GCSE

3410U10-1

THURSDAY, 13 JUNE 2024 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources

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 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 9 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.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**7**	
3.	**7**	
4.	**6**	
5.	**6**	
6.	**7**	
7.	**6**	
8.	**10**	
9.	**6**	
10.	**7**	
11.	**6**	
12.	**7**	
Total	**80**	

Answer ALL questions.

1 This question is about mixtures and how to separate them.

(a) Draw ONE line from each mixture to the method used to separate the mixture. [4 marks]

	MIXTURE	METHOD
A	ethanol and water	filtration
B	sand and water	evaporation
C	iron filings and sulfur powder	distillation
D	salt and water	using a magnet

(b) Which of the mixtures, A, B, C or D, contains a SOLID that has dissolved in water? [1 mark]

_____

5

2 (a) When lithium reacts with water in a large beaker hydrogen gas is released.

Lithium hydroxide solution is also formed. This turns universal indicator purple.

(i) Tick (✓) the box next to the description of what is seen when lithium reacts with water in a large beaker. [1 mark]

- ☐ lithium melts into a ball and sinks
- ☐ lithium fizzes and moves around the surface of the water
- ☐ lithium catches fire and burns with a blue flame

(ii) Tick (✓) the box that describes lithium hydroxide solution. [1 mark]

- ☐ neutral
- ☐ acid
- ☐ alkali

(iii) Lithium hydroxide contains Li^+ and OH^- ions.

CIRCLE the correct formula for lithium hydroxide. [1 mark]

liOH LiOH $Li(OH)_2$ Li_2OH

2 (b) **Lithium reacts with chlorine to form lithium chloride.**

(i) **Tick (✓) the box next to the correct balanced equation for the reaction. [1 mark]**

☐ $2Li + Cl_2 \longrightarrow 2LiCl_2$

☐ $2Li + Cl_2 \longrightarrow 2Li_2Cl$

☐ $2Li + Cl_2 \longrightarrow 2LiCl$

(ii) **Anwen was asked to use a flame test and a silver nitrate test to identify lithium chloride.**

CIRCLE the expected observation for each test. [2 marks]

FLAME TEST	SILVER NITRATE TEST
green flame	yellow precipitate
red flame	blue precipitate
lilac flame	white precipitate

2 (c) **Lithium reacts with oxygen to form lithium oxide.**

Tick (✓) the box next to the calculation used to find the relative formula mass (M_r) of lithium oxide, Li_2O. [1 mark]

A_r(Li) = 7 A_r(O) = 16

- ☐ **7 + 7 + 16**
- ☐ **7 + 16**
- ☐ **7 + 7 + 16 + 16**
- ☐ **7 + 16 + 16**

7

3 **PIE CHART 3 in the separate diagram booklet shows some of the major uses of limestone.**

(a) **Use PIE CHART 3 to find the percentage of limestone used to make cement. [2 marks]**

Percentage = _____ %

(b) **When limestone is heated, it produces calcium oxide and carbon dioxide.**

(i) **Complete the equation for this reaction by giving the formula of calcium oxide. [1 mark]**

$CaCO_3 \longrightarrow$ _____ + CO_2

(ii) **<u>UNDERLINE</u> the name for this type of reaction. [1 mark]**

displacement decomposition

precipitation neutralisation

3 (b)(iii)

When water is added to calcium oxide, an exothermic reaction occurs.

Tick (✓) the observation that shows that this reaction is exothermic. [1 mark]

- ☐ **solid forms**
- ☐ **colour changes**
- ☐ **ice forms**
- ☐ **steam is given off**

(c) Give TWO benefits of limestone quarrying. [2 marks]

_____

_____

_____

7

4 Atoms are made of protons, neutrons and electrons.

Some of the properties of protons, neutrons and electrons are shown in TABLE 4 in the separate diagram booklet.

(a) COMPLETE TABLE 4. [2 marks]

(b) Element X has 7 protons, 7 electrons and 7 neutrons.

Use this information to complete the following sentences. [4 marks]

The atomic number of element X is

_____.

The mass number of element X is

_____.

The electronic structure of element X is

_____.

Element X is in Group _____ of the Periodic Table.

6

5 **DIAGRAMS A, B, C and D in DIAGRAM 5 in the separate diagram booklet represent argon (Ar), nitrogen (N_2), oxygen (O_2) and carbon dioxide (CO_2), but not in that order.**

(a) **Give the LETTER of the diagram that represents argon. [1 mark]**

_____

(b) **Give the LETTER of the diagram that represents a compound. Give a reason for your answer. [2 marks]**

Letter _____

Reason _____

_____

_____

(c)(i) **Use information from DIAGRAM 5. Draw a diagram to represent a molecule of nitrogen dioxide, NO_2. [1 mark]**

5 (c)(ii) Calculate the relative formula mass (M_r) of nitrogen dioxide, NO_2. [1 mark]

$A_r(N) = 14$ $A_r(O) = 16$

M_r = _____

(iii) Balance the equation for the reaction between nitrogen and oxygen to produce nitrogen dioxide. [1 mark]

$$N_2 + \square\ O_2 \longrightarrow \square\ NO_2$$

6

6 Acid rain is formed by sulfur dioxide gas from industrial processes escaping into the atmosphere and reacting with water in clouds.

In recent years, scientists have developed sulfur scrubbers to stop sulfur dioxide gas escaping into the atmosphere from coal-fired power plants. The scrubbers are placed in the chimneys and trap the sulfur dioxide.

There are two types of scrubbers – wet scrubbers and dry scrubbers.

WET SCRUBBERS

Water is sprayed down the chimneys onto beds of crushed limestone. Sulfur dioxide is absorbed by the water forming an acidic solution which is neutralised by the limestone.

Wet scrubbing can be used in small and large power plants. During wet scrubbing 4% of sulfur dioxide escapes.

DRY SCRUBBERS

A mixture of dry alkaline chemicals is sprayed into the chimneys. Some of the dry chemicals neutralise the sulfur dioxide.

Dry scrubbing is limited to small or medium sized power plants. No water is used so costs are lower. During dry scrubbing 10% of sulfur dioxide escapes.

6 (a) **Tick (✓) the physical change happening to the sulfur dioxide in a wet scrubber. [1 mark]**

- ☐ **it freezes**
- ☐ **it dissolves**
- ☐ **it condenses**
- ☐ **it melts**

(b) **Tick (✓) the pH change that happens as a solution of sulfur dioxide is neutralised in a wet scrubber. [1 mark]**

- ☐ **pH 11 to pH 7**
- ☐ **pH 4 to pH 7**
- ☐ **pH 7 to pH 11**
- ☐ **pH 7 to pH 4**

6 (c) **TABLE 6.1 in the separate diagram booklet shows some statements about wet and dry scrubbing.**

Complete TABLE 6.1 using a tick (✓) to show whether each statement applies to wet scrubbing only, to dry scrubbing only or to both wet and dry scrubbing. [3 marks]

(d) **TABLE 6.2 in the separate diagram booklet shows the mass of sulfur dioxide released into the atmosphere per year in the UK every five years between 1990 and 2015.**

Describe the trend in the mass of sulfur dioxide released into the atmosphere between 1990 and 2015. [2 marks]

7

7 (a) Three samples of water, **A**, **B** and **C**, were tested for hardness using soap solution.

The results are shown below.

- No lather formed in samples **A** and **B**
- Lather formed in sample **C**
- When sample **A** was boiled and soap solution added, lather formed
- When sample **B** was boiled and soap solution added, no lather formed

Tick (✓) THREE conclusions that can be drawn from these results. [3 marks]

- ☐ sample **C** is soft water
- ☐ all the samples are hard water
- ☐ samples **A** and **B** are hard water
- ☐ sample **B** contains temporary hardness
- ☐ sample **A** contains temporary hardness
- ☐ samples **A** and **B** contain permanent hardness

7 (b) **Give ONE method other than boiling that can be used to remove hardness from water. [1 mark]**

_____

_____

(c) **Tick (✓) the compound that causes hardness in water. [1 mark]**

- ☐ **sodium nitrate**
- ☐ **zinc chloride**
- ☐ **calcium sulfate**
- ☐ **potassium oxide**

(d) **Give ONE health benefit of living in a hard water area. [1 mark]**

_____

_____

6

8 A group of students investigated the rate of the reaction between magnesium and dilute hydrochloric acid. Their apparatus is shown in DIAGRAM 8.1 in the separate diagram booklet.

The equation for the reaction is as follows.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

They carried out the reaction at 30 °C. The hydrogen gas was collected in a gas syringe and the volume recorded every minute for 6 minutes.

The results are shown in TABLE 8.2 in the separate diagram booklet. The value at 1 minute has been left out.

(a)(i) Plot the volume of hydrogen produced against time on the grid in GRAPH 8.3 in the separate diagram booklet. The first point has been plotted for you. Draw a suitable line. [3 marks]

8 (a)(ii)

I. Use GRAPH 8.3 to estimate the volume of hydrogen that would have been produced after 1 minute. [1 mark]

_____ cm^3

II. Calculate the mean rate of the reaction over the FIRST minute. Give your answer in cm^3/s. [2 marks]

Use the formula

$$\text{mean rate} = \frac{\text{volume of hydrogen } (cm^3)}{\text{time (s)}}$$

Mean rate = _____ cm^3/s

8 (b) There is no catalyst for this reaction.

Give TWO ways the students could increase the rate of this reaction. [2 marks]

_____

_____

_____

(c) The students calculated that if they used 0.5 g of magnesium in this reaction, they would make 2.0 g of magnesium chloride. However, when they used 0.5 g of magnesium only 1.7 g of magnesium chloride was made.

Calculate the percentage yield for this reaction. [2 marks]

Percentage yield = _____ %

10

9 **Mrs Ennion asked her Year 10 class what they knew about fluoride in drinking water.**

Peter, Imran, Catrin and Susan's responses are shown below.

Peter

I read on the internet that fluoride is poisonous

Catrin

My cousin Jack lives in Newcastle and he has to drink fluoridated water

Imran

My dad said that fluoride cleans your teeth

Susan

I saw a television programme and it said that fluoride makes your teeth yellow

Use your own knowledge of fluoridation to comment on each of these responses.
[6 marks QER]

continue your answer on the next page

6

10 **TABLE 10 in the separate diagram booklet gives information about seven elements, A – G.**

(a) **Use information from TABLE 10 to answer parts (i) – (iii).**

(i) **Give the LETTER of the element that has the greatest difference between its melting point and boiling point. [1 mark]**

_____

(ii) **Give the LETTERS of the TWO elements that are gases at room temperature, 20 °C.**

Give a reason for your choice. [2 marks]

Letters _____ and _____

Reason _____

_____

_____

10 (a)(iii) Give the LETTER of the element that is a metalloid.

Explain your choice. [2 marks]

Letter _____

Explanation _____

_____

_____

_____

_____

(b) One of the elements is aluminium. It reacts spectacularly with iron(III) oxide in the thermit reaction.

Complete and balance the equation for the reaction between aluminium and iron(III) oxide to produce aluminium oxide and iron. [2 marks]

$\square\ Al + Fe_2O_3 \longrightarrow$ _____ $+ 2\,Fe$

7

11 (a) Amanda wanted to determine what coloured dyes were present in a sample of orange ink.

DIAGRAM 11.1 in the separate diagram booklet shows a piece of chromatography paper, supported by a pencil, placed in a beaker at the start of her experiment.

COMPLETE DIAGRAM 11.1 by showing

- **the position of the ink sample at the start**
- **the water level in the beaker [2 marks]**

(b) TABLE 11.2 in the separate diagram booklet shows the R_f values for some coloured dyes that are found in inks.

(i) Explain why coloured dyes have different R_f values. [2 marks]

11 (b)(ii)

Orange ink separates into red and yellow dyes.

ON CHROMATOGRAM 11.3 in the separate diagram booklet, draw the positions of the spots you would expect to see after a sample of orange ink has been analysed by chromatography. [2 marks]

Use the formula

$$\frac{\text{distance travelled by dye}}{\text{distance travelled by solvent}} = R_f \text{ value}$$

6

12 (a) Wegener's theory of continental drift was not accepted by other scientists during his lifetime because he had no explanation of how the continents moved.

We now know that the continents sit on tectonic plates which move very slowly.

State why these plates move. [1 mark]

12 (b) **DIAGRAMS 12.1 and 12.2 in the separate diagram booklet show two different types of plate boundary.**

At a constructive plate boundary, the plates move away from each other.

At a destructive plate boundary, the plates move towards each other.

Describe what happens at each type of boundary. [4 marks]

Constructive

Destructive

12 (c) The cities of Los Angeles and San Francisco are on opposite sides of a conservative plate boundary at a distance of 600 km apart.

They are moving closer together as the plates slide past one another at a relative speed of about 40 mm per year.

Use the formula below to calculate the amount of time before the cities are next to one another. [2 marks]

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

1 km = 1 000 m 1 m = 1 000 mm

Time = _____ years

7

END OF PAPER

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

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

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

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

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

GCSE

3410U10-1

THURSDAY, 13 JUNE 2024 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources

FOUNDATION 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 _____

PIE CHART 3

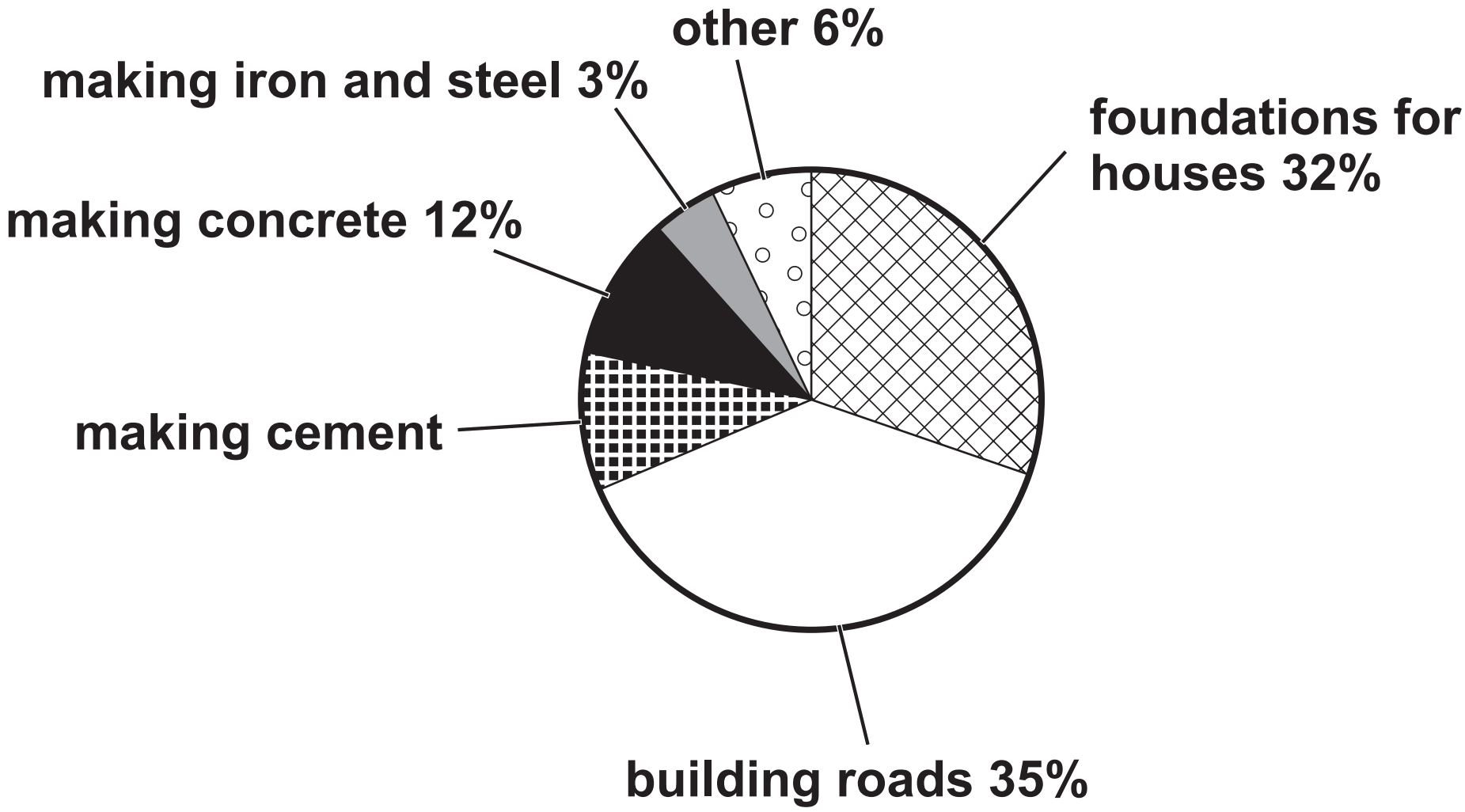

other 6%
making iron and steel 3%
foundations for houses 32%
making concrete 12%
making cement
building roads 35%

TABLE 4

Particle	Mass	Charge
proton	_____	+1
neutron	1	0
electron	0	_____

DIAGRAM 5

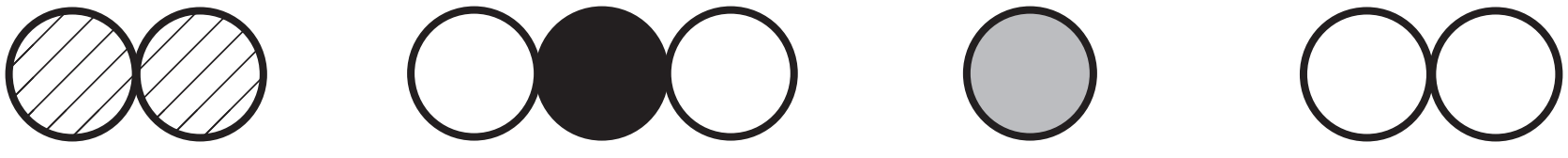


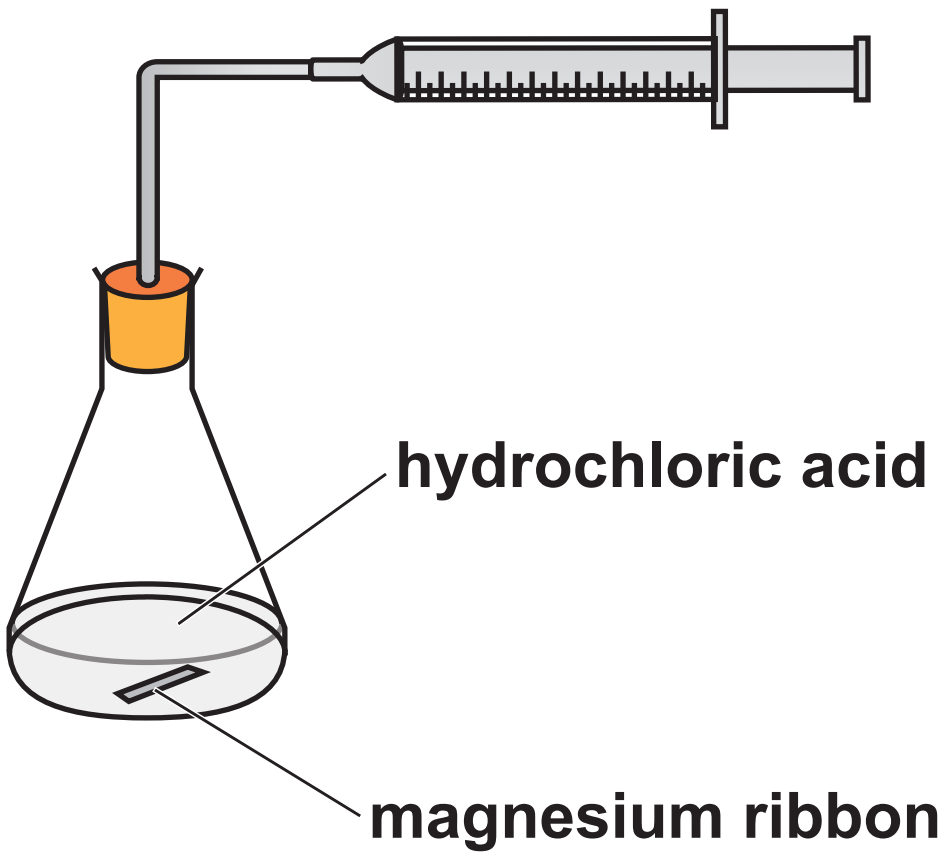
TABLE 6.1

Statement	Wet scrubbing only	Dry scrubbing only	Both wet and dry scrubbing
Can be used in large power plants			
At least 90% efficient			
Neutralises sulfur dioxide			

TABLE 6.2

Year	Mass of sulfur dioxide released (millions of tonnes)
1990	3.50
1995	0.60
2000	0.40
2005	0.35
2010	0.30
2015	0.20

DIAGRAM 8.1



THIS IS A BLANK PAGE

TURN OVER

TABLE 8.2

Time (minutes)	0	1	2	3	4	5	6
Volume of hydrogen (cm^3)	0		29	39	46	50	50

GRAPH 8.3

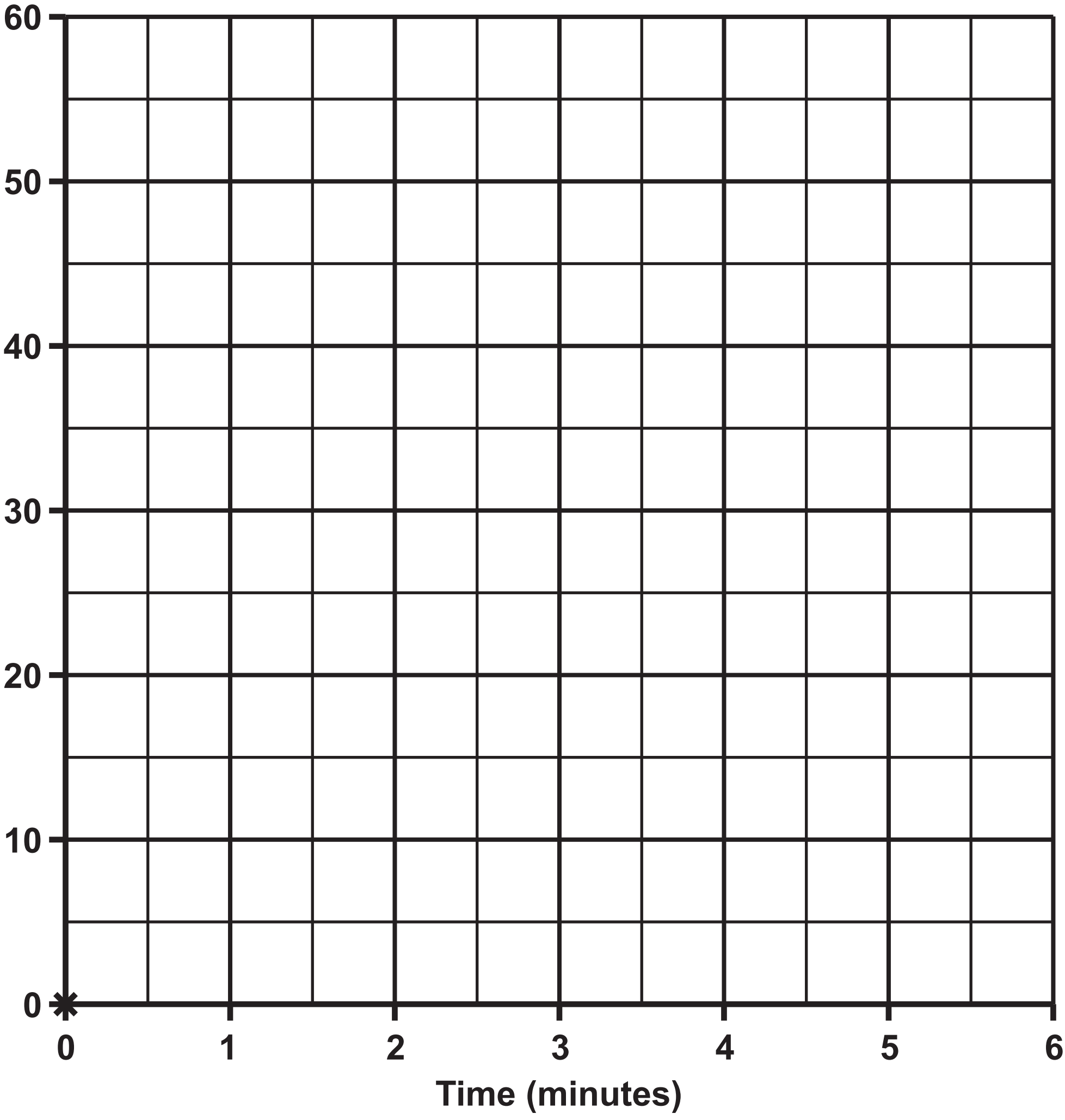
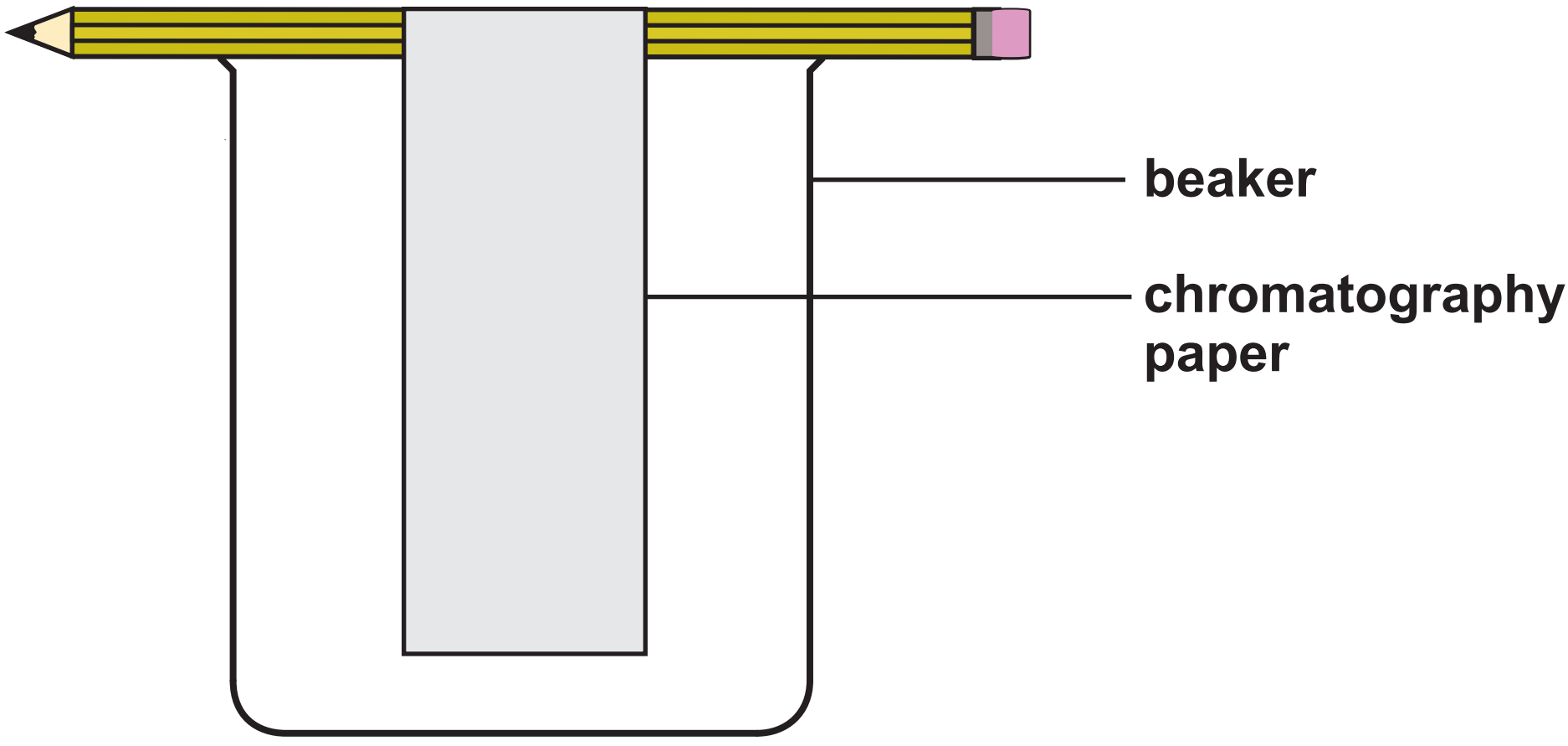

Volume of hydrogen (cm3)
60
50
40
30
20
10
0
0
1
2
3
4
5
6
Time (minutes)

TABLE 10

Element	Melting point (°C)	Boiling point (°C)	Electrical conductivity	Malleability
A	839	1484	good	good
B	−23	115	poor	
C	1414	3265	poor	poor
D	−102	−34	poor	
E	10	112	poor	poor
F	−188	−42	poor	
G	660	2470	good	good

DIAGRAM 11.1



THIS IS A BLANK PAGE

TURN OVER

TABLE 11.2

Dye colour	R_f value
blue	0.40
yellow	0.25
red	0.70
green	0.15

CHROMATOGRAM 11.3

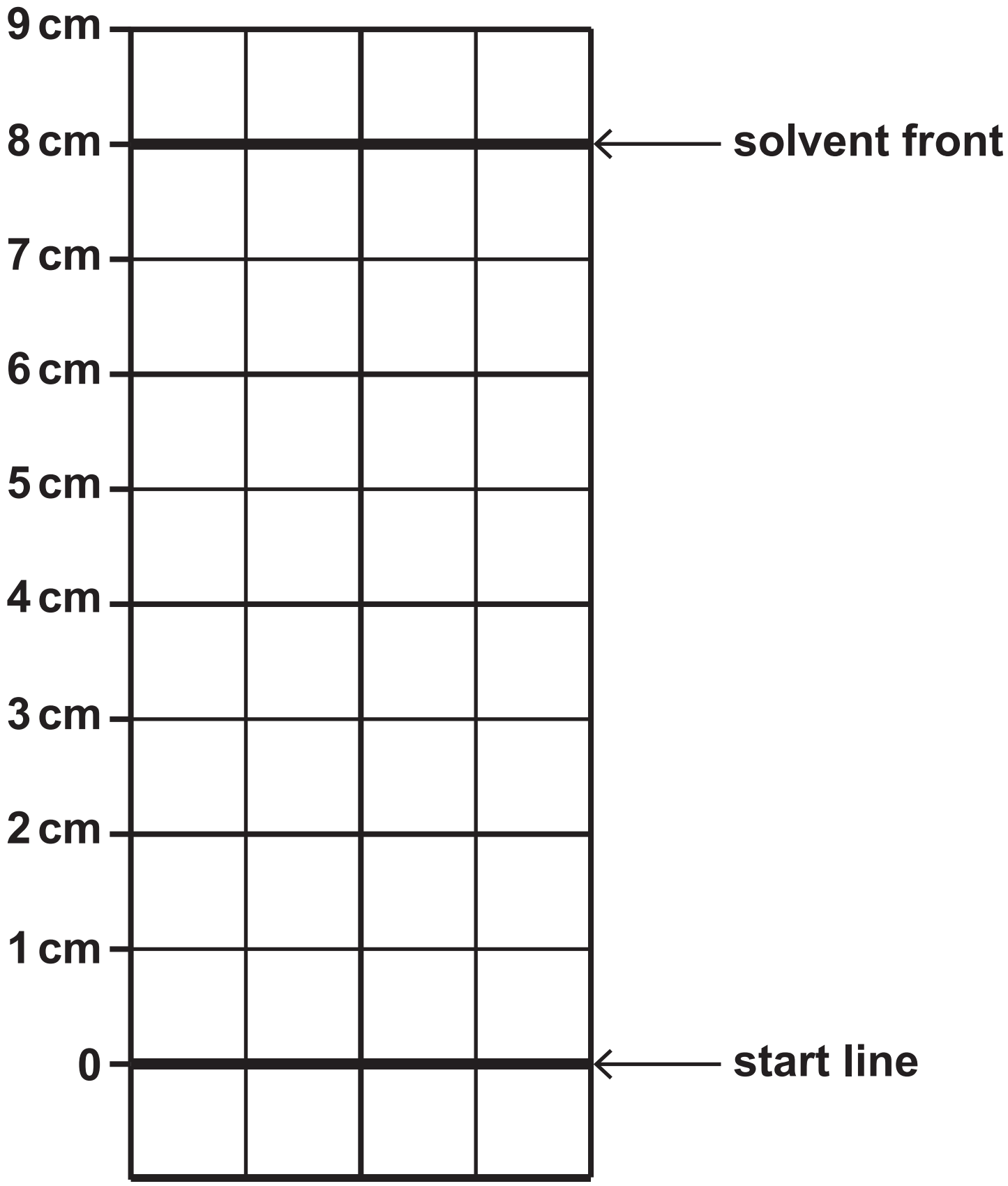
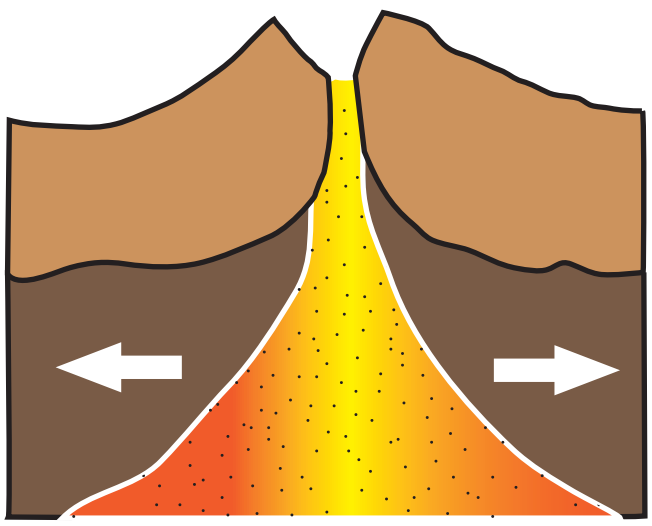
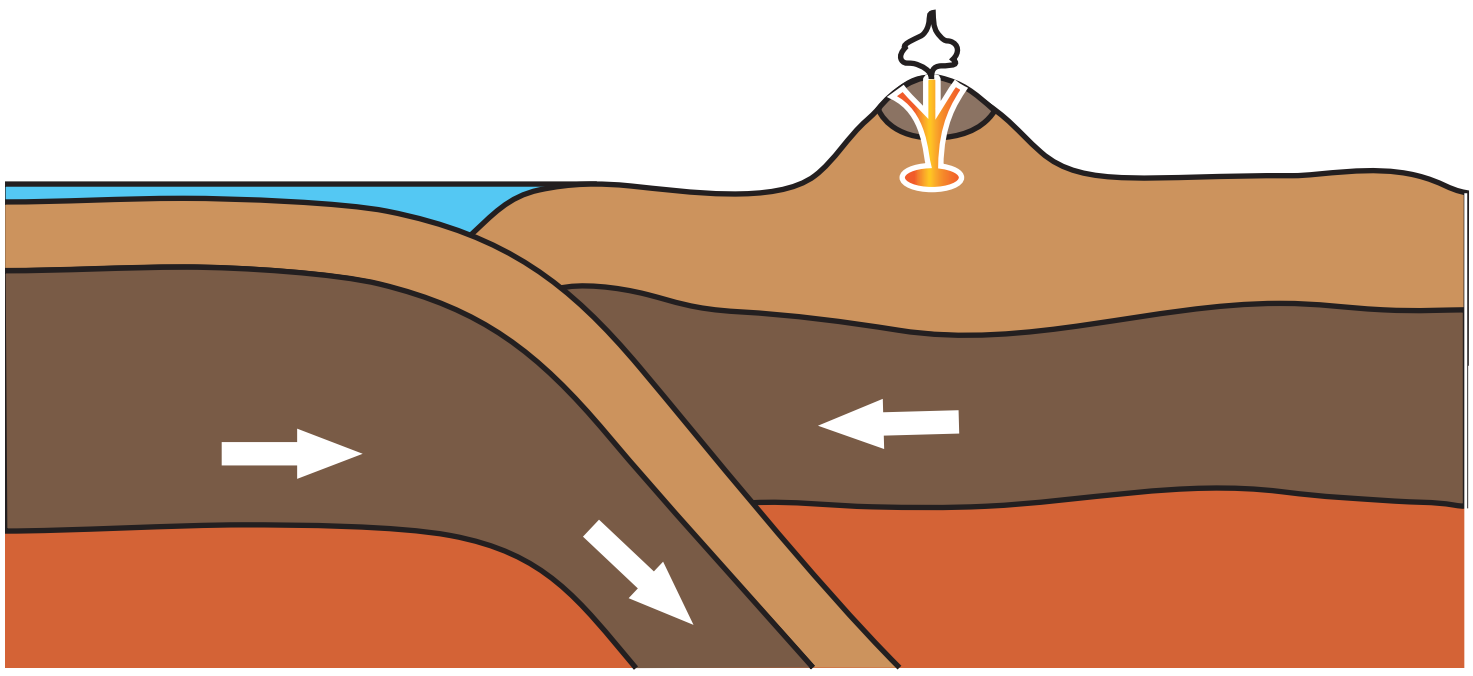


DIAGRAM 12.1



CONSTRUCTIVE

DIAGRAM 12.2



DESTRUCTIVE

GCSE

3410U10-1

THURSDAY, 13 JUNE 2024 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources

FOUNDATION 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

KEY

A_r	relative atomic mass
Sym	symbol
Z	atomic number

1	2	GROUP										3	4	5	6	7	0
								1 H 1									4 He 2
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	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26	59 Co 27	59 Ni 28	63.5 Cu 29	65 Zn 30	70 Ga 31	73 Ge 32	75 As 33	79 Se 34	80 Br 35	84 Kr 36
86 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	99 Tc 43	101 Ru 44	103 Rh 45	106 Pd 46	108 Ag 47	112 Cd 48	115 In 49	119 Sn 50	122 Sb 51	128 Te 52	127 I 53	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	179 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76	192 Ir 77	195 Pt 78	197 Au 79	201 Hg 80	204 Tl 81	207 Pb 82	209 Bi 83	210 Po 84	210 At 85	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89															

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