GCSE

3445UC0-1

TUESDAY, 16 MAY 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 3: Food, Materials and Processes
HIGHER TIER

1 hour 30 minutes plus your additional time allowance

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

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ADDITIONAL MATERIALS

In addition to this examination 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.

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.	5	
2.	14	
3.	10	
4.	13	
5.	13	
6.	12	
7.	8	
Total	75	

Answer ALL questions in the spaces provided.

1 (a) State, in terms of electrons, the difference between ionic and covalent bonding. [2 marks]

1 (b) When magnesium reacts with oxygen, the ionic compound magnesium oxide is formed.

(i) The outer electrons of magnesium and oxygen are shown in DIAGRAM 1.1 in the separate diagram booklet. Draw arrows to show the transfer of electrons when magnesium oxide is formed. [1 mark]

(ii) State the charges on the ions formed [2 marks]

Mg _____

O _____

2 Inos is a Welsh caravan manufacturer based in Denbighshire.

The materials used to build modern caravans are very different to those used in early caravans.

TABLE 2.1 in the separate diagram booklet shows how the materials used in manufacturing the body of a caravan have changed over time.

TABLE 2.2 in the separate diagram booklet shows information about some of the materials used to make the body of caravans.

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

2 (a) Describe how the weight and strength of caravan bodies changed between 1920 and 1970. [4 marks]

Weight: _____

_____

_____

_____

_____

continue on the next page

Strength: _____

_____

_____

_____

_____

_____

(Turn over)

2 (b)(i) State TWO advantages of the materials used in 2015 over those used previously. [2 marks]

1. _____

_____

2. _____

_____

(ii) State ONE disadvantage of the materials used in 2015 over those used previously. [1 mark]

_____

_____

2 (c) GRP is a common composite material, in which glass fibres are mixed with epoxy resin.

(i) A GRP panel contains a volume of 300 cm^3 of epoxy resin.

Use the equation:

mass = density × volume

to calculate the mass of the resin.
[3 marks]

mass = _____ g

2 (c)(ii)

I. State the strength of glass fibre in N/cm^2. [2 marks]

(1 MPa = 100 N/cm^2)

strength = _____ N/cm^2

2 (c)(ii) continued

II. The cross-sectional area (csa) of a glass fibre is 0.00015 cm^2.

Use your answer in part (c)(ii) I. and the equation:

force = strength × csa

to calculate the force required to break it. [2 marks]

force = _____ N

3 Ash dieback disease is a fungal infection caused by a fungus called **Hymenoscyphus fraxineus** that is common in ash trees in Wales.

The disease causes the leaves to blacken and wilt, so eventually the ash tree has no leaves.

The photographs in DIAGRAM 3.1 in the separate diagram booklet show healthy ash leaves and those affected by ash dieback.

(a) Describe the process of photosynthesis AND explain why dieback disease affects the growth of the ash tree. [4 marks]

(Turn over)

3 (b) Describe an experiment to investigate how limiting factors affect the rate of photosynthesis in the *Elodea* plant. DIAGRAM 3.2 in the separate diagram booklet shows the apparatus used in the experiment. [6 marks QER]

continue on the next page

continue on the next page

(Turn over)

10

4 Nuclear reactor 3 at the Hunterston B power station was shut down after cracks in graphite moderator bricks were found to be growing faster than expected. The Office for Nuclear Regulation (ONR) raised concerns over the number of cracks in the joints between the graphite moderator bricks in the core. An unusual event, such as an earthquake, might move the graphite bricks so the control rod channels could become blocked.

(Turn over)

4 (a)(i) Explain the purpose of the graphite moderator in a nuclear reactor.
[2 marks]

4 (a)(ii) Explain why blocked control rod channels are very dangerous. [3 marks]

continue on the next page

(Turn over)

4 (b) DIAGRAM 4.1 in the separate diagram booklet shows a reaction in a nuclear reactor and part of the reaction equation.

COMPLETE the equation. [3 marks]

(c) It is likely that Hunterston B power station will be decommissioned. When it is, the uranium-235 in the fuel rods will continue to decay at the rate shown in GRAPH 4.2 in the separate diagram booklet.

(i) Add lines to the graph to calculate the half-life of uranium-235. [2 marks]

half-life = _____ million years

4 (c)(ii) Uranium-235 becomes safe once its activity drops to 1/32 of its original value. Calculate the time it takes to drop to this value. [3 marks]

time = _____ years

13

5 Analytical scientists work in a wide range of different industries and agencies.

(a) The Food Standards Agency (FSA) commissioned a project to detect the coloured dyes used in food colourings.

DIAGRAM 5.1 in the separate diagram booklet shows a chromatogram of different food colourings.

5 (a)(i) The result for the dye in the red food colouring is not included in the diagram. The R_f value for red colouring is 0.4.

Use the equation:

$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$

to calculate the distance moved by the dye in the red colouring on this chromatogram AND add it to the diagram. [3 marks]

distance travelled = _____ cm

5 (a)(ii) It was claimed that brown colouring was not a combination of other coloured dyes. Explain whether you agree with this claim. [2 marks]

5 (a)(iii) Explain, in terms of the mobile and stationary phases, why the molecules in purple colouring move different distances along the chromatogram. [3 marks]

5 (b) Qualitative chemical testing is used to identify the ions in compounds.

(i) Six unlabelled bottles each contained a solution of one of the compounds in the box below.

copper(II) sulfate	sodium carbonate
lithium carbonate	sodium chloride
potassium sulfate	calcium iodide

I. State which compounds would produce a yellow flame in a flame test. [1 mark]

5 (b)(i) continued

II. State which compounds would produce bubbles of gas when added to hydrochloric acid. [1 mark]

5 (b)(ii) A technician has a colourless solution in an unlabelled bottle. He suspects it is metal chloride. Describe a test that could be carried out to confirm that the solution is a chloride, and give the expected result. [3 marks]

continue on the next page

31

13

(Turn over)

6 Levels of bacteria in milk are routinely monitored.

(a) Most milk sold to consumers is pasteurised and homogenised.

(i) Explain why milk is pasteurised.

[2 marks]

6 (a)(ii) Describe the process of homogenisation and explain why it is carried out. [4 marks]

6 (b) Scientists investigated four types of milk. They monitored the growth of bacterial colonies on agar plates USING 0.1 cm^3 from each type of milk over two days. Their results are shown in DIAGRAM 6.1 and TABLE 6.2 in the separate diagram booklet.

(i) Complete the table. [2 marks]

Space for working

6 (b)(ii)

Unopened UHT milk can be stored on supermarket shelves at room temperature for six months but unopened pasteurised milk must be stored in a refrigerator at 4 °C or below for no longer than seven days.

Explain these differences. [4 marks]

continue on the next page

36

12

(Turn over)

7 A student investigated the reaction between hydrochloric acid (HCl) and calcium carbonate ($CaCO_3$). She measured the volume of gas produced for different concentrations of acid after 60 seconds.

She started each reaction at the same temperature, with the same mass of calcium carbonate and the same volume of acid. The acid was in excess each time.

TABLE 7.1 in the separate diagram booklet shows the time taken to produce 60 cm^3 of CO_2 for each concentration of HCl.

(a)(i) COMPLETE TABLE 7.1 to two significant figures. [2 marks]

7 (a)(ii) Estimate the time taken to produce 60 cm^3 of carbon dioxide if a concentration of 4.0 mol/dm^3 HCl is used. [1 mark]

time = _____ s

7 (b)(i) State and explain, in terms of particles, the effect of increasing acid concentration on the rate of reaction. [3 marks]

7 (b)(ii)

The student noticed that when the experiments ran for 10 minutes, she obtained the same volume of carbon dioxide in each case.

Explain her observation. [2 marks]

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END OF PAPER

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DIAGRAM BOOKLET

This Diagram Booklet MUST be handed in to the invigilators and sent for marking.

Surname _____

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Candidate Number 0 _____

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DIAGRAM 1.1

TABLE 2.1

Year	Materials used
1920	wood
1950	steel and wood
1970	aluminium and wood
2015	glass reinforced plastic (GRP), polyester

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TABLE 2.2

Material		Density (g/cm^3)	Stiffness (GPa)	Melting Point (°C)
wood		0.6		
steel		7.8	210	1 357
aluminium		2.7	69	660
GRP	glass fibres	2.4	180	1 400
	epoxy resin	1.5		
polyester		1.9	150	121

TABLE 2.2 – continued

Material		Strength (MPa)	Is it brittle?	Does it corrode?
wood		1 000	No	no but rots when wet
steel		1 200	No	yes producing rust
aluminium		90	No	yes producing a resistant coating
GRP	glass fibres	3 500	Yes	No
	epoxy resin	60	Yes	No
polyester		250	Yes	No

DIAGRAM 3.1

healthy ash leaves

ash leaves affected by ash dieback

DIAGRAM 3.1

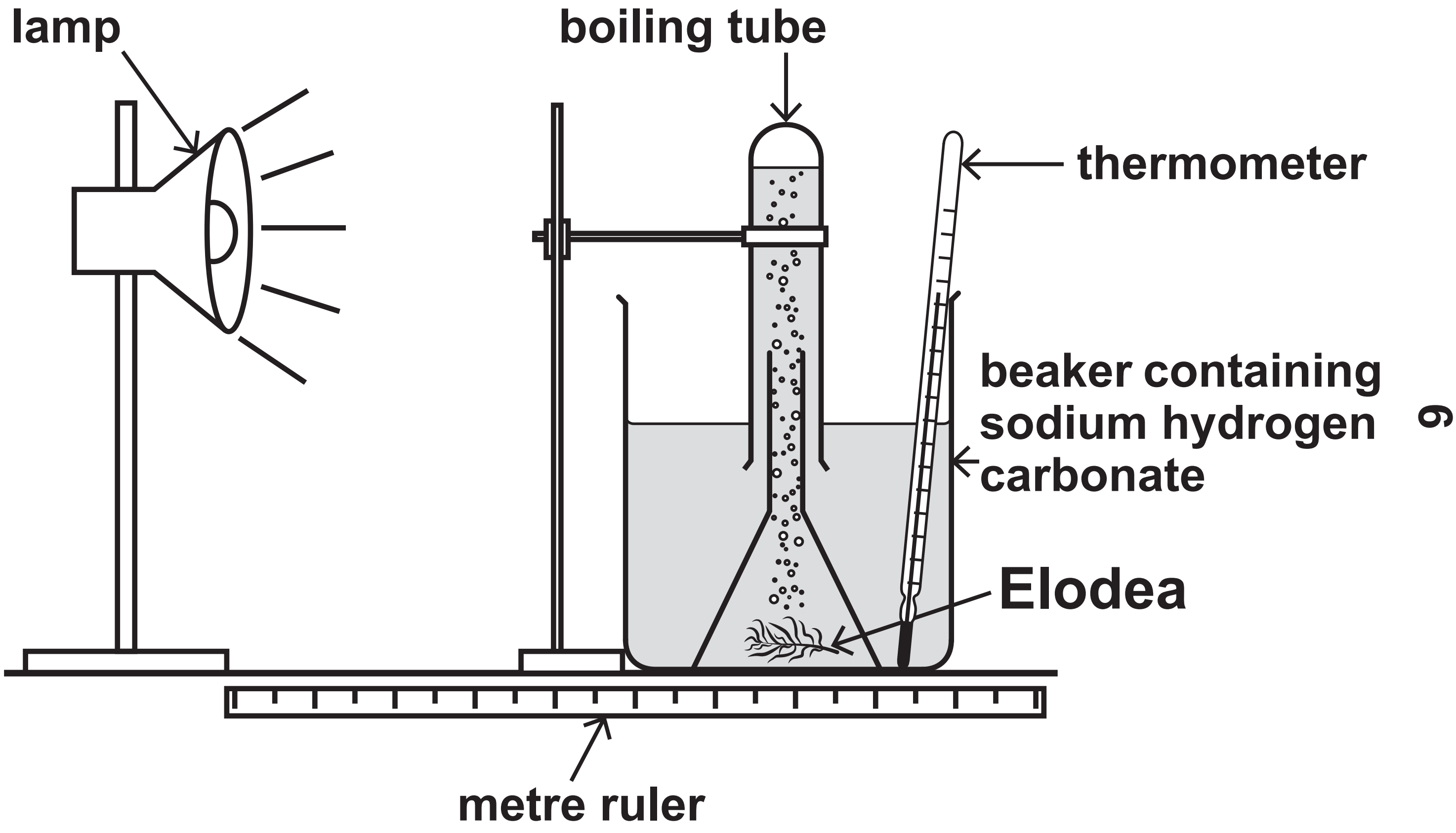
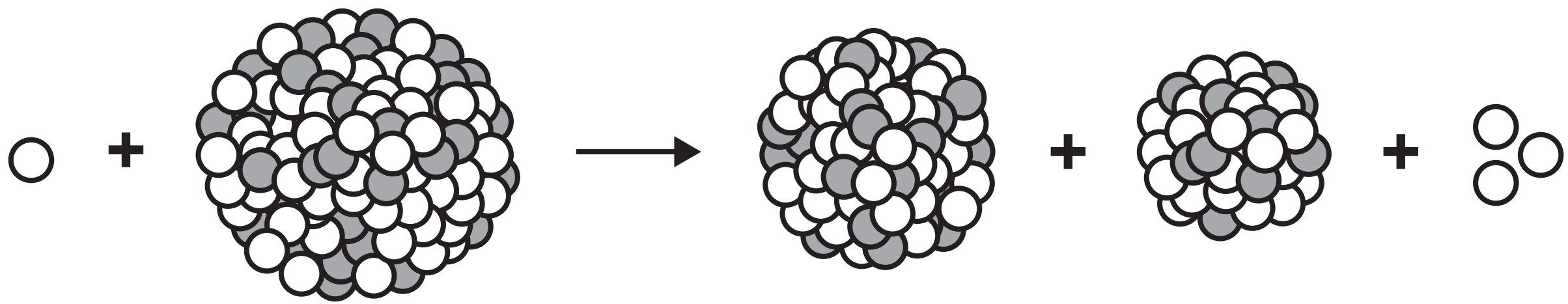

lamp
boiling tube
thermometer
beaker containing sodium hydrogen carbonate
Elodea
metre ruler

DIAGRAM 4.1



$$ {}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{141}_{56}Ba + \underline{\qquad\qquad} Kr + \underline{\qquad\qquad} {}^{1}_{0}n $$

GRAPH 4.2

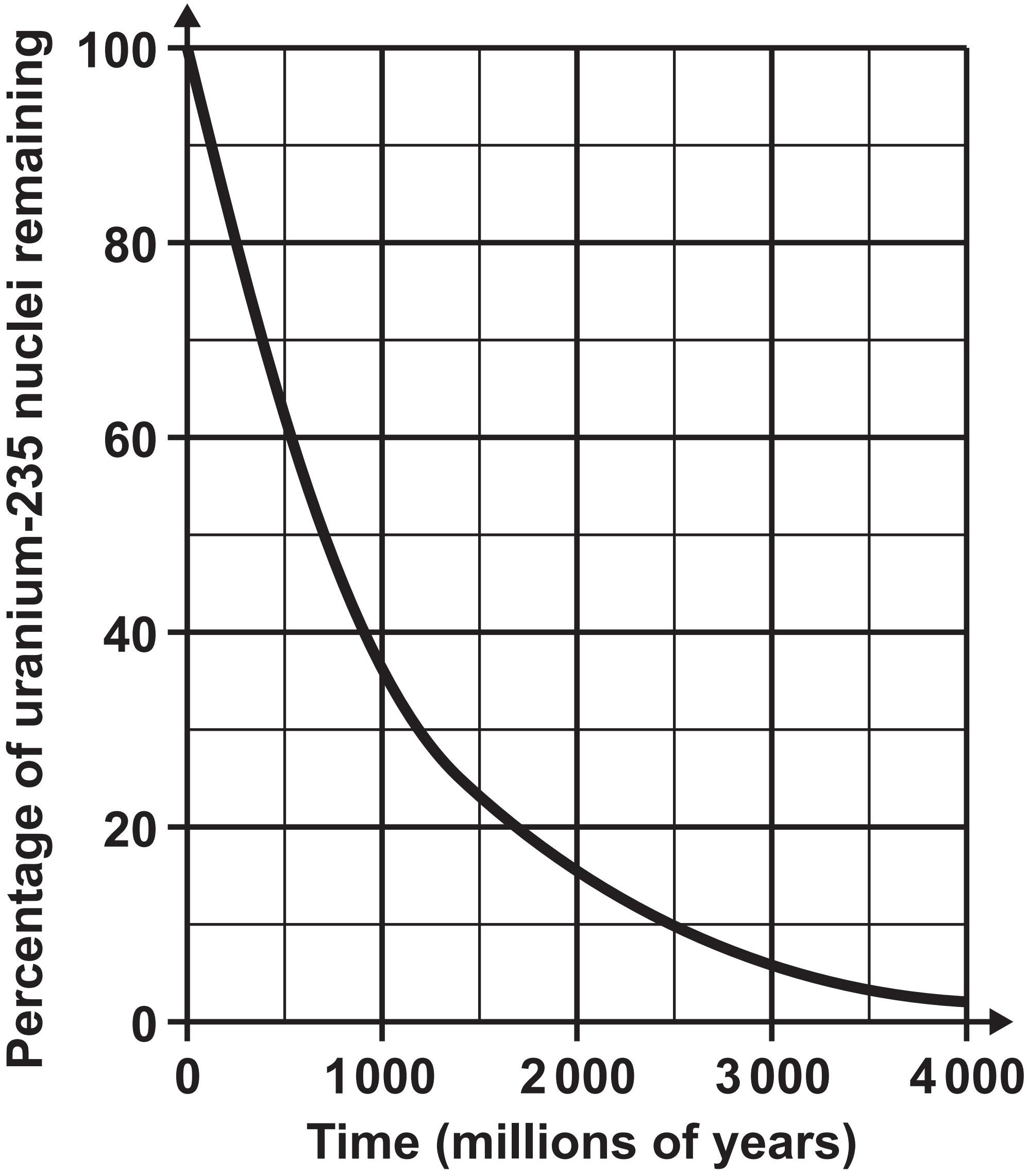

Percentage of uranium-235 nuclei remaining
100
80
60
40
20
0
0
1000
2000
3000
4000
Time (millions of years)

DIAGRAM 5.1

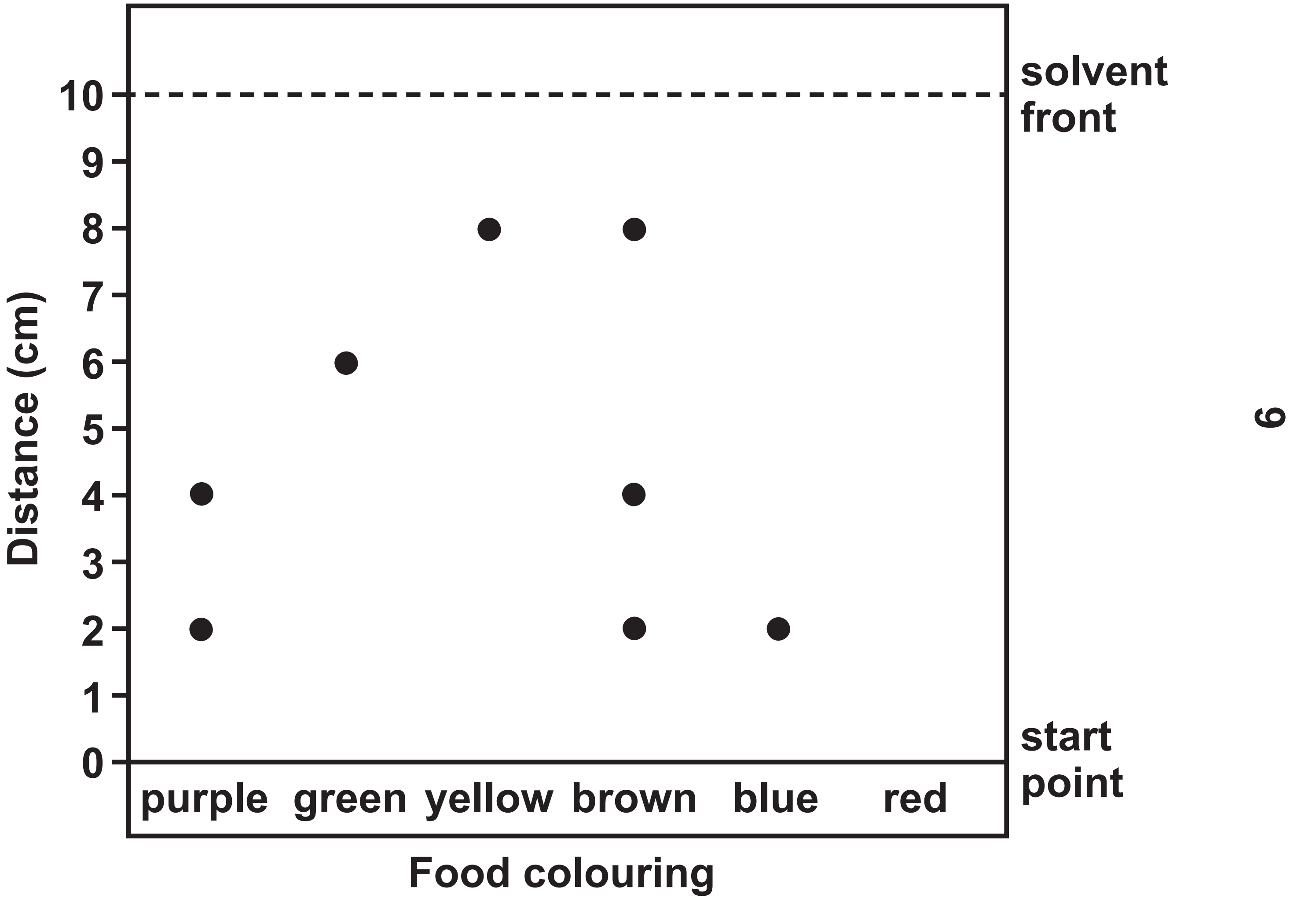

solvent front
10
9
8
7
6
5
4
3
2
1
0
Distance (cm)
purple
green
yellow
brown
blue
red
start point
Food colouring

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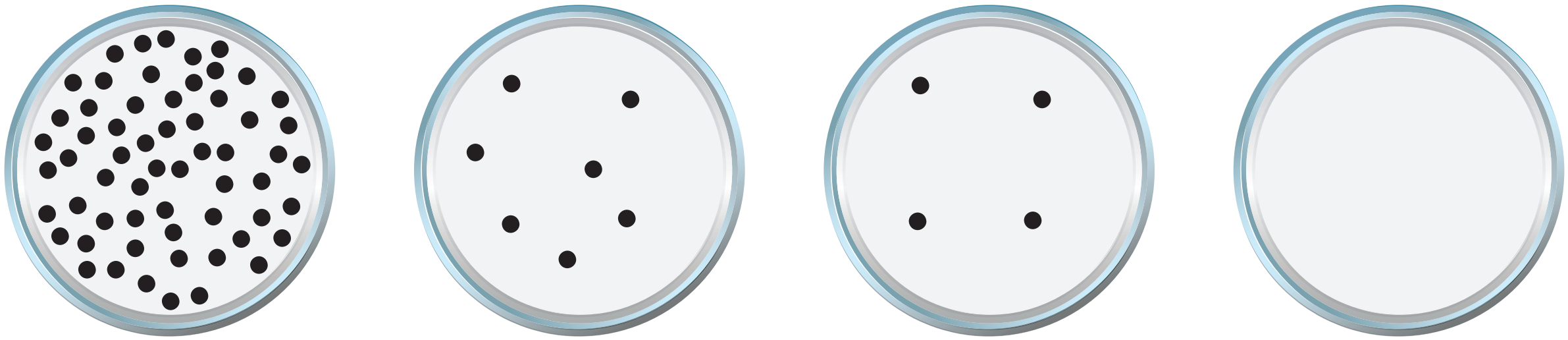
DIAGRAM 6.1



Raw

Traditional pasteurised

Flash pasteurised

UHT

TABLE 6.2

Type of milk	Heat treatment	Number of bacterial colonies in a 40 cm^3 serving
raw	none	24 000
traditional pasteurised	63 °C for 30 minutes	
flash pasteurised	78 °C for 35 seconds	1600
ultra-high temperature pasteurised (UHT)	135 °C for 2 seconds	none

TABLE 7.1

Concentration of HCl (mol/dm^3)	Time to produce $60\,cm^3$ of CO_2 (s)	Mean rate of reaction (cm^3/s)
0.5	234	0.26
1.0	118	0.51
2.0	58	

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UNIT 3: Food, Materials and Processes

HIGHER TIER

Data Booklet

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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		