

Surname	Centre Number	Candidate Number
First name(s)		0



GCSE

3445UC0-1



FRIDAY, 10 MAY 2024 – 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.	9	
2.	10	
3.	7	
4.	11	
5.	7	
6.	13	
7.	8	
8.	10	
Total	75	

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 **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.

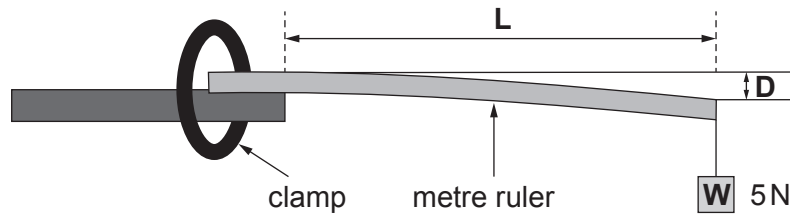
The Periodic Table is printed on the back cover of the examination paper.



JUN243445UC0101

Answer **all** questions.

1. Students are investigating how the stiffness of a wooden metre ruler depends on its length. They use the apparatus shown below. The weight, **W**, on the end of the ruler remains constant at 5 N.



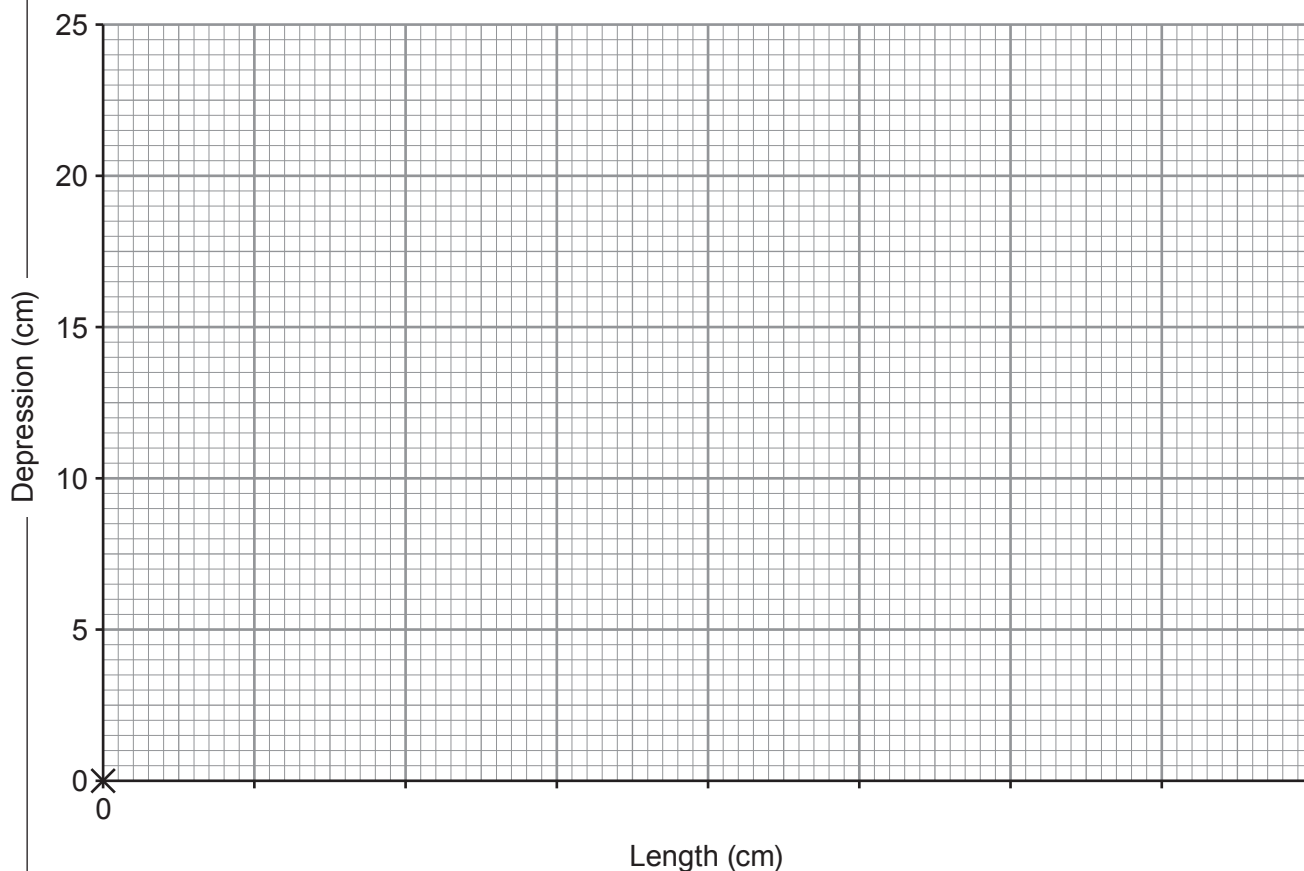
The length, **L**, is varied. For each length, **L**, the depression, **D**, of the end of the ruler is measured.

Their results are shown in the table below.

Length L (cm)	Depression D (cm)
0	0.0
30	1.0
40	3.0
50	6.0
60	10.0
70	15.0
80	22.0



- (a) Plot the data on the grid below and draw a smooth curve. The point (0,0) has already been plotted for you. [4]



- (b) It was expected that depression, **D**, would be directly proportional to length, **L**. Explain whether the graph shows a proportional relationship. [2]

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- (c) Use information in the table and the equation:

$$\text{stiffness} = \frac{\text{weight}}{\text{depression}}$$

to calculate the stiffness of the ruler at a length of 50 cm. [3]

stiffness = N/cm



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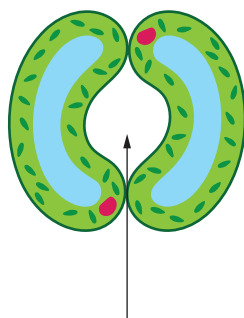
2. Photosynthesis is the process by which plants make food from water and carbon dioxide.

(a) Stomata are an important part of the leaf. In many plants, stomata remain open during the day and closed at night.

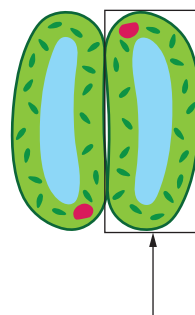
(i) Label the diagram below.

[2]

Open by day



Closed by night



(ii) State **two** functions of stomata.

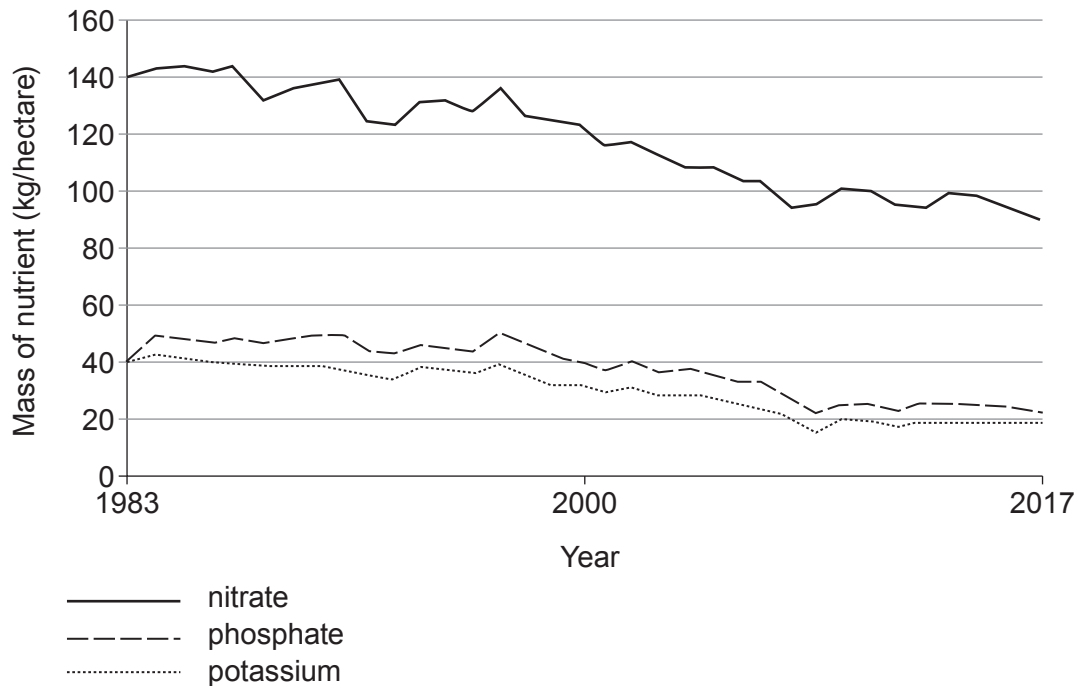
[2]

1.
2.



- (b) Healthy plants require a supply of nutrients. Many farmers use artificial fertilisers to supply these nutrients to the soil.

The graph shows the mass of different nutrients applied to agricultural land between 1983 and 2017.



Use the data from the graph to answer the following questions.

- (i) It is claimed that the use of nitrate fertilisers halved between 1983 and 2017. Use the graph to explain whether you agree.

[3]

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- (ii) The total land area of Wales is approximately 2 100 000 hectares.
60 % of this land is used for farming.

I. Calculate the area of land used for farming in Wales. [1]

area = hectares

II. Calculate the total mass of phosphates used in farming in Wales in 1983. [2]

mass = kg



3. Qualitative analysis is used to identify the ions present in a compound.

- (a) The table shows the observations from chemical tests carried out on solutions of two compounds.

Sample	Test	Observation	Name of compound tested
1	add dilute acid	colourless gas evolved which turns limewater milky	
	flame test	lilac	
2	flame test	lilac	
	add nitric acid then silver nitrate	white precipitate	

Complete the table.

[3]

- (b) Another compound was identified as calcium sulfate (CaSO_4).
Use the information below and the equation:

$$\text{number of moles} = \frac{\text{mass}}{M_r}$$

to calculate the number of moles of calcium sulfate present in 34 g of powder.

[4]

Element	A_r
Calcium	40
Sulfur	32
Oxygen	16

number of moles =



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4. Yeast is used in fermentation to make the ethanol in wine.

(a) Write down the word equation for fermentation. [1]

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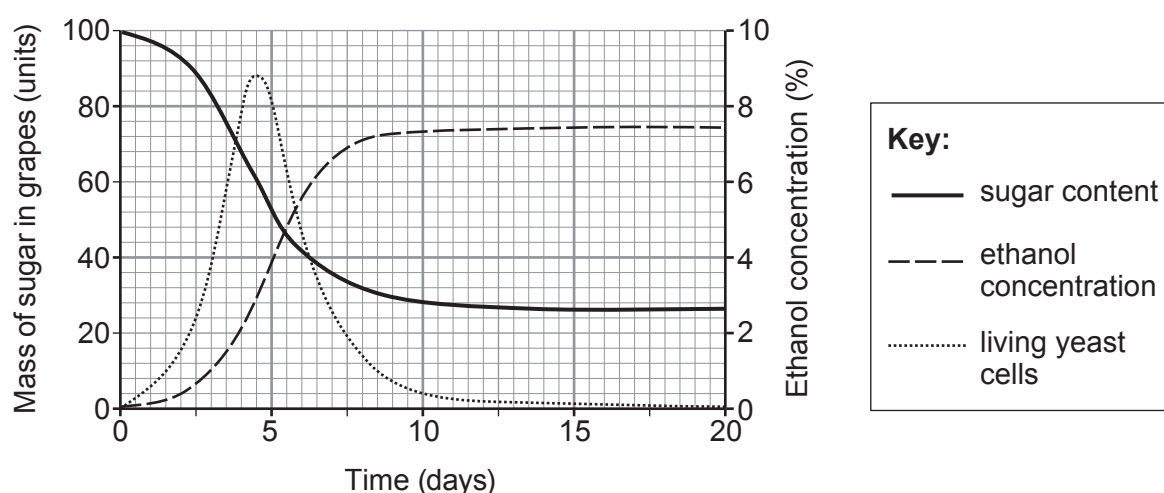
(b) Genetically modified yeast can be used in wine making.

(i) State the meaning of the term 'genetically modified'. [1]

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(ii) One type of genetically modified yeast was used to make wine. The graph below shows how sugar content (solid black line), ethanol concentration (dashed line) and number of living yeast cells (dotted line) change with time.



A home brewer thinks that when the number of living yeast cells is at a maximum, the sugar content will be at its minimum and the ethanol concentration would be at its maximum. Use data from the graph to explain whether you agree. [3]

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- (c) Many countries have banned the use of genetically modified foods.

Suggest **two** reasons for their concern.

[2]

1.

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2.

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- (d) The home brewer also uses this genetically modified yeast to produce beer. Complete the steps in the fermentation process. Three steps have been given. [4]

Step 1: Barley is mixed with water. Starch in the barley is converted to glucose.

Step 2: Hops are added for flavour.

Step 3:

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Step 4:

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Step 5:

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Step 6:

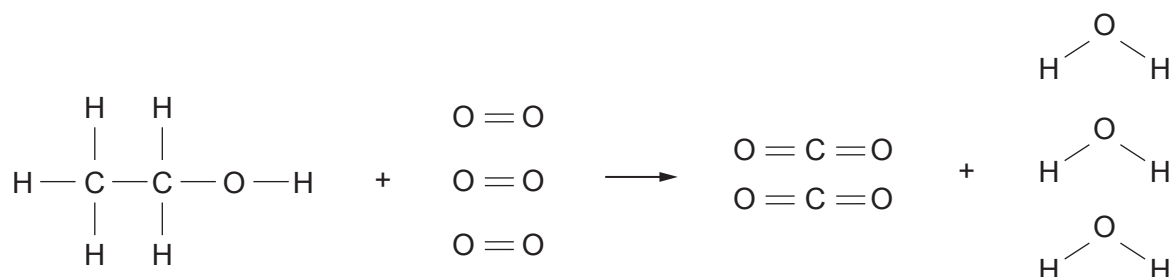
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Step 7: The beer may be pasteurised, then stored in bottles or casks.



5. Ethanol is widely used in biofuels. When ethanol is burned in a car engine, carbon dioxide and water are formed.

The displayed formula equation for this reaction is shown below.



Some of the bond energies for this reaction are shown in the table below.

Bond	Bond energy (kJ/mol)
C–C	347
C–H	413
C=O	732
C–O	336
O–H	464

Use the information above to answer the following questions.

- (a) The energy needed to break all the bonds in the reactants is 4706 kJ. Calculate the energy needed to break an O=O bond.

[4]

energy = kJ



- (b) The energy released to form new bonds in the products is 5712 kJ/mol.

Explain why a car engine using ethanol as a fuel needs a cooling system.

[3]

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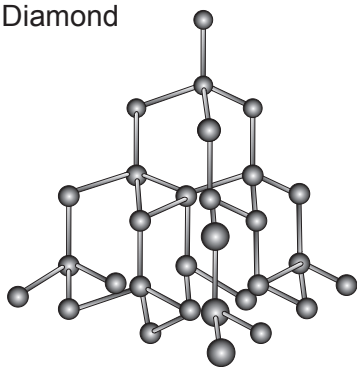
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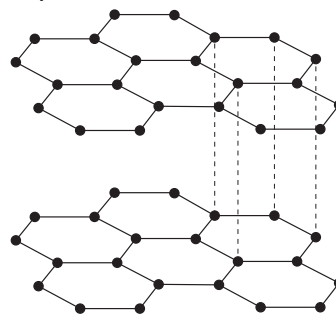
6. Carbon exists as a number of different allotropes. These allotropes have some important commercial uses. The uses of these allotropes depends upon the structure.

(a) Two allotropes of carbon are diamond and graphite.

Diamond



Graphite



Use the diagrams and your knowledge to answer the following questions.

- (i) **Describe** the bonding between a carbon atom and its nearest neighbours in diamond.
Include a dot and cross diagram of one carbon atom and its nearest neighbours in your answer. [3]

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- (ii) State the difference in the bonding between carbon atoms in diamond and graphite. [1]

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- (iii) Explain why graphite is a good conductor of electricity but diamond is a good insulator of electricity. [3]

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- (iv) Explain, in terms of structure and bonding, why graphite is soft and slippery but diamond is hard. [3]

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- (b) Graphene is a single layer of graphite. It can be rolled into the shape of a cylinder which is called a carbon nanotube.

The table gives some data about carbon nanotubes, steel and aluminium.

Material	Strength (MPa)	Density (g/cm ³)	Maximum length of power line before it breaks (km)	Electrical conductivity ($\times 10^6$ units)
carbon nanotube	62 000	1.3	4700	$\gg 1000$
steel	500	8.0	6.4	7
aluminium	80	2.7	1.0	40

Electricity power lines are currently made from a combination of steel and aluminium. Explain why carbon nanotubes would be better. [3]

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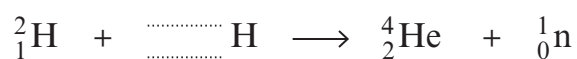
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- [6 QER]

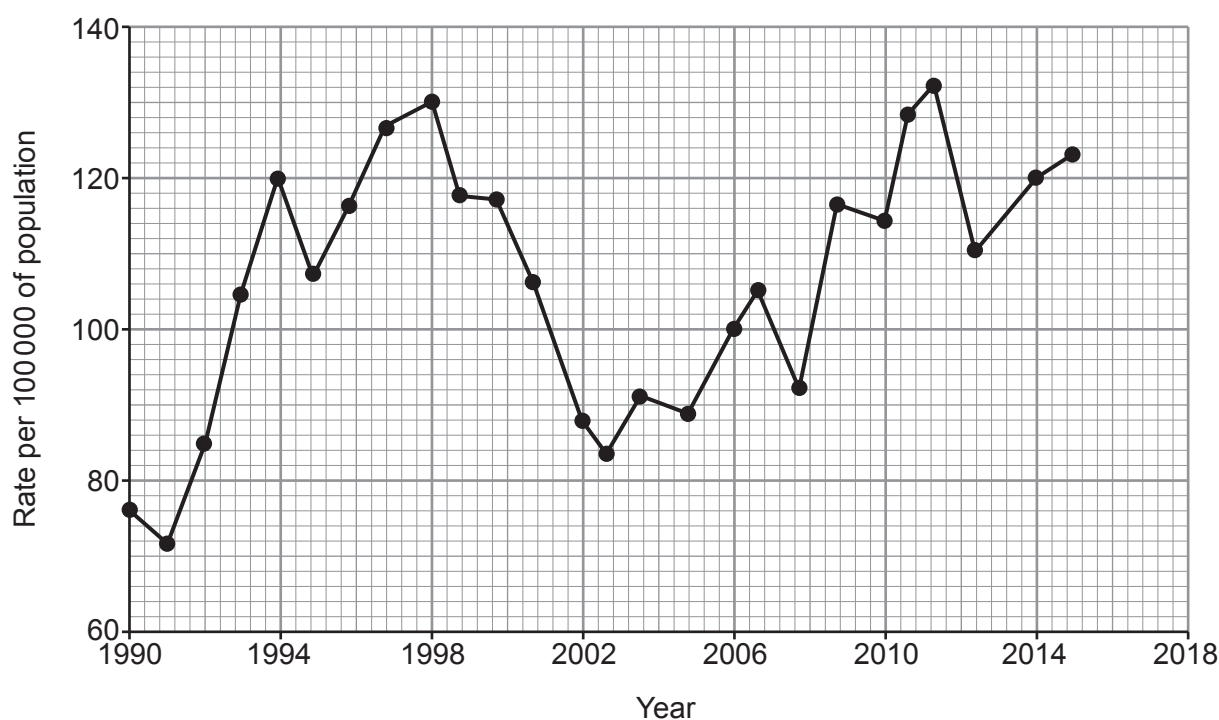
- [2]



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8. The graph below shows the confirmed cases of *Campylobacter* food poisoning per 100 000 of the population in Wales from 1990–2015.



In Wales, for every confirmed case of *Campylobacter* poisoning there are another two unconfirmed cases. The population of Wales is 3 million.

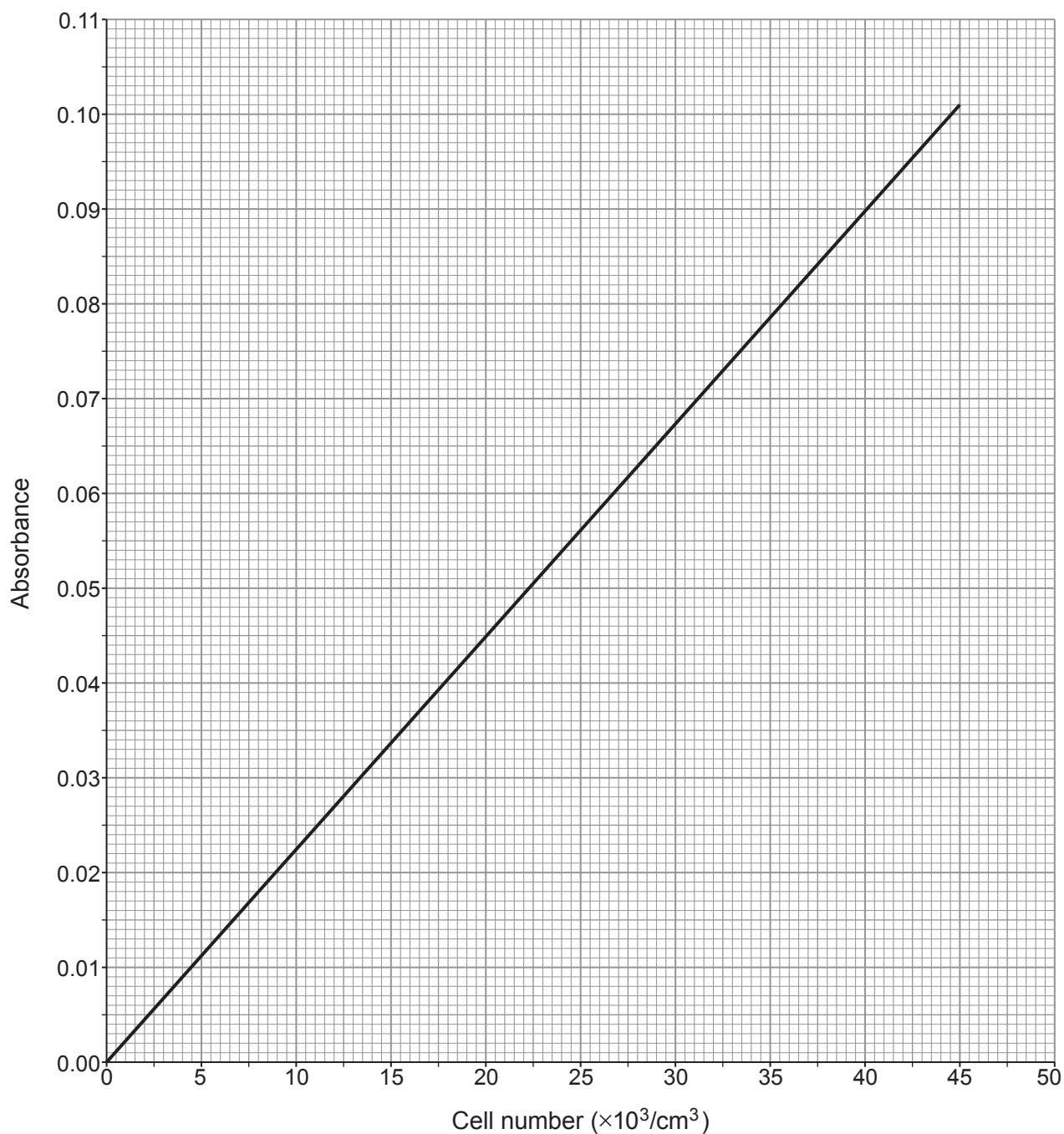
- (a) Calculate the total number of *Campylobacter* cases in Wales in 1998.

[3]

total number of cases =



- (b) Turbidity can be used to calculate the number of bacteria present in a sample. Alun used turbidity to study the growth rate of *Campylobacter* in water. He used the following standard graph.



(i) Alun analysed a water sample. The sample gave an absorbance of 0.01.

I. Use the graph to find the cell number per cm^3 at an absorbance of 0.01. [1]

cell number = per cm^3

II. *Campylobacter* reproduce every 20 mins The sample was left to stand for 1 hour. Alun thought that the absorbance would be 0.03 after 1 hour. Use your knowledge and data in the graph to explain whether he is correct. [3]

Space for calculations.

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(ii) The threshold value for making a person sick is 120 000 bacteria. In (b)(i)I. Alun's sample was 7 cm^3 . Use your answer above to determine whether this sample of water would make a person sick after standing for the hour. [3]

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END OF PAPER





Group

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4

9

LO

4



dr

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1

11

$$^1\text{H}$$

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														

Key

relative atomic mass

A_r	Symbol	Name	Z
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atomic number