GCSE

3445U10-1

THURSDAY, 13 JUNE 2024 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 1: Energy, Resources and the Environment
FOUNDATION TIER

1 hour 30 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 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 3 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 in the separate Data Booklet.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**15**	
3.	**6**	
4.	**12**	
5.	**12**	
6.	**19**	
Total	**75**	

Answer ALL questions.

1 **DIAGRAM 1 in the separate diagram booklet shows an animal cell.**

chloroplast	**vacuole**	**cell membrane**

(a)(i) **Use the correct word(s) from the box to complete the labelling of the animal cell. [1 mark]**

(ii) **Tick (✓) the box next to a structure found inside the nucleus. [1 mark]**

- ☐ **chloroplast**
- ☐ **chromosome**
- ☐ **cellulose**

1 (a)(iii)

Tick (✓) the box next to the correct statement about the function of the nucleus. [1 mark]

☐ **gives structural support of the cell**

☐ **controls the activity of the cell**

☐ **the site of photosynthesis**

(b) Cells are organised into tissues. Complete the following sentences by <u>UNDERLINING</u> the correct word in each bracket. [2 marks]

Tissues are a collection of many

(different / similar / bigger) cells.

Tissues work together to perform a

(smaller / particular / bigger) function.

1 (c) The cell membrane controls the entry and exit of all substances into and out of the cell. Many substances are transported into the cell by diffusion.

(i) Complete the following sentence by UNDERLINING the correct word in each bracket.[2 marks]

Diffusion is the movement of substances from a region of (high / low / zero) concentration to a region of (higher / lower / negative) concentration.

(ii) Oxygen is a gas that diffuses into the cell. Tick (✓) the box next to the gas that diffuses OUT OF the cell.

☐ argon

☐ carbon dioxide

☐ helium

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+ oxygen
+ water

1 (c)(iii)

I. The oxygen that diffuses into the blood is needed by all cells to release energy.

CIRCLE the process that releases energy.

[1 mark]

excretion respiration absorption

II. On the opposite page, complete the equation for this process using the correct terms from the box below. [2 marks]

glucose	**protein**	**sulfur**
salt	**carbon dioxide**	

11

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magnesium + sulfuric acid ⟶ magnesium sulfate + hydrogen

2 This question is about acids and alkalis. Lisa started filling in TABLE 2.1 in the separate diagram booklet.

(a) Complete TABLE 2.1. [4 marks]

(b) Lisa added magnesium to sulfuric acid. She recorded the temperature of the mixture during the reaction.

The word equation for this reaction is shown on the opposite page.

The temperatures are shown in TABLE 2.2 in the separate diagram booklet.

(b)(i)

Use the data from TABLE 2.2 to plot a graph on the grid in GRAPH 2.3, in the separate diagram booklet and join the points with a ruler. The first point has been plotted for you. [3 marks]

(ii) Calculate the temperature change during the first 20 seconds. [2 marks]

temperature change = _____ °C

2 (b)(iii)

Complete TABLE 2.4 in the separate diagram booklet to describe how the temperature changes over the 50 seconds. The first two rows have been completed for you. [3 marks]

(c) **Sulfuric acid has the formula H_2SO_4.**

Complete TABLE 2.5 in the separate diagram booklet to calculate the relative formula mass of H_2SO_4. [3 marks]

15

3 **Digestion is a process whereby large food molecules are broken down into smaller molecules so they can be absorbed for use by the human body.**

Describe the role of the enzyme amylase (carbohydrase) in the digestive system.
[6 marks QER]

Include in your answer:

- **where amylase is made**
- **how amylase works**
- **the conditions necessary for its action**

continue your answer on next page

6

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$$\% \text{ difference} = \frac{\text{concentration in stream 3} - \text{concentration in stream 1}}{\text{concentration in stream 3}} \times 100$$

4 (a) **Welsh Water is responsible for supplying and maintaining safe water supplies in Wales. It monitors the composition of our drinking water.**

TABLE 4.1 in the separate diagram booklet shows the composition of stream water supplying a reservoir in Wales. The samples were taken from three different streams.

Use the information in TABLE 4.1 to answer the following questions.

(i) **State the name of ONE ion whose concentration is the same in each stream. [1 mark]**

_____

(ii) **There is more dissolved sulfur dioxide in stream 3 than in stream 1.**

I. **Use the equation on the opposite page to calculate the percentage difference between the dissolved sulfur dioxide in stream 1 and stream 3. [2 marks]**

percentage difference = _____

4 (a)(ii) continued

II. Complete the following sentence by UNDERLINING the correct term in the bracket.

An increase in dissolved sulfur dioxide makes the rainwater (more acidic / become neutral / less acidic). [1 mark]

III. State how an increase in dissolved sulfur dioxide affects the pH of water. [1 mark]

_____

(iii) A technician believes that streams 1, 2 and 3 have water of the same hardness.

Use the data in TABLE 4.1 to explain whether you agree with the technician. [3 marks]

_____

_____

_____

_____

_____

continue your answer on next page

4 (b) When water is in short supply, seawater can be desalinated. In a school laboratory, distillation apparatus can be used to desalinate seawater. A student was given the choice of apparatus A or B, as shown in DIAGRAM 4.2 in the separate diagram booklet.

(i) State the temperature that the thermometer will record during the desalination of water. [1 mark]

_____ °C

4 (b)(ii) **A student believes that she will collect more water using apparatus A than apparatus B.**

Explain whether you agree. [2 marks]

(iii) **South East England needs an alternative source of water to supply drinking water. One of the options is to build a desalination plant.**

State ONE disadvantage of desalination of sea water. [1 mark]

12

5 Tommy and Arthur are investigating the effect of temperature on the resistance of a thermistor.

The circuit diagram drawn by Tommy is shown in DIAGRAM 5.1 in the separate diagram booklet.

(a) Complete the circuit in DIAGRAM 5.1 by adding:

(i) an AMMETER to measure current through the thermistor. [1 mark]

(ii) a VOLTMETER to measure voltage across the thermistor. [1 mark]

(b) The results of Tommy's experiment are shown in TABLE 5.2 in the separate diagram booklet.

Use only the information in TABLE 5.2 to answer the following questions.

(i) State the independent variable in this experiment. [1 mark]

_____

_____

5 (b)(ii)

State a controlled variable in this experiment. [1 mark]

_____

_____

(c) Use the information in TABLE 5.2 to answer the following questions.

(i) Estimate the CURRENT when the temperature is 100 °C. [2 marks]

current = _____ A

(ii) Use the equation:

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

to calculate the resistance of the thermistor at 90 °C. [2 marks]

resistance = _____ Ω

5 (c)(iii)

Tommy thinks that when he increases the temperature by 20 °C the resistance of the thermistor decreases by half every time. Use Tommy's results to explain whether you agree. [2 marks]

5 (c)(iv)

Arthur wants to know if the thermistor they used in the circuit would be suitable as a temperature sensor. The sensor must work between 20 °C to 60 °C and vary in resistance by at least 100 Ω.
Use Tommy's results to explain whether the thermistor would be suitable. [2 marks]

12

6 Paul lives in an apartment in central London. His electricity bill is £80 a month. Paul wants to replace his old electric boiler with a new one. A local plumbing company has suggested using a new boiler, the Redstar boiler, which has two electrical heaters. Paul will be able to use either heater to provide hot water after the boiler is installed.

DIAGRAM 6 in the separate diagram booklet contains information about the Redstar boiler.

(a) Use the information given about the boiler to answer the following questions.

(i) Calculate the expected payback time for the boiler in years. **[3 marks]**

payback time = _____ years

6 (a)(ii)

Use the equation:

$$\% \text{ efficiency} = \frac{\text{power usefully transferred}}{\text{total power supplied}} \times 100$$

to calculate the efficiency of HEATER 2.
[2 marks]

% efficiency = _____

6 (a)(iii)

Use the equations:

units used (kWh) = power (kW) × time (h)

total cost = cost of one unit × units used

to calculate the cost of the electricity to heat 150 litres of water using HEATER 1.

Cost per unit of electricity = 22 p [3 marks]

cost = _____

6 (a)(iv)

Paul has estimated that he uses 40 litres of hot water per day.

He thinks that HEATER 1 would be the best one to use every day.

Explain whether you agree with Paul.
[2 marks]

6 (b) **The water in London is known to be hard.**

Explain how hard water could have affected Paul's old boiler. [2 marks]

(c) **Heat energy can be transferred by conduction, convection and radiation.**

(i) **Explain how the shiny foam insulation used around the boiler helps to reduce heat loss. [2 marks]**

6 (c)(ii)

Explain how having the foam insulation layer around the boiler benefits the environment. [2 marks]

6 (c)(iii)

Paul thinks that HEATER 2 will not heat all the water in the boiler.

Use the diagram of the boiler in DIAGRAM 6 to explain whether you agree. [3 marks]

19

END OF PAPER

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

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FOUNDATION TIER

1 hour 30 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 _____

DIAGRAM 1

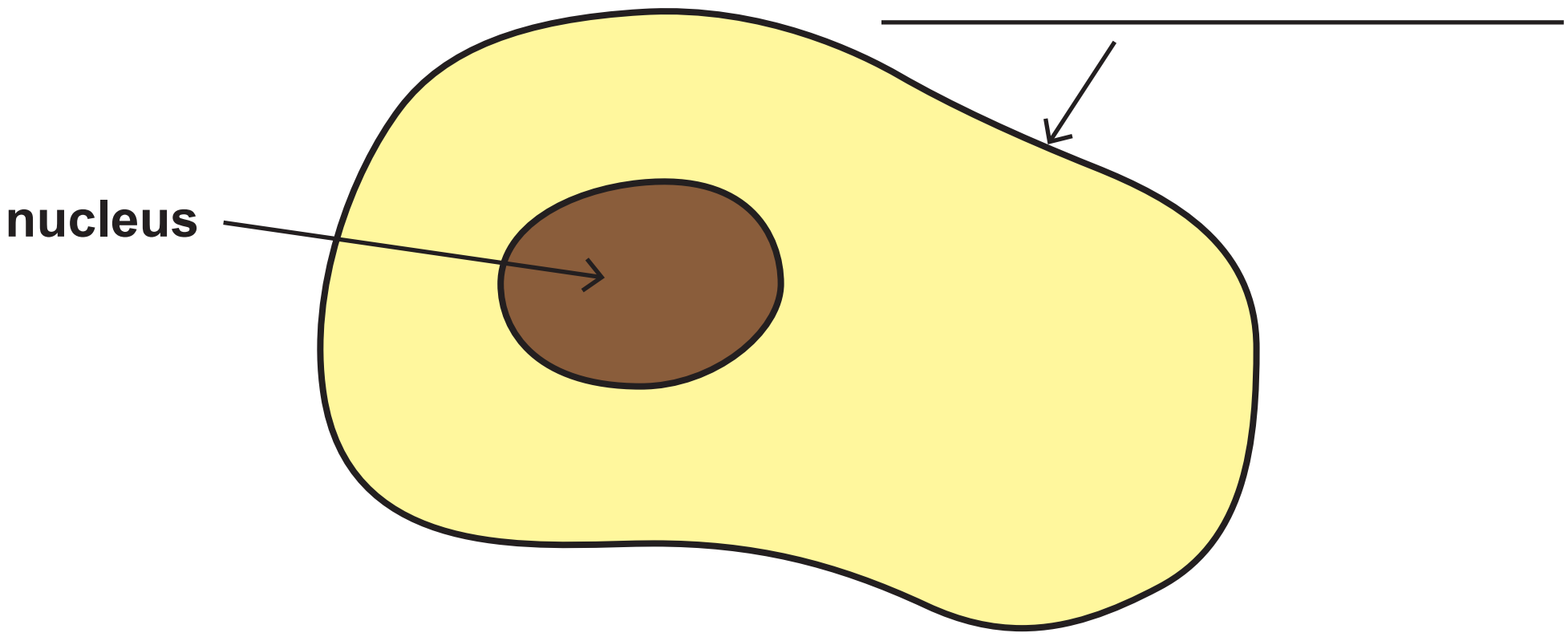

TABLE 2.1

Chemical name	Chemical formula	Colour with Universal Indicator	pH	Acid, alkali or neutral
sulfuric acid	H_2SO_4	red	1	acid
hydrochloric acid	HCl	red	_____	acid
calcium hydroxide	$Ca(OH)_2$	purple	12	alkali
sodium hydroxide	NaOH	_____	14	alkali
water	_____	green	7	_____

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TABLE 2.2

Time (s)	Temperature (°C)
0	20
10	40
20	50
30	60
40	60
50	58

GRAPH 2.3

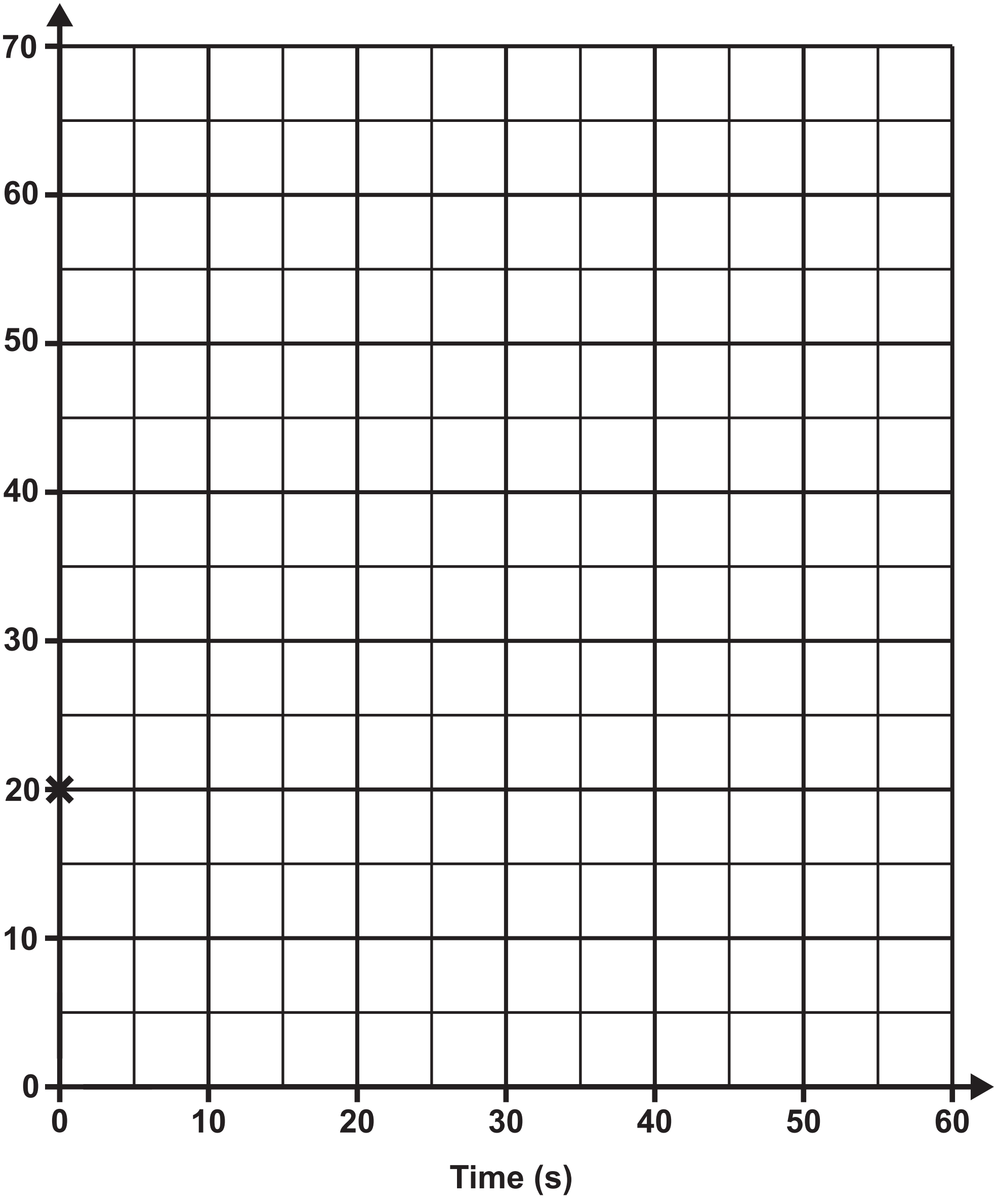

TABLE 2.4

Time (s)	Temperature decreases	Temperature stays the same	Temperature increases
0–10			✓
10–20			✓
20–30			
30–40			
40–50			

TABLE 2.5

Element	Number of atoms	Relative atomic mass (A_r)	Total mass of the element in H_2SO_4
hydrogen	2	1	
sulfur	1	32	
oxygen	4	16	64
		relative formula mass (M_r)	

TABLE 4.1

Component	Concentration (units)		
	stream 1	stream 2	stream 3
sodium ions (Na^+)	5.0	5.0	5.0
potassium ions (K^+)	6.3	6.2	6.2
magnesium ions (Mg^{2+})	15.3	15.4	15.5
calcium ions (Ca^{2+})	50.4	50.1	50.1
chloride ions (Cl^-)	30.1	30.0	30.2
dissolved sulfur dioxide	6.0	8.2	10.0
dissolved carbon dioxide	0.6	0.9	1.6
pH	5.7	5.5	5.4

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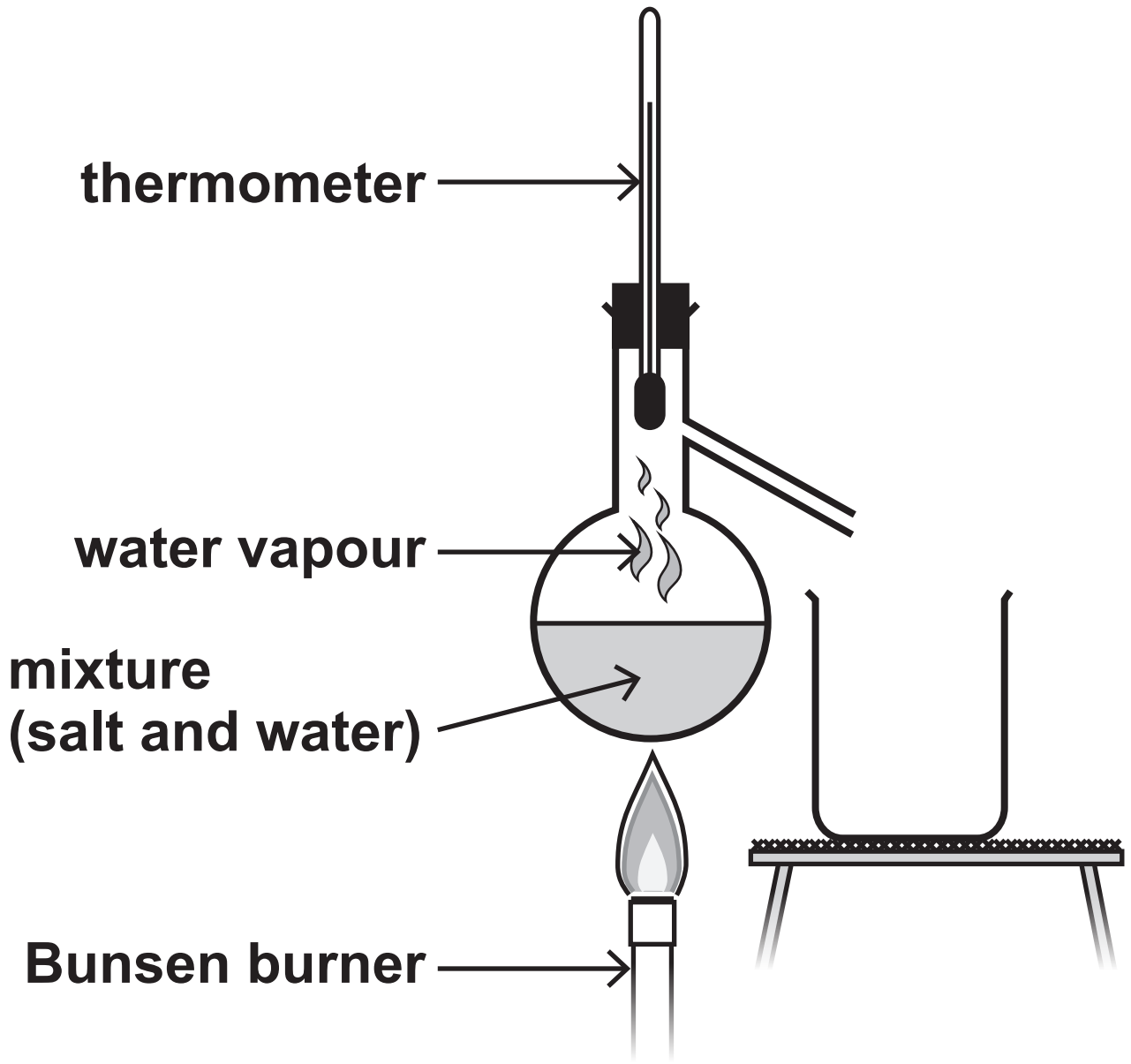
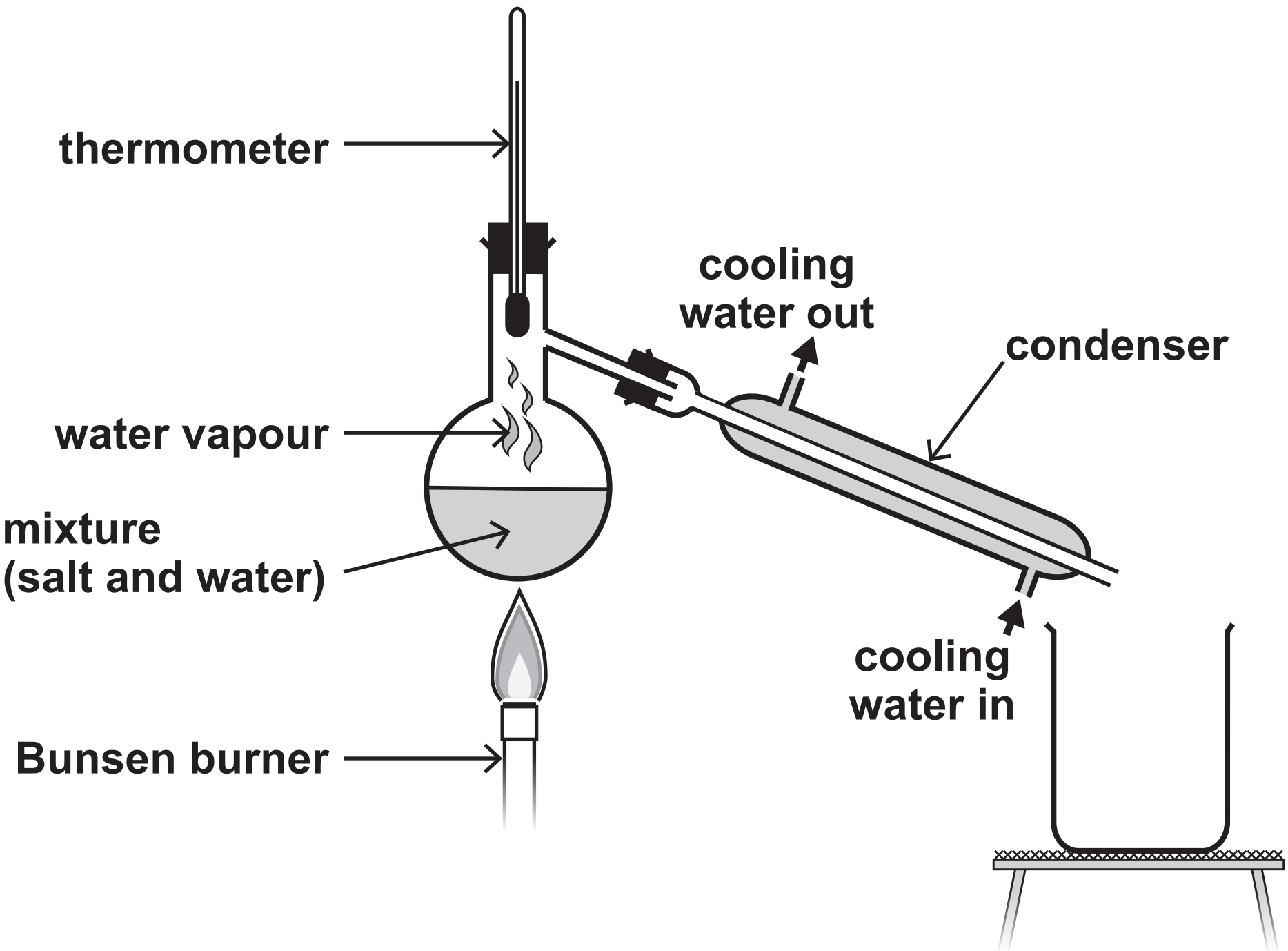
DIAGRAM 4.2



Apparatus A

DIAGRAM 4.2 continued



Apparatus B

DIAGRAM 5.1

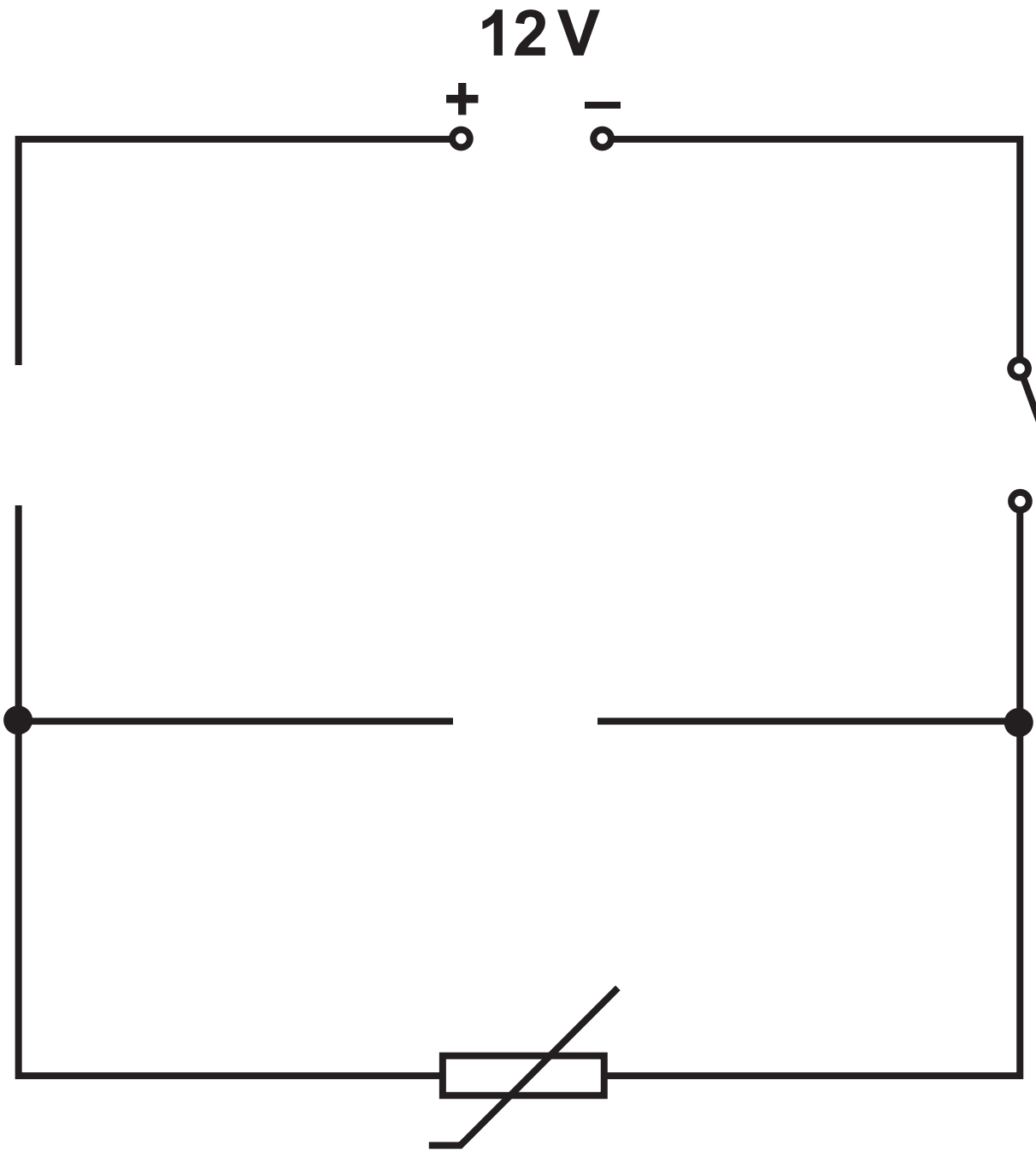
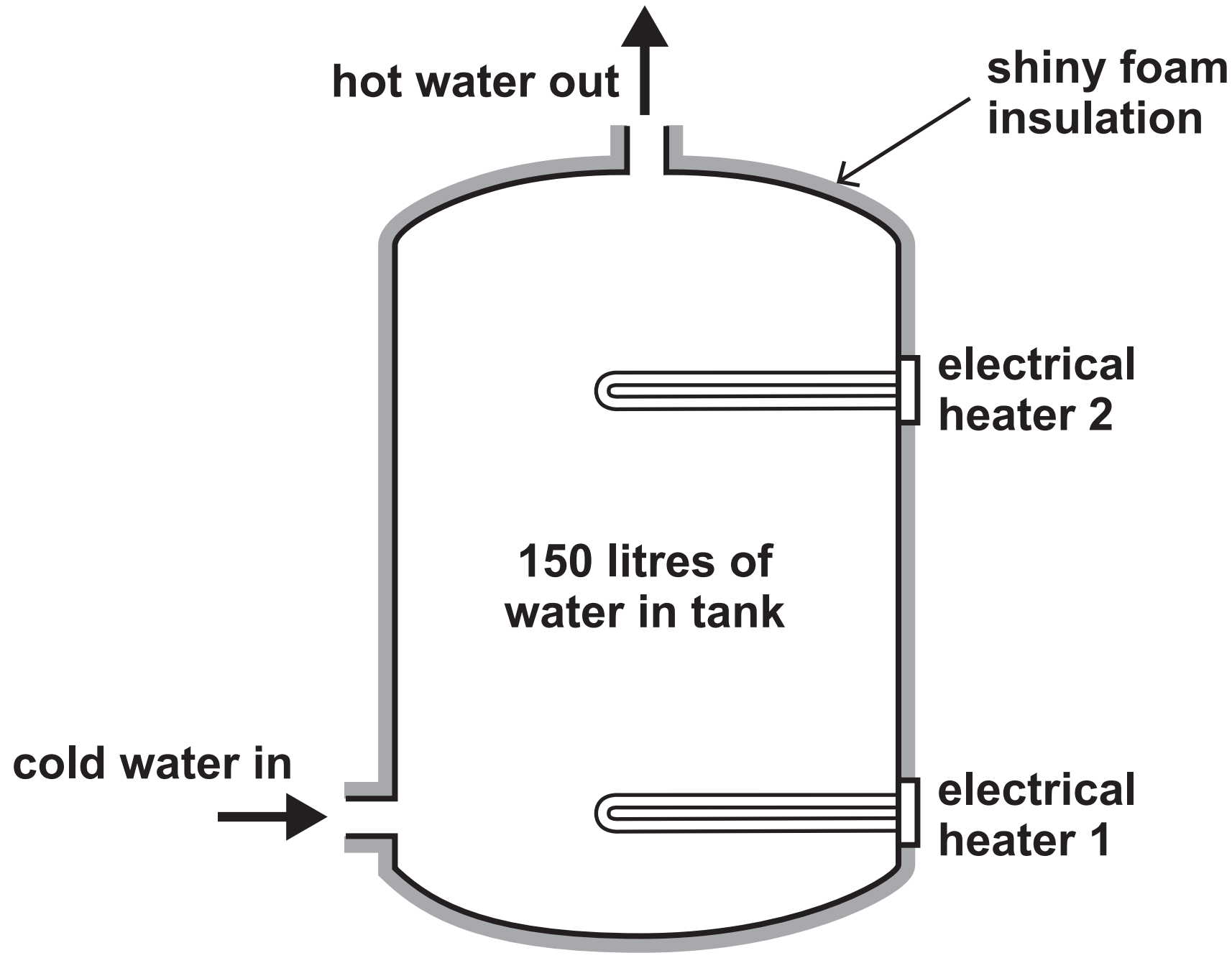


TABLE 5.2

Temperature (°C)	Current (A)	Voltage (V)	Resistance (Ω)
0	0.05	12	240
20	0.10	12	120
40	0.20	12	60
60	0.40	12	30
80	0.80	12	15
90	1.1	12	

DIAGRAM 6
INFORMATION ABOUT THE REDSTAR BOILER



SAVINGS

Cost of boiler	£2500.00
Typical savings	£15.00 per month

TECHNICAL INFORMATION ON THE TWO HEATERS IN THE REDSTAR BOILER

Information	heater 1	heater 2
maximum volume of water that is heated by heater (litres)	150	50
time to heat this volume of water (hours)	3	0.5
total power supplied (kW)	2	4
power used to heat the water (kW)	1.6	3.6
efficiency (%)	80	
cost to heat the water (p)		44

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APPLIED SCIENCE (Double Award)

UNIT 1: Energy, Resources and the Environment

FOUNDATION TIER

Data Booklet

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