

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

3445UB0-1



S23-3445UB0-1

TUESDAY, 13 JUNE 2023 – MORNING

APPLIED SCIENCE (Double Award)

UNIT 2: Space, Health and Life

HIGHER TIER

1 hour 30 minutes

Section A

Section B

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

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a separate Resource Folder, calculator, pencil and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

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 **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 on page 20.



JUN233445UB0101

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]

wavelength = m

- (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]

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- (ii) The photograph 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]

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- (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]

Radioisotope is lutetium-177.

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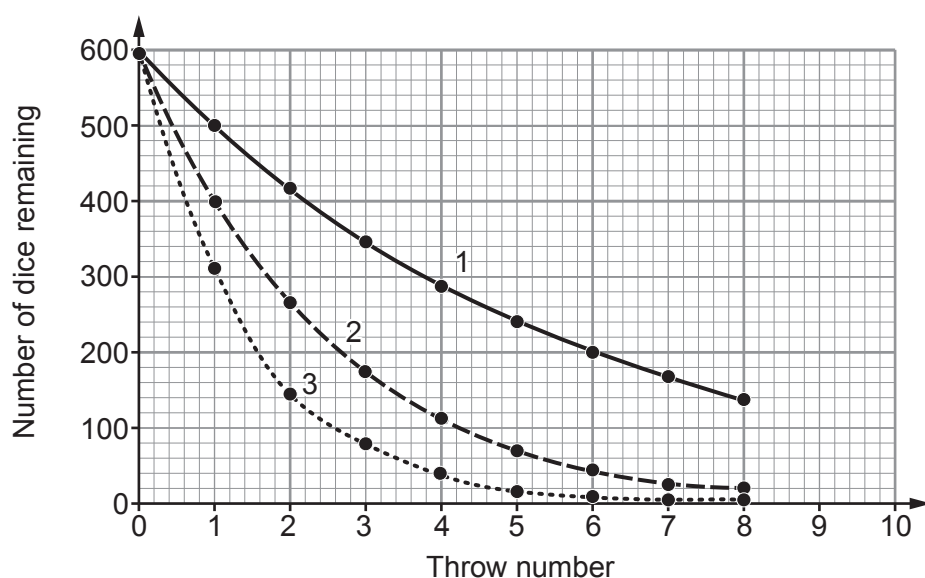
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2. The following questions are based on the information on pages 6 and 7 of the Resource Folder about using dice to model half-life.

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

- (b) The results in **Figures 7 and 8** in the Resource Folder are used to plot graphs on the grid below.



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

half-life = throws



- (ii) Use the information in the graph to **tick (✓)** the boxes next to the **three** correct statements. [3]

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 $\frac{1}{8}$ of the original after 8 throws.

☐

- (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]

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- (ii) State how the presence of the red cubes would affect line 1 on the graph. [1]

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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]

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(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]
(1 year = 365 days)

percentage =



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Section B

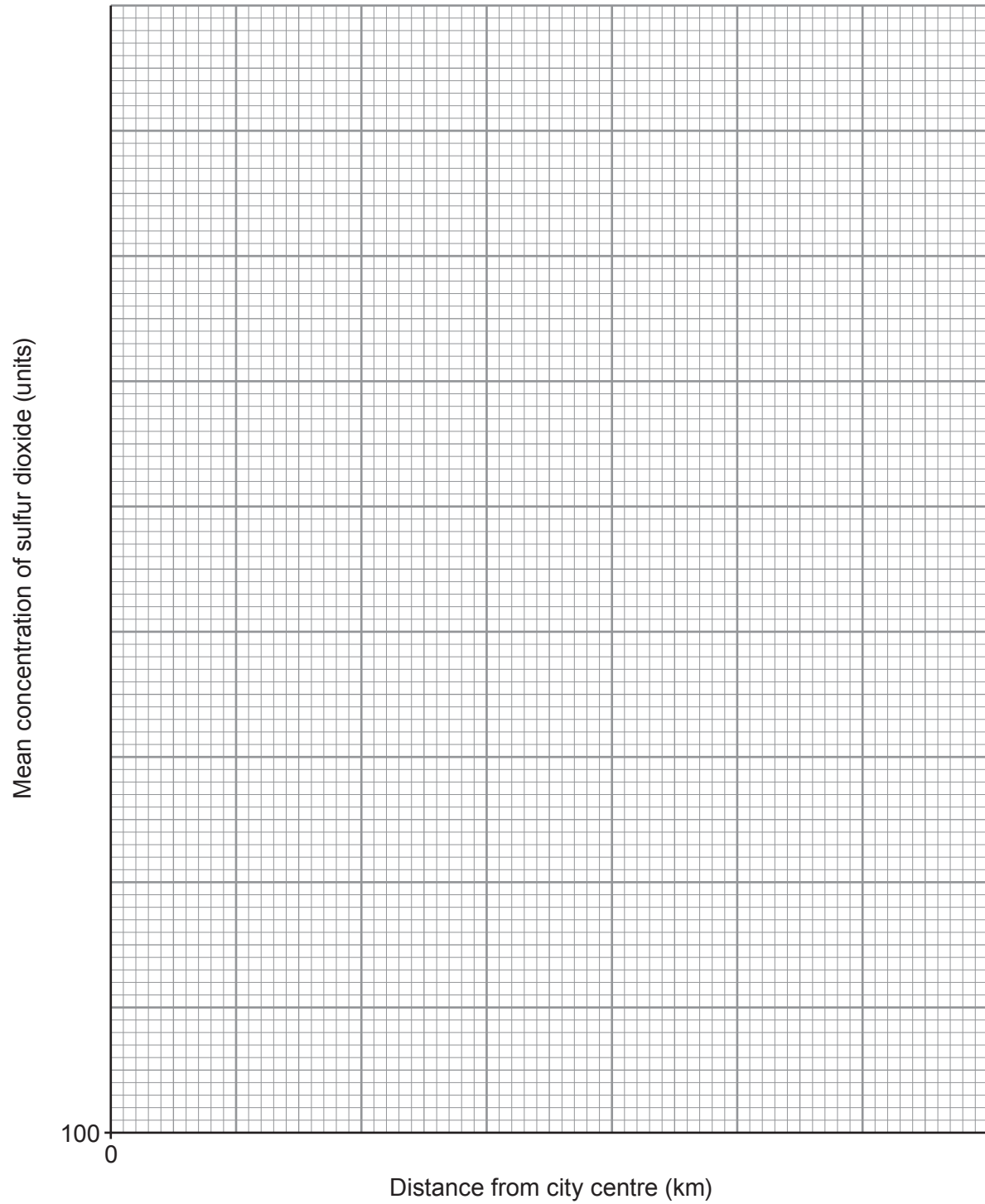
Answer **all** questions.

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 the table.

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

- (a) Use the information in the table to plot a graph showing the change in mean concentration of sulfur dioxide with the distance from the city centre on the grid opposite and draw a suitable line. [3]





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

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

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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 QER]

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- (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.

The table shown below 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.

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

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.

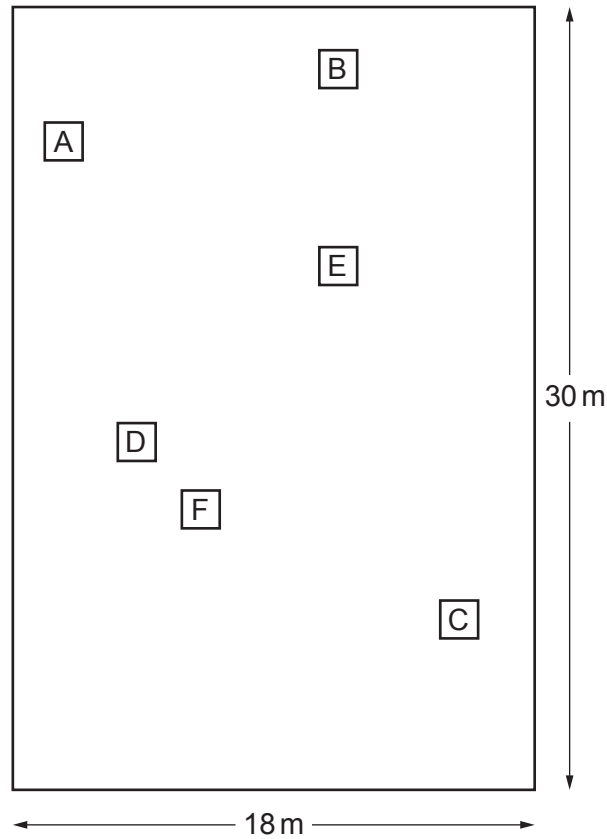
[4]

mass of carbon dioxide saved =kg

10



6. (a) Some students investigated the number of dandelion plants on a lawn. The diagram 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 the table below.

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



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

estimated number of dandelions =

- (ii) The actual number of dandelions on the lawn is 1950.
Use the formula below to calculate the percentage error of your estimate above. [2]

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

percentage error =

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

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7. Glucose homeostasis is an important biological process.

(a) Describe the role of insulin in controlling high blood glucose levels.

[4]

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(b) Describe the difference between type 1 and type 2 diabetes.

[2]

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(c) Describe the chemical test for glucose and state the colour change for a positive result.

[2]

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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) 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]

- (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]

- (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]

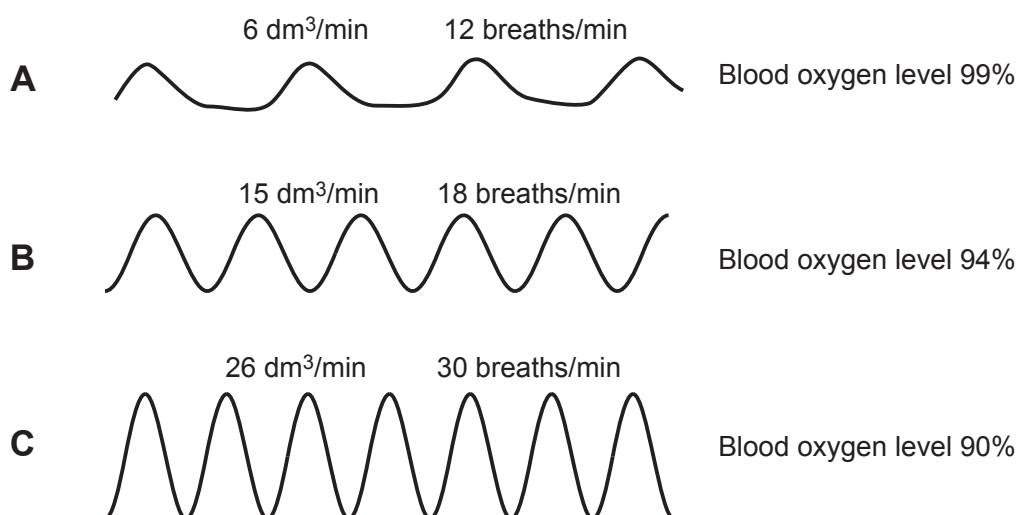


- (d) The diagram below gives information about the breathing of three different individuals, all of whom are resting.

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 dm³ per min and also the number of breaths per minute.

- (i) Use the equation:

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

to compare the volume of air breathed in per breath for each of the breathing patterns.

[4]

A B C.....

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- (ii) Compare the number of breaths per minute with blood oxygen levels in the three individuals. [2]

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END OF PAPER

16





THE PERIODIC TABLE

Group

1 2

3

4

5

6

7

0

¹ H Hydrogen 1										⁴ He Helium 2																															
⁷ Li Lithium 3		⁹ Be Beryllium 4																		¹⁹ F Fluorine 9		¹⁶ O Oxygen 8		¹⁴ N Nitrogen 7		¹² C Carbon 6		¹¹ B Boron 5		¹¹ B Boron 5		¹² C Carbon 6		¹⁴ N Nitrogen 7		¹⁶ O Oxygen 8		¹⁹ F Fluorine 9		²⁰ Ne Neon 10	
²³ Na Sodium 11		²⁴ Mg Magnesium 12																		^{35.5} Cl Chlorine 17		³² S Sulfur 16		³¹ P Phosphorus 15		²⁸ Si Silicon 14		²⁷ Al Aluminium 13		²⁷ Al Aluminium 13		²⁸ Si Silicon 14		³¹ P Phosphorus 15		³² S Sulfur 16		^{35.5} Cl Chlorine 17		⁴⁰ Ar Argon 18	
³⁹ K Potassium 19		⁴⁰ Ca Calcium 20		⁴⁵ Sc Scandium 21		⁴⁸ Ti Titanium 22		⁵¹ V Vanadium 23		⁵² Cr Chromium 24		⁵⁵ Mn Manganese 25		⁵⁶ Fe Iron 26		⁵⁹ Co Cobalt 27		⁵⁹ Ni Nickel 28		^{63.5} Cu Copper 29		⁶⁵ Zn Zinc 30		⁷⁰ Ga Gallium 31		⁷³ Ge Germanium 32		⁷⁵ As Arsenic 33		⁷⁹ Se Selenium 34		⁸⁰ Br Bromine 35		⁸⁴ Kr Krypton 36							
⁸⁶ Rb Rubidium 37		⁸⁸ Sr Strontium 38		⁸⁹ Y Yttrium 39		⁹¹ Zr Zirconium 40		⁹³ Nb Niobium 41		⁹⁶ Mo Molybdenum 42		⁹⁹ Tc Technetium 43		¹⁰¹ Ru Ruthenium 44		¹⁰³ Rh Rhodium 45		¹⁰⁶ Pd Palladium 46		¹⁰⁸ Ag Silver 47		¹¹² Cd Cadmium 48		¹¹⁵ In Indium 49		¹¹⁹ Sn Tin 50		¹²² Sb Antimony 51		¹²⁷ I Iodine 53		¹³¹ Xe Xenon 54									
¹³³ Cs Caesium 55		¹³⁷ Ba Barium 56		¹³⁹ La Lanthanum 57		¹⁷⁹ Hf Hafnium 72		¹⁸¹ Ta Tantalum 73		¹⁸⁴ W Tungsten 74		¹⁸⁶ Re Rhenium 75		¹⁹⁰ Os Osmium 76		¹⁹² Ir Iridium 77		¹⁹⁵ Pt Platinum 78		¹⁹⁷ Au Gold 79		²⁰¹ Hg Mercury 80		²⁰⁴ Tl Thallium 81		²⁰⁷ Pb Lead 82		²⁰⁹ Bi Bismuth 83		²¹⁰ Po Polonium 84		²¹⁰ At Astatine 85		²²² Rn Radon 86							
²²³ Fr Francium 87		²²⁶ Ra Radium 88		²²⁷ Ac Actinium 89																																					

Key

Key

^{A_r}

Symbol

Name

^Z

relative atomic mass

atomic number