Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

Free-Standing Mathematics Qualification
Advanced Level
June 2013

Working with Algebraic and Graphical Techniques 6991/2

Unit 11

Monday 20 May 2013 9.00 am to 10.30 am

For this paper you must have:
- a clean copy of the Data Sheet (enclosed)
- a calculator
- a ruler.

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.
- You may **not** refer to the copy of the Data Sheet that was available prior to this examination. A clean copy is enclosed for your use.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 60.
- You may use either a scientific calculator or a graphics calculator.

Advice
- You do not necessarily need to use all the space provided.

Section A

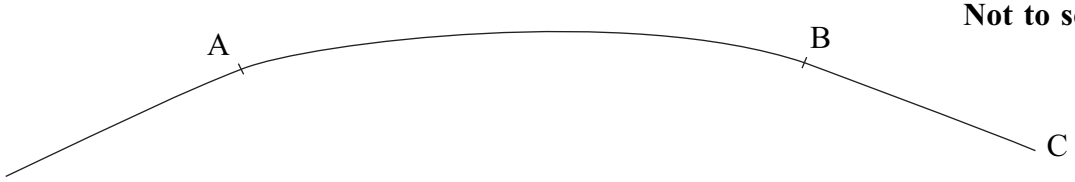
Answer **all** questions.

Answer each question in the space provided for that question.

Use **Bridges** *on page 2 of the Data Sheet.*

1

Not to scale



The diagram above represents the vertical cross-section of a road as it crosses a bridge.
The road goes uphill to the bridge, then downhill after the bridge.
The ends of the bridge, A and B, are at the same horizontal level.
The horizontal distance AB is 12 metres.
BC is a straight line.

The vertical cross-section of the road from A to B can be modelled by

$$y = 0.01x(k - x)$$

where x metres is the horizontal displacement from A, y metres is the vertical displacement from A, and k is a constant.

(a) State the value of k. *(1 mark)*

(b) Find the value of y when $x = 3$. *(1 mark)*

(c) Find the greatest height of the road above the level of A, and the horizontal distance from A at which this greatest value occurs. *(2 marks)*

(d) (i) Express y in the form

$$y = p - 0.01(x - q)^2$$

where p and q are constants. *(4 marks)*

(ii) How are the constants p and q related to your answers to part **(c)**? *(2 marks)*

(e) The point C has coordinates $(14, -0.24)$.
Find the gradient of BC. *(2 marks)*

(f) The vertical cross-section of another bridge can be modelled by

$$y = 0.005x(20 - x) \quad \text{for} \quad 0 \leqslant x \leqslant 20.$$

On the grid on page 5, plot the graph of y against x for $0 \leqslant x \leqslant 20$. *(3 marks)*

QUESTION PART REFERENCE

Answer space for question 1

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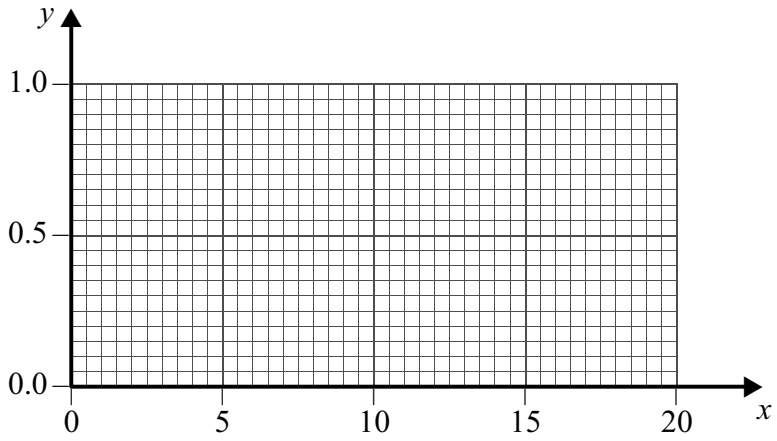

Section B

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Savings accounts** *on page 2 of the Data Sheet.*

2 The amount of money £M in a savings account, at time t days after the account is opened, is given by

$$M = 3800e^{0.00012t}$$

(a) Write down the initial amount of money in the account. *(1 mark)*

(b) Find how long it takes for the amount of money in the account to reach £3820. *(4 marks)*

(c) Find M when $t = 365$. Hence or otherwise find the AER for the savings account to three significant figures. *(3 marks)*

(d) Sketch the graph of M against t. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

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Answer space for question 2

Section C

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Comet** *on page 3 of the Data Sheet.*

3 The distance of the comet from Earth can be modelled for part of its path by

$$y = 1.8 - at^3$$

where y is the distance in astronomical units at time t days after 27 May 2011, and a is a constant.

(a) Complete the table below.

t	0	25	50	75	100
t^3					
y	1.80	1.77	1.69	1.38	0.84

(1 mark)

(b) On the grid opposite, plot the graph of y against t^3.
Draw a line of best fit on your graph. *(3 marks)*

(c) Use your graph to estimate the value of the constant a. *(2 marks)*

(d) Substitute your value of a into the equation

$$y = 1.8 - at^3$$

(i) Use your equation to predict when y would be zero according to this model.
(3 marks)

(ii) Interpret this result. *(1 mark)*

QUESTION PART REFERENCE

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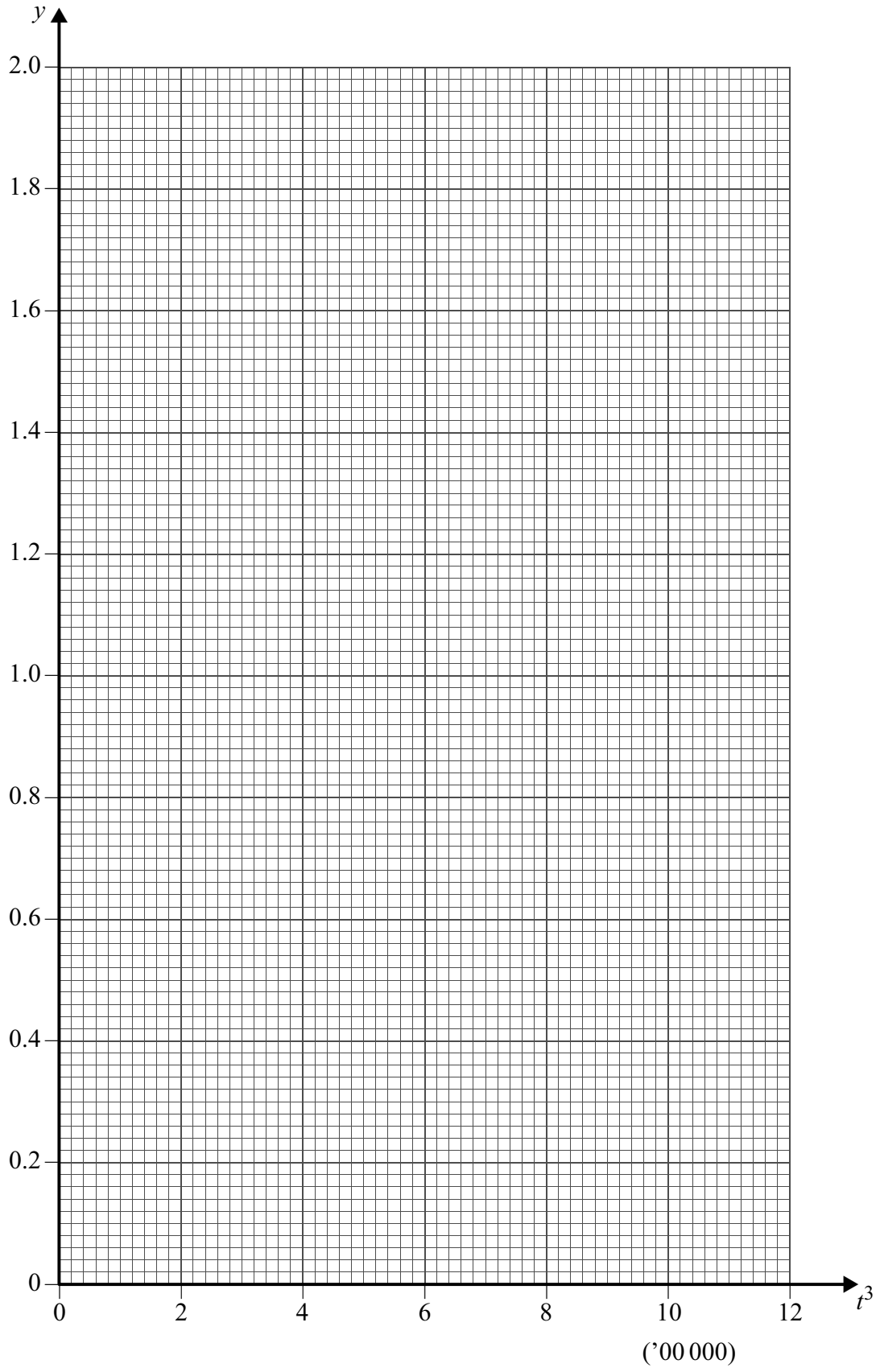

QUESTION PART REFERENCE

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Section D

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Decibels** *on page 3 of the Data Sheet.*

4 (a) Two loudspeakers are playing the same sound, but at different volumes.
The first loudspeaker produces a sound power of 0.12 watts.
The second loudspeaker produces a sound power of 58 watts.
Find the difference in decibels between the sound powers of the two loudspeakers.
(2 marks)

(b) D is the difference in decibels between two power quantities P_2 and P_1.

(i) Show that

$$P_2 = 10^{0.1D} P_1$$
(2 marks)

(ii) Find P_2 when $P_1 = 0.04$ and $D = 62$. *(2 marks)*

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

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Section E

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Sea ice** *on page 4 of the Data Sheet.*

5 The area of sea ice in the northern hemisphere in 2010 can be modelled by

$$y = 8.6 + 5.1\sin\{0.986(t + 20)\}^\circ \qquad (0 \leqslant t \leqslant 365)$$

where y million square kilometres is the area of sea ice, and t is the number of days after 1 January 2010.

(a) Complete this table, giving your values to three significant figures.

t	0	20	40	60	80	100	120	140	160
y	10.3	11.8	13.0	13.6					

(2 marks)

(b) Plot the graph of y against t on the grid opposite. *(2 marks)*

(c) If the actual sea ice area was 12.6 million square kilometres when t was 40, find the percentage error caused by using the model. *(3 marks)*

(d) (i) Estimate the gradient of the tangent to the graph when $t = 30$. *(2 marks)*

(ii) State the units of the gradient. *(1 mark)*

(iii) Give a practical interpretation of this result. *(1 mark)*

(e) Find one positive value of t which makes the area of sea ice equal to 6.4 million square kilometres. *(4 marks)*

(f) Describe fully the transformations which map the graph of $y = \sin t$ to the graph of $y = 8.6 + 5.1\sin t$. *(4 marks)*

QUESTION PART REFERENCE

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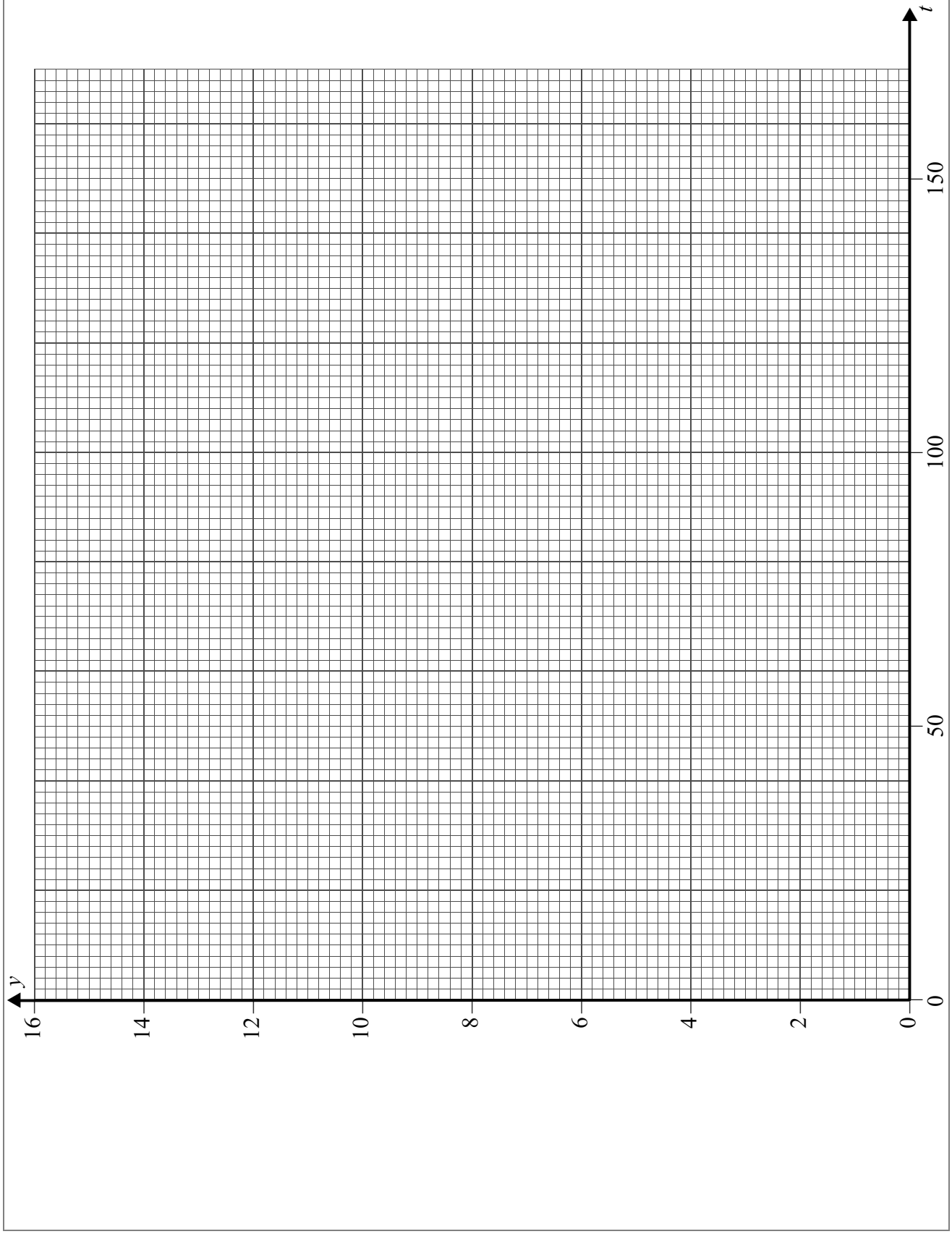

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END OF QUESTIONS