OCR
Oxford Cambridge and RSA

Level 3 Certificate
Quantitative Problem Solving (MEI)
H867/01 Introduction to Quantitative Reasoning
Wednesday 18 May 2016 – Morning
Time allowed: 2 hours

6001083033

You must have:
- the Insert (inserted)

You may use:
- a scientific or graphical calculator

H867701

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.

INFORMATION
- The total mark for this paper is **72**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **20** pages.
- Final answers should be given to a degree of accuracy appropriate to the context.

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Answer **all** the questions.

1 Athletes in the decathlon take part in ten different events. Points are allocated in each event depending upon how well they do. Shorter times are considered better in running events. Longer distances are considered better in the long jump.

Ashton Eaton set a world record in 2015. He ran 100 m in 10.23 seconds and he jumped 7.88 metres in the long jump. The table below shows statistics summarising the long term performance of decathletes in these events:

Event	Mean	Standard deviation
100 m	10.99 s	0.25 s
Long jump	7.26 m	0.31 m

(Adapted from Cox and Dunn (2002) *An analysis of decathlon data*)

Calculate *z*-scores for Ashton Eaton's performance in the two events. Should he have been awarded more points in the 100 m or in the long jump event? Explain your reasoning clearly. **[4]**

1

2 Vets use a model in which the mass of a rabbit is proportional to the cube of the circumference of its head. This gives the formula

$$M = ah^3$$

where

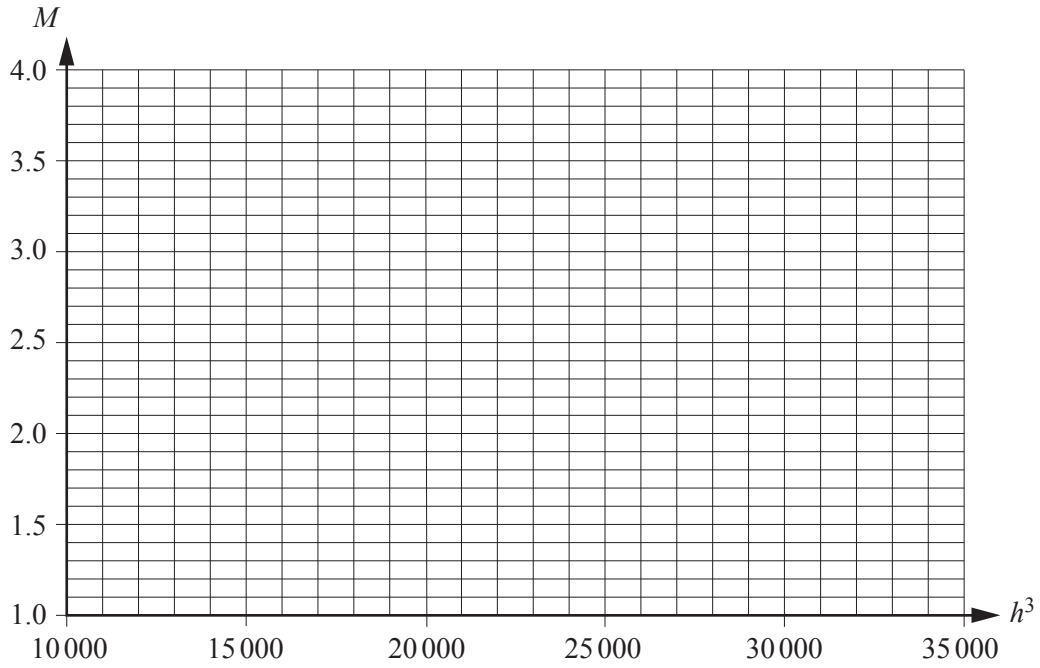
- its mass is M kg
- the circumference of its head is h cm
- a is a constant for the type of rabbit in this question.

In order to estimate the value of a for a particular type of rabbit, a vet measured the mass and the head circumference of 5 rabbits. The results are given in the table below.

Rabbit	***M***	***h***	h^3
Daniel	1.5	24	13 824
Theo	2.0	27	
Alessia	2.6	28	
Elsa	3.4	32	
Asha	2.7	30	27 000

(i) Complete the final column of the table above. **[1]**

(ii) Plot the data on the grid below and draw a line of best fit. **[3]**



(iii) Use your line of best fit to estimate the value of a. **[2]**

2 (iii)	

(iv) Another rabbit has a head circumference of 36 cm and a mass of 6.1 kg. Use the vet's model to determine whether this rabbit is overweight or underweight. **[3]**

2 (iv)	

(v) Give one reason why this model seems to be appropriate. **[1]**

2 (v)	

3 The UK government predicts that in the years from 2023 to 2027 inclusive the UK will produce 416 million tonnes ± 4 % of carbon dioxide each year.

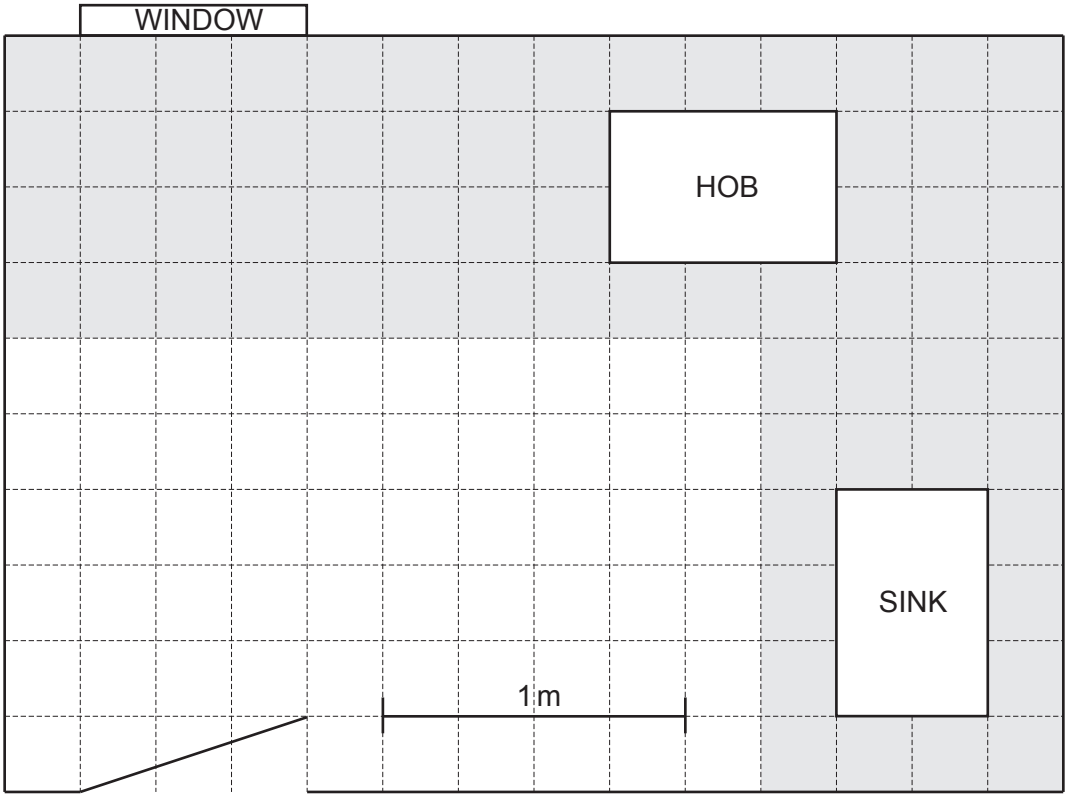
(i) What is the largest **total** amount of carbon dioxide the UK is predicted to produce in the five years from 2023 to 2027? **[3]**

3 (i)	

(ii) The UK is predicted to have a population of (66 ± 5) million in the period from 2023 to 2027. There is a target of producing less than 6 tonnes of carbon dioxide per person per year. Given the prediction, is this target certain to be met? Support your answer with relevant calculations. **[4]**

3 (ii)	

4 An architect is designing a kitchen for student accommodation. He creates the scale drawing shown below.



Health and safety regulations say that the hob must be more than 1 m away from the sink, as measured at their closest points.

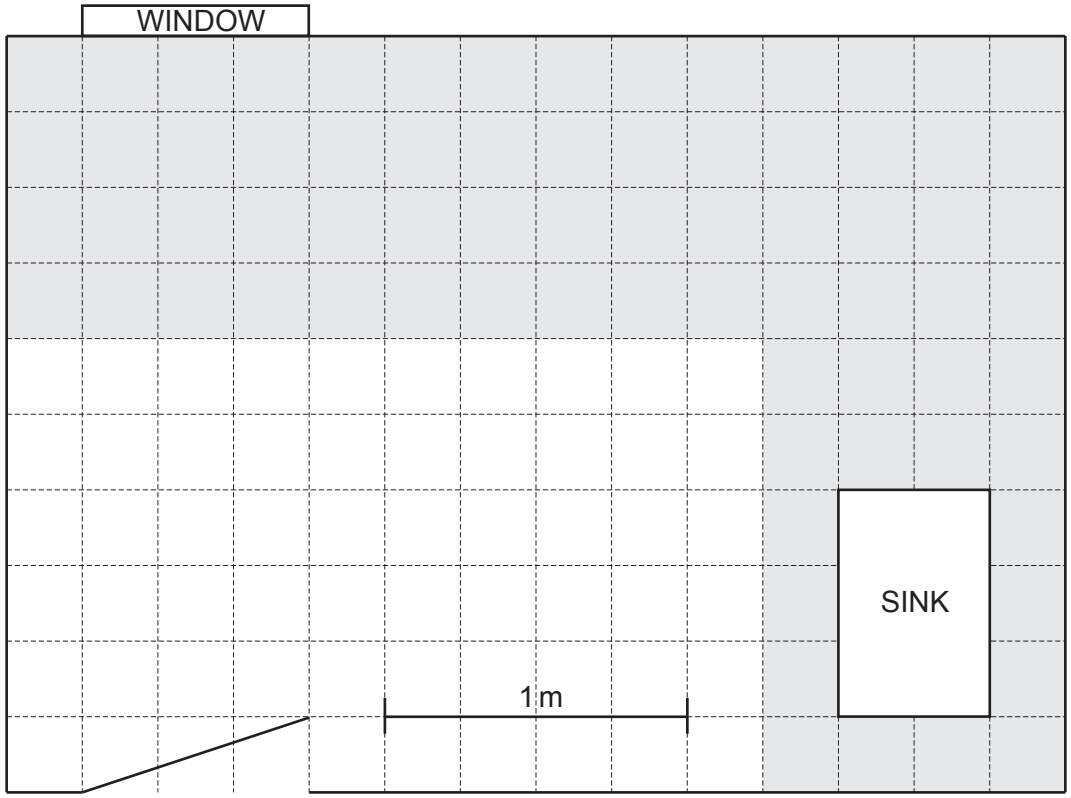
(i) How far is the sink away from the hob? Does it satisfy the health and safety regulations? **[2]**

4 (i)

There are three constraints on where the hob can be placed.

- It must be on the worktop (shaded in the diagram below).
- It must be more than 1 m from the sink.
- It must be more than 50 cm away from the window.

(ii) The same size and shape of hob must be used. On the diagram below, draw a possible position for the hob. **[3]**



5 A researcher is examining the effectiveness of a new test for diabetes. She tests 1000 people whose diabetes status is already known. The results are summarised in the table below.

(i) Fill in the column and row totals in the table below. Use the data to estimate the proportion of people who have diabetes. Give your answer in the form 1 in n where n is a whole number. **[3]**

		Diabetes status		
		Diabetic	**Not diabetic**	**Total**
Test outcome	**Positive**	44	48	
	Negative	4	904	
	Total			1000

5 (i)

(ii) A hospital serves a population of 300 000 people. The average cost of treating a patient who definitely has diabetes is £2600 per year. Estimate, to the nearest million pounds, the amount that this hospital spends on diabetes treatment each year. Show your reasoning. **[4]**

5 (ii)

(iii) State one assumption you have used in your calculation in part **(ii)**. **[1]**

5 (iii)	

(iv) Use the data in the table to estimate the probability that someone with diabetes gets a positive result in the test. **[2]**

5 (iv)	

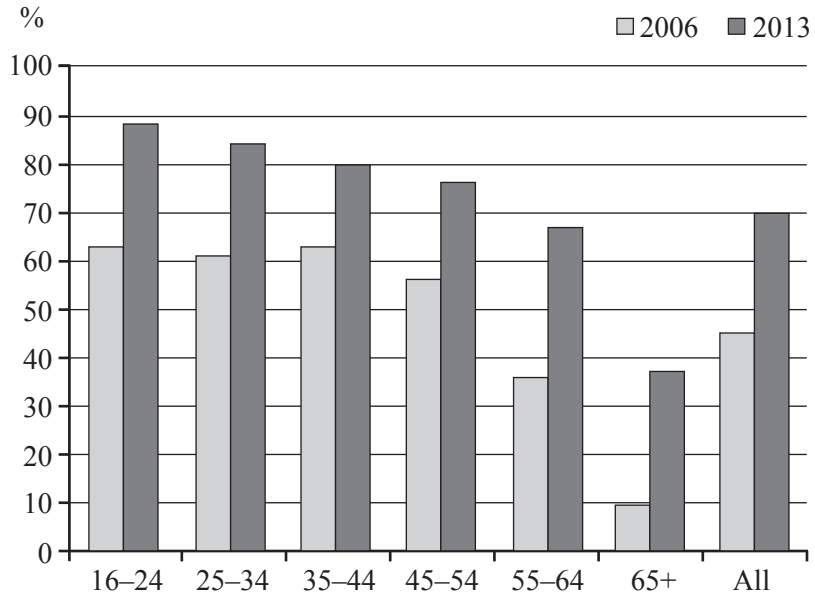
(v) Use the data in the table to estimate the probability that someone with a positive result has diabetes. **[2]**

5 (v)	

(vi) Is the researcher's test useful in determining whether or not someone has diabetes? Use your results from part **(iv)** and / or part **(v)** to support your argument. **[1]**

5 (vi)	

6 The chart below shows the percentage of people in different age groups who reported that they used the internet every day in 2006 and in 2013.



(Source: ONS statistical bulletin, Internet Access, 2013)

(i) State two main points the chart above shows. **[2]**

6 (i)	

The table below gives the numbers in the different age groups for 2013 and the percentages of them using the internet daily.

Age	Number of people in age group (million)	Percentage who use the internet daily
16–24	7.4	88
25–34	8.7	84
35–44	8.5	80
45–54	9.0	76
55–64	7.3	67
65+	11.1	37

(ii) Jean claims that a greater number of 16 to 24 year olds than 45 to 54 year olds use the internet daily. Use the figures in the table on page 12 to determine if this claim is true, showing your working clearly. **[3]**

6 (ii)	

(iii) The chart has a category labelled 'All'. It is 70% to the nearest whole number for 2013. Use the information in the table to show how this figure was calculated. **[5]**

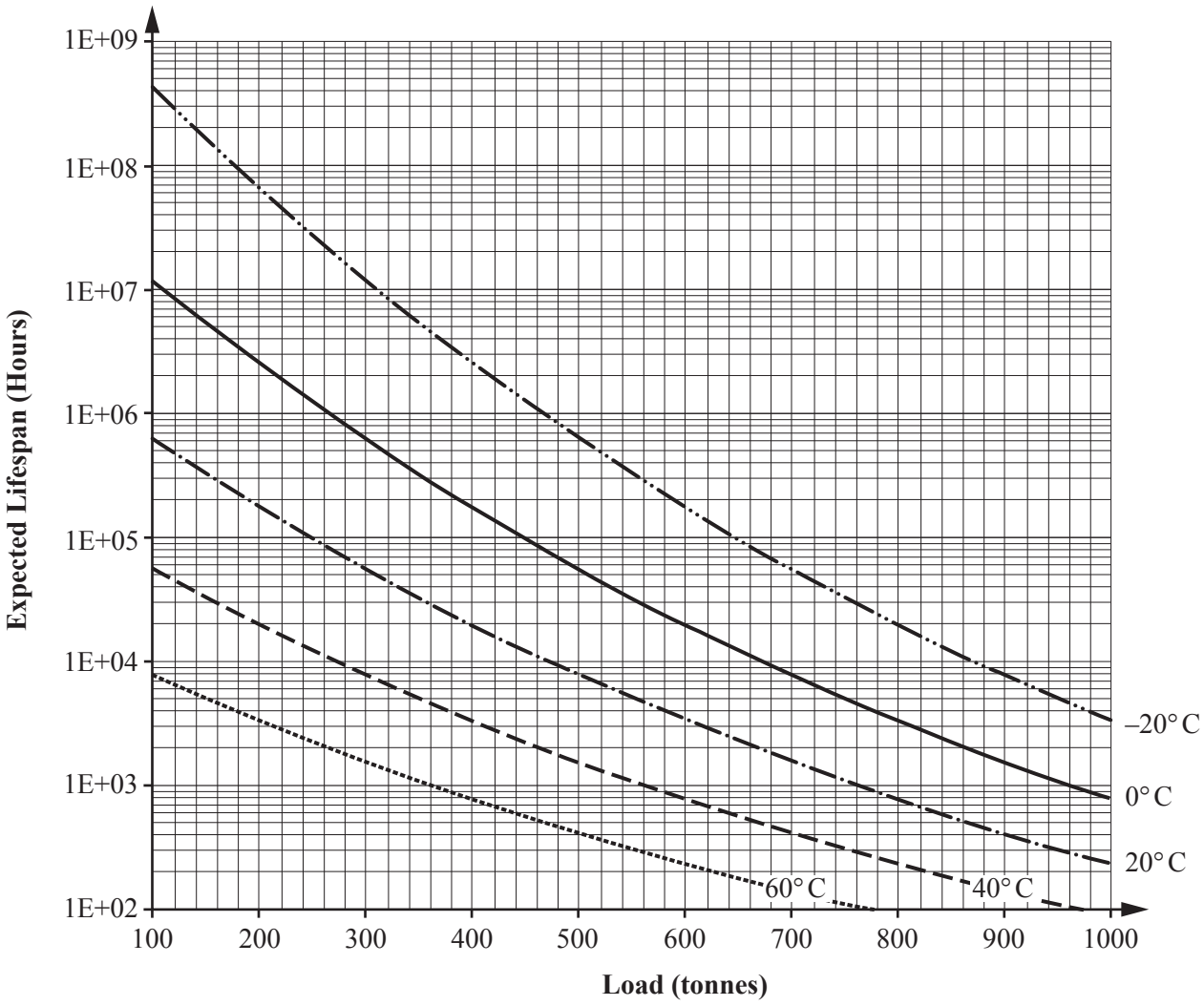
6 (iii)	

7 The breaking load of materials is an important property used to determine their strength. The breaking load of a strand of spider silk is approximately 10^{-3} kg. The breaking load of an iron wire of the same diameter as the silk is approximately 5×10^{-6} kg.

(i) How many times stronger than iron is spider silk? **[2]**

7 (i)	

The graph below shows part of a specification provided by the manufacturers of a steel component of a bridge. It shows the expected lifespan of the component at different temperatures and loads. The vertical axis has a logarithmic scale.



(ii) What is the expected lifespan of the component if it has a load of 400 tonnes at a temperature of 20 °C? **[2]**

7 (ii)	

(iii) An engineer wants this bridge component to last more than 2 years.

(*A*) How many hours are in 2 years? Give your answer to the nearest 10 000 hours. **[2]**

(*B*) The component is to operate at temperatures of 40 °C. Use the graph on page 14 to determine the maximum load that can be exerted on the component if it is to last at least 2 years. **[1]**

7 (iii) (*A*)	
7 (iii) (*B*)	

8 *For this question you may need to use information from the Insert.*

Bronwyn wants to check her payslip to see if she is paying the correct amount of tax and national insurance. Bronwyn's gross annual salary is £24 000 in the tax year 2015/16. She pays £100 each month into a pension scheme.

(i) Show that her income tax each year should be £2440. **[2]**

8 (i)	

(ii) Find her monthly national insurance. **[3]**

8 (ii)	

Some politicians have suggested introducing a new income tax system with a flat rate of 12% and no tax-free allowance. Bronwyn decides to create a spreadsheet to see how this would affect her. She decides that she will make the comparison without considering any pension payments.

	A	B	C
1	Gross income	Current income tax	New income tax
2	24000		
3	25000		
4	26000		
5	27000		
6	28000		
7	29000		

Bronwyn creates the spreadsheet shown above. The formula in cell C2 is

$$= A2 * 0.12$$

(iii) Write down the formula in cell B2. **[2]**

8 (iii)	

(iv) Fill in the **values** in each empty cell in the spreadsheet shown below. Two have been done for you. **[3]**

	A	B	C
1	Gross income	Current income tax	New income tax
2	24000	2680	
3	25000		
4	26000		
5	27000		
6	28000		
7	29000		3480

(v) Between two of the consecutive incomes in column A in the spreadsheet above, the amount of income tax paid in the two systems is the same. Which two incomes are these? **[1]**

8 (v)	

(vi) Bronwyn is told that she will get a 2% pay rise next year. Assume that her pension contribution is fixed at £100 per month and that the tax system is the same as in 2015/16. Find the percentage increase in the amount of income tax she will pay. **[5]**

8 (vi)	

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