Surname	Centre Number	Candidate Number
First name(s)		0

wjec cbac

GCSE

3430UE0-1

S24-3430UE0-1

FRIDAY, 17 MAY 2024 – MORNING

SCIENCE (Double Award)
Unit 5 – CHEMISTRY 2
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**7**	
3.	**10**	
4.	**7**	
5.	**6**	
6.	**9**	
7.	**6**	
Total	**60**	

3430UE01 01

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(s) 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 **7** 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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Answer **all** questions.

1. (a) Carys and Pavel prepared crystals of zinc sulfate by reacting zinc carbonate with an acid.

(i) Give the name of the acid they used. [1]

....

(ii) In the first stage of their preparation, they added excess zinc carbonate to the acid.

I. Give the observation that **immediately** shows a reaction is taking place. [1]

....

II. State why they added **excess** zinc carbonate. [1]

....

(iii) Describe the remaining two stages they carried out to obtain a **pure** sample of zinc sulfate crystals. [2]

....

....

....

(iv) Give the chemical formula of zinc sulfate. [1]

....

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(b) In another experiment, Carys and Pavel investigated the temperature rise when dilute hydrochloric acid neutralises sodium hydroxide solution.

The acid was added 5 cm^3 at a time to 25 cm^3 of sodium hydroxide solution. They recorded the highest temperature reached after each addition using a digital thermometer.

They obtained the following results. The result for 15 cm^3 of acid is missing.

Volume of acid added (cm^3)	Temperature (°C)
0	20.4
5	21.9
10	23.4
15	
20	26.4
25	26.3
30	25.9
35	25.5
40	25.1

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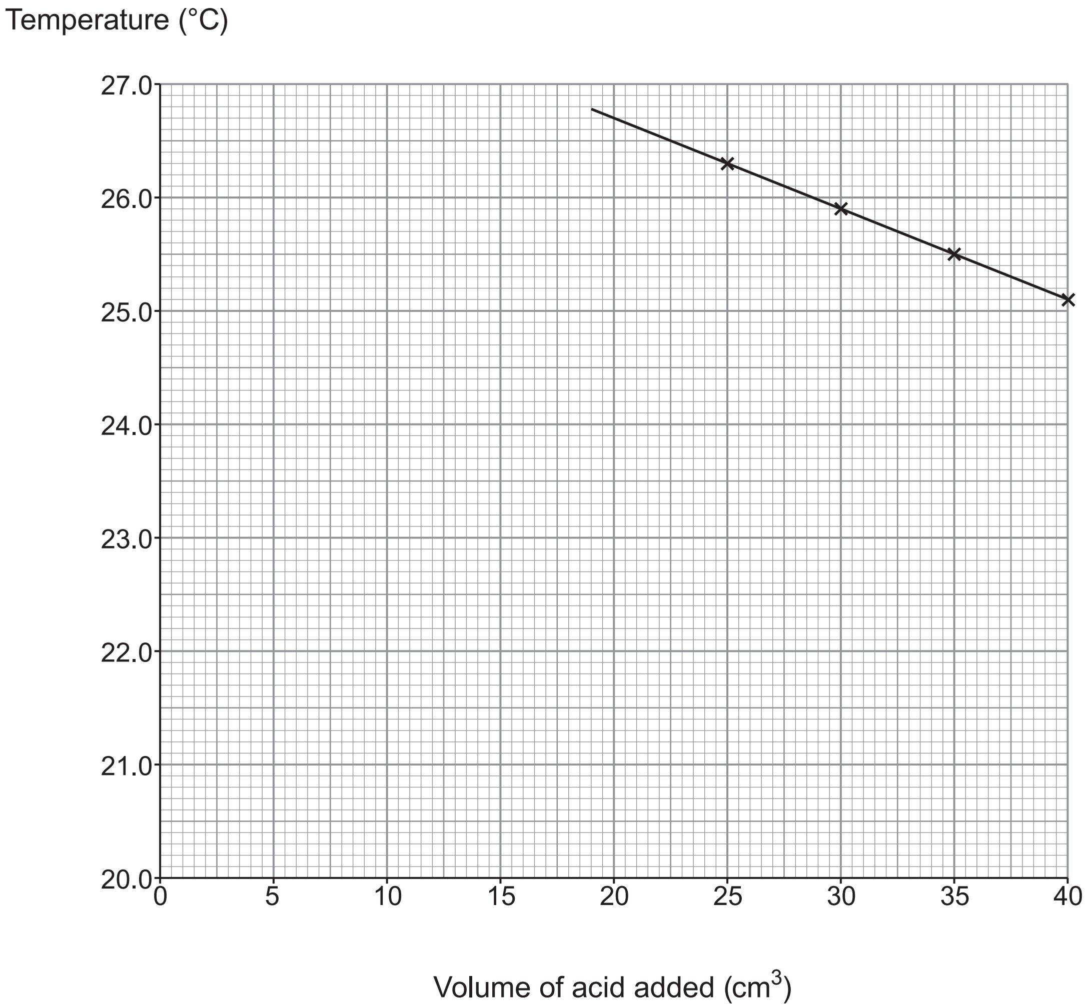
(i) The last four results have been plotted on the grid below and a straight line drawn through the points.

Plot the remaining four points and draw a **straight line** through them so that it intersects the line already drawn. [3]



(ii) I. Use your graph to give the temperature that would have been recorded when 15 cm^3 of acid was added. [1]

.... °C

II. Carys and Pavel concluded that the volume of acid needed to just neutralise all the sodium hydroxide solution was somewhere between 20 cm^3 and 25 cm^3.

Use the graph to suggest the exact volume of acid needed. [1]

.... cm^3

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(iii) The temperatures recorded are slightly **lower** than expected.

Tick (✓) to show which **two** improvements to the method would enable Carys and Pavel to obtain results closer to the expected values. [2]

use a beaker instead of a flask	☐
repeat the method	☐
add the acid in smaller intervals	☐
wrap cotton wool around the flask	☐
use a larger flask	☐
place a lid on the flask	☐

(c) In a different experiment, it was found that the maximum temperature was reached when 40 cm^3 of hydrochloric acid was added to 20 cm^3 of sodium hydroxide solution.

State what this means in terms of the relative concentrations of the solutions used. [2]

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....

....

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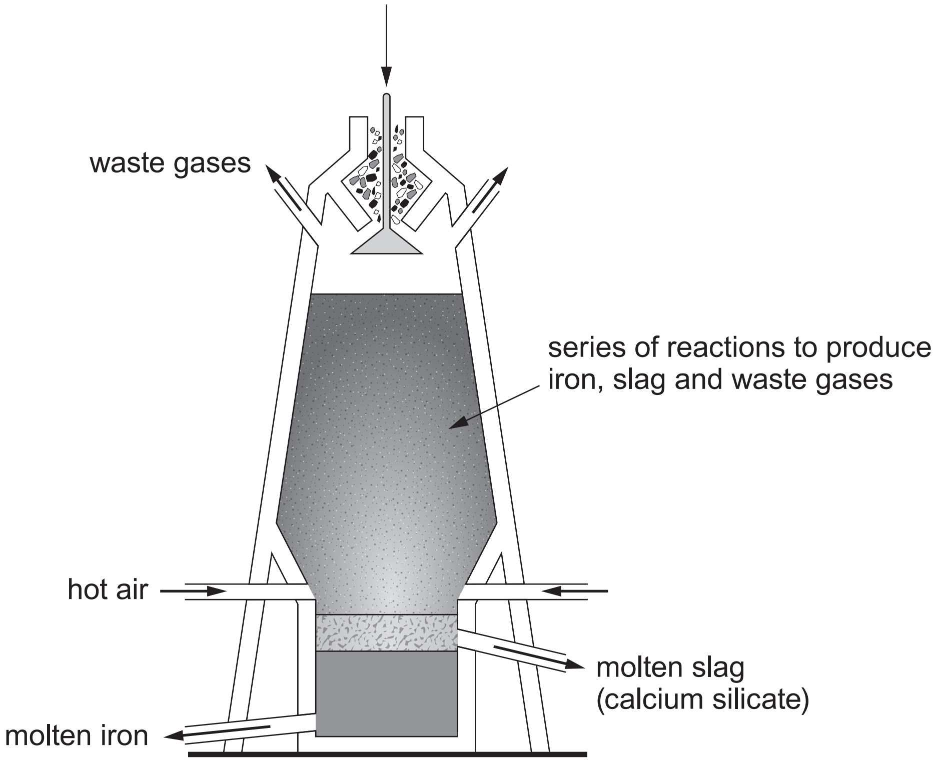
2. The diagram shows a blast furnace used to extract iron from iron ore.



(a) One of the reactions inside the furnace is the reaction between carbon dioxide and carbon, in the form of coke, to form carbon monoxide.

Give the symbol equation for this reaction. [2]

....

Examiner only

(b) This equation represents one of the reactions that produce iron inside the furnace.

$$\square\ Fe_2O_3 + 3\,C \longrightarrow \square\ Fe + \square\ CO_2$$

(i) Balance the equation. [1]

(ii) Explain why this reaction shows that both oxidation and reduction take place.

Refer to oxygen in your answer. [2]

....

....

....

(c) The formation of slag inside the furnace involves a two-stage process as summarised by the following equations.

Stage 1 $CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$

Stage 2 $CaO + SiO_2 \longrightarrow$ calcium silicate

(i) Complete the name of the type of reaction taking place in stage 1. [1]

thermal ....

(ii) Give the formula of calcium silicate, formed in stage 2. [1]

....

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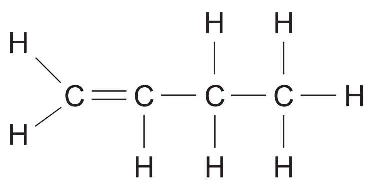
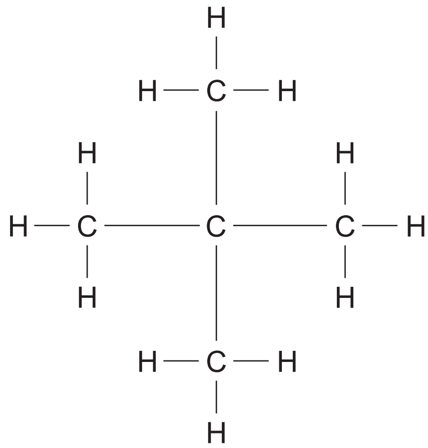
7

3. (a) The structural formulae of seven organic compounds, **A-G**, are shown below.



A



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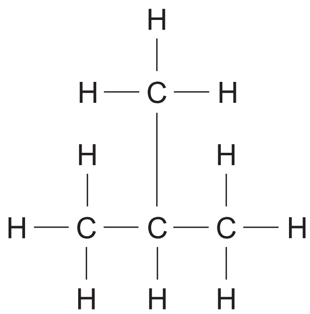
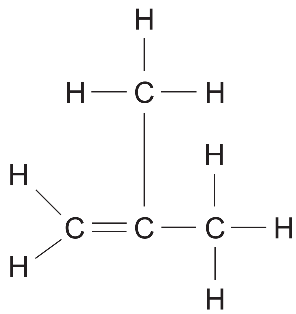
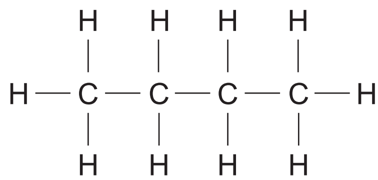


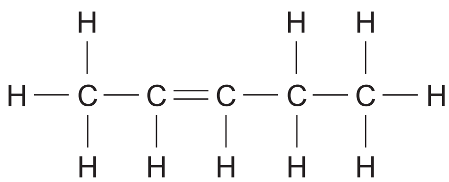
C



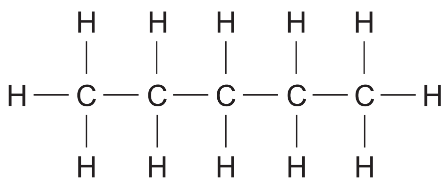
D



E



F



G

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(i) Give the letters of the **three** compounds that have the general formula C_nH_{2n}. [1]

....

(ii) State the **number** of compounds that are saturated. [1]

....

(iii) Give the **letter** of the compound that is but-1-ene. [1]

....

(iv) Draw the structural formula of the isomer of C_5H_{12} **not** shown. [1]

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(v) Describe the chemical test that can be used to distinguish between compounds **C** and **D**.

Give the expected observation for both compounds. [2]

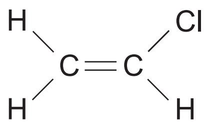
....

....

....

Examiner only

(b) The structural formula of vinyl chloride is shown below.



Vinyl chloride can undergo a reaction known as polymerisation to produce polyvinyl chloride, commonly known as PVC.

Explain what happens to vinyl chloride molecules during the formation of PVC. Draw the repeating unit of PVC. [3]

....

....

....

....

....

....

repeating unit

(c) PVC is widely used in everyday life and has replaced many traditional materials.

Apart from cost, suggest **two** reasons why PVC has replaced iron for making drainpipes and guttering. [1]

....

....

10

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4. (a) Calcium reacts with fluorine to form calcium fluoride.

Showing the outer electrons only, draw dot and cross diagrams to show how bonding takes place during the formation of calcium fluoride.

Include the electronic structures and the charges of the ions formed. [3]

calcium 2,8,8,2 fluorine 2,7

(b) Potassium chloride and calcium oxide are both ionic compounds with high melting points.

The table gives information about the ions that make up each compound.

Ionic compound	Ions present
potassium chloride	potassium and chloride
calcium oxide	calcium and oxide

Calcium oxide has a higher melting point than potassium chloride.

Explain this difference. [2]

....

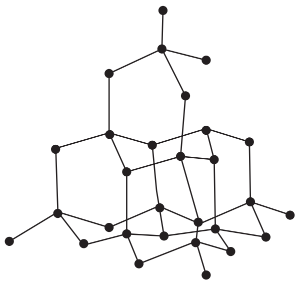
....

....

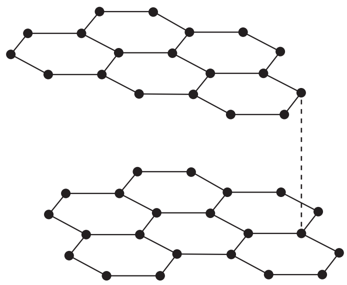
....

Examiner only

(c) The diagrams show the structures of diamond and graphite.



diamond



graphite

Both structures have covalent bonds between carbon atoms.

Give **two** differences between the structures of diamond and graphite. [2]

....

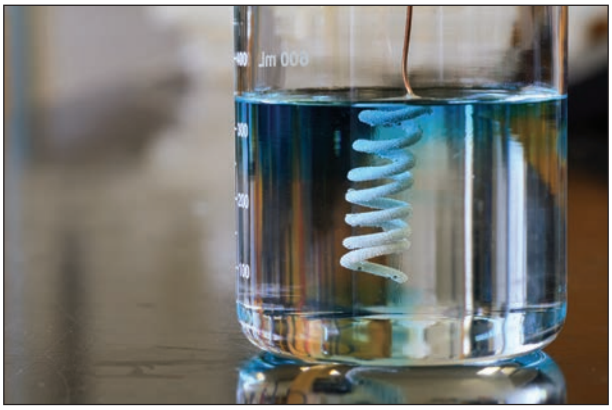
....

....

....

7

5. (a) The photograph shows what happens when a coil of copper wire is placed in silver nitrate solution.



(i) Explain why the solution turns blue. [2]

....

....

....

(ii) Complete and balance the equation for the reaction taking place. [2]

$\square$ $AgNO_3$ + Cu $\longrightarrow$ .... + $\square$ Ag

Examiner only

(b) When silver nitrate solution is mixed with sodium chloride solution a white precipitate of silver chloride is produced.

(i) Tick (✓) the box next to the correct ionic equation for this reaction. [1]

$Ag^{+}(aq) + Cl^{-}(aq) \longrightarrow AgCl(aq)$	☐
$Ag^{+}(s) + Cl^{-}(s) \longrightarrow AgCl(s)$	☐
$Ag^{+}(aq) + Cl^{-}(aq) \longrightarrow AgCl(s)$	☐
$Ag^{+}(s) + Cl^{-}(s) \longrightarrow AgCl(aq)$	☐

(ii) State the colour of the precipitate that forms when silver nitrate solution is mixed with sodium iodide solution. [1]

....

6

6. Alternative methods of extracting copper

As the Earth's supply of high-grade copper ores continues to decline, alternative methods such as phytomining and bioleaching are becoming more commonly used to extract copper from low-grade ores.

Phytomining

Phytomining involves growing plants in soils that contain low-grade copper ores.

The plants absorb the copper ions through their roots and they are concentrated inside the plants' cells.

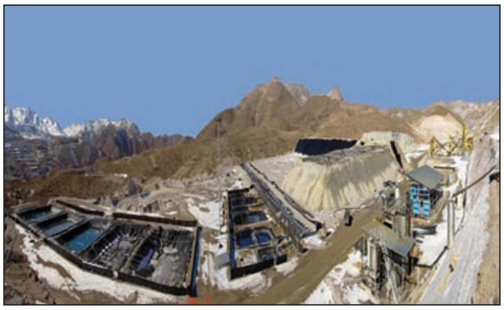
The plants are then harvested and burned. The ash that is left behind contains higher concentrations of copper ions than the low-grade ores in the soil.

The copper ions are washed out from the ash using sulfuric acid, forming a concentrated solution of copper(II) sulfate.

Scrap iron is then added to the copper(II) sulfate solution to allow the copper to be collected.

The main drawback to phytomining as an alternative method of copper extraction is that the process is dependent on the successful growth of the plants used for the extraction.

Bioleaching



Bioleaching is a very simple process that uses bacteria to extract copper from the minerals found within the lowest grade copper ores.

The bacteria are added to tanks of water containing the ores. There they feed on the nutrients found within the minerals in these ores, causing the copper ions to separate out.

An acidic solution is formed during the process. This contains a higher concentration of copper ions than the low-grade ores.

The solution formed is called a leachate, which is why the process is called bioleaching.

Copper is collected from the leachate solution by mixing it with iron.

The main drawback to bioleaching as an alternative method of copper extraction is that the process is extremely slow and therefore not efficient.

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

phytomining uses lower grade ores than bioleaching ☐

bioleaching conserves supplies of the lowest grade metal ores ☐

phytomining conserves supplies of high-grade metal ores ☐

bioleaching uses high-grade metal ores ☐

phytomining uses the lowest grade metal ores ☐

(ii) State whether you agree with the following statement. Give a reason for your answer. [1]

'Phytomining and bioleaching both involve biological processes'

Agree **Yes** / **No**

Reason ....

....

(iii) Suggest a reason why phytomining might **not** be a suitable method for extracting metals in some countries, even if they have supplies of the low-grade metal ores. [1]

....

....

(iv) Although effective in extracting copper, suggest a reason why bioleaching is an extremely slow process. [1]

....

....

Examiner only

(b) Explain why iron can be used in the last stage of both the phytomining and bioleaching methods of copper extraction. [2]

....

....

....

(c) Low-grade copper ores commonly contain the mineral cuprite. Cuprous oxide is an old name for the oxide of copper found in cuprite.

A sample of cuprous oxide was found to contain 2.54 g of copper and 0.32 g of oxygen.

Use this information to find the simplest formula of cuprous oxide.

You **must** show your working. [3]

$A_r(\text{Cu}) = 63.5$ $A_r(\text{O}) = 16$

Simplest formula ....

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7. The photograph shows an oil refinery where fractional distillation of crude oil takes place.

Explain the process of fractional distillation of crude oil. [6 QER]

6

END OF PAPER

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

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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+}		

THE PERIODIC TABLE

1	2					Group						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

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number