wjec cbac GCSE

3445UA0-1

FRIDAY, 16 JUNE 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 1: Energy, Resources and the Environment
HIGHER TIER

1 hour 30 minutes plus your additional time allowance

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

VP*(X21-3445UA0-1) MLP
VP*(S20-3430U10-1) MLP

ADDITIONAL MATERIALS

In addition to this paper you will 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 4 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.

The Periodic Table is printed in the separate data booklet.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	8	
2.	11	
3.	16	
4.	6	
5.	8	
6.	13	
7.	13	
Total	75	

Answer ALL questions.

1 Sioned reacted sulfuric acid with zinc oxide (ZnO).

She followed the method below to form zinc sulfate.

1. **Pour 50 cm^3 of 1.0 mol/dm^3 sulfuric acid into a conical flask.**

2. **Heat the sulfuric acid to 50 °C.**

3. **Add 5 g of zinc oxide to the warmed acid and stir.**

4. **Repeat step 3 until the zinc oxide is in excess.**

(a) The main hazard in this experiment is that 1.0 mol/dm^3 sulfuric acid is an irritant.

1 (a) continued

(i) Describe ONE risk associated with using sulfuric acid. [1 mark]

(ii) State a suitable control measure Sioned should carry out to reduce this risk. [1 mark]

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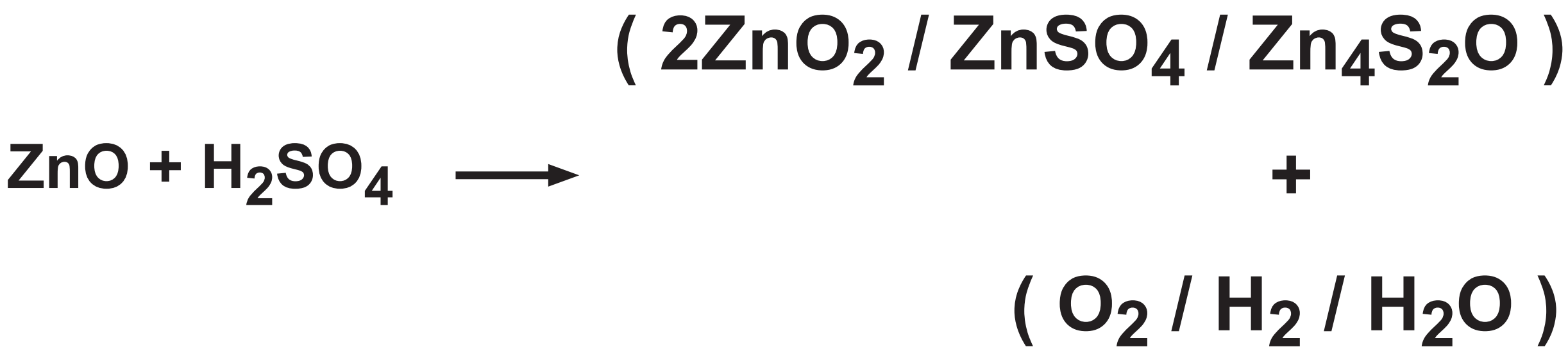
(2ZnO2 / ZnSO4 / Zn4S2O)
ZnO + H2SO4
+
(O2 / H2 / H2O)

1 (b) CIRCLE the correct formula in each bracket to complete the symbol equation for the reaction on the opposite page. [2 marks]

(c) State TWO additional steps that Sioned needs to carry out to obtain pure zinc sulfate crystals. [2 marks]

1.

1 (c) continued

2.

(d) Robert has calculated the relative formula mass of zinc oxide to be 97.

Use the Periodic Table in the separate data booklet to explain if he is correct. [2 marks]

2 **Several groups of students investigated the rate of diffusion of blue dye into potato by the method below.**

1. **Cut a cylinder of potato.**

2. **Place the cylinder in a test tube containing a solution of blue dye.**

3. **Put the test tube in a water bath at 20°C.**

4. **Measure the concentration of the dye after 20 minutes.**

5. **Continue to measure the concentration every 20 minutes up to 80 minutes.**

This method is shown in DIAGRAM 2.1 in the separate diagram booklet.

2 continued

The concentration of the dye left in the test tube after each 20-minute interval is shown on GRAPH 2.1 in the separate diagram booklet.

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

(ii) State TWO variables that should be controlled. [2 marks]

1.

2.

2 (b)(i) State how the concentration of dye left in the test tube changed during the first 20 minutes. [1 mark]

(ii) Explain why this change occurred. [2 marks]

2 (c) One student suggests that the rate of diffusion is constant over the whole 80 minutes. Explain whether you agree. [3 marks]

2 (d) The students repeated the experiment in a water bath at 30°C. ADD ANOTHER LINE to GRAPH 2.1 to show the expected results. [2 marks]

11

3 One renewable energy source that large energy suppliers use to generate electricity is wind. The percentage of electricity generated in this way has been gradually increasing over the last few years.

GRAPH 3.1 in the separate diagram booklet shows the power output of a wind turbine in one day. This wind turbine has a mean output of 0.6 MW.

(a) Use GRAPH 3.1 and the equation:

$$\text{units generated (kWh)} = \text{power (kW)} \times \text{time (h)}$$

to calculate the number of units generated between 04:00 and 10:00. [4 marks]

(1 MW = 1000 kW)

continue on the next page

number of units = _____ kWh

3 (b) TABLE 3.2 in the separate diagram booklet gives information about generating electricity by wind and a nuclear power station.

Use TABLE 3.2 to answer the questions on the next page.

3 (b)(i) Calculate the number of wind turbines that need to be built to provide the same power as the nuclear power station will provide in its lifetime. [2 marks]

number of
wind turbines = _____

(ii) Calculate the land area needed by a wind farm to produce the same power as one nuclear power station. [3 marks]

land area = _____ km^2

3 (c)(i) Evaluate the cost effectiveness of the two methods of generating electricity. [3 marks]

3 (c)(ii) Evaluate the environmental impact of the two methods of generating electricity. [2 marks]

3 (d) The lifetime carbon footprints of a wind farm and a nuclear power station are

5 gCO_2/kWh.

Suggest how the carbon footprint of a coal-fired power station might compare to this value.

Give a reason for your answer.
[2 marks]

4 DIAGRAM 4.1 and 4.2 in the separate diagram booklet show the side view of the chest cavity, and a bell jar model that can be used to illustrate inspiration.

Describe the process of inspiration in the human body AND explain the limitations of the bell jar as a model of this process. [6 marks QER]

continue on the next page (Turn over)

21

16

(Turn over)

5 **Developments in plastic technology have allowed the production of bioplastics using plants as the source of raw material.**

TABLE 5.1 in the separate diagram booklet compares the production of the same mass of a bioplastic with polystyrene. Polystyrene is made from crude oil.

Use your knowledge and the information in TABLE 5.1 to answer the following questions.

(a) **Explain TWO advantages to the environment of using bioplastics.**

[4 marks]

(Turn over)

5 (b) Explain ONE environmental disadvantage of using bioplastics. [2 marks]

5 (c) Manufacturers of this bioplastic claim that it is a carbon-neutral product. State the additional information that is needed to support this claim. [2 marks]

8

6 Jamie is investigating series and parallel electrical circuits.

The following equations apply to electrical circuits:

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

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{power} = \text{current}^2 \times \text{resistance}$$

$$R_T = R_1 + R_2$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

(Turn over)

6 (a) Jamie built the circuits shown in DIAGRAM 6.1 and 6.2 in the separate diagram booklet with identical resistors. In the series circuit the total resistance in 4.5 ohms and the ammeter reading is 2 Amps.

(i) I. Compare the total resistance in the parallel circuit with the series circuit. [2 marks]

6 (a)(i) continued

II. Compare the ammeter reading in the parallel circuit with the series circuit. [1 mark]

(ii) Explain how the voltmeter readings in the two circuits compare. [2 marks]

6 (a)(iii)

Explain how the power dissipated in resistor R_1 in each circuit compares. [2 marks]

6 (b) Jamie used identical 2.25 Ω resistors in both circuits.

(i) Calculate the power dissipated by R_1 in the parallel circuit. [4 marks]

power dissipated = _____ W

(ii) Use your answer above to calculate the power dissipated in resistor R_1 in the series circuit. [2 marks]

power dissipated = _____ W

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Al2O3
+

7 DIAGRAM 7.1 in the separate diagram booklet shows the extraction of aluminium from aluminium oxide by electrolysis.

(a) Complete the labelling of DIAGRAM 7.1. [3 marks]

(b) Complete the balanced SYMBOL equation for this process on the opposite page. [3 marks]

aluminium oxide $\longrightarrow$ aluminium + oxygen

7 (c) Explain, in terms of electrons, what happens at each of the electrodes. [3 marks]

7 (d) Over the last 10 years the mass of aluminium recycled in Wales has increased.

(i) Suggest TWO economic benefits of recycling aluminium. [2 marks]

7 (d)(ii) **Explain ONE environmental benefit of recycling aluminium. [2 marks]**

13

END OF PAPER

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

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HIGHER 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 _____

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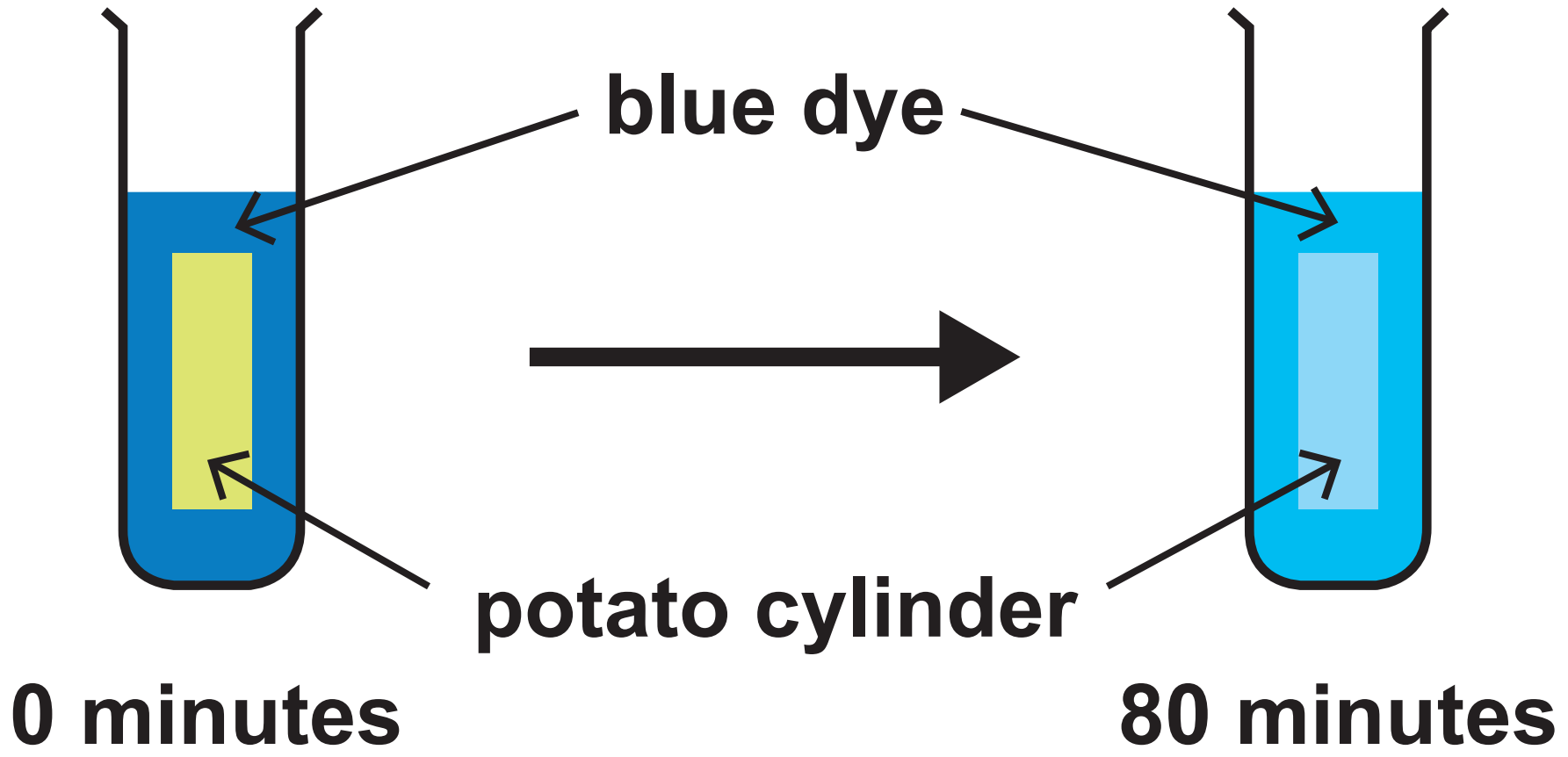
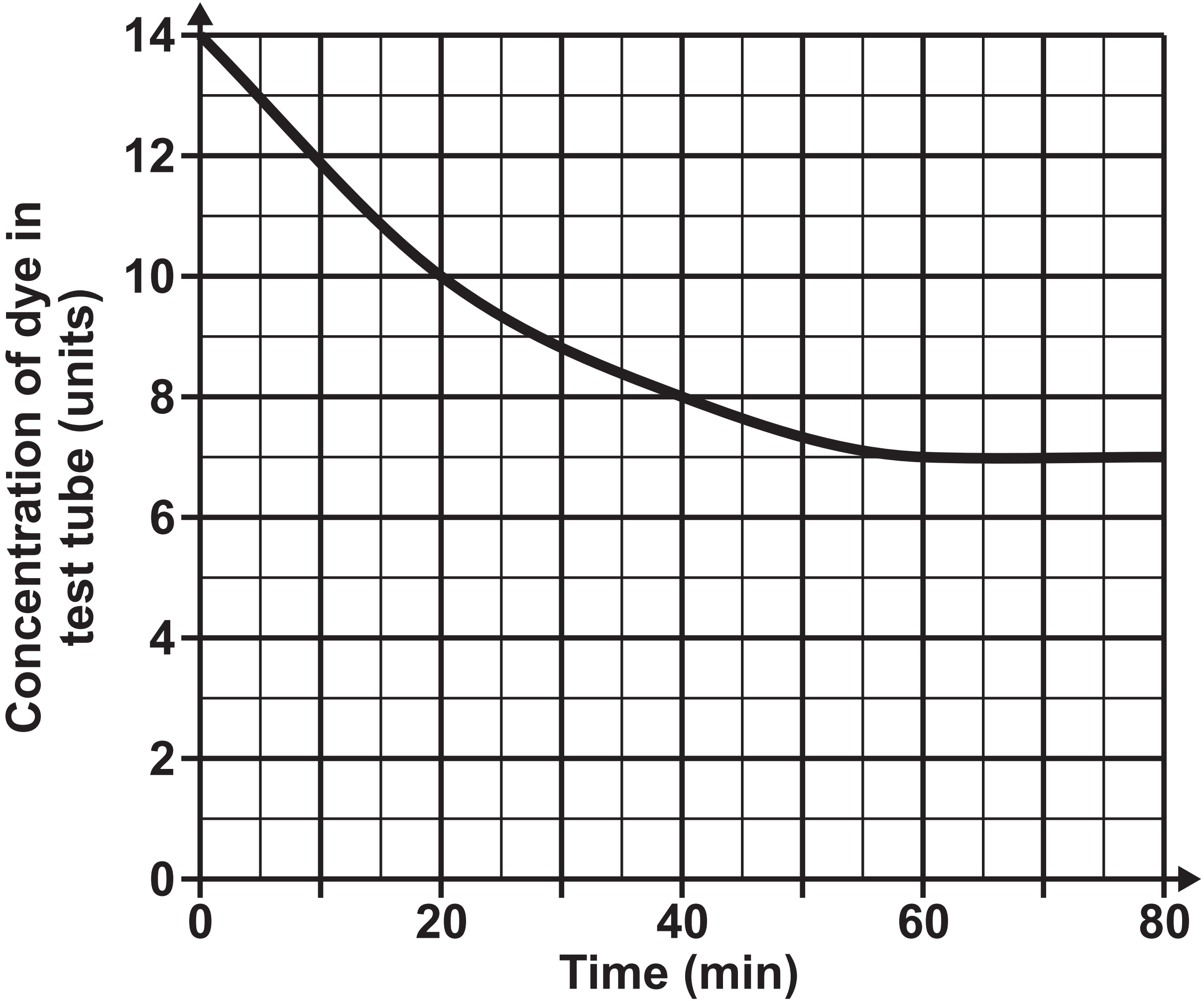
DIAGRAM 2.1



GRAPH 2.2


Concentration of dye in test tube (units)
14
12
10
8
6
4
2
0
0
20
40
60
80
Time (min)

GRAPH 3.1

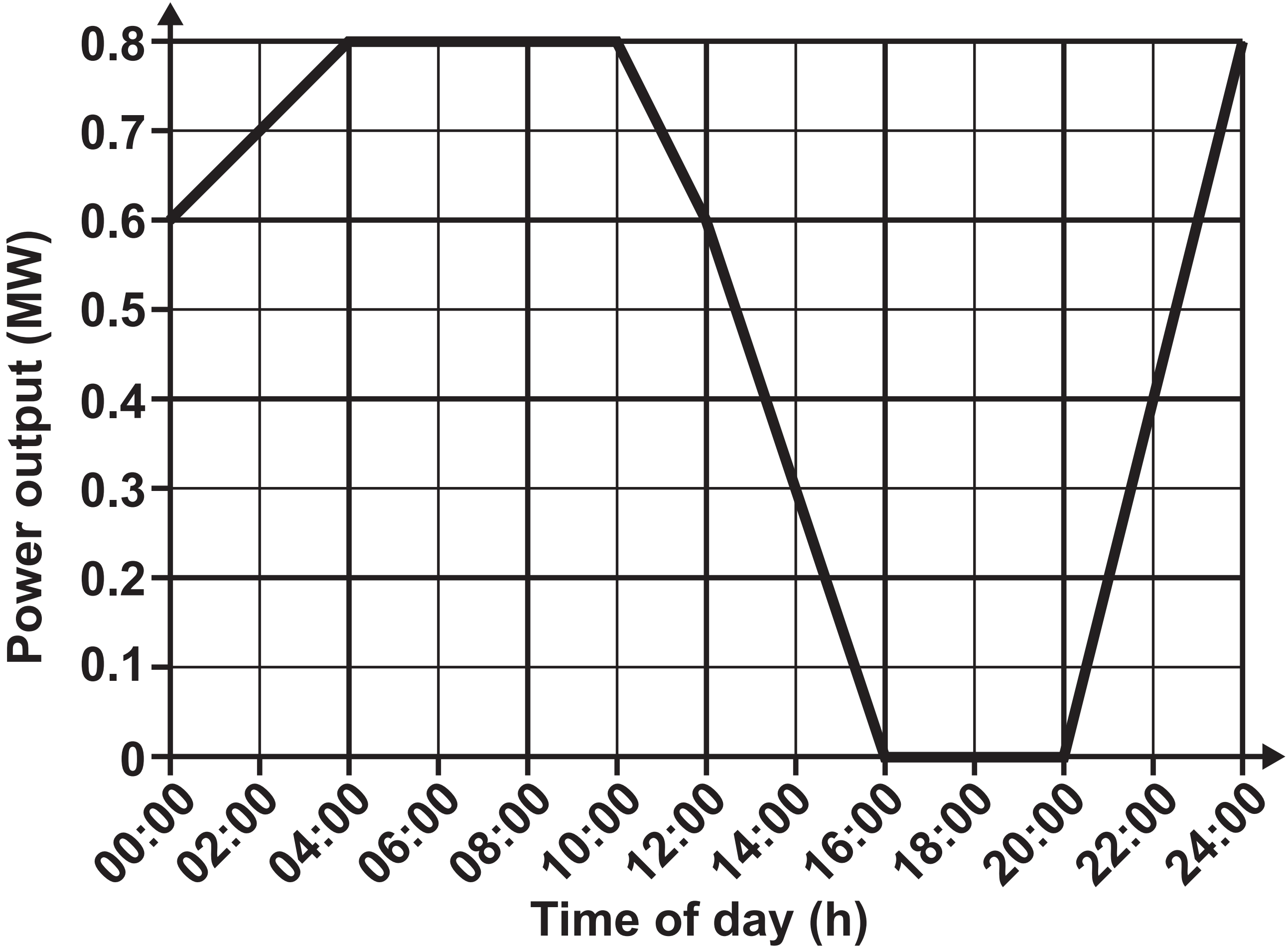

Power output (MW)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
24:00
Time of day (h)

TABLE 3.2

	wind turbine	nuclear power station
expected lifetime (years)	20	60
mean power output (MW)	0.60	3 600
land area needed (km^2)	0.55	4.5
cost to commission (£ million)	3	4 000
waste produced	none	radioactive waste
lifetime carbon footprint (gCO2/kWh)	5	5
overall cost of generating electricity (p/kWh)	5.6	2.8

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DIAGRAM 4.1: Side view of the chest cavity

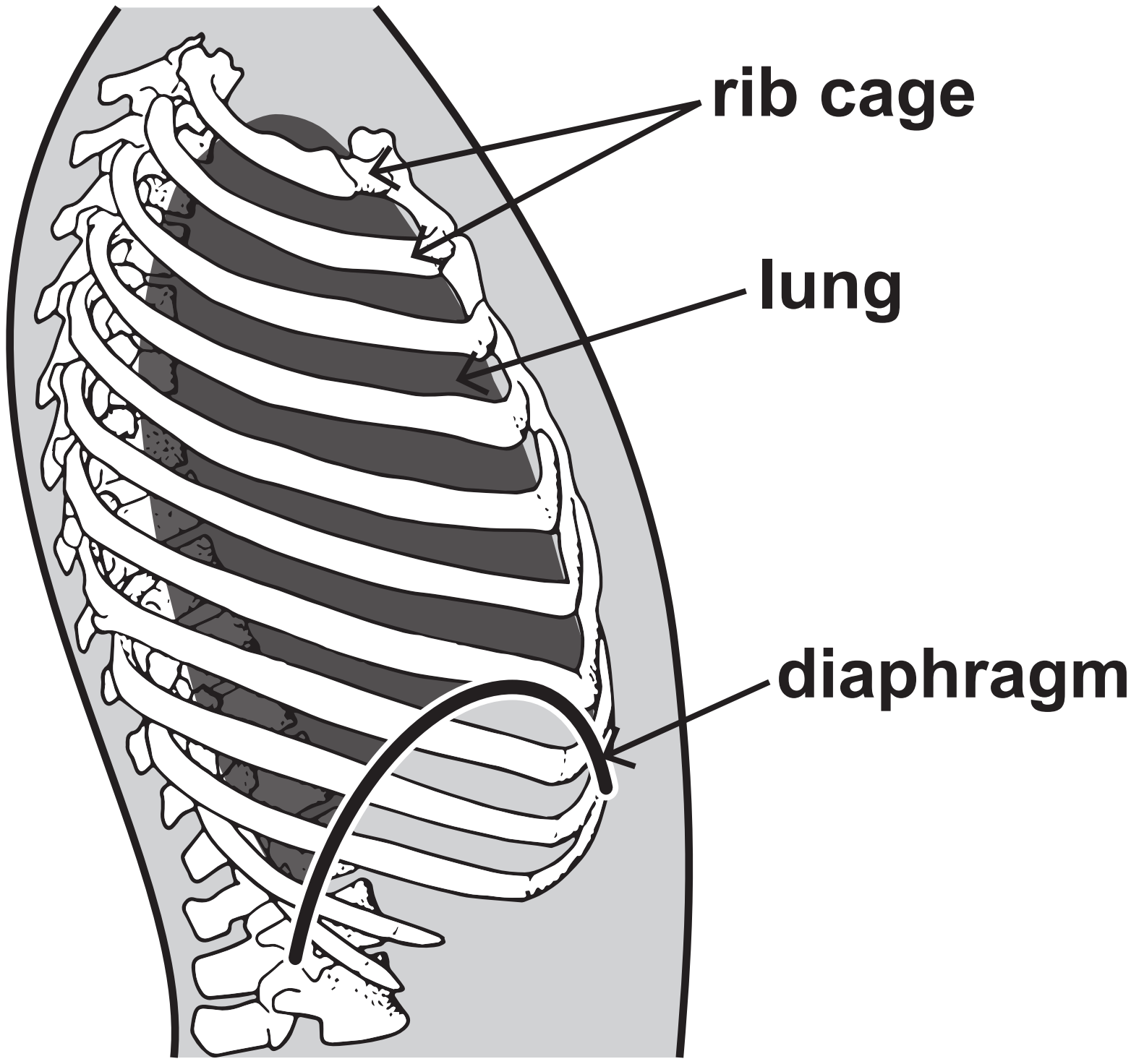
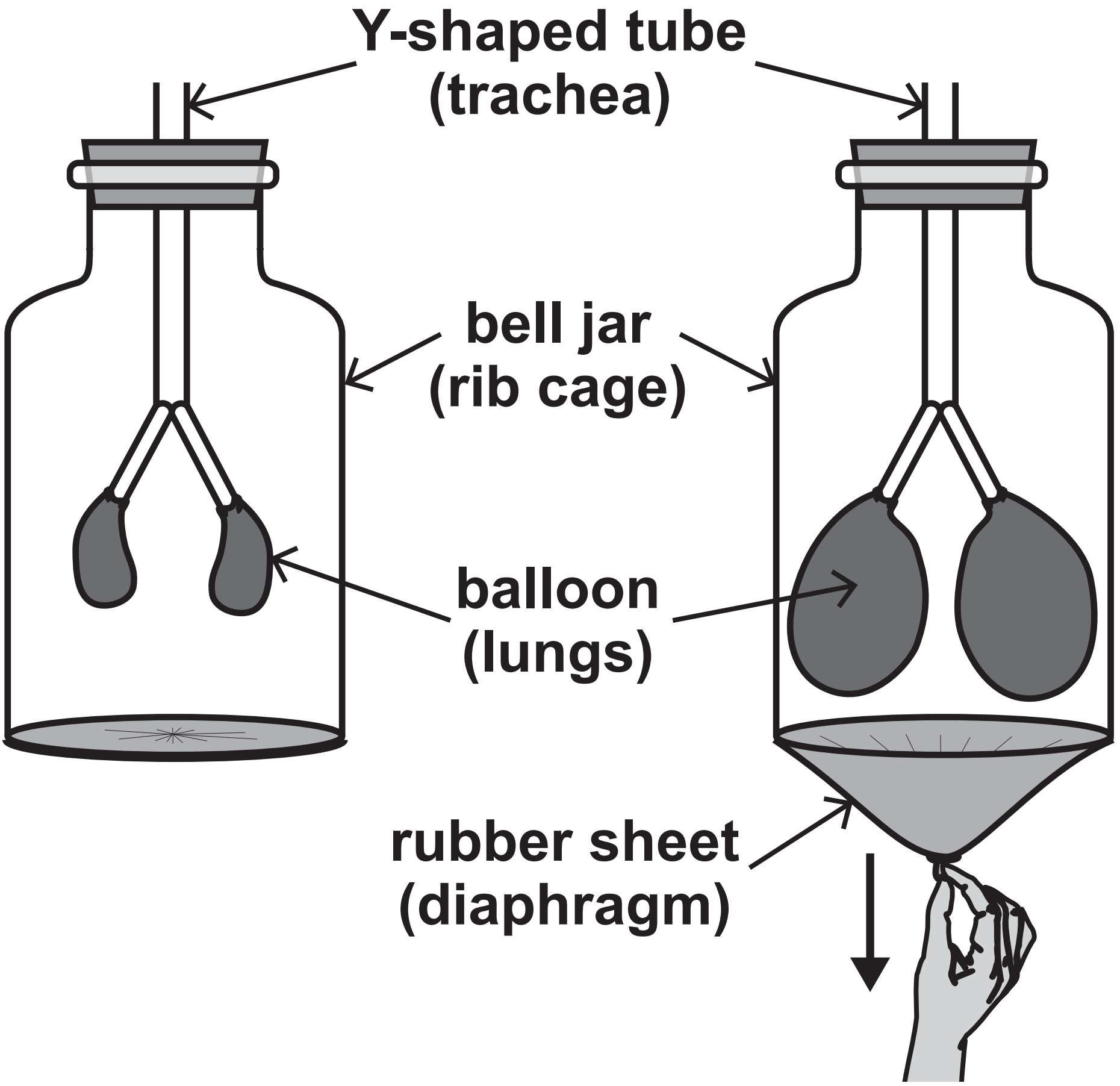


DIAGRAM 4.2: Bell jar model



Before inspiration

After inspiration

TABLE 5.1

	Bioplastic	Polystyrene
Energy consumption (kWh)	10.7	22.6
Water used in production (dm^3)	74.6	185
Waste for landfill produced (g)	1.74	2.10
Biodegradable	Yes	No
Breakdown products	carbon dioxide, water and methane	styrene
kgCO2eq / kg produced	0.50	2.2

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DIAGRAM 6.1: Series circuit

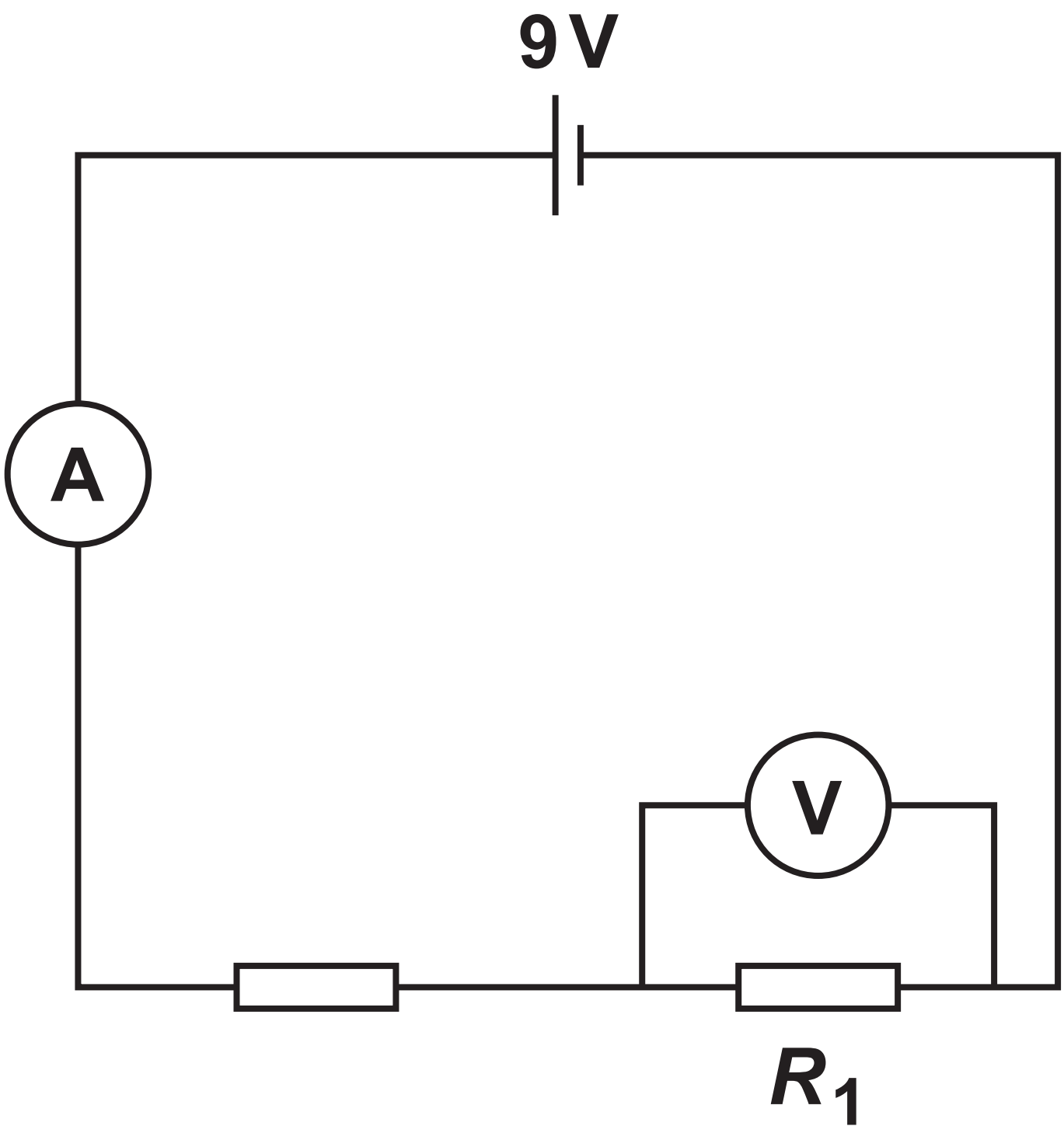


DIAGRAM 6.2: Parallel circuit

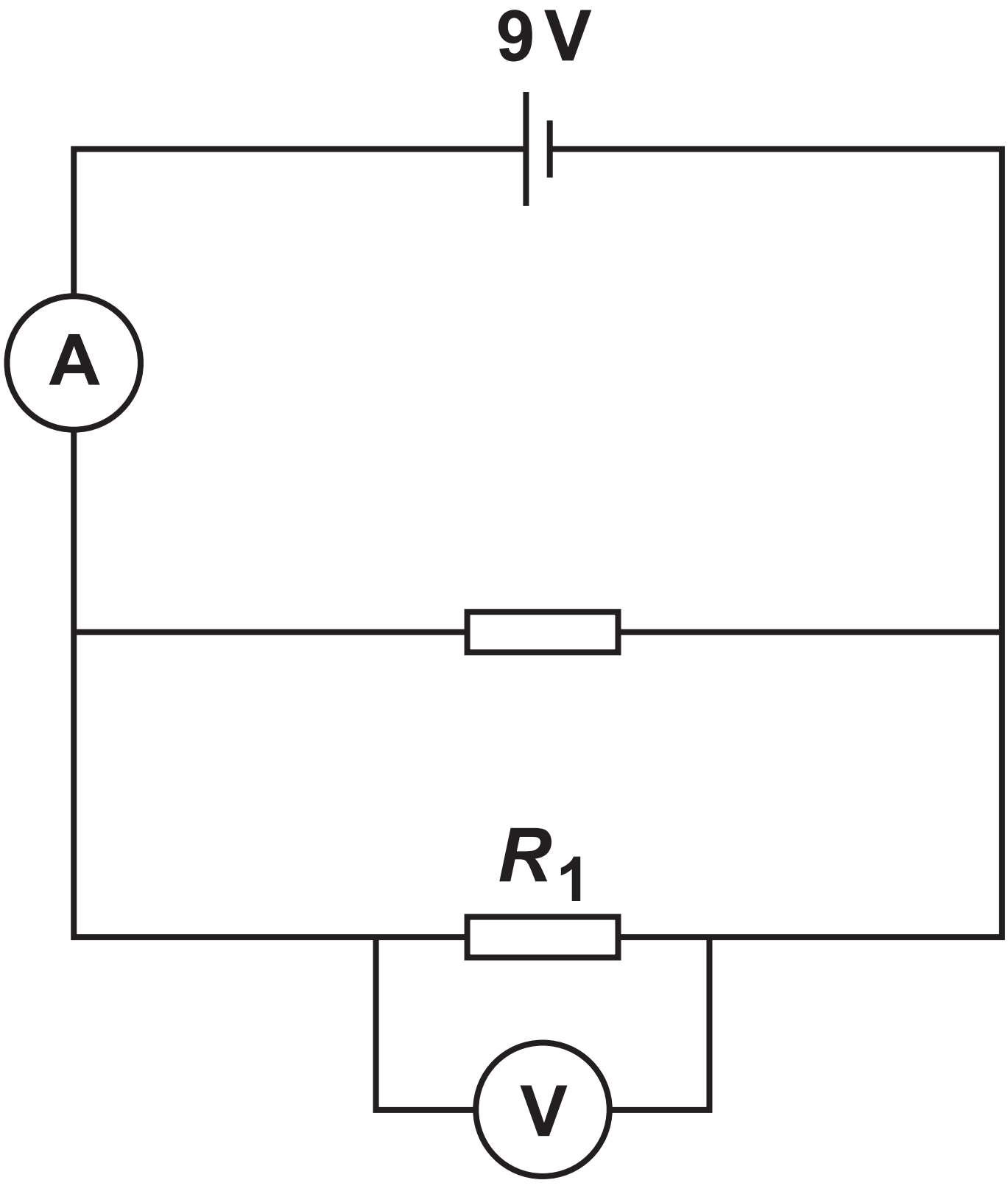
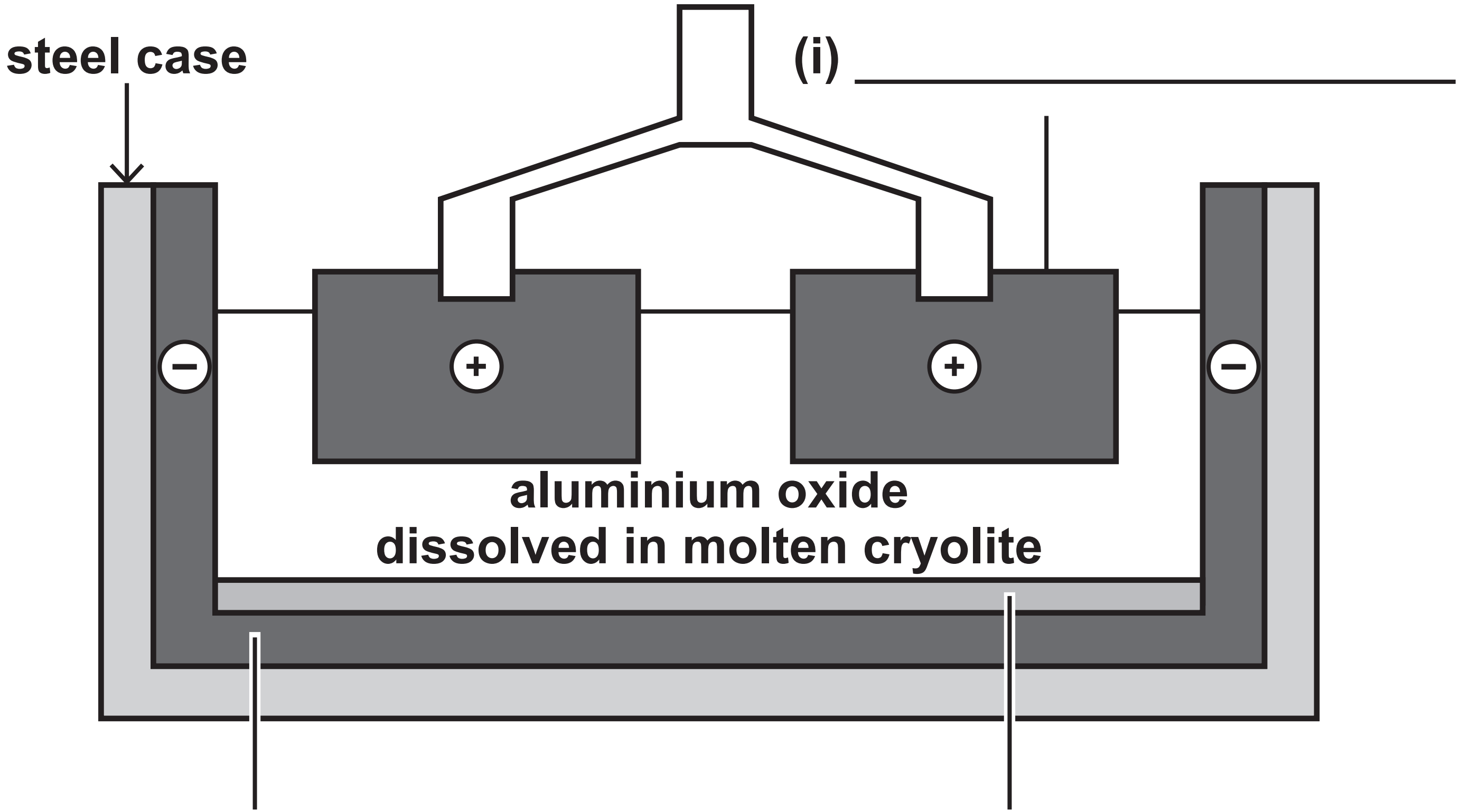


DIAGRAM 7.1



(iii) _____

(ii) _____

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APPLIED SCIENCE (Double Award)

UNIT 1: Energy, Resources and the Environment

HIGHER TIER

Data Booklet

THE PERIODIC TABLE

1	2	GROUP						
								1 H 1
7 Li 3	9 Be 4	KEY A_r — relative atomic mass Sym — symbol Z — atomic number						
23 Na 11	24 Mg 12							
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
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
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
223 Fr 87	226 Ra 88	227 Ac 89						

3	4	5	6	7	0
					4 He 2
11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
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
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
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

THE PERIODIC TABLE

PERIODIC TABLE – KEY
ATOMIC NUMBER – SYMBOL – NAME

1	H – Hydrogen	19	K – Potassium
2	He – Helium	20	Ca – Calcium
3	Li – Lithium	21	Sc – Scandium
4	Be – Beryllium	22	Ti – Titanium
5	B – Boron	23	V – Vanadium
6	C – Carbon	24	Cr – Chromium
7	N – Nitrogen	25	Mn – Manganese
8	O – Oxygen	26	Fe – Iron
9	F – Fluorine	27	Co – Cobalt
10	Ne – Neon	28	Ni – Nickel
11	Na – Sodium	29	Cu – Copper
12	Mg – Magnesium	30	Zn – Zinc
13	Al – Aluminium	31	Ga – Gallium
14	Si – Silicon	32	Ge – Germanium
15	P – Phosphorus	33	As – Arsenic
16	S – Sulfur	34	Se – Selenium
17	Cl – Chlorine	35	Br – Bromine
18	Ar – Argon	36	Kr – Krypton

37	Rb – Rubidium	57	La – Lanthanum
38	Sr – Strontium	72	Hf – Hafnium
39	Y – Yttrium	73	Ta – Tantalum
40	Zr – Zirconium	74	W – Tungsten
41	Nb – Niobium	75	Re – Rhenium
42	Mo – Molybdenum	76	Os – Osmium
43	Tc – Technetium	77	Ir – Iridium
44	Ru – Ruthenium	78	Pt – Platinum
45	Rh – Rhodium	79	Au – Gold
46	Pd – Palladium	80	Hg – Mercury
47	Ag – Silver	81	Tl – Thallium
48	Cd – Cadmium	82	Pb – Lead
49	In – Indium	83	Bi – Bismuth
50	Sn – Tin	84	Po – Polonium
51	Sb – Antimony	85	At – Astatine
52	Te – Tellurium	86	Rn – Radon
53	I – Iodine	87	Fr – Francium
54	Xe – Xenon	88	Ra – Radium
55	Cs – Caesium	89	Ac – Actinium
56	Ba – Barium		