Surname	Centre Number	Candidate Number
Other Names		0

GCSE

3445UC0-1

S19-3445UC0-1

TUESDAY, 14 MAY 2019 – AFTERNOON

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.	**7**	
2.	**12**	
3.	**6**	
4.	**13**	
5.	**18**	
6.	**6**	
7.	**13**	
Total	**75**	

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ADDITIONAL MATERIALS

A calculator.

INSTRUCTIONS TO CANDIDATES

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

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** is a quality of extended response (QER) question where your writing skills will be assessed.

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

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

1. Photosynthesis is the process by which green plants produce their own glucose.

(a) Complete the word equation for photosynthesis below. [1]

..... + ... → glucose + oxygen

(b) State **three** different ways green plants use the glucose they produce. [3]

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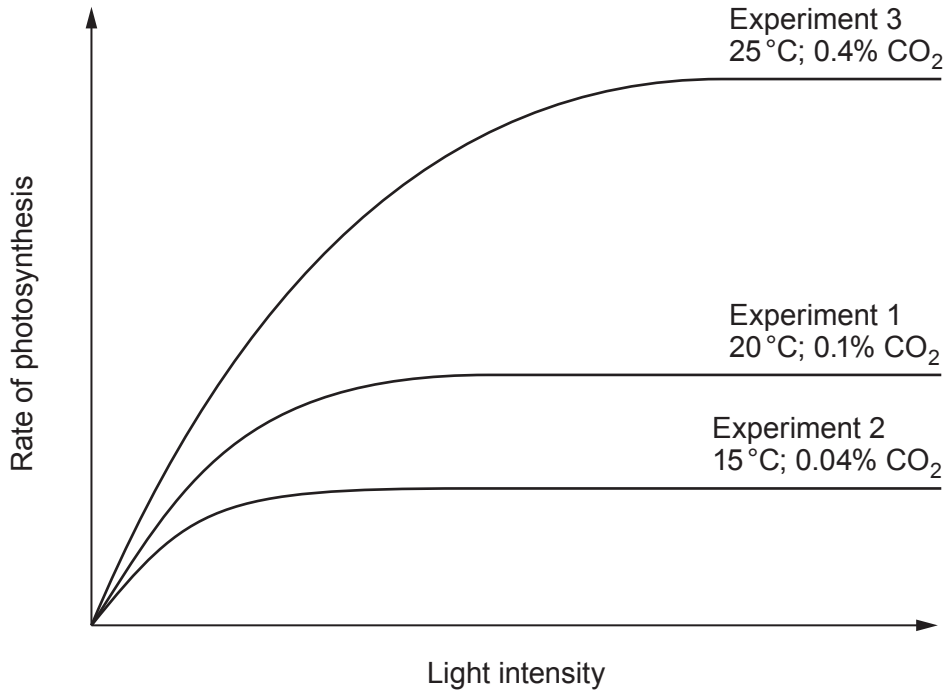
(c) The rate of photosynthesis is affected by light intensity, temperature and carbon dioxide concentration as shown in the graph below.



Use the information in the graph to describe how differences in light intensity, temperature and carbon dioxide concentration affect the rate of photosynthesis. [3]

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2. *(a)* Food poisoning is a notifiable disease in Wales. Doctors are required to report every case of food poisoning.

(i) Explain how some bacteria cause food poisoning. [2]

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(ii) State **two** symptoms of food poisoning. [1]

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(iii) State **two** different types of precaution that can be taken when **preparing** food to reduce the risk of food poisoning. [2]

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(b) **Figure 1** shows the number and rate of reported cases of food poisoning in Wales between 1992 and 2016.

Figure 1

Year	Total number of reported cases	Rate (number per 100 000 population)
1992	3 590	124.5
1998	5 946	205.0
2000	4 716	162.2
2006	4 301	145.4
2010	4 980	165.6
2014	4 516	146.1
2016	4 504	145.7

The percentage of reported cases of food poisoning during each quarter of a year is shown in **Figure 2**.

Figure 2

Quarter	% of total for year		
	2012	2014	2016
Jan-Mar	18	17	19
Apr-Jun	26	26	25
Jul-Sep	32	32	33
Oct-Dec	24	25	23

Figure 3 shows the rate of food poisoning amongst females by age group in 2016.

Figure 3

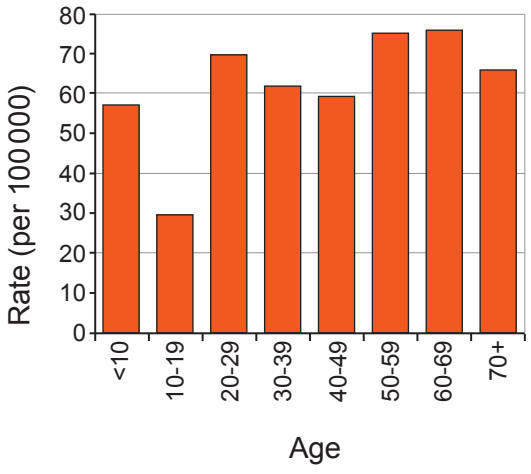

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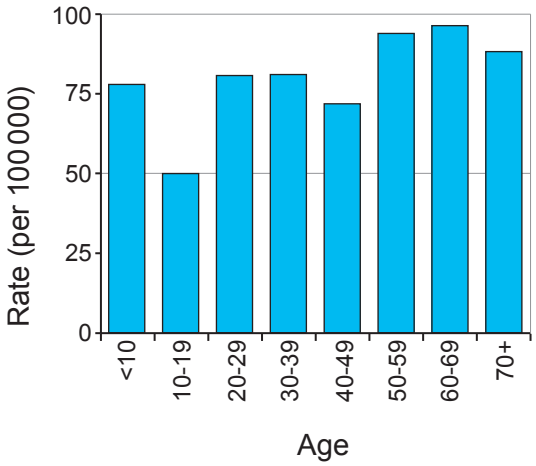
Figure 4 shows the rate of food poisoning amongst males by age group in 2016.

Figure 4



Use the data in **Figures 1 to 4** to answer the following questions.

(i) Since 1998, egg-laying hens have been vaccinated against a species of *Salmonella*. Explain how this has affected the number of reported cases of food poisoning. [2]

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(ii) Explain the variation in the percentage of reported cases of food poisoning in each of the quarters in a year. [3]

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(iii) It is suggested that the rate of food poisoning does not depend on gender or age. Explain whether this suggestion is confirmed by the data. [2]

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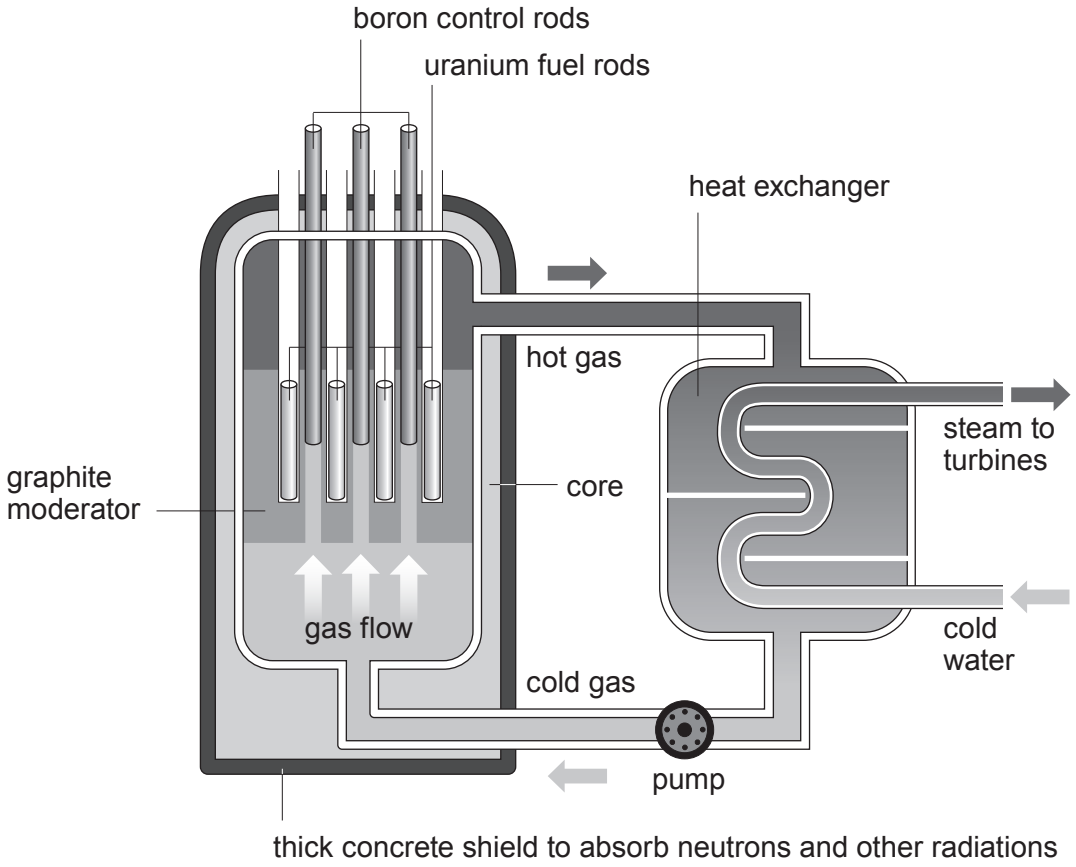
3. The diagram shows the structure of a nuclear reactor. The boron control rods and pump are powered by mains electricity.



Explain why the reactor cannot function safely during an interruption to the supply of electricity in a power cut. Explain how a nuclear accident is prevented and the consequences of a nuclear accident. [6 QER]

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Turn over.

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4. Colorimetry is a method used to determine the concentration of haemoglobin in blood.

The table below shows how the absorbance depends on the concentration of haemoglobin. One mean value is missing.

Concentration of haemoglobin (mg/100 cm^3)	Absorbance (units)				
	Test 1	**Test 2**	**Test 3**	**Test 4**	**Mean**
50	0.20	0.21	0.20	0.19	0.20
100	0.37	0.41	0.63	0.39	
150	0.60	0.61	0.60	0.60	0.60
200	0.80	0.79	0.81	0.83	0.81
250	0.99	0.99	0.99	0.99	0.99

(a) Rhodri and Dafydd calculated the missing mean absorbance value. Rhodri calculated a mean value of 0.45 and Dafydd calculated a value of 0.39. Show how both values were obtained and explain which is the better method of calculating a mean. [3]

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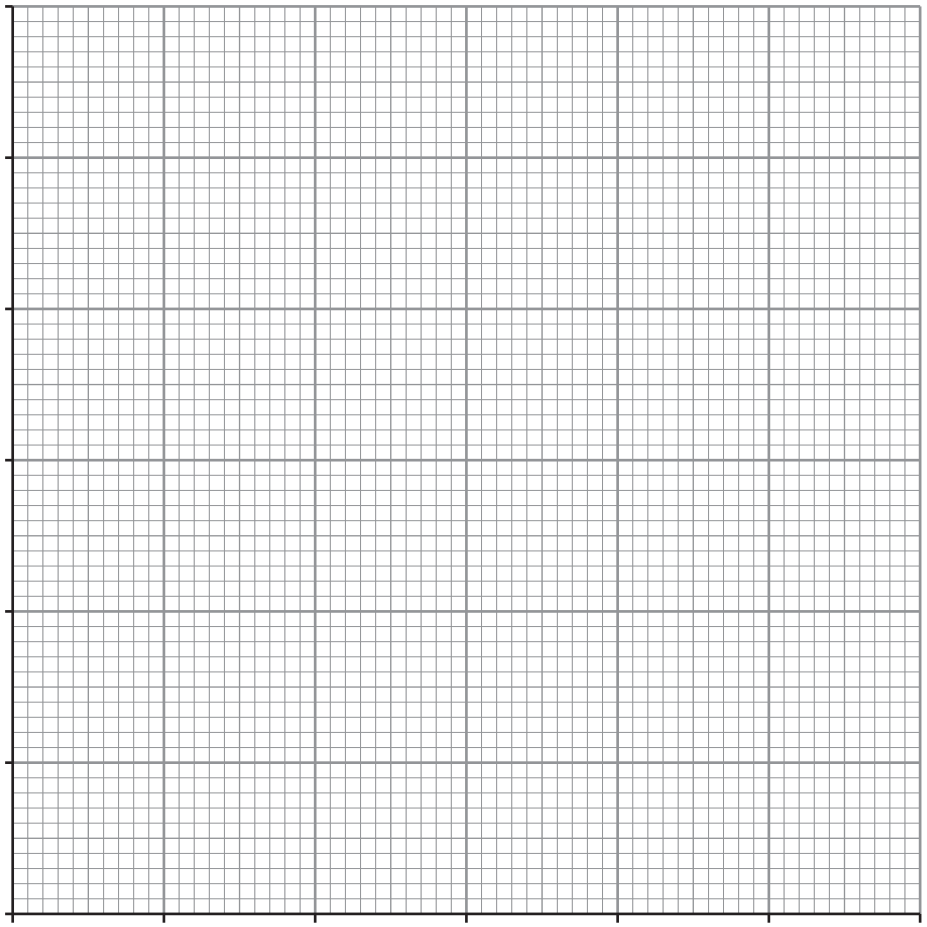
(b) (i) Use the data in the table to plot a graph of mean absorbance against concentration of haemoglobin on the grid below and draw a suitable line. [4]



(ii) Describe the relationship between absorbance and concentration of haemoglobin. [2]

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(c) One part of the structure of haemoglobin has the chemical formula $FeN_4C_6H_{18}O_4$.

(i) Calculate the relative molecular mass (M_r) of this part of haemoglobin. [2]

M_r = ...

(ii) Calculate the total mass of this part of haemoglobin in 2.5 moles. [2]

Mass = ...

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5. Hydrogen peroxide, H_2O_2, has anti-fungal properties and can be used to preserve milk. Before the milk is used to make cheese the H_2O_2 needs to be removed.

Hydrogen peroxide decomposes to form water and oxygen gas as shown below.

hydrogen peroxide $\longrightarrow$ water + oxygen

(a) Write a balanced symbol equation for the reaction. [2]

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(b) The rate of this reaction is very slow at room temperature without a catalyst.

A student suggests that the rate of reaction can be increased by adding a catalyst or increasing the temperature.

State **two** variables that should be controlled in an experiment to determine the effect of temperature on the rate of decomposition of hydrogen peroxide. [2]

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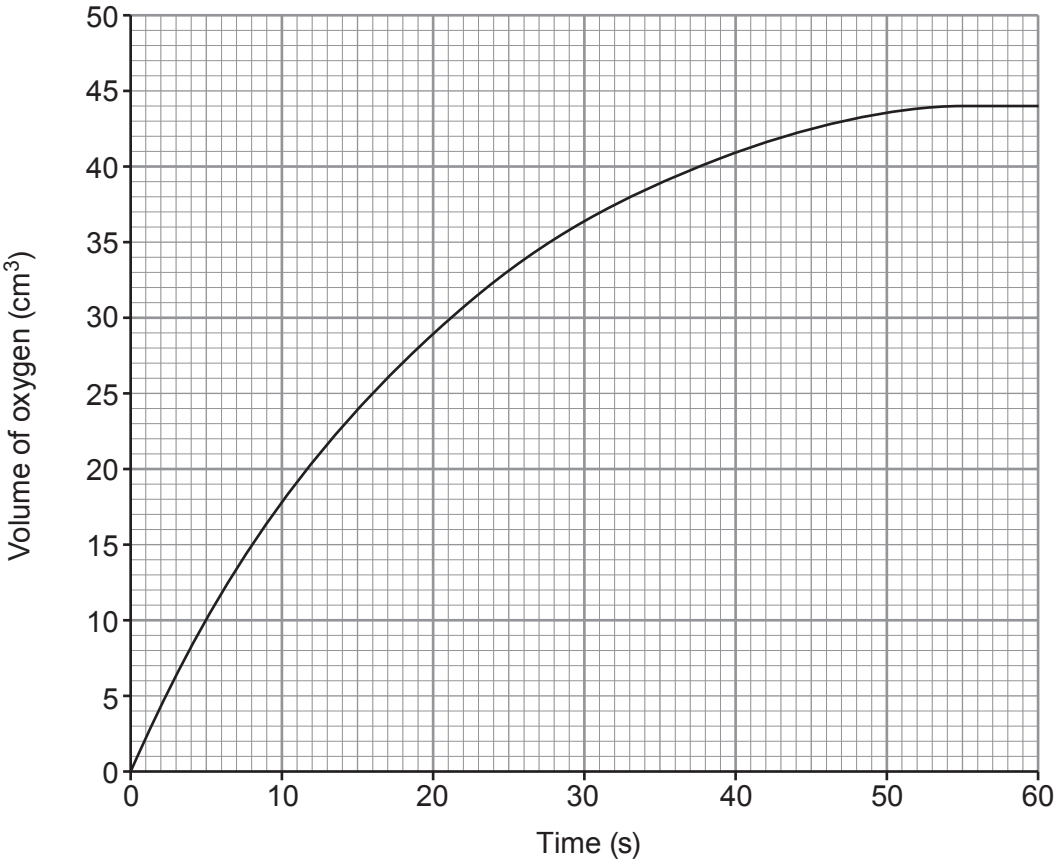
(c) In an investigation, the student measured the volume of oxygen collected in a measuring cylinder every 10 seconds for a total of 60 seconds.

The graph below shows the results at 22°C.



(i) Calculate the rate of reaction at 30 seconds by drawing a tangent. [3]

Rate = ... cm^3/s

(ii) The rate of reaction at 5 seconds was $2\,cm^3/s$. Explain, using particle theory, why the rate of decomposition was less at 30 seconds. [2]

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(iii) The experiment was repeated at 35°C. **Add** a line to the grid to show the results you would expect. [2]

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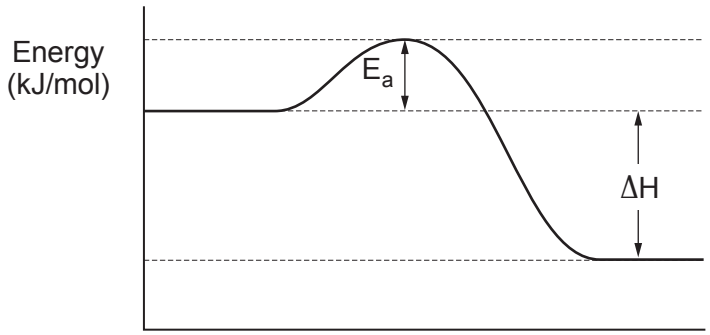
(d) The energy changes during the decomposition of hydrogen peroxide without a catalyst are shown below. The energy E_a is 75 kJ/mol and ΔH is -196.1 kJ/mol.



(i) Explain what type of reaction is shown by this energy diagram. [2]

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(ii) A student states that the values of E_a and ΔH do not change when a catalyst is used. Explain whether you agree with the student. [3]

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(e) The rate of a chemical reaction doubles if the temperature is increased by 10°C.
At 6°C, milk undergoes a chemical reaction that makes it go sour in 6 days. Calculate how long it will take milk to go sour at 36°C. [2]

Time = ...

18

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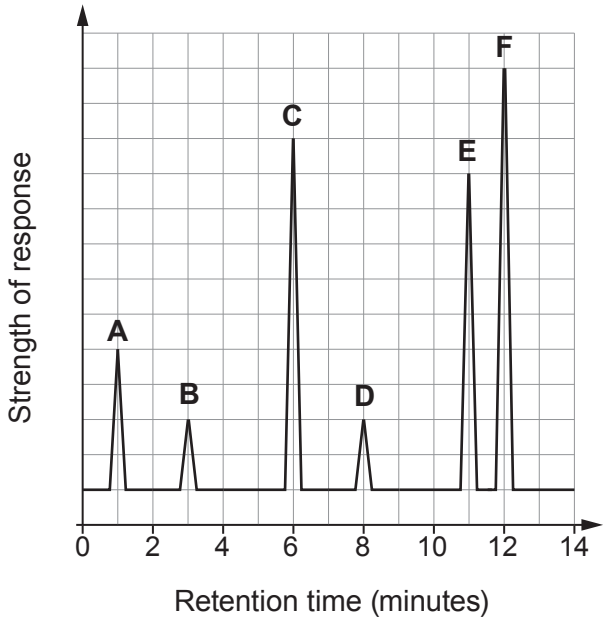
6. Chromatography is an important technique used by analytical chemists to separate substances found in mixtures.

Gas chromatography can be used to show:

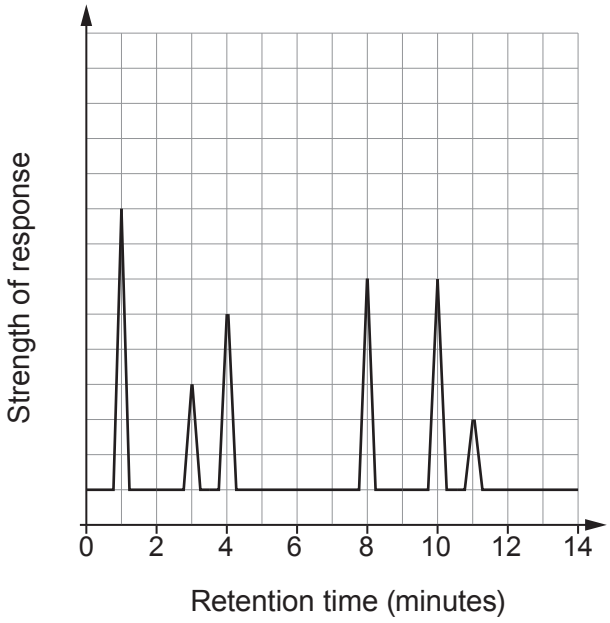
- the number of compounds
- the identity of each compound
- how much of each compound is present in a mixture.

The diagrams below show the gas chromatograms from **mixtures 1** and **2**. Each mixture contains more than one compound. The compounds in **mixture 1** are labelled **A-F**.

Mixture 1



Mixture 2



(a) Use the chromatograms to compare the similarities and differences between **mixtures 1** and **2**. [4]

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(b) Explain in terms of molecules why **F** has the greatest retention time. [2]

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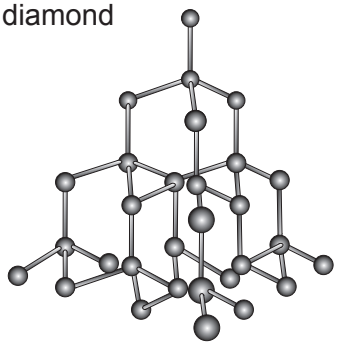
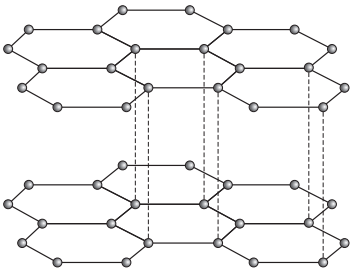
7. Allotropes of carbon include diamond, graphite, graphene, carbon fibres, fullerenes and carbon nanotubes.

(a) The structures of diamond and graphite are shown below.

diamond



graphite



Answer the following questions with reference to the bonding in diamond and graphite.

(i) Explain why diamond is an insulator of electricity but graphite is a conductor. [4]

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(ii) Explain why graphite is soft and slippery but diamond is hard. [3]

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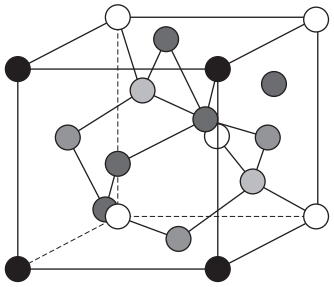
(b) A unit cubic cell of diamond is shown below.



Each side has dimensions of 0.36 nm (1 nm = 10^{-9} m).

The number of carbon atoms in a cubic cell is 8.

The mass of a carbon atom is 2×10^{-26} kg.

Use the information above and the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

to calculate the density of this unit cubic cell of diamond to 2 significant figures. [4]

Density = ... kg/m^3

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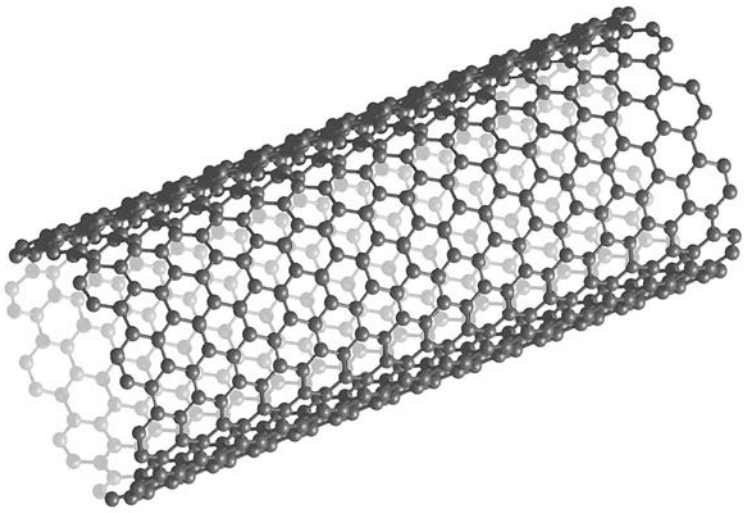
(c) A carbon nanotube is shown below.



Some properties of these nanotubes are compared with three other materials in the table below.

Material	Tensile strength (MPa)	Density (g/cm^3)
stainless steel	505	8.00
aluminium	572	2.81
Kevlar	3620	1.44
carbon nanotube	62000	1.34

Explain why carbon nanotubes are likely to replace materials such as steel and aluminium in the manufacture of power lines. [2]

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END OF PAPER

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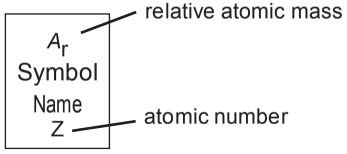
THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											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											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	128 Te Tellurium 52	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



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