Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S24-3440UA0-1

3440UA0-1

MONDAY, 10 JUNE 2024 – MORNING

APPLIED SCIENCE (Single Award)
UNIT 1: Science in the Modern World
HIGHER TIER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**19**	
2.	**12**	
3.	**13**	
4.	**10**	
5.	**6**	
6.	**6**	
7.	**9**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator, pencil 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 **5** is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

A Periodic Table is printed on page 20.

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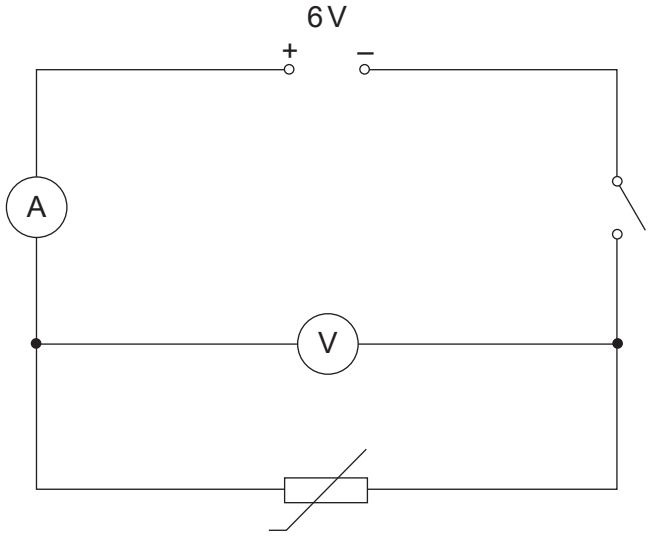
Answer **all** questions.

1. Thermistors are used as temperature sensors in thermostats. A group of students investigate a thermistor at different temperatures. The circuit they use is shown below. They keep the voltage constant.



(a) (i) State the purpose of the ammeter. [1]

.....

(ii) State the purpose of the voltmeter. [1]

.....

(b) The students' results are shown below.

Temperature (°C)	Current (mA)	Voltage (V)	Resistance (kΩ)
10	0.4	6.0	15.0
20	0.8	6.0	7.5
30	1.6	6.0	3.8
40	0.6	6.0	10.0
50	6.4	6.0	0.94

(i) Jason says there are no anomalous current readings.
Explain whether you agree with Jason. [2]

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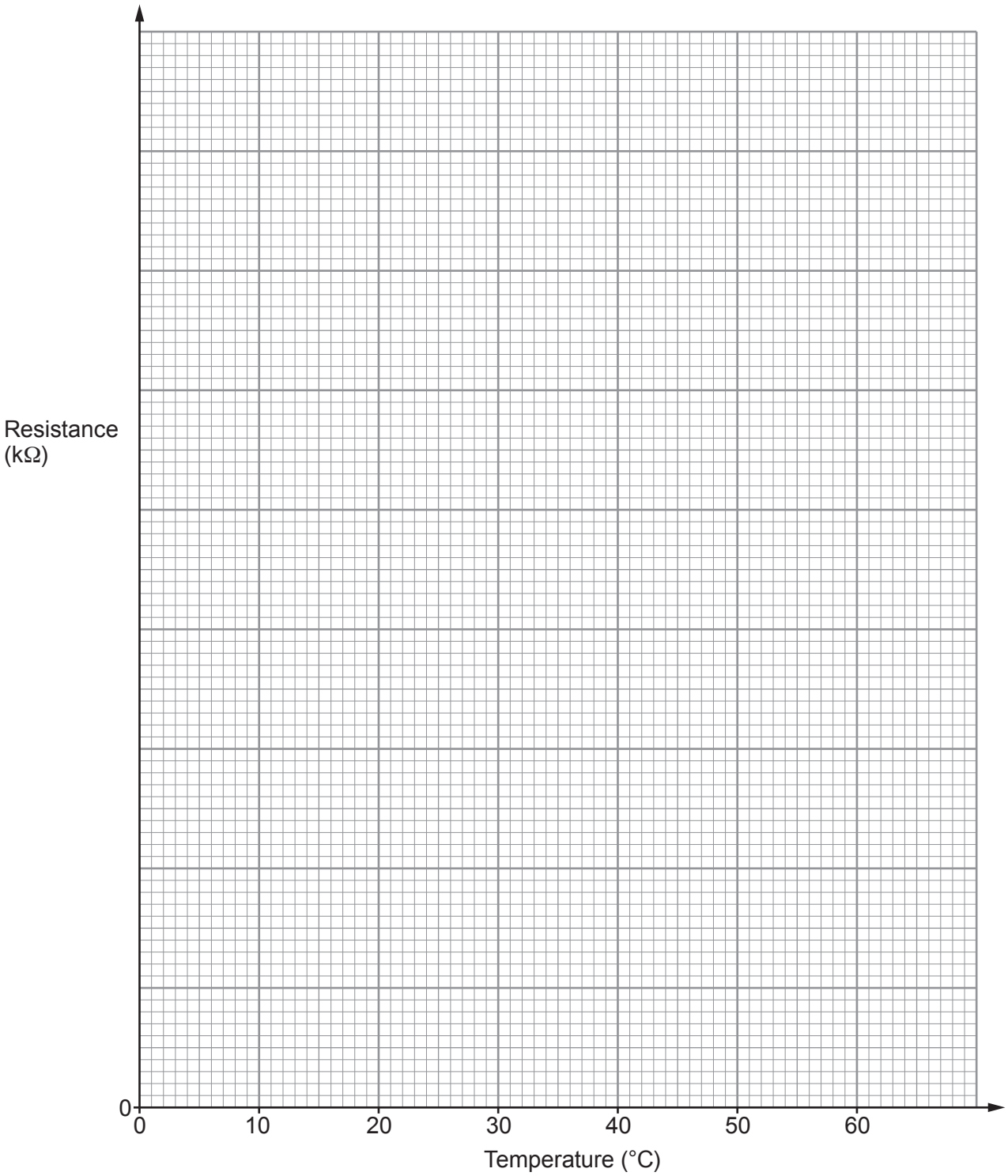
(ii) Plot the data on the grid below and draw a suitable curved line. [4]



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(iii) Jason concluded that every time the temperature doubled the resistance of the thermistor halved. Use the data in the table to explain whether you agree with Jason. [3]

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(iv) **Extend** your line on the graph to estimate the resistance of the thermistor at 60 °C. [2]

resistance = ... kΩ

(v) A thermistor is used in a thermostat. The thermostat needs to increase in resistance by at least 12.5 kΩ when the temperature drops from 50 °C to 10 °C. Use the data in the table in (b) to explain whether the thermistor used in this investigation is suitable. [2]

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(c) Describe how you would amend the investigation to find the current-voltage $(I–V)$ characteristic of a thermistor. [4]

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2. Red squirrel populations in Great Britain have declined since the introduction of the grey squirrel in 1876.

(a) The binomial name of the red squirrel is *Sciurus vulgaris*. Its scientific classification is shown in the table below.

Scientific classification	
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Sciuridae
Genus	*Sciurus*
Species	*vulgaris*

The binomial name of the grey squirrel is *Sciurus carolinensis*.

(i) Complete the classification table for the grey squirrel. [1]

Family	.....
Genus	.....
Species	.....

(ii) State the advantage of using binomial names. [1]

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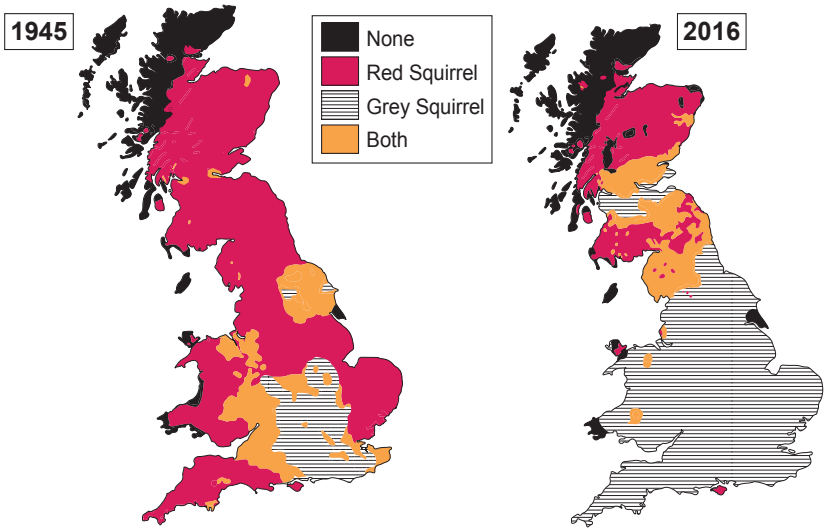
(b) The diagram shows how the squirrel population in Great Britain has changed between 1945 and 2016.



State **three** reasons why the grey squirrel has been more successful when competing with red squirrels. [3]

1. .....

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2. .....

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3. .....

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Turn over.

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(c) Anglesey is an island connected to the North Wales coast by a road and railway bridge. This made it an ideal site for an EU-funded project to conserve the red squirrel.

At the start of the conservation project, the red squirrels could only be found in two forests there. One of these was a 244 hectare (ha) forest where grey squirrels were controlled by trapping.

(i) One method of calculating the number of squirrels involves counting the number of dreys (nests).

number of red squirrels per ha = number of dreys per ha $\times$ 0.26

number of grey squirrels per ha = number of dreys per ha $\times$ 0.74

The mean number of red squirrel dreys per ha is 0.48, and the mean number of grey squirrel dreys per ha is 1.2.

Calculate the difference in the populations of red and grey squirrels in this forest. [4]

difference in populations = ...

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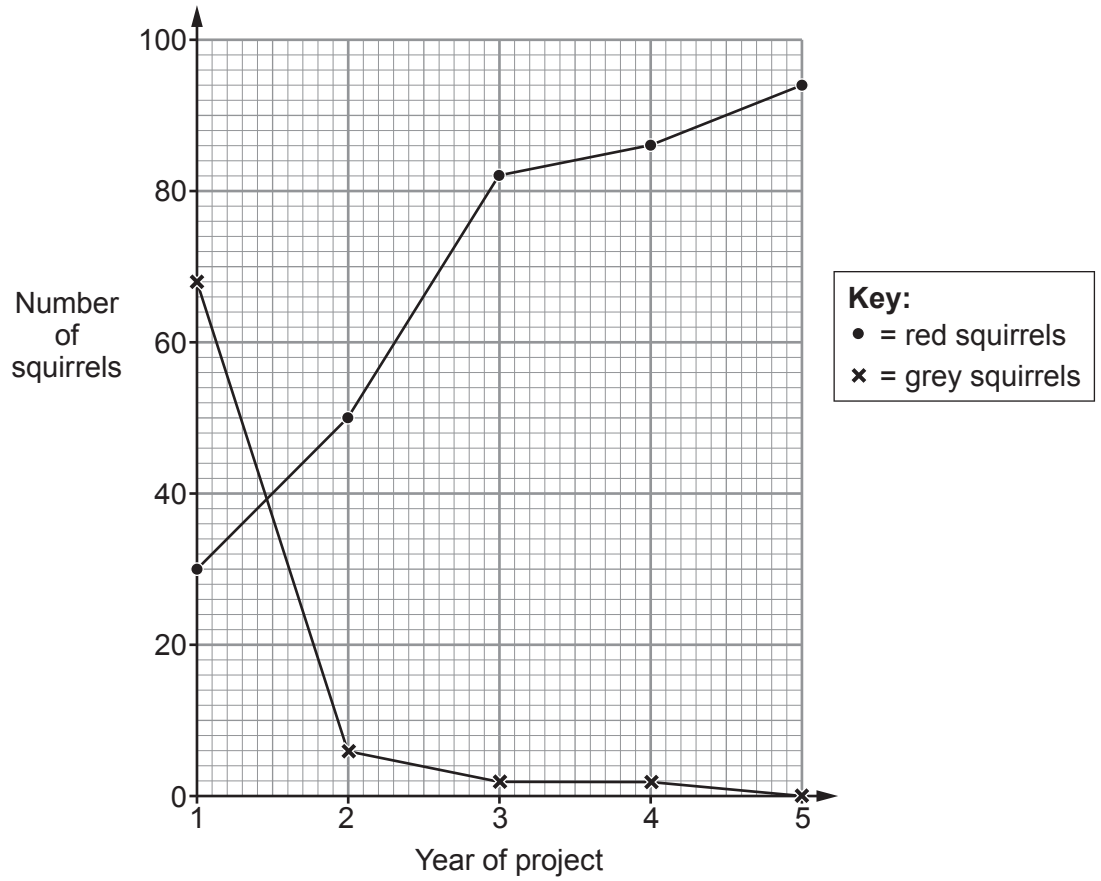
(ii) The results of controlling grey squirrel numbers by trapping over five years in a different forest are shown in the graph.



Use the graph to describe how the number of each type of squirrel has changed over time since the project started. [2]

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(iii) Suggest **one** method, other than the trapping of grey squirrels, that could be used to conserve the red squirrels. [1]

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3. A householder uses gas for heating and cooking.
Electricity is used for lighting and operating electrical appliances.
The table shows information about the householder's energy consumption and the total yearly cost.

Year	Units of electricity used (kWh)	Units of gas used (kWh)	Total cost of gas and electricity (£)
Jan 1 to Dec 31 2017	3950	27900	1708.50
Jan 1 to Dec 31 2018	4100	22400	1511.00

(a) The cost of 1 unit of gas in both years was 4 p. Use the information above and the equation:

cost = cost of one unit × units used (kWh)

to calculate the cost of 1 unit of electricity in 2017. [4]

cost of 1 unit of electricity = ... p

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(b) On the 1st January 2018 the householder fitted a solar panel, at a cost of £2000, to provide hot water for heating, to save on gas.

(i) Use data from the table to calculate the number of units of gas saved by using the solar panel in 2018. [1]

number of units = ... kWh

(ii) Calculate the time it would take for his annual savings on gas to pay back the cost of the solar panel. [3]

payback time = ... years

(iii) Suggest why the actual payback time could be less than the calculated figure in (ii). [1]

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(c) The water pipes inside a solar panel are made from copper.
Copper carbonate can accumulate in copper pipes by a two-step process. In the first reaction, copper corrodes to copper oxide (CuO) by oxidation. In a second reaction, copper oxide combines with carbon dioxide to make copper carbonate ($CuCO_3$), which gives it a bluey-green colour.

(i) Write balanced symbol equations for both reactions. [3]

Reaction 1 .....

Reaction 2 ..... ⟶ $CuCO_3$

(ii) Copper is an element but copper oxide and copper carbonate are compounds.
State the difference between an element and a compound. [1]

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4. Sodium reacts with oxygen to form sodium oxide.

Use information in the Periodic Table on page 20 to answer the following questions.

(a) Give the electronic configuration of sodium and oxygen. [2]

sodium ..... oxygen .....

(b) Give the chemical formula of sodium oxide. ..... [1]

(c) Explain the electronic changes that take place during the reaction to form sodium oxide. You must include the charge on the ions. [4]
You may include a diagram in your answer.

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(d) (i) Name **one** alkali metal that will react less violently than sodium with oxygen. [1]

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(ii) Explain your answer in terms of electrons. [2]

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5. Animal waste (manure and urine) from farms is used as fertiliser. Describe the processes that convert the waste into a form of nitrogen that can enter the plants. [6 QER]

6

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6. The table gives information about some of the planets in our Solar System.

Planet	Mean distance from Sun (AU)	Diameter (10^6 m)	Length of day i.e. time to spin once on axis (Earth days)	Length of year i.e. time to orbit Sun (Earth years)	Mean temperature (°C)	Content of atmosphere
Mercury	0.4	5	59	0.2	427	None
Venus	0.7	12	243	0.6	480	carbon dioxide (96%), nitrogen (3.5%)
Earth	1.0	13	1	1	14	nitrogen (77%), oxygen (21%)
Mars	1.5	7	1	2	–63	carbon dioxide (95.3%), argon
Neptune	30.0	50	0.7	165	–200	hydrogen, helium, methane

On Earth 1 year = 365 days

Use the information in the table to answer the following questions.

(a) It is claimed that one day on Venus is longer than its year. Explain whether you agree. [2]

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(b) Generally, planets closer to the Sun are hotter. Explain why Venus is hottest even though Mercury is closer to the Sun. [2]

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(c) Using only the data for **Mars** and **Neptune**, explain how it shows that the length of a planet's year is not proportional to its distance from the Sun. [2]

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Examiner only

7. Aluminium is widely used in our homes. It is extracted by the electrolysis of aluminium oxide. The following equations represent what happens at the electrodes.

$$Al^{3+} + 3e^- \longrightarrow Al$$

$$2O^{2-} - 4e^- \longrightarrow O_2$$

(a) Give the meaning of the term electrolysis. [2]

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(b) Explain why the aluminium oxide must be molten for electrolysis to occur. [1]

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(c) State how the information above shows that aluminium is reduced. [1]

.....

(d) Electrolysis is also used to electroplate metals.
Explain at which electrode the metal would be placed in order for it to be electroplated. [2]

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(e) The chemical formula of aluminium oxide is Al_2O_3. Use information from the Periodic Table on page 20 to calculate the relative formula mass (M_r) of aluminium oxide. [3]

relative formula mass (M_r) = ...

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END OF PAPER

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

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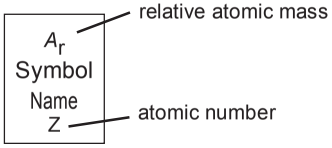
THE PERIODIC TABLE

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



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