GCSE

3445U30-1

TUESDAY, 16 MAY 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 3: Food, Materials and Processes
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.

This 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 4(a) 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 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.	**11**	
3.	**12**	
4.	**10**	
5.	**13**	
6.	**5**	
7.	**14**	
Total	**75**	

Answer ALL questions in the spaces provided.

1 Ash dieback disease is a fungal infection 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 1.1 in the separate diagram booklet show healthy ash leaves and those affected by ash dieback.

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stomata nitrogen chlorophyll

oxygen glucose water

carbon dioxide

1 (a) Photosynthesis occurs in green leaves.

(i) Use word(s) from the box opposite to complete the paragraph below. You may use each word once, more than once or not at all. [5 marks]

Leaves use _____ to absorb light energy.

They convert _____

and _____ into _____ and _____ .

1 (a)(ii)

Complete the following sentence by <u>UNDERLINING</u> the correct word in the brackets. [1 mark]

Ash dieback disease affects the growth of an ash tree as the leaves are unable to make

(food / water / nitrogen).

1 (b) The apparatus shown in DIAGRAM 1.2 in the separate diagram booklet is used to investigate how light intensity affects the rate of photosynthesis of an *Elodea* plant.

The method used is described below.

1. Add ONE SPATULA of sodium hydrogen carbonate to a beaker containing 200 cm^3 of water at 20 °C, to supply carbon dioxide.

2. Place the *Elodea* in the beaker.

3. Completely fill a boiling tube with water and carefully place over the end of the funnel with the end under the water, clamp into place.

4. Place the lamp 5 cm away from the *Elodea*.

continues on next page

1 (b) continued

5. Start the stopwatch and record the NUMBER OF BUBBLES of oxygen produced in a FEW SECONDS.

6. Repeat the experiment with the lamp 10 cm, 15 cm, 20 cm, 25 cm and 30 cm from the apparatus.

(i) Steps 1 and 5 could lead to uncertainties. In TABLE 1.3 in the separate diagram booklet, CIRCLE ONE improvement in each row that you would use. [3 marks]

1 (b)(ii)

State how you would change step 6 to investigate the effect of temperature on photosynthesis. [1 mark]

(Turn over)

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

(a) The Food Standards Agency (FSA) funded a project to analyse the colours used in food and drinks.

DIAGRAM 2.1 in the separate diagram booklet shows a chromatogram of the dyes present in different food colourings.

(i) It was thought that the dye in the blue colouring would not be present in other colourings.
Explain whether you agree. [2 marks]

2 (a)(ii)

Use the equation:

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

to calculate the R_f value for the dye in the RED colouring. [3 marks]

R_f = _____

2 (b) Analytical scientists also identify unknown compounds.
There were three bottles, each containing a solution of one of the following compounds.

copper(II) sulfate
lithium carbonate
sodium chloride

(i) State which of these compounds would produce a yellow flame in a flame test. [1 mark]

2 (b)(ii)

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

II. The gas turns limewater milky. Name this gas. [1 mark]

2 (b)(iii)

1 cm^3 of silver nitrate solution is added to three different test tubes, each containing a solution of one of the compounds in the box below.

copper(II) sulfate
lithium carbonate
sodium chloride

I. State which of these compounds will give a white precipitate. [1 mark]

II. Complete the risk assessment in TABLE 2.2 in the separate diagram booklet for silver nitrate. [2 marks]

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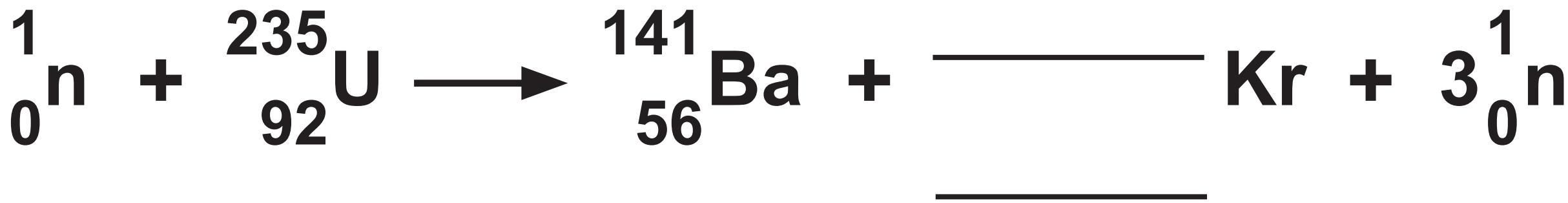
1 0 n + 235 92 U → 141 56 Ba + ——— Kr + 3 1 0 n

3 Hunterston B is a nuclear power station in Scotland.

(a) The reaction in the reactor is shown in the equation on the opposite page.

(i) COMPLETE the equation. [2 marks]

(ii) CIRCLE the part of the reactor that slows down neutrons so they can be absorbed by uranium nuclei. [1 mark]

moderator fuel rods concrete

(iii) State how many neutrons are produced by the fission of each uranium nucleus. [1 mark]

3 (b) Nuclear reactor 3 at the Hunterston B power station was shut down after cracks were found in the graphite bricks. This made it difficult for the control rods to move up and down.

(i) Explain the role of control rods.
[2 marks]

3 (b)(ii)

An unusual event, such as an earthquake, might move the damaged graphite bricks so that the control rods are unable to move. Explain why this is dangerous.
[2 marks]

3 (c) After Hunterston B power station is decommissioned, the uranium-235 in the fuel rods will continue to decay at the rate shown in GRAPH 3.1 in the separate diagram booklet.

(i) Use GRAPH 3.1 to answer the following questions.

I. Find the time taken for the uranium-235 to decay from 100% to 50%. [1 mark]

time = _____ million years

3 (c)(i)

II. State the half-life of uranium-235. [1 mark]

half-life = _____ million years

(ii) TABLE 3.2 in the separate diagram booklet shows the percentage of uranium-235 nuclei remaining after different half lives. Complete TABLE 3.2. [2 marks]

12

4 Heating is a common method used to preserve food.

(a) STATE THREE methods, OTHER THAN HEATING, in which the growth of bacteria can be slowed down or stopped in food products.

EXPLAIN how each method works. [6 marks QER]

continue answer on next page

continue answer on next page

(Turn over)

4 (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 4.1 and TABLE 4.2 in the separate diagram booklet.

(i) Complete TABLE 4.2. [2 marks]

Space for working

4 (b)(ii) It is claimed that unopened UHT milk can be stored on supermarket shelves at room temperature for six months. Explain whether you agree with the claim. [2 marks]

10

5 DIAGRAM 5.1 in the separate diagram booklet shows apparatus that can be used to investigate the rate of the reaction between large zinc pieces and hydrochloric acid. A catalyst was also added to the flask.

Large pieces of zinc were placed in excess dilute hydrochloric acid and the volume of hydrogen produced was recorded every 15 seconds. The results obtained are shown in TABLE 5.2 in the separate diagram booklet.

(a)(i) Plot the results on GRAPH 5.3 in the separate diagram booklet and draw a suitable curve. [3 marks]

5 (a)(ii)

Use your graph to answer the following questions.

I. Describe the relationship between volume of hydrogen produced and time. [2 marks]

5 (a)(ii) continued

II. State the volume of hydrogen collected at 25 s. [1 mark]

volume = _____ cm^3

III. At what time did the reaction stop? [1 mark]

time = _____ s

5 (b)(i) State the purpose of the catalyst. [1 mark]

_____

_____

(ii) The mass of catalyst added at the start of the experiment was 1.5 g. State the mass of catalyst remaining after 60 s. [1 mark]

mass = _____ g

(iii) State how the VOLUMES IN TABLE 5.2 would be different if the catalyst had not been added. [1 mark]

_____

_____

5 (c)(i) State how the VOLUMES IN TABLE 5.2 would be affected by using the same mass of zinc POWDER instead of large pieces of zinc. [1 mark]

5 (c)(ii) Explain how the VOLUMES IN TABLE 5.2 would be affected if the original experiment was repeated at a higher temperature. [2 marks]

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

6 (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 6.1 in the separate diagram booklet. Draw arrows on the diagram 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 _____

5

7 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 7.1 in the separate diagram booklet shows how the materials used in manufacturing the body of a caravan have changed over time.

TABLE 7.2 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.

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

Weight: _____

Strength: _____

7 (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]

_____

_____

7 (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

7 (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

7 (c)(ii)

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

14

END OF PAPER

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

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TUESDAY, 16 MAY 2023 – MORNING

APPLIED SCIENCE (Single Award)

UNIT 3: Food, Materials and Processes
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 1.1

healthy ash leaves

ash leaves affected by ash dieback

DIAGRAM 1.2

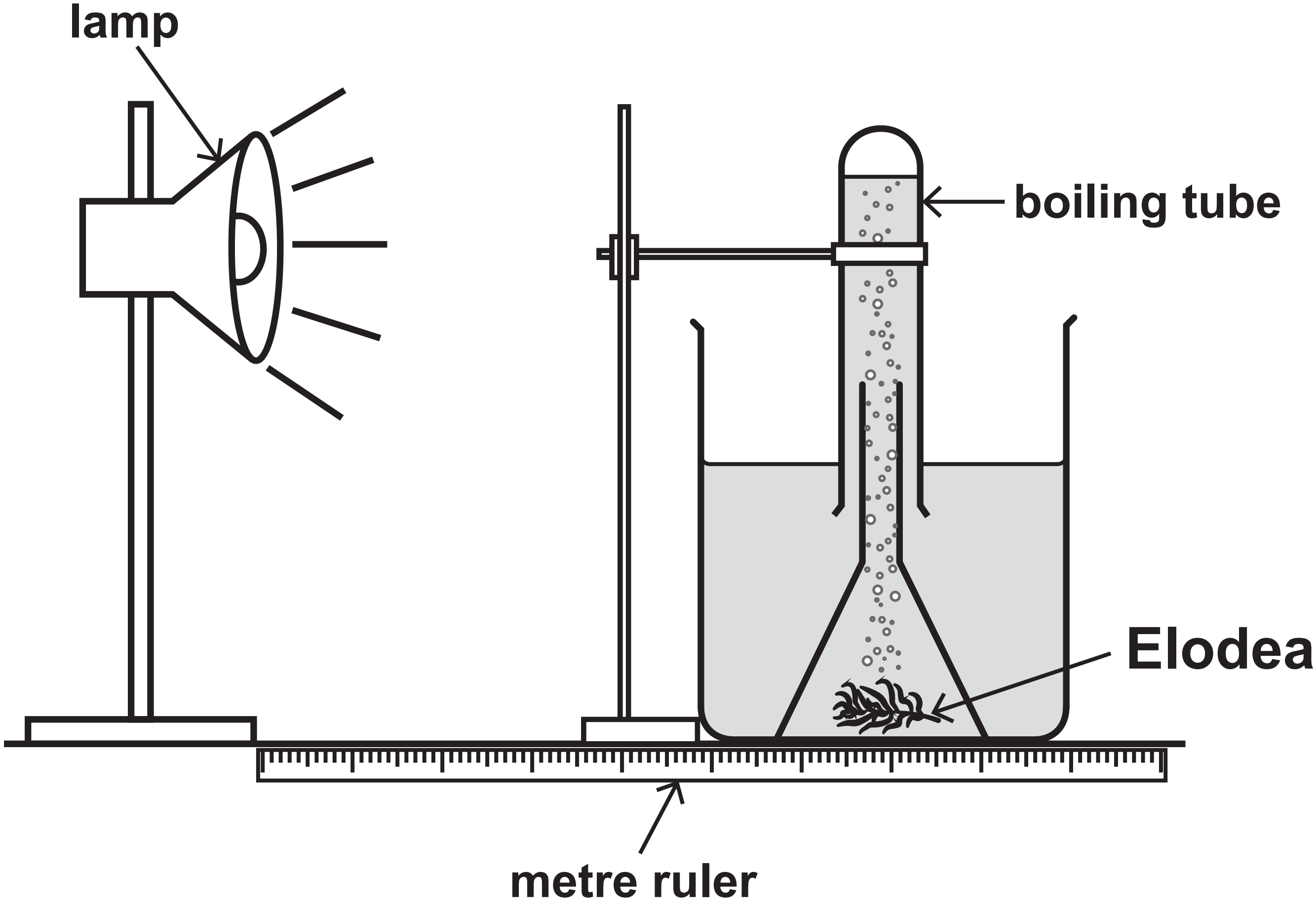

TABLE 1.3

Current method	Improvement	
add ONE SPATULA	add 1 kg	add 1 g
record the NUMBER OF BUBBLES	collect the gas in a beaker	collect the gas in a measuring cylinder
produced in a FEW SECONDS	produced in 1 minute	produced in 1 hour

DIAGRAM 2.1

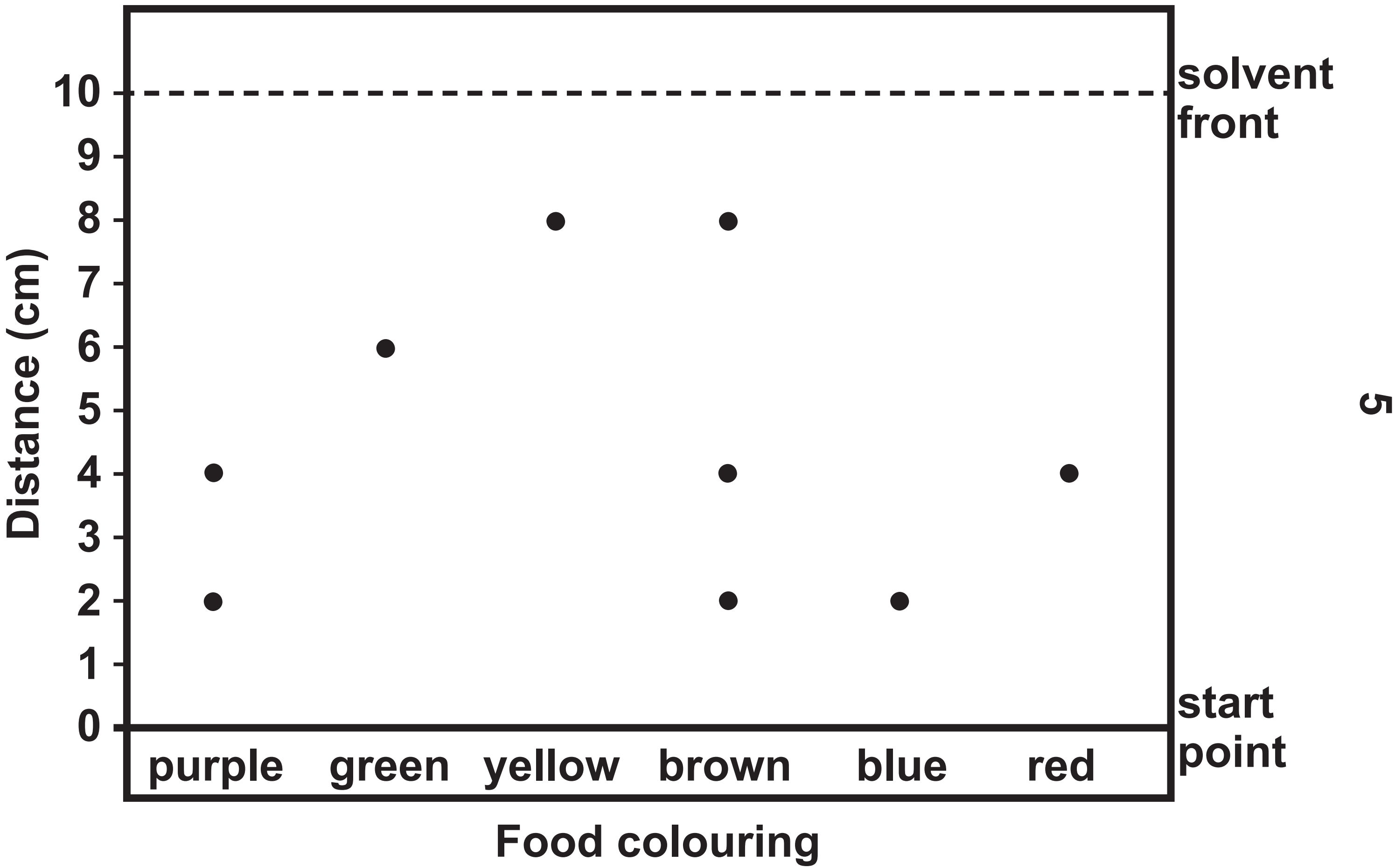
10
9
8
7
6
5
4
3
2
1
0
Distance (cm)
solvent front
start point
purple
green
yellow
brown
blue
red
Food colouring

TABLE 2.2

Hazard	Risk	Control measure
silver nitrate is irritant	could cause eye damage if splashes in the eyes when	

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GRAPH 3.1

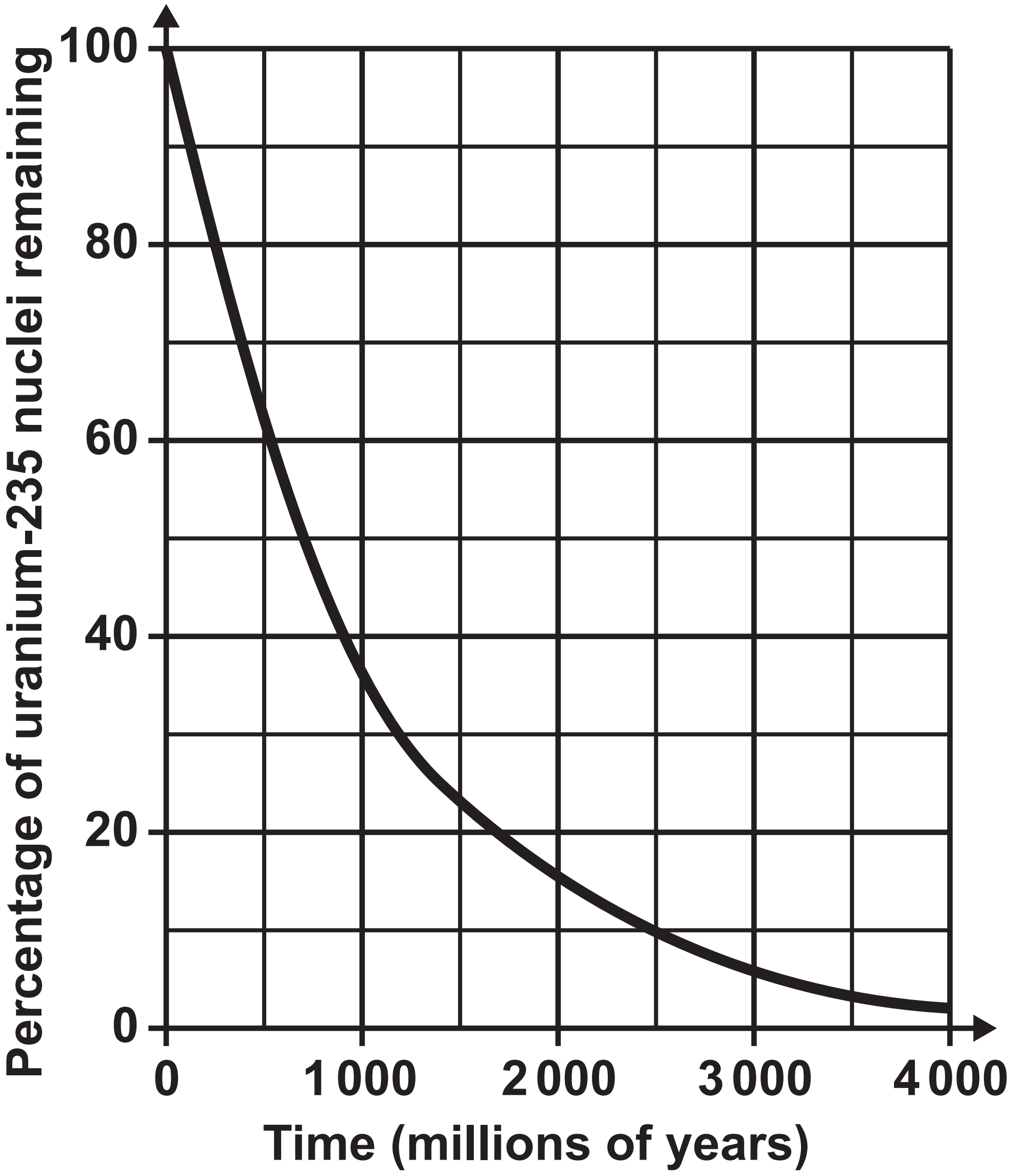
Percentage of uranium-235 nuclei remaining
100
80
60
40
20
0
0
1 000
2 000
3 000
4 000
Time (millions of years)

TABLE 3.2

Number of half-lives	0	1	2	3	4
Percentage of uranium-235 nuclei remaining	100	_____	25	_____	6.25

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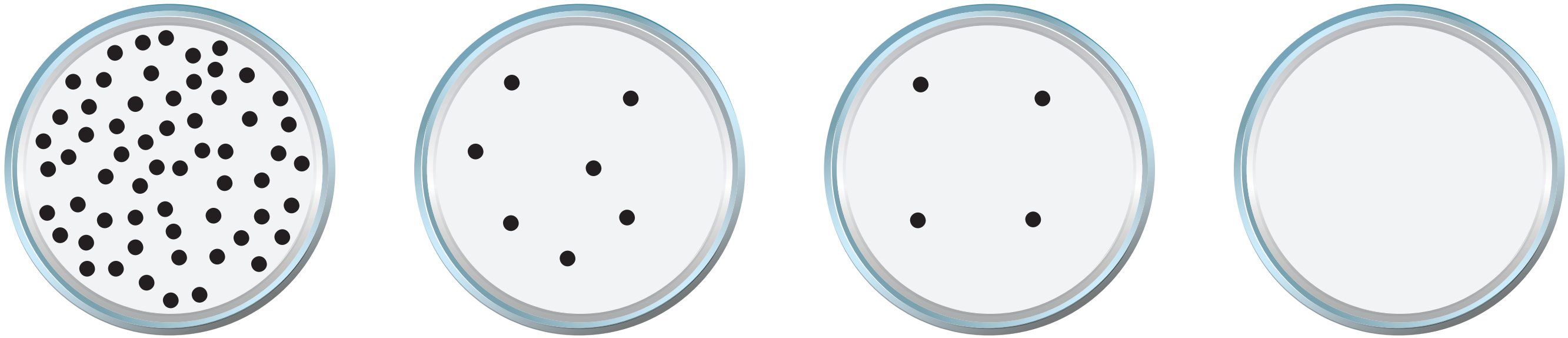
DIAGRAM 4.1



Raw

Traditional pasteurised

Flash pasteurised

UHT

TABLE 4.2

Type of milk	Heat treatment	Number of bacterial colonies from 0.1 cm^3 of milk	Number of bacterial colonies in a 40 cm^3 serving
raw	none	60	24 000
traditional pasteurised	63 °C for 30 minutes	7	
flash pasteurised	78 °C for 35 seconds		1 600
ultra-high temperature pasteurised (UHT)	135 °C for 2 seconds	none	none

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DIAGRAM 5.1

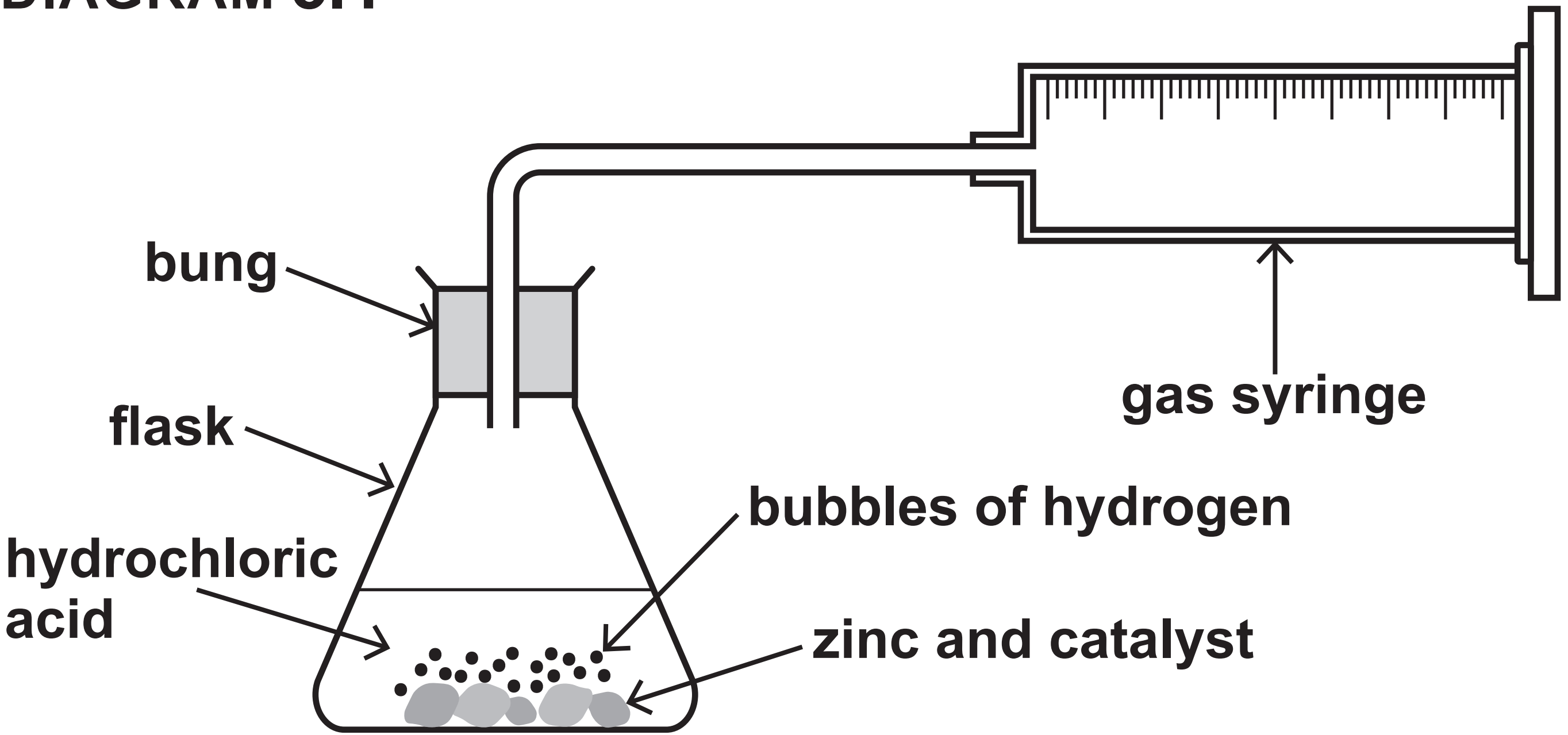

TABLE 5.2

Time (s)	0	15	30	45	60
Volume of hydrogen (cm^3)	0	28	40	48	48

GRAPH 5.3

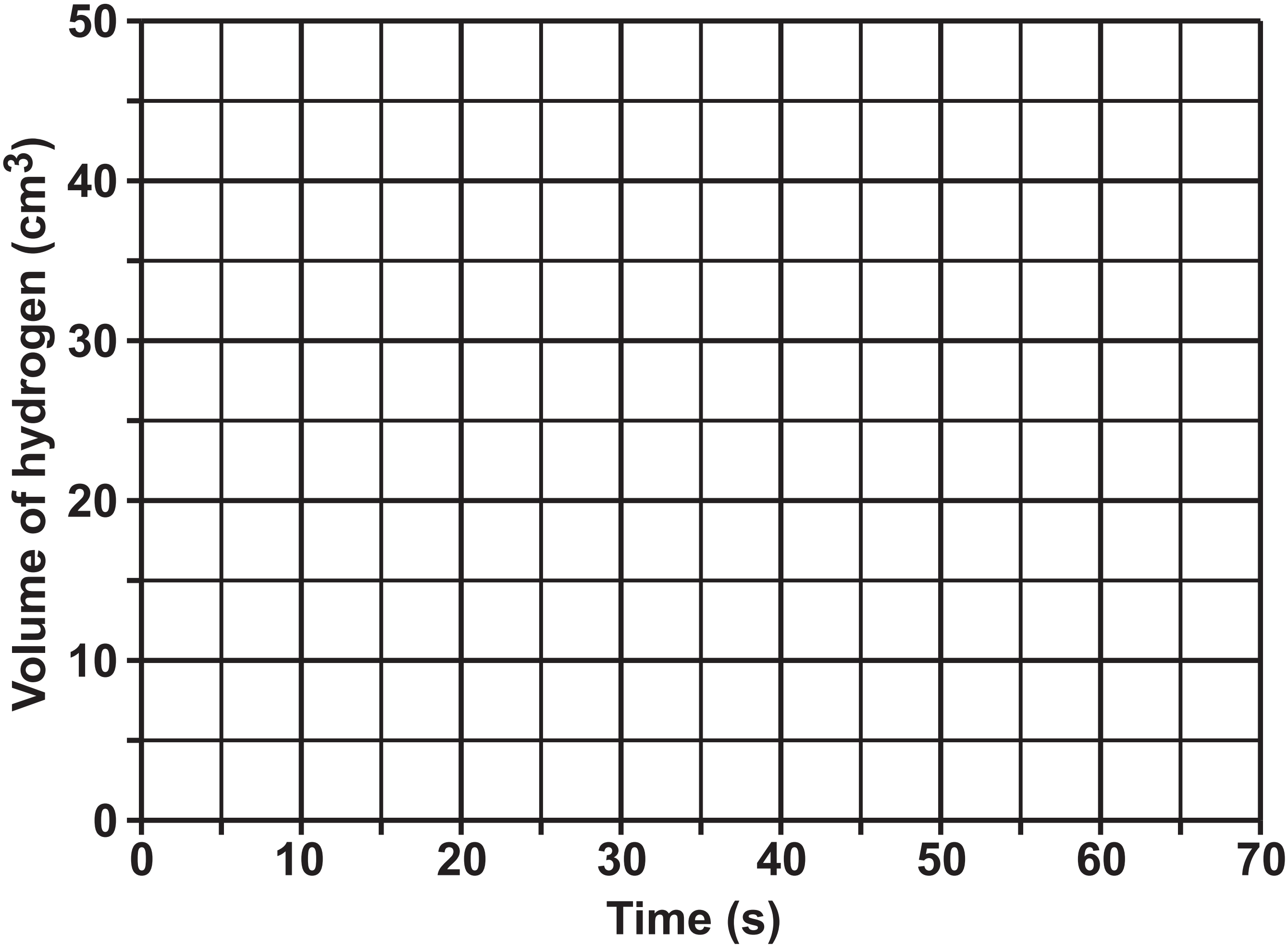
Volume of hydrogen (cm3)
50
40
30
20
10
0
0
10
20
30
40
50
60
70
Time (s)

DIAGRAM 6.1

TABLE 7.1

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

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TABLE 7.2

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 7.2 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

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TUESDAY, 16 MAY 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 3: Food, Materials and Processes

FOUNDATION 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		