wjec cbac GCSE

3445U20-1

TUESDAY, 13 JUNE 2023 – 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

In addition to this examination paper, you will require a separate Resource Folder, calculator, pen or pencil 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 given is incorrect.

You will need to refer to the separate resource folder to answer questions 7, 8 AND 9.

The Periodic Table is printed in the separate Data Booklet.

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.	6	
	2.	11	
	3.	4	
	4.	10	
	5.	12	
	6.	7	
Section B	7.	6	
	8.	11	
	9.	8	
	Total	75	

SECTION A

Answer ALL questions.

1 Look at DIAGRAM 1.1 in the seperate diagram booklet. Our solar system contains several planets and other objects that orbit the Sun.

Answer the following questions using your knowledge, DIAGRAM 1.1 and the words in the box below.

Each word can be used once, more than once, or not at all.

Comet	Jupiter	Mars
Oort	Venus	Pluto

1 (a) Name the second rocky planet from the Sun. [1 mark]

(b) Name the gas planet closest to the Sun. [1 mark]

(c) Name the type of object that orbits the Sun in a highly elliptical orbit. [1 mark]

(d) Between which TWO planets is the asteroid belt found? [2 marks]

_____

and

_____

1 (e) Name the cloud. [1 mark]

_____

6

2 DIAGRAM 2.1 in the separate diagram booklet shows the carbon cycle.

(a) Use the diagram and your knowledge to answer the following questions.

(i) CIRCLE the name of the process shown by label A. [1 mark]

feeding

photosynthesis

respiration

2 (a)(ii)

TICK (✓) the boxes next to the THREE correct statements. [3 marks]

- ☐ **Photosynthesis uses carbon dioxide from the atmosphere.**
- ☐ **Decomposing dead plants adds carbon dioxide to the atmosphere.**
- ☐ **Fossilising dead plants adds carbon dioxide to the atmosphere.**
- ☐ **Respiration adds carbon dioxide to the atmosphere.**
- ☐ **Burning dead plants removes carbon dioxide from the atmosphere.**
- ☐ **When green plants feed they add carbon dioxide to the atmosphere.**

2 (a)(iii)

State TWO ways that human activity has caused carbon dioxide levels to increase. [2 marks]

1. _____

2. _____

2 (b) TABLE 2.2 in the separate diagram booklet is taken from a climate change website.

It gives the mass of carbon dioxide produced by a person travelling to work either by car or bus.

FOUR people each travel a total of 20 km per day.

Use the information to answer the questions on the following page.

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TURN OVER

total mass of carbon dioxide produced (kg) = **number of people** x **mass of carbon dioxide produced per person**

2 (b)(i)

Use the equation on the opposite page to answer the following questions.

I. Calculate the total mass of carbon dioxide produced when four people drive 20 km by car. [2 marks]

mass of carbon dioxide produced = _____ kg

2 (b)(i) continued

II. Calculate the mass of carbon dioxide produced if four people travelled 20 km by bus. [1 mark]

mass of carbon dioxide produced = _____ kg

2 (b)(ii) Calculate the savings in carbon dioxide production per week if they travel by bus on the same 20 km journey from Monday to Friday instead of using their cars. [2 marks]

savings in carbon dioxide production = _____ kg

3 Lichen is an indicator species for air pollution.

Students measured the abundance of lichen at various distances from the city centre.

Their results are shown in GRAPH 3.1 in the separate diagram booklet.

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

(i) Estimate the abundance of lichen 4.0 km from the city centre. [1 mark]

abundance = _____ units

3 (a)(ii) Describe the trend shown by the graph. [1 mark]

(b) Explain why the abundance of lichen is not the same at all the distances shown. [2 marks]

continue answer on the next page

16

4

(Turn over)

4 DIAGRAM 4.1 in the separate diagram booklet shows the apparatus used to find the acceleration of a squash ball as it rolls down a ramp.

A stopwatch is also required.

(a) Describe the method used in this investigation. [6 marks QER]

Include in your answer:

- How you would carry out the experiment
- How to reduce the uncertainty in your results.

continue answer on the next page

(Turn over)

(Turn over)

4 (b) The following readings were taken during the investigation.

Time to travel 50 cm along the bench = 2.0 s

Time to reach the bottom of the ramp = 2.5 s

(i) Use the equation:

$$\text{velocity} = \frac{0.5}{\text{time to travel 50 cm along the bench}}$$

to calculate the velocity of the ball travelling along the bench. [2 marks]

continue answer on the next page

velocity = _____ m/s

4 (b)(ii) Use the equation:

$$\text{acceleration} = \frac{\text{velocity along the bench}}{\text{time to reach the bottom of the ramp}}$$

to calculate the acceleration of the ball down the ramp. [2 marks]

continue answer on the next page

acceleration = _____ m/s^2

10

(Turn over)

5 Cystic fibrosis is an example of an inherited disease. A carrier of cystic fibrosis has one unaffected allele (F) and one affected allele (f).

(a) Two parents are planning to have a child. The father is a carrier of cystic fibrosis (Ff), the mother is unaffected.

(i) CIRCLE the genotype of the unaffected mother. [1 mark]

FF ff Ff

(ii) Complete PUNNETT SQUARE 5.1 in the separate diagram booklet to show the possible genotypes of the children. [2 marks]

5 (a)(iii) State the chance of a child from these parents being born with cystic fibrosis. [1 mark]

(iv) The possible genotypes of children from two carrier parents are shown in PUNNETT SQUARE 5.2 in the separate diagram booklet.

These carrier parents thought they would have the same chance of having a child with cystic fibrosis as the parents in (a)(ii). Explain whether you agree. [1 mark]

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continue answer on the next page

5 (b) Cystic fibrosis causes a build-up of thick mucus in the lungs. Mucus in the lungs helps bacteria to grow.

<u>UNDERLINE</u> TWO statements below which show ways white blood cells help to defend the body against bacterial infection. [2 marks]

Carry oxygen to the bacteria

Ingest bacteria

Produce antibodies

Make glucose

(Turn over)

5 (c)(i) Complete TABLE 5.3 in the separate diagram booklet to show how the number of bacteria doubles every 15 minutes. [2 marks]

(c)(ii) Antibiotic resistance is a concern. The list below describes the stages involved in the development of bacteria with antibiotic resistance. It is not in the correct order.

1. Many more bacteria survive antibiotic treatment.

2. There was a mutation to a gene in a few bacteria.

3. The survivors reproduce, passing on the mutated gene.

4. Bacteria with the mutation survive antibiotics.

5 (c)(ii) continued

Arrange the stages in the correct order starting with stage 2. [2 marks]

2 → _____ → _____ → _____

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

The development of antibiotic resistant bacteria is an example of (evolution / vaccination / digestion).

12

6 Some students investigated the number of dandelion plants on a lawn. DIAGRAM 6.1 in the separate diagram booklet shows the lawn and the location of 5 quadrats (A to E) which the students had placed at random.

The students counted the number of dandelions in each quadrat and recorded their results in TABLE 6.2 in the separate diagram booklet.

(a) Calculate the mean number of dandelions per quadrat. [1 mark]

mean number of dandelions = _____

6 (b) Calculate the area of the lawn. [1 mark]

area of lawn = _____ m^2

(c) Each quadrat has an area of 1 m^2. Calculate how many quadrats will fit in the area of the lawn. [1 mark]

number of quadrats = _____

(d) Use your answers to (a) and (c) to calculate the total number of dandelions on the lawn. [1 mark]

number of dandelions = _____

6 (e) The actual number of dandelions on the lawn is 600.

Use the formula below, and your answer to (d), to calculate the percentage error of your answer to (d). [2 marks]

$$\text{percentage error} = \frac{\text{number of dandelions} - 600}{600} \times 100$$

percentage error = _____ %

6 (f) State ONE improvement to the method used by the students which would give more confidence in their answer for the number of dandelions. [1 mark]

7

SECTION B

Refer to the separate Resource Folder to answer questions 7, 8 and 9.

7 X-rays are commonly used to diagnose illness.

(a) Refer to FIGURE 2 to answer the following questions.

(i) State the range of wavelength for X-rays. [1 mark]

_____ m

(ii) Estimate the highest frequency of X-rays. [1 mark]

_____ Hz

7 (b) Refer to FIGURE 3 to answer the following questions.

(i) A patient has received a total radiation dose of 70 units from X-rays during the year.

Calculate how many chest X-rays this dose is equivalent to. [2 marks]

number of chest X-rays = _____

b (ii) A patient has an X-ray taken of their spine. Calculate the fraction of the yearly background radiation this dose is equivalent to. [2 marks]

(1 year = 365 days)

fraction = _____

6

8 (a) Use the information under FIGURE 1 to answer the following question.

The wave speed of ultrasound in body tissue is 1540 m/s.

Use the equation:

$$\text{wavelength} = \frac{\text{wave speed}}{\text{frequency}}$$

to calculate the wavelength of the ultrasound used in a 2 MHz scan.
[3 marks]

wavelength = _____ m

8 (b) Use the information in FIGURE 4 to answer the following questions.

(i) Select the most suitable radioisotope of iodine from the table in FIGURE 4 that would be used as a tracer. Explain your choice. [2 marks]

8 (b)(ii)

DIAGRAM 8.1 in the separate diagram booklet shows a patient undergoing external beam radiation therapy for a brain tumour.

Select the most suitable radioisotope from the table in FIGURE 4 that would be used for this treatment. Explain your choice. [3 marks]

8 (c) Refer to FIGURES 4 AND 6 in the Resource Folder to answer the following question.

State which of the radioisotopes **R1, R2, R3, R4, R5** or **R6**, is lutetium-177.

Explain your reasoning. [3 marks]

Radioisotope _____ is lutetium-177.

continue answer on the next page

39

11

(Turn over)

9 The following questions are based on the information on page 5 of the Resource Folder about using dice to model half-life.

(a) Each group's results were added together to give class results. Give ONE reason why this makes the data more repeatable. [1 mark]

(b) The results in FIGURES 7 AND 8 are used to plot graphs on GRAPH 9.1 in the separate diagram booklet.

(i) Add lines to GRAPH 9.1 to determine the half-life represented by line 3. [2 marks]

half-life = _____ throws

9 (b)(ii)

Use the information in GRAPH 9.1 to tick (✓) the boxes next to the THREE correct statements. [3 marks]

☐ Line 1 represents the data from Model 2.

☐ Line 2 shows decay of the quickest rate.

☐ Line 2 shows the equivalent of three half-lives after 5 throws.

☐ Line 1 represents the longest half-life.

☐ Line 3 would have been produced if 600 coins had been used instead of dice and the number of 'heads' counted after each throw.

☐ Line 3 has an activity that is 1/8 of the original after 8 throws.

9 (c) The teacher suggests to the class that they add 5 red wooden cubes to the 50 dice they start with. The red cubes would not be removed after each throw but would be counted every time to improve the modelling of radioactive decay.

(i) State what the red cubes represent. [1 mark]

9 (c) (ii)

State how the presence of the red cubes would affect line 1 on GRAPH 9.1. [1 mark]

8

END OF PAPER

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APPLIED SCIENCE (Double Award)

UNIT 2: Space, Health and Life
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

Not drawn to scale

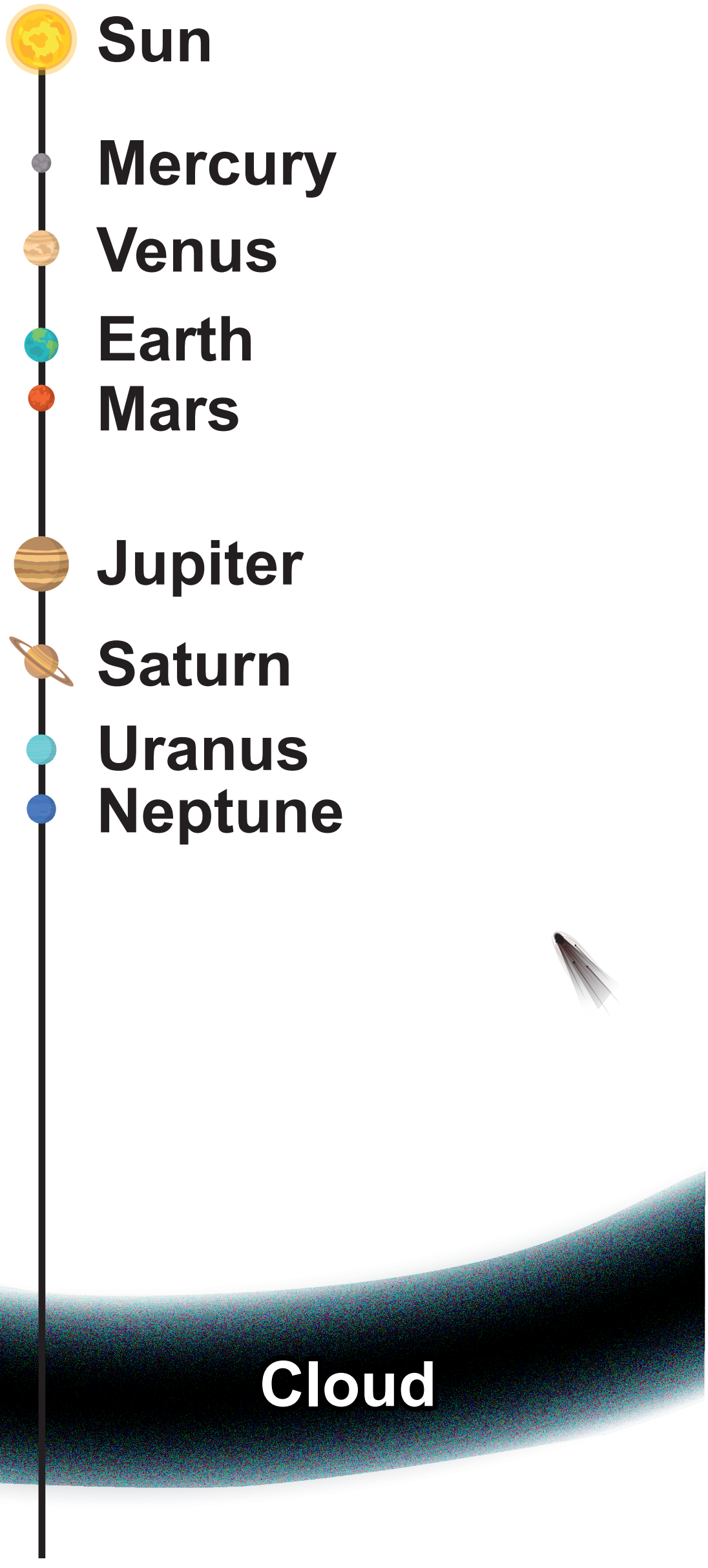


DIAGRAM 2.1

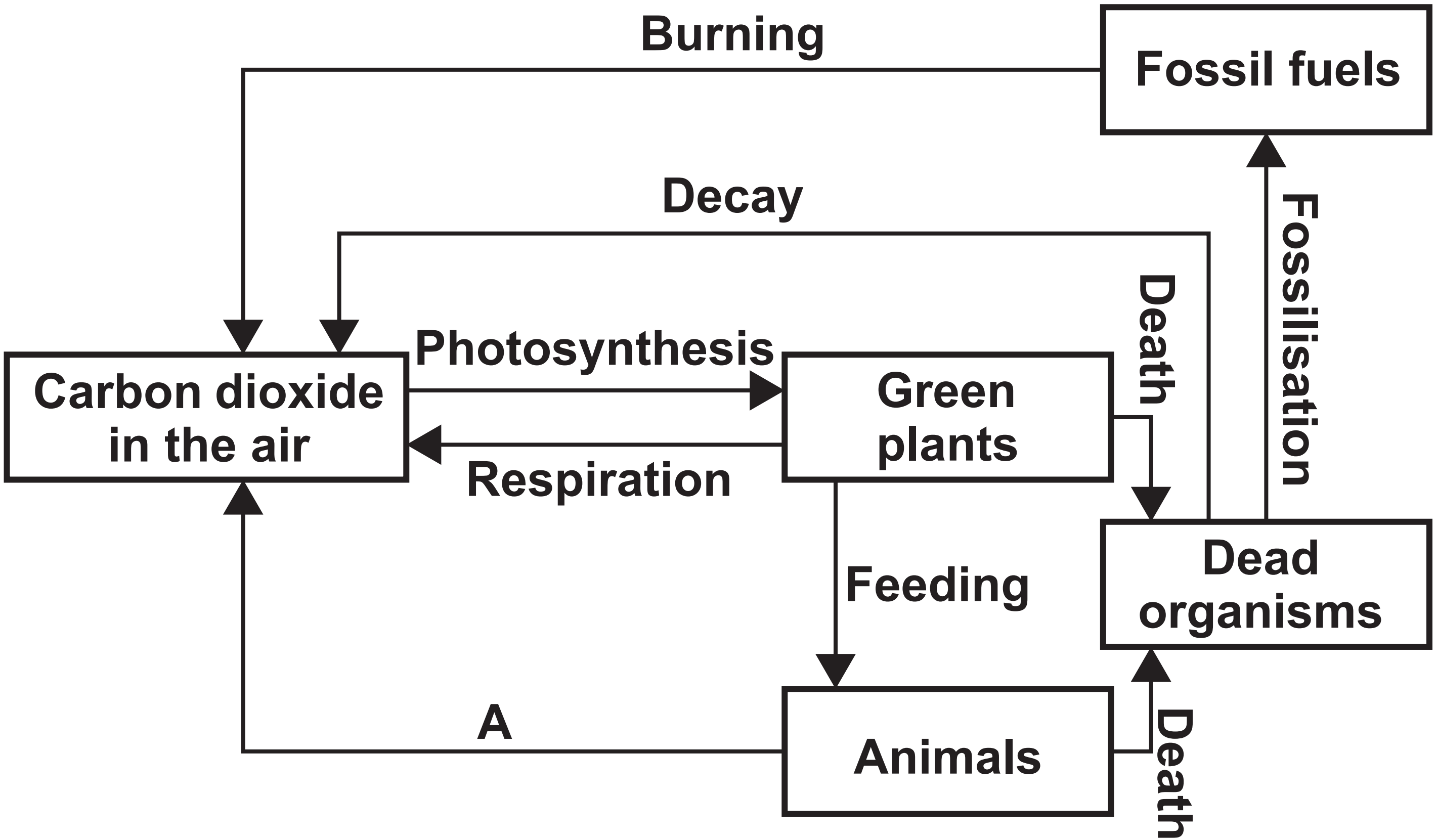

Burning
Fossil fuels
Decay
Fossilisation
Death
Photosynthesis
Carbon dioxide in the air
Green plants
Respiration
Feeding
Dead organisms
A
Animals
Death

TABLE 2.2

Distance travelled (km)	20
Mass of carbon dioxide produced per person travelling by car (kg)	1.20
Mass of carbon dioxide produced per person travelling by bus (kg)	0.20

GRAPH 3.1

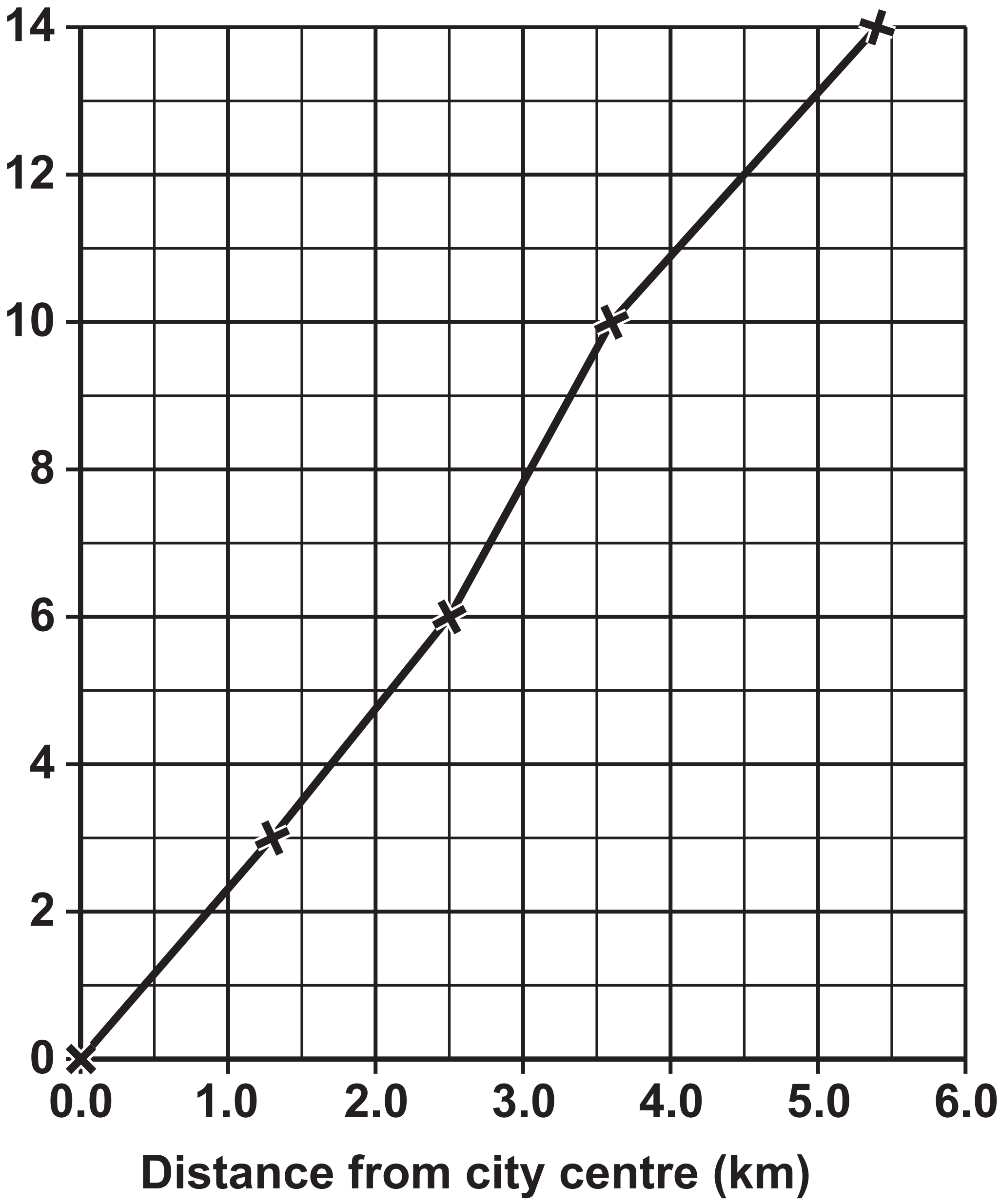
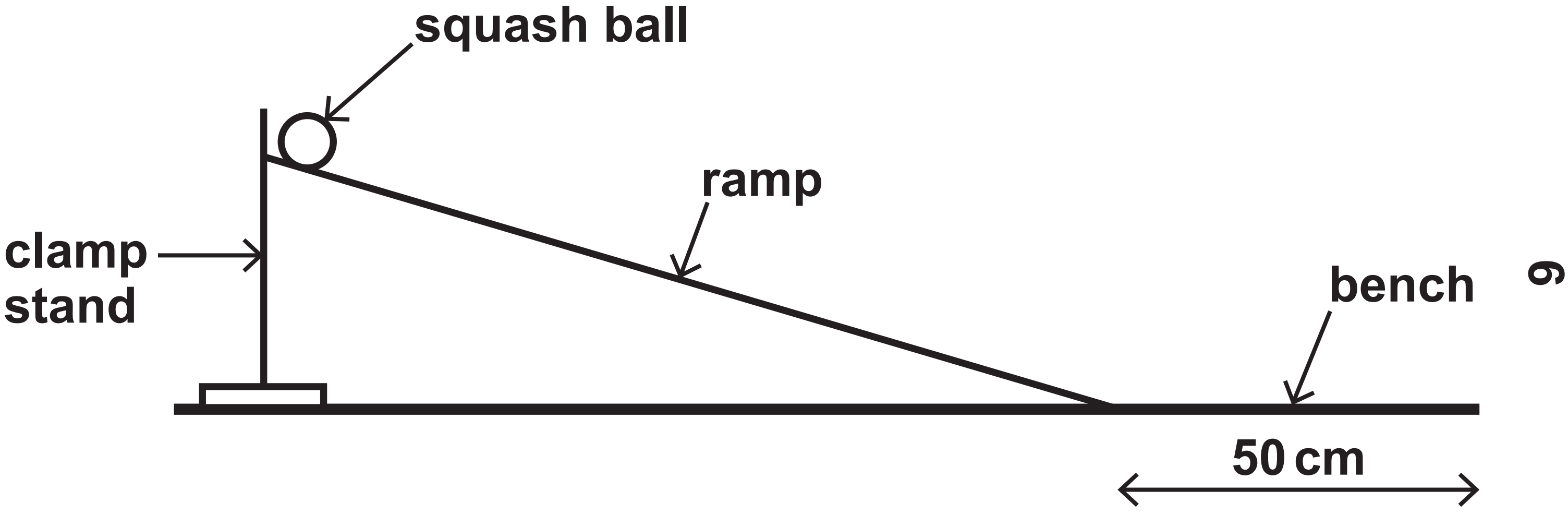

Abundance of lichen (units)
14
12
10
8
6
4
2
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Distance from city centre (km)

DIAGRAM 4.1



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PUNNETT SQUARE 5.1

	F	f

PUNNETT SQUARE 5.2

	F	f
F	FF	Ff
f	Ff	ff

TABLE 5.3

Time (minutes)	0	25	30	45	60
Number of bacteria	1	2	_____	8	_____

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DIAGRAM 6.1

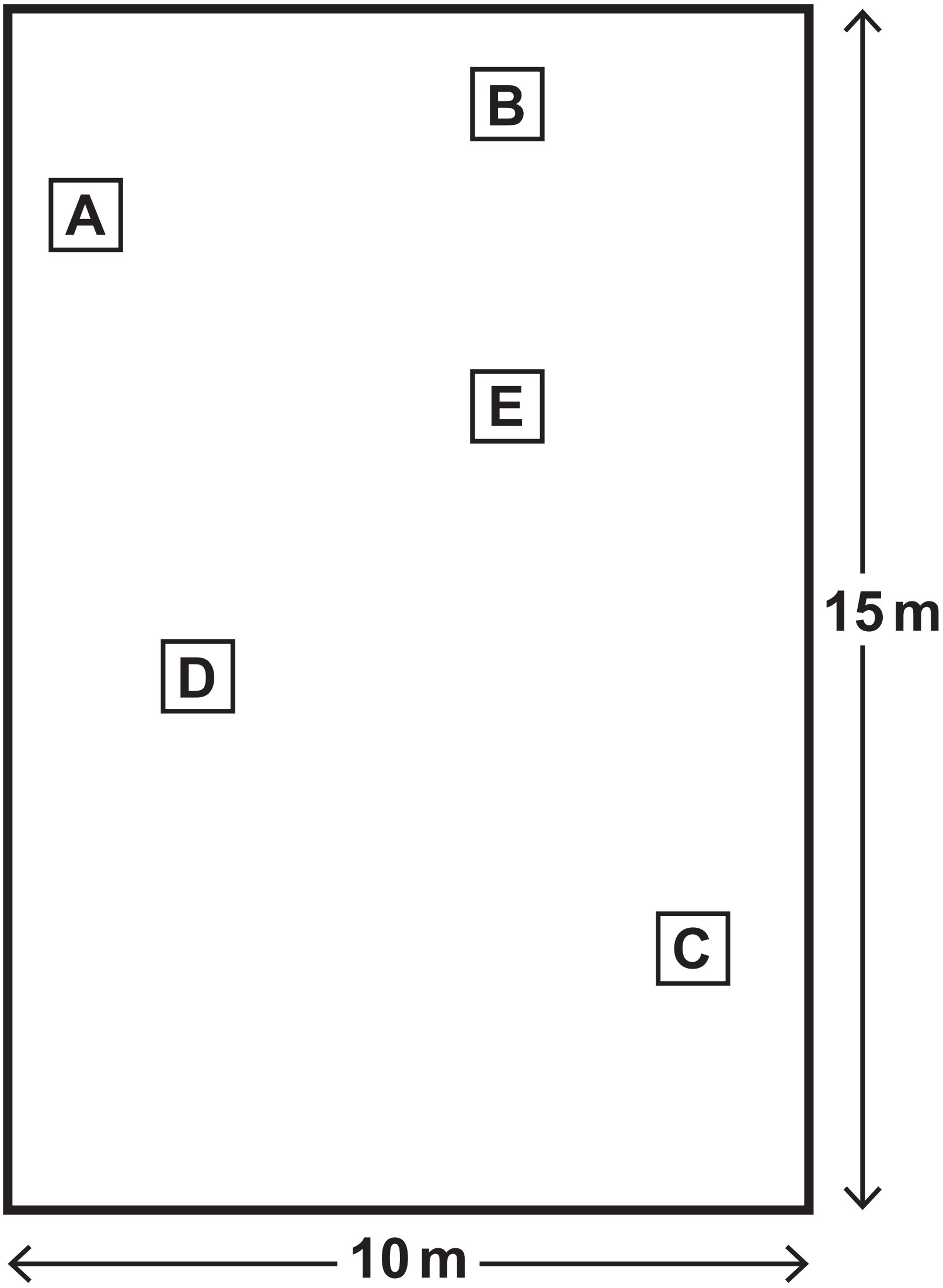
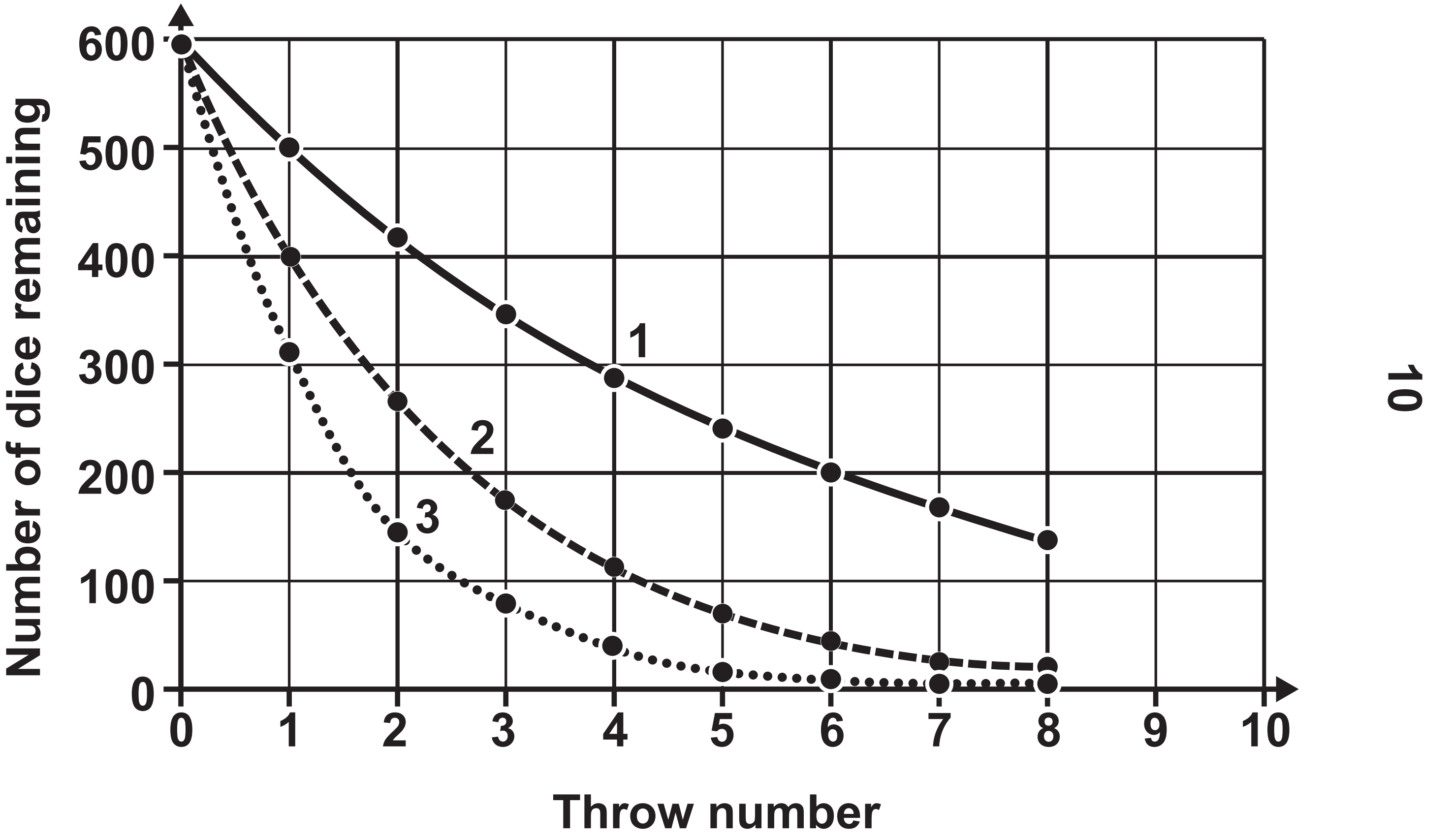


TABLE 6.2

Quadrat	Number of dandelions
A	6
B	3
C	4
D	8
E	4

DIAGRAM 8.1

GRAPH 9.1


Number of dice remaining
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
Throw number
1
2
3

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UNIT 2: Space, Health and Life

FOUNDATION TIER

Data Booklet

THE PERIODIC TABLE

1	2	GROUP						
								1 H 1
7 Li 3	9 Be 4							
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						

KEY

A_r	relative atomic mass
Sym	symbol
Z	atomic number

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		