



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 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 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.

- (a) Photosynthesis occurs in green leaves.
- (i) Use word(s) from the box below to complete the paragraph below. You may use each word once, more than once or not at all. [5 marks]

stomata nitrogen chlorophyll oxygen
glucose water carbon dioxide

Leaves use _____ to absorb light energy.

They convert _____

and _____ into

_____ and

_____ .

(Turn over)

1 (a)(ii)

Complete the following sentence by UNDERLINING 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**.
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]

(Turn over)

1 (b)(ii)

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

10

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]

(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]

$R_f =$ _____

(Turn over)

- 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]**
-

- (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 cm³ 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]

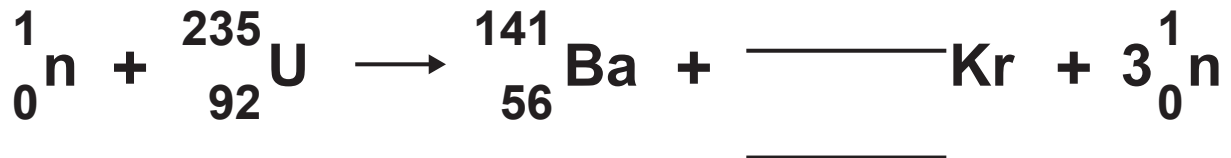
II. Complete the risk assessment in TABLE 2.2 in the separate diagram booklet for silver nitrate. [2 marks]

11

(Turn over)

3 Hunterston B is a nuclear power station in Scotland.

(a) The reaction in the reactor is shown in the equation below.



(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]

(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

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

(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]

(ii) Use your graph to answer the following questions.

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

(Turn over)

5 (a)(ii) continued

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

volume = _____ cm³

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

time = _____ s

(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]

(Turn over)

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]

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

13

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

- (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

(Turn over)

**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.

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

Weight: _____

continue your answer on the next page

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:

$$\text{mass} = \text{density} \times \text{volume}$$

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 = $100 \text{ N}/\text{cm}^2$)

strength = _____ N/cm^2

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 \times csa

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

force = _____ N

14

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 _____

DIAGRAM 1.1



healthy ash leaves



**ash leaves affected
by ash dieback**

DIAGRAM 1.2

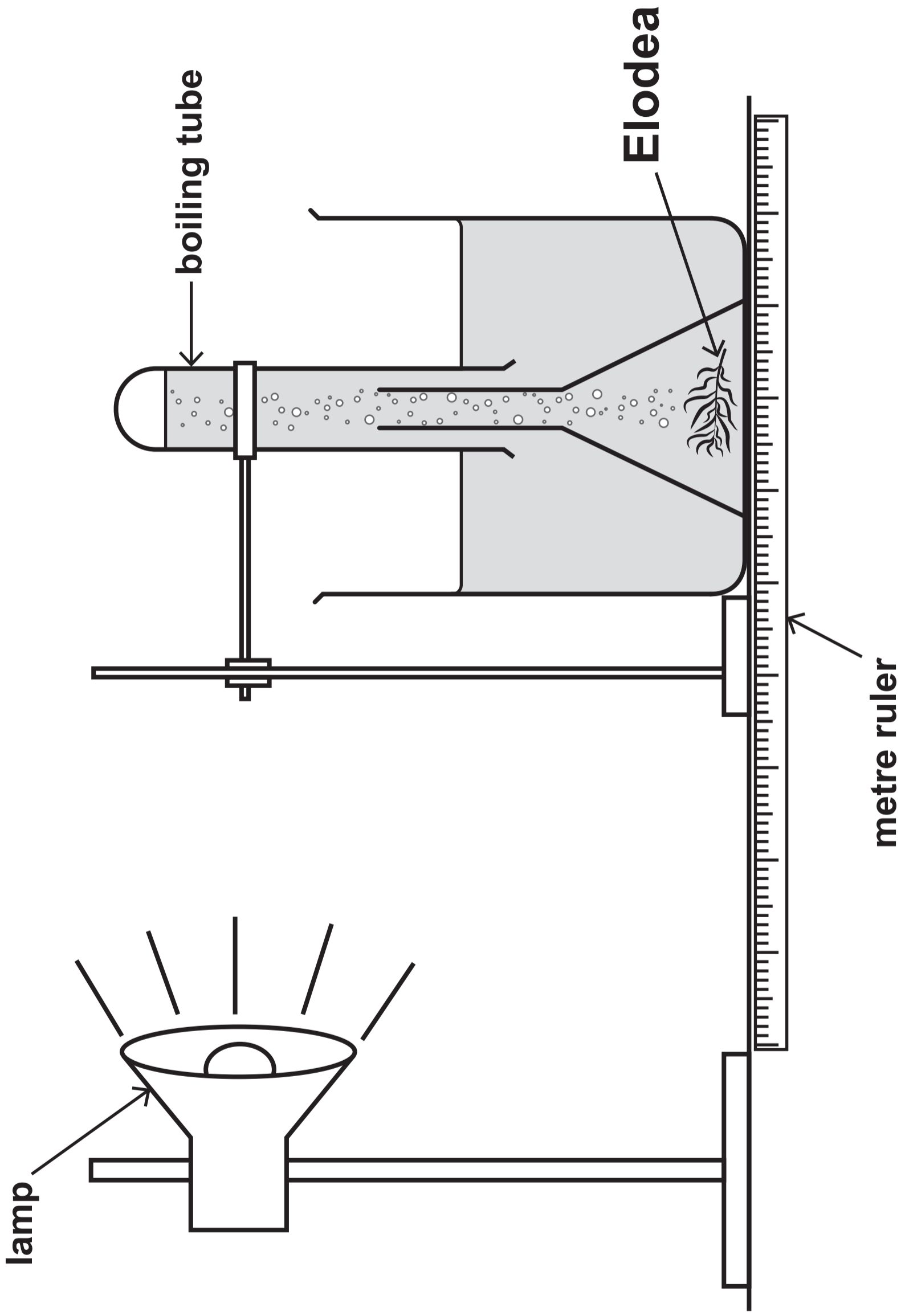


TABLE 1.3

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

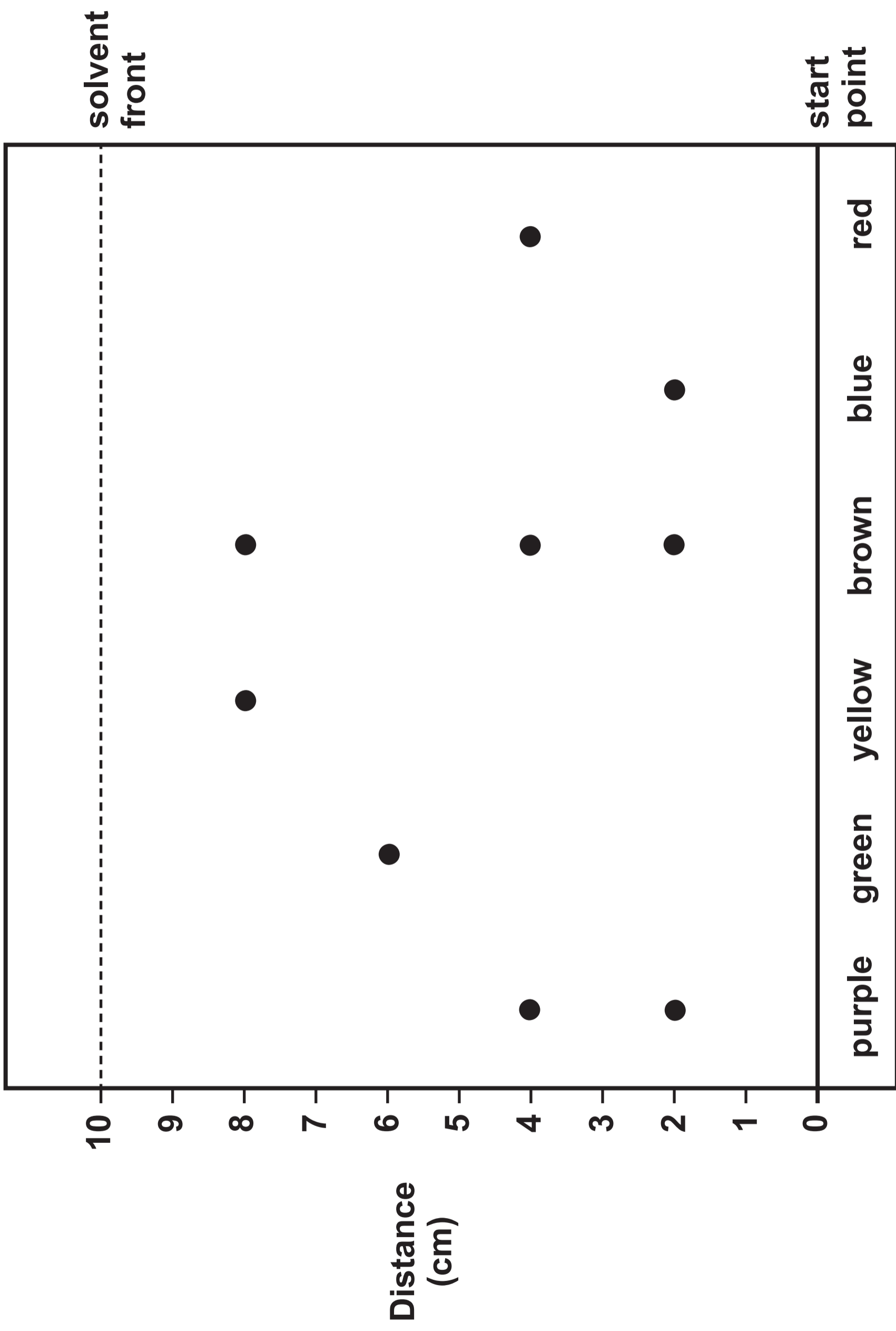
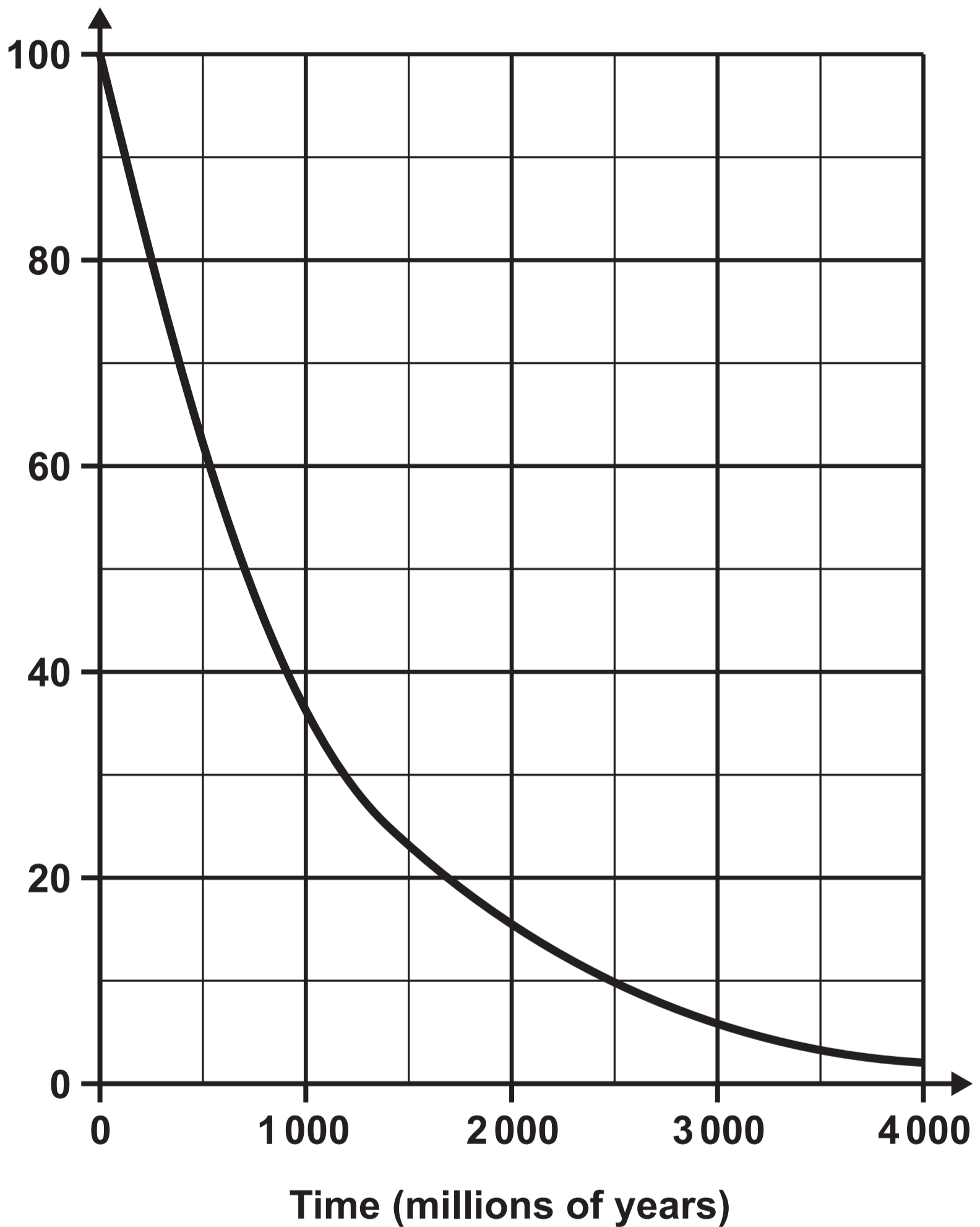


TABLE 2.2

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

GRAPH 3.1

Percentage of uranium-235 nuclei remaining

**TABLE 3.2**

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

DIAGRAM 4.1

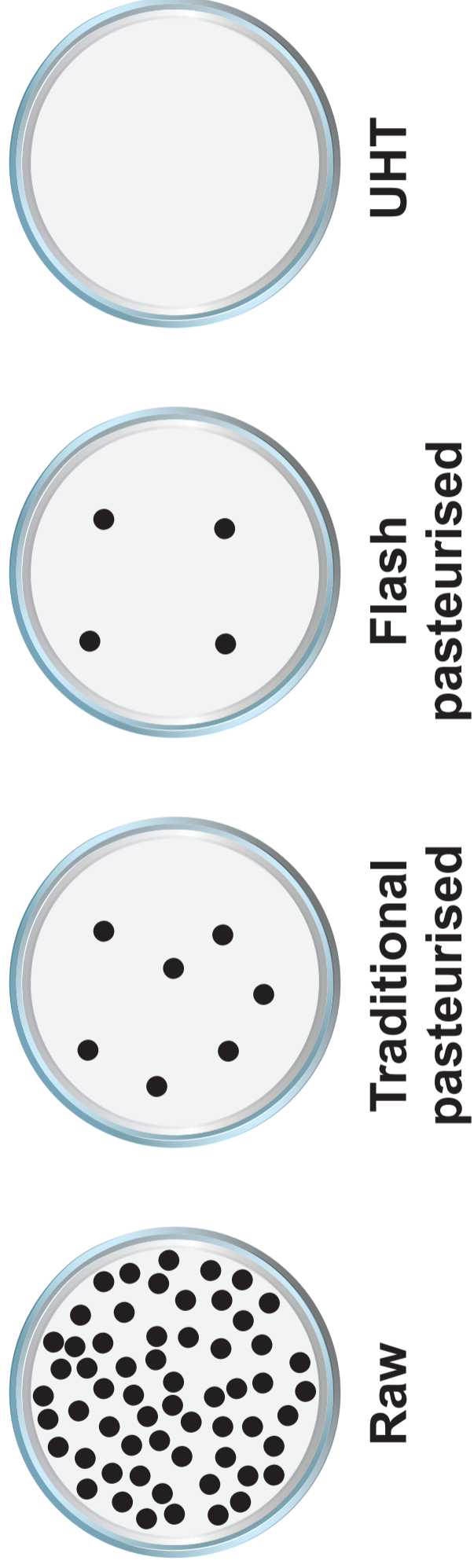


TABLE 4.2

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

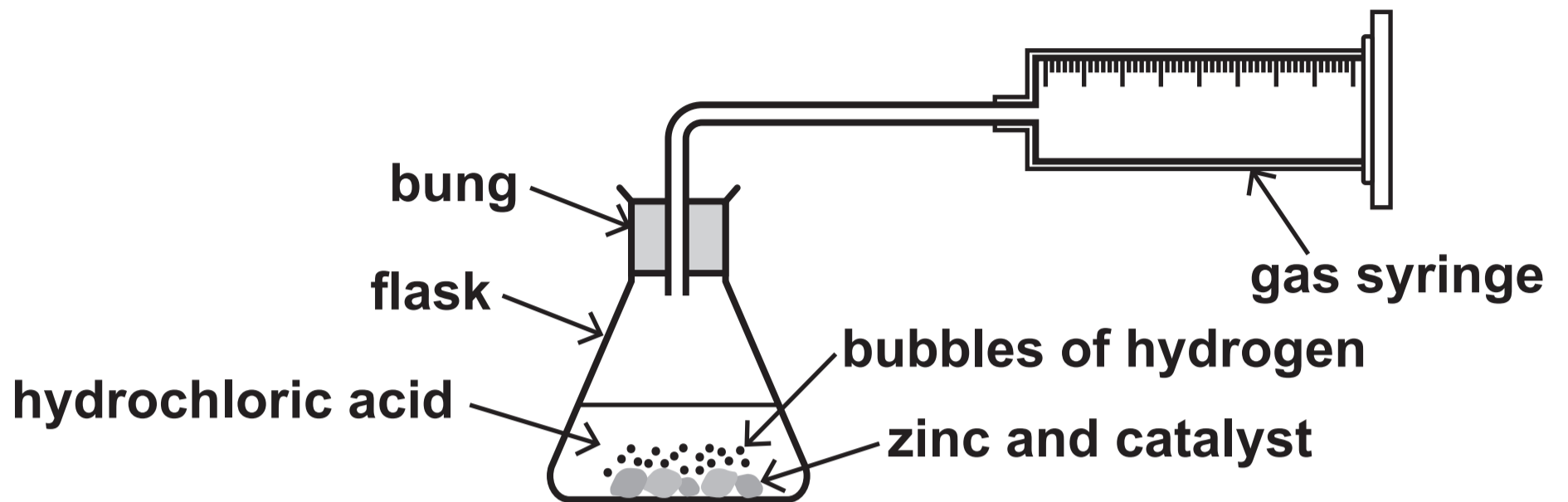


TABLE 5.2

Time (s)	0	15	30	45	60
Volume of hydrogen (cm³)	0	28	40	48	48

GRAPH 5.3

Volume of hydrogen (cm³)

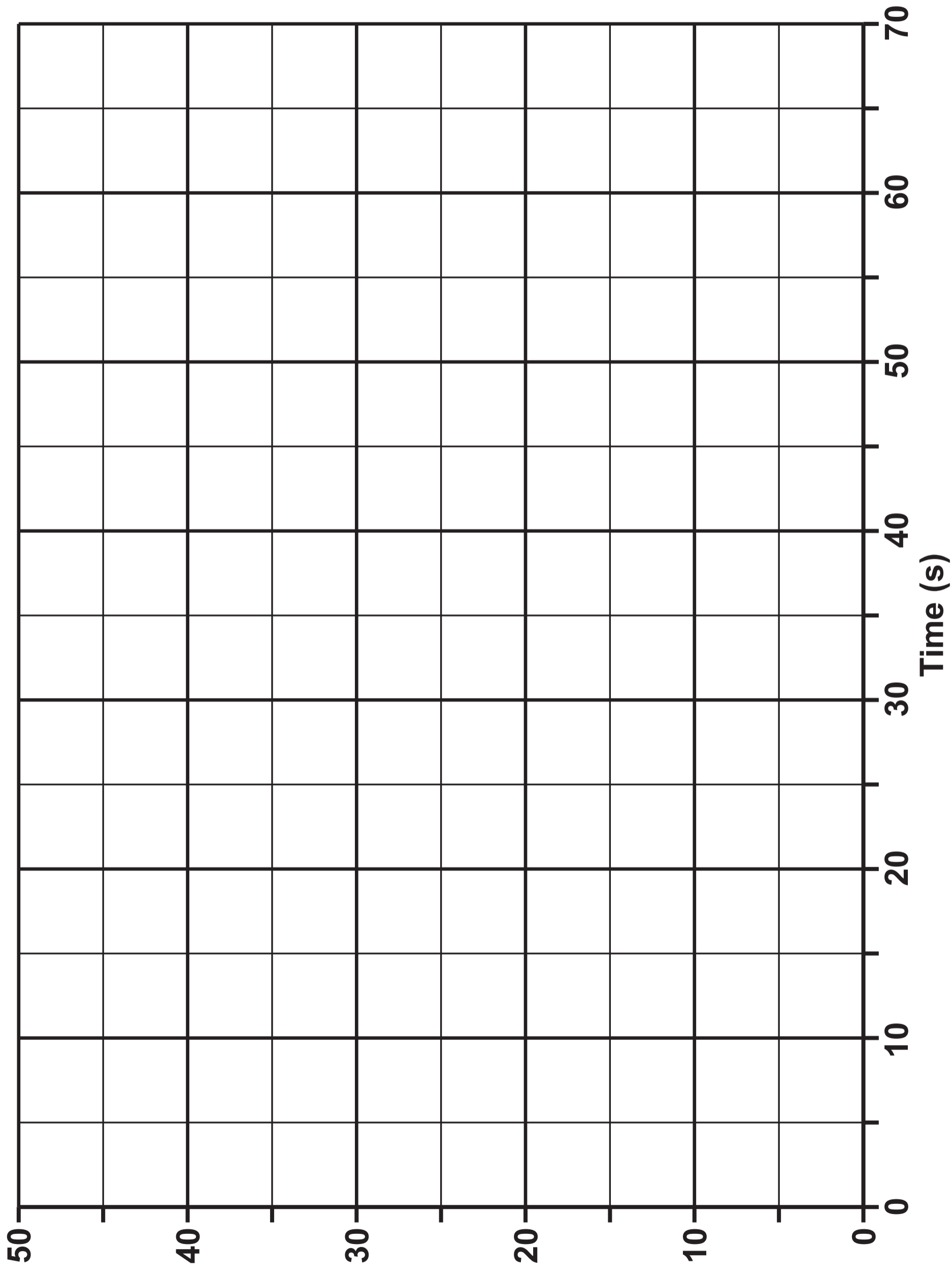


DIAGRAM 6.1

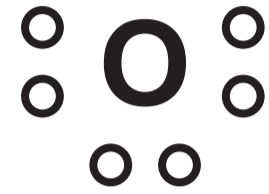


TABLE 7.1

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

TABLE 7.2

Material	Density (g/cm ³)	Stiffness (GPa)	Melting Point (°C)	Strength (MPa)	Is it brittle?	Does it corrode?
wood	0.6			1 000	No	no but rots when wet
steel	7.8	210	1 357	1 200	No	yes producing rust
aluminium	2.7	69	660	90	No	yes producing a resistant coating
GRP	glass fibres	180	1 400	3 500	Yes	No
	epoxy resin			60	Yes	No
polyester	1.9	150	121	250	Yes	No



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Data Booklet

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