

**3410UB0-1**

**MONDAY, 19 MAY 2025 – MORNING**

**CHEMISTRY – Unit 2:**  
**Chemical Bonding, Application of Chemical**  
**Reactions and Organic Chemistry**

**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 need a calculator and a ruler.**

## **ITEMS INCLUDED WITH QUESTION PAPER**

**A separate Diagram Booklet.**

**A separate Data 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.**

**Question 11(a) is a quality of extended response (QER) question where your writing skills will be assessed.**

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

**(Turn over)**

| For Examiner’s use only |              |              |
|-------------------------|--------------|--------------|
| Question                | Maximum Mark | Mark Awarded |
| 1.                      | 6            |              |
| 2.                      | 7            |              |
| 3.                      | 7            |              |
| 4.                      | 10           |              |
| 5.                      | 5            |              |
| 6.                      | 6            |              |
| 7.                      | 9            |              |
| 8.                      | 6            |              |
| 9.                      | 9            |              |
| 10.                     | 5            |              |
| 11.                     | 10           |              |
| Total                   | 80           |              |

**Answer ALL questions.**

**1 (a) Lithium reacts with chlorine to form the ionic compound lithium chloride.**

**(i) DIAGRAM 1.1 in the separate diagram booklet shows the electronic changes that occur when lithium reacts with chlorine to form lithium chloride. The ● and × symbols represent outer shell electrons.**

**COMPLETE DIAGRAM 1.1 by writing the electronic structures of the lithium and chloride ions in the brackets and their charges in the boxes. [2 marks]**

**(Turn over)**



**1 (a)(ii)**

**Give TWO properties of ionic compounds such as lithium chloride.  
[2 marks]**

**Property 1**

---

**Property 2**

---

**(Turn over)**



**1 (b) The • and × symbols in  
DIAGRAM 1.2 in the separate  
diagram booklet represent the  
outer shell electrons in an atom of  
hydrogen and an atom of chlorine.**

**Complete DIAGRAM 1.3 in the  
separate diagram booklet to show  
the electrons in a molecule of  
hydrogen chloride. [2 marks]**

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| <b>6</b> |

**(Turn over)**



**2 (a) DIAGRAM 2 in the separate diagram booklet shows a cell used in the electrolysis of aluminium oxide.**

**The following equation represents the overall reaction.**



**(i) Give the SYMBOL of the ION attracted to the positive electrode.  
[1 mark]**

---

**(Turn over)**



**2 (a)(ii)**

**Oxygen is formed at the carbon anode. At the high temperature of the cell, the carbon anode burns.**

**Name the gas formed when the carbon anode burns in oxygen.  
[1 mark]**

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**(Turn over)**



2 (a)(iii)

During the process each aluminium ion,  $\text{Al}^{3+}$ , gains three electrons forming an aluminium atom at the cathode.

Tick (✓) the box next to the electrode equation for the process at the cathode. [1 mark]

☐☐☐☐

(Turn over)



**2 (a)(iv)**

**Aluminium is a good electrical conductor. It is used to make over-head power cables.**

**Give ONE other property of aluminium that makes it a suitable material for this use. [1 mark]**

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**(Turn over)**



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☐

**near a port to import bauxite**

☐

**nearby limestone quarries**

☐

**near a direct supply of electricity**

☐

**near a port to export bauxite**

☐

**nearby recycling centre**

☐

**nearby bauxite deposit**

**2 (b) The ore most commonly used for the extraction process is bauxite, which contains a lot of impurities.**

**The UK has no bauxite deposits meaning it must be imported from other countries, including Australia and Guinea. Bauxite is processed forming aluminium oxide to be used in the electrolysis process.**

**Tick (✓) the box next to TWO statements on the opposite page that describe the requirements for the siting of an aluminium extraction plant in the UK. [2 marks]**

**(Turn over)**



**2 (c) Aluminium reacts with chlorine to form aluminium chloride.**

**Complete the balancing of the symbol equation for this reaction.  
[1 mark]**



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**(Turn over)**



**3 (a) Sulfuric acid is produced by the contact process.**

**DIAGRAM 3.1 in the separate diagram booklet shows the main stages in the process.**

**(i) Name the TWO raw materials used in stage 1. [2 marks]**

**Solid raw material A**

---

**Gaseous raw material B**

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**(Turn over)**



**3 (a)(ii)**

**Name the catalyst used in stage 2.  
[1 mark]**

---

**(iii) Use the symbol equation below for the reaction in stage 2 to complete DIAGRAM 3.2 in the separate diagram booklet. [2 marks]**



**(iv) In stage 4, one molecule of oleum,  $\text{H}_2\text{S}_2\text{O}_7$ , reacts with one molecule of water to form sulfuric acid.**

**In DIAGRAM 3.3 in the separate diagram booklet, tick (✓) the box next to the product that correctly balances the equation for this reaction. [1 mark]**

**(Turn over)**



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**TURN OVER**

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**carbon, hydrogen and oxygen  
react to make sugar**

☐

**sugar turns black and  
expands up the beaker**

☐

**the reaction is exothermic**

☐

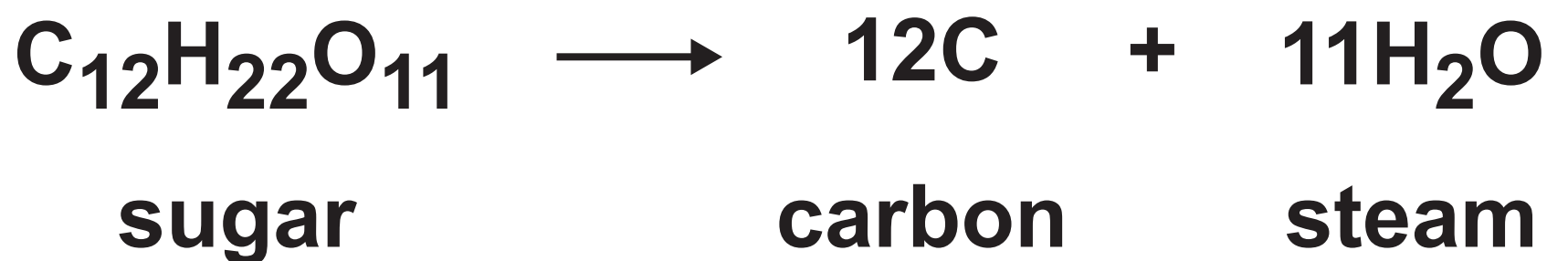
**the elements hydrogen and oxygen  
are removed from the sugar**

☐

**sugar splits up into carbon,  
hydrogen and oxygen**

**3 (b) IMAGE 3.4 in the separate diagram booklet shows concentrated sulfuric acid acting as a dehydrating agent in its reaction with sugar.**

**The equation represents the reaction.**



**Tick (✓) the box next to the statement on the opposite page that explains why this is a dehydration reaction. [1 mark]**

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**(Turn over)**



**4 (a)(i)**

**Look at DIAGRAM 4.1 in the separate diagram booklet.**

**Equations A-E represent reactions that take place in the blast furnace.**

**Choose the letter, A-E, of the equation that matches each of the descriptions in TABLE 4.2 in the separate diagram booklet. [4 marks]**

**(Turn over)**



**4 (a)(ii)**

**The equation below shows another reaction that takes place in the blast furnace.**



**Use the equation to explain the meaning of the term reduction.  
[2 marks]**

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**(Turn over)**



**4 (b) TABLE 4.3 in the separate diagram booklet shows the colours of three metal nitrate solutions.**

**The list below shows iron, copper and silver in their relative positions in the reactivity series.**

|                       |               |
|-----------------------|---------------|
| <b>Most reactive</b>  | <b>iron</b>   |
|                       | <b>copper</b> |
| <b>Least reactive</b> | <b>silver</b> |

**A student carried out a series of experiments. She added excess silver, copper and iron to solutions of silver nitrate, copper(II) nitrate and iron(II) nitrate.**

**TABLE 4.4 in the separate diagram booklet shows some of her observations. Two observations are missing.**

**(Turn over)**



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**TURN OVER**



**4 (b)(i)**

**Use the information in TABLE 4.3 and the relative positions of the metals in the reactivity series.**

**COMPLETE TABLE 4.4 by putting in the missing observations. [2 marks]**

**(ii) Copper reacts with silver nitrate solution forming silver and copper(II) nitrate solution.**

**Complete and balance the symbol equation for the reaction on the opposite page. [2 marks]**

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**(Turn over)**



**5 (a) The range of colours in fireworks are formed by heating metals and their compounds.**

**TABLE 5.1 in the separate diagram booklet shows a list of substances which are commonly used in fireworks.**

**Some fireworks are restricted by law and these are only used in official public displays.**

**Fireworks generate energy in the form of sound, light and heat.**

**Different metal compounds release different amounts of light energy when fireworks are ignited. The amount of energy released determines the wavelength of light seen, as shown in DIAGRAM 5.2 in the separate diagram booklet.**

**continued on the next page**

**(Turn over)**



**5 (a) continued**

**Elements can also be added to create special effects as in TABLE 5.3 in the separate diagram booklet.**

**(i) Tick (✓) the box next to the correct statement. [1 mark]**

☐

**shorter wavelengths of light are given off by blue and violet fireworks**

☐

**shorter wavelengths of light are given off by red and orange fireworks**

☐

**longer wavelengths of light are given off by blue and violet fireworks**

☐

**longer wavelengths of light are given off by green and yellow fireworks**

**(Turn over)**



**5 (a)(ii)**

**The amount of energy released, which varies from metal to metal, is related to the wavelength of the light.**

**Tick (✓) the box next to the statement which best describes the relationship between energy and wavelength. [1 mark]**

☐

**as the energy increases  
the wavelength increases**

☐

**as the energy decreases  
the wavelength increases**

☐

**the wavelength changes  
with changes in energy**

☐

**as the energy decreases  
the wavelength decreases**

**(Turn over)**



**5 (a)(iii)**

**Tick (✓) the box next to the mixture you would choose to make a sparkly, smoky orange firework. [1 mark]**

☐

**iron, zinc and  
calcium chloride**

☐

**aluminium, magnesium and  
strontium carbonate**

☐

**barium chloride, phosphorus  
and calcium chloride**

☐

**iron, magnesium and zinc**

**(Turn over)**



**5 (b) DIAGRAM 5.4 in the separate diagram booklet shows the reactions between sodium hydroxide solution and two different chlorides of iron.**

**(i) Give the colour of precipitate A.  
[1 mark]**

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**(ii) Give the chemical formula of the green precipitate. [1 mark]**

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| <b>5</b> |

**(Turn over)**



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**the mass of BOTH cathodes increases**

☐

**$\text{Cu}^{2+}$  ions enter the solution at BOTH anodes**

☐

**$\text{Cu}^{2+}$  ions gain electrons at BOTH cathodes**

☐

**the blue colour of copper(II) sulfate solution turns paler in BOTH beakers as  $\text{Cu}^{2+}$  ions are removed**

☐

**the blue colour of copper(II) sulfate solution remains the same in both beakers**

**6 (a) DIAGRAM 6.1 in the separate diagram booklet shows the apparatus used in two experiments.**

**The electrolyte in both experiments is copper(II) sulfate solution.**

**Experiment A uses graphite electrodes and experiment B uses copper electrodes.**

**Tick (✓) the box next to TWO statements on the opposite page that describe what happens during the experiments. [2 marks]**

**(Turn over)**



**6 (b) DIAGRAM 6.2 in the separate diagram booklet shows apparatus that can be used to show the electrolysis of sodium chloride solution.**

**The solution with the indicator is green before the electrolysis starts.**

**(i) Complete the electrode equation for the reaction at the cathode. [1 mark]**



**(Turn over)**



**6(b)(ii)**

**Explain the meaning of the term oxidation in relation to the formation of chlorine at the anode. [2 marks]**

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**(Turn over)**



**6 (b)(iii)**

**During the electrolysis process the colour of the universal indicator turns from green to purple.**

**Choose the letter, A, B or C, next to the statement that explains this colour change. [1 mark]**

- A**     **$\text{Na}^+$  and  $\text{Cl}^-$  ions remain in the electrolyte keeping the electrolyte neutral**
- B**     **$\text{Na}^+$  and  $\text{OH}^-$  ions remain in the electrolyte turning the solution alkaline**
- C**     **$\text{H}^+$  and  $\text{Cl}^-$  ions remain in the electrolyte turning the solution acidic**

**Letter** \_\_\_\_\_

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| <b>6</b> |

**(Turn over)**



**7 (a) Methanol, ethanol, propanol and butanol belong to the alcohol family as shown in TABLE 7.1 in the separate diagram booklet.**

**(i) Give the general formula for the alcohol family of compounds.  
[1 mark]**

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**(Turn over)**



**7 (a)(ii)**

**Alcohols give out heat energy when they are burned.**

**TABLE 7.2 in the separate diagram booklet shows values for the energy given out when 1.0 g of each alcohol is burned.**

- I. In GRAPH 7.3 in the separate diagram booklet, plot the energy given out against the number of carbon atoms in each alcohol. Draw a suitable curve.**

**One point has been plotted for you.  
[3 marks]**

**(Turn over)**



**7 (a)(ii)**

**II. The molecular formula of pentanol is  $\text{C}_5\text{H}_{11}\text{OH}$ .**

**Use GRAPH 7.3 to predict the energy given out when 1.0 g of pentanol is burned. Show clearly how you got this answer. [1 mark]**

**Energy given out = \_\_\_\_\_ kJ**

**(Turn over)**



**7 (b) A group of students was asked to find the experimental values for the energy given out when alcohols burn.**

**Four students each burned 1.0 g of an alcohol and recorded the temperature rise of 200 g of water.**

**DIAGRAM 7.4 in the separate diagram booklet shows the apparatus used by each of the students.**

**They used their results to calculate the energy given out for each alcohol.**

**All the students' experimental values are LOWER than expected.**

**continued on the next page**

**(Turn over)**



**7 (b) continued**

**State ONE improvement to the apparatus that would give results closer to the expected values. Give a reason for your answer. [2 marks]**

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**(Turn over)**



**7 (c)(i)**

**DIAGRAM 7.5** in the separate diagram booklet shows the structures of four isomers with the formula  $\text{C}_4\text{H}_9\text{OH}$ .

**Give the LETTER of 2-methylpropan-2-ol. [1 mark]**

**Letter** \_\_\_\_\_

**(ii) DIAGRAM 7.6** in the separate diagram booklet shows the structure of one isomer with the formula  $\text{C}_3\text{H}_7\text{OH}$ .

**Name this isomer. [1 mark]**

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**8**      **DIAGRAM 8** in the separate diagram booklet shows the observations recorded by a student when different substances were added to dilute ethanoic acid,  $\text{CH}_3\text{COOH}$ .

**(a)**    The formula of the salt formed when magnesium reacts with ethanoic acid is  $\text{Mg}(\text{CH}_3\text{COO})_2$ .

**UNDERLINE** the name of this salt.  
[1 mark]

**magnesium  
ethoxide**

**magnesium  
ethane**

**magnesium  
hydrogencarbonate**

**magnesium  
ethanoate**

**(Turn over)**



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**8 (b) Complete the symbol equation for the reaction between sodium hydroxide and ethanoic acid on the opposite page. [2 marks]**

**(c) Name the metal compound *X* in DIAGRAM 8. [1 mark]**

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**8 (d) Universal indicator turns orange in dilute ethanoic acid showing that it has a pH of 3.**

**Predict how the observation would be different if universal indicator were added to dilute hydrochloric acid rather than dilute ethanoic acid. Give your reasoning. [2 marks]**

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| <b>6</b> |

**(Turn over)**



**9 (a) Propene undergoes addition polymerisation forming polypropene.**

**(i) Complete and balance the equation for this reaction in DIAGRAM 9.1 in the separate diagram booklet. [2 marks]**

**(ii) Use the reaction in part (i) to explain the meaning of addition polymerisation. [2 marks]**

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**(Turn over)**



**9 (b) DIAGRAM 9.2 in the separate diagram booklet is an equation that shows the bonds which are broken and the bonds which are formed during the combustion of methane.**

- (i) The bond energy of an  $\text{O}=\text{O}$  bond is 498 kJ. The energy needed to break all the bonds in the reactants is 2648 kJ.**

**Calculate the energy needed to break ONE  $\text{C}-\text{H}$  bond. [2 marks]**

**Energy = \_\_\_\_\_ kJ**

**(Turn over)**



9 (b)(ii)

The bond energy of an O—H bond is 464 kJ. The total energy released when the bonds in the products are formed is 3466 kJ.

Calculate the energy released when making ONE C=O bond. [2 marks]

Energy = \_\_\_\_\_ kJ

(Turn over)



**9 (b)(iii)**

**Use information given in parts (i) and (ii) to find the value of  $X$  in the energy level diagram in DIAGRAM 9.3 in the separate diagram booklet. [1 mark]**

**$X =$  \_\_\_\_\_ **kJ****

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| <b>9</b> |

**(Turn over)**



- 10 Sodium hydrogencarbonate, also known as sodium bicarbonate, belongs to the group of medicines called antacids. Antacids relieve heartburn or acid indigestion by neutralising excess stomach acid.**

**The recommended adult dose is 1-5 g in a 200 cm<sup>3</sup> glass of water.**

**A student made up a dose of sodium hydrogencarbonate solution by adding one heaped teaspoon of powder to 200 cm<sup>3</sup> of water.**

**To determine the concentration of the sodium hydrogencarbonate solution, 20.0 cm<sup>3</sup> of the solution was titrated with dilute hydrochloric acid of concentration 0.40 mol/dm<sup>3</sup>. The endpoint was determined using an indicator.**

**continued on the next page**

**(Turn over)**



**10 continued**

**The procedure was repeated three times and the mean volume of dilute hydrochloric acid solution needed to neutralise  $20.0\text{ cm}^3$  of the sodium hydrogencarbonate solution was found to be  $12.5\text{ cm}^3$ .**

- (a) Use the equation below to calculate the number of moles of hydrochloric acid in  $12.5\text{ cm}^3$  of the  $0.40\text{ mol/dm}^3$  solution. [2 marks]**

$$\text{concentration (mol/dm}^3\text{)} = \frac{\text{number of moles}}{\text{volume (dm}^3\text{)}}$$

**Number of moles = \_\_\_\_\_ mol**

**(Turn over)**



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10 (b)

Sodium hydrogencarbonate reacts with hydrochloric acid according to the equation on the opposite page.

The equation shows that 1 mol of hydrochloric acid neutralises 1 mol of sodium hydrogencarbonate.

Calculate the mass of sodium hydrogencarbonate in 20.0 cm<sup>3</sup> of the solution. [2 marks]

$$M_r(\text{NaHCO}_3) = 84$$

Mass = \_\_\_\_\_ g

(Turn over)



**10 (c)**

**Did the student use a mass of sodium hydrogencarbonate within the recommended dose?**

**Give your reasoning. [1 mark]**

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| <b>5</b> |

**(Turn over)**



**11 (a)**

**TABLE 11.1 in the separate diagram booklet shows information about the manufacture of ammonia by the Haber process.**

**Explain why these conditions are used.**

**Your answer should include reference to the yield and the rate of the reaction. [6 marks QER]**

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**continue answer on the next page**

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11 (b)

**TABLE 11.2** in the separate diagram booklet shows the results obtained when tests were carried out on fertilisers **A** and **B**.

- (i) Name the pungent smelling gas that turns red litmus paper blue. [1 mark]
- 

**(Turn over)**



11 (b)(ii)

Use the information given to identify fertilisers **A** and **B**. [2 marks]

**A**

---

**B**

---

(iii) Phosphoric acid is used in the manufacture of some fertilisers.

Balance the equation for the production of phosphoric acid.  
[1 mark]



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**END OF PAPER**



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**GCSE**

**3410UB0-1**

**MONDAY, 19 MAY 2025 – MORNING**

## **CHEMISTRY – Unit 2:**

**Chemical Bonding, Application of Chemical Reactions and Organic Chemistry**

**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

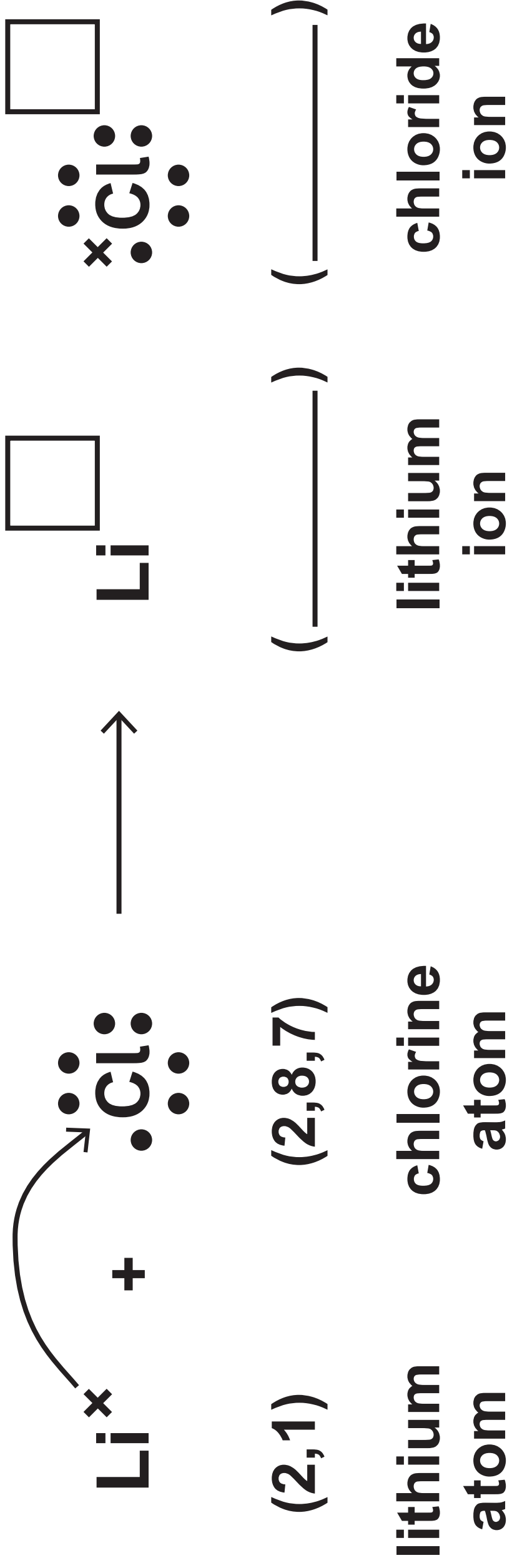
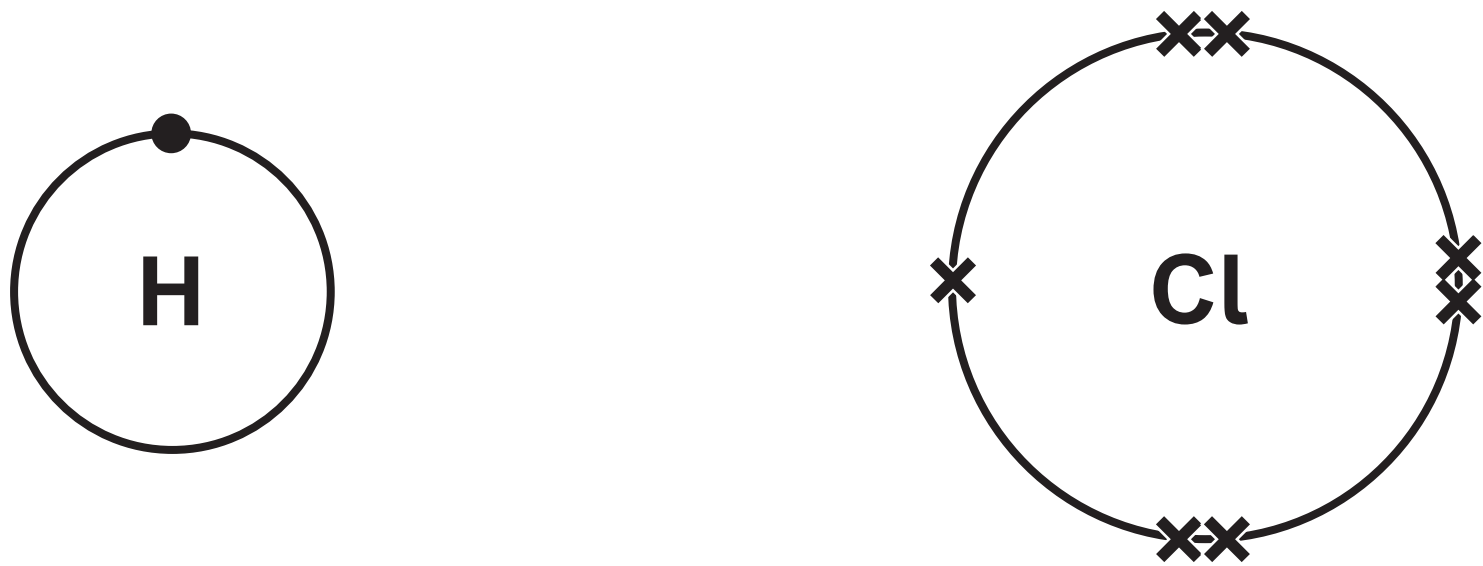
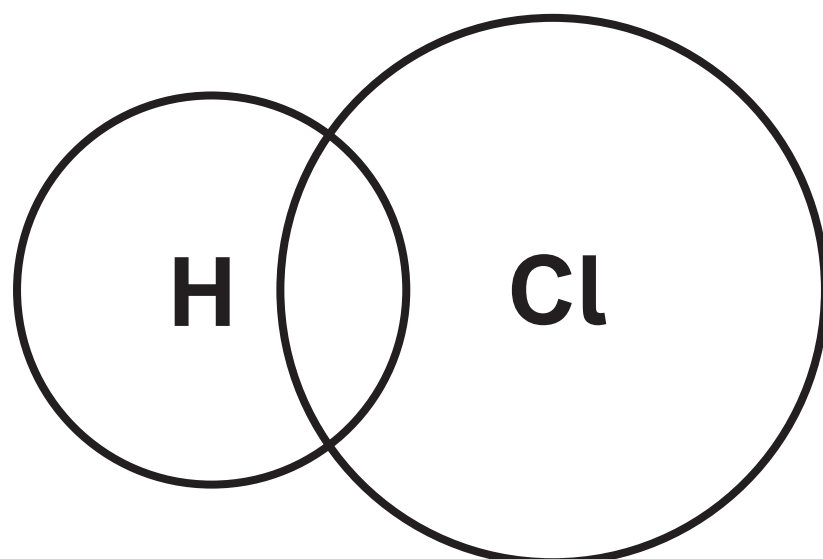


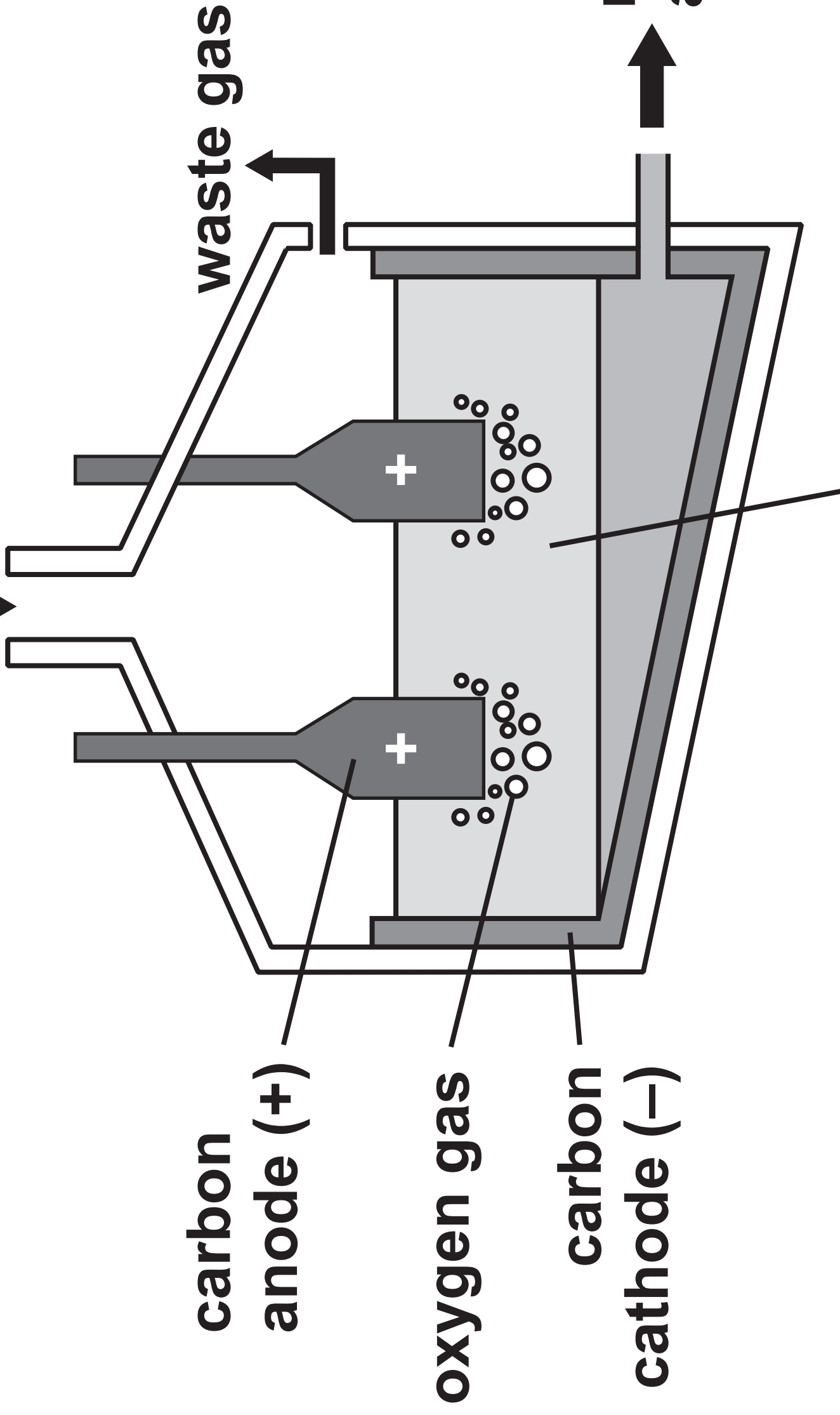


**DIAGRAM 1.2****DIAGRAM 1.3**



# DIAGRAM 2

aluminium oxide





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# DIAGRAM 3.1

Stage 1

Solid raw material  
A burns in gaseous raw material B to form sulfur dioxide,  $\text{SO}_2$

Stage 2

$\text{SO}_2$  reacts with oxygen in the presence of a catalyst forming sulfur trioxide,  $\text{SO}_3$

$$2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$$

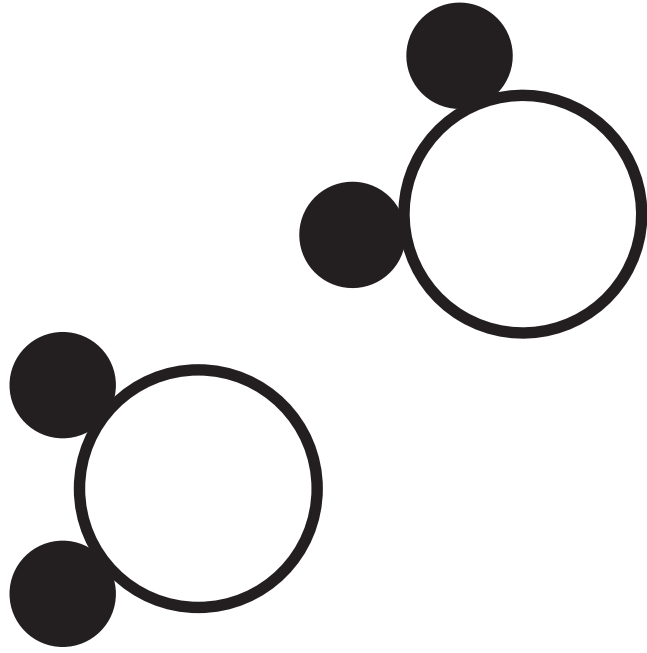
Stage 3

$\text{SO}_3$  dissolves in concentrated sulfuric acid forming oleum,  $\text{H}_2\text{S}_2\text{O}_7$

Stage 4

$\text{H}_2\text{S}_2\text{O}_7$  reacts with a small amount of water forming sulfuric acid

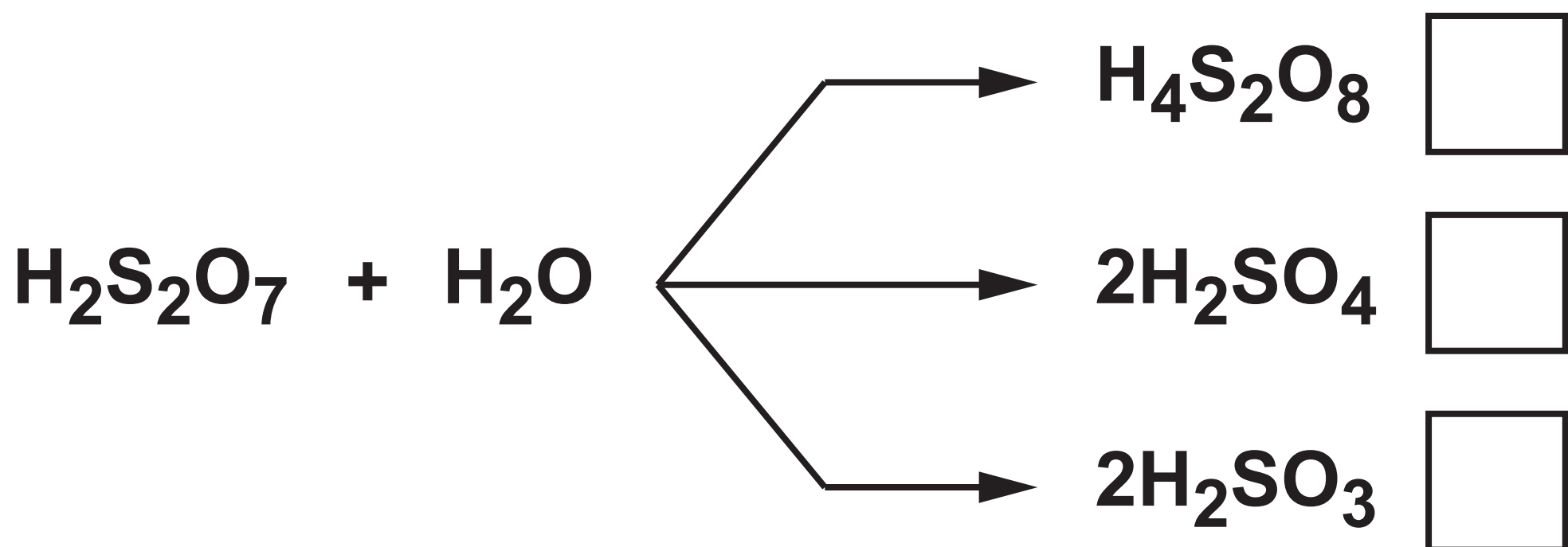
# DIAGRAM 3.2



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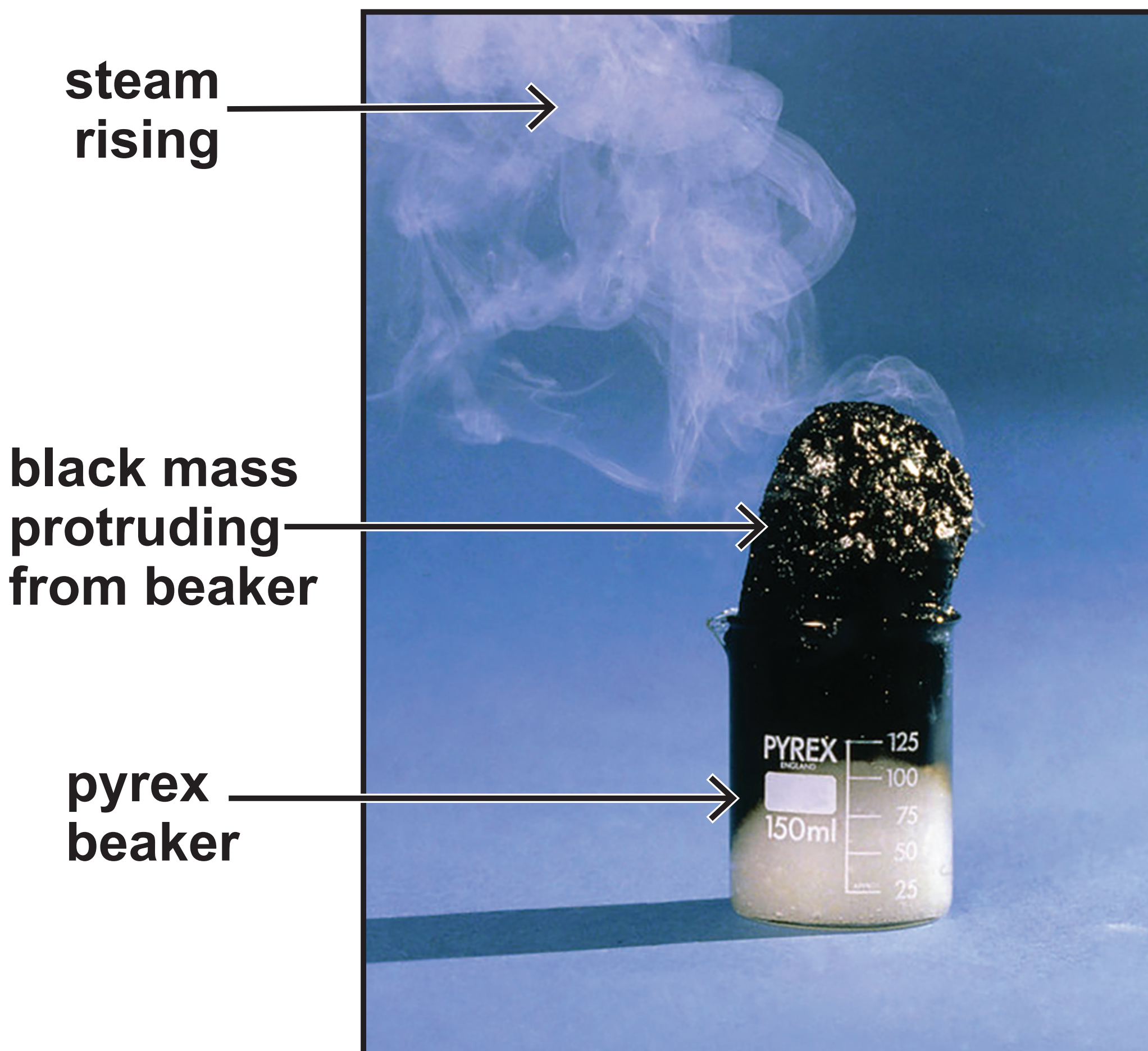




**DIAGRAM 3.3**



## IMAGE 3.4





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## DIAGRAM 4.1

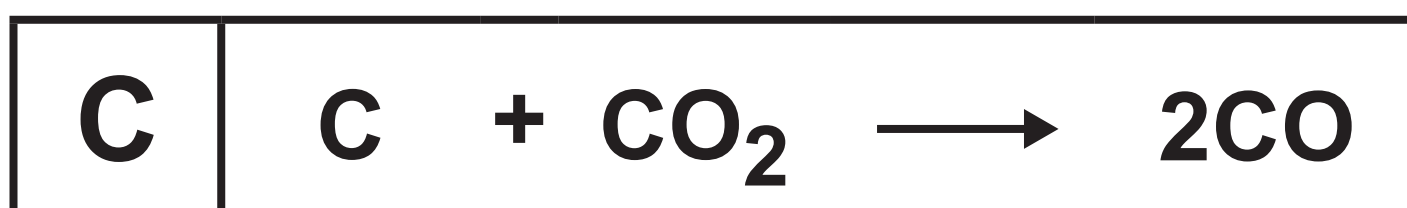
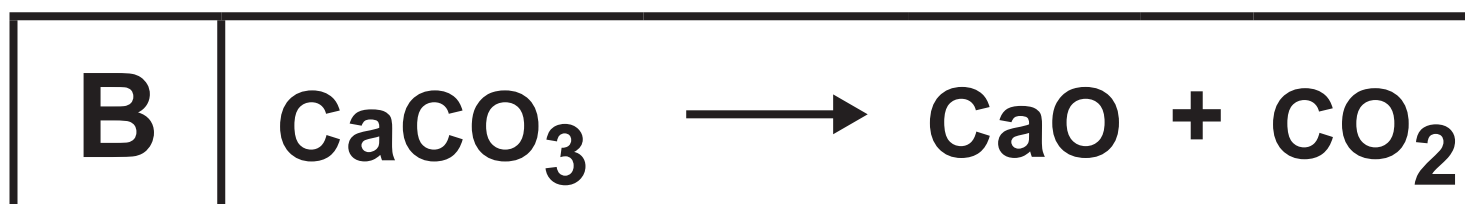


TABLE 4.2

|                                                | Letter |
|------------------------------------------------|--------|
| a decomposition reaction                       |        |
| a reaction that is used to heat up the furnace |        |
| a reaction that forms a reducing agent         |        |
| a neutralisation reaction                      |        |



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**TABLE 4.3**

| <b>Metal nitrate<br/>solution</b> | <b>Colour</b>     |
|-----------------------------------|-------------------|
| <b>silver nitrate</b>             | <b>colourless</b> |
| <b>copper(II) nitrate</b>         | <b>blue</b>       |
| <b>iron(II) nitrate</b>           | <b>green</b>      |

TABLE 4.4

| Metal nitrate solution |                                 |                    |                  |
|------------------------|---------------------------------|--------------------|------------------|
|                        | silver nitrate                  | copper(II) nitrate | iron(II) nitrate |
| silver                 |                                 | no colour change   |                  |
| copper                 | colourless solution turns blue  |                    | no colour change |
| iron                   | colourless solution turns green |                    |                  |



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**TURN OVER**

**TABLE 5.1**

| <b>Colour</b> | <b>Metal or metal compound</b>                             |
|---------------|------------------------------------------------------------|
| <b>red</b>    | <b>strontium carbonate</b>                                 |
| <b>orange</b> | <b>calcium chloride</b>                                    |
| <b>green</b>  | <b>barium chloride</b>                                     |
| <b>blue</b>   | <b>copper(II) chloride</b>                                 |
| <b>violet</b> | <b>strontium carbonate<br/>and<br/>copper(II) chloride</b> |
| <b>white</b>  | <b>magnesium powder</b>                                    |

DIAGRAM 5.2

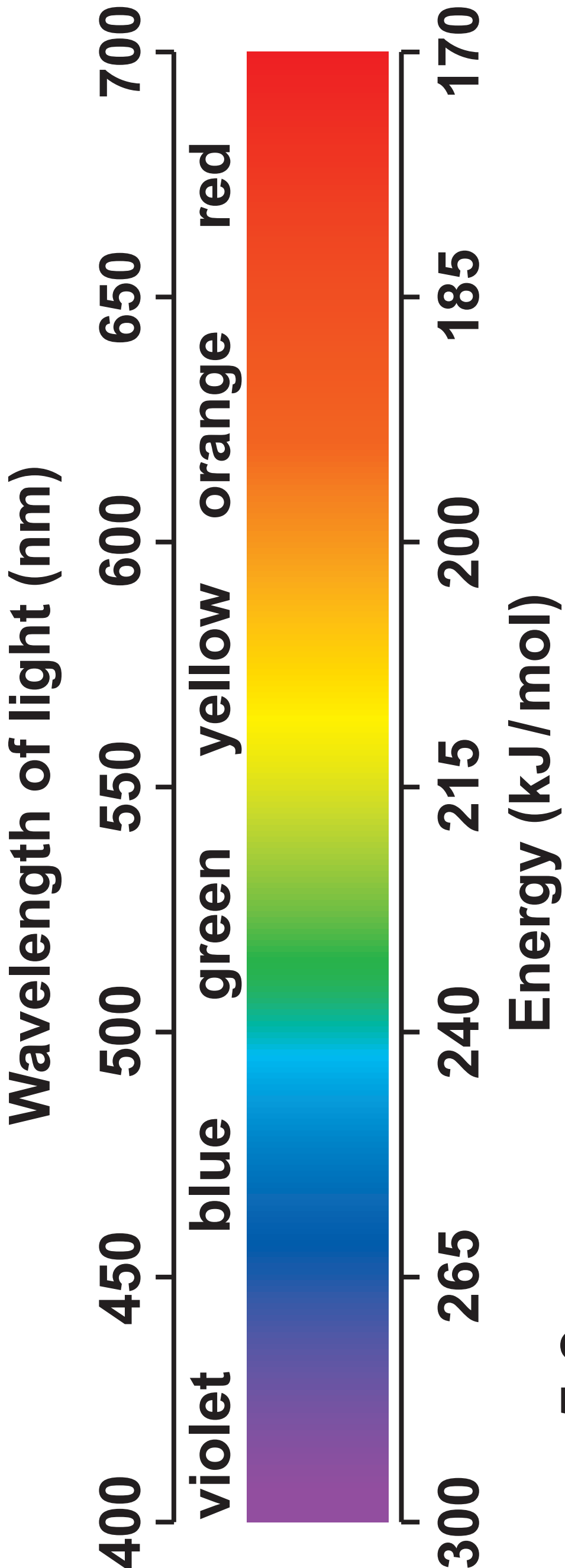
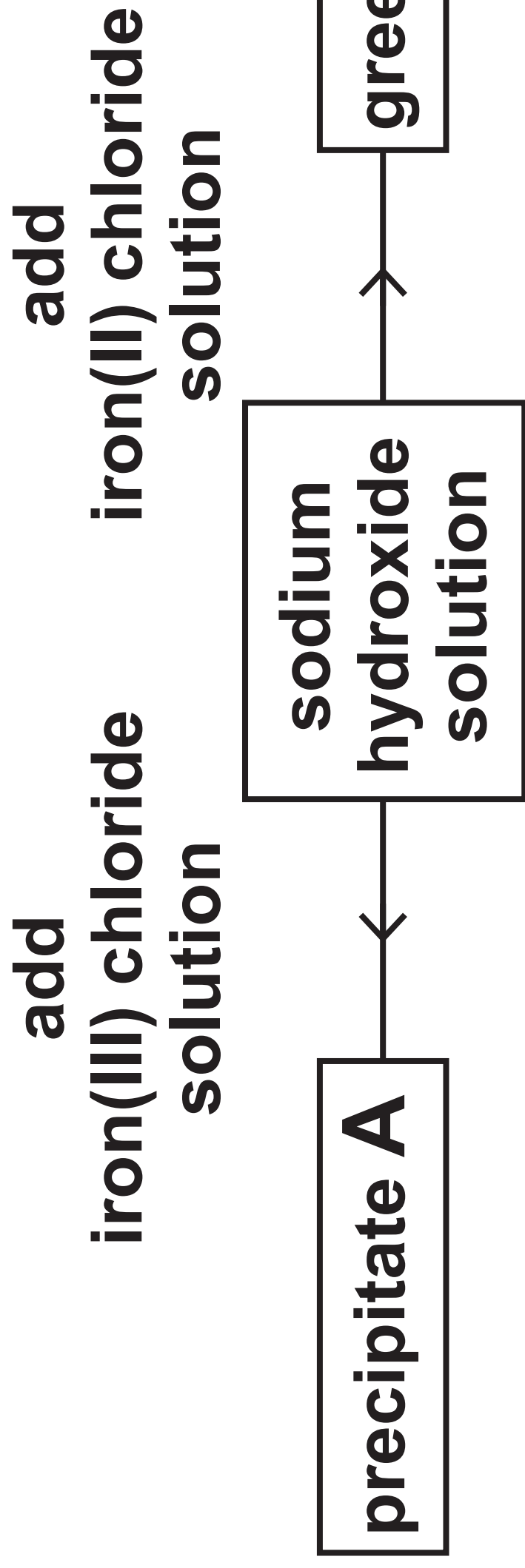


TABLE 5.3

| Special effect          | Element    |
|-------------------------|------------|
| glitter effect          | aluminium  |
| sparkly effect          | iron       |
| glow in the dark effect | phosphorus |
| smoke effect            | zinc       |



# DIAGRAM 5.4

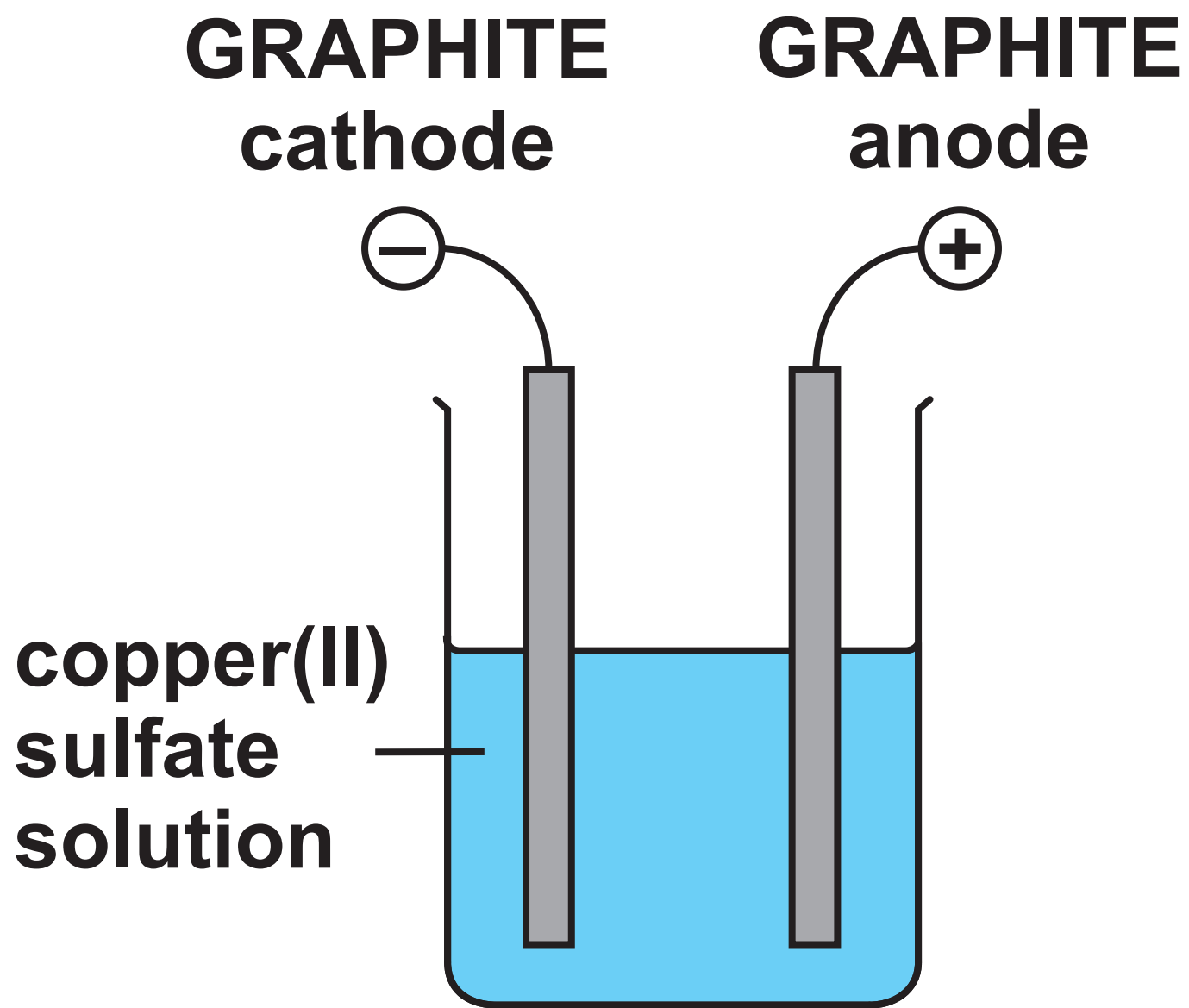




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## DIAGRAM 6.1



**experiment A**

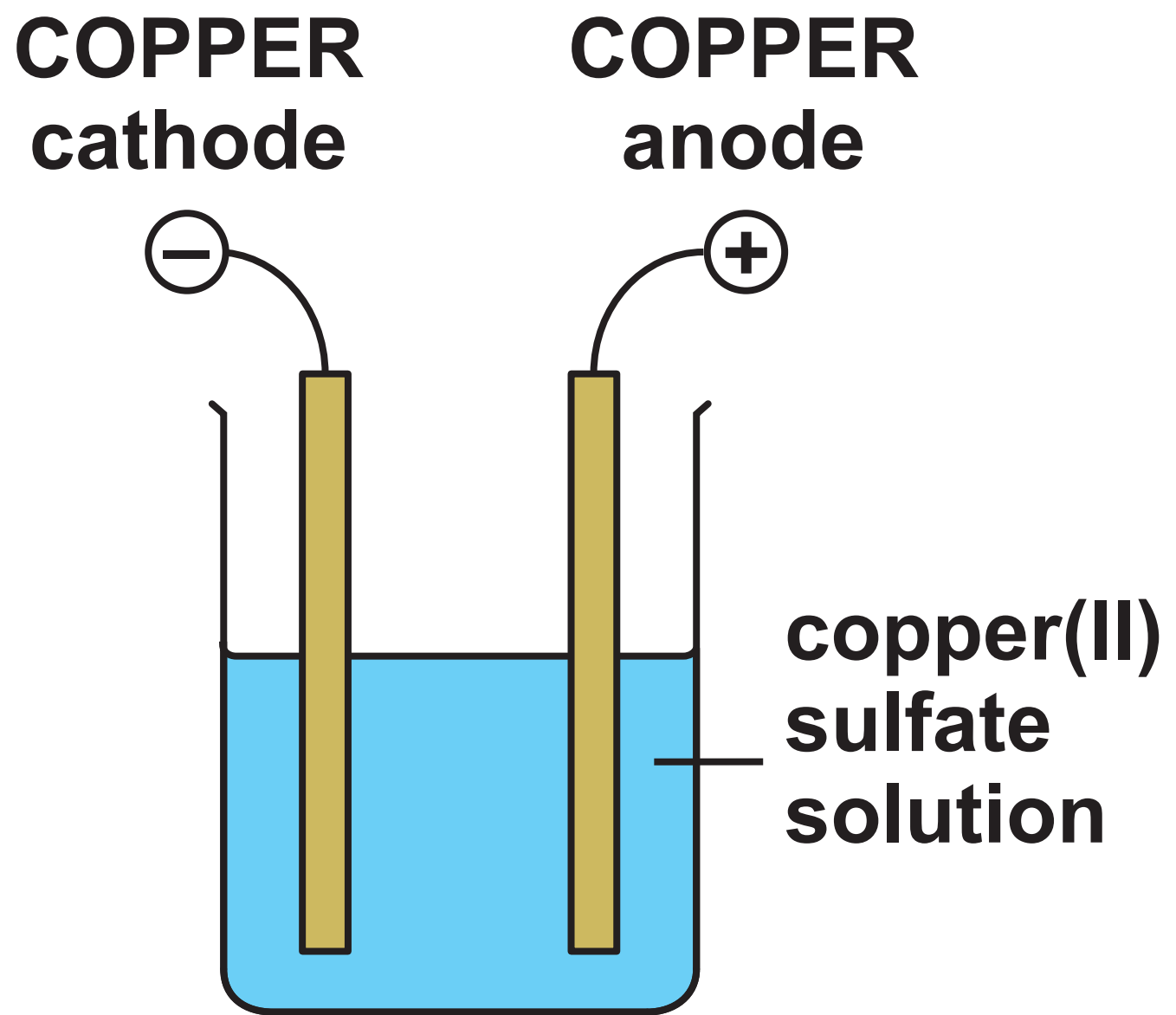
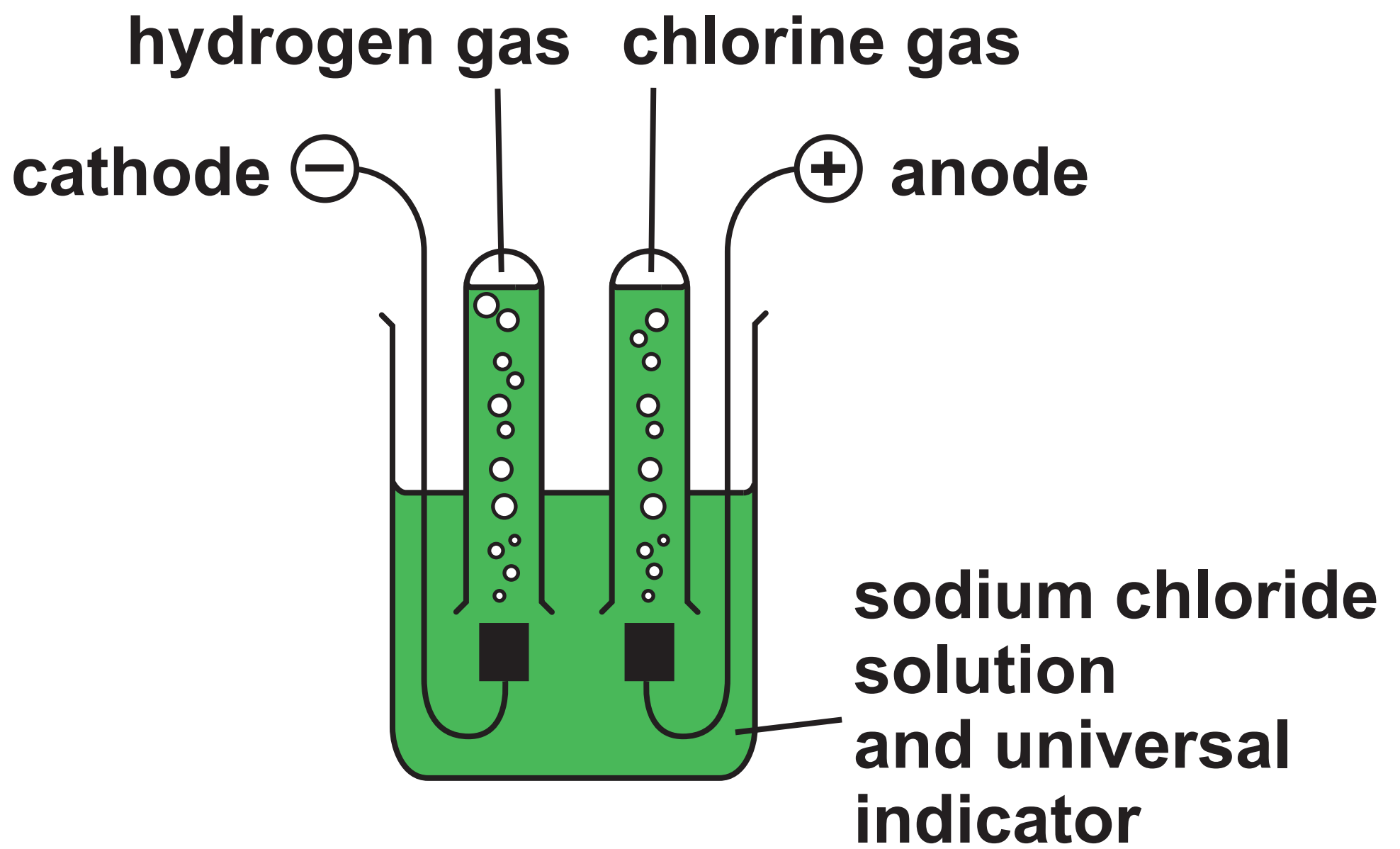
**DIAGRAM 6.1 continued****experiment B**



**DIAGRAM 6.2**



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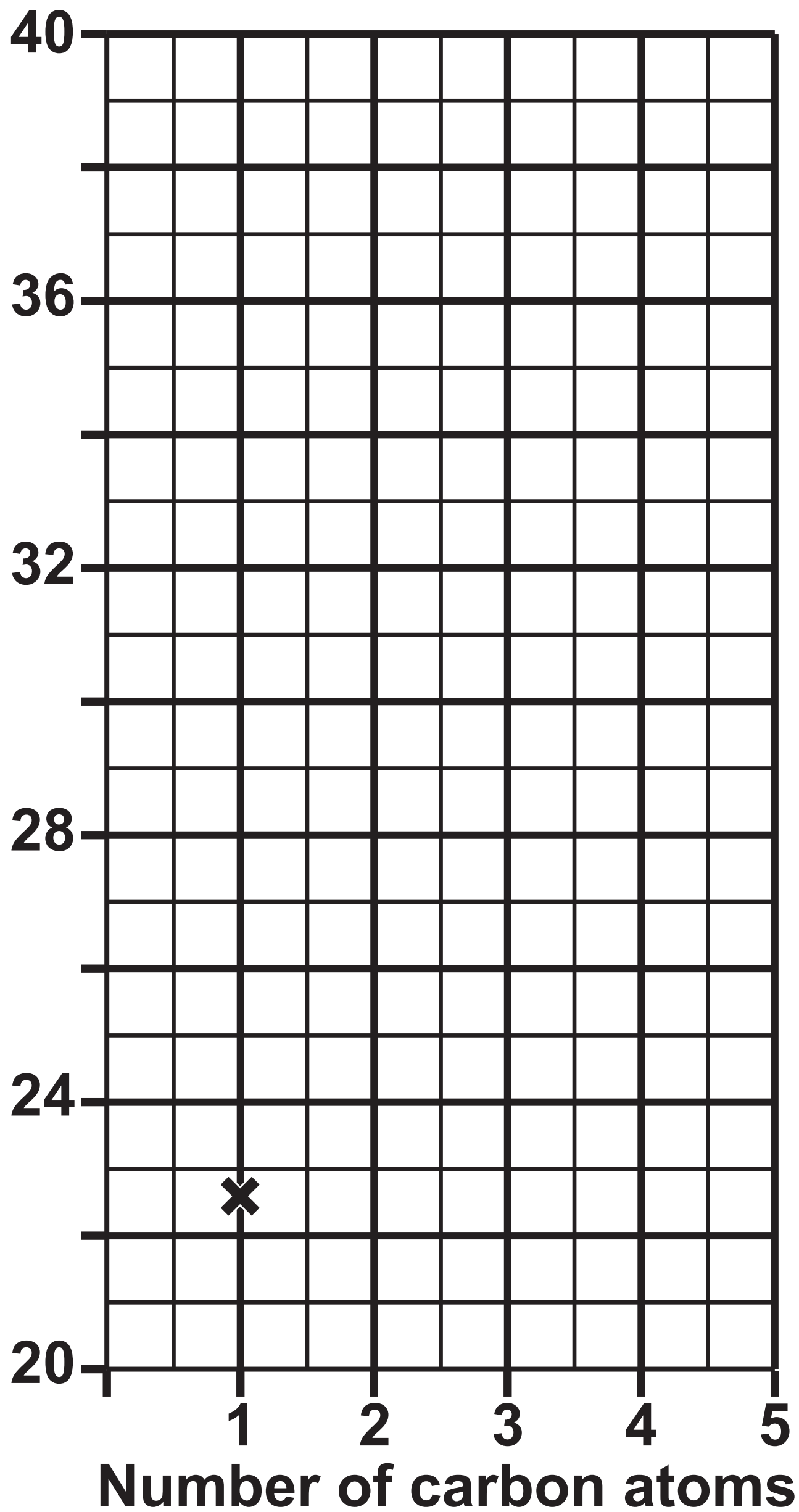
**TURN OVER**

**TABLE 7.1**

| <b>Alcohol</b>  | <b>Molecular formula</b>            |
|-----------------|-------------------------------------|
| <b>methanol</b> | <b>CH<sub>3</sub>OH</b>             |
| <b>ethanol</b>  | <b>C<sub>2</sub>H<sub>5</sub>OH</b> |
| <b>propanol</b> | <b>C<sub>3</sub>H<sub>7</sub>OH</b> |
| <b>butanol</b>  | <b>C<sub>4</sub>H<sub>9</sub>OH</b> |

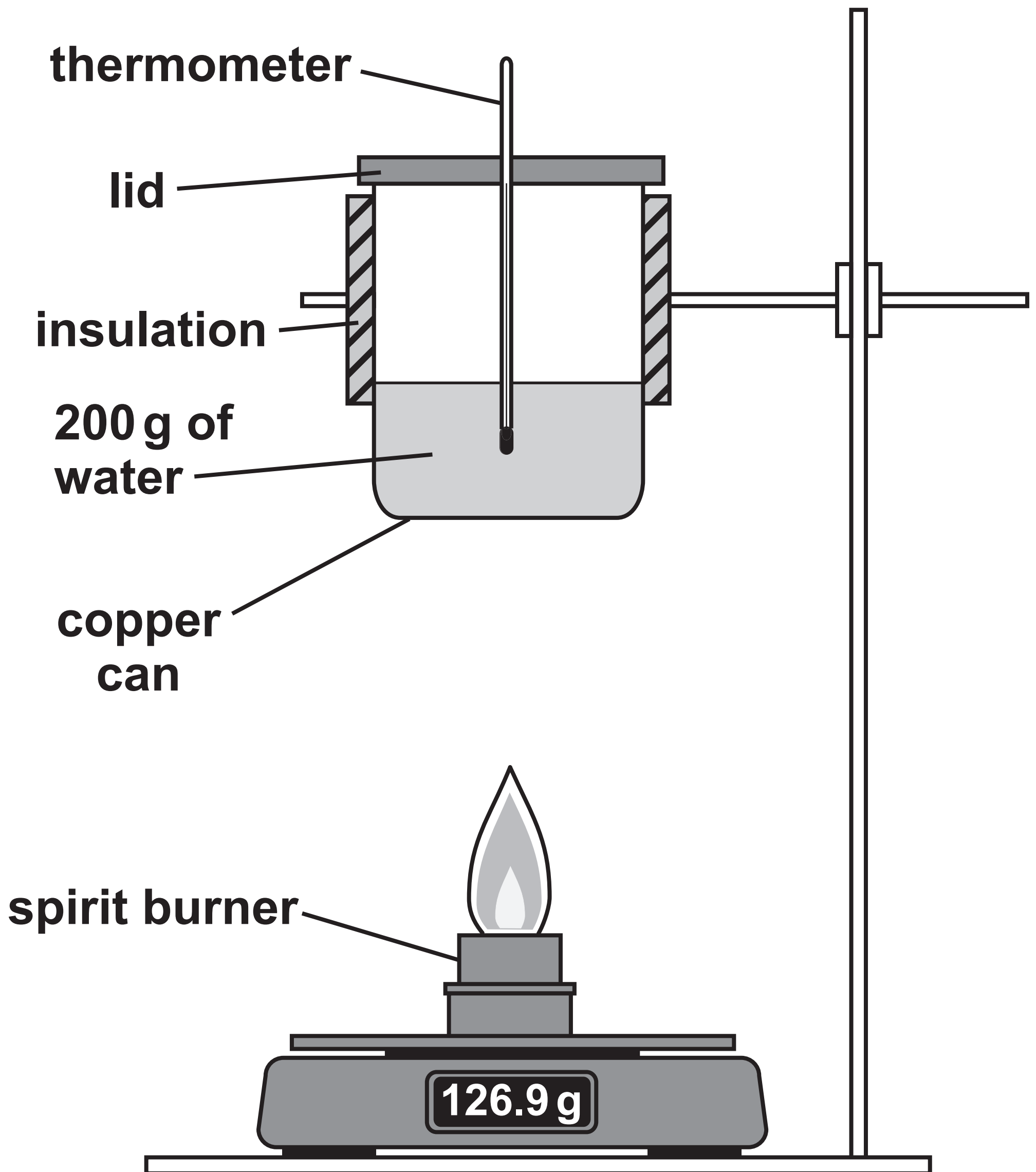
**TABLE 7.2**

| <b>Alcohol</b>  | <b>Number of carbon atoms</b> | <b>Energy given out (kJ)</b> |
|-----------------|-------------------------------|------------------------------|
| <b>methanol</b> | <b>1</b>                      | <b>22.6</b>                  |
| <b>ethanol</b>  | <b>2</b>                      | <b>29.8</b>                  |
| <b>propanol</b> | <b>3</b>                      | <b>33.6</b>                  |
| <b>butanol</b>  | <b>4</b>                      | <b>36.2</b>                  |

**GRAPH 7.3****Energy given out (kJ)**



## DIAGRAM 7.4



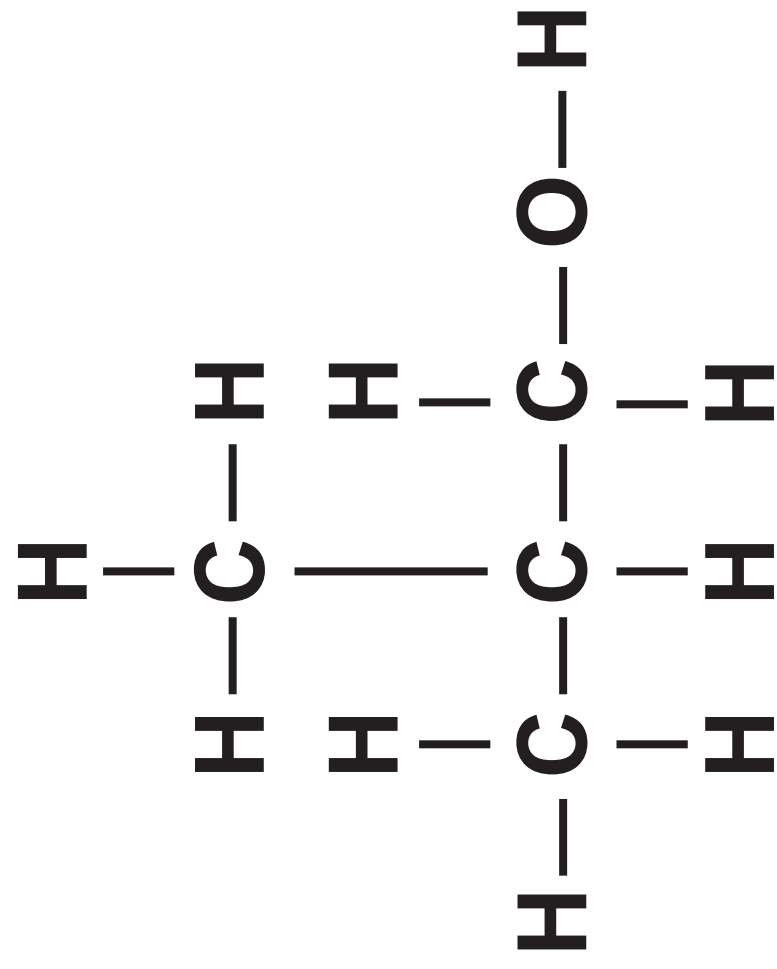


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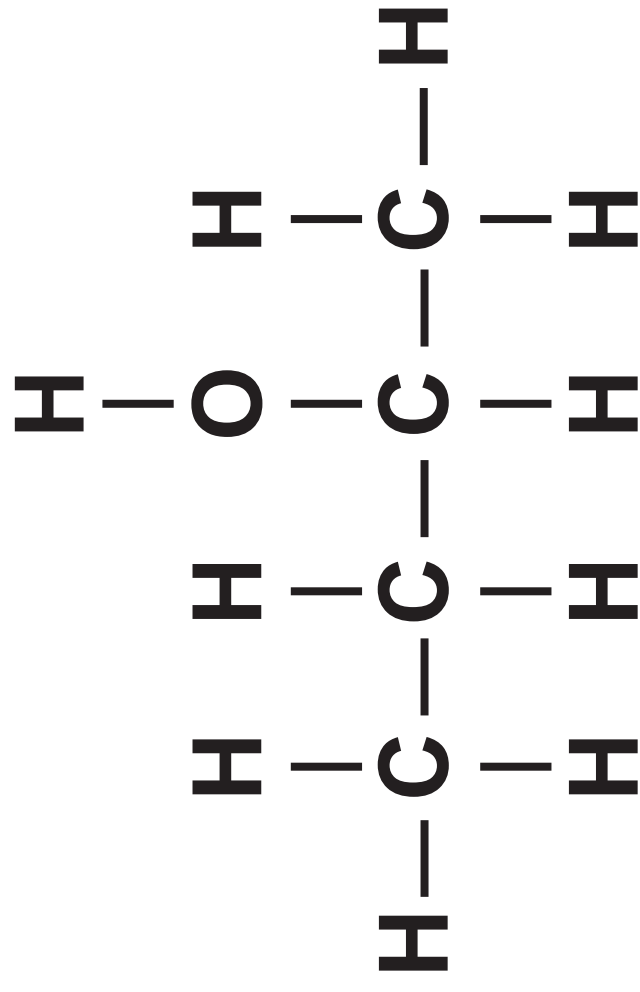
**TURN OVER**

# DIAGRAM 7.5

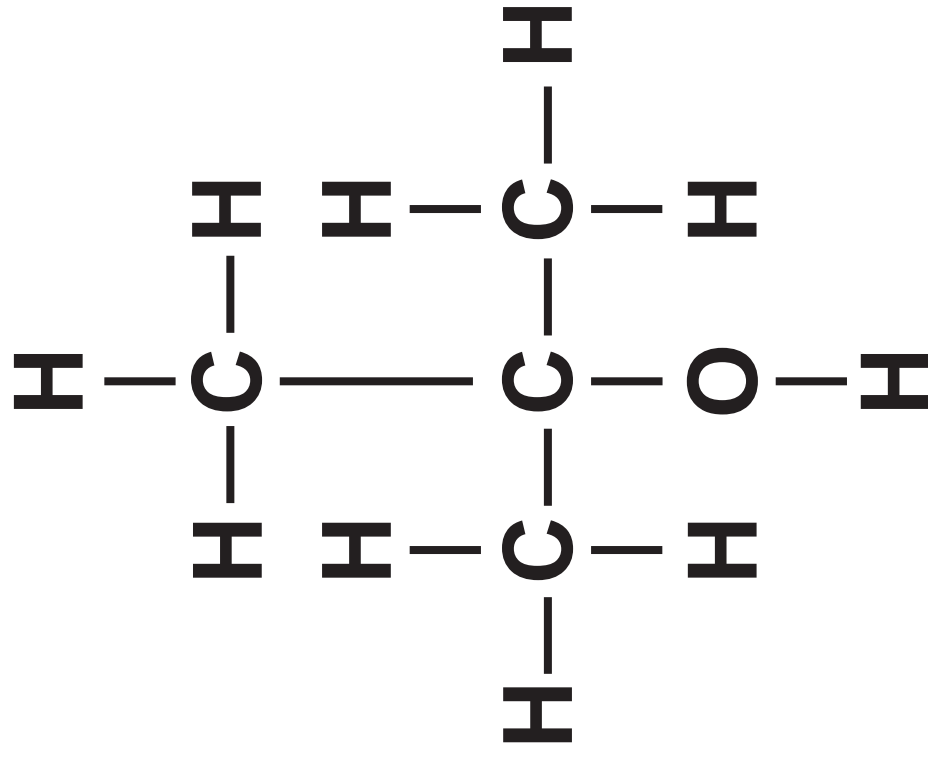
A



B



C



D

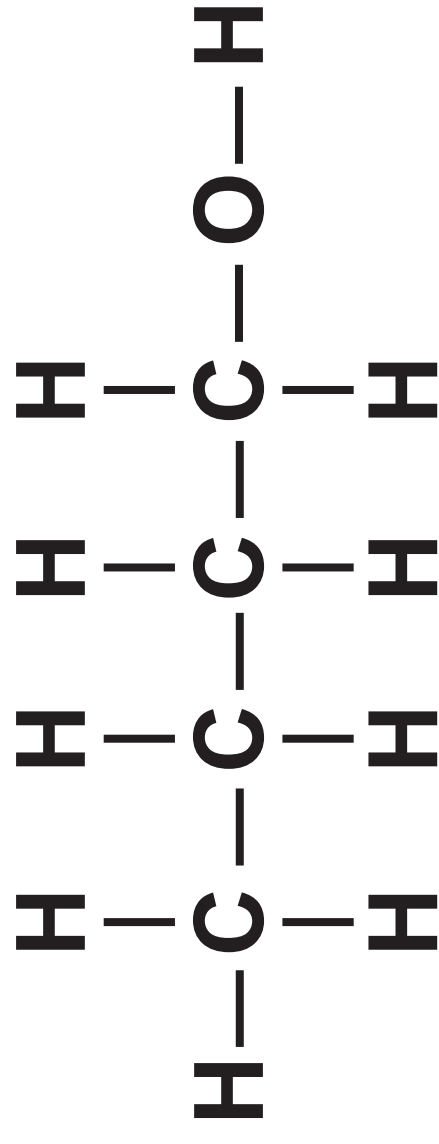
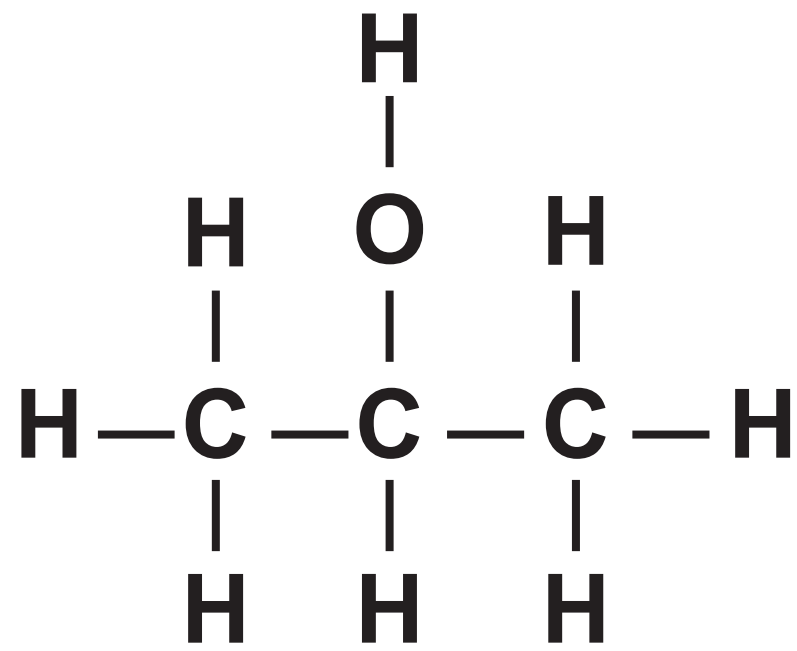
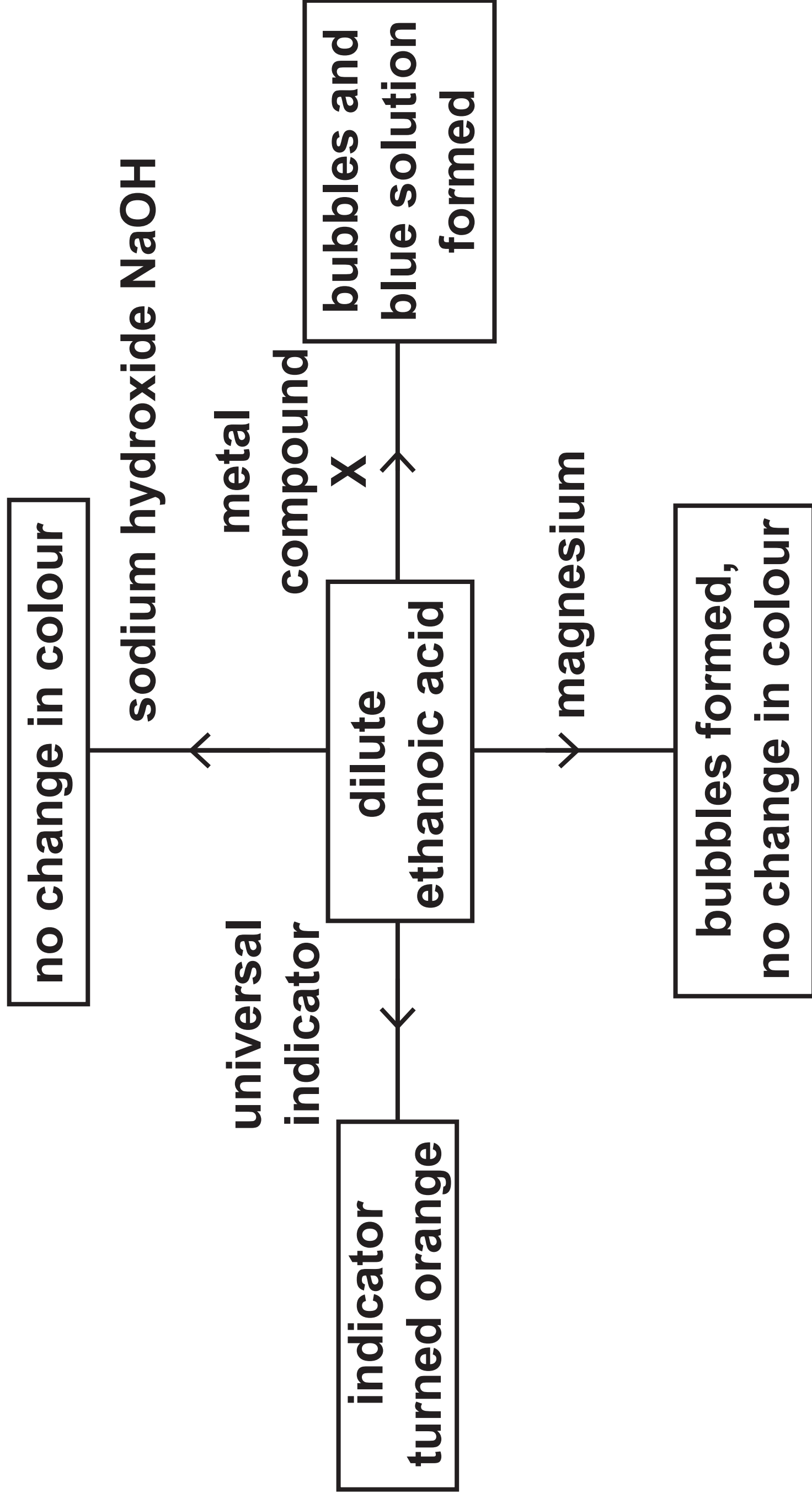


**DIAGRAM 7.6**

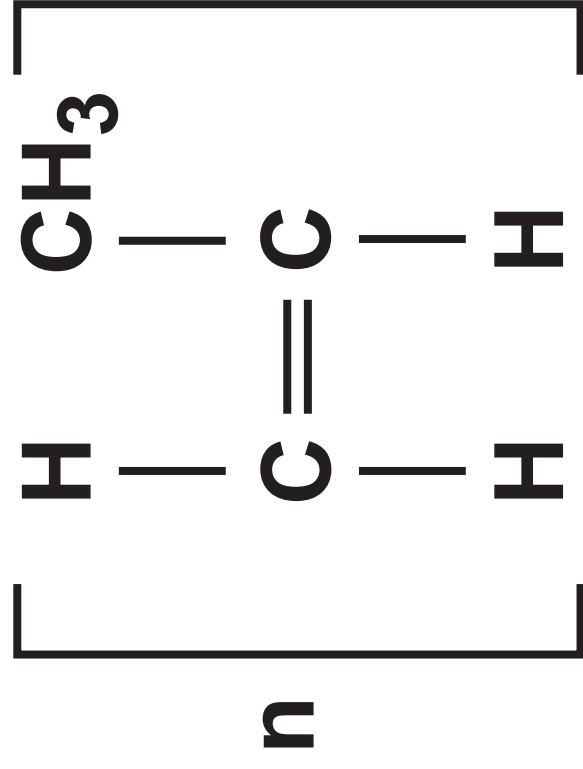


# DIAGRAM 8





# DIAGRAM 9.1



18



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**TURN OVER**

**DIAGRAM 9.2**

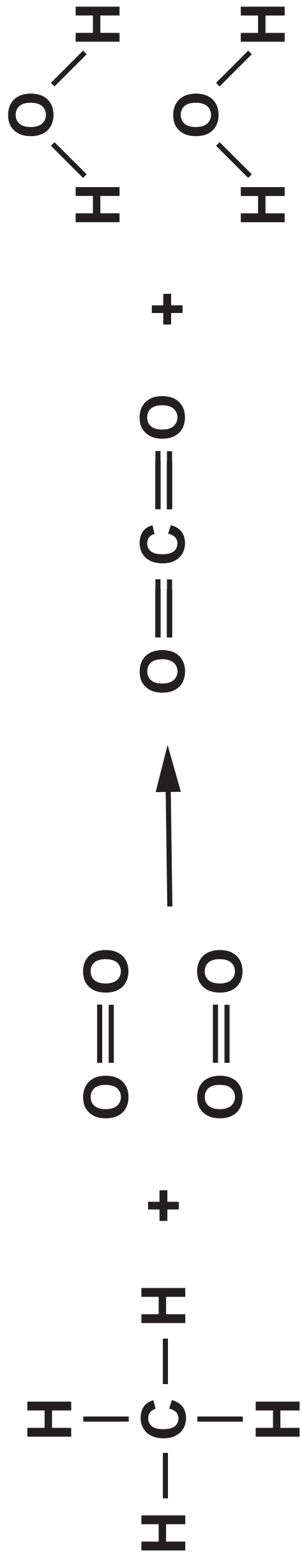


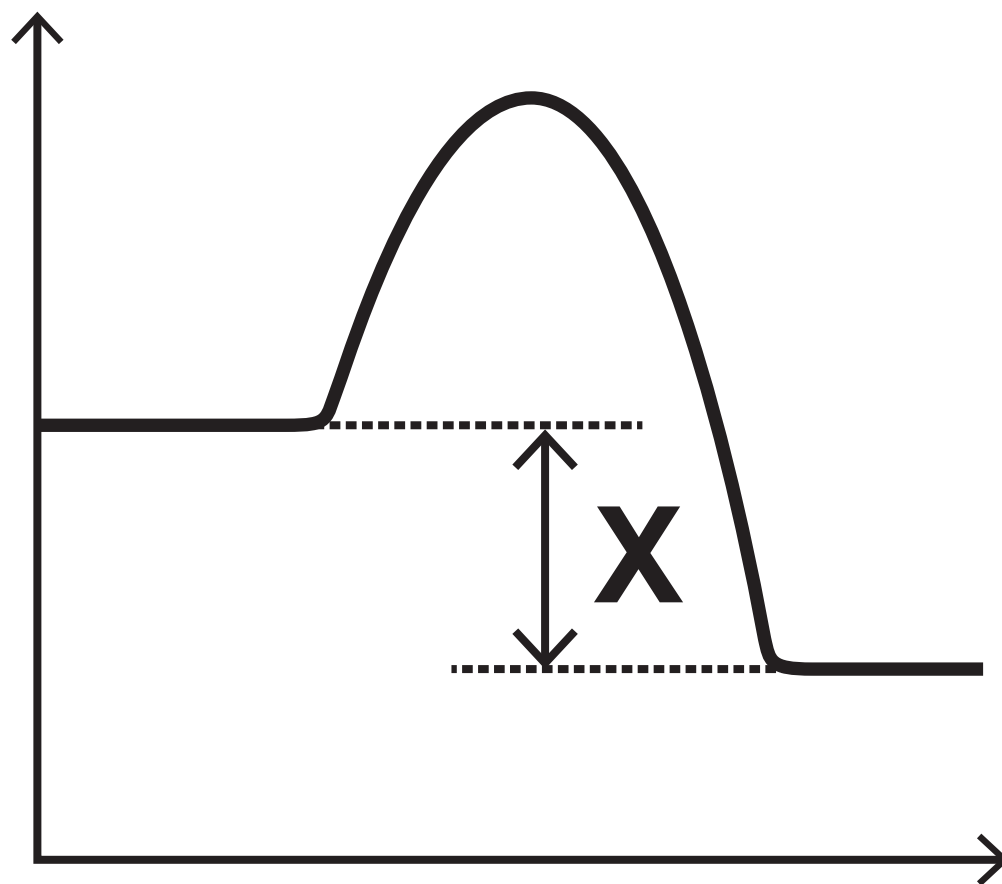
**DIAGRAM 9.3****Energy (kJ)****Reaction pathway**



TABLE 11.1

|                        |                                                                                                             |
|------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Reaction</b>        | <p><b>The forward reaction is exothermic</b></p> $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ |
| <b>Conditions used</b> | <p><b>iron catalyst</b><br/><b>450°C</b><br/><b>200 atm</b></p>                                             |



**TABLE 11.2**

| <b>Fertiliser</b> | <b>Test for positive ion</b>                                                                                                                                     | <b>Test for negative ion</b>                                                                                      |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>A</b>          | <p>add sodium hydroxide solution and warm</p> <ul style="list-style-type: none"><li>• pungent smelling gas is formed which turns red litmus paper blue</li></ul> | <p>add barium chloride solution</p> <ul style="list-style-type: none"><li>• white precipitate is formed</li></ul> |
| <b>B</b>          | <p>flame test</p> <ul style="list-style-type: none"><li>• lilac flame seen</li></ul>                                                                             | <p>add silver nitrate solution</p> <ul style="list-style-type: none"><li>• white precipitate is formed</li></ul>  |



**3410UB0-1**

**MONDAY, 19 MAY 2025 – MORNING**

## **CHEMISTRY – Unit 2:**

**Chemical Bonding, Application of Chemical  
Reactions and Organic Chemistry**

**HIGHER TIER**

# **Data Booklet**

# FORMULAE FOR SOME COMMON IONS

| POSITIVE IONS |                  |
|---------------|------------------|
| Name          | Formula          |
| aluminium     | $\text{Al}^{3+}$ |
| ammonium      | $\text{NH}_4^+$  |
| barium        | $\text{Ba}^{2+}$ |
| calcium       | $\text{Ca}^{2+}$ |
| copper(II)    | $\text{Cu}^{2+}$ |
| hydrogen      | $\text{H}^+$     |
| iron(II)      | $\text{Fe}^{2+}$ |
| iron(III)     | $\text{Fe}^{3+}$ |
| lithium       | $\text{Li}^+$    |
| magnesium     | $\text{Mg}^{2+}$ |
| nickel        | $\text{Ni}^{2+}$ |
| potassium     | $\text{K}^+$     |
| silver        | $\text{Ag}^+$    |
| sodium        | $\text{Na}^+$    |
| zinc          | $\text{Zn}^{2+}$ |

| NEGATIVE IONS |                    |
|---------------|--------------------|
| Name          | Formula            |
| bromide       | $\text{Br}^-$      |
| carbonate     | $\text{CO}_3^{2-}$ |
| chloride      | $\text{Cl}^-$      |
| fluoride      | $\text{F}^-$       |
| hydroxide     | $\text{OH}^-$      |
| iodide        | $\text{I}^-$       |
| nitrate       | $\text{NO}_3^-$    |
| oxide         | $\text{O}^{2-}$    |
| sulfate       | $\text{SO}_4^{2-}$ |

# THE PERIODIC TABLE

# 2

# GROUP

# 1H1

|                              |                              |                                                                                                                                                                               |                              |                              |                             |                              |                              |                              |
|------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|
| <div>7<br/>Li<br/>3</div>    | <div>9<br/>Be<br/>4</div>    | <div>KEY</div> <div><div><div><div><math>A_r</math></div><div>Sym</div><div>Z</div></div><div>relative atomic mass</div><div>symbol</div><div>atomic number</div></div></div> |                              |                              |                             |                              |                              |                              |
| <div>23<br/>Na<br/>11</div>  | <div>24<br/>Mg<br/>12</div>  |                                                                                                                                                                               |                              |                              |                             |                              |                              |                              |
| <div>39<br/>K<br/>19</div>   | <div>40<br/>Ca<br/>20</div>  | <div>45<br/>Sc<br/>21</div>                                                                                                                                                   | <div>48<br/>Ti<br/>22</div>  | <div>51<br/>V<br/>23</div>   | <div>52<br/>Cr<br/>24</div> | <div>55<br/>Mn<br/>25</div>  | <div>56<br/>Fe<br/>26</div>  | <div>59<br/>Co<br/>27</div>  |
| <div>86<br/>Rb<br/>37</div>  | <div>88<br/>Sr<br/>38</div>  | <div>89<br/>Y<br/>39</div>                                                                                                                                                    | <div>91<br/>Zr<br/>40</div>  | <div>93<br/>Nb<br/>41</div>  | <div>96<br/>Mo<br/>42</div> | <div>99<br/>Tc<br/>43</div>  | <div>101<br/>Ru<br/>44</div> | <div>103<br/>Rh<br/>45</div> |
| <div>133<br/>Cs<br/>55</div> | <div>137<br/>Ba<br/>56</div> | <div>139<br/>La<br/>57</div>                                                                                                                                                  | <div>179<br/>Hf<br/>72</div> | <div>181<br/>Ta<br/>73</div> | <div>184<br/>W<br/>74</div> | <div>186<br/>Re<br/>75</div> | <div>190<br/>Os<br/>76</div> | <div>192<br/>Ir<br/>77</div> |
| <div>223<br/>Fr<br/>87</div> | <div>226<br/>Ra<br/>88</div> | <div>227<br/>Ac<br/>89</div>                                                                                                                                                  |                              |                              |                             |                              |                              |                              |

|                 |                  |                 | 3               | 4               | 5               | 6               | 7                | 0               |
|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|-----------------|
|                 |                  |                 |                 |                 |                 |                 |                  | 4<br>He<br>2    |
|                 |                  |                 | 11<br>B<br>5    | 12<br>C<br>6    | 14<br>N<br>7    | 16<br>O<br>8    | 19<br>F<br>9     | 20<br>Ne<br>10  |
|                 |                  |                 | 27<br>Al<br>13  | 28<br>Si<br>14  | 31<br>P<br>15   | 32<br>S<br>16   | 35.5<br>Cl<br>17 | 40<br>Ar<br>18  |
| 59<br>Ni<br>28  | 63.5<br>Cu<br>29 | 65<br>Zn<br>30  | 70<br>Ga<br>31  | 73<br>Ge<br>32  | 75<br>As<br>33  | 79<br>Se<br>34  | 80<br>Br<br>35   | 84<br>Kr<br>36  |
| 106<br>Pd<br>46 | 108<br>Ag<br>47  | 112<br>Cd<br>48 | 115<br>In<br>49 | 119<br>Sn<br>50 | 122<br>Sb<br>51 | 128<br>Te<br>52 | 127<br>I<br>53   | 131<br>Xe<br>54 |
| 195<br>Pt<br>78 | 197<br>Au<br>79  | 201<br>Hg<br>80 | 204<br>Tl<br>81 | 207<br>Pb<br>82 | 209<br>Bi<br>83 | 210<br>Po<br>84 | 210<br>At<br>85  | 222<br>Rn<br>86 |

# THE PERIODIC TABLE

## PERIODIC TABLE – KEY

### ATOMIC NUMBER – SYMBOL – NAME

|    |                |    |                |
|----|----------------|----|----------------|
| 1  | H – Hydrogen   | 19 | K – Potassium  |
| 2  | He – Helium    | 20 | Ca – Calcium   |
| 3  | Li – Lithium   | 21 | Sc – Scandium  |
| 4  | Be – Beryllium | 22 | Ti – Titanium  |
| 5  | B – Boron      | 23 | V – Vanadium   |
| 6  | C – Carbon     | 24 | Cr – Chromium  |
| 7  | N – Nitrogen   | 25 | Mn – Manganese |
| 8  | O – Oxygen     | 26 | Fe – Iron      |
| 9  | F – Fluorine   | 27 | Co – Cobalt    |
| 10 | Ne – Neon      | 28 | Ni – Nickel    |
| 11 | Na – Sodium    | 29 | Cu – Copper    |
| 12 | Mg – Magnesium | 30 | Zn – Zinc      |
| 13 | Al – Aluminium | 31 | Ga – Gallium   |
| 14 | Si – Silicon   | 32 | Ge – Germanium |
| 15 | P – Phosphorus | 33 | As – Arsenic   |
| 16 | S – Sulfur     | 34 | Se – Selenium  |
| 17 | Cl – Chlorine  | 35 | Br – Bromine   |
| 18 | Ar – Argon     | 36 | Kr – Krypton   |

|           |                        |           |                       |
|-----------|------------------------|-----------|-----------------------|
| <b>37</b> | <b>Rb – Rubidium</b>   | <b>57</b> | <b>La – Lanthanum</b> |
| <b>38</b> | <b>Sr – Strontium</b>  | <b>72</b> | <b>Hf – Hafnium</b>   |
| <b>39</b> | <b>Y – Yttrium</b>     | <b>73</b> | <b>Ta – Tantalum</b>  |
| <b>40</b> | <b>Zr – Zirconium</b>  | <b>74</b> | <b>W – Tungsten</b>   |
| <b>41</b> | <b>Nb – Niobium</b>    | <b>75</b> | <b>Re – Rhenium</b>   |
| <b>42</b> | <b>Mo – Molybdenum</b> | <b>76</b> | <b>Os – Osmium</b>    |
| <b>43</b> | <b>Tc – Technetium</b> | <b>77</b> | <b>Ir – Iridium</b>   |
| <b>44</b> | <b>Ru – Ruthenium</b>  | <b>78</b> | <b>Pt – Platinum</b>  |
| <b>45</b> | <b>Rh – Rhodium</b>    | <b>79</b> | <b>Au – Gold</b>      |
| <b>46</b> | <b>Pd – Palladium</b>  | <b>80</b> | <b>Hg – Mercury</b>   |
| <b>47</b> | <b>Ag – Silver</b>     | <b>81</b> | <b>Tl – Thallium</b>  |
| <b>48</b> | <b>Cd – Cadmium</b>    | <b>82</b> | <b>Pb – Lead</b>      |
| <b>49</b> | <b>In – Indium</b>     | <b>83</b> | <b>Bi – Bismuth</b>   |
| <b>50</b> | <b>Sn – Tin</b>        | <b>84</b> | <b>Po – Polonium</b>  |
| <b>51</b> | <b>Sb – Antimony</b>   | <b>85</b> | <b>At – Astatine</b>  |
| <b>52</b> | <b>Te – Tellurium</b>  | <b>86</b> | <b>Rn – Radon</b>     |
| <b>53</b> | <b>I – Iodine</b>      | <b>87</b> | <b>Fr – Francium</b>  |
| <b>54</b> | <b>Xe – Xenon</b>      | <b>88</b> | <b>Ra – Radium</b>    |
| <b>55</b> | <b>Cs – Caesium</b>    | <b>89</b> | <b>Ac – Actinium</b>  |
| <b>56</b> | <b>Ba – Barium</b>     |           |                       |