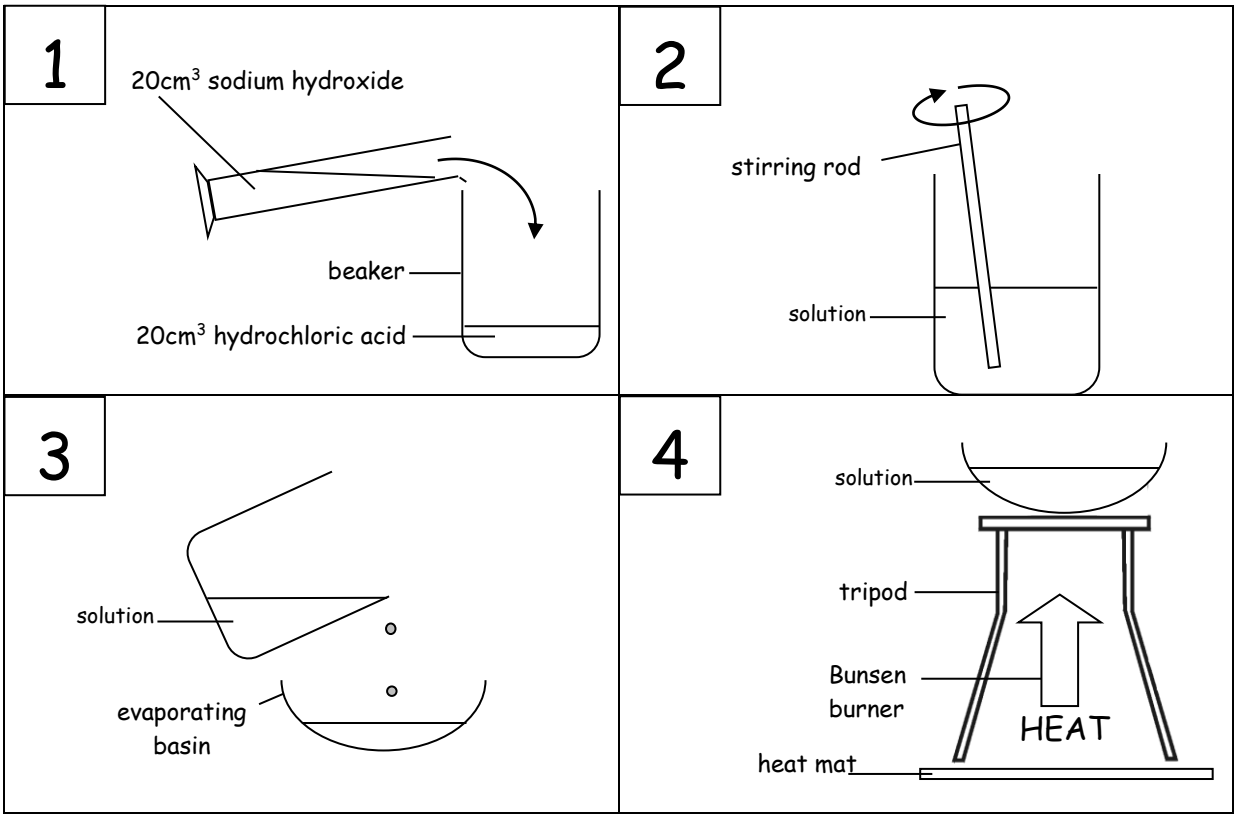
This process is called <u>neutralisation</u>.

4.9 Neutralisation I: Acids and Alkalis

a) **Copy** the following passage into your jotter.

When acid is added to alkali the pH moves towards 7 (neutral). This process is called neutralisation. But what happens to the acid and the alkali after the neutralisation?

b) **Copy** the following diagram into your jotter.



c) **Carry out** the following experiment

1. Measure 20 cm^3 of hydrochloric acid in a measuring cylinder. Transfer it into a beaker. Rinse out your measuring cylinder. Measure 20cm^3 of sodium hydroxide in the measuring cylinder and add to your beaker.
2. Stir the contents of the beaker thoroughly
3. Transfer your mixture into an evaporating basin. Boil off the water in the evaporating basin to leave the new substance formed.

   NB. Turn off Bunsen burner *just* *before* the last of the water has boiled off
4. Observe the contents of the evaporating basin for signs of a new substance.

4.10 Naming Salts From Neutralisation

a) **Answer** the following questions.

1. When an acid and an alkali are added together, which substances are formed?
2. Explain whether a chemical reaction has taken place.
3. Name this type of chemical reaction.

b) **Copy** the following note into your jotter

ACID + ALKALI ⟶ SALT + WATER

<u>Naming Salts from Neutralising Acids and Alkalis</u>

- Salts have 2 parts their names (Like a 1st name and a surname)
  - The 1st name comes from the alkali used
    - sodium hydroxide gives salts with a 1st name of sodium ……X……
    - potassium hydroxide gives salts called potassium ……X……
  - The 2nd name comes from the acid used in the neutralisation

Name of Acid	Salt Name Ends In
Hydrochloric acid	…… Chloride
Sulphuric acid	…… Sulphate
Nitric acid	…… Nitrate

c) **Copy** and **complete** the following word equations in your jotter

hydrochloric acid + sodium hydroxide ⟶ sodium choride + water

nitric acid + lithium hydroxide ⟶ ..... + water

sulphuric acid + ... ⟶ potassium sulphate + ...

..... + ... ⟶ magnesium nitrate + water

+ ⟶ calcium chloride +

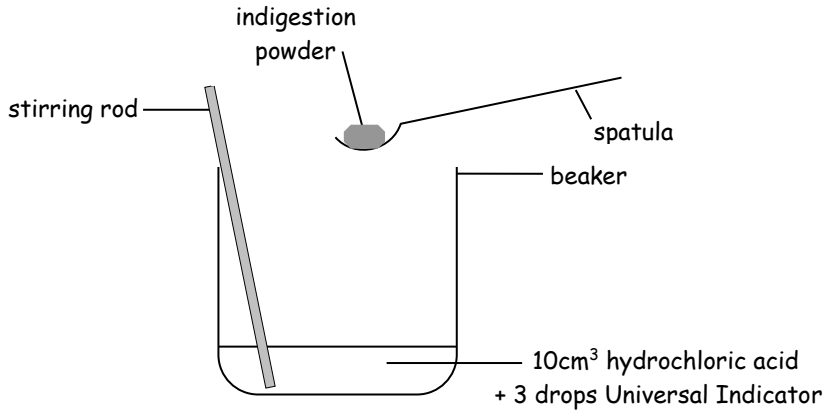
sulphuric acid + iron hydroxide ⟶ ..... + water

4.11 Indigestion Powder and Neutralisation

a) **Copy** the following passage into your jotter.

Acids and alkalis neutralise each other to form a salt and water. Other substances also neutralise acids to form a salt.

b) **Copy** the following diagram into your jotter.



c) **Carry out** the following experiment.

1. Measure 10cm^3 of hydrochloric acid in a measuring cylinder. Transfer this acid to your beaker.
2. Add 3 drops of universal indicator
3. Collect container of indigestion powder and a spatula
4. Add a spatula of indigestion powder and stir the beaker thoroughly.
5. Continue adding indigestion powder until the solution turns green (add too much powder and it might turn blue)

d) **Answer** the following questions, in sentences, in your jotter

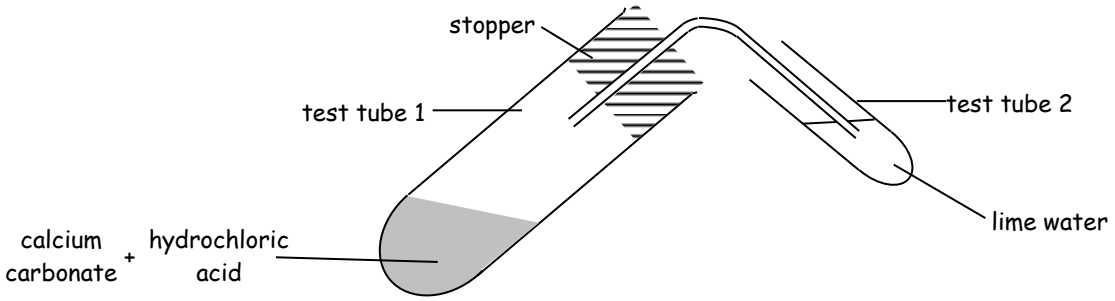
1. What was the colour of the acid at the beginning and end of the experiment?
2. How do you know the acid had been neutralised by the indigestion powder?
3. What was different about this neutralisation of the acid with indigestion powder and the previous neutralisation of acids with alkalis?

4.12 Neutralisation II: Acids & Metal Carbonates

a) **Copy** the following passage into your jotter.

Indigestion powder is made of a metal carbonate compound like calcium carbonate. But what is the name of the gas given off during the neutralisation?

b) **Copy** the following diagram into your jotter.



c) **Carry Out** the following experiment.

1. Collect a large test tube, a delivery tube with a stopper and a 2nd test tube for lime water.
2. Fill test tube 2 with lime water. Add enough lime water so that it covers the end of the delivery tube.
3. Add some calcium carbonate and some hydrochloric acid to test tube 1.
4. Quickly fit the stopper with the delivery tube to test tube 1, dip the end if the delivery tube into test tube 2.
5. Observe any chemical change in test tube 2.

d) **Answer** the following questions

1. What happened to the lime water when you added it to test tube 2?
2. Which gas is given off when acid is neutralised by a metal carbonate?
3. Complete the following word equation:

ACID + METAL CARBONATE ⟶ SALT + WATER + ...

4.13 Naming Salts II

a) **Read** the following passage.

Neutralisation of an acid always produces a salt. The same rules apply when metal carbonates or alkalis neutralise acids:

ACID + ALKALI (metal hydroxide) ⟶ SALT + WATER

ACID + METAL CARBONATE ⟶ SALT + WATER + CARBON DIOXIDE

- The alkali/metal carbonate gives the 1st name of the salt
- the neutralised acid gives the 2nd name (surname) of the salt.

b) **Copy** and **complete** the following word equations

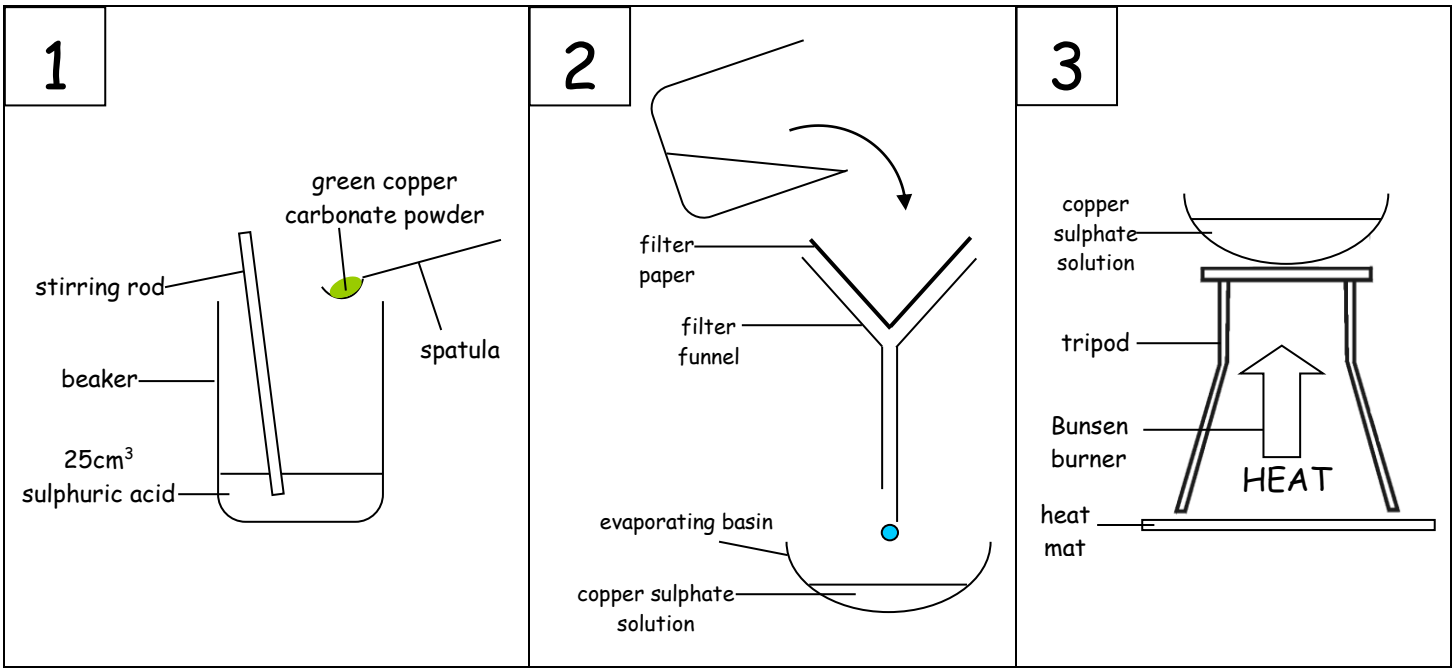
hydrochloric acid	+	calcium carbonate	⟶	calcium choride	+	water	+	carbon dioxide
hydrochloric acid	+	lithium carbonate	⟶	_____	+	water	+	carbon dioxide
nitric acid	+	_____	⟶	sodium nitrate	+	water	+	carbon dioxide
.....	+	_____	⟶	potassium sulphate	+	water	+	carbon dioxide
.....	+	_____	⟶	magnesium choride	+	water	+	carbon dioxide
sulphuric acid	+	copper carbonate	⟶	.....	+	water	+	carbon dioxide

4.14 Making Crystals By Neutralisation

a) **Copy** the following passage into your jotter.

It is possible to make a particular salt that you need by neutralisation and then evaporation. This experiment makes crystals of copper sulphate.

b) Copy the following diagrams into your jotter



c) **Carry out** the following experiment

1. Add small spatula of copper carbonate to sulphuric acid
2. Stir with stirring rod until bubbling stops
3. Add some more copper carbonate and continue to stir until bubbling stops
4. Continue to add copper carbonate until bubbling does not begin when more copper carbonate is added. This is the point of neutralisation, all acid has reacted away
5. Filter off excess copper carbonate leaving blue copper sulphate filtrate to run through into beaker
6. Evaporate off water to leave blue copper sulphate crystals
   (If time is short, leave water to evaporate naturally over a couple of days)

d) **Copy** the following passage into your jotter.

copper carbonate + sulphuric acid → copper sulphate + water + carbon dioxide

(green powder) (blue crystals) (evaporated) (gas given off)

4.15 Acid Rain

a) **Read** p55 – p60 of the Intermediate 1 Chemistry text book

b) **Copy** the following passage into your jotter.

Acid Rain is an environmental problem which can:

- damage buildings made from carbonate rocks (e.g. marble)
- corrode metals structures made of iron and steel (e.g. bridges)
- affect plant life by changing the pH of soil (e.g. less crops grown)
- affect animal life by changing the pH of rivers/lakes (e.g. kills fish)

c) **Copy** the following word equations into your jotter.

carbon + oxygen $\xrightarrow{\text{burning}}$ carbon dioxide

sulphur + oxygen $\xrightarrow{\text{burning}}$ sulphur dioxide

nitrogen + oxygen $\xrightarrow{\text{spark}}$ nitrogen dioxide

} All dissolve in rain water to form acidic solutions

d) **Copy** the following passage into your notes

<u>Reducing Acid Rain</u>

Acid rain could be reduced if the gases that cause acid rain were reduced:

- *Carbon dioxide* is released when fossil fuels like coal, petrol and gas are burned
  - If we burn less fossil fuels, then less carbon dioxide will be released
- *Sulphur dioxide* is released when fossil fuels like coal are burned
  - Use low-sulphur fuels instead of high sulphur fuels
  - Remove sulphur dioxide fumes before release into atmosphere
- *Nitrogen dioxide* is produced in car engines by the sparking of air with petrol to set the petrol on fire.
  Fit catalytic converters to cars to remove nitrogen dioxide fumes from car exhaust fumes.

Revision
4.16

Access 3 Level Revision Questions

- Circle the correct answer

1. An acid could have a pH of:

   3 or **8**

2. Which of these is formed during neutralisation?

   a carbonate or **a salt**

3. When an alkali is neutralised by an acid the pH of the alkali

   goes up or **goes down**

4. Which gas causes acid rain?

   sulphur dioxide or **oxygen**

5. What is the pH of a neutral solution? ……

6. When phosphorus oxide is added to water with universal indicator, the indicator turns red. What does this tell you about phosphorus oxide?
   ……

7. Look at the chart of pH of three substances labelled A, B and C.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
			↑				↑			↑			
			A				B			C			

   (a) Which substance could be vinegar? ……
   (b) Which two could neutralise each other? ……

8. Give an example of how acid rain causes damage to the environment.
   ……
   ……
   ……

Revision 4.17

Intermediate 1 Level Revision Questions

1. Adding an acid to an alkaline solution **increases** / **decreases** the pH.

2. When an acid is added to a metal carbonate the products are a salt, water and **oxygen** / **carbon dioxide**.

3. When sulphur dioxide dissolves in water the solution is **acidic** / **alkaline**.

4. Vinegar is a household **acid** / **alkali**.

5. The pH of a neutral solution is
   A 1
   B 5
   C 7
   D 9

6. Which of these is a laboratory alkali?
   A lemon juice
   B baking soda
   C sodium hydroxide
   D sodium chloride

7. Look at the table of pH of different substances

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	↑			↑			↑				↑			↑
	nitric acid			vinegar			water				ammonia			potassium hydroxide

   (a) Which is more acidic, lemon juice or nitric acid? ……
   (b) Name two which could neutralise each other. ……
   (c) Nitric acid makes salts which are nitrates.
   Name an acid which make salts containing sulphates. ……

8. (a) Name a substance used to test for carbon dioxide. ……
   (b) Name a gas which dissolves in water to make an acid. ……
   (c) Name the type of reaction between an acid and an alkali. ……