



3445U20-1

MONDAY, 10 JUNE 2024 – MORNING

**APPLIED SCIENCE (Double Award)
UNIT 2: Space, Health and Life**

FOUNDATION TIER

**1 hour 30 minutes plus your additional
time allowance**

Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

ADDITIONAL MATERIALS

- **Separate Resource Folder**
- **Calculator**
- **Pencil**
- **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 8(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.

You will need to refer to the separate resource folder to answer questions 9 AND 10.

A Periodic Table is printed in the separate data booklet.

For Examiner's use only			
	Question	Maximum Mark	Mark Awarded
Section A	1.	8	
	2.	5	
	3.	6	
	4.	10	
	5.	5	
	6.	3	
	7.	4	
	8.	9	
Section B	9.	6	
	10.	19	
	Total	75	

SECTION A

Answer ALL questions.

- 1 Living things are classified using a system developed by Carl Linnaeus.**
- (a) The first division of living things is to place them into a kingdom. There are 5 kingdoms.**

Complete the labelling of the kingdoms on DIAGRAM 1.1 in the separate diagram booklet. [3 marks]

(Turn over)

- 1 (b) Linnaeus' system further ranked living things to a species level. This is illustrated in TABLE 1.2 in the separate diagram booklet. The levels are not in the correct order.

Place the letters representing the levels in the correct order in the column below. Some have been done for you. [2 marks]

F
C
B
E

(Turn over)

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TURN OVER

Kingdom	Animalia
Class	
Order	Carnivora
	Canidae
Genus	
	lupus

1 (c) The classification of a brown bear is shown in DIAGRAM 1.3 in the separate diagram booklet. Its scientific name is *Ursus arctos*.

A wolf has the scientific name *Canis lupus*. Complete the classification table on the opposite page for a wolf. [3 marks]

8

2 (a) On DIAGRAM 2 in the separate diagram booklet, label the carbon cycle. Use words from the box below. [3 marks]

dissolving evaporating
decay respiration
combustion

(Turn over)

2 (b) Complete the following sentences by UNDERLINING the correct word in the brackets. [2 marks]

(i) When plant and animal waste decomposes,

(sulfates / nitrates / oxides)

are added to the soil.

(ii) Plants use

(sulfates / nitrates / oxides)

in the soil to grow.

5

(Turn over)

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TURN OVER

1. Take a tray and a net to the first location.

2.

3. Study the organisms in the tray.

4.

5. Pour the invertebrates and the water gently back into the stream.

6. Repeat steps 1 – 5 at the second and third locations.

- 3 Indicator species may be used in an investigation to monitor water pollution at three different locations along a stream.**
- (a) The method for an investigation to monitor water pollution in a stream is described on the opposite page. However, some of the stages are missing.**

Complete the method by writing in the missing steps. [2 marks]

(Turn over)

3 (b) CHART 3.1 in the separate diagram booklet is available to you.

Results from the water sampling at each location are given in TABLE 3.2 in the separate diagram booklet.

- (i) Use the data in TABLE 3.2 to complete a bar chart on the grid in GRAPH 3.3 in the separate diagram booklet. [2 marks]**
- (ii) State which location is the cleanest. [1 mark]**
-

(Turn over)

3 (b)(iii)

**Give ONE reason for your answer.
[1 mark]**

6

(Turn over)

4 (a) Theories about the Universe have changed over time.

Tick (✓) the boxes next to the names of TWO of these theories. [2 marks]

Liquid State

Steady State

Loud Bang

Big Bang

(b) Images of the Universe are taken using electromagnetic waves.

Name TWO types of electromagnetic wave. [2 marks]

_____ and

(Turn over)

4 (c) DIAGRAM 4.1 in the separate diagram booklet shows a spectrum from a star and four elements.

Complete the table below by placing a tick (✓) if the element is present in the star. Hydrogen has been done for you. [1 mark]

Element	Element is present (✓)
hydrogen	✓
helium	
sodium	
lithium	

(Turn over)

4 (d) TABLE 4.2 in the separate diagram booklet gives information about the planets in our solar system.

Use the information in TABLE 4.2 to answer the questions below.

**(i) Name the coldest ROCKY planet.
[1 mark]**

(ii) State how many ROCKY planets have moons. [1 mark]

**(iii) Name the gas giant that orbits the Sun with the greatest SPEED.
[1 mark]**

(Turn over)

4 (d)(iv)

Eris is a dwarf planet. Its orbit is 10 180 million km away from the Sun. Shaun says it is found in the asteroid belt between the orbits of Mars and Jupiter.

Explain whether you agree with Shaun. [1 mark]

(Turn over)

4 (e) On DIAGRAM 4.3 in the separate diagram booklet, tick (✓) the box next to the shape of the orbit of a comet around the Sun. [1 mark]

10

(Turn over)

5 Some students investigated the energy content of food. Their apparatus is shown in **DIAGRAM 5.1** in the separate diagram booklet.

Their results are shown in **TABLE 5.2** in the separate diagram booklet.

(a) Use the equation

$$\text{energy released} = 15 \times 4.2 \times \text{temperature increase}$$

to calculate the energy released by the bread. [2 marks]

energy released = _____ J

(Turn over)

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TURN OVER

Energy from 5 g of oatie biscuits (J)	Energy from 15 g of oatie biscuits (J)
441	<hr/>

Energy from 4 g of cheese (J)	Energy from 20 g of cheese (J)
882	<hr/>

- 5 (b) The students were asked to use their results to calculate the energy provided by a snack consisting of 15 g of oatie biscuits and 20 g of cheese.
Complete the tables on the opposite page to work out their answer.
[3 marks]**

Space for working

**total energy
from snack = _____ J**

5

(Turn over)

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TURN OVER

Term

Blind study

Description

an inactive substance made to look like the real drug

when the patient and the researcher do not know if they are using the real drug

Double-blind study

when only the researcher does not know if they are using the real drug

Placebo

when the patient does not know if they are given the real drug

6 All drugs can have side effects. New drugs undergo testing before they can be prescribed by doctors.

The terms on the opposite page are used in drug development studies.

**On the opposite page join each term to its description with a straight line.
[3 marks]**

3

- 7** Some of the methods used in the treatment and diagnosis of disease are included in **TABLE 7.1** in the separate diagram booklet.

Place ONE tick (✓) in each row underneath the method used by each treatment or diagnosis. [4 marks]

4

8 Vaccines are used to protect against disease.

(a) Complete the following sentences about how the body reacts after infection or vaccination by UNDERLINING the correct term in the brackets.

(i) Vaccines contain molecules called (antibodies / antigens / memory cells). [1 mark]

(ii) White blood cells respond to these molecules and produce (antibodies / antigens / pathogens). [1 mark]

question continues

(Turn over)

8 (a) continued

(iii) (Antibiotics / antigens /

memory cells) are produced

following infection or a vaccination.

[1 mark]

(Turn over)

8 (b) GRAPH 8.1 in the separate diagram booklet shows the immune response over a 10-week period when a vaccine was given as two doses.

Describe the changes in antibody concentration over 10 weeks using data from the graph. [6 marks QER]

continue answer on next page (Turn over)

9

(Turn over)

SECTION B

Refer to the separate Resource Folder to answer questions 9 and 10.

9 Jake's heart rate, breathing rate and airflow were monitored during a training session. Use the information in TABLE 2 in the Resource Folder to answer the following questions.

(a) State the value of the resting heart rate. [1 mark]

heart rate = _____ bpm

(b) State the time at which the exercise stopped. [1 mark]

time = _____ min

(Turn over)

9 (c) Calculate the time the exercise lasted. [1 mark]

time = _____ min

(d)(i) Calculate the drop in heart rate between 14 and 15 minutes. [1 mark]

drop in heart rate = _____ bpm

(ii) Assuming that the heart rate drops at the same rate, calculate the heart rate after 16 minutes. [1 mark]

**heart rate after 16 minutes =
_____ bpm**

(Turn over)

9 (e) Estimate the breathing rate after 16 minutes. [1 mark]

breathing rate =

_____ breaths per minute

6

(Turn over)

10 (a)

Dave says the distances of each leg in a long-distance triathlon are all double those in a middle-distance triathlon.

Tom says the distances of each leg in an Olympic triathlon are double those in a sprint triathlon.

Use data from TABLE 1 in the Resource Folder to explain whether Dave or Tom is correct. [2 marks]

continue answer on next page (Turn over)

10 (b)

Piera says Jake breathed in less air per minute at 4 minutes than at 3 minutes because his breathing rate was lower.

Petula disagrees because Jake's airflow per breath was greater at 4 minutes than at 3 minutes.

Use data from TABLE 2, and the equation on page 4 in the Resource Folder, to explain whether you agree with Piera or Petula. [2 marks]

(Turn over)

10 (c)

Use the information in TABLE 4 and equations from pages 5 to 8 in the Resource Folder to answer the following questions.

(i) Calculate Malcolm's BMI. [2 marks]

BMI = _____

(ii) Calculate Malcolm's maximum heart rate. [1 mark]

**maximum
heart rate = _____ bpm**

(Turn over)

10 (d)

Karen wants to exercise in the aerobic zone. Use the information in TABLES 3 and 4 and on pages 5 to 6 in the Resource Folder to determine the range in heart rate she should aim for. [1 mark]

heart rate range is from

_____ bpm to

_____ bpm.

(Turn over)

10 (e)

Data in the TRIATHLON TIMES section (pages 7 to 8) and TABLE 1 in the Resource Folder was used to plot distance-time graphs for each of the triathlons described. There were three sections in each graph to show the swim, cycle and run legs. The graphs did not include transition times. One of the graphs is shown in GRAPH 10.1 in the separate diagram booklet.

**Determine which type of triathlon is represented by the graph and give TWO reasons for your answer.
[3 marks]**

Type of triathlon:

continue answer on next page

(Turn over)

Reason 1:

Reason 2:

(Turn over)

10 (f)

**Use the information about Triathlon times on pages 7 to 8, the information in TABLE 1 and an equation on page 10 in the Resource Folder to calculate the mean speed during an Ironman triathlon.
[3 marks]**

**mean
speed = _____ km/h**

(Turn over)

10 (g)

When a triathlete mounts their bike they are travelling at 1.5 m/s.

Use the information in TABLE 5 and an equation on page 10 in the Resource Folder to calculate the acceleration along level ground in a cycle leg. [3 marks]

acceleration = _____ m/s²

(Turn over)

10 (h)

It is thought that the higher the age group of the triathlete, the lower the mean speed in the cycle leg. Use data from **GRAPH 1** in the Resource Folder to explain whether this statement is true for all age groups. [2 marks]

continue answer on next page

(Turn over)

19

END OF PAPER

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

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GCSE

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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.**

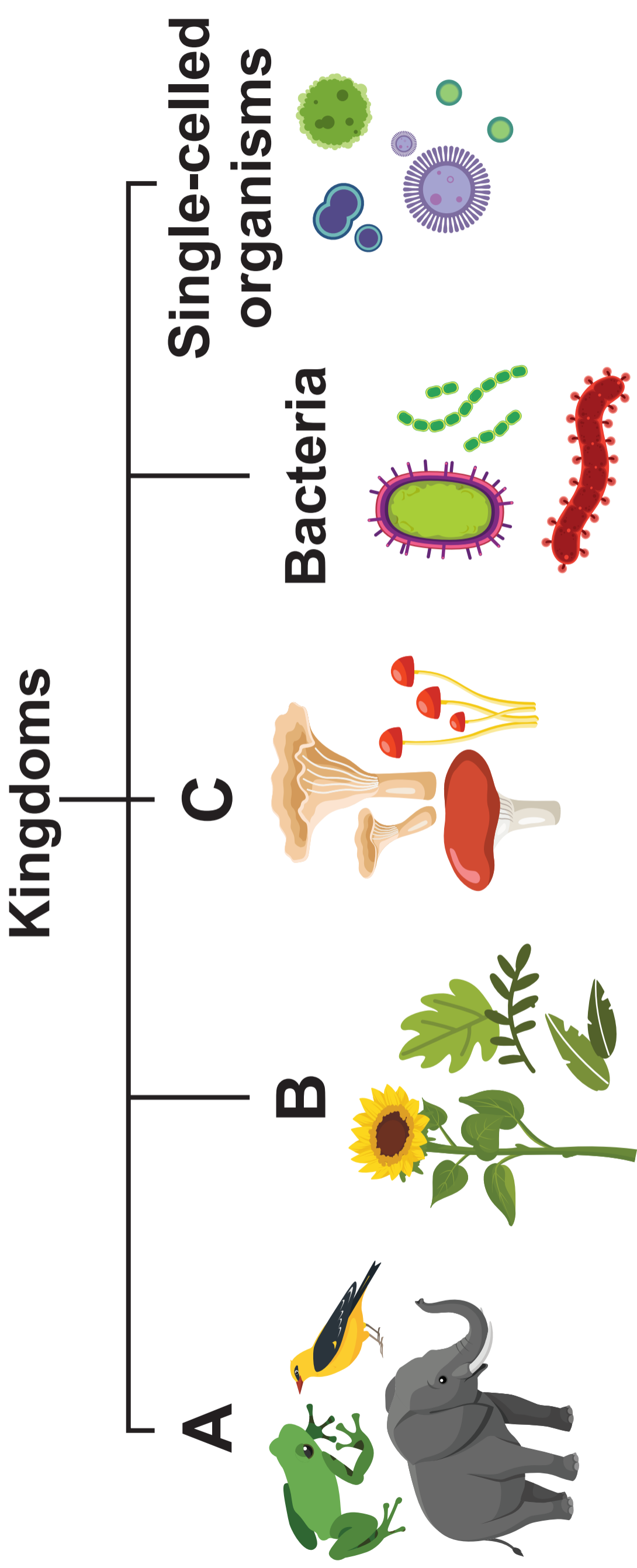
Surname _____

First name(s) _____

Centre Number _____

Candidate Number 0 _____

DIAGRAM 1.1



A

B

C

TABLE 1.2

A	B	C	D	E	F	G
species	order	class	phylum	genus	kingdom	family

DIAGRAM 1.3

Kingdom	Animalia
	Chordata
Class	Mammalia
Order	Carnivora
	Ursidae
Genus	Ursus
	arctos

DIAGRAM 2

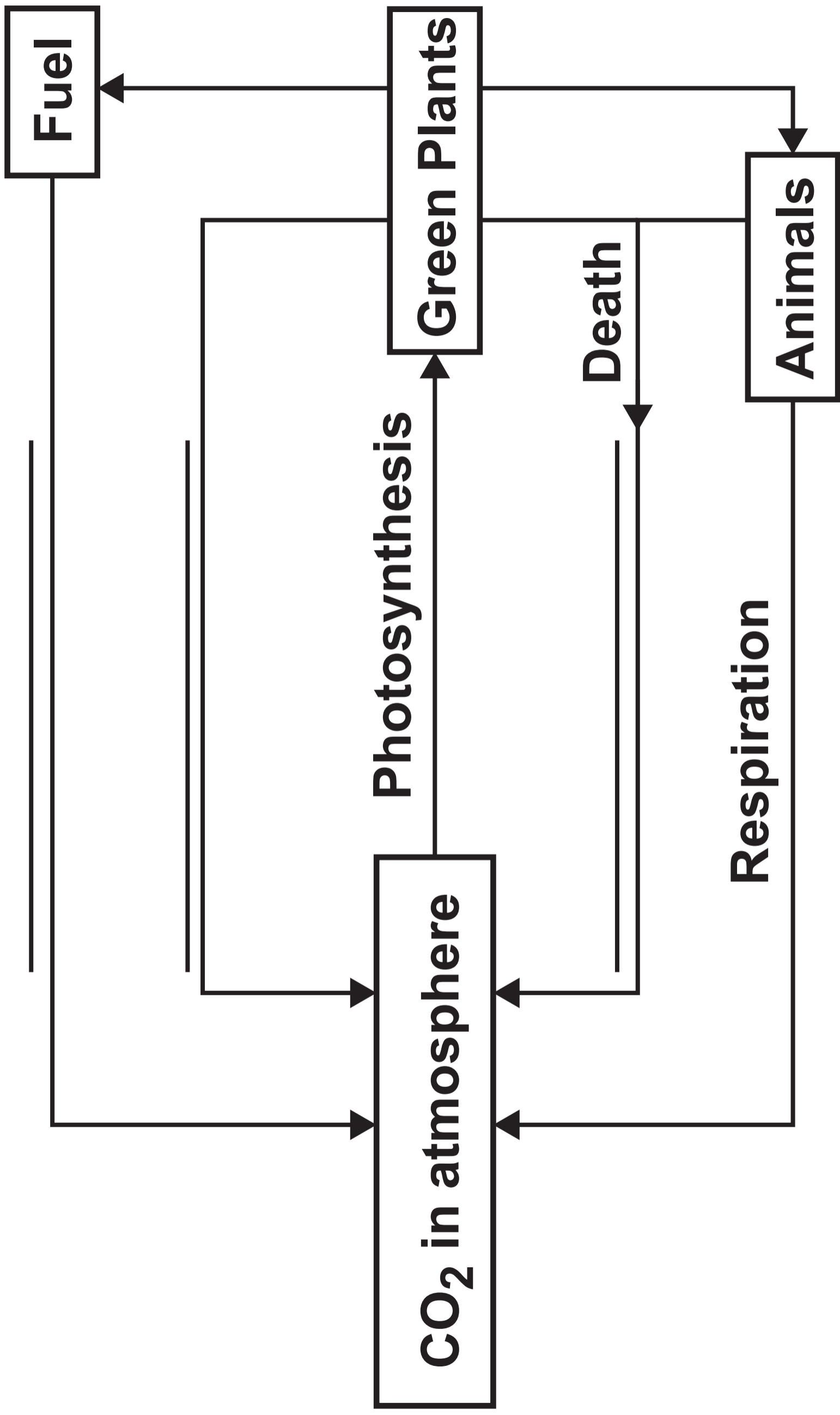


DIAGRAM 3.1
POLLUTION
LEVEL

INDICATOR
SPECIES

A
Clean water



Stonefly nymph



Mayfly nymph

B
Some
pollution



Freshwater
shrimp



Caddis fly
larva

C
Moderate
pollution



Water louse



Bloodworm

D
High
pollution



Sludgeworm



Rat-tailed
maggot

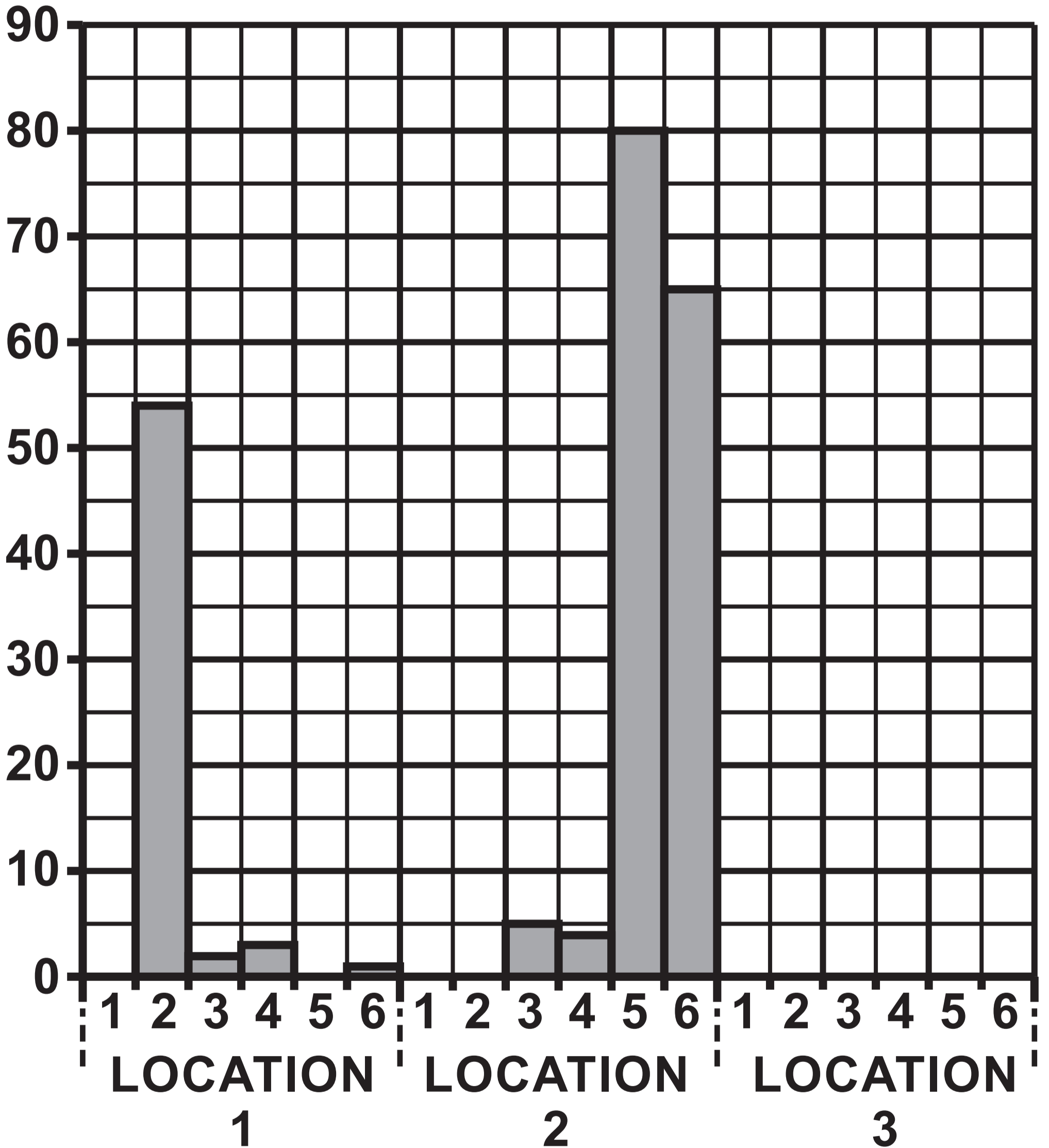
E Very High pollution – no life

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TURN OVER

TABLE 3.2

Species	Total number in water sample		
	location 1	location 2	location 3
1 – Stonefly nymph	0	0	31
2 – Caddis fly larva	54	0	4
3 – Water louse	2	5	3
4 – Bloodworm	3	4	2
5 – Sludgeworm	0	80	1
6 – Rat-tailed maggot	1	65	1

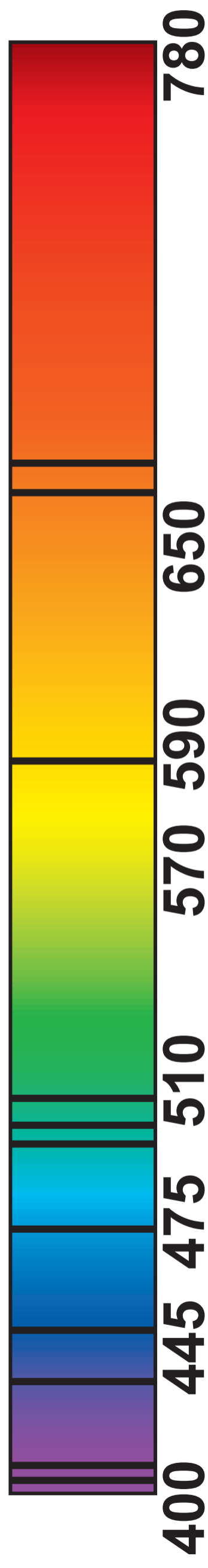
GRAPH 3.3**Total number in water sample**

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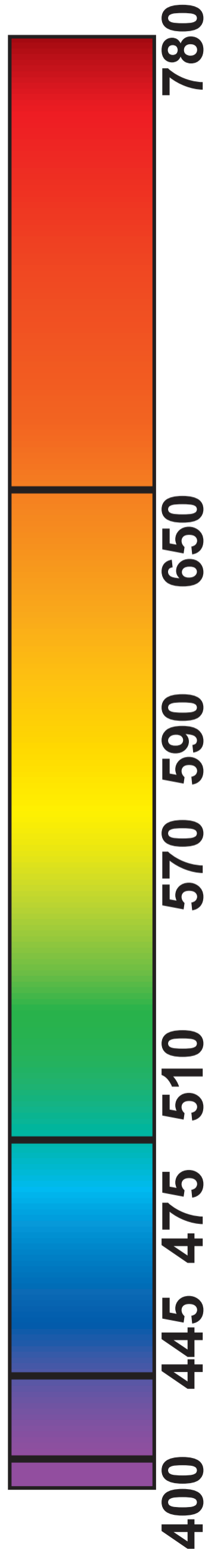
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DIAGRAM 4.1

Absorption spectrum of a star



Absorption spectrum of hydrogen



Absorption spectrum of helium

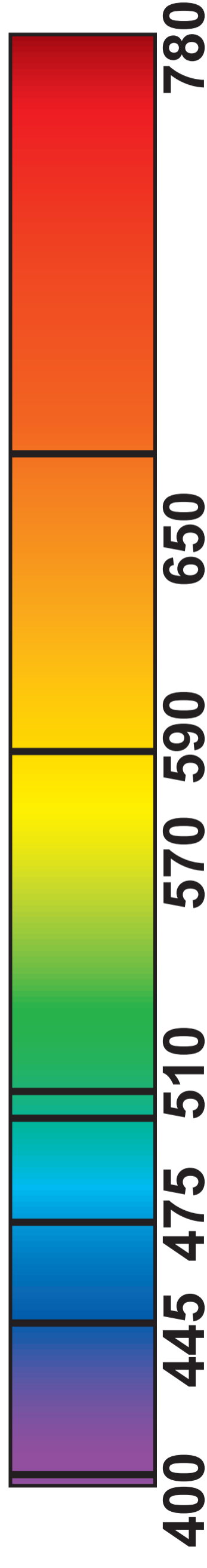
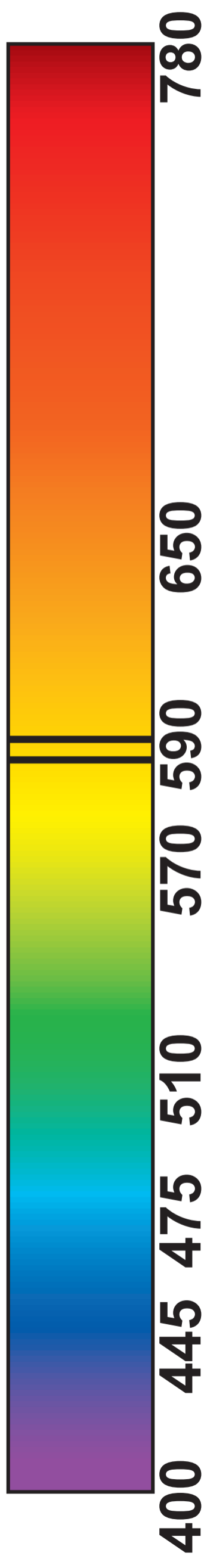
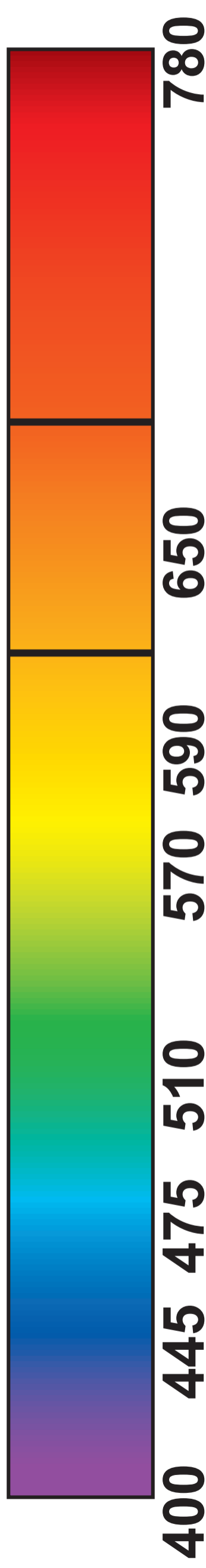


DIAGRAM 4.1 continued

Absorption spectrum of sodium



Absorption spectrum of lithium



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TABLE 4.2

	Mercury	Venus	Earth	Mars
density (kg/m³)	5427	5243	5514	3933
mean distance from the Sun (million km)	58	108	150	228
mean speed of orbit (km/s)	47.4	35.0	29.8	24.1
mean temperature (°C)	167	464	15	-65
number of moons	0	0	1	2

TABLE 4.2 continued

	Jupiter	Saturn	Uranus	Neptune
density (kg/m³)	1326	687	1271	1638
mean distance from the Sun (million km)	779	1434	2873	4495
mean speed of orbit (km/s)	13.1	9.7	6.8	5.4
mean temperature (°C)	-110	-140	-195	-200
number of moons	79	82	27	14

DIAGRAM 4.3

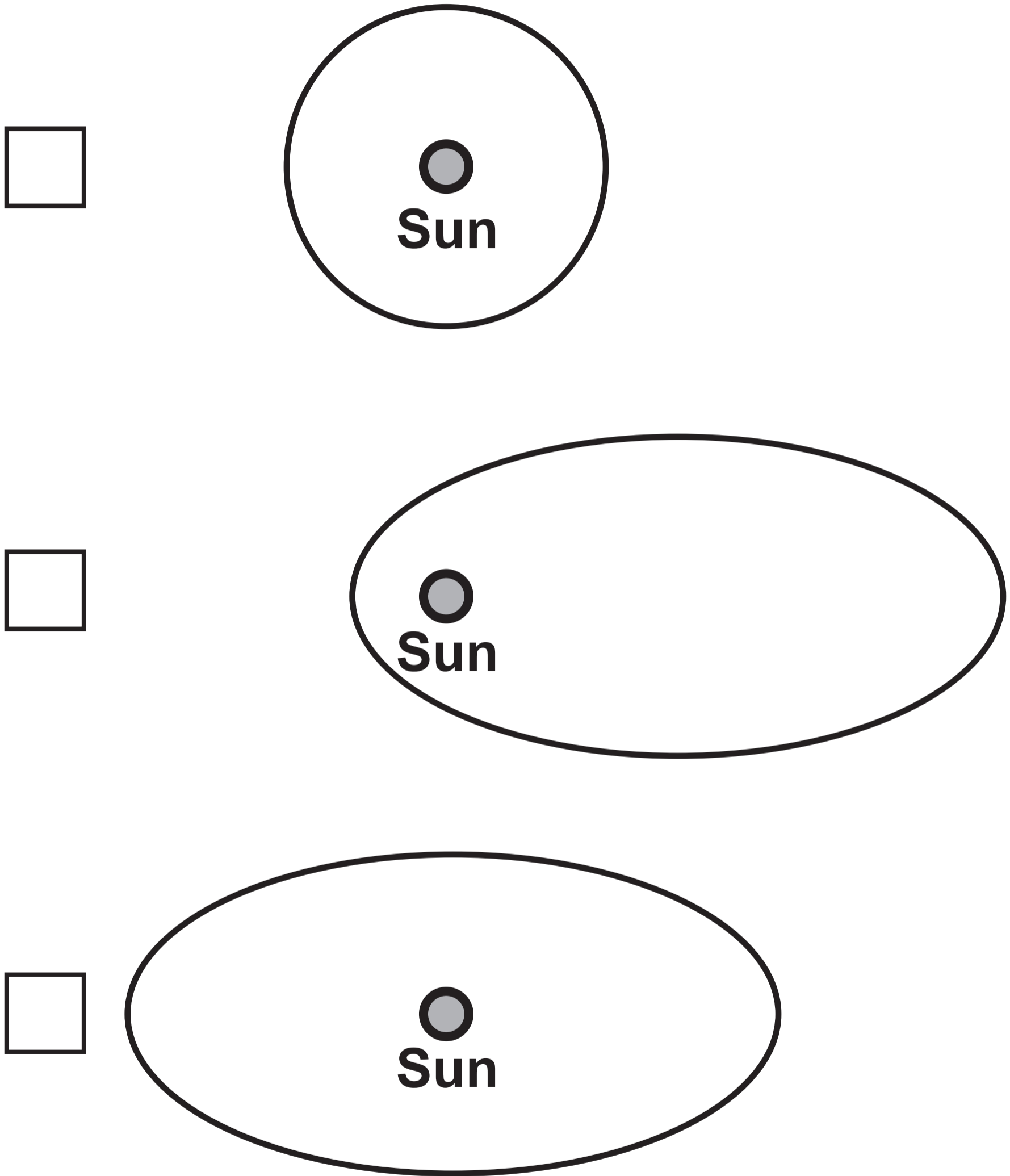


DIAGRAM 5.1

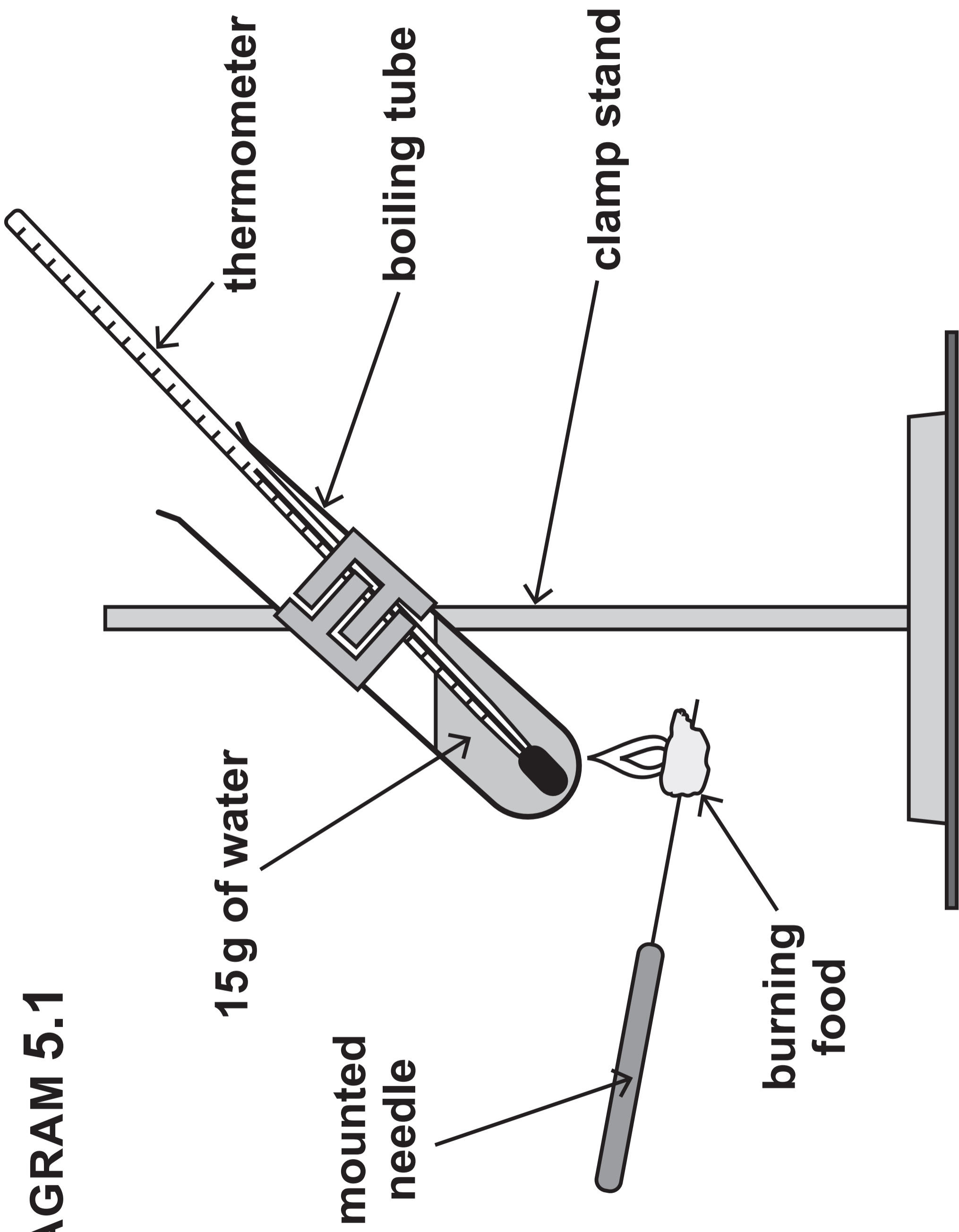


TABLE 5.2

Food	Mass of food burnt (g)	Initial water temperature (°C)	Final water temperature (°C)	Temperature increase (°C)
bread	2.5	18	23	5
cheese	4.0	17	31	14
cornflakes	3.0	17	29	12
oatie biscuit	5.0	18	25	7

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TABLE 7.1

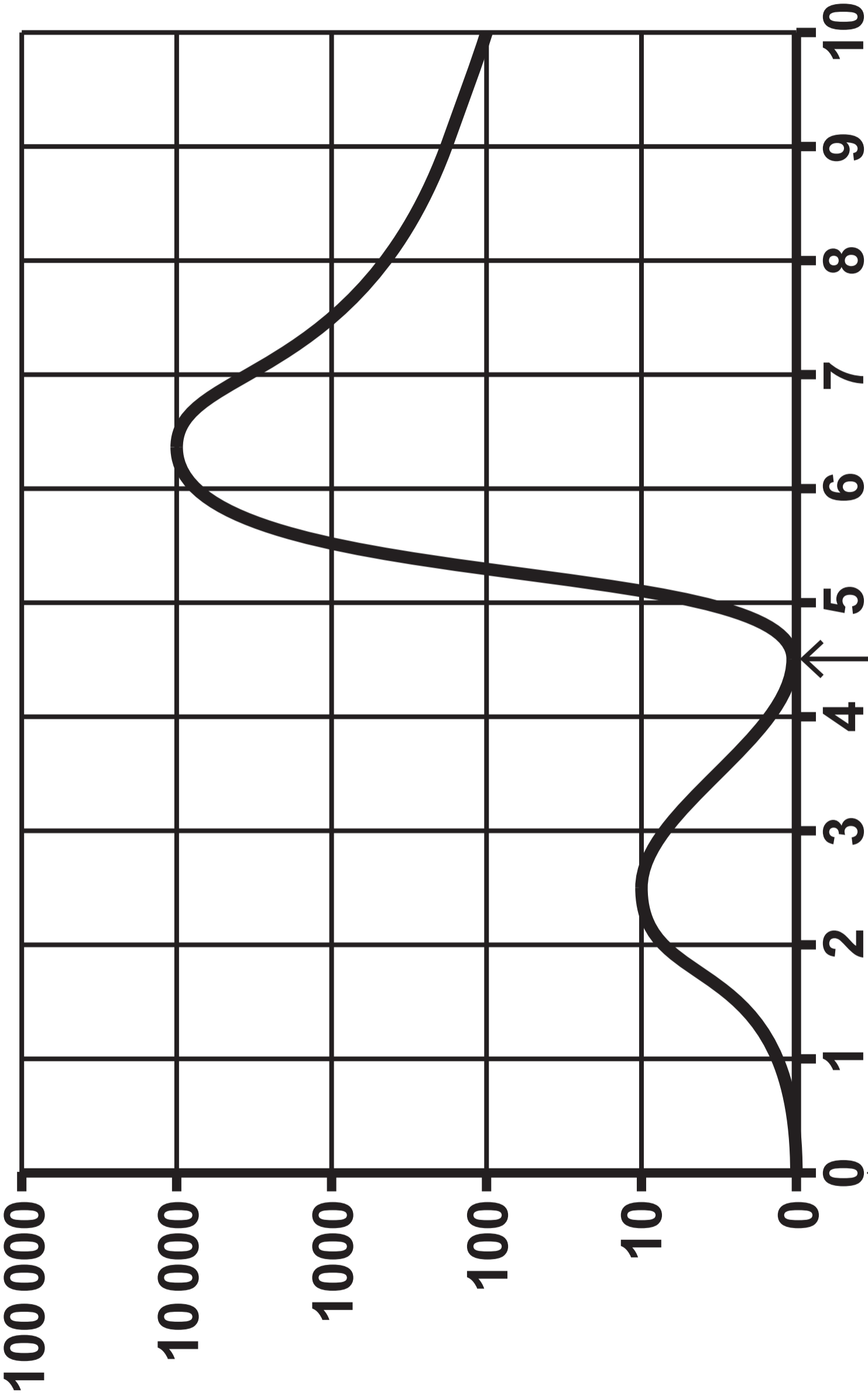
Treatment or diagnosis	Uses high intensity light waves	Uses short wavelength electromagnetic waves
chemotherapy		
ultrasound		
MRI scan		
CAT scan		

TABLE 7.1 continued

Treatment or diagnosis	Uses high frequency sound waves	Uses strong magnetic fields	Uses drugs
chemotherapy			
ultrasound			
MRI scan			
CAT scan			

GRAPH 8.1

Antibody concentration (units)

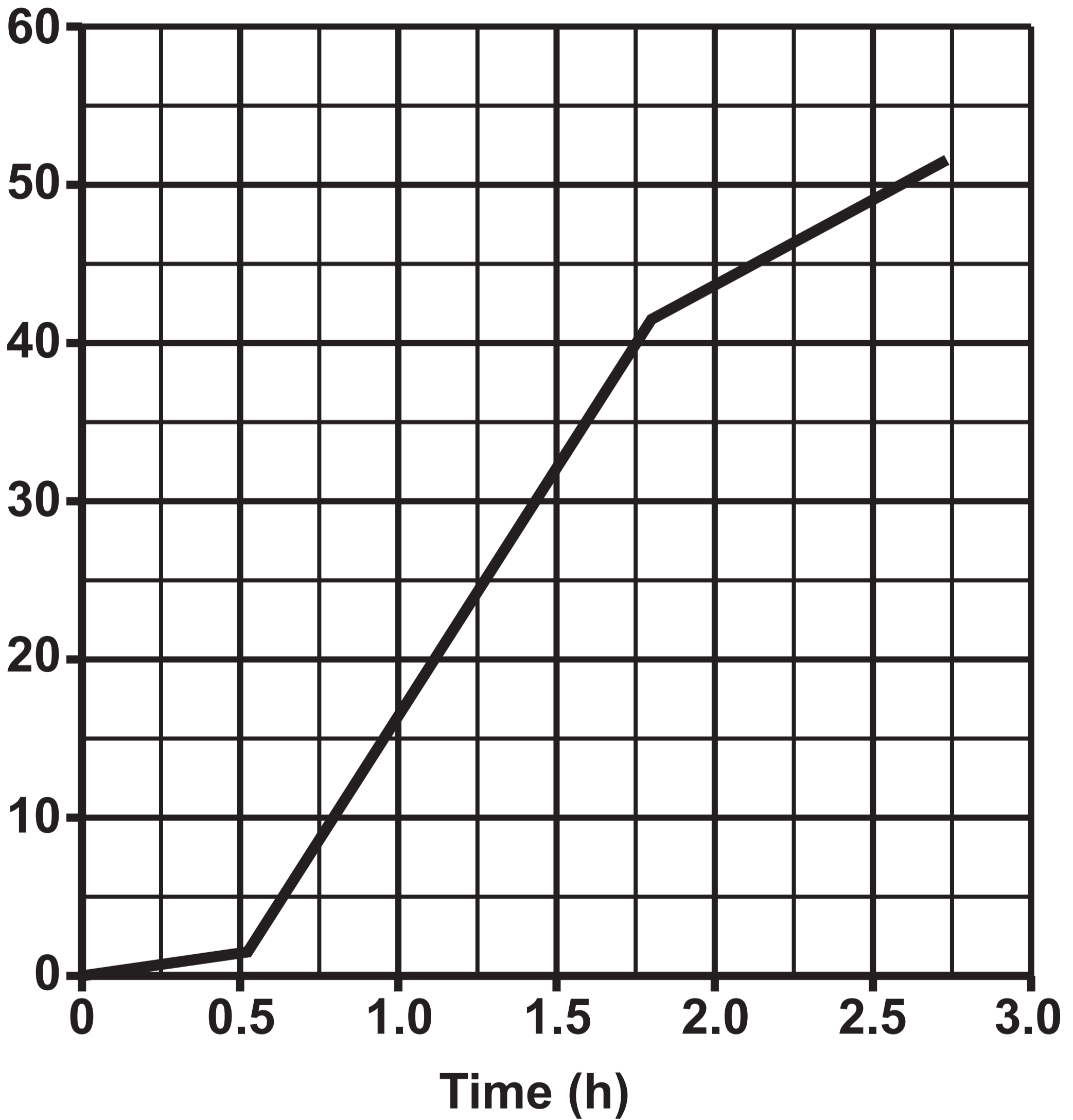


Time (weeks)

Booster vaccination

First vaccination

GRAPH 10.1
Distance (km)





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Data Booklet

THE PERIODIC TABLE

1 2 GROUP

1 H 1

7 Li 3	9 Be 4
23 Na 11	24 Mg 12

KEY	
A_r	— relative atomic mass
Sym	— symbol
Z	— atomic number

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		