Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Use of Mathematics (Pilot) USE1

Algebra

Monday 18 May 2015 9.00 am to 10.00 am

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

Time allowed
- 1 hour

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, unless stated otherwise.
- 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 40.
- 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 **Boyle's Law** *on page 2 of the Data Sheet.*

1 A fixed mass of gas is kept at a constant temperature in a cylinder.
A piston is exerting pressure on the gas. As the piston moves, the pressure on the gas changes, and the volume of the gas also changes.

A scientist models the relationship between the volume, $V\,\mathrm{m}^3$, of the gas and the pressure, P pascals (Pa), on the gas with a model that states that the volume of the gas is inversely proportional to the pressure; that is

$$V = \frac{k}{P}$$

where k is a constant.

The volume of the gas is $6\,\mathrm{m}^3$ when its pressure is $50\,\mathrm{Pa}$.

(a) Find k and hence express V in terms of P.

[1 mark]

(b) Use your answer to part **(a)** to complete the table opposite.

[1 mark]

(c) On the grid opposite, draw a graph of V against P for $30 \leqslant P \leqslant 150$.

[2 marks]

(d) (i) Find the gradient of the graph when $P = 45$.

[2 marks]

(ii) State the units of this gradient.

[1 mark]

(iii) Interpret the meaning of this gradient.

[1 mark]

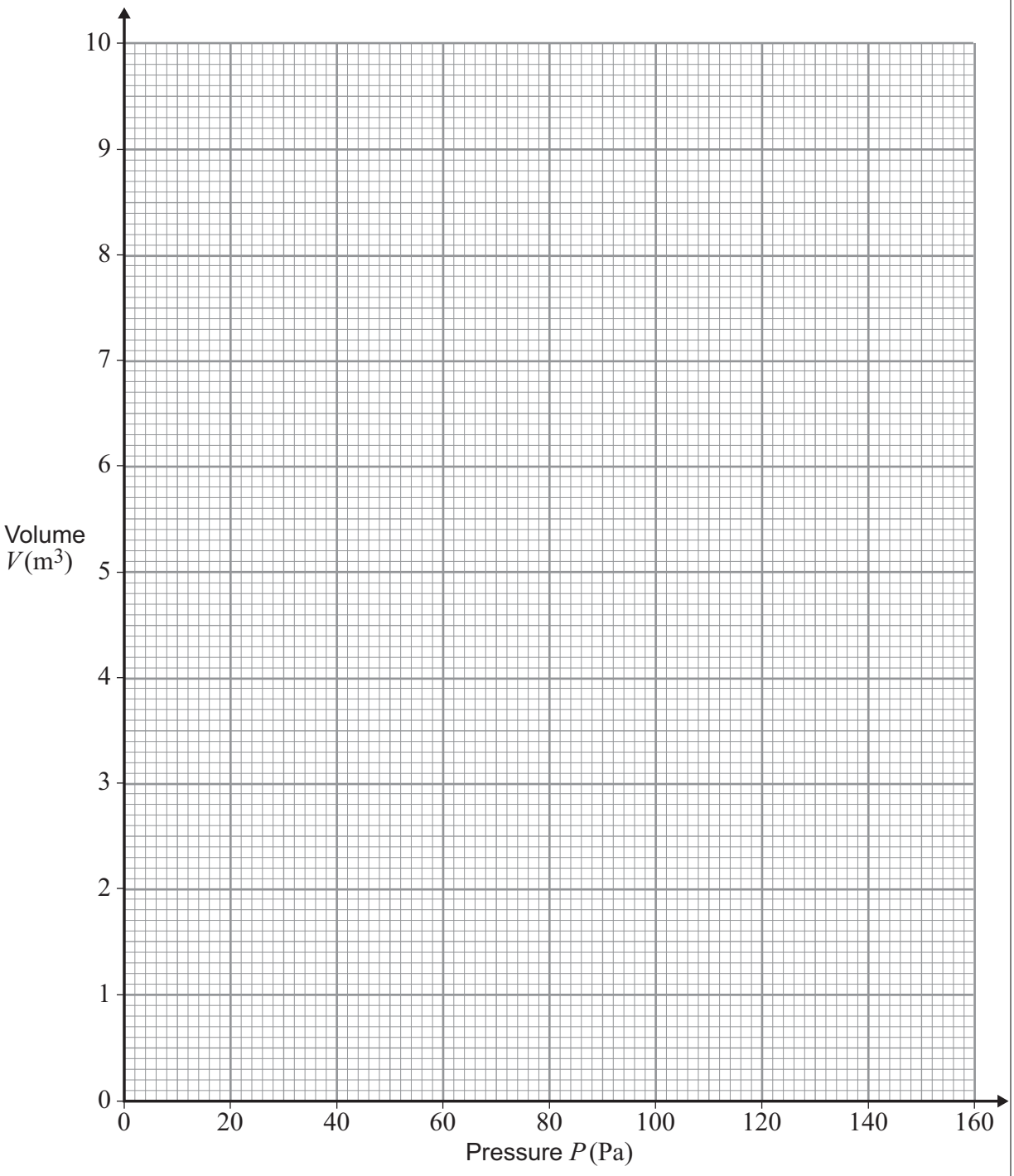
QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

P	30	40	50	75	100	150
V			6			



QUESTION PART REFERENCE

Answer space for question 1

QUESTION PART REFERENCE

Answer space for question 1

Section B

Answer **all** questions.

Answer each question in the space provided for that question.

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

2 Gemma, a restaurant owner, adds a new item, Pasta with Scampi, to her menu. She sells it at a different price each week, and finds that she can model the revenue using a quadratic function.

If £P is the price of a portion of Pasta with Scampi, and £R is the weekly revenue from selling Pasta with Scampi, Gemma models the relationship between them using the function

$$R = 120P - 5P^2$$

(a) Find the values of the unit price which make the revenue equal zero.

[2 marks]

(b) In the context of the restaurant, explain what is happening in each case when the revenue from selling Pasta with Scampi is zero.

[2 marks]

(c) Find the unit price which gives the maximum revenue.

[1 mark]

(d) Find the maximum revenue.

[2 marks]

(e) By forming and solving a quadratic equation of the form $aP^2 + bP + c = 0$, where a, b and c are constants, find the possible values of the unit price if the weekly revenue is £595.

[4 marks]

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

QUESTION PART REFERENCE

Answer space for question 2

Section C

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Ornaments** *on pages 4 and 5 of the Data Sheet.*

3 Martin experiments with different values of the tab width, w mm, for different values of the distance, r mm, from the tab to the centre of the ornament.

He finds that the values of w which work best for different values of r are those shown in the table below.

w	0.9	1.2	1.5	1.65	1.85
r	10	20	40	60	100

Martin thinks that the relationship between w and r may be modelled by an equation of the form

$$r = a^w$$

where a is a constant.

(a) For this model, show that

$$\ln r = w \ln a$$

[1 mark]

(b) Complete the table opposite, giving your answers to two decimal places.

[1 mark]

(c) On the grid opposite, plot $\ln r$ against w and draw a line of best fit.

[3 marks]

(d) Use your line of best fit to estimate the value of a, and write down an equation for r in terms of w.

[3 marks]

(e) Use your equation to find the tab width that would be needed, according to this model, if the distance from the tab to the centre of the ornament is 300 mm.

Give your answer to the nearest tenth of a millimetre.

[3 marks]

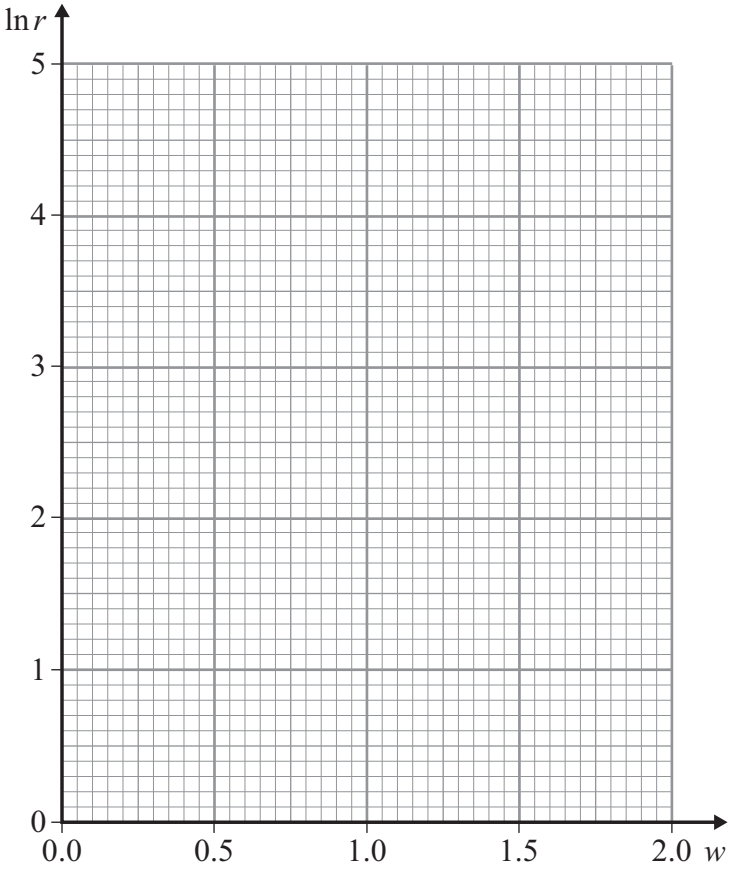
(f) Suggest a reason why the model might not actually be valid when the distance from the tab to the centre of the ornament is 300 mm.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 3

w	0.9	1.2	1.5	1.65	1.85
$\ln r$	2.30				



QUESTION PART REFERENCE

Answer space for question 3

QUESTION PART REFERENCE

Answer space for question 3

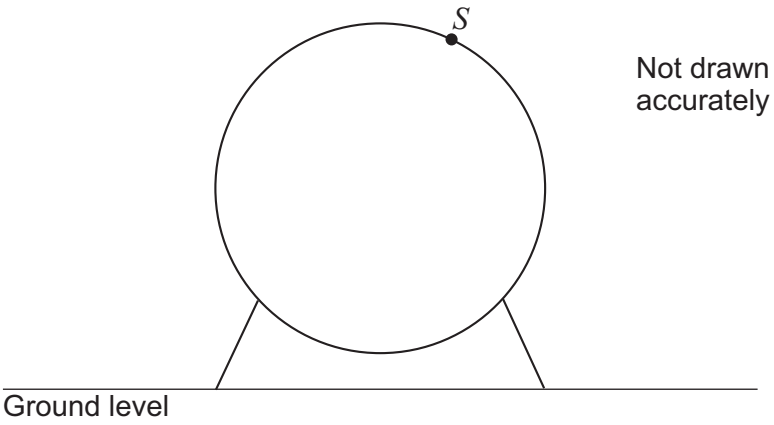
Section D

Answer **all** questions.

Answer each question in the space provided for that question.

Use **Big wheel** *on page 6 of the Data Sheet.*

4



(a) Sara is a passenger on a big wheel.

When Sara is at the point S, as shown above, the wheel has stopped to pick up other passengers.

The wheel then rotates anticlockwise with constant speed for several revolutions. At a time t seconds after the wheel starts to rotate, Sara's height above ground level, y metres, is given by

$$y = 12 + 11\sin[9(t + 7)]^\circ$$

(i) As the wheel rotates, how high above ground level is Sara at her lowest point and at her highest point?

[2 marks]

(ii) Find the time the wheel takes to make a complete revolution.

[2 marks]

(iii) At what time will Sara first be at a height of 7 metres?

[2 marks]

(b) Another big wheel has a radius of 8.5 metres.

Baz, a passenger on this wheel, starts at a point which is at the same horizontal level as the centre of the wheel.

The wheel then rotates anticlockwise at a constant speed, completing one revolution every 25 seconds.

At Baz's lowest point, he is 1.5 metres above ground level.

At a time t seconds after the wheel starts to rotate, Baz's height above ground level is h metres.

Find an equation which can be used to model h.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

END OF QUESTIONS