GCSE

3445U10-1

FRIDAY, 16 JUNE 2023 – 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 will require a calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Data Booklet.

A separate Diagram 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(b) 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.	**10**	
2.	**14**	
3.	**9**	
4.	**12**	
5.	**11**	
6.	**8**	
7.	**11**	
Total	**75**	

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TURN OVER


sulfuric acid + sodium hydroxide ⟶ _____ + water

Answer ALL questions.

1 **Ffion is investigating a neutralisation reaction between sulfuric acid and sodium hydroxide.**

(a) **Use the correct words from the box below to complete the WORD equation for this reaction on the opposite page. [1 mark]**

sodium chloride	sodium nitrate
sodium sulfate	

(b) **In the experiment she monitors the change of pH using both a pH meter and an indicator.**

CHART 1.1 in the separate diagram booklet shows the colour of phenolphthalein indicator at different pH.

(i) **TABLE 1.2 in the separate diagram booklet shows Ffion's results. Complete TABLE 1.2. [2 marks]**

1 (b)(ii)

Use the information in the table to tick (✓) the boxes next to the THREE correct statements. [3 marks]

- ☐ **Before any sodium hydroxide is added to the acid the phenolphthalein turns green.**
- ☐ **The pH is lowest at the start of the experiment.**
- ☐ **When 10 cm^3 of sodium hydroxide has been added the solution is neutral.**
- ☐ **As sodium hydroxide is added the pH rises.**
- ☐ **The pH is highest at the end of the experiment.**
- ☐ **When 40 cm^3 of sodium hydroxide has been added the solution is acidic.**

1 (c) **Sodium hydroxide (NaOH) contains the three elements sodium, hydrogen and oxygen.**

(i) **Select the correct numbers from the box below to complete TABLE 1.3 in the separate diagram booklet. [3 marks]**

1	2	8	11	12	16

(ii) **Sodium metal is found in Group 1 of the Periodic Table. Use the Periodic Table in the separate data booklet to name ONE other metal found in this group. [1 mark]**

10

2 **The UK has been generating more energy using wind power over recent years.**

(a) **Circle ONE renewable energy source below. [1 mark]**

coal **gas** **solar**

(b) **The information in TABLE 2.1 in the separate diagram booklet shows the power output of a wind turbine in one day.**

(i) **Use the data from TABLE 2.1 to complete the line on GRAPH 2.2 in the separate diagram booklet and join the points with a ruler. The last three points have been plotted for you. [3 marks]**

(ii) **State why the power generated by this wind turbine is not constant during this day. [1 mark]**

2 (b)(iii)

Use the information to answer the following questions.

I. State the maximum power produced by the wind turbine during this day. [1 mark]

maximum power = _____ MW

II. State the time of day that the wind speed was greatest. [1 mark]

time = _____

III. Determine between which hours the wind turbine did not generate any electricity. [1 mark]

from: _____

to: _____

2 (b)(iv)

David suggested that the wind turbine generated a power greater than 0.6 MW for 16 hours.

ADD a horizontal line to GRAPH 2.2 and use it to explain whether David was correct.
[4 marks]

2 (c) **Last year this wind turbine had a mean power output of 0.6 MW. A typical nuclear power station has a continuous power output of 3 600 MW.**

Calculate how many wind turbines would be needed to generate the same power output as a nuclear power station. [2 marks]

number of wind turbines = _____

14

3 Clara is studying the structure and function of cells. DIAGRAM 3.1 in the separate diagram booklet shows animal and plant cells.

(a) Complete TABLE 3.2 in the separate diagram booklet to show which parts are present in animal cells. [3 marks]

(b) Describe the functions of the parts of a PLANT CELL listed in the table.
[6 marks QER]

continue your answer on the next page

9

4 **DIAGRAM 4.1 in the separate diagram booklet shows part of the National Grid.**

(a) **Complete the sentences about the National Grid by selecting the correct words from the box below. Each word can be used once, more than once or not at all. [4 marks]**

faster	**reliable**	**increases**
generates	**safely**	**decreases**

The National Grid makes sure that the electricity supply to consumers is

_____ .

Transformer X _____ the

voltage and _____ the current.

Transformer Y changes the voltage so that consumers can use it

_____ in their homes.

4 (b) Five electrical supply companies (A, B, C, D and E) each produce the same amount of electrical power.

TABLE 4.2 in the separate diagram booklet shows the percentage of electrical power output from each energy source by each company.

Use TABLE 4.2 to answer the following questions.

(i) State which energy company produces the most electrical power from coal. [1 mark]

_____

(ii) State which company produces the most nuclear waste. [1 mark]

_____

(iii) Calculate the MEAN percentage of electrical power output generated from COAL by the five companies (A, B, C, D and E). [2 marks]

mean percentage = _____

4 (c) **The carbon footprint of an energy supply customer can be an important factor when choosing a supply company.**

(i) **State what is meant by the term 'carbon footprint'. [2 marks]**

(ii) **A customer decides against using Company A since they believe that they have the highest carbon footprint from generating electricity.**

Use information from the table to explain whether the customer is correct. [2 marks]

12

5 Jamie is investigating an electrical circuit which has two IDENTICAL resistors, R_1 and R_2.

The circuit that he built is shown in DIAGRAM **5.1** in the separate diagram booklet.

(a) Complete the sentences by <u>UNDERLINING</u> the correct word(s) in the brackets.

(i) In this series circuit the current in R_1 is

(the same as / higher than / lower than)

the current in R_2. [1 mark]

(ii) In this series circuit the voltage across R_1 is

(the same as / higher than / lower than)

the voltage across R_2. [1 mark]

5 (b) The voltage across R_1 is 4.5 V.

(i) Each resistor was found to have a resistance of 2.25 Ω.

I. Use the equation:

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

to calculate the current in R_1. [2 marks]

current = _____ A

II. Use the equation:

power = voltage × current

to calculate the power developed in resistor R_1. [2 marks]

power developed in R_1 = _____ W

5 (b)(ii) State the voltage across R_2. [1 mark]

voltage across R_2 = _____ V

(c) Jamie then built a parallel circuit using the same 2.25 Ω resistors.

This parallel circuit is shown in DIAGRAM **5.2** in the separate diagram booklet.

(i) State which ammeter (A_1, A_2, A_3 or A_4) measures the current through R_1. [1 mark]

_____

(ii) State the voltmeter reading across R_1. [1 mark]

voltmeter reading = _____ V

5 (b)(iii)

Ammeter A_2 reads 4 amps.

I. State the reading on ammeter A_3. [1 mark]

ammeter reading = _____ A

II. Calculate the reading shown on ammeter A_1. [1 mark]

ammeter reading = _____ A

11

6 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.

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

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

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

1. _____

_____

_____

2. _____

_____

_____

6 (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]

8

7 **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 7.1 in the separate diagram booklet.

The concentration of the dye left in the test tube after each 20-minute interval is shown on GRAPH 7.2 in the separate diagram boolet.

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

---

7 (a)(ii)

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

1. _____

_____

2. _____

_____

7 (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]

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

(d) **The students repeated the experiment in a water bath at 30 °C. ADD ANOTHER LINE to GRAPH 7.2 to show the expected results. [2 marks]**

11

END OF PAPER

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

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APPLIED SCIENCE (Double Award)

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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 _____

CHART 1.1

pH scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14
phenolphthalein	colourless								pale pink	pink				

TABLE 1.2

Volume of sodium hydroxide added (cm^3)	pH meter reading	Phenolphthalein indicator colour
0	1.0	colourless
5	1.0	colourless
10	1.1	colourless
15	1.2	colourless
20	2.0	_____
25	9.0	pale pink
30	13.0	_____
35	14.0	pink
40	14.0	pink

TABLE 1.3

Element	Number of protons	Number of neutrons	Number of electrons	Mass number
sodium	11	12	_____	23
oxygen	8	_____	8	16
hydrogen	1	0	1	_____

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TURN OVER

TABLE 2.1

Time of day (hours:mins)	Power output of wind turbine (MW)
00:00	0.6
04:00	1.0
08:00	1.2
12:00	0.8
16:00	0.0
20:00	0.0
24:00	0.8

GRAPH 2.2

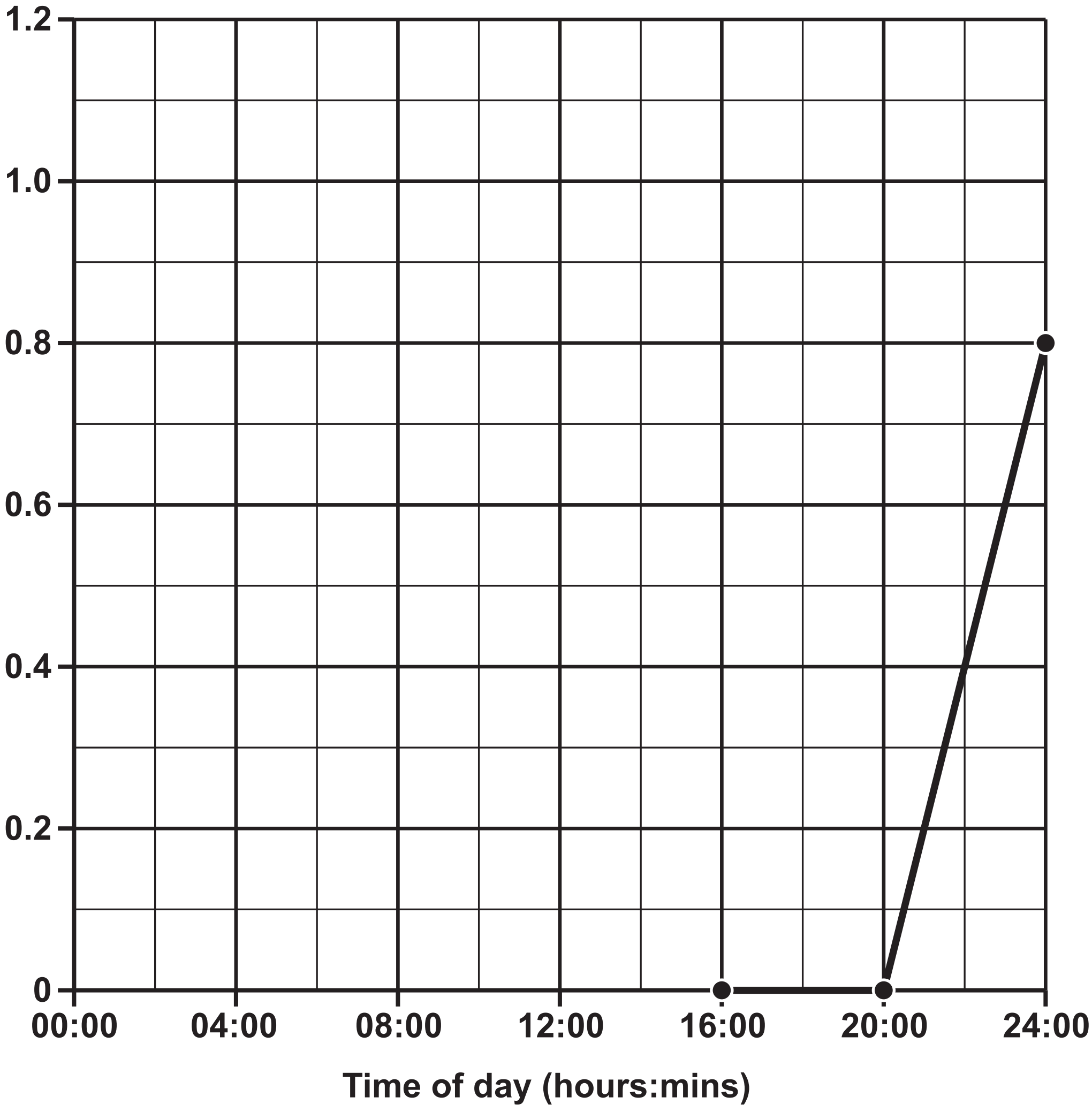
Power output (MW)
1.2
1.0
0.8
0.6
0.4
0.2
0
00:00
04:00
08:00
12:00
16:00
20:00
24:00
Time of day (hours:mins)

DIAGRAM 3.1

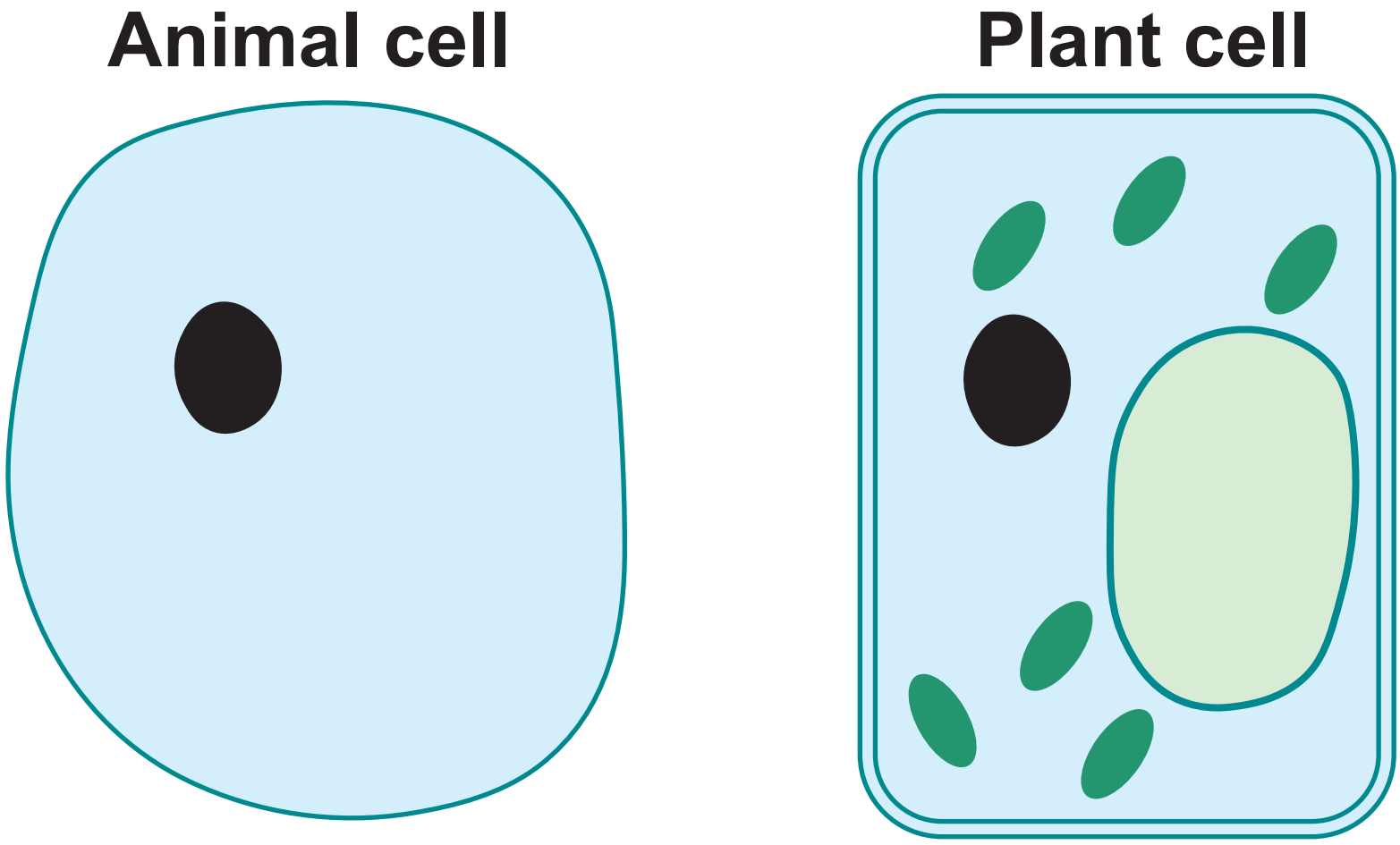

TABLE 3.2

Part	Plant cells	Animal cells (✓ or ✗)
cell wall	✓	✗
cytoplasm	✓	✓
chloroplast	✓	✗
nucleus	✓	
cell membrane	✓	
vacuole	✓	

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DIAGRAM 4.1

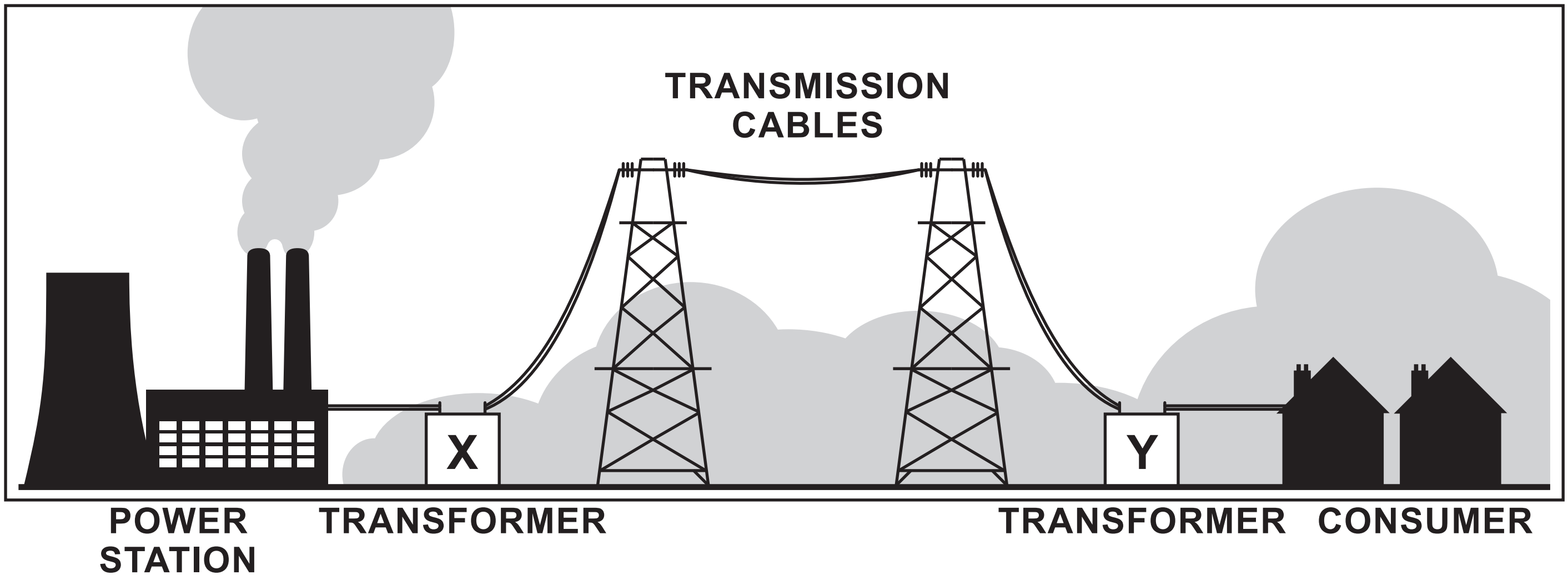

TRANSMISSION CABLES
X
Y
POWER STATION
TRANSFORMER
TRANSFORMER
CONSUMER

TABLE 4.2

	Percentage of electrical power output from each energy source (%)				
Energy source	Company A	Company B	Company C	Company D	Company E
coal	4.8	5.8	7.1	10.8	10.1
natural gas	63.0	55.5	9.6	63.0	46.0
nuclear	5.2	20.6	71.2	23.3	13.9
renewable	27.0	18.1	12.1	2.9	30.0

DIAGRAM 5.1

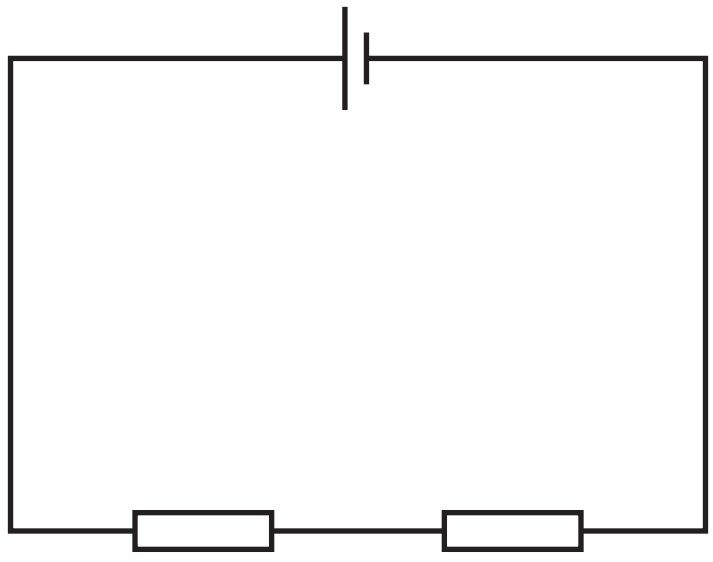


DIAGRAM 5.2

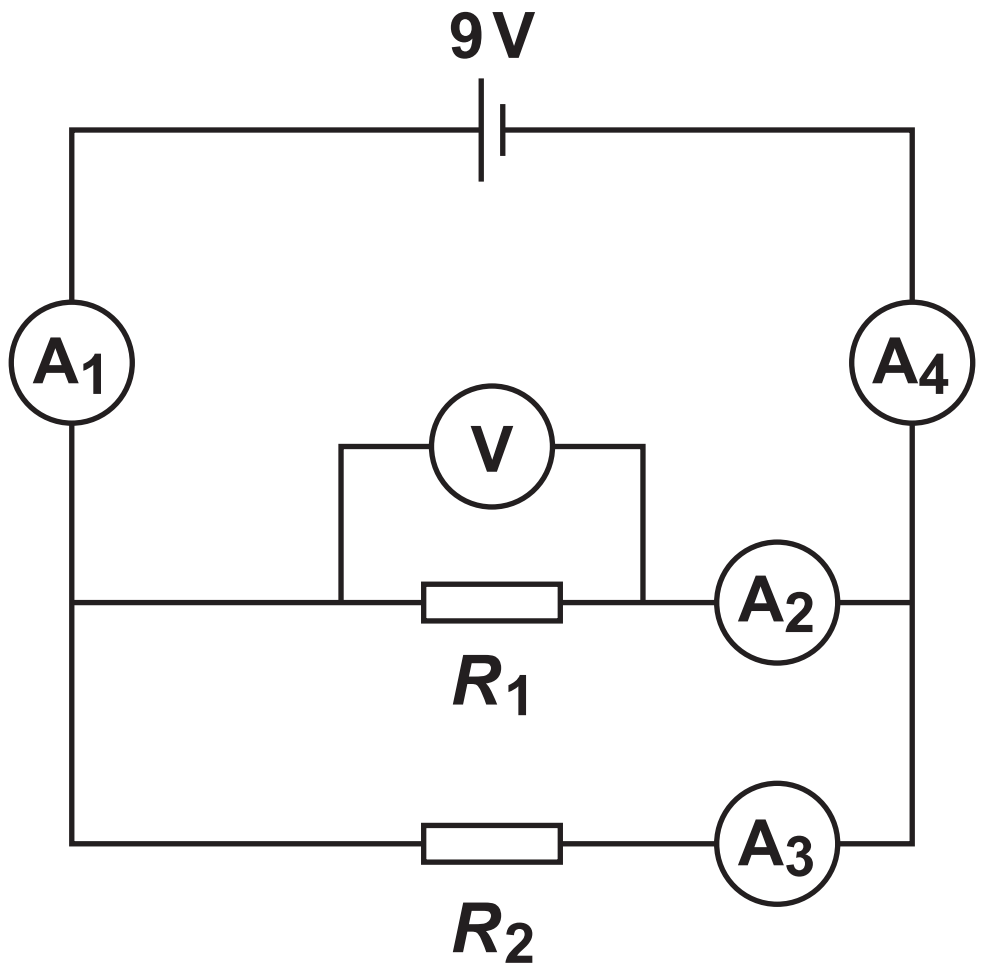
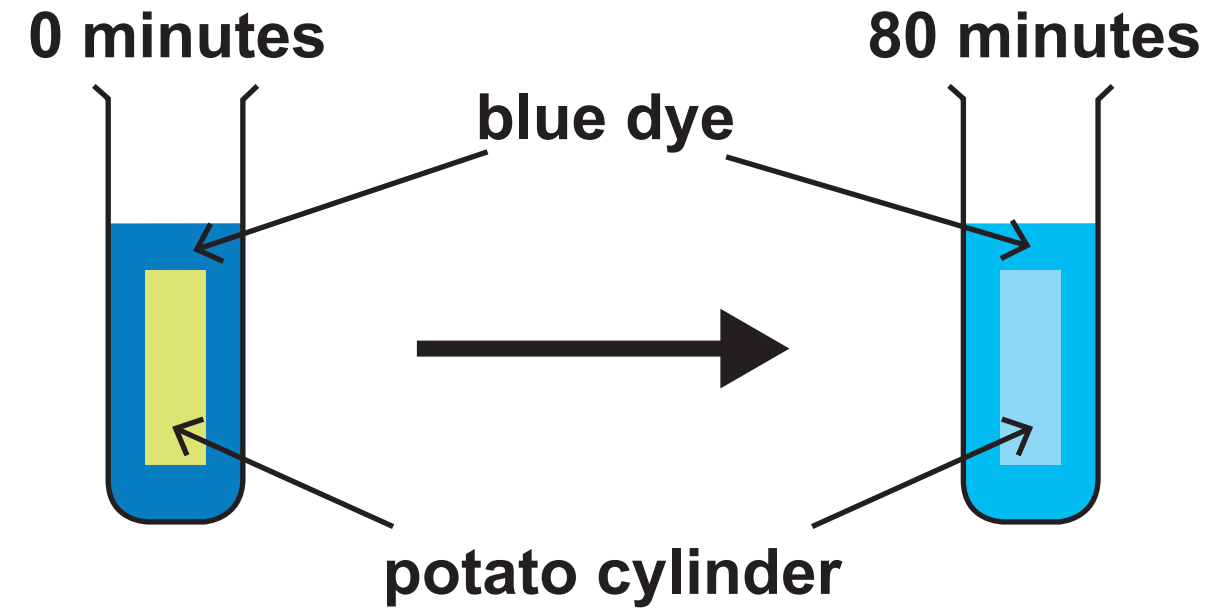
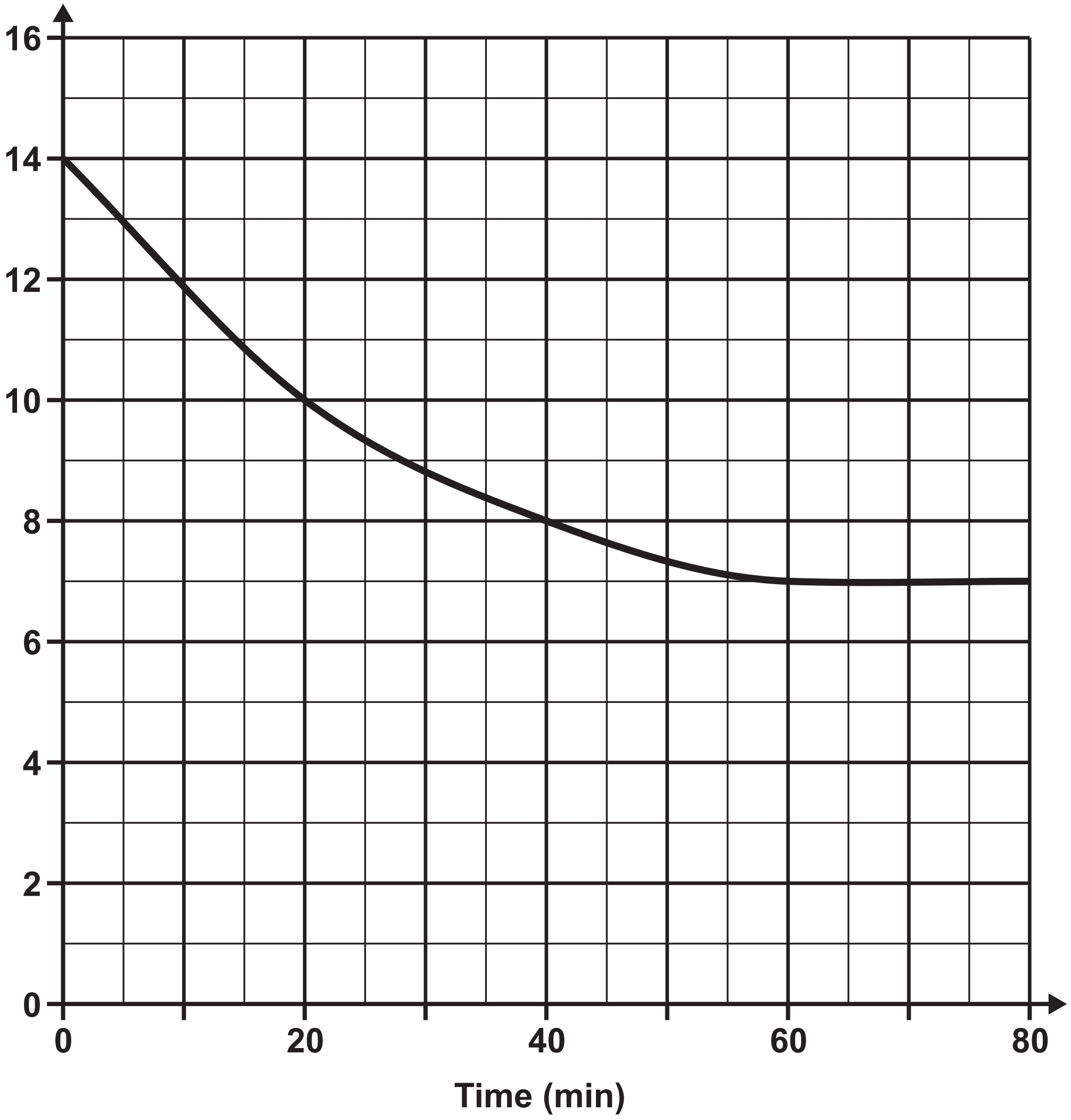


DIAGRAM 7.1



GRAPH 7.2


Concentration of dye in test tube (units)
16
14
12
10
8
6
4
2
0
0
20
40
60
80
Time (min)

GCSE

3445U10-1

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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		34	Se – Selenium
2	He – Helium		35	Br – Bromine
3	Li – Lithium		36	Kr – Krypton
4	Be – Beryllium		37	Rb – Rubidium
5	B – Boron		38	Sr – Strontium
6	C – Carbon		39	Y – Yttrium
7	N – Nitrogen		40	Zr – Zirconium
8	O – Oxygen		41	Nb – Niobium
9	F – Fluorine		42	Mo – Molybdenum
10	Ne – Neon		43	Tc – Technetium
11	Na – Sodium		44	Ru – Ruthenium
12	Mg – Magnesium		45	Rh – Rhodium
13	Al – Aluminium		46	Pd – Palladium
14	Si – Silicon		47	Ag – Silver
15	P – Phosphorus		48	Cd – Cadmium
16	S – Sulfur		49	In – Indium
17	Cl – Chlorine		50	Sn – Tin
18	Ar – Argon		51	Sb – Antimony
19	K – Potassium		52	Te – Tellurium
20	Ca – Calcium		53	I – Iodine
21	Sc – Scandium		54	Xe – Xenon
22	Ti – Titanium		55	Cs – Caesium
23	V – Vanadium		56	Ba – Barium
24	Cr – Chromium		57	La – Lanthanum
25	Mn – Manganese		72	Hf – Hafnium
26	Fe – Iron		73	Ta – Tantalum
27	Co – Cobalt		74	W – Tungsten
28	Ni – Nickel		75	Re – Rhenium
29	Cu – Copper		76	Os – Osmium
30	Zn – Zinc		77	Ir – Iridium
31	Ga – Gallium		78	Pt – Platinum
32	Ge – Germanium		79	Au – Gold
33	As – Arsenic		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