

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

3440UB0-1



FRIDAY, 10 MAY 2024 – MORNING

APPLIED SCIENCE (Single Award)
UNIT 2: Science to Support our Lifestyles

HIGHER TIER

1 hour 30 minutes

ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

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. If you run out of space, use the additional page(s) 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 7(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.

A Periodic Table is printed on page 20.

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



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Answer **all** questions.

1. Sharon investigated the reaction between magnesium and hydrochloric acid. She added a different number of magnesium strips of the same length to five different boiling tubes. Each boiling tube contained 10 cm³ of hydrochloric acid. She recorded the temperature before adding the magnesium and after 5 minutes.

Her results are shown below.

Number of strips of magnesium	Temperature at the start (°C)	Temperature at the end (°C)
1	20.0	22.1
2	20.0	24.2
3	20.0	25.9
4	20.0	28.4
5	20.0	30.2

- (a) (i) State how Sharon could check the repeatability of her results. [1]

- (ii) State how Sharon could check the reproducibility of her results. [1]

- (b) Sharon thinks that the temperature change is proportional to the number of strips of magnesium. Explain whether you agree. [2]

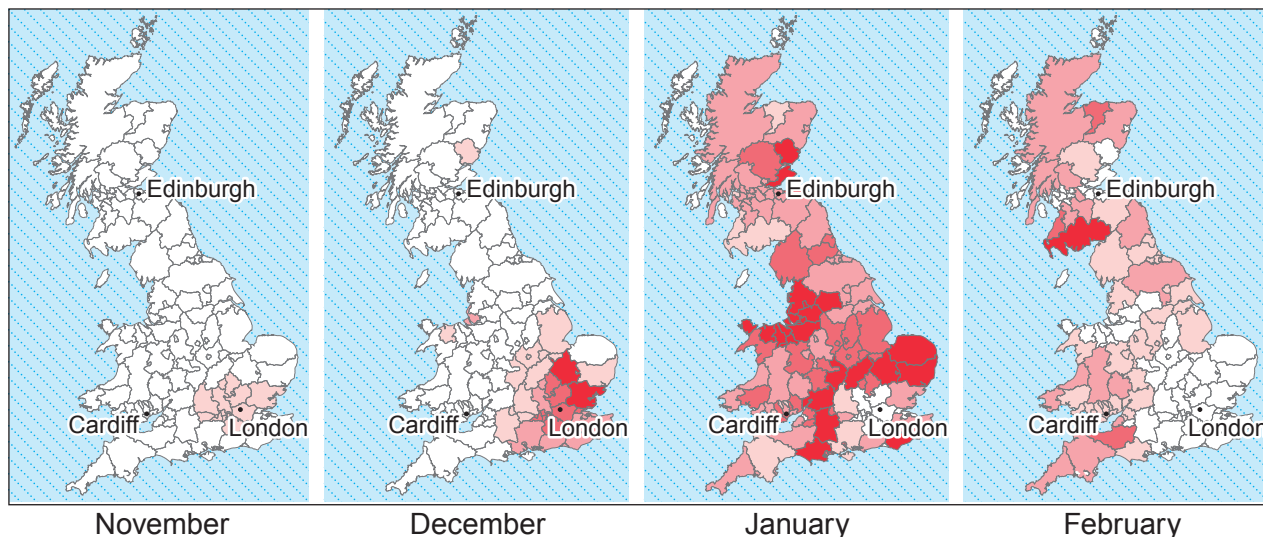
- (c) When hydrogen reacts with oxygen to form water, the temperature of the surroundings increases.

State this type of reaction, and explain this in terms of bond energies. [3]



2. Public Health England uses computers to model the potential spread of influenza (flu), in order to prepare suitable quantities of vaccines, in different counties of Great Britain.

The maps below show a potential flu outbreak over the winter months in different counties.



Key: Influenza cases per 100 000 population



- (a) State why Public Health England quotes the number of cases of flu per 100 000 of the population, for each county. [1]

- (b) Use the information in the diagram to answer the following questions.

- (i) It was expected that outbreaks of flu would start at the same time in major cities such as Cardiff, Edinburgh and London. Explain whether the data supports this. [2]



(ii) Explain why flu spreads more rapidly in a city than in a rural area. [3]

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(iii) Suggest in which month the vaccine should be given to the populations of Cardiff, Edinburgh and London. [2]

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(c) A vaccine helps to prevent people from developing flu.

(i) Explain how a vaccine works. [3]

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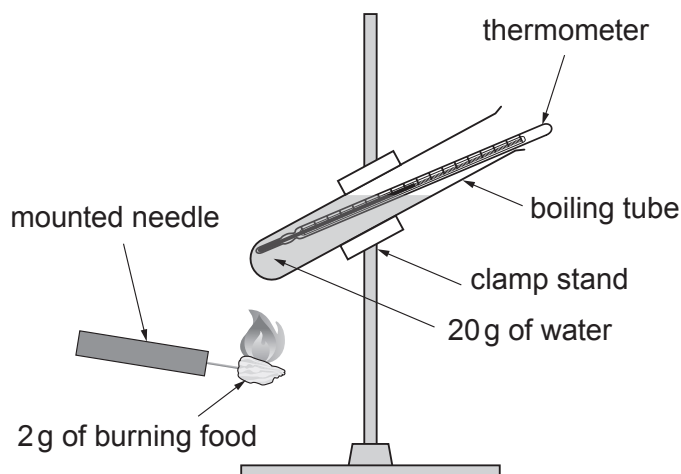
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(ii) State why it is still possible to contract flu after being vaccinated. [1]

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3. Rhian uses the following apparatus to measure the energy content of a 2 g sample of food.



The temperature increased from 20°C to 65°C. She used 20 g of water.

- (a) Use the equation:

$$\text{energy (J/g)} = \frac{\text{mass of water (g)} \times \text{temperature change (}^{\circ}\text{C)} \times 4.2}{\text{mass of food (g)}}$$

to calculate the energy supplied to the water in kJ per gram.

[3]

energy = kJ/g

- (b) The food label states that 100 g of the food contains 285 kJ.

- (i) Calculate the percentage difference between the energy supplied from Rhian's result and the value on the food label.

[3]

percentage difference =

- (ii) Explain **two** improvements that Rhian can make to improve her method, to bring her result closer to the value on the food label.

[2]

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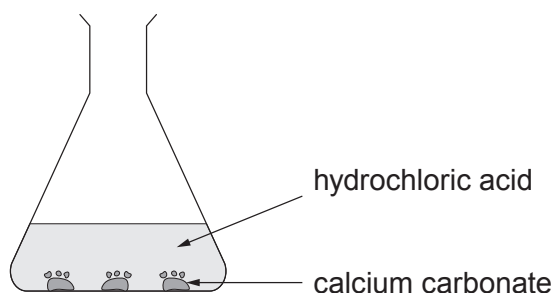
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4. Vincent carries out an investigation into the effect of surface area on the rate of reaction. Hydrochloric acid was added to calcium carbonate and the time to react completely was recorded.



He obtains the following results.

Concentration of acid (mol/dm^3)	Mass of calcium carbonate (spatulas)	Type of calcium carbonate	Temperature of hydrochloric acid ($^{\circ}\text{C}$)	Time to react completely (minutes)
2	2	marble chips	60	5
2	2	powder	20	5
1	1	powder	40	5

- (a) Explain why it is difficult to make conclusions from Vincent's table of results. [2]

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- (b) State **two** improvements that Vincent should make to his method of collecting results to reduce the uncertainty in his data. [2]

1.

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2.

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- (c) Explain, in terms of collision theory, the effect of increased surface area on the rate of reaction. [2]

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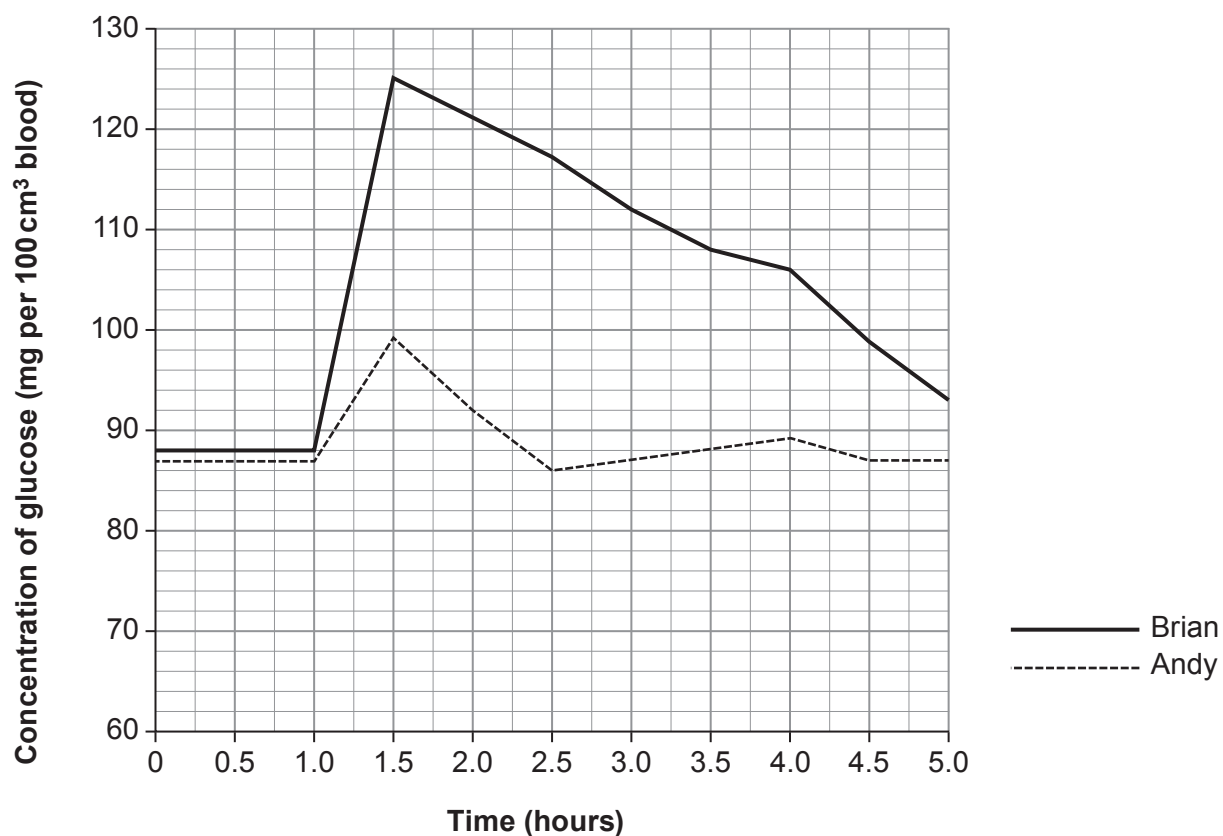


5. Two students, Brian and Andy, have their blood glucose monitored as part of a research project on glucose-based drinks.

The concentration of glucose in the blood of the two students was measured every 30 minutes for 5 hours.

The students drank the same glucose-based drink one hour after the start of the experiment.

Their results are shown below.



- (a) Explain how the results show that Brian is diabetic.

[3]

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- (b) Describe how the blood glucose level is controlled in Andy's body.

[3]

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- (c) Andy is 160 cm tall and has a mass of 70 kg. He thinks that he is classified within the normal BMI range.

The table below shows the classification of different categories of BMI.

BMI	Classification
less than 18	underweight
19–24	normal
25–29	overweight
greater than 30	obese

Use the equation:

$$\text{BMI} = \frac{\text{mass (kg)}}{\text{height (m)}^2}$$

and the table, to explain whether Andy is correct.

[4]

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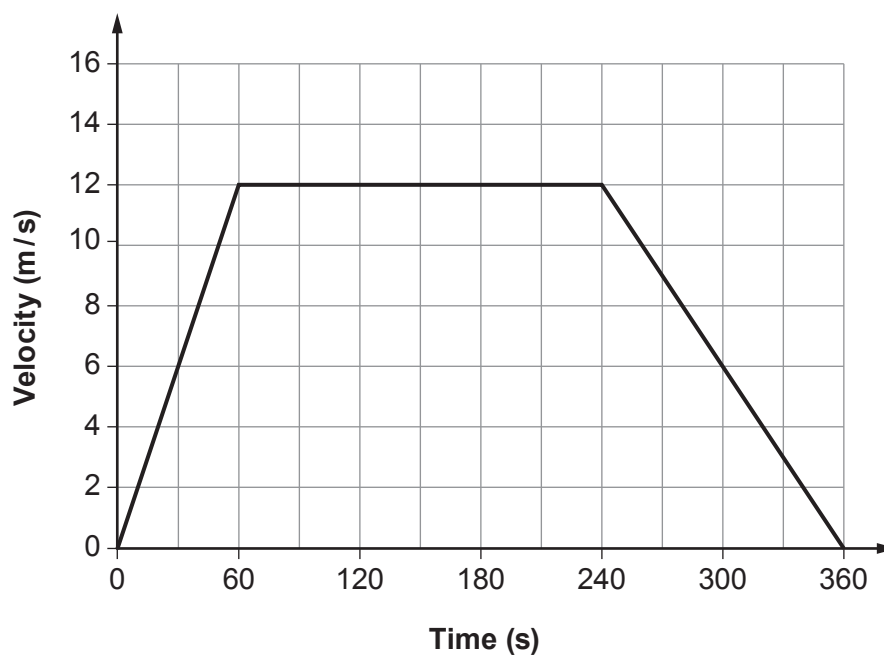
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6. The velocity-time graph for a cycle race is shown below.



Use the graph, and the following equations, to answer the questions.

$$\text{mean velocity} = \frac{\text{total distance}}{\text{time}}$$

$$\text{acceleration} = \text{gradient of velocity-time graph}$$

$$\text{distance travelled} = \text{area under the line of the velocity-time graph}$$

- (a) Calculate the acceleration between 0 and 60 seconds.

[2]

acceleration = unit =



(b) Calculate the total distance travelled.

[4]

total distance = m

(c) Calculate the mean velocity.

[3]

mean velocity = m/s

9



[6 QER]

[2]

8. Vitamin B12 deficiency can arise as the result of a genetic condition, due to the recessive allele, **b**.

Jason and Kylie both have a heterozygous genotype for vitamin B12 deficiency and they are concerned that their future children may have the condition.

- (a) Define the following terms.

- (i) Heterozygous genotype.

[2]

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- (ii) Recessive allele.

[2]

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- (b) Complete the Punnett square to calculate the probability of Jason and Kylie producing an unaffected child. [3]

probability =

7

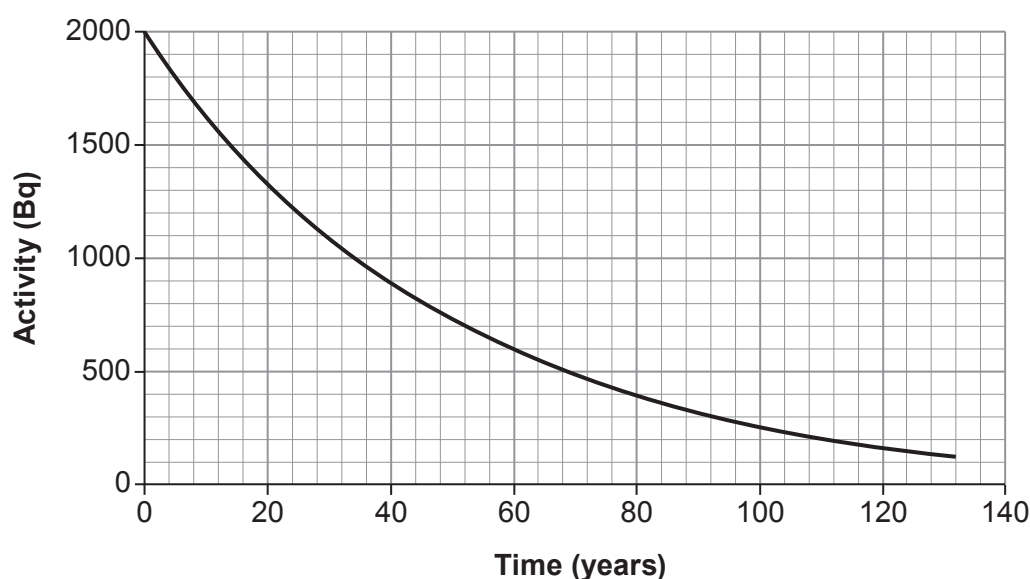


9. An explosion occurred at the Chernobyl nuclear power station on April 26th, 1986, releasing radioactive fallout containing caesium-137 (Cs-137). This fallout spread over Northern Europe, including the UK.

There was a risk that Cs-137 would enter the food chain as a result of sheep eating contaminated grass in highland areas of England and Wales. To prevent this, the UK government announced that sheep from contaminated areas would not be sold for human consumption until levels became safe.

The sheep exposed in 1986 were found to produce a mean activity level of **1600 Bq**. Sheep could only enter the food chain once the activity level had dropped below 1000 Bq. The restrictions were removed in 2012.

The decay curve for Cs-137, starting at 2000 Bq, is shown below.



- (a) Use data from the graph to explain why it was safe to remove the restrictions in 2012.

[3]

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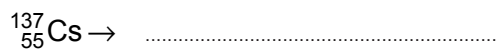
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- (b) The sheep have no detectable radiation after the Cs-137 decayed for 5 half-lives. Use data from the graph to calculate the year this would occur. [3]

year =

- (c) Cs-137 undergoes beta decay to form an isotope of barium (Ba). Complete the decay equation for Cs-137. [2]



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THE PERIODIC TABLE

1 2 3 4 5 6 7 0

Group

1 H Hydrogen 1 4 He Helium 2																			
7 Li Lithium 3	9 Be Beryllium 4							19 F Fluorine 9	20 Ne Neon 10										
23 Na Sodium 11	24 Mg Magnesium 12							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																	

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