OCR
Oxford Cambridge and RSA

Thursday 15 May 2025 – Afternoon

Level 3 Certificate Core Maths B (MEI)

H869/01 Introduction to Quantitative Reasoning

Time allowed: 2 hours

You must have:
- the Insert (inside this document)

You can use:
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working.
- Give your final answers to a degree of accuracy that is appropriate to the context.

INFORMATION
- The total mark for this paper is **72**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

1 This question refers to article A in the pre-release material, **'Online advertising'**.
You can find the article on the Insert accompanying this paper.

(a) Yuki runs an online handmade jewellery business.
She has just finished an online advertising campaign.

The table shows a summary of the results from the campaign.

Impressions	100 000
Cost Per Mille (CPM)	£2.80
Click Through Rate	1.6%
Conversion Rate	0.5%

Cost Per Mille (CPM) means the price paid for a thousand **impressions** of the ad, as shown in article A.

(i) Calculate the total cost of the campaign. **[2]**

1(a)(i)	

(ii) How many people clicked on the ad during the campaign? **[1]**

1(a)(ii)	

(iii) Yuki estimates that her average profit is around £35 for each online sale.

Determine if the campaign was worthwhile by considering the total cost of the campaign and the profit generated.

Show your working. **[3]**

1(a)(iii)	

(b) According to an online advertising agency, on average, each person in the UK over the age of 14 views over 5000 online ads a day.

Show that the information below does **not** support this claim.

- Annual spend on online advertising on over 14s in the UK is about £12 billion.
- The average CPM is £3.50 for this spend.
- There are 55.7 million over 14s in the UK.
- About 50% of impressions result in a view.

One billion is a thousand million. **[4]**

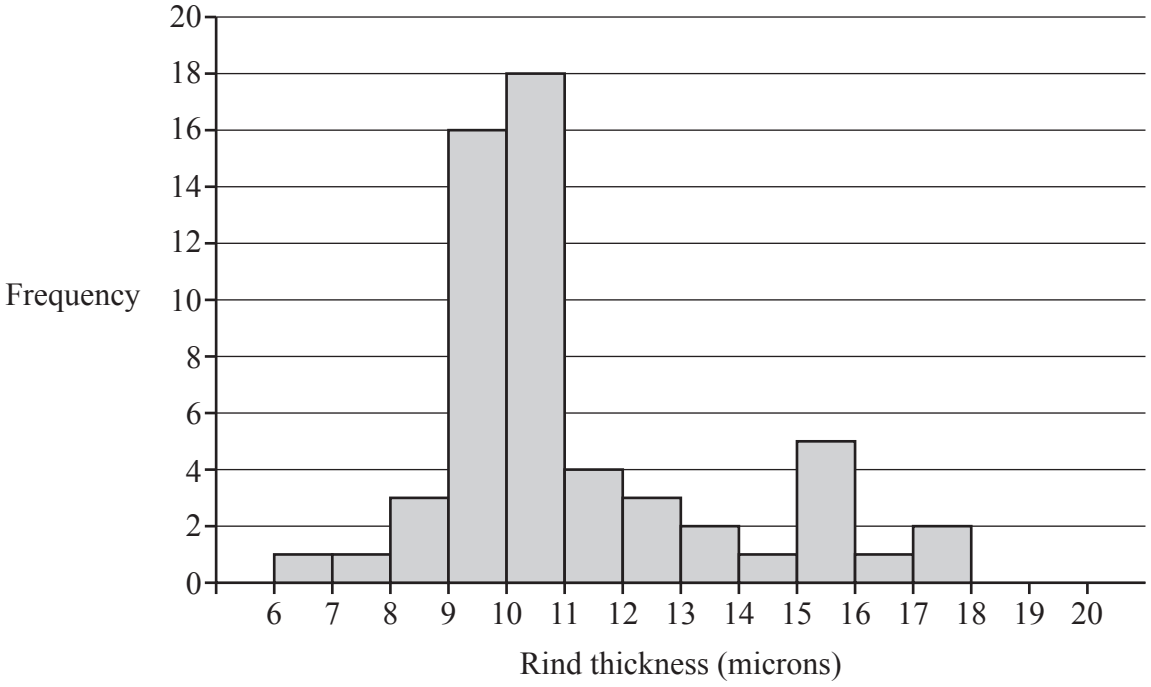
1(b)	

2 This question refers to article B in the pre-release material, **'Obsidian Rind'**.
You can find the article on the Insert accompanying this paper.

(a) **Fig. 2.1** shows the rind thicknesses measured on 57 stone tools from a region of California in America.

No stone tools were found to have a rind thickness less than 6 microns.

Fig. 2.1



(i) How many of the stone tools had a rind thickness of 15 microns or more? **[1]**

2(a)(i)	

(ii) In this region of California, 1 micron of rind took 300 years to form.

Estimate how long ago the people who made the tools last lived in the region. **[2]**

2(a)(ii)	

(iii) State a further conclusion that can be made using **Fig. 2.1** about the people who lived in this region.

Justify your conclusion using information from **Fig. 2.1**. **[2]**

2(a)(iii)	**Conclusion**
	Justification

(b) Ages estimated using obsidian rind thicknesses have a large measure of uncertainty, which can be up to ±25%.

Obsidian rind dating estimates the age of an arrowhead found in another region of America as 15 200 years.

The oldest evidence of humans in this part of America is 12 600 to 13 000 years old (and was dated by other, more accurate, methods).

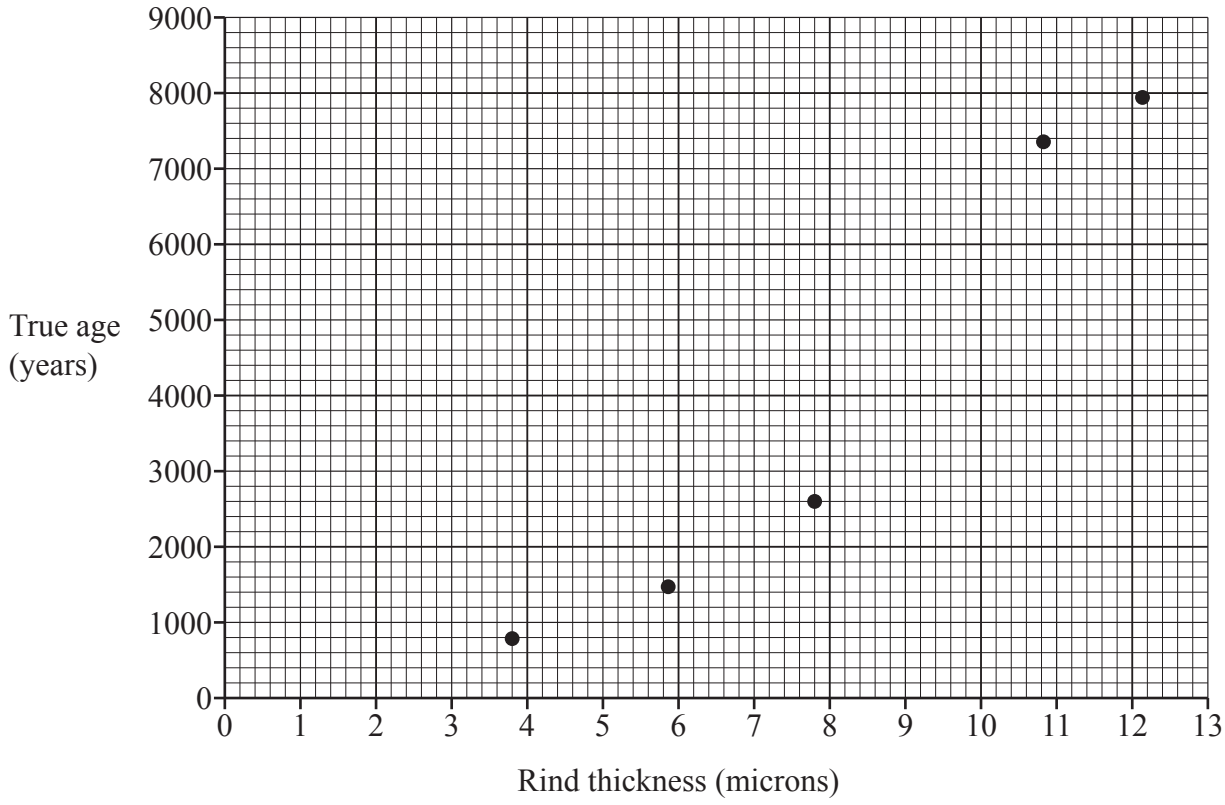
Explain whether the arrowhead's estimated age is consistent with this evidence. **[2]**

2(b)	

(c) **Fig. 2.2** shows a scatter graph of the rind thicknesses of some obsidian tools plotted against their true ages.

These obsidian tools were collected in the coastal area of Peru.

Fig. 2.2



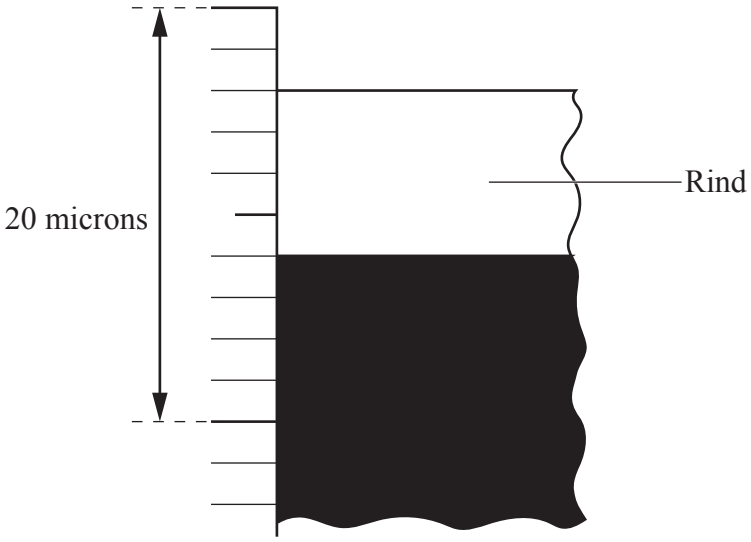
(i) Draw a line of best fit for the 5 points on **Fig. 2.2**. **[1]**

(ii) **Fig. 2.3** shows the magnified image of the cross-section of an obsidian hand axe.

Calculate an estimate of the age of the hand axe.

Use your line of best fit from **(c)(i)**. **[2]**

Fig. 2.3

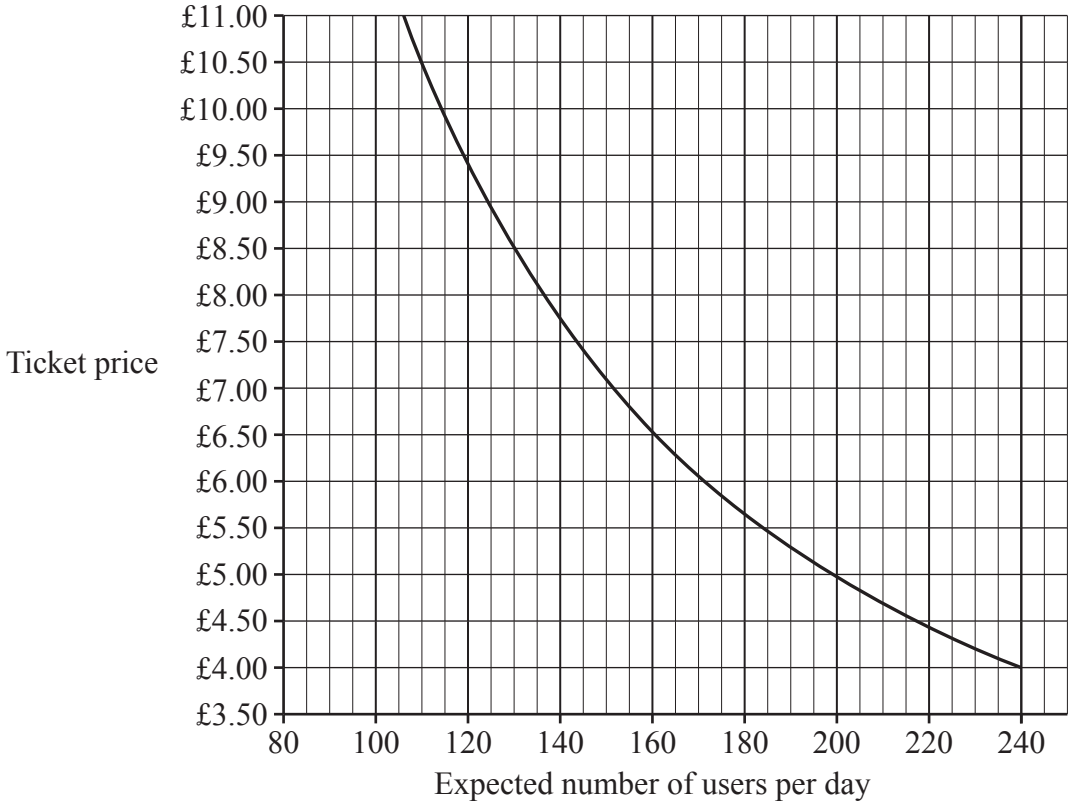


2(c)(ii)	

3 In a Park and Ride scheme, people park their car outside a town and then take a bus into the town. The ticket they buy includes both parking and a bus journey to the town and back. A town council is considering introducing a Park and Ride scheme to help reduce traffic and pollution in the town.

Fig. 3.1 shows a demand curve for Park and Ride ticket prices between £4 and £11.

Fig. 3.1



(a) (i) How many users, to the **nearest 5 users**, can the town council expect per day if the ticket price is £6? **[1]**

3(a)(i)	

(ii) Explain whether halving the ticket price always doubles the expected number of users per day.

Use information from **Fig. 3.1** to support your answer. **[3]**

3(a)(ii)	

(b) The town council uses information from **Fig. 3.1** to calculate the predicted daily revenue for each ticket price, as shown in **Fig. 3.2**.

(i) Fill in the **two** missing numbers in **Fig. 3.2**. **[2]**

3(b)(i)

Fig. 3.2

Ticket price	Expected number of users per day (to the nearest 5)	Predicted daily revenue
£9.50	120	£1140
£9.00		

(ii) The town council needs to choose what ticket price to set.

The town council have these criteria:

- Ticket prices can be set in multiples of **£0.50 only**.
- The town council needs at least £1100 daily revenue to make the Park and Ride viable.
- The town council wants as many people as possible to use the Park and Ride each day.

Determine the ticket price that the council should set.

You can use the blank copy of the table from **Fig. 3.2** which is in the answer space below. **[3]**

3(b)(ii)

Ticket price	Expected number of users per day (to the nearest 5)	Predicted daily revenue

The ticket price giving daily revenue of at least £1100 which attracts the maximum number of users is £.....

(c) A member of the town council suggests an equation that estimates daily revenue:

$R = 721 \times t^{0.2}$

where
R is the predicted daily revenue,
t is the ticket price.

(i) The council member claims that the equation gives results within $\pm 2\%$ of the predicted daily revenue calculated using the demand curve.

Show that this claim is **correct** for the ticket price of £9.50.

Use the information in **Fig. 3.2**. **[4]**

3(c)(i)	

(ii) **Fig. 3.3** shows part of a spreadsheet which uses the council member's equation from part **(c)(i)** to estimate the predicted daily revenue.
The ticket price is increased in £0.50 steps, starting from £4.25.

The starting value in A2 is entered manually.
Formulae are used to calculate the values in A3 and B2 which are both then copied down to the rows below.

Fig. 3.3

	A	B
1	Ticket price (£)	Revenue (£)
2	4.25	962.9706502
3	4.75	984.6320922
4	5.25	1004.539747
5	5.75	1022.983982

Write down the formula in cell A4 **and** the formula in cell B4. **[2]**

3(c)(ii)	**Cell A4:**
	Cell B4:

4 Trees capture carbon dioxide (CO_2) by photosynthesis. The amount of CO_2 captured or emitted is measured in tonnes.

(a) **Fig. 4.1** shows the **cumulative** CO_2 captured in tonnes to **2** decimal places as a willow tree ages.

Fig. 4.1

Tree age	CO_2 (tonnes)	Tree age	CO_2 (tonnes)	Tree age	CO_2 (tonnes)	Tree age	CO_2 (tonnes)	Tree age	CO_2 (tonnes)
0	0.00	10	0.05	20	0.19	30	0.44	40	0.81
1	0.00	11	0.06	21	0.21	31	0.47	41	0.85
2	0.00	12	0.07	22	0.23	32	0.50	42	0.89
3	0.01	13	0.08	23	0.25	33	0.54	43	0.94
4	0.01	14	0.10	24	0.28	34	0.57	44	0.99
5	0.02	15	0.11	25	0.30	35	0.61	45	1.04
6	0.02	16	0.12	26	0.33	36	0.64	46	1.09
7	0.03	17	0.14	27	0.35	37	0.68	47	1.14
8	0.03	18	0.16	28	0.38	38	0.72	48	1.19
9	0.04	19	0.17	29	0.41	39	0.76	49	1.25

A small wood has 8 willow trees growing in it.
These trees are all 37 years old.

(i) Calculate how many tonnes of CO_2 these 8 willow trees captured in total over the past year. **[1]**

4(a)(i)	

(ii) **One** of these 37-year-old willow trees is burnt down.
When a tree is burnt, all its captured CO_2 is emitted back to the atmosphere.

Calculate the net CO_2 capture or emission of the 8 willow trees over the past year. **[2]**

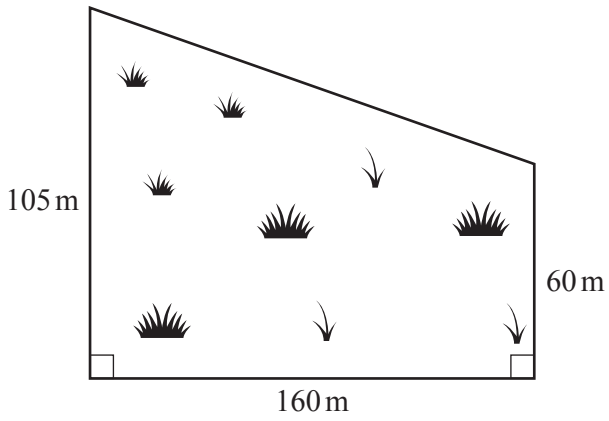
4(a)(ii)	

(b) London Plane trees, when mature, are good at capturing CO_2.

A town council is planning to create a woodland populated with London Plane trees.

Fig. 4.2 shows the design of the planned woodland.

Fig. 4.2



(i) Each London Plane tree needs $400\,m^2$ of space.

The council will plant as many London Plane trees as possible in the woodland.

One mature London Plane tree can capture up to 0.03 tonnes of CO_2 a year.

Calculate the total number of tonnes of CO_2 that the London Plane trees in the woodland will capture each year, once mature. **[3]**

4(b)(i)	

(ii) A typical petrol-driven car:

- is driven 11 910 km each year
- uses 5.7 litres of petrol per 100 km driven
- produces 0.0023 tonnes of CO_2 for each litre of petrol used.

Estimate the annual CO_2 emissions, in tonnes, for a typical petrol-driven car.

Show all your calculations and approximations. **[4]**

4(b)(ii)	

(iii) Explain whether the planned woodland of London Plane trees is likely to be effective in reducing the amount of CO_2 in the region around the woodland.

Use your answers to parts **(b)(i)** and **(b)(ii)** to support your answer. **[1]**

4(b)(iii)	

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Turn over for the next question

5 This question refers to article C in the pre-release material, **'Just noticeable differences (JND)'**. You can find the article on the Insert accompanying this paper.

A snack company wants to reduce the salt in their products. The company wishes to reduce salt gradually so that their customers do **not** notice the reduction.

The company uses Just Noticeable Differences (JNDs) for saltiness to help them do this.

(a) Salt concentration is the stimulus in this situation.
Salt concentration is measured as the number of grams of salt dissolved in one litre of water.

Fig. 5.1 shows some test results and the corresponding Weber fractions, W, calculated using the formula

$$W = \frac{J}{x}$$

where
x is the initial salt concentration,
J is the Just Noticeable Difference in salt concentration.

(i) Calculate the Weber fraction, W, that is missing from **Fig. 5.1**. **[1]**

5(a)(i)

Fig. 5.1

Initial salt concentration (x grams/litre)	JND from initial salt concentration (J grams/litre)	Weber fraction, W (2 decimal places)
29.22	5.26	0.18
17.53	3.68	0.21
11.66	2.21	0.19
5.84	1.86	0.32
2.92	0.49	0.17
1.46	0.26	

(ii) Calculate an appropriate average that could be used as a representative value for the Weber fraction.

You should:
- consider potential outliers
- explain your method. **[2]**

5(a)(ii)	

(iii) As part of the tests, it is decided to investigate salt concentration using two solutions of different strengths:
- 29.22 grams/litre (29.22 g of salt in 1 litre) and
- 17.55 grams/litre (17.55 g of salt in 1 litre).

To do this a mixture is made up from:
- 0.15 litres of the 29.22 grams/litre solution and
- 0.14 litres of the 17.55 grams/litre solution.

What is the concentration of this mixture? **[3]**

5(a)(iii)	

(b) The company's Salt and Vinegar crisps have a particularly high salt content.

- Saltiness (the stimulus in this situation) is measured as the number of grams of salt in a 28 g packet of crisps.
- Tests with the crisps on customers gives a Weber fraction, W, of 0.11.
- Customers adjust to a reduced level of salt in crisps after a month.

The company adjust the saltiness of the crisps every month so that the saltiness, S, that does **not** taste any less salty than the previous month is given by:

$$S = 1.3 \times (1 - W)^n$$

where
n is the number of months after starting to reduce the salt content,
W is the Weber fraction.

Fig. 5.2 shows some values of S up to month 10.

(i) Complete **Fig. 5.2** to show the saltiness at the start and after 10 months. **[2]**

5(b)(i) **Fig. 5.2**

Months after starting to reduce salt content	Saltiness of crisps to 2 dp (grams per 28 g packet)
0 (start)	
1	1.16
2	1.03
3	0.92
4	0.82
5	0.73
6	0.65
7	0.58
8	0.51
9	0.46
10	

(ii) Explain if the salt content of the crisps can be reduced by 50% of its initial level within 4 months without customers being aware of any reduction in saltiness. **[2]**

5(b)(ii)	

(c) The company also sells 'healthy bars' for vending machines in schools.
The company does an experiment to see whether they would sell more bars if the bars had a higher sugar content.

The company's experiment has these steps:

1. Select one of the schools the company supplies at random.

2. Do **not** tell any school staff or students about the experiment.

3. Choose a particular bar type for the experiment.

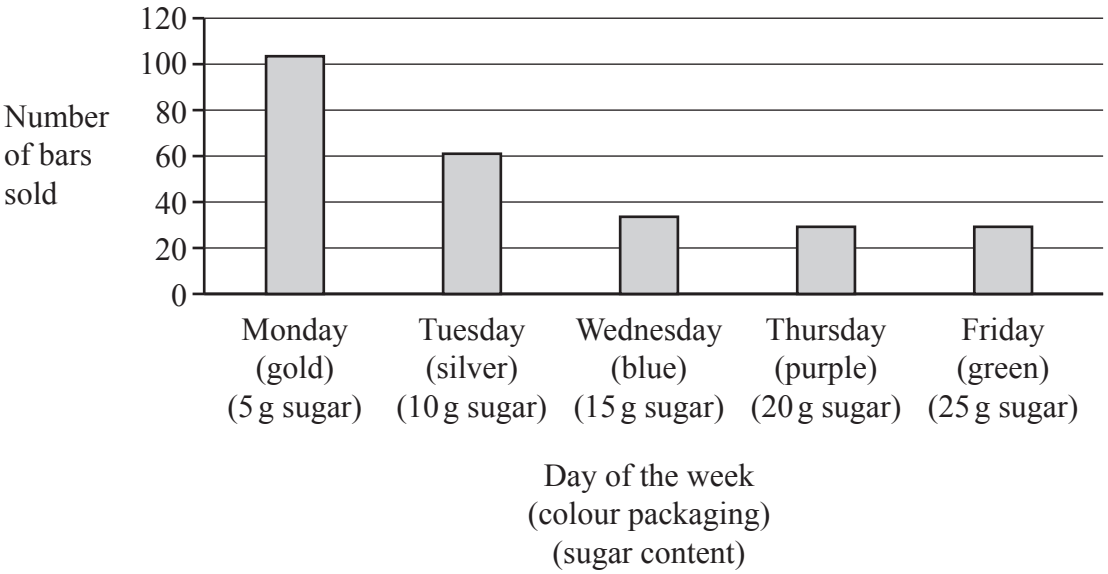
4. Set the sugar content of the bars at 5 g for Monday.
Increase this by 5 g each day.

5. Wrap the bars in a different colour each day, as shown in **Fig. 5.3**.

6. Record the number of bars sold for each sweetness (or colour) bar.

Fig. 5.3 shows the results of the experiment.

Fig. 5.3



(i) Explain briefly why the company's experiment might be considered unethical. **[1]**

5(c)(i)	

(ii) Using the chart in **Fig. 5.3** the company make the following conclusion.

'Far from people preferring a sweeter bar, they prefer bars which are less sweet.'

Give **two other** possible explanations for the results shown in **Fig. 5.3**. **[2]**

5(c)(ii)	**Explanation 1:**
	Explanation 2:

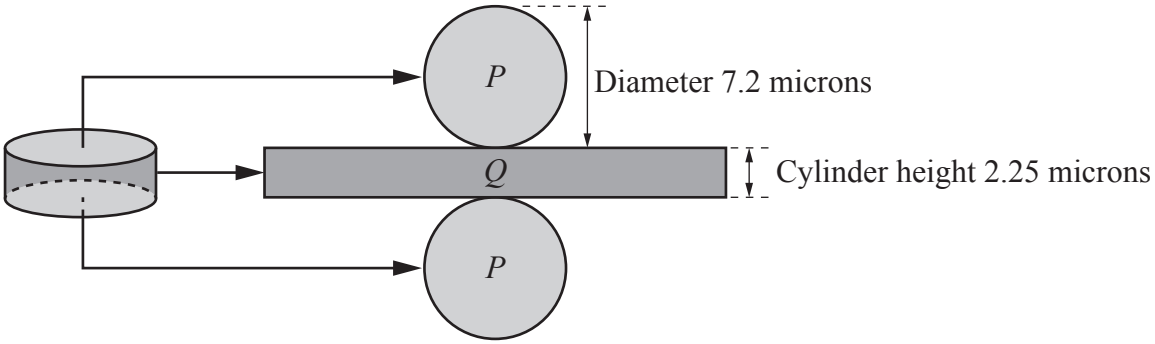
(iii) Give **one** reason why it is **not** possible for the company to use this experiment to decide whether increasing the sugar content of bars would lead to them selling more bars. **[1]**

5(c)(iii)	

6 This question refers to article D in the pre-release material, **'Blood'**.
You can find the article on the Insert accompanying this paper.

(a) **Fig. 6.1** shows a red blood cell modelled as a thin cylinder.
P is the area of each of the two circular end regions.
Q is the area of the curved side.

Fig. 6.1



(i) Calculate the value of *P*.

Give your answer to the **nearest microns^2**. **[2]**

6(a)(i)	

(ii) Calculate the value of *Q*.

Give your answer to the **nearest microns^2**. **[2]**

6(a)(ii)	

(iii) The surface area of an actual red blood cell is 136 microns^2.

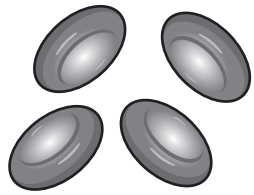
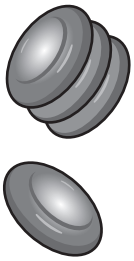
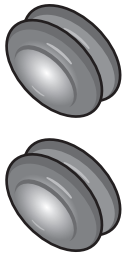
Use your answers to **(a)(i)** and **(a)(ii)** to explain whether the model above gives a close estimate of the surface area of a red blood cell. **[2]**

6(a)(iii)	

Red blood cells can stick together to form clusters. The effective area of a group of cells is the surface area of the cells that comes into contact with plasma.

Fig. 6.2 shows four ways that four red cells can be arranged.

Fig. 6.2

Arrangement 1	Arrangement 2	Arrangement 3	Arrangement 4
			

(iv) Complete **Fig. 6.3** by writing expressions for the effective areas of arrangements 3 and 4.

Model each red blood cell as a cylinder with surface area $2P + Q$. **[2]**

6(a)(iv)

Fig. 6.3

Arrangement	Effective surface area, S, in terms of P and Q
1	$(2P + Q) + (2P + Q) + (2P + Q) + (2P + Q) = 8P + 4Q$
2	$P + P + 4Q = 2P + 4Q$
3	
4	

(v) A large effective surface area is important because it enables a greater amount of oxygen to be absorbed.

Make **one** observation about how the effective surface area of a group of four red blood cells is affected by different arrangements.

Use the information in **Fig. 6.3**. **[1]**

6(a)(v)

(b) **Fig. 6.4** shows which blood groups can donate blood to other blood groups.

Fig. 6.4

People with group O blood can donate to all blood groups.
People with group A blood can donate to blood groups A and AB.
People with group B blood can donate to blood groups B and AB.
People with group AB blood can only donate to blood group AB.

Fig. 6.5 shows the blood groups of the patients at a health centre.

Fig. 6.5

	Patients' blood group				
	O	**A**	**B**	**AB**	**Total**
Male	2058	1836	471	212	4577
Female	2171	1918	463	252	4804
					9381

A new patient joins the health centre.
The new patient is blood group B.

Calculate the probability that this new patient is able to donate to another patient selected at random from the other patients at the health centre.

Give your answer as a fraction. **[3]**

6(b)	

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.