OCR
Oxford Cambridge and RSA

Wednesday 15 May 2019 – Morning

Level 3 Certificate
Quantitative Problem Solving (MEI)

H867/01 Introduction to Quantitative Reasoning

Time allowed: 2 hours

You must have:
- the Insert (inserted)

You may 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
- The Insert will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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 **24** pages.
- Final answers should be given to a degree of accuracy appropriate to the context.

1 This question refers to the article A in the pre-release material, 'Making an investment'. You can find the article on the insert accompanying this paper.

Andy wants to invest £1000 for 10 years for his grandchildren.

He considers these three ways.

- Buy £1000 worth of Premium Bonds.
- Put £1000 in a savings account.
- Buy £1000 worth of gold.

(i) (*A*) On average £1000 worth of Premium Bonds will win £120 over 10 years.

What percentage profit is this over the ten years? **[1]**

1 (i) (*A*)	

(*B*) There are currently a total of about 45 700 million Premium Bonds.
Each month about 3 million Premium Bonds win a prize.

What is the probability of a particular bond winning a prize in a given month? **[2]**

1 (i) (*B*)	

(*C*) One month 2 932 798 Premium Bonds win prizes.
The frequency of the different possible prizes is given in the pre-release material in Table A2.

A particular Premium Bond wins a prize.

What is the probability that the prize is more than £1000?
Write your answer in the form 1 in n.
Give n to the nearest 1000. **[2]**

1 (i) (*C*)	

(ii) £1000 is invested in a savings account paying 2% compound interest annually.

How much is it worth at the end of 10 years?
Give your answer to the nearest £. **[3]**

1 (ii)	

(iii) Andy obtains some figures for the annual average price of gold in £ per troy ounce.
In 2000 the cost of gold was £183.70 per troy ounce. This price was indexed as 100.

(*A*) In 2017 the price of gold was £980.50 per troy ounce.

What was the indexed price of gold in 2017?
Give your answer to the nearest whole number. **[3]**

1 (iii) (*A*)	

The graph in Fig. 1.1 shows how the indexed price of gold changed from 2000 to 2016.

(*B*) Plot the point for 2017. **[1]**

1 (iii) (*B*)

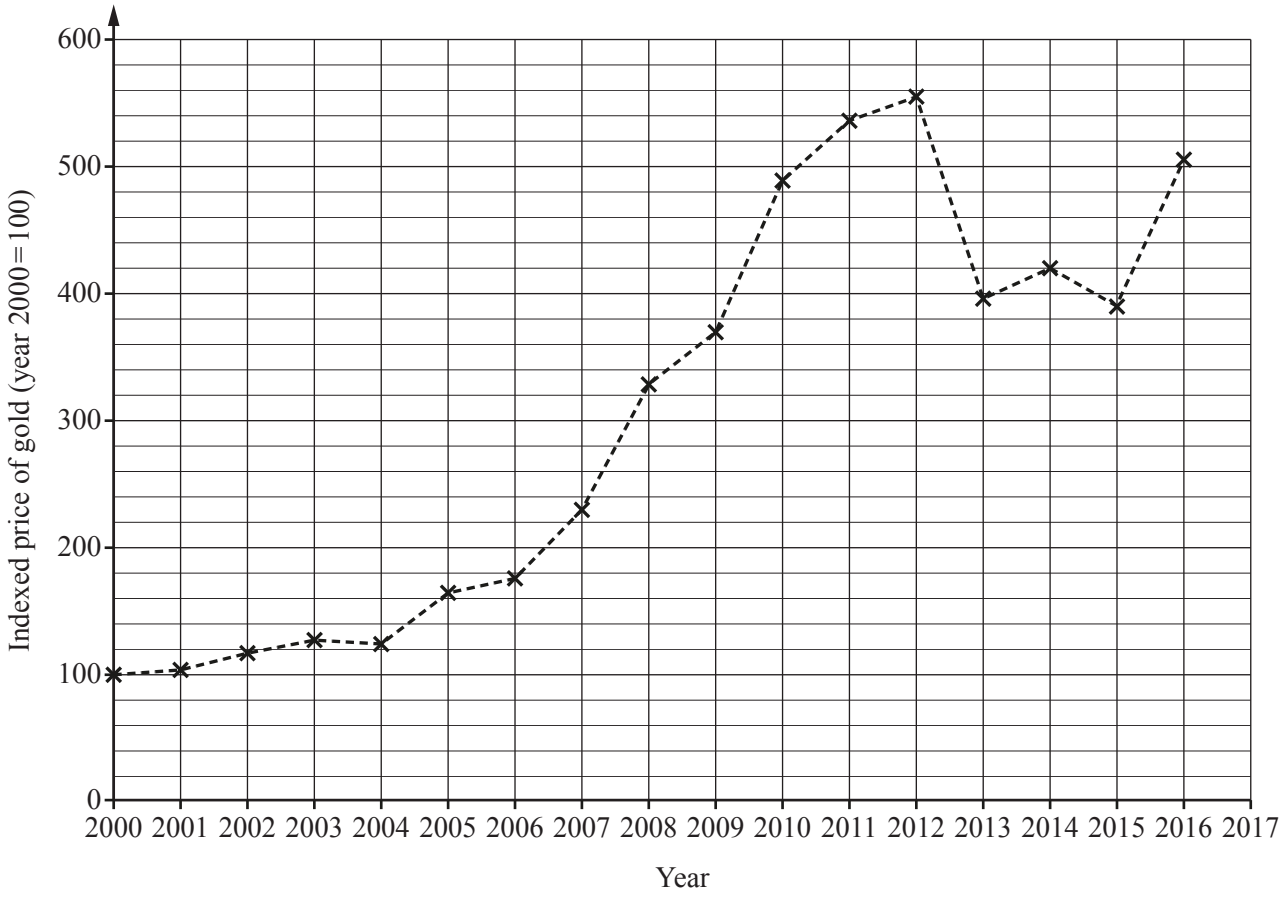


Fig. 1.1

(iv) Tick the box of the investment you would advise Andy to choose.
Give an advantage for the investment you advised and a disadvantage for each of the other two investments. **[3]**

1 (iv)

Premium Bonds ☐

.....

.....

Savings account ☐

.....

.....

Buying gold ☐

.....

.....

2 Janine has started to sell jewellery online.
Customers are asked to complete the online form shown in Fig. 2.1.

Please rate your recent purchase experience from Janine's Jewels.
Click on the number of stars you think it rates. ☆ ☆ ☆ ☆ ☆
Thank you.

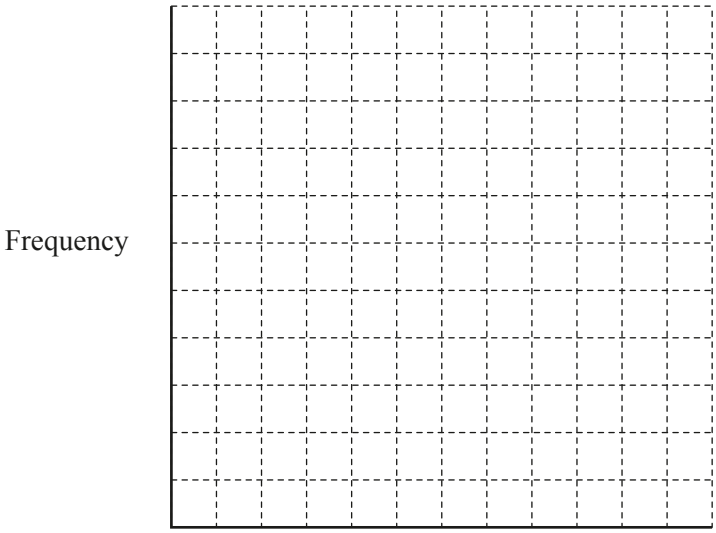
Fig. 2.1

(i) Janine records the number of stars. Here are the results for a week.

2	4	4	2	1	5	2	1	1	5
4	4	2	4	4	2	2	5	4	2

Use this grid to draw a dot plot of these figures. **[2]**

2 (i)



(ii) Give one reason why the mean number of stars for the data on the dot plot, which is 3, is not a useful figure for Janine. **[1]**

2 (ii)

Janine thinks that rating a single feature does not give enough detailed information.
She wants to use the features in Table 2.2. She will combine the stars awarded for the three features to give a mean star score.

However not all features are equally important. She weights the different features as shown in Table 2.2.

Feature	**Weighting**
Jewellery matched the online pictures	4
Prompt delivery of jewellery	2
Quality of packaging	1

Table 2.2

(iii) The responses from a customer are shown in Table 2.3.

Calculate the mean star score, using Janine's weightings, for this customer.
Give your answer correct to 1 decimal place. **[3]**

Feature	**Stars awarded**
Jewellery matched the online pictures	
Prompt delivery of jewellery	
Quality of packaging	

Table 2.3

2 (iii)	

Some online shopping companies rank their sellers (vendors) on the mean number of stars they gain. Janine's friend Amber sets up a spreadsheet to find the mean number of stars particular vendors obtain. She uses two vendors to check her spreadsheet.

Chris Craft gained two 5-star ratings.

Jess Jewels gained ten 4-star ratings and thirty 5-star ratings.

(iv) The spreadsheet in Fig. 2.4 shows the results. There is an error somewhere.

	A	B	C	D	E	F	G	H
1	Vendor			Stars				
2		1	2	3	4	5	Total number of stars	Mean
3	Chris Craft	0	0	0	0	2	10	5
4	Jess Jewels	0	0	0	10	30	60	1.5

Fig. 2.4

Fig. 2.5 shows the spreadsheet after the 'Show Formulas' command.

	A	B	C	D	E	F	G	H
1	Vendor			Stars				
2		1	2	3	4	5	Total number of stars	Mean
3	Chris Craft	0	0	0	0	2	=B2*B3+C2*C3+D2*D3+E2*E3+F2*F3	=G3/SUM(B3:F3)
4	Jess Jewels	0	0	0	10	30	=B3*B4+C3*C4+D3*D4+E3*E4+F3*F4	=G4/SUM(B4:F4)

Fig. 2.5

(*A*) In which cell is the wrong formula? **[1]**

2 (iv) (*A*)	

(*B*) Write down the correct formula. **[2]**

2 (iv) (*B*)	

(*C*) The spreadsheet formula is corrected.
Vendors are put in rank order based on their mean number of stars.
This is shown in Table 2.6.

Vendor	Stars					Mean number of stars	Ranking
	1	**2**	**3**	**4**	**5**		
R	0	0	0	0	1	5	1
T	0	0	0	65	65	4.5	2
W	0	0	1	1	2	4.25	3
S	0	0	0	250	0	4	4
U	0	0	25	13	2	3.425	5

Table 2.6

Janine and Amber do not think that ranking vendors by using the mean number of stars they gained is appropriate.

Use the results in Table 2.6 to suggest why they might think this. **[1]**

2 (iv) (*C*)	

3 This question refers to the articles A and E in the pre-release material, 'Making an investment' and 'Electrical energy'. You can find these articles on the insert accompanying this paper.

Amy lives in Glasgow. She is considering putting in solar panels and finds the information in Table 3.1 online.

Year	Megawatts of power generated by solar panels	Average cost (US$) to produce 1 watt of power from a solar panel
1975	0.4	100
1980	8	30
1985	100	10
1990	200	8
1995	700	5
2000	2000	3
2010	14 000	1.5
2015	300 000	0.4

Table 3.1

(i) (*A*) By how much did the average cost to produce 1 watt of power from a solar panel drop between 1975 and 1995? **[1]**

3 (i) (*A*)	

(*B*) There is a rough rule called Swanson's Rule which states that:
'The average cost to produce 1 watt of power from a solar panel decreases by 20% when the total power generated by solar panels doubles'.

Find a pair of years in the table where this is true. **[1]**

3 (i) (*B*)	

(ii) Amy decides to buy eight solar panels, but wonders if there is enough sunlight.
She finds the chart Fig. 3.2 online.
It shows the average daily solar energy per square metre for Glasgow for each month.

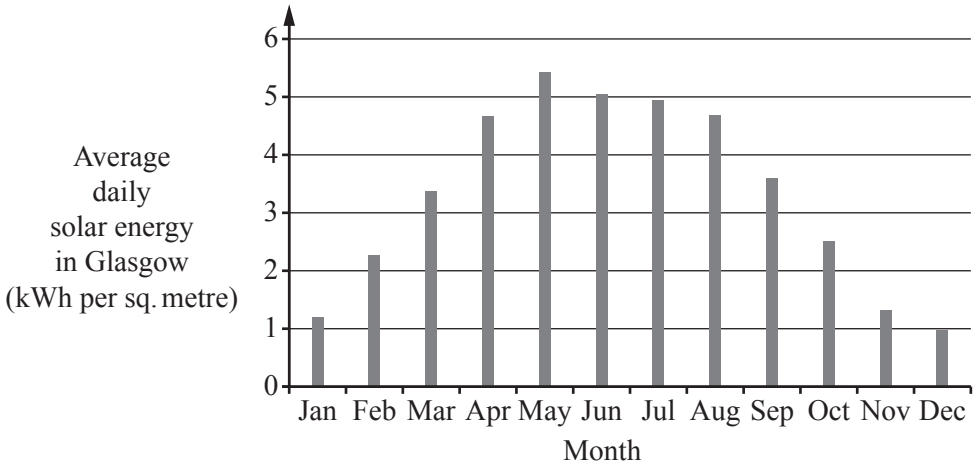


Fig. 3.2

(*A*) Use the chart and some **estimates** to work out a **rough figure** for the total yearly solar energy per square metre in Glasgow.

Show clearly any estimations or assumptions you make. **[3]**

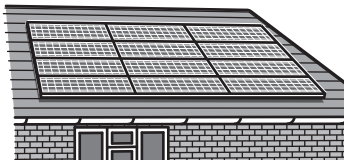
3 (ii) (*A*)	

(*B*) Solar panels only convert 25% solar energy into electrical energy.

How much electrical energy would each square metre of solar panel in Glasgow produce in a year? **[1]**

3 (ii) (*B*)	

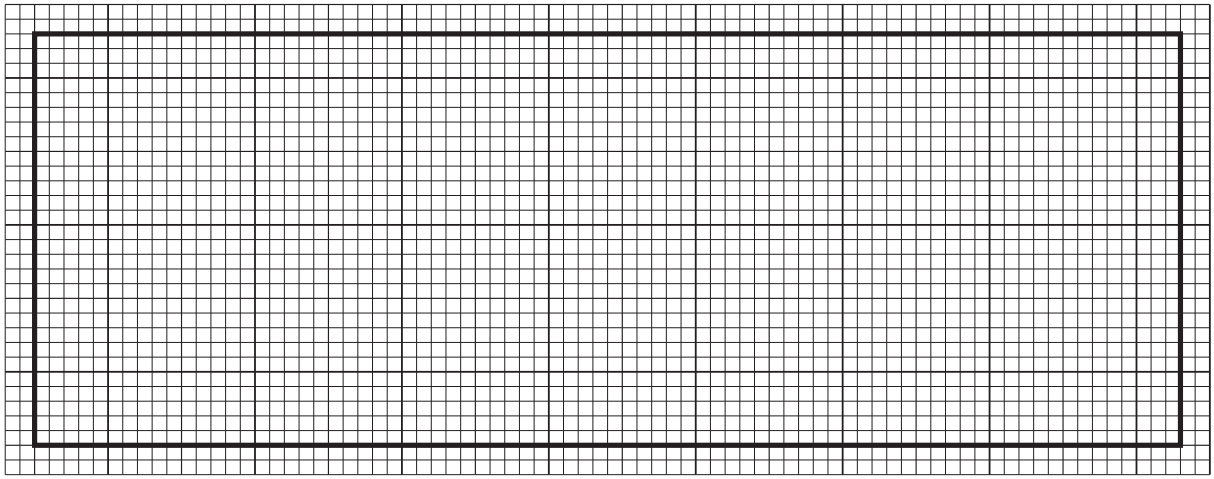
(iii) The solar panels are rectangular each measuring 1665 mm by 991 mm.
They must be at least 30 cm from the roof's edge.
This is to protect them from the wind.



Amy measures her roof. It is 2.8 m by 7.8 m.

Make a scale drawing showing how the eight solar panels could be arranged. **[3]**

3 (iii)



2 cm represents 1 m

(iv) Amy makes these notes.

- Cost to buy and install 8 panels £6000.
- Special offer of one-off single payment at time of purchase for lifetime maintenance and insurance £3000.
- Lifetime of solar panels about 25 years.
- Total electrical energy generated by the panels a year 2800 kWh.
- Cost of electricity from electricity company 14.05 p a kWh.
- Assume that all the electricity generated will be used.

(*A*) If Amy goes ahead and has the 8 solar panels fitted, what will her payback time be? Give your answer to the nearest year. **[4]**

(*B*) Why may the payback time be less than your answer in part **(*A*)**? **[1]**

3 (iv) (*A*)	
3 (iv) (*B*)	

(*C*) Amy decides to go ahead but she needs to borrow £2000.
She will have to make 12 monthly payments of £44.71 for 4 years.

How much interest in total will Amy have to pay? **[2]**

3 (iv) (*C*)	

4 This question refers to article B in the pre-release material, 'Measuring poverty'. You can find the article on the insert accompanying this paper.

(i) The poverty line is set by the World Bank at an income of US$ 1.90 per day.
Table 4.1 gives the percentage of the population of Indonesia who were living below this line. It covers the years between 2000 and 2016.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
% below poverty line	39.8	36.0	23.4	23.3	24.4	21.6	28.0	22.8	21.6

Year	2009	2010	2011	2012	2013	2014	2015	2016
% below poverty line	18.4	15.9	13.6	11.8	9.8	8.3	7.5	6.8

Table 4.1

(*A*) For how many of these years were more than 25% of the population of Indonesia living on US$ 1.90 a day or less? **[1]**

4 (i) (*A*)	

(*B*) Make one comment about what the data in Table 4.1 show about the percentage of the population of Indonesia living below the poverty line. **[1]**

4 (i) (*B*)	

(*C*) The current rate of exchange is £1 for US$ 1.41.

How much money, in £, would the poverty line of US$ 1.90 a day be? **[2]**

4 (i) (*C*)	

(*D*) This is a headline from a newspaper.

> About 1 in 10 people in the world living on less than US$ 1.90 a day!

According to the World Bank 700 million people lived on less than US$ 1.90 a day at the time when the headline was printed.
At this time the world population was 7400 million.

Comment on whether the headline is giving a realistic summary of the situation, justifying your answer. **[2]**

4 (i) (*D*)	

(ii) According to some large banks the total wealth in the world is US$ 2.56×10^{14}.
The world population is 7.4×10^{9} people.

Use these figures to calculate the average wealth for one person in the world.
Give your answer to a sensible accuracy. **[3]**

4 (ii)	

(iii) Engel's coefficient is used to measure poverty.

$$\text{Engel's coefficient} = \frac{\text{Amount spent on food}}{\text{Total income}}.$$

(It can also be used to measure the poverty of a group of people.
The total amount of money the group spends on food and their total income are used.)

Table 4.2 shows the descriptions used by the United Nations to describe poverty and wealth using Engel's coefficient.

Engel's coefficient, *E*	**UN description**
$E < 0.2$	Extremely wealthy
$0.2 \leqslant E < 0.3$	Rich
$0.3 \leqslant E < 0.4$	Affluent
$0.4 \leqslant E < 0.5$	Moderate prosperity
$0.5 \leqslant E < 0.6$	Only basic needs met
$E \geqslant 0.6$	In poverty

Table 4.2

(*A*) These are the average figures, in Vietnamese dong, for a large sample of households in Vietnam in 2006.

Amount of money spent on food	**Total income**
14 000 000	28 700 000

What is the UN description of Vietnam's state of poverty or wealth? **[2]**

4 (iii) (*A*)	

(*B*) In 2006 the average family in the Philippines spent 58 000 Philippine pesos on food.
In that year the Engel's coefficient was 0.50.

Calculate the average total income for a family in the Philippines in 2006. **[1]**

4 (iii) (*B*)	

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5 This question refers to article C in the pre-release material, 'Cloudiness in rivers, lakes and the sea'. You can find the article on the insert accompanying this paper.

(i) The intensity (brightness) of sunlight deceases as it travels through water.
The graph in Fig. 5.1 models how the intensity of sunlight varies with depth in unpolluted sea water.
The vertical scale is logarithmic.
The intensity at the surface is 100 units.

As a rough rule photosynthesis is not possible with light intensities 0.6 units or less.

(*A*) Plot the point on the graph which shows that the light intensity at a depth of 200 m is 0.6 units. **[1]**

(*B*) Estimate the intensity of sunlight at a depth of 360 m.
Show on the graph how you arrived at your answer. **[2]**

5 (i)(*A*)/(*B*)

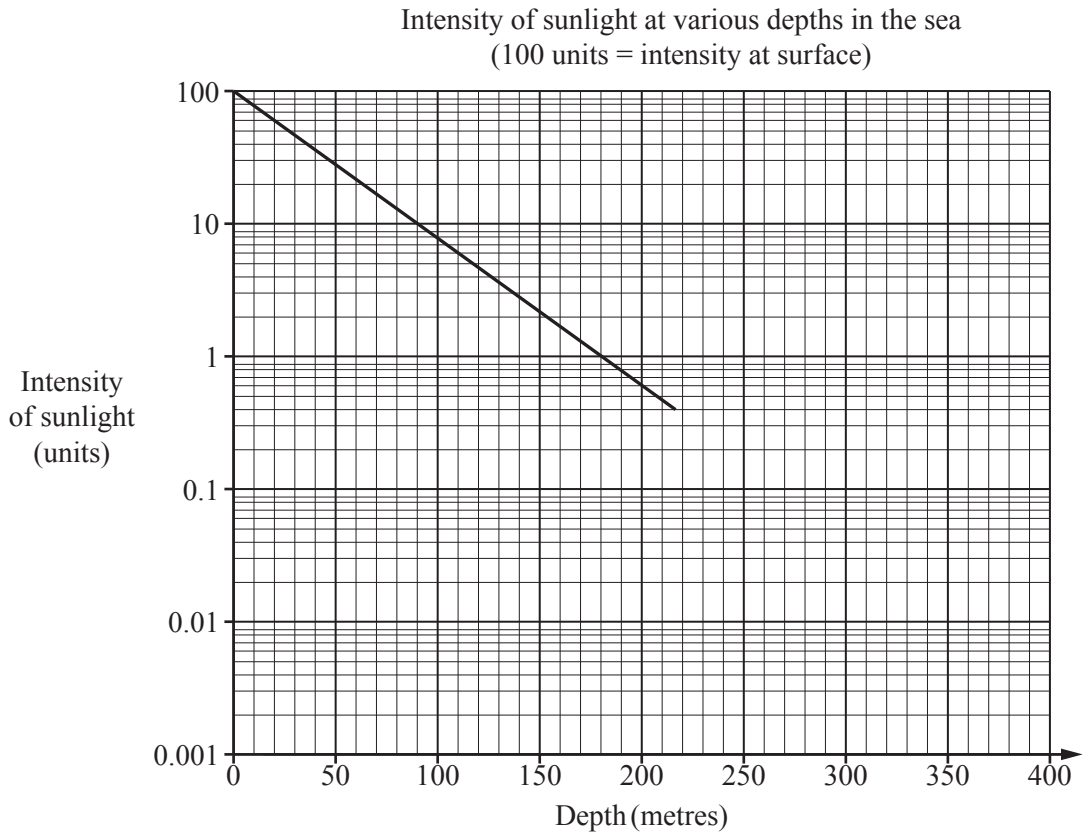

Fig. 5.1

5 (i) (*B*)

(*C*) The extinction coefficient is defined in the pre-release material.

Use the graph in Fig. 5.1 to estimate the extinction coefficient for unpolluted sea water.
Give your answer to a sensible accuracy. **[2]**

5 (i) (*C*)	

(*D*) A lake polluted by industrial waste has an extinction coefficient of $4\,m^{-1}$.

At what depth, in cm, in the lake would the intensity of sunlight be reduced to 37 units? **[1]**

5 (i) (*D*)	

(ii) The Secchi disc is a simple way to measure how clear water is, as detailed in the pre-release material.

(*A*) In an experiment a Secchi disc is lowered into a river.
The disc ceases to be visible at a depth of 4.5 m.
It becomes visible again at a depth of 4.3 m.

What is the Secchi depth for the river water? **[1]**

5 (ii) (*A*)	

The graph in Fig. 5.2 shows the mean Secchi depths for the largest lakes in Maine, USA each year from 1975 to 2013.

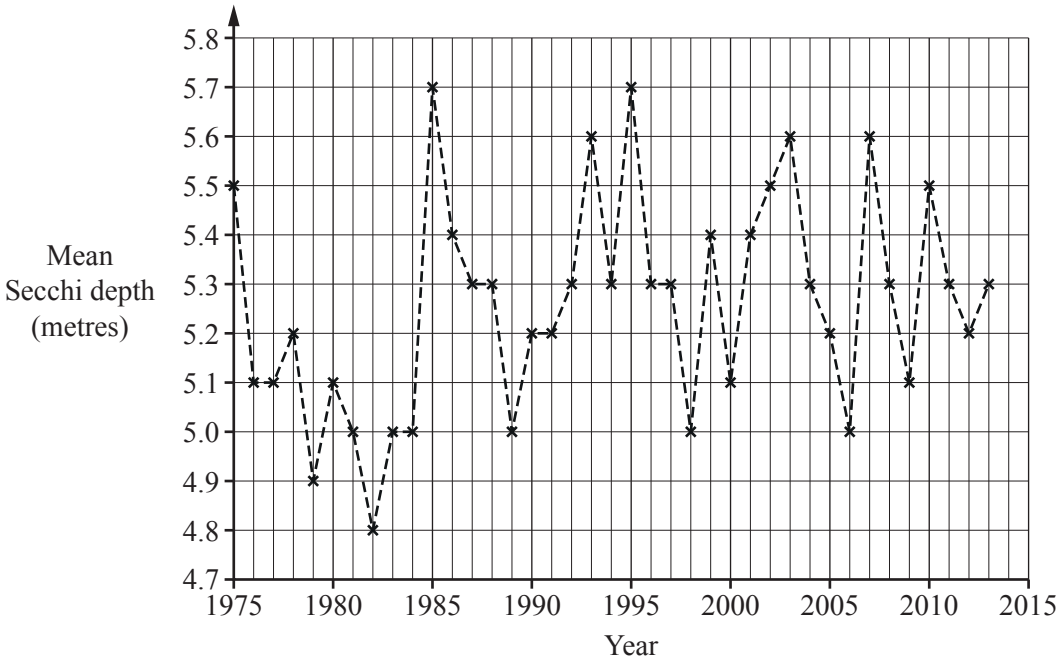

Fig. 5.2

(*B*) In how many years was the mean Secchi depth less than 5.0 metres? **[1]**

5 (ii) (*B*)	

(*C*) What is the mode of the mean Secchi depths? **[1]**

5 (ii) (*C*)	

(iii) It is reasonable to suppose that the extinction coefficient, k, and the Secchi depth, d, are related.

Table 5.3 shows the values of k and d found at five locations.

Location	Crater Lake	Topaz Lake	Lake Superior	Lahontan Reservoir	Mississippi
Extinction coefficient *k* (per metre)	0.06	0.30	0.31	0.81	2.85
Secchi disc depth *d* (metres)	29.6	5.7	5.8	2.1	0.64

Table 5.3

An approximate rule connecting k and d is $kd = c$, where c is a constant.

Show that the rule is realistic for these data and find a suitable value of c. **[3]**

5 (iii)

6 This question refers to article D in the pre-release material, 'The transit method (for detecting exoplanets)'. You can find the article on the insert accompanying this paper.

(i) Astronomers suspected that a particular star was orbited by a planet.
The scatter diagram in Fig. 6.1 shows readings of the brightness of the star at times close to the suspected transit.

(*A*) Draw a curve on the graph that best fits these points. **[1]**

6 (i)(*A*)

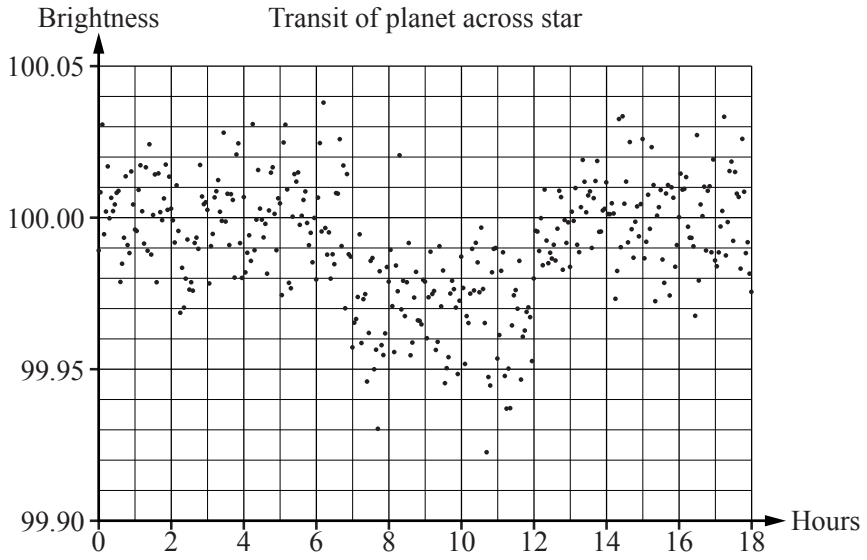

Fig. 6.1

(*B*) Use the formula given in the pre-release material and the curve you drew on Fig. 6.1 to calculate an estimate of the radius of the planet.
The star has a radius of 3.8×10^5 km. **[3]**

6 (i) (*B*)

(*C*) A nearly identical dip was observed about a thousand hours after the one above.

How many days does the planet take to orbit the star? **[1]**

6 (i) (*C*)

(ii) Fig. 6.2 shows the brightness graph of another star.
Observations were made each day for 75 days.

Use the brightness graph to make two deductions about any planets orbiting the star.
Do not do any calculations using the formula given in the pre-release material. **[2]**

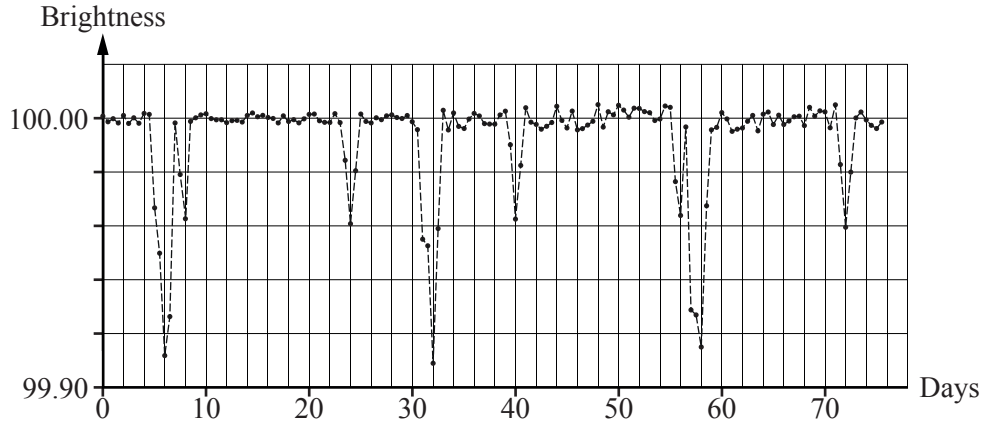

Fig. 6.2

6 (ii)	**Deduction 1**
	Deduction 2

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).