



GCSE

3410U20-1

**FRIDAY, 27 MAY 2022 – MORNING**

**CHEMISTRY – Unit 2:**

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

**FOUNDATION 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 paper you may 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.**

**Question 6 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)**

<b>For Examiner's use only</b>		
<b>Question</b>	<b>Maximum Mark</b>	<b>Mark Awarded</b>
<b>1.</b>	<b>9</b>	
<b>2.</b>	<b>7</b>	
<b>3.</b>	<b>7</b>	
<b>4.</b>	<b>13</b>	
<b>5.</b>	<b>10</b>	
<b>6.</b>	<b>6</b>	
<b>7.</b>	<b>8</b>	
<b>8.</b>	<b>6</b>	
<b>9.</b>	<b>7</b>	
<b>10.</b>	<b>7</b>	
<b>Total</b>	<b>80</b>	

Answer all questions.

- 1 Selwyn carried out an experiment to prepare copper(II) chloride crystals.

DIAGRAMS 1, 2, 3 and 4 show the stages of the experiment he carried out.

- (a) Choose apparatus from below to label the diagrams. [4 marks]

evaporating basin                      conical flask

electronic balance                      filter funnel

filter paper                                      beaker

test tube

- (b) In STAGE 1 Selwyn added copper(II) carbonate until ALL the dilute hydrochloric acid was used up.

Tick (✓) the box next to the statement which best describes what Selwyn would see when all the acid had been used up. [1 mark]

bubbling increases

bubbling stops

bubbling decreases

(Turn over)



1 (c) The gas formed in **STAGE 1** turns limewater milky. Underline the name of this gas.

[1 mark]

oxygen

hydrogen

carbon dioxide

nitrogen

(d) Choose words from below to complete the following sentences. [2 marks]

evaporation

filtration

distillation

neutralisation

The process used to remove the unreacted copper(II) carbonate in **STAGE 2** is called

---

The process used to remove water in **STAGE 3** is called

---



- 1 (e) The container holding the crystals has a mass of 29.8 g. Using the information given in **STAGE 4**, calculate the mass of the crystals formed. [1 mark]

Mass of  
crystals formed = \_\_\_\_\_ g

9



**2 (a) Crude oil is formed from simple marine organisms.**

**Tick (✓) the box next to the length of time it takes for the organisms to turn into crude oil. [1 mark]**

**hundreds of years**

**thousands of years**

**millions of years**

**(b) Crude oil can be separated into simpler mixtures called fractions.**

**Tick (✓) the box next to the method used to separate crude oil into fractions. [1 mark]**

**fractional distillation**

**filtration**

**cracking**

**polymerisation**

**(Turn over)**

<b>Fraction</b>	<b>Size of molecules (chain length)</b>	<b>Viscosity</b>	<b>Ease of ignition</b>	<b>Amount of smoke formed</b>
<b>petrol</b>	<b>C<sub>5</sub> – C<sub>10</sub></b>	<b>very runny</b>	<b>very easy</b>	<b>no smoke</b>
<b>naphtha</b>	<b>C<sub>8</sub> – C<sub>12</sub></b>	<b>fairly runny</b>	<b>quite easy</b>	<b>little smoke</b>
<b>kerosene</b>	<b>C<sub>10</sub> – C<sub>16</sub></b>	<b>thick</b>	<b>quite hard</b>	<b>quite a lot of smoke</b>
<b>diesel oil</b>	<b>C<sub>14</sub> – C<sub>20</sub></b>	<b>very thick</b>	<b>very hard</b>	<b>very smoky</b>

**2 (c) The table opposite shows properties of some fractions that are obtained from crude oil.**

**USE ONLY THE INFORMATION FROM THE TABLE TO ANSWER THE FOLLOWING QUESTIONS.**

**(i) Name the fraction which is the easiest to pour. [1 mark]**

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**(ii) Name the fraction which is the hardest to burn. [1 mark]**

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**(iii) Name the fraction with the smallest RANGE of chain lengths. [1 mark]**

---

**(iv) Name the fraction which burns with the cleanest flame. Give the reason for your choice. [2 marks]**

**Fraction** \_\_\_\_\_

**Reason**

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7

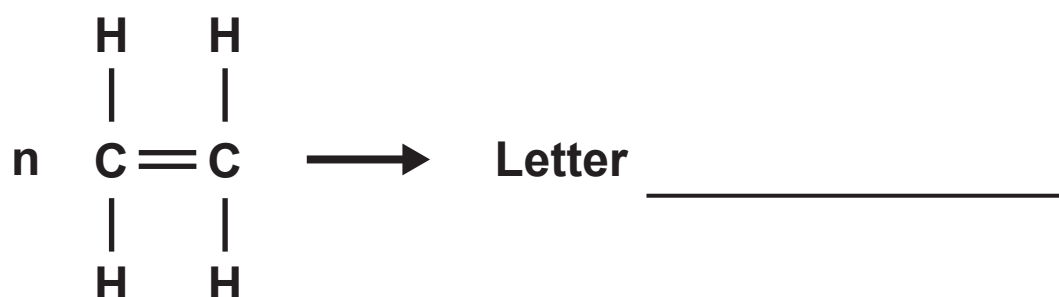
**(Turn over)**

Name	Molecular formula	Structural formula
ethane	C <sub>2</sub> H <sub>6</sub>	<pre>       H   H             H — C — C — H                   H   H           </pre>
propane	C <sub>3</sub> H <sub>8</sub>	
butane	_____	<pre>       H   H   H   H                     H — C — C — C — C — H                           H   H   H   H           </pre>

3 (a) Complete the table on the opposite page.  
[2 marks]

(b) **DIAGRAM 5** contains four polymers **A**, **B**, **C** and **D**.

Give the **LETTER** of the polymer formed during the polymerisation of ethene. [1 mark]



(c) The equation in **DIAGRAM 6** shows the reaction taking place when testing for a **C=C** bond.

**bromine water**

**potassium dichromate**

**universal indicator**

**barium chloride**

Choose the name of reagent **X** from the words above. [1 mark]



- 3 (d) The equation below shows the fermentation of glucose.



- (i) Underline the chemical name for  $\text{C}_2\text{H}_5\text{OH}$ .  
[1 mark]

sugar

biofuel

ethanol

alcohol

- (ii) Calculate the relative molecular mass,  $M_r$ , of  $\text{C}_2\text{H}_5\text{OH}$ . [2 marks]

$$A_r(\text{H}) = 1 \quad A_r(\text{O}) = 16 \quad A_r(\text{C}) = 12$$

$M_r =$  \_\_\_\_\_

7



4 (a) **DIAGRAM 7** shows the apparatus a teacher used to demonstrate what happens when an electric current is passed through molten lead bromide.

(i) Lead bromide contains the ions  $\text{Pb}^{2+}$  and  $\text{Br}^-$ .

Underline the correct formula of lead bromide. [1 mark]

$\text{Pb}_2\text{Br}$        $\text{PbBr}$        $\text{PbBr}^2$        $\text{PbBr}_2$

(ii) Give the state (solid, liquid or gas) of the lead bromide during the process. [1 mark]

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(iii) Name the orange gas formed at the anode. [1 mark]

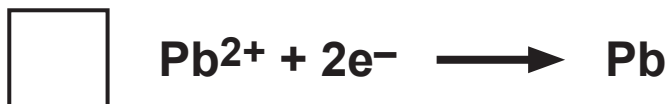
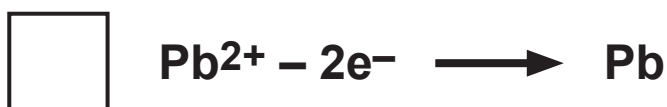
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4 (a)(iv)

During the process each lead ion,  $\text{Pb}^{2+}$ , gains two electrons forming a lead atom at the cathode. [1 mark]

Tick ( $\checkmark$ ) the box next to the equation for the reaction at the cathode.



(b) Iron is extracted from its ore in the blast furnace. DIAGRAM 8 shows the materials which enter and leave the furnace.

(i) Underline the correct word(s) in the brackets to complete each sentence. [3 marks]

The furnace is heated by burning  
( coke / iron / iron ore ).

Hot air provides  
( waste gases / oxygen / slag )  
for burning to take place.

Impurities are removed by adding  
( steel / hot air / limestone ) to the furnace.

(Turn over)



4 (b)(ii)

The word equation below shows the main reaction taking place in the blast furnace.



The symbol equation is shown in **DIAGRAM 9**.  
Give the **LETTER** next to the products which correctly balance the symbol equation for this reaction. [1 mark]

Letter \_\_\_\_\_

Alloy	Composition	Properties
mild steel	iron plus 0.15 – 0.30 % carbon	malleable (easy to bend), ductile (easy to pull into wire) and soft (easy to scratch)
high carbon steel	iron plus 0.70 – 1.50 % carbon	strong, brittle and hard
cast iron	iron plus 2.00 – 5.00 % carbon	very strong, very brittle and very hard

- 4 (c) Chemists have designed a wide variety of alloys for different uses.

Some alloys contain iron and carbon only, whereas others contain additional metals.

The table opposite shows the composition and properties of some alloys.

**USE ONLY THE INFORMATION IN THE TABLE OPPOSITE TO ANSWER PARTS (i)–(iii).**

- (i) Name the alloy that contains the **LEAST** amount of carbon. [1 mark]
- 

- (ii) Underline the effect of increasing the percentage (%) of carbon in these alloys. [1 mark]

**strength decreases**

**hardness decreases**

**softness increases**

**brittleness increases**



4 (c)(iii)

Give the property of mild steel which makes it useful for making car bodies. [1 mark]

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(iv) **DIAGRAMS 10A, 10B and 10C** are models showing the arrangement of atoms in pure iron and in two alloys, **BUT NOT NECESSARILY IN THAT ORDER.**

Choose the **LETTER** of the model which best represents cast iron. Give the reason for your choice. [2 marks]

Letter \_\_\_\_\_

Reason

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13



- 5 Joe, Alex and Megan were asked to investigate the temperature rise when four metals were added to excess copper(II) sulfate solution. 0.5 g of each metal was added to separate 50 cm<sup>3</sup> samples of copper(II) sulfate solution as shown in DIAGRAM 11.

The temperature rise for each reaction was measured.

Their results are shown in the table below.

Metal	Temperature rise (°C)
magnesium	47
calcium	54
zinc	38
iron	25

- (a)(i) Draw a bar chart on the grid in DIAGRAM 12 to show the results. One bar has been drawn for you. [2 marks]
- (ii) Put the FOUR metals in order of reactivity. [1 mark]

Most reactive \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Least reactive \_\_\_\_\_

(Turn over)



**5 (a)(iii)**

The temperature rise for each metal was lower than expected. The students were asked to suggest how the apparatus in **DIAGRAM 11** could be improved so that the temperature rise recorded for each metal was closer to the expected value.

Joe suggested wrapping the polystyrene cup in cotton wool.

Megan suggested putting a lid on the polystyrene cup.

Alex suggested using a cup made from copper.

Choose which student's suggestion would **NOT** result in the temperature rises being closer to the expected value. Explain your choice. [2 marks]

**Student** \_\_\_\_\_

**Reason**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



5 (a)(iv)

Complete the equation for the reaction between magnesium and copper(II) sulfate solution. [2 marks]



(Turn over)

**energy given out (J) = volume of solution (cm<sup>3</sup>) x 4.2 x temperature rise (°C)**

- 5 (b) The students repeated the experiment using chromium and recorded a temperature rise of 30 °C.

What does the temperature rise of 30 °C tell you about the reactivity of chromium compared to the four metals in part (a)?  
[1 mark]

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- (c) The energy given out by the reaction can be calculated using the formula opposite.

Calculate the energy given out during the displacement reaction between IRON and copper(II) sulfate solution. [2 marks]

Energy given out = \_\_\_\_\_ J

10

(Turn over)







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6



- 7 (a) Skiers and mountaineers use hand warmers in very cold weather conditions. Hand warmers are small packets that produce heat when needed. Some ski clothing is specially designed to hold a hand warmer.



TABLE 1 in DIAGRAM 14 describes how three types of hand warmers work.

TABLE 2 in DIAGRAM 15 shows some information about each type of hand warmer.

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

Gloves need to be worn when using hand warmers

Boiling water is used to recharge battery powered hand warmers

Some chemical reactions give out heat energy

All hand warmers are reusable

(Turn over)



7 (a)(ii)

Give TWO reasons why hand warmer **A** is the most popular choice. [2 marks]

Reason 1

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Reason 2

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**TURN OVER**

<b>Time (hours)</b>	<b>Increase in mass (g)</b>
<b>0.0</b>	<b>0.0</b>
<b>0.5</b>	<b>1.4</b>
<b>1.0</b>	<b>2.6</b>
<b>1.5</b>	<b>3.7</b>
<b>2.0</b>	<b>4.4</b>
<b>2.5</b>	<b>4.7</b>
<b>3.0</b>	<b>4.8</b>
<b>3.5</b>	<b>4.8</b>
<b>4.0</b>	<b>4.8</b>

- 7 (b) An air-activated hand warmer contains several chemicals mixed together. One of these chemicals is iron.**

**When the pack is opened, a reaction takes place between iron and oxygen in the air, causing an increase in mass.**

**A student investigated the increase in mass of the opened pack over several hours.**

**The results are shown opposite.**

- (i) Plot the mass increase of the pack against time on the grid in **DIAGRAM 16** and draw a suitable line. Two plots have been done for you. [3 marks]**
- (ii) Tick (✓) the box next to the time it takes for the reaction to finish. [1 mark]**

**2 hours**

**3 hours**

**4 hours**

**5 hours**



7 (b)(iii)

Tick (✓) the box next to the statement that best explains the shape of the graph. [1 mark]

Iron reacts with oxygen forming iron oxide until all the oxygen is used up

Heat formed expands the iron

Iron oxide loses oxygen, forming iron

Iron reacts with oxygen forming iron oxide until all the iron is used up

8

(Turn over)



- 8 (a) The table below shows the electronic structure of the elements present in potassium fluoride.

Element	Electronic structure
potassium	2,8,8,1
fluorine	2,7

**DIAGRAM 17** shows the electron transfer that occurs when potassium reacts with fluorine to form potassium fluoride. The • and × symbols are outer shell electrons.

A student was asked to draw a diagram showing the electronic structures and charges on the ions formed. This is shown in **DIAGRAM 18**. There are **TWO** mistakes in the student's answer.

- (i) Circle the **TWO** mistakes in the student's answer. [2 marks]
- (ii) Name the type of bonding found in potassium fluoride. [1 mark]
-

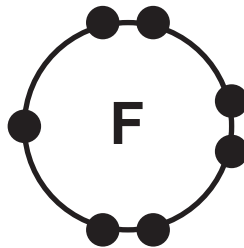


8 (a)(iii)

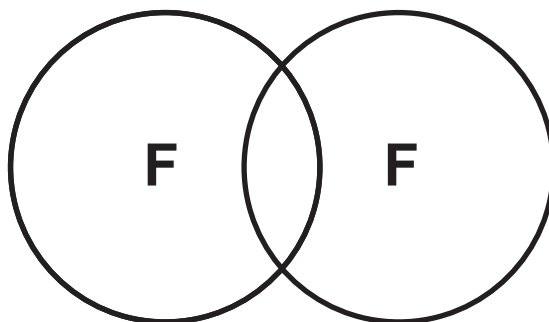
**DIAGRAM 19** shows four different structures. Give the **LETTER** of the structure most likely to represent potassium fluoride. [1 mark]

Letter \_\_\_\_\_

8 (b) The diagram below shows the electrons in the outer shell of an atom of fluorine.



Complete the diagram to show the outer shell electrons in a molecule of fluorine. [2 marks]



6

(Turn over)



**9 (a) DIAGRAM 20** outlines the manufacture of ammonia by the Haber process.

**(i) Name the raw material X. [1 mark]**

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**(ii) The pressure used in the Haber process is 200 atm. State why a higher pressure is NOT used. [1 mark]**

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**(iii) At 450 °C, the reaction is very slow. Iron is used in the process to speed up the reaction. Give the name for a substance used to speed up a chemical reaction. [1 mark]**

---

**(iv) The reaction between nitrogen and hydrogen is represented by the equation in DIAGRAM 21.**

**Complete the equation in DIAGRAM 22 using the key. [2 marks]**

**(Turn over)**



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**TURN OVER**

Fertiliser	Test for positive ion	Test for negative ion
<b>A</b>	On adding sodium hydroxide solution and warming, a pungent smelling gas is formed which turns red litmus blue	On adding barium chloride solution a white precipitate forms
<b>B</b>	Lilac flame test	On adding silver nitrate solution a white precipitate forms
<b>C</b>	On adding sodium hydroxide solution and warming, a pungent smelling gas is formed which turns red litmus blue	On adding silver nitrate solution a white precipitate forms

- 9 (b) One of the main uses of ammonia is in the manufacture of fertilisers.

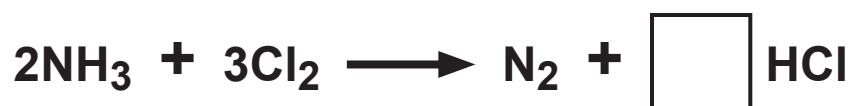
The table opposite shows the results obtained when tests were carried out on three different fertilisers **A**, **B** and **C**.

Give the **LETTER** of the fertiliser which is ammonium sulfate. [1 mark]

Letter \_\_\_\_\_

- (c) Ammonia reacts with chlorine to form nitrogen and hydrogen chloride.

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



7



**10 (a) The list below shows part of the reactivity series.**

**sodium**

**aluminium**

**(carbon)**

**tin**

**copper**

**silver**

**(i) Tin is extracted from its ore by heating with carbon. Aluminium is extracted from its ore using a different method. Give the name of the method used to extract aluminium. [1 mark]**

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**TURN OVER**



10 (a)(ii)

The equation below shows the extraction of tin from tin oxide using carbon.



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

Carbon is reduced

Tin is oxidised

Tin oxide is reduced

Carbon dioxide is oxidised

(iii) When aluminium and copper(II) oxide are heated together, aluminium oxide and copper are formed.

Complete and balance the equation opposite for this reaction. [3 marks]

(Turn over)



**10 (b) A teacher wanted to find out the position of four metals A, B, C and D in the reactivity series.**

**She heated each metal in turn with oxides of the other three. The results were as follows.**

**A reduced the oxide of C**

**B reduced the oxide of A**

**B reduced the oxide of C**

**D reduced the oxide of B**

**Place the metals in order of reactivity.  
[2 marks]**

**Most reactive** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Least reactive** \_\_\_\_\_

7

**END OF PAPER**



<b>Question number</b>	<b>Additional page, if required. Write the question numbers in the left-hand margin.</b>



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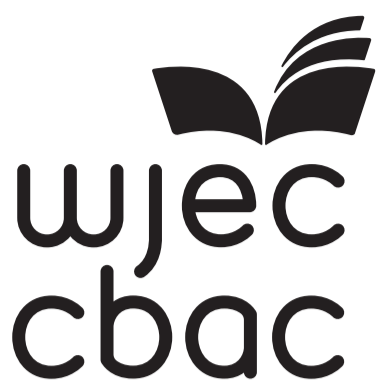




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**CHEMISTRY – Unit 2:**

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

FOUNDATION 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

## KEY

Ar	relative atomic mass
Sym	symbol
Z	atomic number

1 2 GROUP

3 4 5 6 7 0

1	H	1
---	---	---

7	Li	3	9	Be	4	11	B	5	12	C	6	14	N	7	16	O	8	19	F	9	20	Ne	10
23	Na	11	24	Mg	12	27	Al	13	28	Si	14	31	P	15	32	S	16	35.5	Cl	17	40	Ar	18
39	K	19	40	Ca	20	55	Mn	25	52	Cr	24	51	V	23	56	Fe	26	59	Co	27	59	Ni	28
86	Rb	37	88	Sr	38	89	Y	39	91	Zr	40	93	Nb	41	101	Ru	44	103	Rh	45	106	Pd	46
133	Cs	55	137	Ba	56	139	La	57	179	Hf	72	181	Ta	73	190	Os	76	192	Ir	77	195	Pt	78
223	Fr	87	226	Ra	88	227	Ac	89	184	W	74	186	Re	75	197	Au	79	199	Hg	80	201	Pb	82
									63.5	Cu	29	65	Zn	30	70	Ga	31	73	Ge	32	75	As	33
									112	Cd	48	115	In	49	119	Sn	50	122	Sb	51	127	I	53
									128	Te	52	128	Te	52	131	Xe	54	131	Xe	54	210	Po	84
									204	Tl	81	204	Tl	81	207	Pb	82	209	Bi	83	210	Po	84
									201	Hg	80	204	Tl	81	207	Pb	82	209	Bi	83	210	Po	84
									197	Au	79	201	Hg	80	207	Pb	82	209	Bi	83	210	Po	84
									222	Rn	86	222	Rn	86	222	Rn	86	222	Rn	86	222	Rn	86



## THE PERIODIC TABLE

### PERIODIC TABLE – KEY ATOMIC NUMBER – SYMBOL – NAME

1	H – Hydrogen		39	Y – Yttrium
2	He – Helium		40	Zr – Zirconium
3	Li – Lithium		41	Nb – Niobium
4	Be – Beryllium		42	Mo – Molybdenum
5	B – Boron		43	Tc – Technetium
6	C – Carbon		44	Ru – Ruthenium
7	N – Nitrogen		45	Rh – Rhodium
8	O – Oxygen		46	Pd – Palladium
9	F – Fluorine		47	Ag – Silver
10	Ne – Neon		48	Cd – Cadmium
11	Na – Sodium		49	In – Indium
12	Mg – Magnesium		50	Sn – Tin
13	Al – Aluminium		51	Sb – Antimony
14	Si – Silicon		52	Te – Tellurium
15	P – Phosphorus		53	I – Iodine
16	S – Sulfur		54	Xe – Xenon
17	Cl – Chlorine		55	Cs – Caesium
18	Ar – Argon		56	Ba – Barium
19	K – Potassium		57	La – lanthanum
20	Ca – Calcium		72	Hf – Hafnium
21	Sc – Scandium		73	Ta – Tantalum
22	Ti – Titanium		74	W – Tungsten
23	V – Vanadium		75	Re – Rhenium
24	Cr – Chromium		76	Os – Osmium
25	Mn – Manganese		77	Ir – Iridium
26	Fe – Iron		78	Pt – Platinum
27	Co – Cobalt		79	Au – Gold
28	Ni – Nickel		80	Hg – Mercury
29	Cu – Copper		81	Tl – Thallium
30	Zn – Zinc		82	Pb – Lead
31	Ga – Gallium		83	Bi – Bismuth
32	Ge – Germanium		84	Po – Polonium
33	As – Arsenic		85	At – Astatine
34	Se – Selenium		86	Rn – Radon
35	Br – Bromine		87	Fr – Francium
36	Kr – Krypton		88	Ra – Radium
37	Rb – Rubidium		89	Ac – Actinium
38	Sr – Strontium			



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

# **Diagram Booklet**

**Surname** \_\_\_\_\_

**First name(s)** \_\_\_\_\_

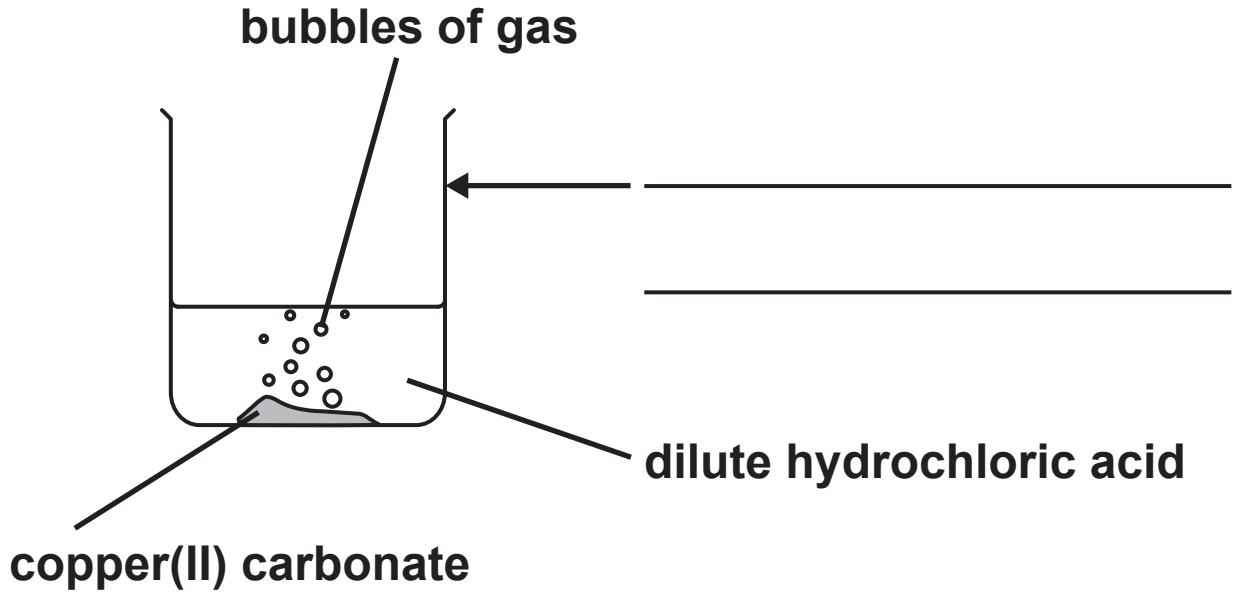
**Centre Number** \_\_\_\_\_

**Candidate Number** 0 \_\_\_\_\_



**DIAGRAM 1**

**STAGE 1**



**DIAGRAM 2**

**STAGE 2**

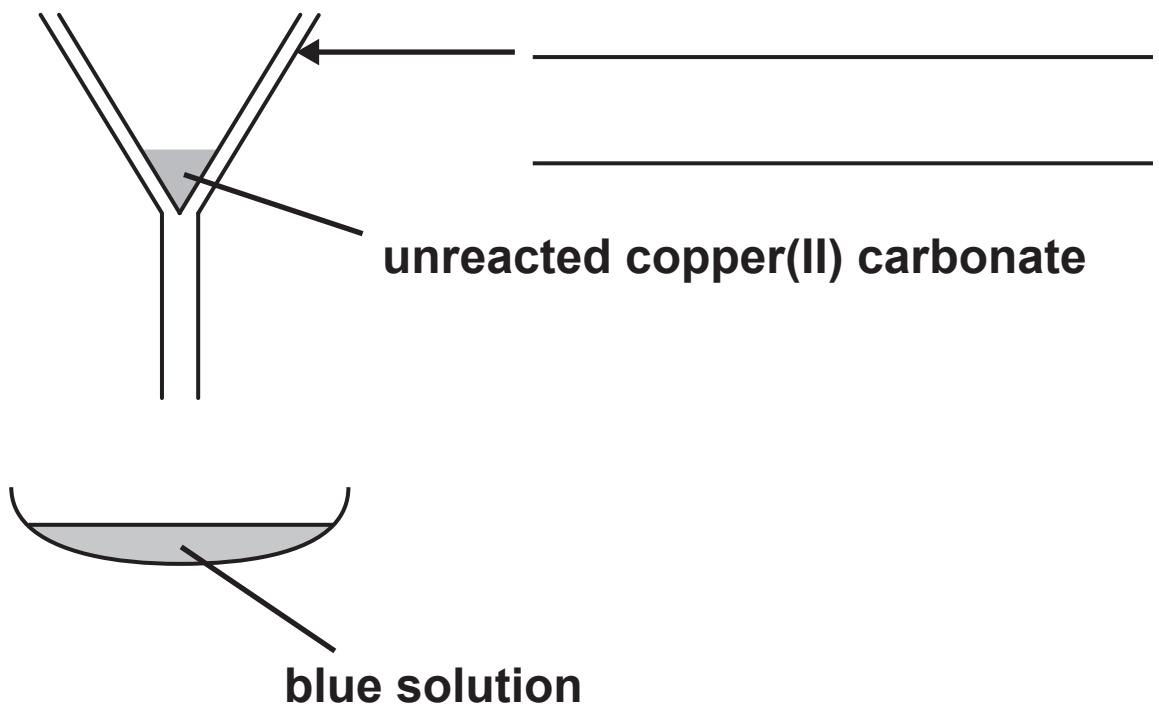




DIAGRAM 3

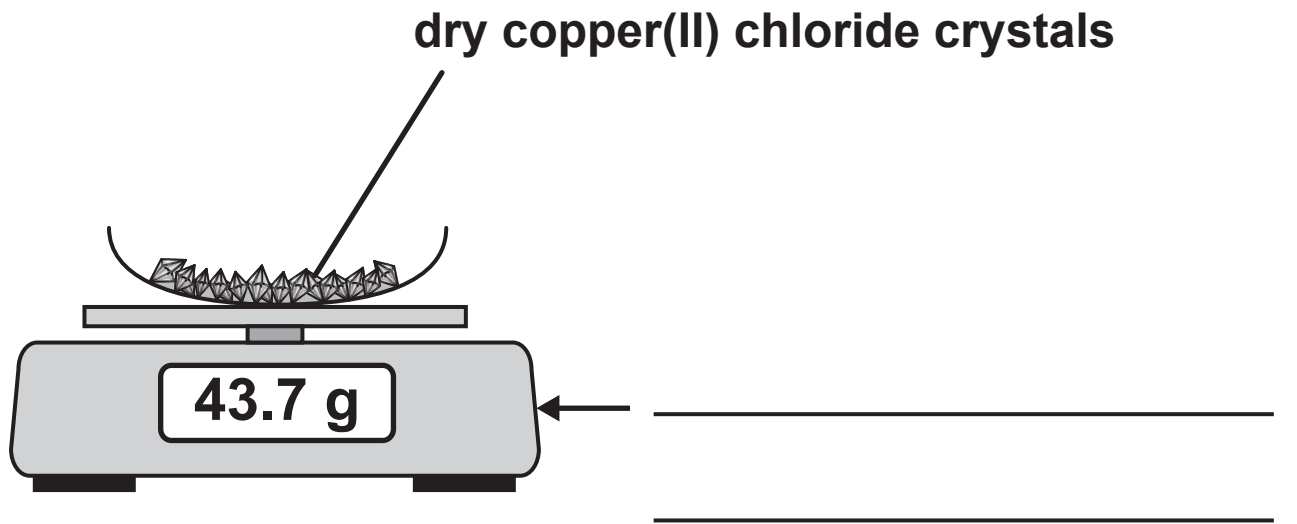
STAGE 3



dry copper(II) chloride crystals

DIAGRAM 4

STAGE 4

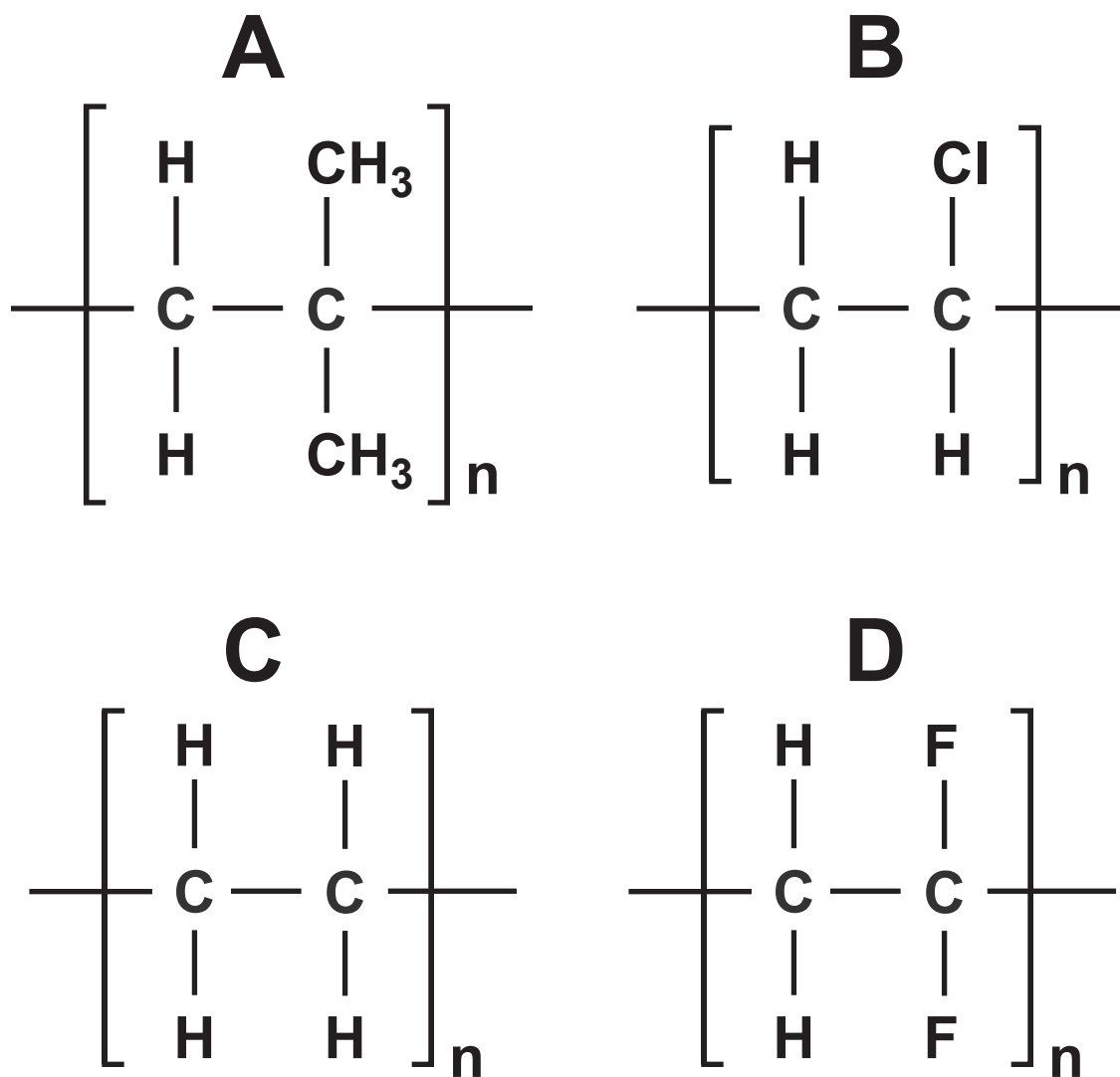


dry copper(II) chloride crystals

43.7 g

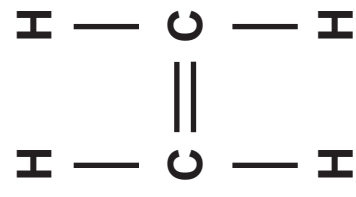


DIAGRAM 5





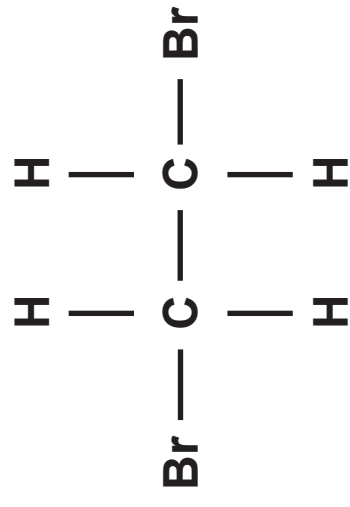
**DIAGRAM 6**



colourless

+

reagent X



colourless

5



DIAGRAM 7

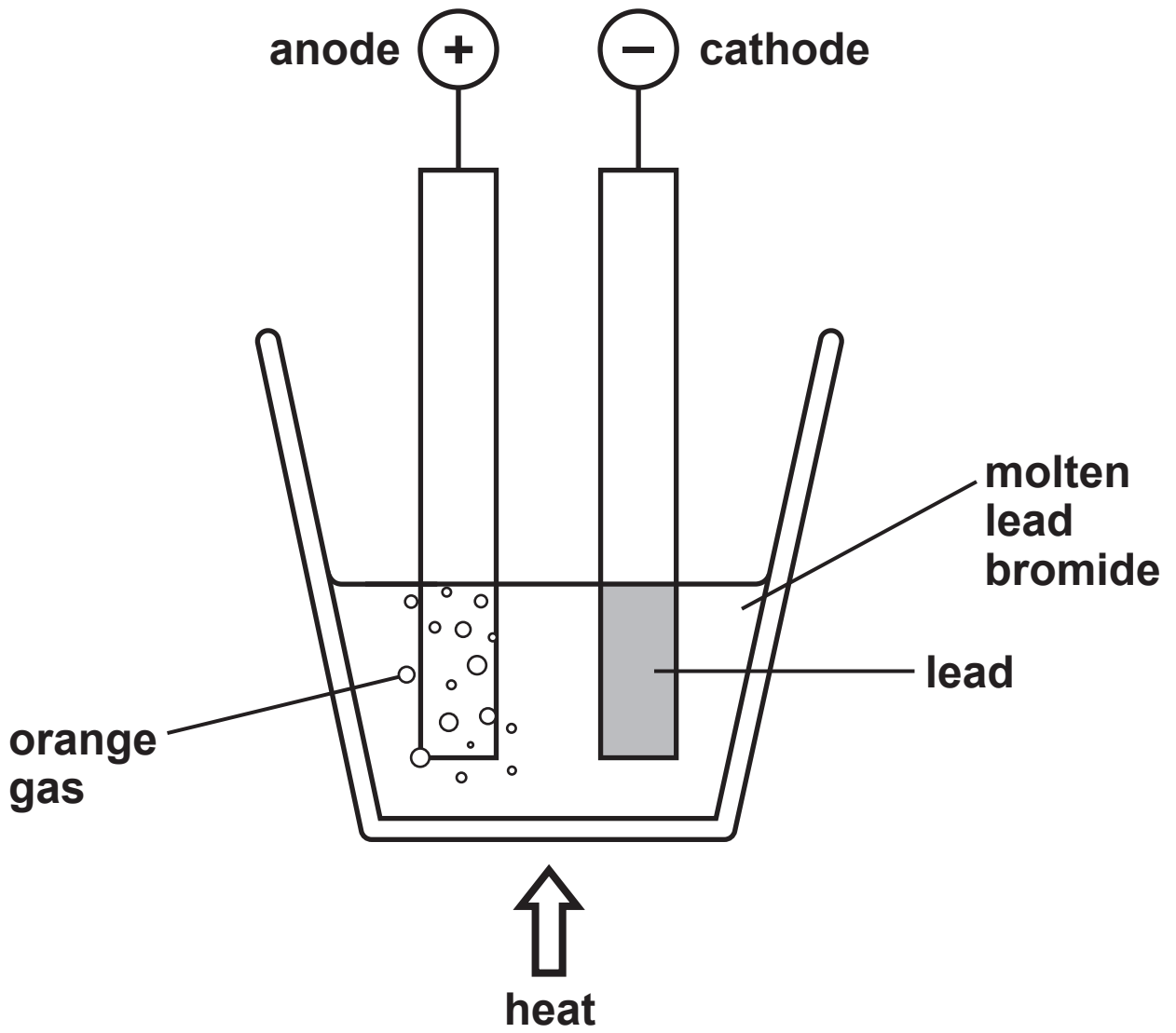
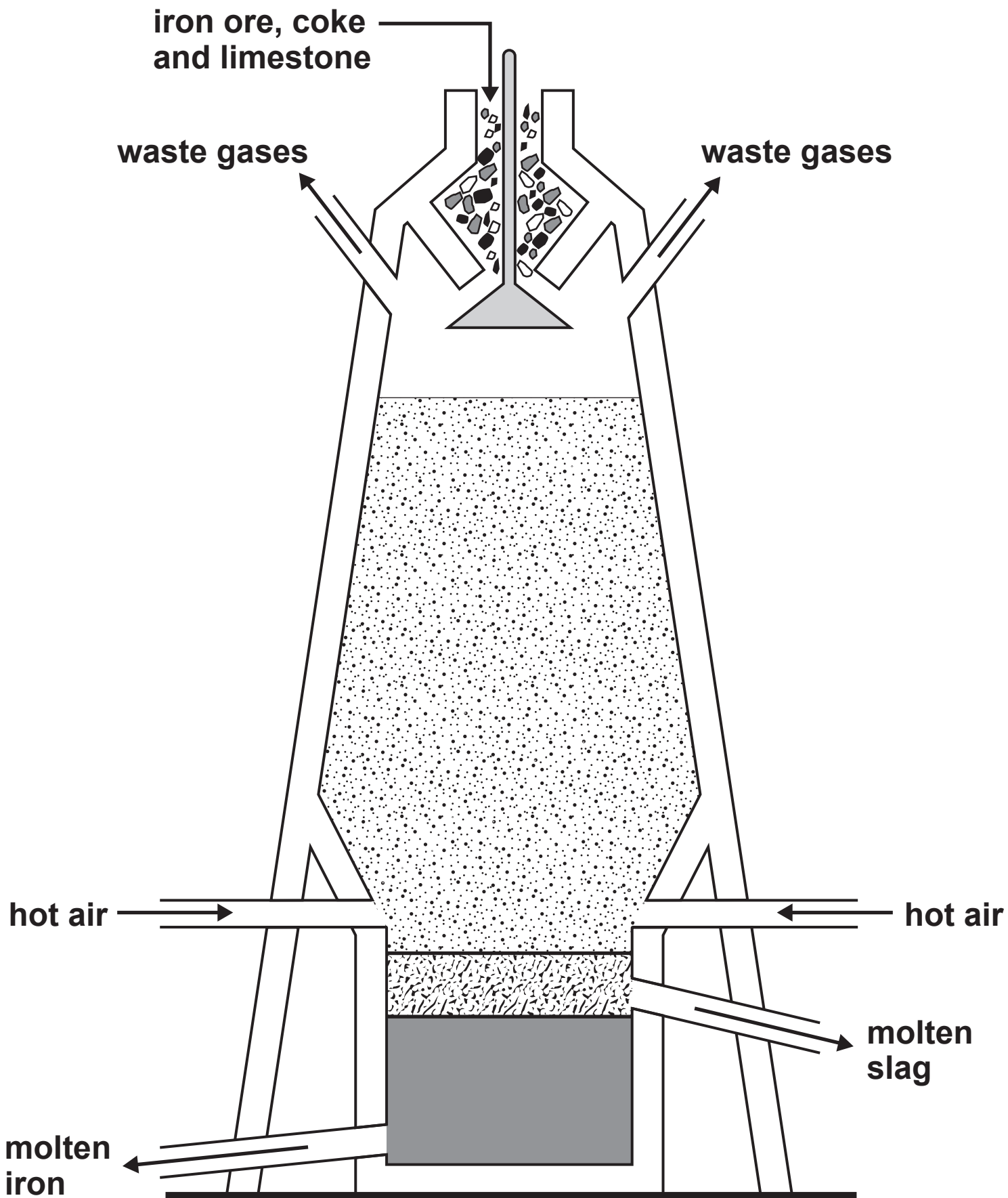


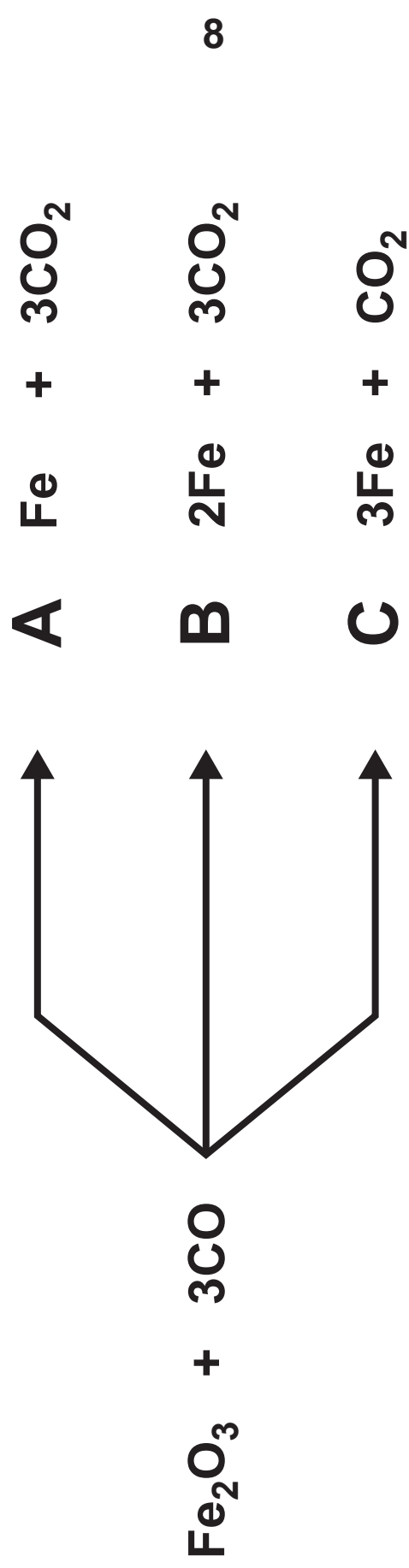


DIAGRAM 8



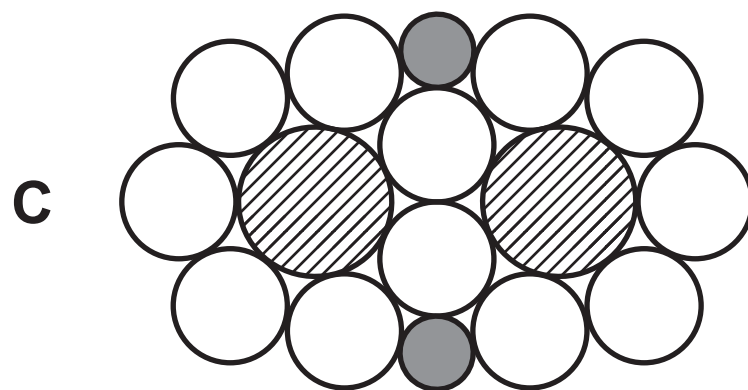
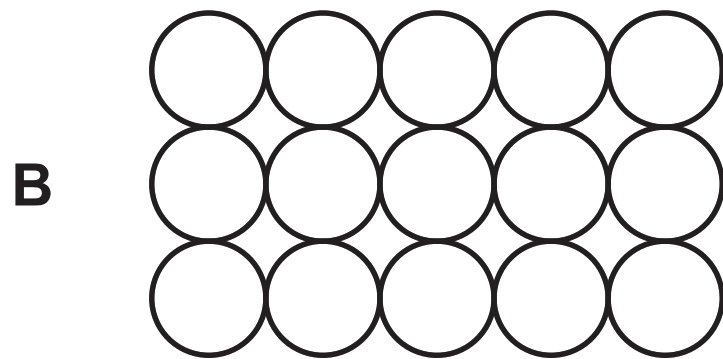
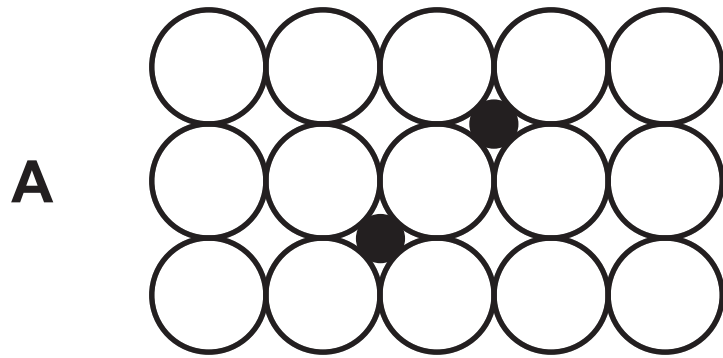


**DIAGRAM 9**





## DIAGRAM 10





**DIAGRAM 11**

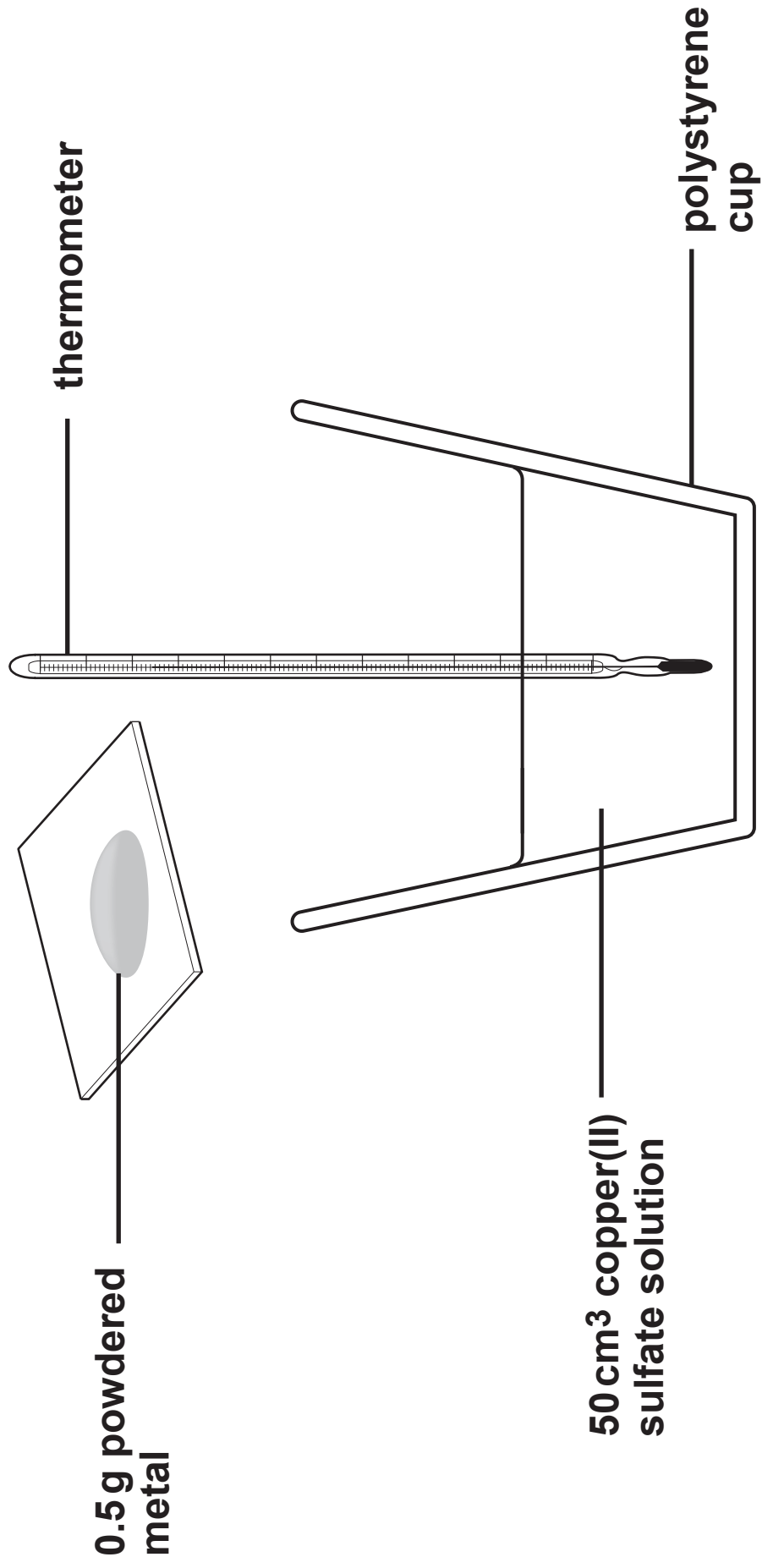
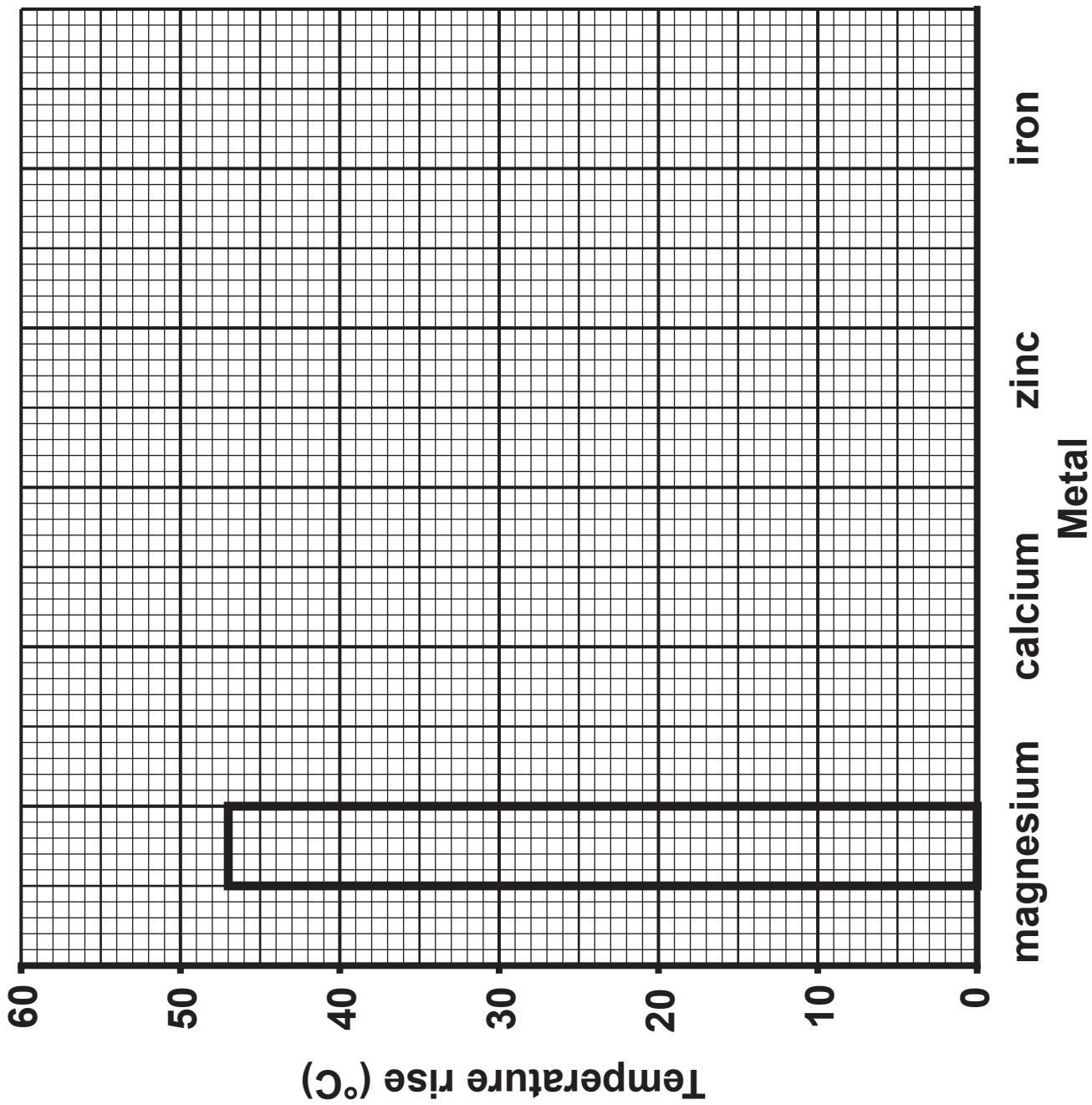




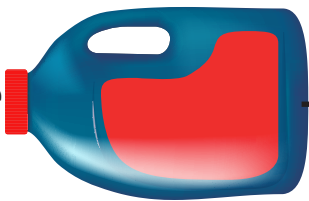
DIAGRAM 12



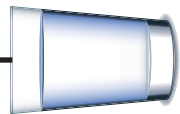


# DIAGRAM 13

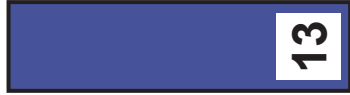
battery acid



milk



water






drain cleaner





# DIAGRAM 14

## TABLE 1

<p><b>A</b> Air-activated (disposable)</p> <p>The packaging seal is broken allowing air to reach the chemicals causing a chemical reaction to occur.</p> <p>This type of hand warmer can only be used once.</p>	<p><b>B</b> Battery powered (reusable)</p> <p>A metal coil heats up when the device is switched on.</p> <p>The device needs recharging.</p>	<p><b>C</b> Supersaturated solution (reusable)</p> <p>A metal button on the packaging is pressed. This causes crystals to form in the solution.</p> <p>The hand warmer can be reactivated by placing it in boiling water.</p>
		



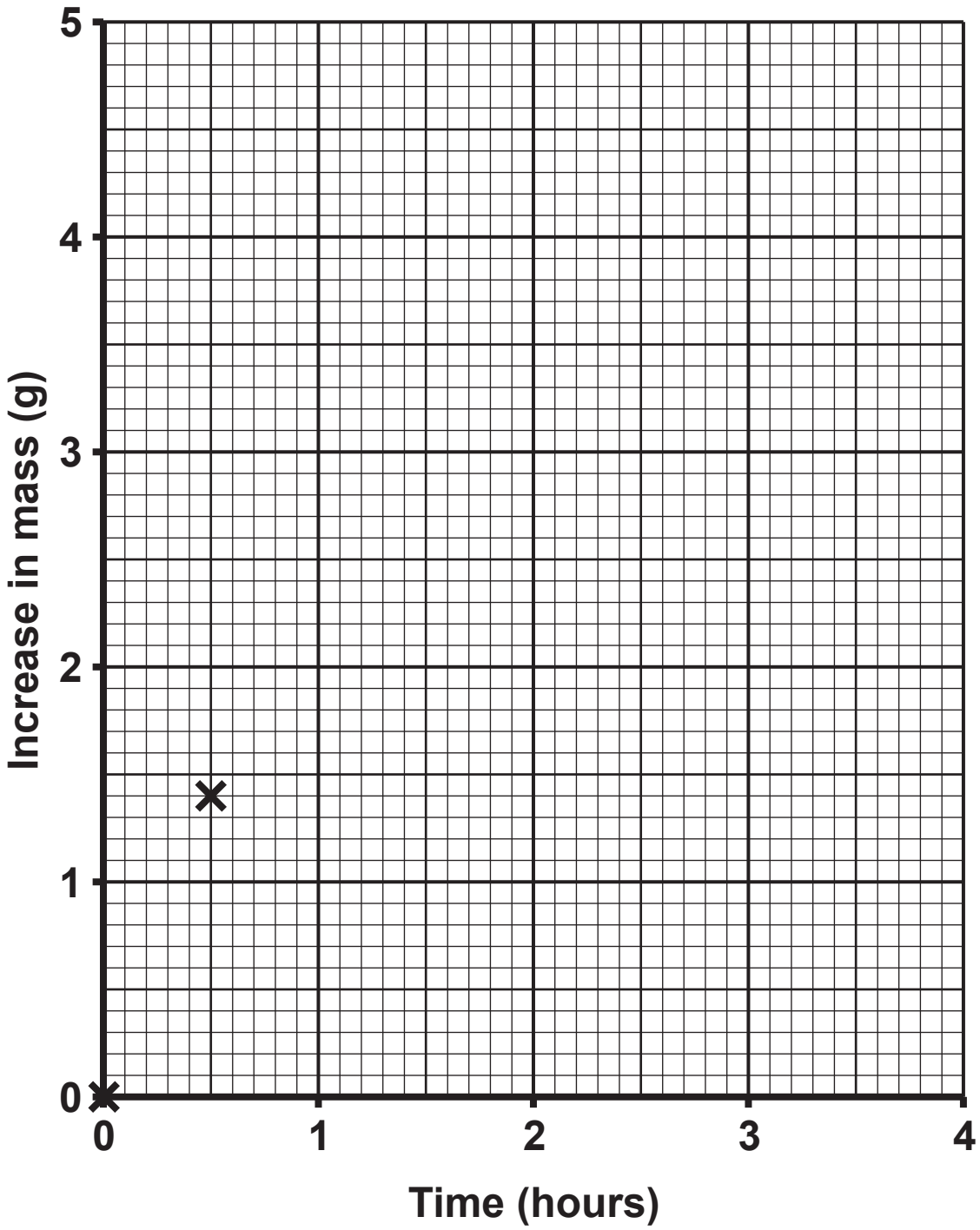
## DIAGRAM 15

TABLE 2

Type of hand warmer	Cost (£)	Time to warm up after activation	Temperature after being activated and placed in a freezer (°C)				
			after 15 mins	after 30 mins	after 60 mins	after 90 mins	after 120 mins
A	1	less than 1 min	39	39	38	38	37
B	80	less than 1 min	32	29	28	27	26
C	24	less than 1 min	42	34	27	18	8

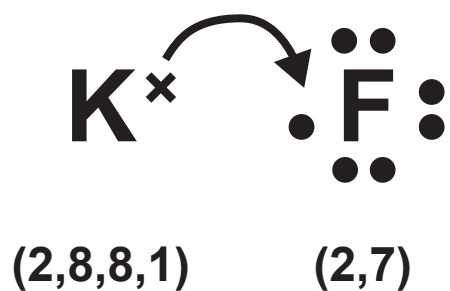


DIAGRAM 16





## DIAGRAM 17



## DIAGRAM 18

Student's answer



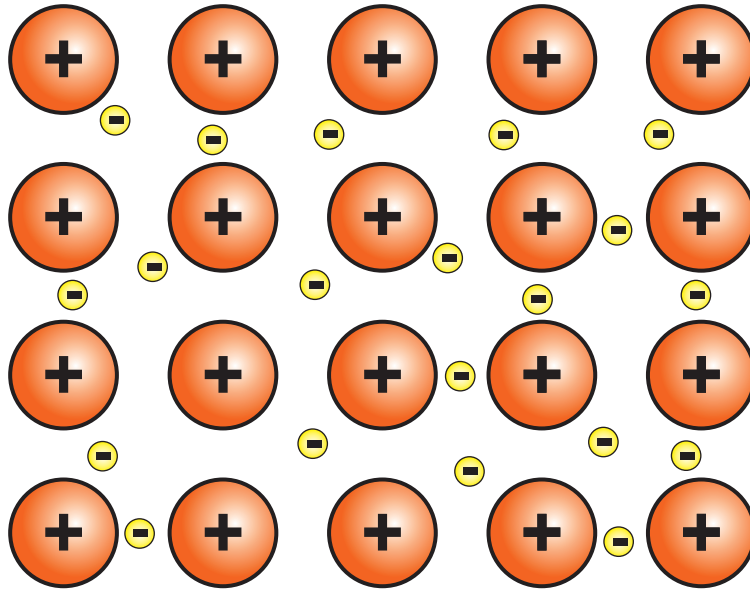


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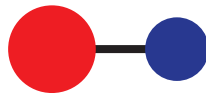
**TURN OVER**

# DIAGRAM 19

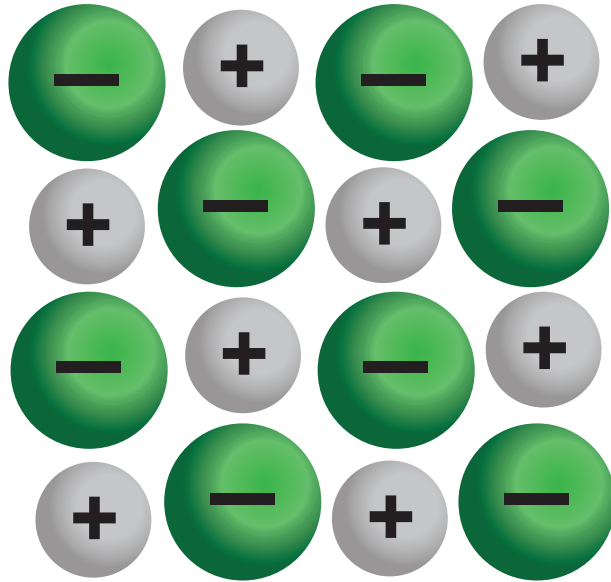
## A



## B



C



D

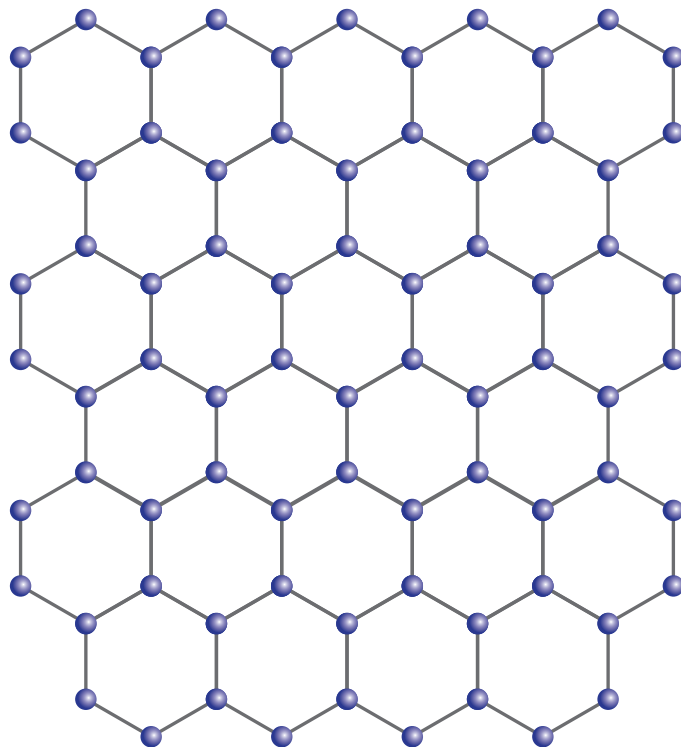
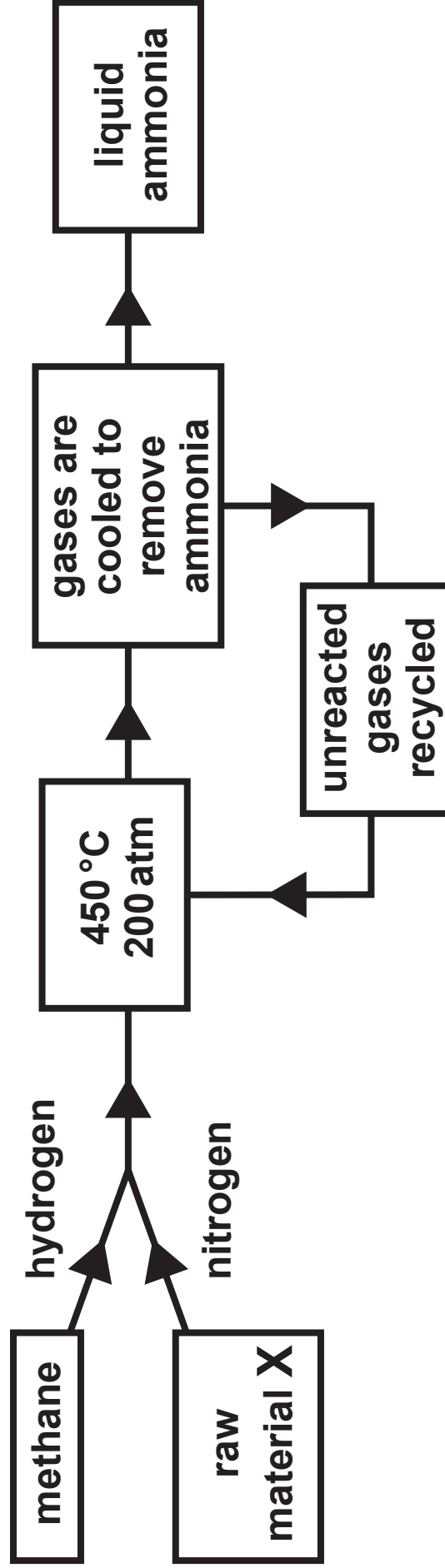




DIAGRAM 20





## DIAGRAM 21



## DIAGRAM 22

Key:  nitrogen gas, N<sub>2</sub>

 hydrogen gas, H<sub>2</sub>

