wjec cbac

GCSE

3445UB0-1

TUESDAY, 13 JUNE 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 2: Space, Health and Life
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 separate Resource Folder, calculator and a ruler.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.
A separate Data Booklet.
A separate Resource Folder.

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.

(Turn over)

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question 5(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 1, 2 and 3.

A Periodic Table is printed in the separate Data Booklet.

(Turn over)

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.	11	
	2.	8	
	3.	6	
Section B	4.	7	
	5.	10	
	6.	9	
	7.	8	
	8.	16	
	Total	75	

Section A

Answer ALL questions.

Refer to the separate Resource Folder to answer the following questions.

1 (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]

continue on the next page

(Turn over)

wavelength = ____________ m

(Turn over)

1 (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]

(Turn over)

1 (b)(ii)

DIAGRAM 1.1 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]

continue on the next page (Turn over)

1 (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 on the next page

(Turn over)

11

(Turn over)

2 The following questions are based on the information on pages 5 and 6 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]

(Turn over)

2 (b) The results in FIGURES 7 AND 8 in the Resource Folder are used to plot lines on GRAPH 2.1 in the separate diagram booklet.

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

half-life = ___________ throws

(Turn over)

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TURN OVER

- [ ] 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.

2 (b)(ii)

Use the information in GRAPH 2.1 to TICK (✓) the boxes next to the THREE correct statements on the opposite page. [3 marks]

(Turn over)

2 (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]

(Turn over)

2 (c)(ii)

State how the presence of the red cubes would affect line 1 on GRAPH 2.1. [1 mark]

____

____

8

3 X-rays are commonly used to diagnose illness.

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

It is stated that X-rays have shorter wavelengths than ultraviolet rays but longer wavelengths than gamma rays. Explain whether you agree using data to support your answer.
[3 marks]

continue on the next page

(Turn over)

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

A patient has a series of X-rays taken following an accident. These were: one chest; one abdomen; and one skull X-ray.
Calculate the percentage of the yearly background radiation the patient received from this combination of X-rays. [3 marks]
(1 year = 365 days)

percentage = ____________

6

Section B

Answer ALL questions.

4 Lichen can be used as an indicator species for air pollutants such as sulfur dioxide.
Students performed an air pollution survey by recording the distribution of lichen around a city.
Their results are shown in TABLE 4.1 in the separate diagram booklet.

(a) On GRAPH 4.2 in the separate diagram booklet, use the information in TABLE 4.1 to plot a graph showing the change in mean concentration of sulfur dioxide with the distance from the city centre and draw a suitable line. [3 marks]

(Turn over)

4 (b) Describe the relationship between distance from the city centre and mean concentration of sulfur dioxide. [2 marks]

(Turn over)

4 (c) Explain the effect of sulfur dioxide on the abundance of lichen. [2 marks]

7

(Turn over)

5 (a) Explain why, for thousands of years, the percentage of carbon dioxide in the Earth's atmosphere remained approximately constant AND how this stabilised conditions for life on Earth. [6 marks QER]

continue on the next page

continue on the next page (Turn over)

(Turn over)

5 (b) During the past 200 years, evidence shows that the percentage of carbon dioxide in the atmosphere has been steadily rising.

One factor that contributes to this increase is how people travel to work.

TABLE 5.1 in the separate diagram booklet is taken from a climate change website.
It gives information about the mass of carbon dioxide produced EACH JOURNEY PER PERSON travelling to work by different methods each day.

question continues on the next page

(Turn over)

5 (b) continued

Use this information to calculate the mass of carbon dioxide saved during a 5-day working week, if 250 people travel 30 km EACH WAY to work and back home by train instead of every person using their own car. [4 marks]

mass of
carbon dioxide saved = __________ kg

10

(Turn over)

6 (a) 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 6 quadrats (A to F) of area 1 m^2 which the students had placed at random on the lawn.

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

(i) Use the information to estimate the total number of dandelions on the lawn. [3 marks]

estimated
number of dandelions = __________

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TURN OVER

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

6 (a)(ii)

The actual number of dandelions on the lawn is 1950.
Use the formula on the opposite page to calculate the percentage error of your estimate in (a)(i). [2 marks]

percentage error = ___________

(Turn over)

6 (b) A species of dandelion has become resistant to one type of weedkiller. Explain, in terms of natural selection, how this has occurred. [4 marks]

continue on the next page (Turn over)

9

7 Glucose homeostasis is an important biological process.

(a) Describe the role of insulin in controlling high blood glucose levels. [4 marks]

continue on the next page **(Turn over)**

7 (b) Describe the difference between type 1 and type 2 diabetes. [2 marks]

(Turn over)

7 (c) Describe the chemical test for glucose and state the colour change for a positive result. [2 marks]

8

(Turn over)

8 Cystic fibrosis is an example of an inherited disease caused by a recessive allele. A carrier of the disease has a genotype Ff.

(a) DIAGRAM **8.1** in the separate diagram booklet shows two punnett squares. Compare the chances of a child being born with cystic fibrosis if both parents are carriers, with a child whose father suffers from cystic fibrosis and a mother who is a carrier. [4 marks]

(Turn over)

8 (b) Cystic fibrosis causes a build-up of thick mucus in the lungs, which leads to poor gas exchange. Mucus in the lungs also allows increased bacterial growth that is responsible for infections.

Explain how the body defends itself against bacterial infection in the lungs. [3 marks]

continue on the next page (Turn over)

8 (c) Sufferers of cystic fibrosis benefit from being physically active to slow the rate of decline in lung function.

Explain the short-term and long-term effects of exercise on lung function. [3 marks]

(Turn over)

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TURN OVER

$$\text{volume of air per breath} = \frac{\text{volume of air breathed in per minute}}{\text{number of breaths per minute}}$$

8 (d) DIAGRAM 8.2 in the separate diagram booklet gives information about the breathing of three different individuals, all of whom are resting.

A is a person who is not affected by cystic fibrosis.

B is a person with cystic fibrosis.

C is a person with cystic fibrosis and a lung infection.

The numbers show the volume of air breathed in per minute in dm^3 per min and also the number of breaths per minute.

(i) Use the equation on the opposite page to compare the volume of air breathed in per breath for each of the breathing patterns. [4 marks]

answer question on the next page

A ______________

B ______________

C ______________

(Turn over)

8 (d)(ii)

Compare the number of breaths per minute with blood oxygen levels in the three individuals. [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 ______________________________

First name(s) ______________________________

Centre Number ______________________________

Candidate Number 0 ______________________________

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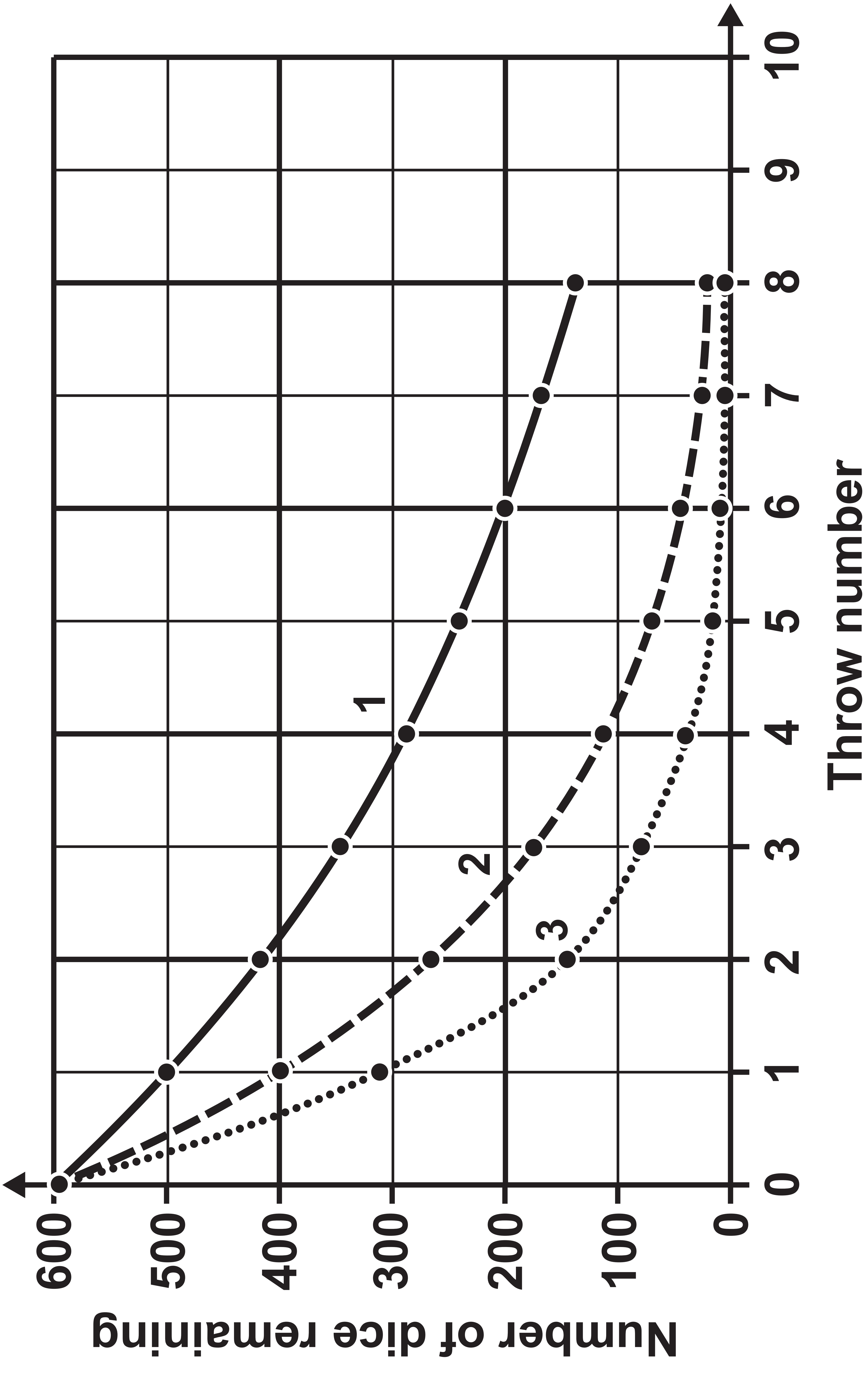
DIAGRAM 1.1

GRAPH 2.1


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

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TURN OVER

TABLE 4.1

Distance from city centre (km)	Abundance of lichen (units)	Mean concentration of sulfur dioxide (units)
0.0	0	250
1.3	3	198
2.5	6	160
3.6	10	140
5.4	14	122

GRAPH 4.2

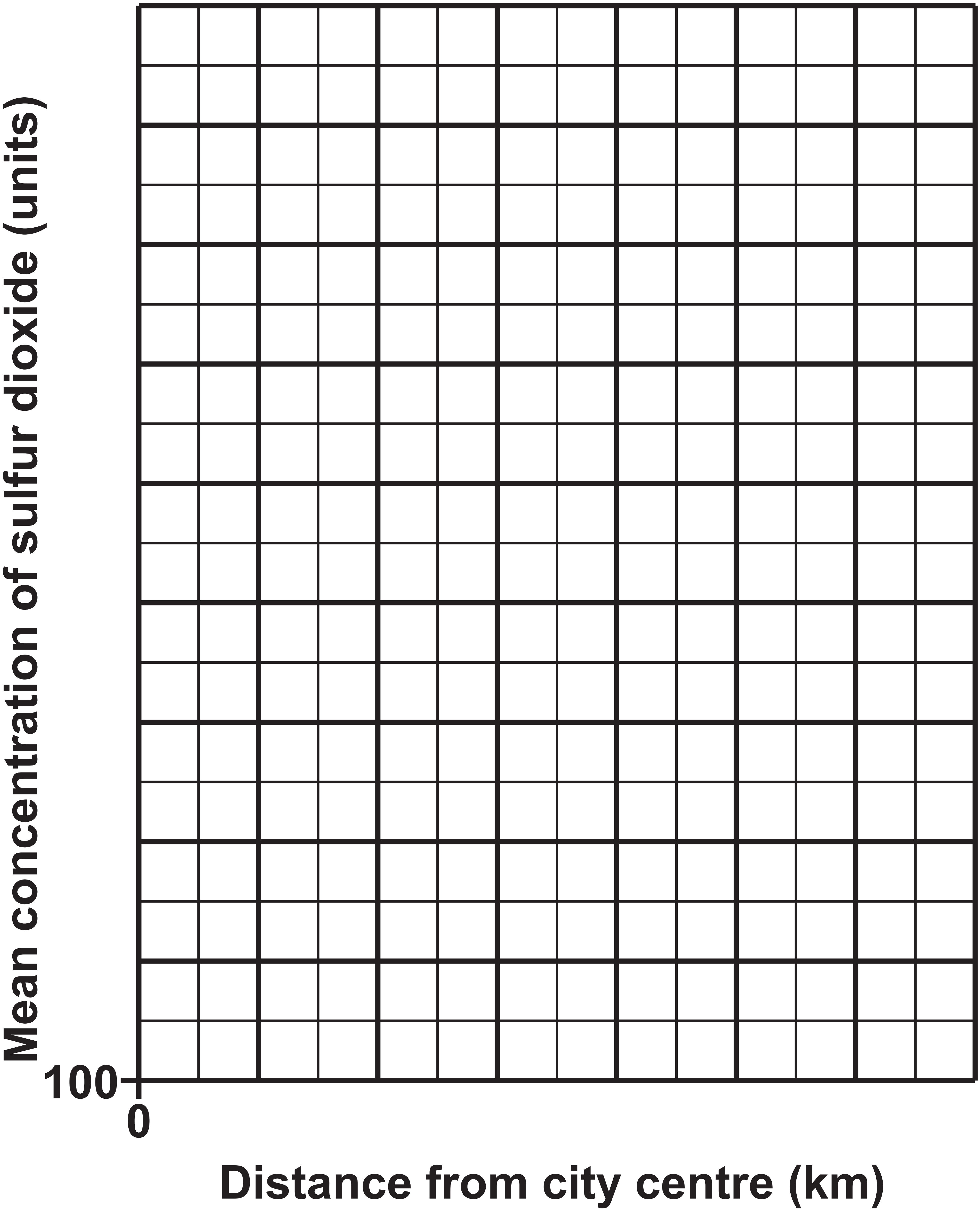
Mean concentration of sulfur dioxide (units)
100
0
Distance from city centre (km)

TABLE 5.1

Distance travelled (km)	10	20	25	50
carbon dioxide produced travelling by car (kg)	0.60	1.20	1.50	3.00
carbon dioxide produced travelling by bus (kg)	0.10	0.20	0.25	0.50
carbon dioxide produced travelling by train (kg)	0.18	0.36	0.45	0.90

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DIAGRAM 6.1

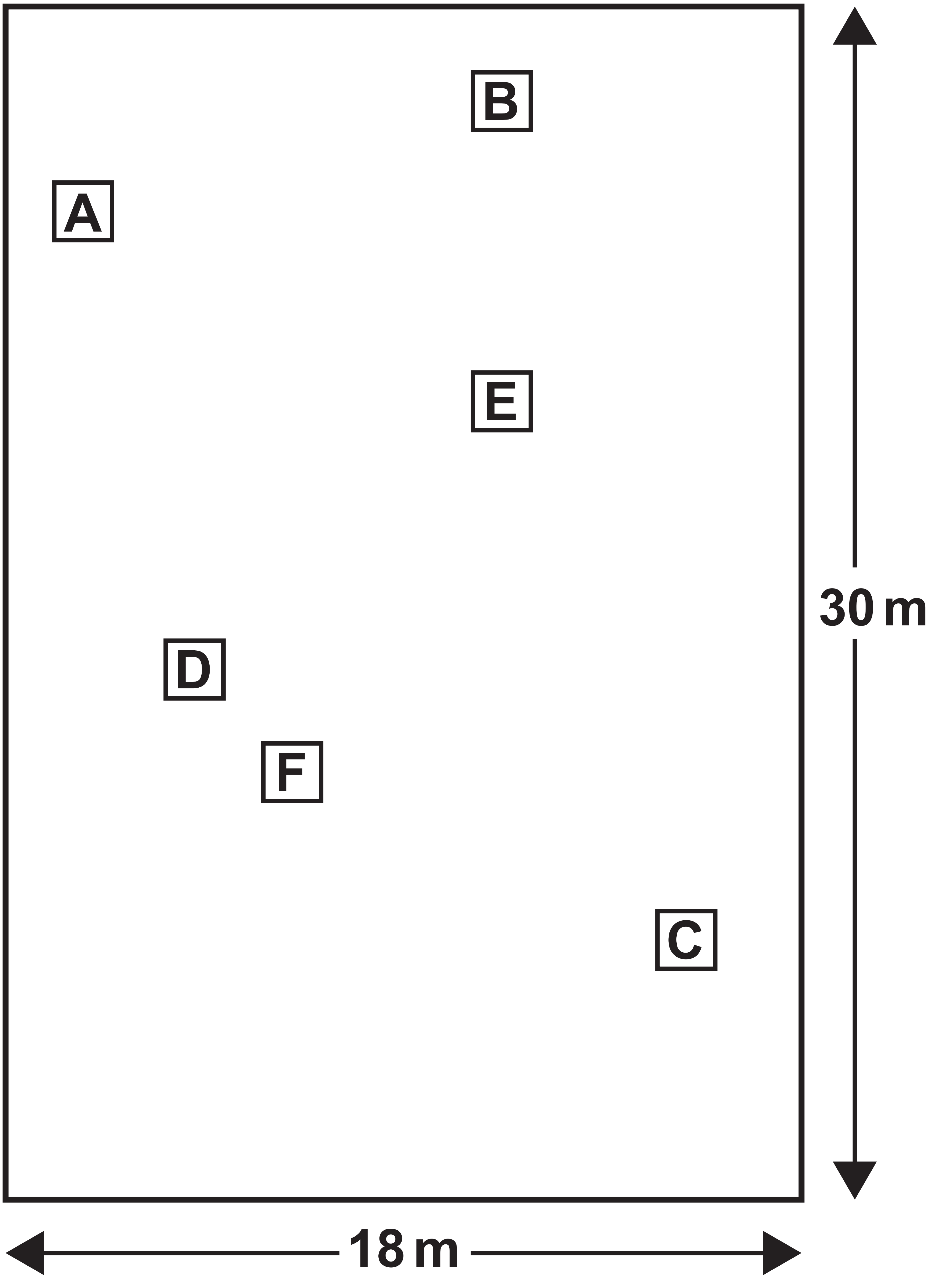


TABLE 6.2

Quadrat	Number of dandelions
A	6
B	3
C	2
D	7
E	4
F	5

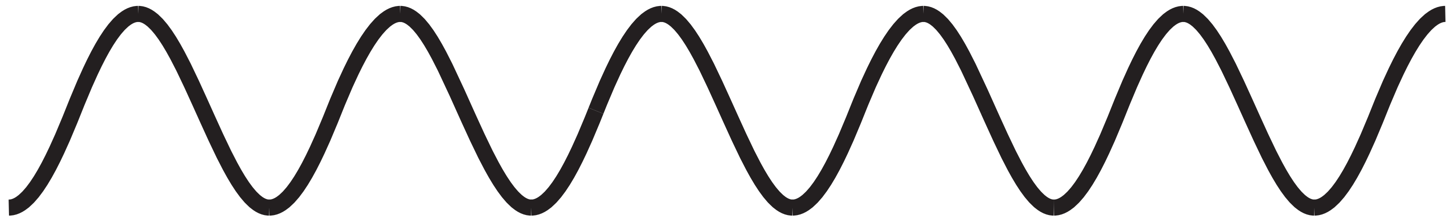
DIAGRAM 8.1

DIAGRAM 8.2

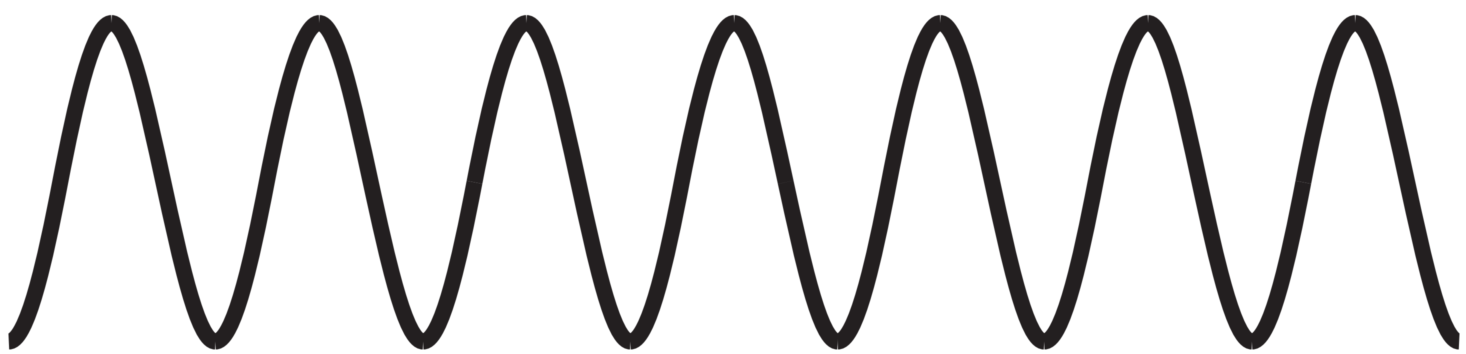
6 dm^3/min 12 breaths/min

A  Blood oxygen level 99%

15 dm^3/min 18 breaths/min

B  Blood oxygen level 94%

26 dm^3/min 30 breaths/min

C  Blood oxygen level 90%

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Data Booklet

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THE PERIODIC TABLE

KEY

A_r	relative atomic mass
Sym	symbol
Z	atomic number

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						

			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		