Surname		Centre Number	Candidate Number
First name(s)			0

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GCSE

3430UB0-1

S23-3430UB0-1

FRIDAY, 16 JUNE 2023 – MORNING

SCIENCE (Double Award)
Unit 2 – CHEMISTRY 1
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	8	
2.	7	
3.	4	
4.	6	
5.	8	
6.	9	
7.	9	
8.	9	
Total	**60**	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page 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 **4** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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CJ*(S20-3430UB0-1)

Answer **all** questions.

1.   The diagrams below show the electronic structures of five elements, **A**, **B**, **C**, **D** and **E**.

The letters are not the symbols of the elements.
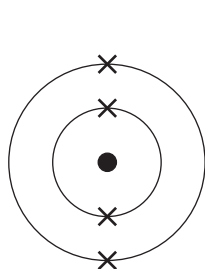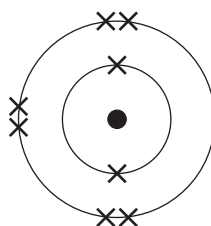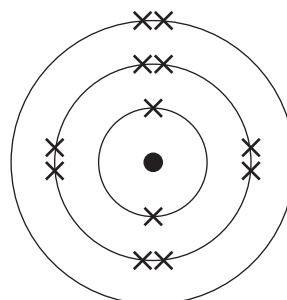
A   **B**   **C**
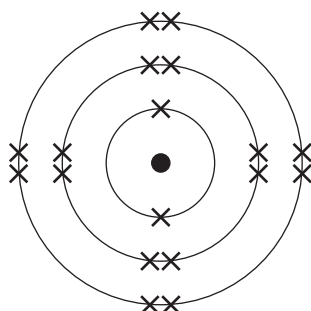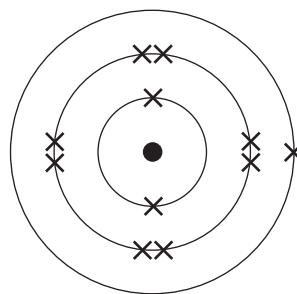
D   **E**

(a)   Give the **letters** of the elements found in Period 2 of the Periodic Table. Give a reason for your choice.   [2]

Letters .... and ....

Reason ....

....

(b) Give the **letter** of the element found in Group 0 of the Periodic Table. Give a reason for your choice. [2]

Letter ....

Reason ....

....

(c) Explain how the electronic structure of element **E** can be used to determine its atomic number. [2]

....

....

....

(d) One of the diagrams represents the element oxygen. Oxygen reacts with potassium to form potassium oxide.

Give the formula for potassium oxide and balance the equation for this reaction. [2]

$$\boxed{}\ K\ +\ O_2\ \longrightarrow\ 2\ \text{..............................}$$

3430UB01
03

8

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2. The diagram shows the distribution of water on Earth.

freshwater, 35 million km³

oceans, 1.365 billion km³

← surface water, 1.2%

← groundwater, 30.1%

← glaciers and ice caps, 68.7%
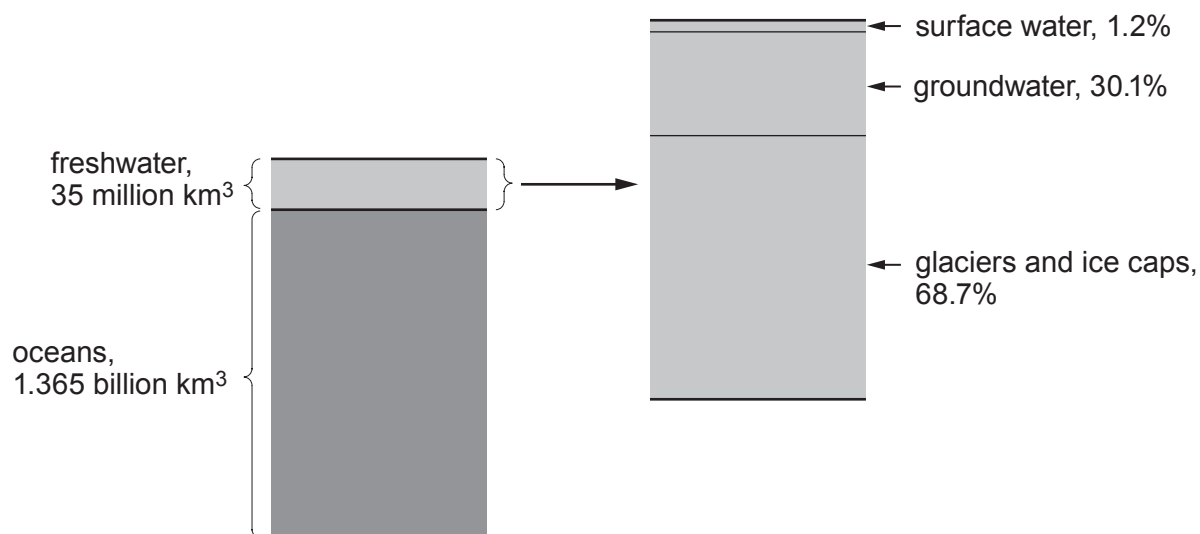
(a) Use the information in the diagram to calculate the volume of freshwater that is available as surface water. [2]

Volume = ... million km³

(b) As the Earth's population continues to increase, there is going to be a greater need to get freshwater from seawater. This is known as desalination.

Give a method that could be used to obtain freshwater from seawater. [1]

....

Examiner only

(c)   Calcium ions, Ca^{2+}, cause hardness in groundwater.

Describe an experiment to **compare** the hardness of two groundwater samples.   [3]

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(d)   Washing soda is used to soften hard water. This contains sodium carbonate.

Give the formula of sodium carbonate.   [1]

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7

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3430UB01
05

6

3. A food colouring contains a mixture of yellow and green dyes.

The table shows the R_f values of these dyes using different solvents in separate chromatography experiments.

Colour	R_f value when the solvent is		
	Water	Acid	Alcohol
yellow	0.74	0.35	0.00
green	0.76	0.81	0.46

(a) Why would yellow and green dyes be difficult to separate in a chromatography experiment using **water** as the solvent? [1]

....

....

(b) Describe what you would expect to see in the chromatogram obtained using **alcohol** as the solvent. [1]

....

....

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(c)   Complete the chromatogram to show the results you would expect using **acid** as the solvent.   [2]

10 cm - - - - - - - - - - - - - - - - - -   solvent front

9 cm

8 cm

7 cm

6 cm

5 cm

4 cm

3 cm

2 cm

1 cm

✗   start line

4

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3430UB01
07

4. The diagrams show two types of plate boundaries, **A** and **B**. Describe what happens at each boundary. [6 QER]

A

B

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6

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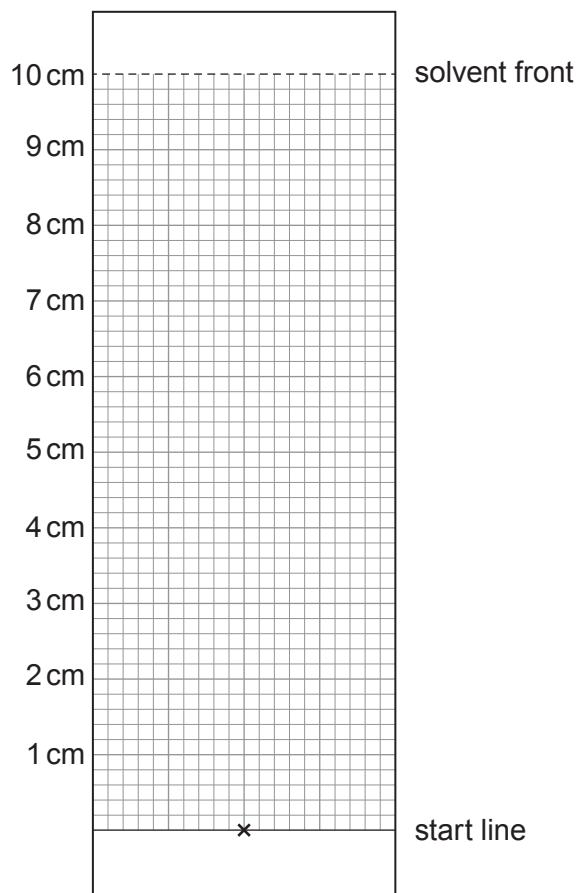
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ON THIS PAGE**

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Turn over.

5. Marble chips (calcium carbonate) react with dilute hydrochloric acid to produce carbon dioxide gas.

Graph **A** shows the volume of carbon dioxide produced during the reaction between 0.25 g of marble chips and **excess** dilute hydrochloric acid at 30 °C.
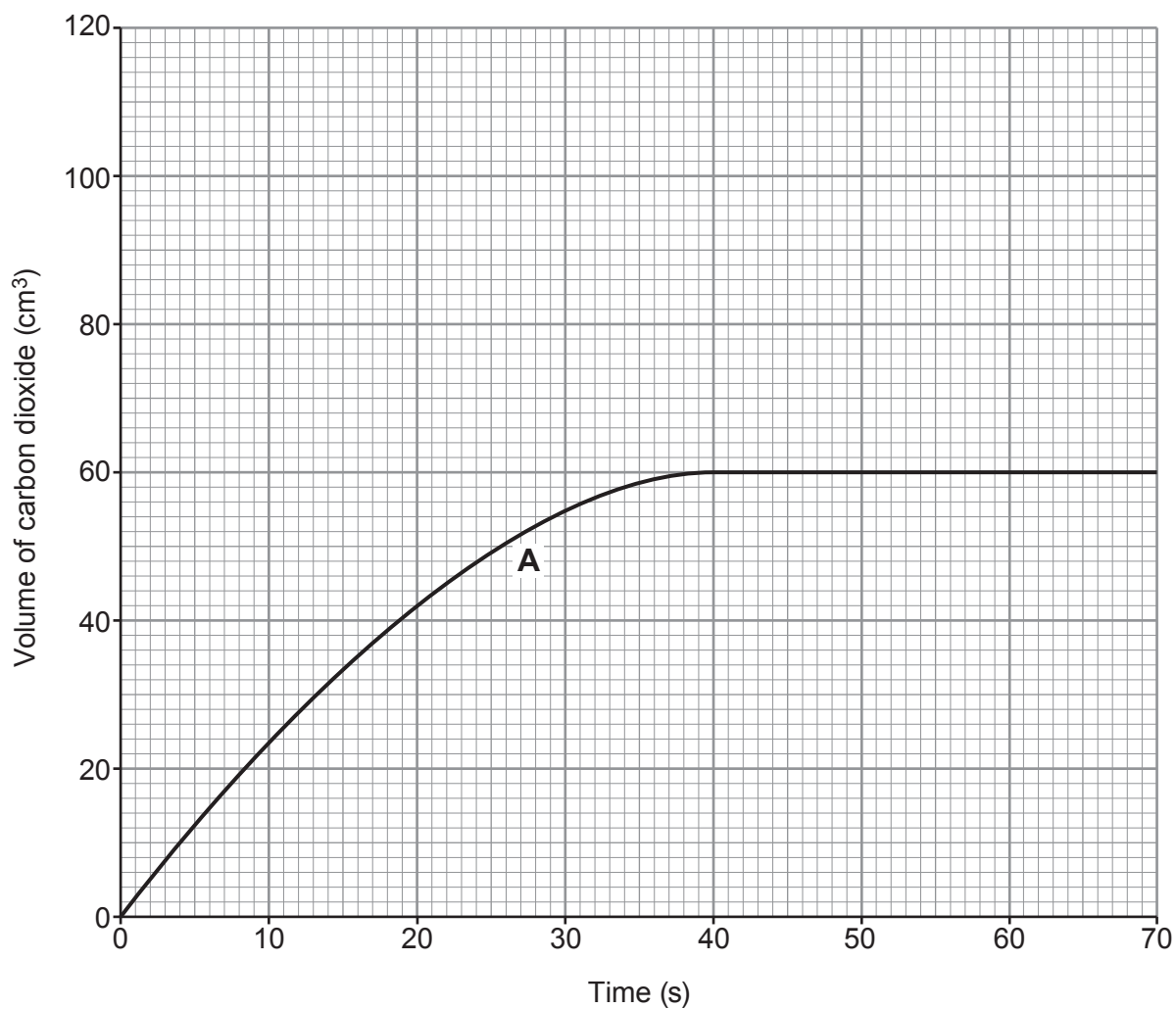
(a) State why no more marble chips remain when the reaction stops. [1]

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....
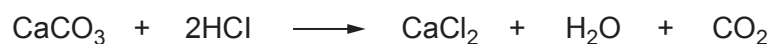
(b) The original experiment was repeated at 60 °C.

On the grid draw the curve you would expect to see for the production of carbon dioxide at this temperature. [1]

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(c)   The equation for the reaction between calcium carbonate and dilute hydrochloric acid is as follows.

$$CaCO_3 \ + \ 2HCl \ \longrightarrow \ CaCl_2 \ + \ H_2O \ + \ CO_2$$

Calculate the mass of calcium chloride produced when 7.8 g of calcium carbonate is reacted with excess acid. [2]

$$M_r(CaCO_3) = 100 \qquad M_r(CaCl_2) = 111$$

Mass = ... g

(d)   When the reaction was repeated with a different mass of calcium carbonate, it was found that 14.3 g of calcium chloride formed. This represents a yield of 53.7%.

Calculate the maximum mass of calcium chloride that could have been formed. [2]

Maximum mass = ... g

(e)   Catalysts can be added to some chemical reactions in order to increase their rate.

Explain how a catalyst increases the rate of a chemical reaction. [2]

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6. Fluoride ions are added to drinking water in some areas of the UK.

The table below shows the effect of different levels of fluoride in drinking water on the number of decayed, missing and filled teeth (DMFT) and the percentage of people suffering from fluorosis.

Concentration of fluoride (mg/dm^3)	Mean DMFT	Percentage of people affected by fluorosis (%)
0.3	7.0	4
0.6	4.5	6
0.9	3.0	15
1.2	2.5	35
1.5	2.3	40
1.8	2.0	45
2.1	2.1	60
2.4	2.1	68
2.7	2.1	75

(a) The recommended concentration of fluoride ions to be added to drinking water in the UK is $1.0\,mg/dm^3$.

Use the information in the table to explain why this is the recommended level in terms of DMFT and fluorosis. [4]

DMFT

....

....

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Fluorosis

....

....

....

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(b) Chlorine is added to all drinking water in the UK, whilst fluoride is only added in some areas.

Explain why some people are opposed to adding fluoride but no-one is opposed to adding chlorine to drinking water. [2]

....

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(c) Fluorine reacts with titanium at very high temperatures, forming titanium fluoride.

In an experiment 3.8 g of fluorine reacted with 2.4 g of titanium.

Calculate the simplest formula for titanium fluoride. You **must** show your working. [3]

$$A_r(Ti) = 48 \qquad\qquad A_r(F) = 19$$

Simplest formula ....

9

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7. A great deal of scientific research into global warming has happened over the last 30 years.

More recently, two new contrasting theories linked to global warming have been widely reported. These are outlined below.

Solar activity
A small number of scientists believe that changes in solar activity (changes in the brightness and warmth of the Sun) is causing global warming. Solar activity occurs on the surface of the Sun when nuclear reactions cause flares to be released, high winds to occur and a release of high energy particles from the Sun.

Global dimming
Some scientists believe that global warming is increasing the Earth's mean temperature, but that global dimming is preventing it from increasing even more. Global dimming is the reduction in the amount of radiation reaching the Earth's surface from the Sun. It is thought to be caused by an increase of aerosol particles in the Earth's atmosphere caused by pollution, dust and smog, as well as volcanic eruptions. These particles absorb solar energy and reflect sunlight back into space.

Figure 1 shows the mean atmospheric temperature, carbon dioxide concentration in the atmosphere and solar activity between 1930 and 2010.

Figure 1

Year	Mean atmospheric temperature (°C)	CO_2 concentration (ppm)	Solar activity (arbitrary units)
1930	13.6	309	3.9
1940	13.6	311	4.0
1950	13.8	316	4.2
1960	13.9	320	4.2
1970	14.0	331	4.0
1980	14.2	342	3.9
1990	14.3	358	3.7
2000	14.4	370	3.7
2010	14.6	383	3.6

ppm = parts per million

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Figure 2 shows the mean atmospheric temperature within a 20-mile radius of the Mount Pinatubo volcano in the Philippines between 1990 and 2000. Mount Pinatubo erupted in 1991.

Figure 2

Year	Mean atmospheric temperature (°C)
1990	15.1
1991	14.7
1992	14.8
1993	14.7
1994	14.7
1995	14.6
1996	14.7
1997	14.8
1998	14.7
1999	14.8
2000	14.9

(a) Tick (✓) the box that **best** describes the change in carbon dioxide concentration in the atmosphere between 1930 and 2010. [1]

Carbon dioxide concentration increased by approximately 10 ppm every 10 years ☐

Carbon dioxide concentration increased more between 1970 and 2010 than it did between 1930 and 1960 ☐

Carbon dioxide concentration increased more between 1930 and 1960 than it did between 1970 and 2010 ☐

There is no trend to the change in carbon dioxide concentration between 1930 and 2010 ☐

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(b) A newspaper report states that global warming is caused by increases in atmospheric carbon dioxide levels **and** by increases in solar activity.

Explain whether the data in **Figure 1** supports this claim. [2]

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(c) **Figure 2** shows that the mean atmospheric temperature near Mount Pinatubo decreased after the volcanic eruption of 1991. Suggest why scientists would **not** use these findings to explain how volcanic activity affects **global** temperatures. [1]

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....

(d) State **one** industrial method that is being developed to reduce the concentration of carbon dioxide in the atmosphere. [1]

....

(e) The Earth's original atmosphere contained about 95% carbon dioxide. Today, the atmosphere contains 0.04% carbon dioxide. Explain why the level of carbon dioxide decreased over geological time. [3]

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(f) When carbon dioxide turns limewater milky, calcium hydroxide is produced.

Give the formula of calcium hydroxide. [1]

....

9

(3430UB0-1)

8. The diagram shows reactions of bromine, Br_2.

bromine,
Br_2

sodium iodide
solution

hot iron

solution **B**
and
halogen **C**
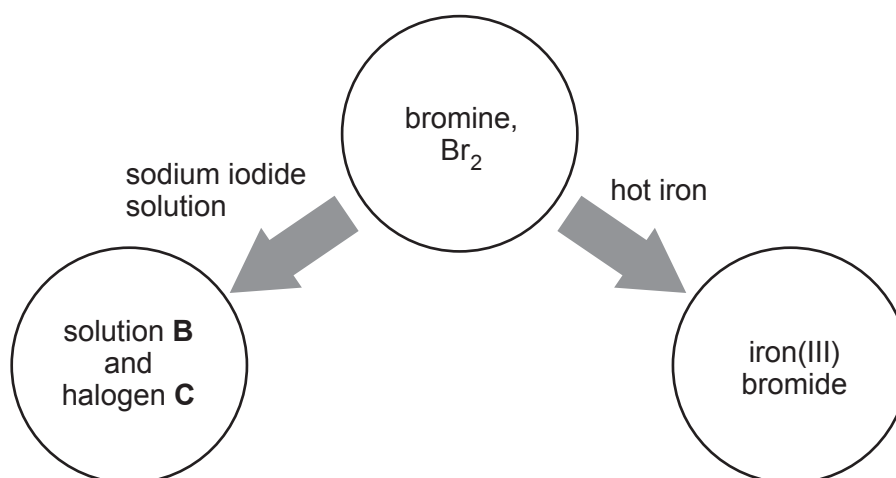
iron(III)
bromide

(a) (i) Give the names of solution **B** and halogen **C**. [2]

solution **B** ....

halogen **C** ....

(ii) Explain why bromine reacts with sodium iodide solution. [2]

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(b) Write the symbol equation for the reaction between bromine, Br_2, and iron to form iron(III) bromide. [2]

....

(c) Silver nitrate solution was added to a solution of sodium iodide. Silver iodide was formed.

(i) State what you would expect to see. [1]

....

(ii) Give the **ionic** equation for the formation of silver iodide. [2]

....

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.	Examiner only

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PMT

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FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	Formula	Name	Formula
aluminium	Al^{3+}	bromide	Br^-
ammonium	NH_4^+	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^-
calcium	Ca^{2+}	fluoride	F^-
copper(II)	Cu^{2+}	hydroxide	OH^-
hydrogen	H^+	iodide	I^-
iron(II)	Fe^{2+}	nitrate	NO_3^-
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^+	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^+		
silver	Ag^+		
sodium	Na^+		
zinc	Zn^{2+}		

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THE PERIODIC TABLE

Group

1	2												3	4	5	6	7	0
						1 H Hydrogen 1												4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4												11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12												27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30		70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48		115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80		204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89																

Key

relative atomic mass

A_r
Symbol
Name
Z — atomic number

(3430UB0-1)