



GCSE

3410UA0-1

FRIDAY, 16 JUNE 2023 – MORNING

CHEMISTRY – Unit 1:

**Chemical Substances, Reactions and
Essential Resources
HIGHER TIER**

1 hour 45 minutes plus your additional time allowance

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

ADDITIONAL MATERIALS

In addition to this examination paper you will require a calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Data Booklet.

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in Question 6(a).

The Periodic Table and the formulae for some common ions are printed in the separate Data Booklet.

| For Examiner's use only | | |
|--------------------------------|---------------------|---------------------|
| Question | Maximum Mark | Mark Awarded |
| 1. | 9 | |
| 2. | 11 | |
| 3. | 9 | |
| 4. | 8 | |
| 5. | 5 | |
| 6. | 9 | |
| 7. | 12 | |
| 8. | 9 | |
| 9. | 8 | |
| Total | 80 | |

Answer ALL questions.

- 1 (a) DIAGRAM 1.1 in the separate diagram booklet shows an outline of part of the Periodic Table.**

The letters shown are NOT the chemical symbols of the elements.

Choose LETTERS from the diagram to complete TABLE 1.2 in the separate diagram booklet. [4 marks]

- (b) DIAGRAM 1.3 in the separate diagram booklet shows the electronic structure of an element in the Periodic Table.**

Draw a diagram in the space below to show the electronic structure of the element which lies directly ABOVE it. [1 mark]

1 (c) **TABLE 1.4** in the separate diagram booklet shows information about atoms **X**, **Y** and **Z**.

(i) Complete the table. [3 marks]

(ii) UNDERLINE the term used to describe atoms **Y** and **Z**. [1 mark]

ions inert insoluble isotopes

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2 (a) TABLE 2.1 in the separate diagram booklet shows information about some Group 1 elements.

Use the information in the table to answer parts (i) and (ii).

**(i) State the information which explains why the elements have similar chemical properties.
[1 mark]**

**(ii) State which PROPERTY has a value which does NOT fit the trend down the group.
[1 mark]**

2 (b) The flow diagram in DIAGRAM 2.2 in the separate diagram booklet shows some reactions of sodium.

(i) State how REACTION 1 is prevented when storing sodium in the laboratory. [1 mark]

(ii) Give the names of alkaline solution A and gas B. [2 marks]

and

(iii) Name the Group 1 metal which would react LEAST violently with water. [1 mark]

(iv) Complete the symbol equation for REACTION 3. [1 mark]



(Turn over)

- 2 (c) Sodium fluoride is added to some UK public water supplies to reduce tooth decay in children.

In America sodium hexafluorosilicate, Na_2SiF_6 , is more commonly used. The relative formula mass of sodium hexafluorosilicate is 188.

- (i) Calculate the percentage of fluorine in sodium hexafluorosilicate. [2 marks]

$$A_r(\text{F}) = 19 \quad M_r(\text{Na}_2\text{SiF}_6) = 188$$

Percentage = _____ %

(Turn over)

2 (c)(ii)

State an ETHICAL reason why some people oppose the fluoridation of water supplies. [1 mark]

(iii) Apart from water supplies, state the most commonly used source of fluoride to reduce tooth decay. [1 mark]

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3 (a) DIAGRAMS 3.1 and 3.2 in the separate diagram booklet show two methods used to separate mixtures.

(i) I. Name the changes of state happening in apparatus **A and apparatus **B** when water is separated from salt in Method 1. [2 marks]**

Apparatus **A** _____

Apparatus **B** _____

II. Name this method of separation. [1 mark]

3 (a)(ii)

Explain how an orange dye is separated into a red spot and a yellow spot on the filter paper in Method 2. [2 marks]

3 (b) GRAPH 3.3 in the separate diagram booklet shows the solubility of potassium nitrate at different temperatures.

Use the information in the graph to answer parts (i) and (ii).

(i) 60 g of potassium nitrate was added to 100 g of water at 30 °C. After stirring the mixture some of the potassium nitrate did not dissolve.

Calculate the mass of potassium nitrate which did NOT dissolve. [1 mark]

Mass = _____ g

(Turn over)

3 (b)(ii)

On cooling a saturated solution of potassium nitrate containing 100 g of water from 55 °C to a lower temperature, 36 g of solid was formed.

Determine the temperature to which the solution was cooled.

Show your working. [3 marks]

Temperature = _____ °C

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4 (a) The flow diagram in DIAGRAM 4.1 in the separate diagram booklet shows the reactions necessary to make slaked lime (calcium hydroxide) from a marble chip (calcium carbonate).

(i) In REACTION 1, one compound breaks down when heated to form two products.

Complete the name of this type of reaction.
[1 mark]

thermal _____

(ii) Give TWO observations you would expect to make as REACTION 2 happens. [2 marks]

1 _____

2 _____

(iii) Complete the symbol equation on the opposite page for the reaction between calcium oxide and water in REACTION 2.
[1 mark]

(Turn over)

4 (b)(i)

The relative formula mass of calcium hydroxide is 74.

Calculate the number of moles of calcium hydroxide in 2.96 g. [2 marks]

Number of moles = _____ mol

(ii) Explain why calcium hydroxide is used to treat some soils. [2 marks]

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- 5 Temporary hard water is caused by the presence of dissolved calcium hydrogencarbonate, $\text{Ca}(\text{HCO}_3)_2$.

TABLE 5.1 in the separate diagram booklet shows three different methods of removing temporary hardness from water.

- (a) Complete the symbol equation on the opposite page for the reaction taking place in Method 1. [1 mark]
- (b) UNDERLINE the ratio of calcium ions to sodium ions exchanged in Method 3. [1 mark]

2:1 1:1 1:2 2:2

- (c) Give the number of the method which does NOT form limescale. Give the reason for your answer. [2 marks]

Number _____

Reason _____

(Turn over)

5 (d) Tick (✓) the box next to the name of a compound that causes permanent hardness when dissolved in water. [1 mark]

calcium sulfate

potassium sulfate

magnesium hydrogencarbonate

sodium sulfate

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| 5 |

- 6 (b) Use the information on this page and in GRAPH 6.2 and GRAPH 6.3 in the separate diagram booklet to answer parts (i)–(iii).**

Do Volcanoes Cause Global Warming?

Volcanoes release vast amounts of greenhouse gases, such as carbon dioxide, which contribute to global warming.

GRAPH 6.2 shows the effect of four volcanic eruptions on the mean atmospheric temperature.

Erupting volcanoes also emit large quantities of sulfur dioxide into the atmosphere. Unlike carbon dioxide, sulfur dioxide increases the reflection of radiation from the Sun back into space, which cools the Earth’s atmosphere.

GRAPH 6.3 shows the effect of the same four large volcanic eruptions on the percentage of solar radiation reaching the Earth’s surface. The graph also shows the change in carbon dioxide levels in the atmosphere over the same time period.

6 (b)(i) Tick (✓) the box next to the statement which best describes the effect of volcanic eruptions on the overall level of carbon dioxide in the atmosphere. [1 mark]

No significant impact on the overall level of carbon dioxide

A significant increase in the level of carbon dioxide

A significant decrease in the level of carbon dioxide

(ii) Tick (✓) the box next to the statement which best describes the effect that volcanic eruptions have on the mean atmospheric temperature. [1 mark]

Mean atmospheric temperature decreases

Mean atmospheric temperature increases

No effect on the mean atmospheric temperature

(Turn over)

6 (b)(iii)

Tick (✓) the box next to the statement which best explains the change in solar radiation reaching the Earth's surface after volcanic eruptions. [1 mark]

Solar radiation decreases because it is reflected by sulfur dioxide

Solar radiation increases because it is absorbed by carbon dioxide

Solar radiation increases because it is absorbed by carbon dioxide and sulfur dioxide

Solar radiation decreases because it reacts with sulfur dioxide forming sulfuric acid

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7 Chalk is a form of calcium carbonate, CaCO_3 .

A student carried out an experiment to investigate the rate of reaction between POWDERED chalk and EXCESS dilute hydrochloric acid at 20°C .

The equation on the opposite page shows that chalk reacts with dilute hydrochloric acid forming carbon dioxide gas.

DIAGRAM 7.1 in the separate diagram booklet shows the apparatus used.

(a) State the purpose of the cotton wool. [1 mark]

(b) The student recorded the mass of the flask and contents every 10 seconds for 70 seconds.

Describe what the student must do to calculate the mass of carbon dioxide formed in the first 10 seconds. [1 mark]

(Turn over)

- 7 (c) Look at **GRAPH 7.2** in the separate diagram booklet. Line **A** shows the mass of carbon dioxide formed against time.

A tangent to line **A** has been drawn at 23 s.

Use the tangent and the equation below to calculate the rate of reaction at 23 s.

Show your working. Give your answer to **TWO** significant figures. [3 marks]

$$\text{rate} = \frac{\text{change in mass}}{\text{change in time}}$$

Rate = _____ g/s

7 (d) The student repeated the experiment using the **SAME** mass of chalk powder as the original experiment but a **DIFFERENT CONCENTRATION** of acid. **TABLE 7.3** in the separate diagram booklet shows the mass of carbon dioxide formed.

(i) Plot the results from the table on **GRAPH 7.2** in the separate diagram booklet and draw a suitable line.

Label this line **B**. [3 marks]

(ii) Use particle theory to explain why the rate of this reaction is lower than that in the original experiment. [3 marks]

- 7 (e) Sketch on **GRAPH 7.2** in the separate diagram booklet the curve you would expect if the experiment was repeated using the **ORIGINAL** acid and **TWICE** the mass of chalk. Assume that the acid is still in excess.

Label this line **C**. [1 mark]

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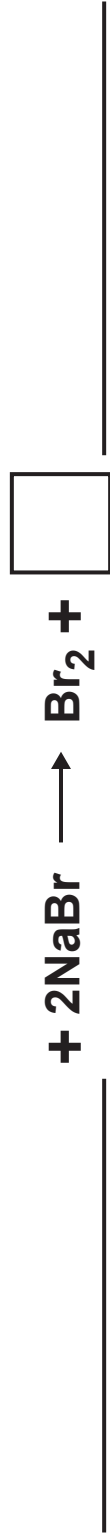
8 (a) TABLE 8.1 in the separate diagram booklet shows information about some Group 7 elements.

(i) State how the radius of the atom changes down Group 7. [1 mark]

(ii) Explain in terms of electronic structure why the reactivity of the elements decreases down Group 7. [2 marks]

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- 8 (b) Sea water contains sodium bromide, which is the raw material for the production of bromine.**

Between 1953 and 2004 bromine, Br₂, was manufactured from sea water at a chemical plant in Amlwch, Anglesey.

Sea water was treated with chlorine, which converts sodium bromide into bromine.

On the opposite page, complete the balanced equation for the reaction between chlorine and sodium bromide. [3 marks]

8 (c) 4.47 g of copper bromide was found to contain 1.27 g of copper.

(i) Calculate the mass of bromine in 4.47 g of the copper bromide. [1 mark]

Mass = _____ g

8 (c)(ii)

Calculate the simplest formula of the copper bromide.

You **MUST** show your working. [2 marks]

$$A_r(\text{Br}) = 80 \quad A_r(\text{Cu}) = 63.5$$

Simplest formula _____

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(Turn over)

- 9 (a) A student tested compounds A, B and C to identify them.**

Her observations are recorded in TABLES 9.1, 9.2 and 9.3 in the separate diagram booklet.

- (i) Use your knowledge of the tests for ions to complete the tables for compounds B and C. [3 marks]**
- (ii) Write the chemical formula for compound A. [1 mark]**
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- 9 (b) When silver nitrate solution reacts with sodium chloride solution to produce a white precipitate the following reaction occurs.



Put a tick (✓) in the box on the opposite page which shows the ionic equation for the formation of the precipitate. [1 mark]

- 9 (c) When silver carbonate is heated it breaks down to give silver metal and carbon dioxide and oxygen gas.



Calculate the mass of silver that would be produced from heating 13.8 g of silver carbonate. [3 marks]

$$M_r(\text{Ag}_2\text{CO}_3) = 276 \quad A_r(\text{Ag}) = 108$$

Mass = _____ g

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END OF PAPER

| Question number | Additional page, if required. Write the question numbers in the left-hand margin. |
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CHEMISTRY – Unit 1:

**Chemical Substances, Reactions and Essential Resources
HIGHER TIER**

1 hour 45 minutes plus your additional time allowance

DIAGRAM BOOKLET

**This Diagram Booklet MUST be handed in to
the invigilators and sent for marking.**

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

DIAGRAM 1.1

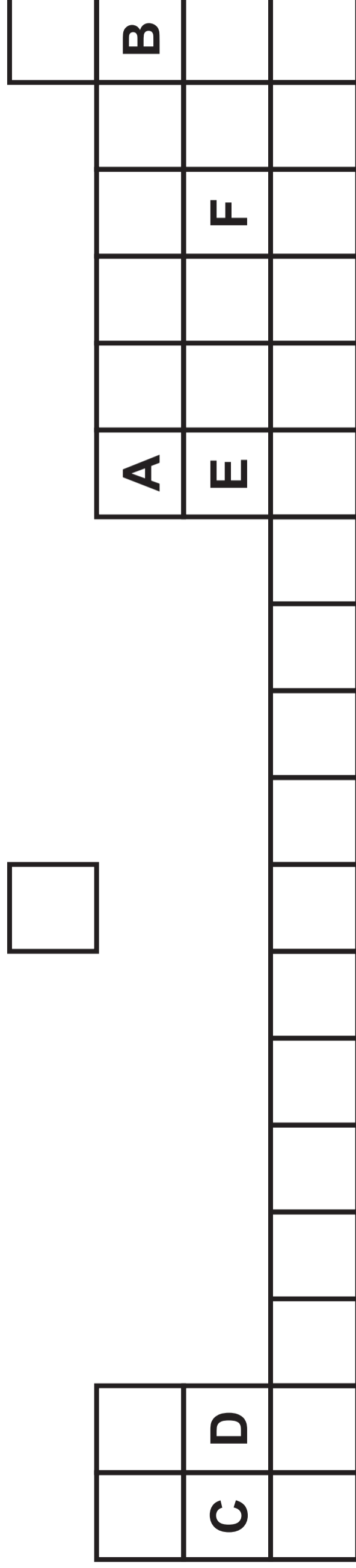


TABLE 1.2

| | Letter |
|---|--------|
| The element in Group 3 and Period 2 | _____ |
| The element which has 10 protons in its nucleus | _____ |
| The element with the electronic structure 2,8,6 | _____ |
| The element which forms a 2+ ion | _____ |

DIAGRAM 1.3

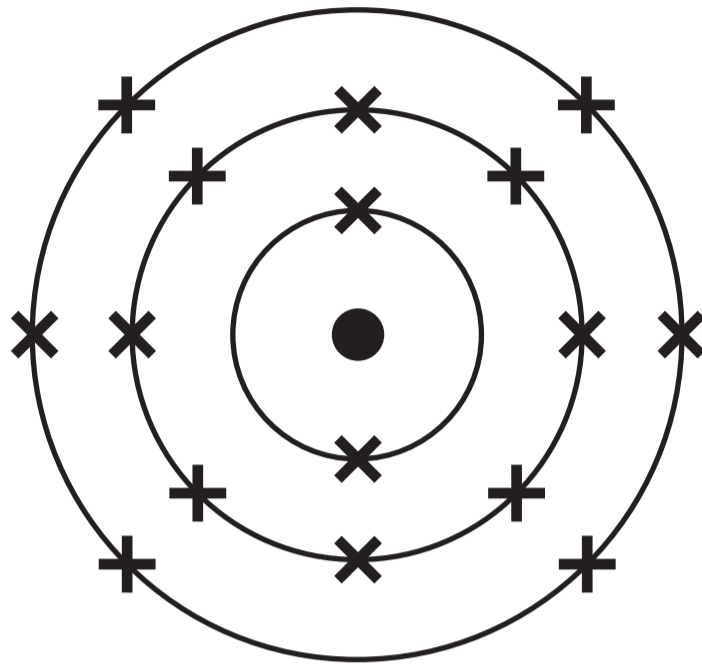


TABLE 1.4

| Atom | Symbol | Number of protons | Number of neutrons | Number of electrons |
|------|----------------------|-------------------|--------------------|---------------------|
| X | $^{31}_{15}\text{X}$ | _____ | 16 | 15 |
| Y | $^{39}_{19}\text{Y}$ | 19 | _____ | 19 |
| Z | $^{40}_{19}\text{Z}$ | 19 | 21 | _____ |

TABLE 2.1

| Element | Relative atomic mass | Number of electrons in the outer shell | Melting point (°C) | Boiling point (°C) | Density (g/cm³) |
|------------------|-----------------------------|---|---------------------------|---------------------------|-----------------------------------|
| lithium | 7 | 1 | 180 | 1342 | 0.53 |
| sodium | 23 | 1 | 98 | 883 | 0.97 |
| potassium | 39 | 1 | 63 | 759 | 0.89 |
| rubidium | 85 | 1 | 39 | 688 | 1.53 |
| caesium | 134 | 1 | 29 | 671 | 1.93 |

DIAGRAM 2.2

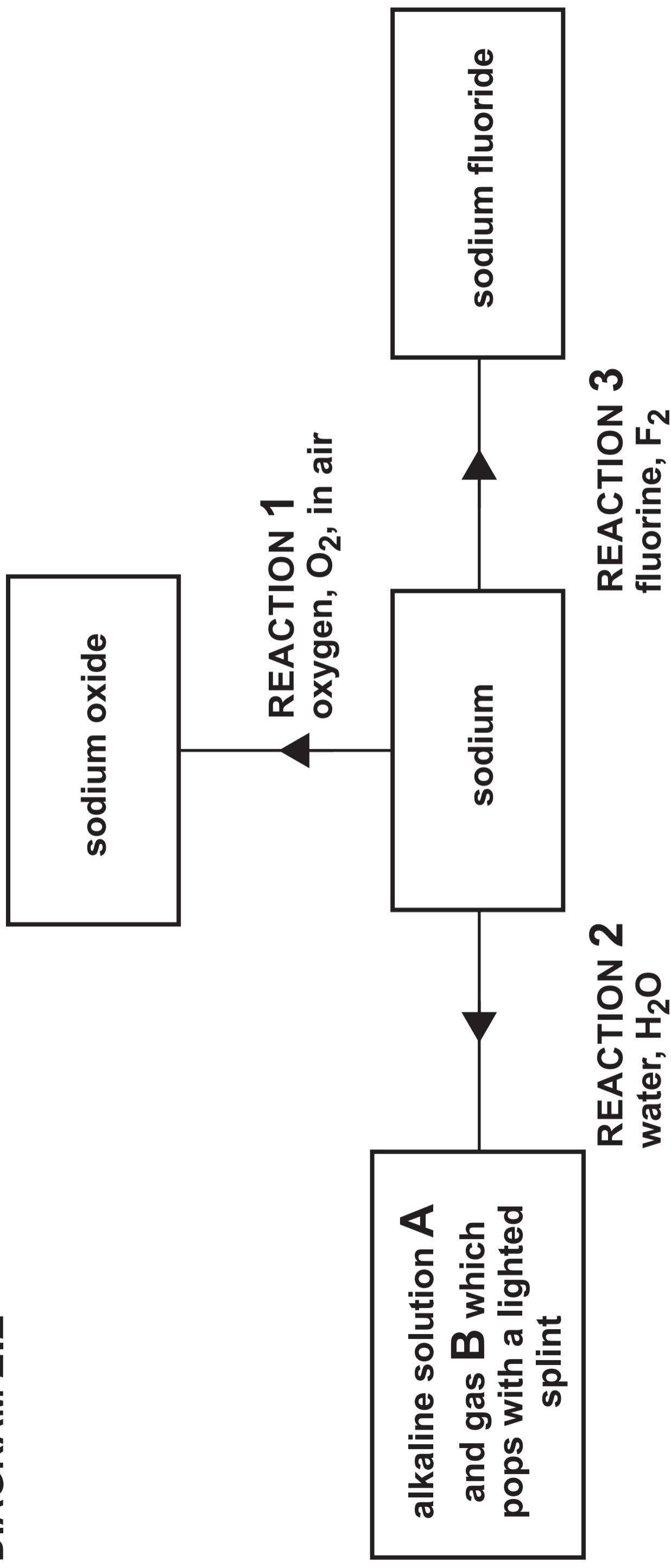
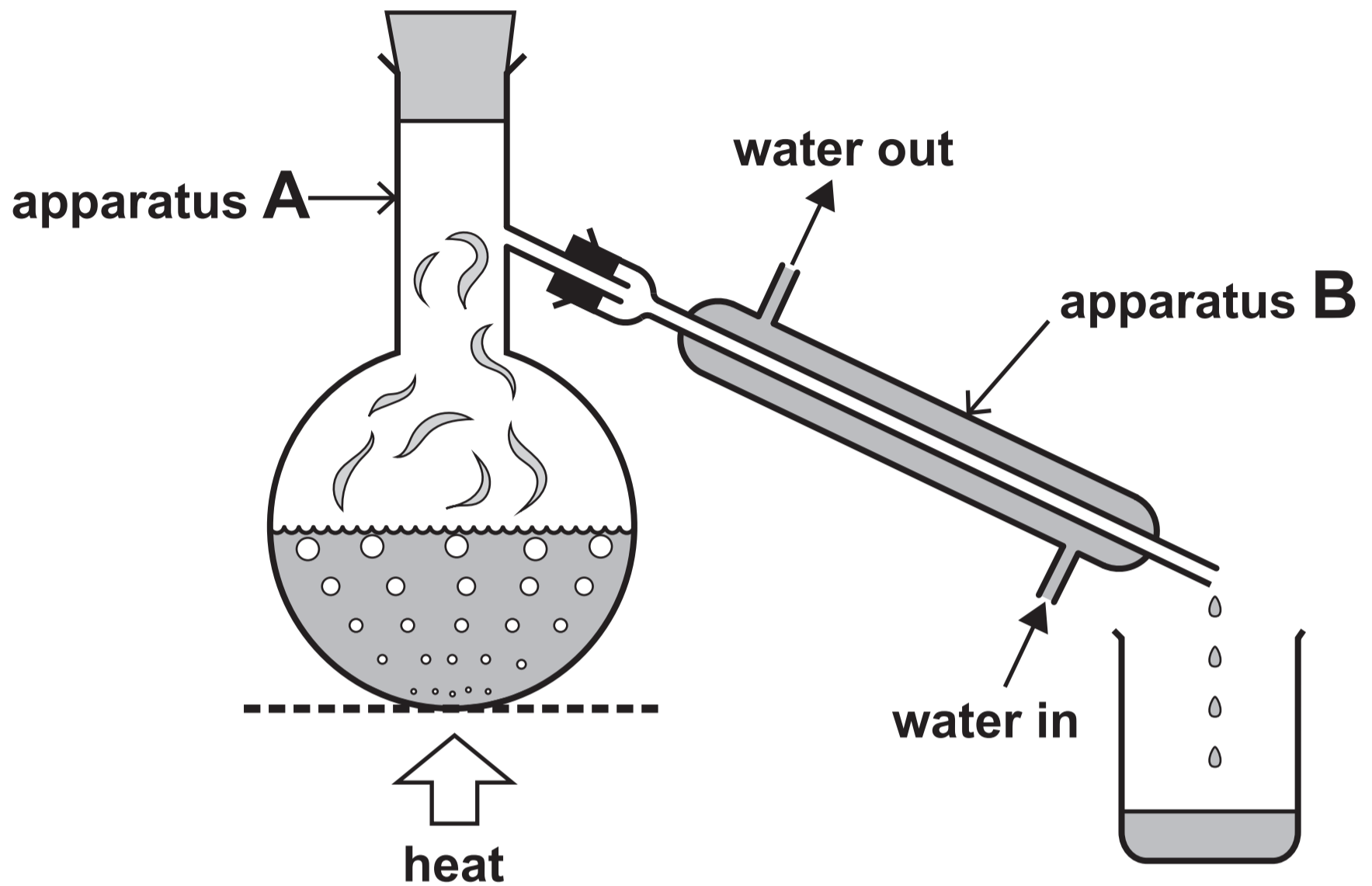
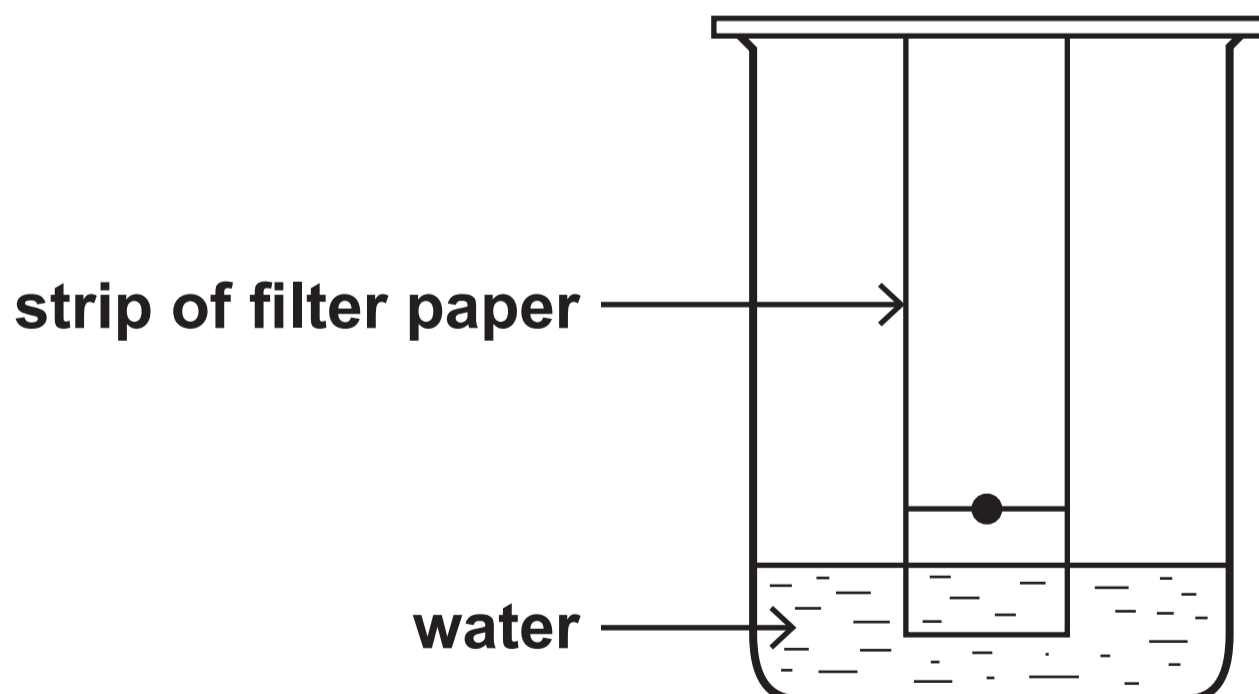


DIAGRAM 3.1 – Method 1**DIAGRAM 3.2 – Method 2**

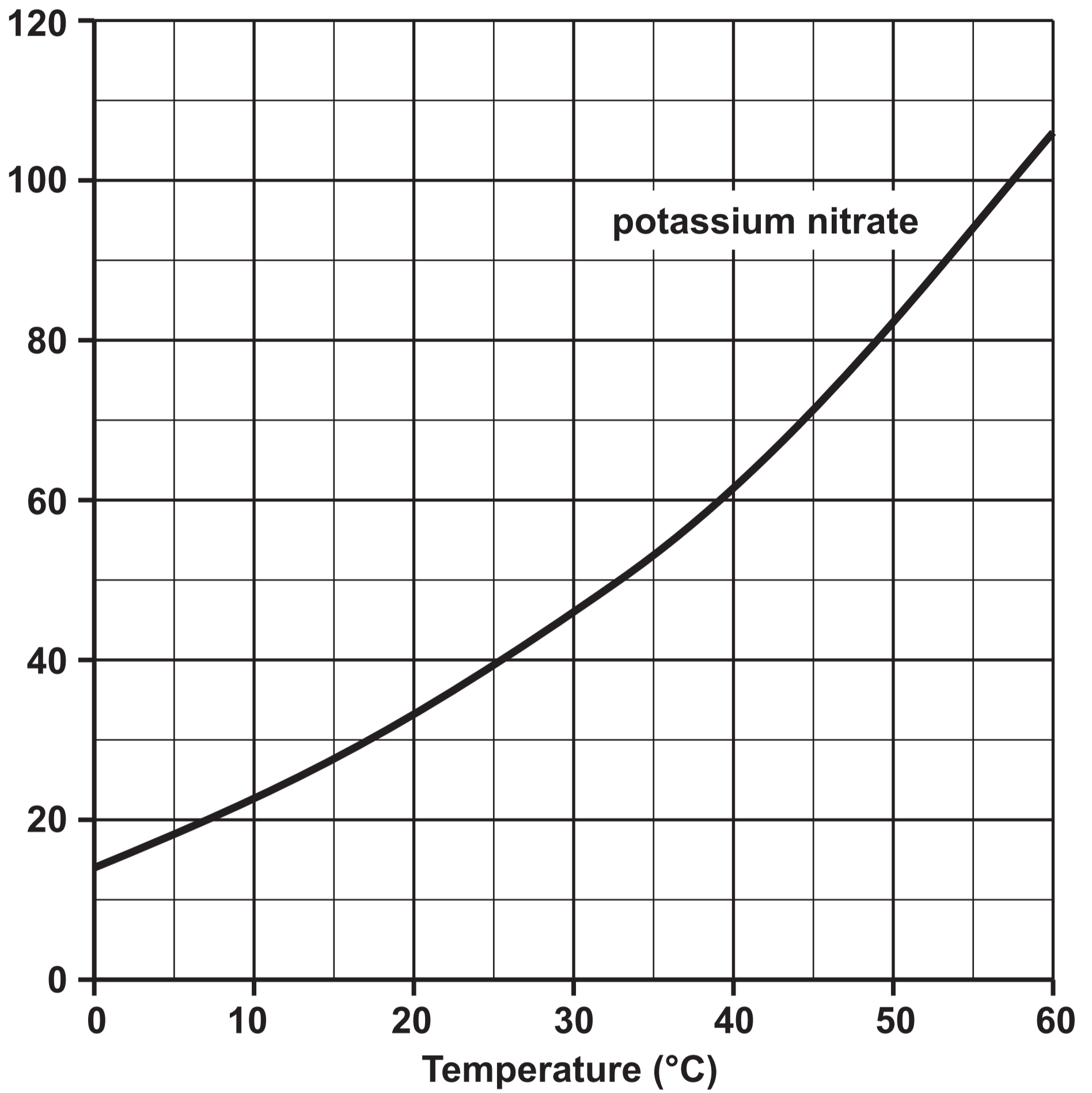
GRAPH 3.3**Solubility (g per 100 g of water)**

DIAGRAM 4.1

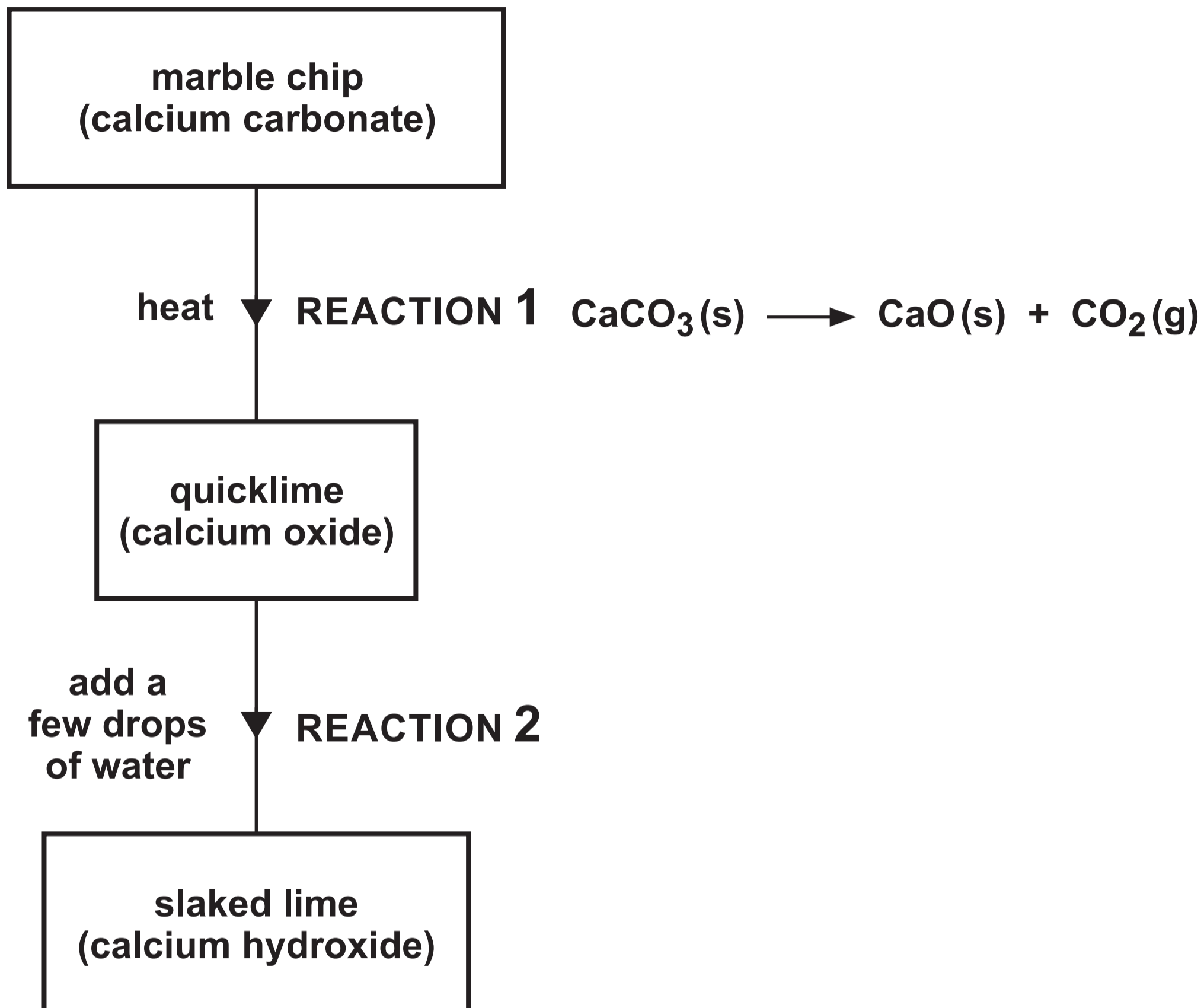


TABLE 5.1

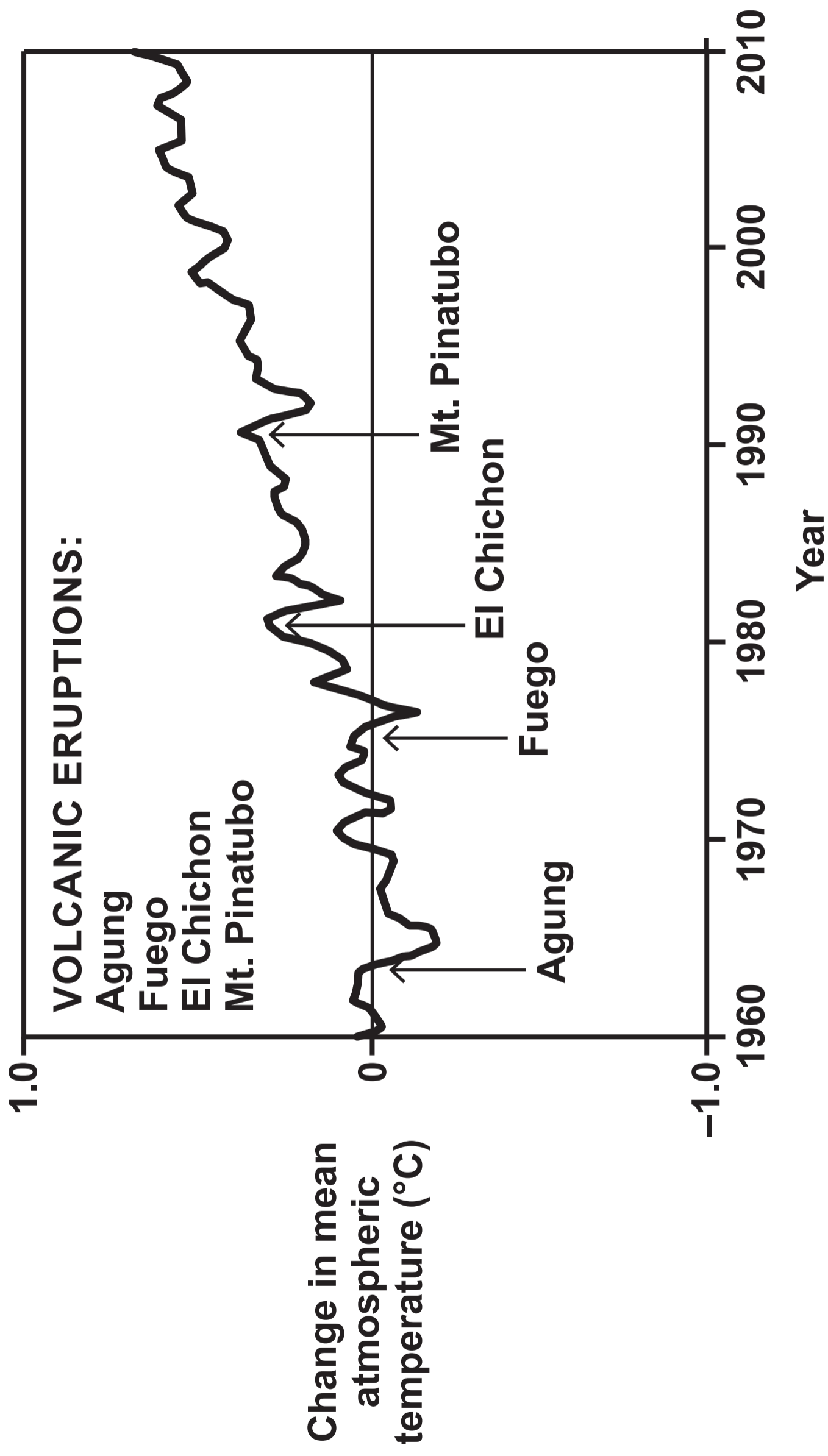
| Method | Product(s) in softened water |
|---|---|
| 1. Adding sodium carbonate | insoluble calcium carbonate dissolved sodium hydrogencarbonate |
| 2. Boiling | insoluble calcium carbonate carbon dioxide |
| 3. Passing through an ion exchange column containing Na⁺ ions | dissolved sodium hydrogencarbonate |

TABLE 6.1

| Gas | Approximate percentage (%) of gases in the Earth's atmosphere | |
|-----------------------|--|------------------------------|
| | ORIGINAL | TODAY |
| carbon dioxide | 75 | 0.04 |
| water vapour | 25 | variable, between 1–2 |
| oxygen | 0 | 21 |

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GRAPH 6.2



GRAPH 6.3

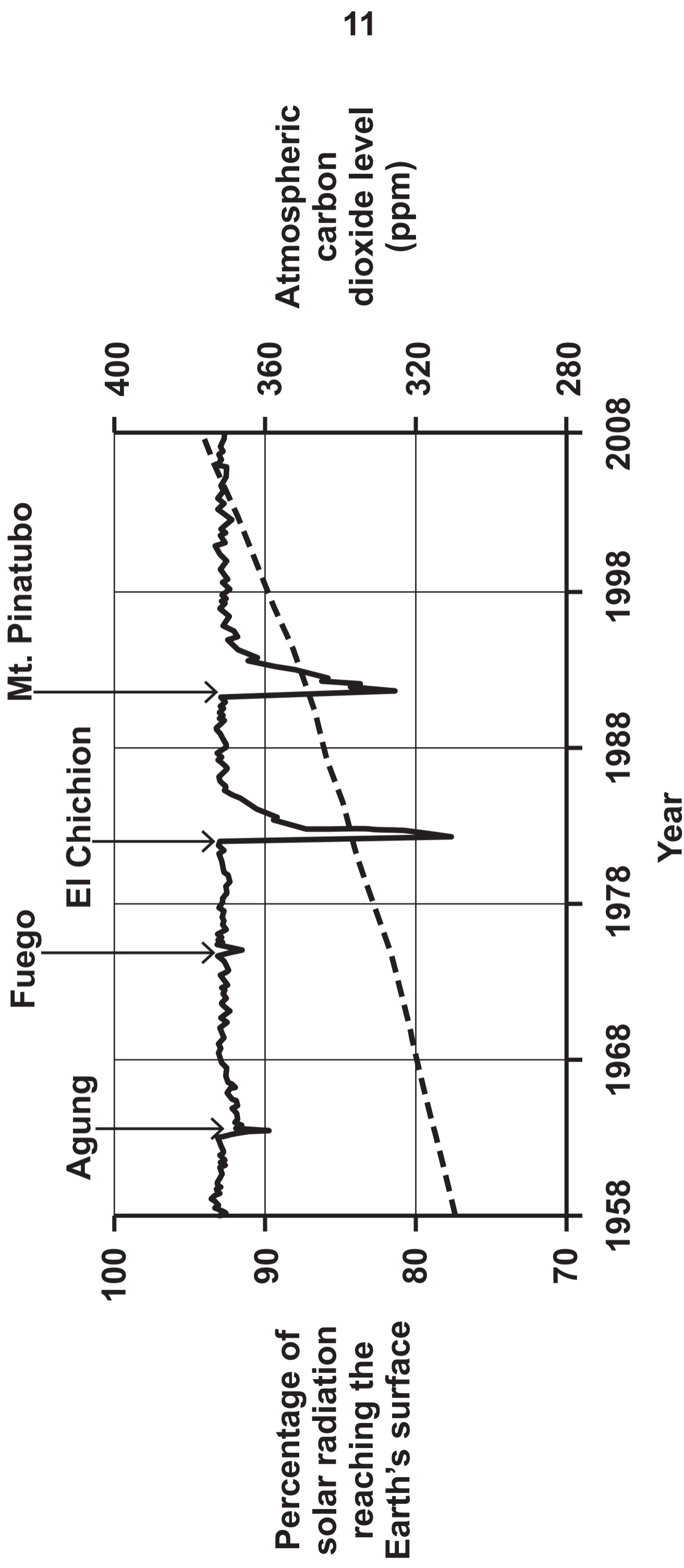
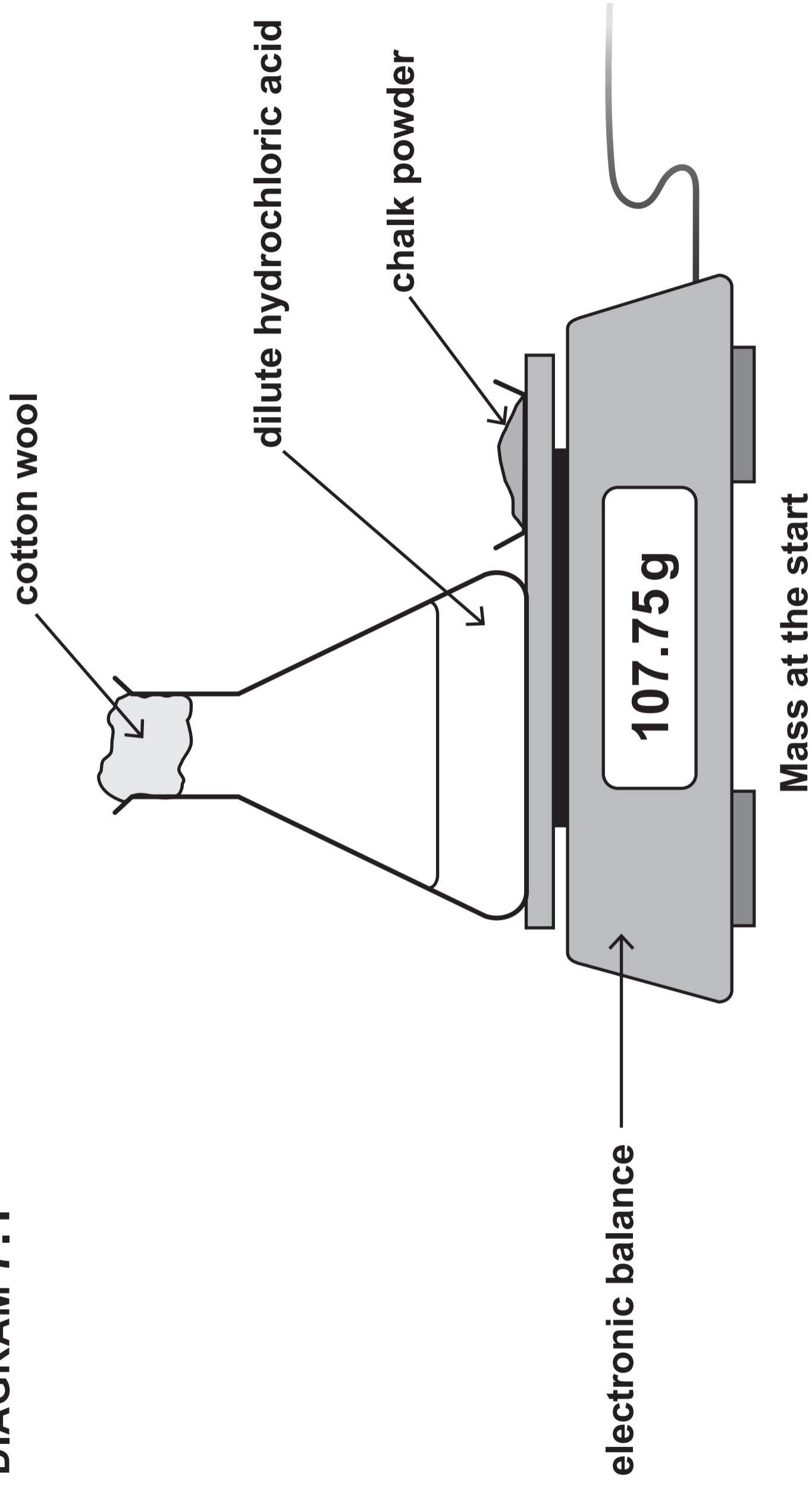


DIAGRAM 7.1



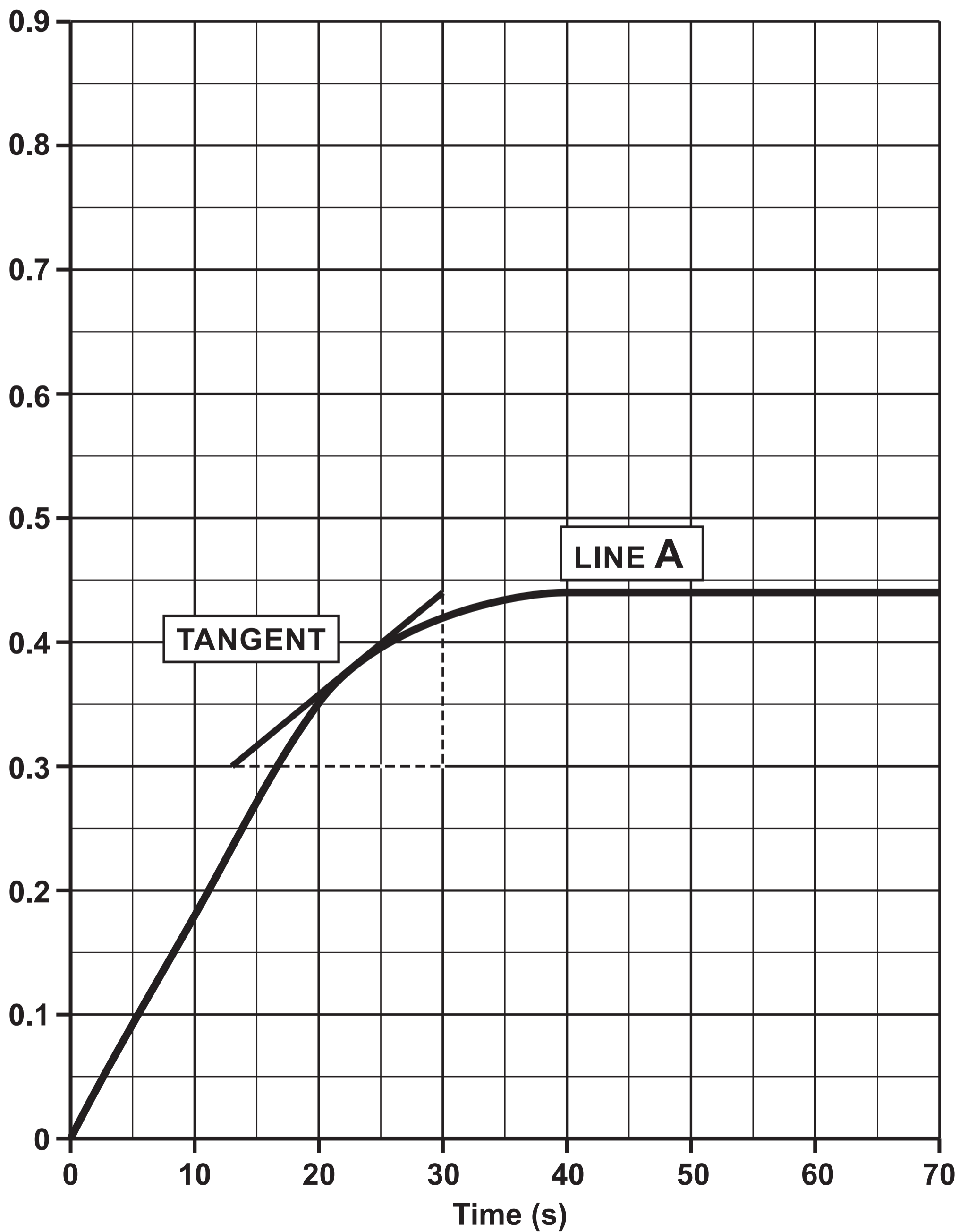
GRAPH 7.2**Mass of carbon dioxide formed (g)**

TABLE 7.3

| Time (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Mass of carbon dioxide formed (g) | 0.00 | 0.11 | 0.20 | 0.28 | 0.35 | 0.40 | 0.43 | 0.44 |

TABLE 8.1

| Element | Radius of the atom (nm) | Number of electrons in outer shell |
|-----------------|------------------------------------|---|
| chlorine | 0.099 | 7 |
| bromine | 0.114 | 7 |
| iodine | 0.133 | 7 |

TABLE 9.1

| Compound A | Observation | Ion present |
|-----------------------------|-------------------|-------------|
| Flame test | apple-green flame | barium |
| Add silver nitrate solution | white precipitate | chloride |

TABLE 9.2

| Compound B | Observation | Ion present |
|-----------------------------|-------------------|-------------|
| Flame test | lilac flame | _____ |
| Add silver nitrate solution | cream precipitate | _____ |

TABLE 9.3

| Compound C | Observation | Ion present |
|-----------------------------|--------------------|-------------|
| Flame test | brick-red flame | _____ |
| Add silver nitrate solution | yellow precipitate | _____ |



GCSE

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FRIDAY, 16 JUNE 2023 – MORNING

CHEMISTRY – Unit 1:

**Chemical Substances, Reactions and Essential Resources
HIGHER TIER**

Data Booklet

FORMULAE FOR SOME COMMON IONS

| POSITIVE IONS | |
|---------------|------------------|
| Name | Formula |
| aluminium | Al^{3+} |
| ammonium | NH_4^+ |
| barium | Ba^{2+} |
| calcium | Ca^{2+} |
| copper(II) | Cu^{2+} |
| hydrogen | H^+ |
| iron(II) | Fe^{2+} |
| iron(III) | Fe^{3+} |
| lithium | Li^+ |
| magnesium | Mg^{2+} |
| nickel | Ni^{2+} |
| potassium | K^+ |
| silver | Ag^+ |
| sodium | Na^+ |
| zinc | Zn^{2+} |

| NEGATIVE IONS | |
|---------------|--------------------|
| Name | Formula |
| bromide | Br^- |
| carbonate | CO_3^{2-} |
| chloride | Cl^- |
| fluoride | F^- |
| hydroxide | OH^- |
| iodide | I^- |
| nitrate | NO_3^- |
| oxide | O^{2-} |
| sulfate | SO_4^{2-} |

THE PERIODIC TABLE

PERIODIC TABLE – KEY ATOMIC NUMBER – SYMBOL – NAME

| | |
|----|----------------|
| 1 | H – Hydrogen |
| 2 | He – Helium |
| 3 | Li – Lithium |
| 4 | Be – Beryllium |
| 5 | B – Boron |
| 6 | C – Carbon |
| 7 | N – Nitrogen |
| 8 | O – Oxygen |
| 9 | F – Fluorine |
| 10 | Ne – Neon |
| 11 | Na – Sodium |
| 12 | Mg – Magnesium |
| 13 | Al – Aluminium |
| 14 | Si – Silicon |
| 15 | P – Phosphorus |
| 16 | S – Sulfur |
| 17 | Cl – Chlorine |
| 18 | Ar – Argon |
| 19 | K – Potassium |
| 20 | Ca – Calcium |
| 21 | Sc – Scandium |
| 22 | Ti – Titanium |
| 23 | V – Vanadium |
| 24 | Cr – Chromium |
| 25 | Mn – Manganese |
| 26 | Fe – Iron |
| 27 | Co – Cobalt |
| 28 | Ni – Nickel |
| 29 | Cu – Copper |
| 30 | Zn – Zinc |
| 31 | Ga – Gallium |
| 32 | Ge – Germanium |
| 33 | As – Arsenic |

| | |
|----|-----------------|
| 34 | Se – Selenium |
| 35 | Br – Bromine |
| 36 | Kr – Krypton |
| 37 | Rb – Rubidium |
| 38 | Sr – Strontium |
| 39 | Y – Yttrium |
| 40 | Zr – Zirconium |
| 41 | Nb – Niobium |
| 42 | Mo – Molybdenum |
| 43 | Tc – Technetium |
| 44 | Ru – Ruthenium |
| 45 | Rh – Rhodium |
| 46 | Pd – Palladium |
| 47 | Ag – Silver |
| 48 | Cd – Cadmium |
| 49 | In – Indium |
| 50 | Sn – Tin |
| 51 | Sb – Antimony |
| 52 | Te – Tellurium |
| 53 | I – Iodine |
| 54 | Xe – Xenon |
| 55 | Cs – Caesium |
| 56 | Ba – Barium |
| 57 | La – Lanthanum |
| 72 | Hf – Hafnium |
| 73 | Ta – Tantalum |
| 74 | W – Tungsten |
| 75 | Re – Rhenium |
| 76 | Os – Osmium |
| 77 | Ir – Iridium |
| 78 | Pt – Platinum |
| 79 | Au – Gold |
| 80 | Hg – Mercury |

| | |
|-----------|----------------------|
| 81 | Tl – Thallium |
| 82 | Pb – Lead |
| 83 | Bi – Bismuth |
| 84 | Po – Polonium |
| 85 | At – Astatine |
| 86 | Rn – Radon |
| 87 | Fr – Francium |
| 88 | Ra – Radium |
| 89 | Ac – Actinium |