

Surname	Centre Number	Candidate Number
First name(s)		0



**GCSE**

3445UC0-1



**TUESDAY, 16 MAY 2023 – MORNING**

**APPLIED SCIENCE (Double Award)  
UNIT 3: Food, Materials and Processes**

**HIGHER TIER**

1 hour 30 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	5	
2.	14	
3.	10	
4.	13	
5.	13	
6.	12	
7.	8	
<b>Total</b>	<b>75</b>	

**ADDITIONAL MATERIALS**

In addition to this examination paper, you will require a 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 3(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.

The Periodic Table is printed on the back cover of the examination paper.



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Answer **all** questions in the spaces provided.

1. (a) State, in terms of electrons, the difference between ionic and covalent bonding. [2]

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- (b) When magnesium reacts with oxygen, the ionic compound magnesium oxide is formed.

- (i) The outer electrons of magnesium and oxygen are shown below. Draw arrows to show the transfer of electrons when magnesium oxide is formed. [1]



- (ii) State the charges on the ions formed [2]

Mg ..... O .....



2. Inos is a Welsh caravan manufacturer based in Denbighshire. The materials used to build modern caravans are very different to those used in early caravans.

**Table 1** shows how the materials used in manufacturing the body of a caravan have changed over time.

Year	Materials used
1920	wood
1950	steel and wood
1970	aluminium and wood
2015	glass reinforced plastic (GRP), polyester

**Table 2** shows information about some of the materials used to make the body of caravans.

Material	Density (g/cm <sup>3</sup> )	Stiffness (GPa)	Melting Point (°C)	Strength (MPa)	Is it brittle?	Does it corrode?
wood	0.6			1 000	No	no but rots when wet
steel	7.8	210	1 357	1 200	No	yes producing rust
aluminium	2.7	69	660	90	No	yes producing a resistant coating
GRP	glass fibres	2.4	1 400	3 500	Yes	No
	epoxy resin	1.5		60	Yes	No
polyester	1.9	150	121	250	Yes	No

Use the information above to answer the following questions.

- (a) Describe how the weight and strength of caravan bodies changed between 1920 and 1970. [4]

Weight: .....

.....

.....

Strength: .....

.....

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(b) (i) State **two** advantages of the materials used in 2015 over those used previously. [2]

1. ....

2. ....

(ii) State **one** disadvantage of the materials used in 2015 over those used previously. [1]

.....

(c) GRP is a common composite material, in which glass fibres are mixed with epoxy resin.

(i) A GRP panel contains a volume of 300 cm<sup>3</sup> of epoxy resin.

Use the equation: [3]

mass = density × volume

to calculate the mass of the resin.

mass = ..... g

(ii) I. State the strength of glass fibre in N/cm<sup>2</sup>. [2]

(1 MPa = 100 N/cm<sup>2</sup>)

strength = ..... N/cm<sup>2</sup>

II. The cross-sectional area (csa) of a glass fibre is 0.00015 cm<sup>2</sup>.

Use your answer in part (c)(ii)I. and the equation:

force = strength × csa

to calculate the force required to break it. [2]

force = ..... N

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14

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3. Ash dieback disease is a fungal infection caused by a fungus called *Hymenoscyphus fraxineus* that is common in ash trees in Wales.

The disease causes the leaves to blacken and wilt, so eventually the ash tree has no leaves.

The photographs show healthy ash leaves and those affected by ash dieback.



- (a) Describe the process of photosynthesis **and** explain why dieback disease affects the growth of the ash tree. [4]

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4. Nuclear reactor 3 at the Hunterston B power station was shut down after cracks in graphite moderator bricks were found to be growing faster than expected. The Office for Nuclear Regulation (ONR) raised concerns over the number of cracks in the joints between the graphite moderator bricks in the core. An unusual event, such as an earthquake, might move the graphite bricks so the control rod channels could become blocked.

- (a) (i) Explain the purpose of the graphite moderator in a nuclear reactor. [2]

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- (ii) Explain why blocked control rod channels are very dangerous. [3]

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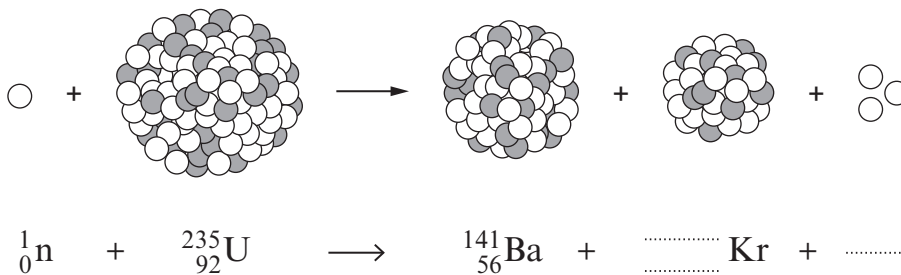
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- (b) The diagram shows a reaction in a nuclear reactor and part of the reaction equation.

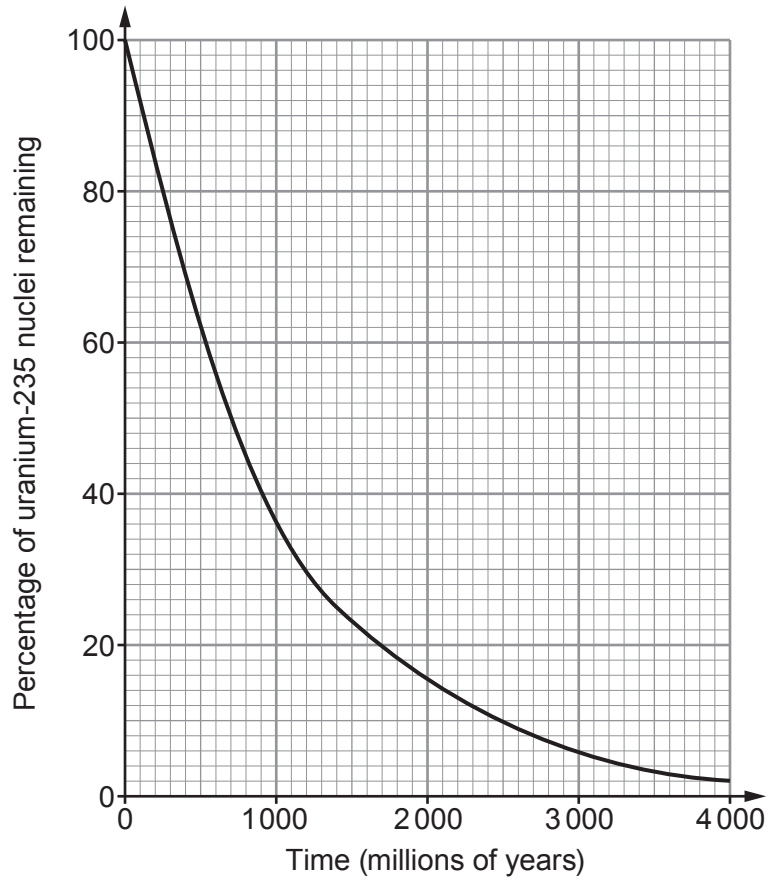


Complete the equation.

[3]



- (c) It is likely that Hunterston B power station will be decommissioned. When it is, the uranium-235 in the fuel rods will continue to decay at the rate shown in the graph below.



- (i) Add lines to the graph to calculate the half-life of uranium-235. [2]

half-life = ..... million years

- (ii) Uranium-235 becomes safe once its activity drops to 1/32 of its original value. Calculate the time it takes to drop to this value. [3]

time = ..... years

13

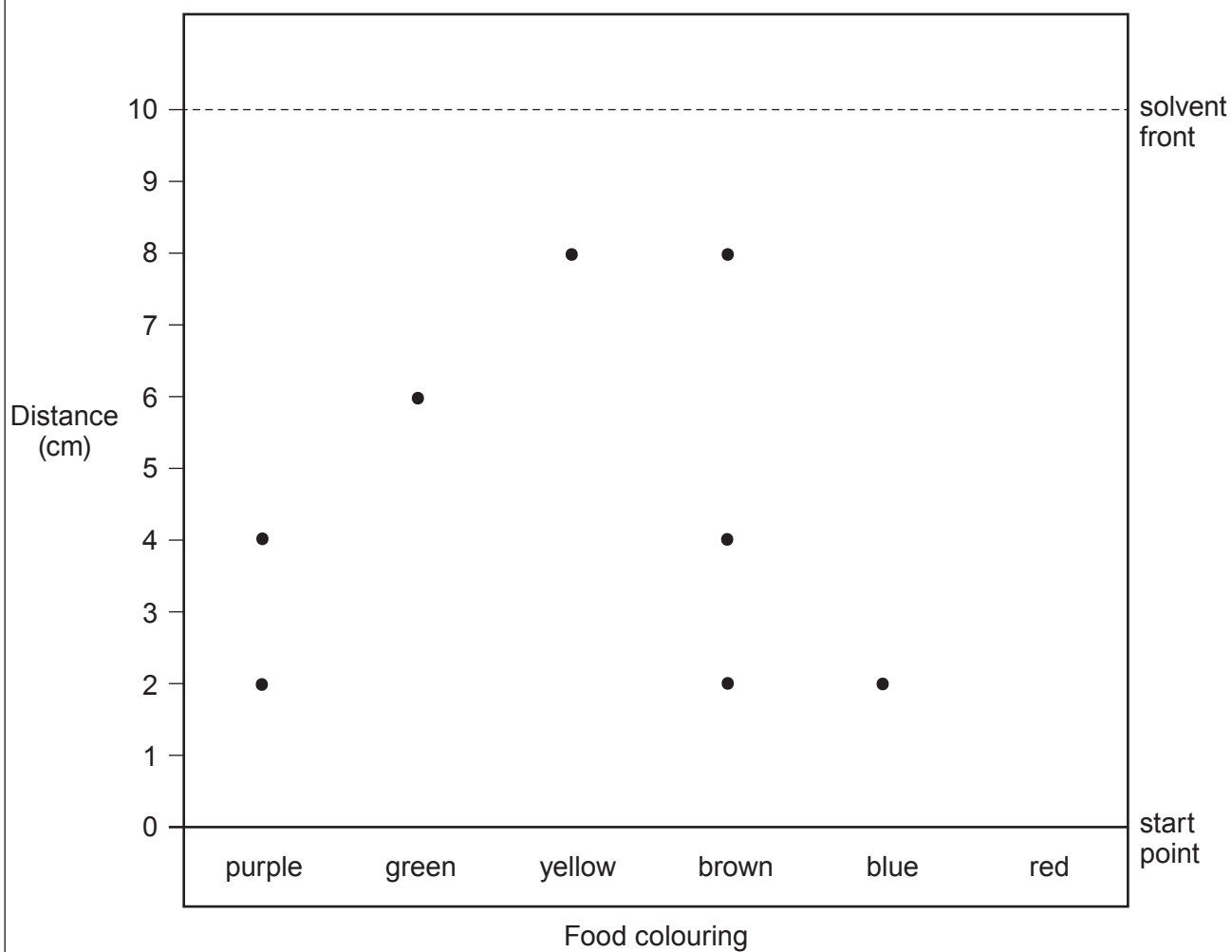
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5. Analytical scientists work in a wide range of different industries and agencies.

- (a) The Food Standards Agency (FSA) commissioned a project to detect the coloured dyes used in food colourings.

The diagram below shows a chromatogram of different food colourings.



- (i) The result for the dye in the red food colouring is not included in the diagram. The  $R_f$  value for red colouring is 0.4.

Use the equation:

$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$

to calculate the distance moved by the dye in the red colouring on this chromatogram **and** add it to the diagram.

[3]

distance travelled = ..... cm

- (ii) It was claimed that brown colouring was not a combination of other coloured dyes. Explain whether you agree with this claim. [2]

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- (iii) Explain, in terms of the mobile and stationary phases, why the molecules in purple colouring move different distances along the chromatogram. [3]

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(b) Qualitative chemical testing is used to identify the ions in compounds.

(i) Six unlabelled bottles each contained a solution of one of the compounds in the box below.

copper(II) sulfate	sodium carbonate	lithium carbonate
sodium chloride	potassium sulfate	calcium iodide

I. State which compounds would produce a yellow flame in a flame test. [1]

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II. State which compounds would produce bubbles of gas when added to hydrochloric acid. [1]

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(ii) A technician has a colourless solution in an unlabelled bottle. He suspects it is metal chloride. Describe a test that could be carried out to confirm that the solution is a chloride, and give the expected result. [3]

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6. Levels of bacteria in milk are routinely monitored.

(a) Most milk sold to consumers is pasteurised and homogenised.

(i) Explain why milk is pasteurised. [2]

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(ii) Describe the process of homogenisation and explain why it is carried out. [4]

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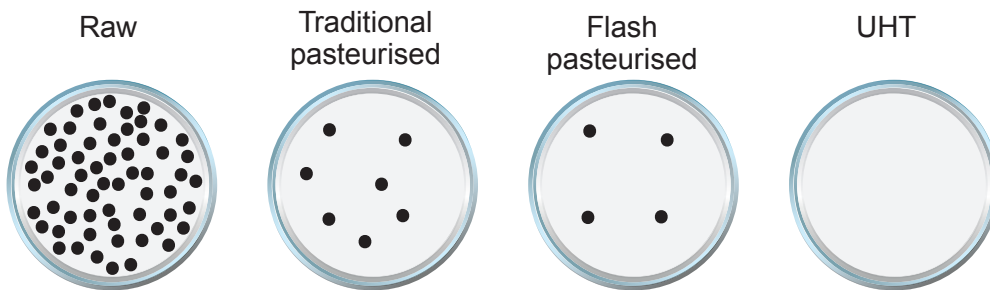
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(b) Scientists investigated four types of milk. They monitored the growth of bacterial colonies on agar plates using 0.1 cm<sup>3</sup> from each type of milk over two days. Their results are shown below.



Type of milk	Heat treatment	Number of bacterial colonies in a 40 cm <sup>3</sup> serving
raw	none	24 000
traditional pasteurised	63°C for 30 minutes	.....
flash pasteurised	78°C for 35 seconds	1600
ultra-high temperature pasteurised (UHT)	135°C for 2 seconds	none



(i) Complete the table.

[2]

Space for working

(ii) Unopened UHT milk can be stored on supermarket shelves at room temperature for six months but unopened pasteurised milk must be stored in a refrigerator at 4°C or below for no longer than seven days. Explain these differences. [4]

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7. A student investigated the reaction between hydrochloric acid (HCl) and calcium carbonate ( $\text{CaCO}_3$ ). She measured the volume of gas produced for different concentrations of acid after 60 seconds.

She started each reaction at the same temperature, with the same mass of calcium carbonate and the same volume of acid. The acid was in excess each time.

The table below shows the time taken to produce  $60\text{ cm}^3$  of  $\text{CO}_2$  for each concentration of HCl.

Concentration of HCl ( $\text{mol/dm}^3$ )	Time to produce $60\text{ cm}^3$ of $\text{CO}_2$ (s)	Mean rate of reaction ( $\text{cm}^3/\text{s}$ )
0.5	234	0.26
1.0	118	0.51
2.0	58	.....

- (a) (i) **Complete** the table to two significant figures. [2]
- (ii) Estimate the time taken to produce  $60\text{ cm}^3$  of carbon dioxide if a concentration of  $4.0\text{ mol/dm}^3$  HCl is used. [1]

time = ..... s



- (b) (i) State and explain, in terms of particles, the effect of increasing acid concentration on the rate of reaction. [3]

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- (ii) The student noticed that when the experiments ran for 10 minutes, she obtained the same volume of carbon dioxide in each case.

Explain her observation. [2]

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# THE PERIODIC TABLE

Group      1      2      3      4      5      6      7      0

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

## Key

