General Certificate of Secondary Education
June 2007

MATHEMATICS (SPECIFICATION A)   **3301/1H**
Higher Tier
Paper 1 Non-Calculator

H

For this paper you must have:
- mathematical instruments.

You must **not** use a calculator.

Time allowed: 2 hours

Instructions
- Use blue or black ink or ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You may ask for more answer paper, graph paper and tracing paper. This must be tagged securely to this answer book.

Advice
- In all calculations, show clearly how you work out your answer.

3301/1H

Formulae Sheet: Higher Tier

You may need to use the following formulae:

Volume of prism = area of cross-section × length
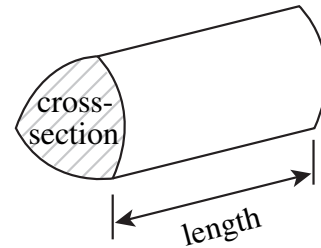
Volume of sphere = $\frac{4}{3}\pi r^3$

Surface area of sphere = $4\pi r^2$
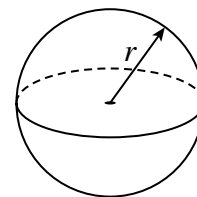
Volume of cone = $\frac{1}{3}\pi r^2 h$

Curved surface area of cone = $\pi r l$
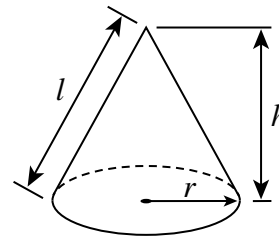
In any triangle *ABC*

Area of triangle = $\frac{1}{2}ab \sin C$

Sine rule $\quad \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

Cosine rule $\quad a^2 = b^2 + c^2 - 2bc \cos A$
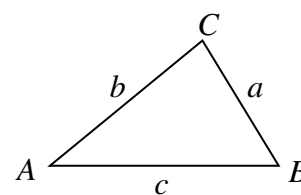
The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$, where $a \neq 0$, are given by

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

Answer **all** questions in the spaces provided.

1   Polly Parrot squawks every 12 seconds.
    Mr Toad croaks every 21 seconds.
    They both make a noise at the same time.

    After how many seconds will they next make a noise at the same time?

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            Answer .... seconds   *(2 marks)*

2   Use approximations to estimate the value of $\dfrac{8012}{48.61 \times 0.397}$

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            Answer ....   *(3 marks)*

Turn over for the next question

Turn over ▶

3 (a) Explain why the sum of the angles in any quadrilateral is 360°.

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(2 marks)

(b) A quadrilateral has one right angle.
The other angles are $2x$, $3x - 12$ and $x - 6$
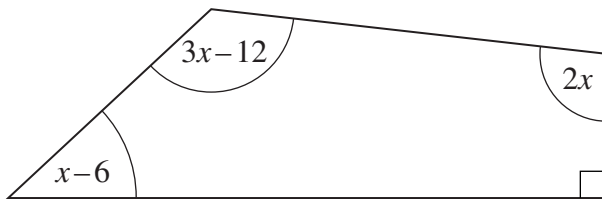
Not drawn accurately

(i) Write down an equation in terms of x.

Answer .... *(1 mark)*

(ii) Solve your equation and find the size of the largest angle in the quadrilateral.

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Answer $x =$ .... degrees

Largest angle = ... degrees   *(3 marks)*

4 The diagram shows a fair octagonal spinner.
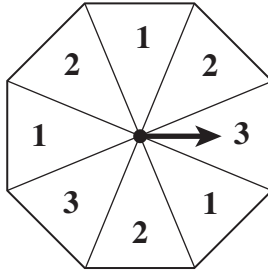
(a) Dave spins the spinner 20 times.
The results are shown in this table.

Spin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Result	1	3	1	2	3	2	1	2	1	2	3	3	2	1	2	2	1	2	3	1

(i) What is the relative frequency of the spinner landing on 1?

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Answer ....   *(2 marks)*

(ii) Steve also spins the spinner 20 times.

Explain why Steve may not get the same results as Dave.

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(1 mark)

(b) How many times would you expect a result of 3 if you spin the spinner 1000 times?

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Answer ....   *(2 marks)*

5 The diagram shows a network of one-way streets.
Vehicles travel in the direction of the arrows.
The fractions on the diagram show how the traffic divides at each junction.
300 vehicles enter the network at *A*.
All 300 vehicles leave the network at either *B* or *C* or *D*.
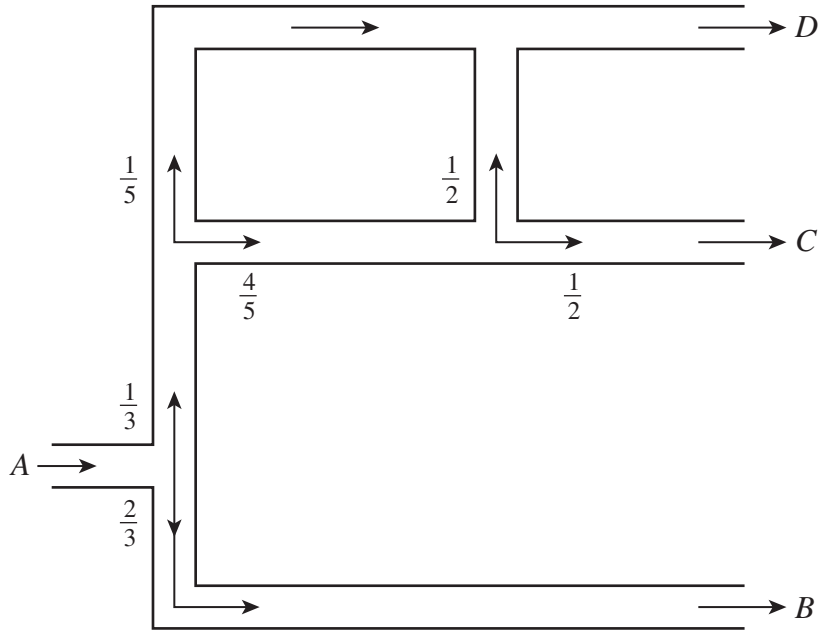
(a) Show that 200 vehicles leave the network at *B*.

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(2 marks)

(b) How many vehicles leave the network at *D*?

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Answer .... *(3 marks)*

6 The diagram shows two triangles, A and B.
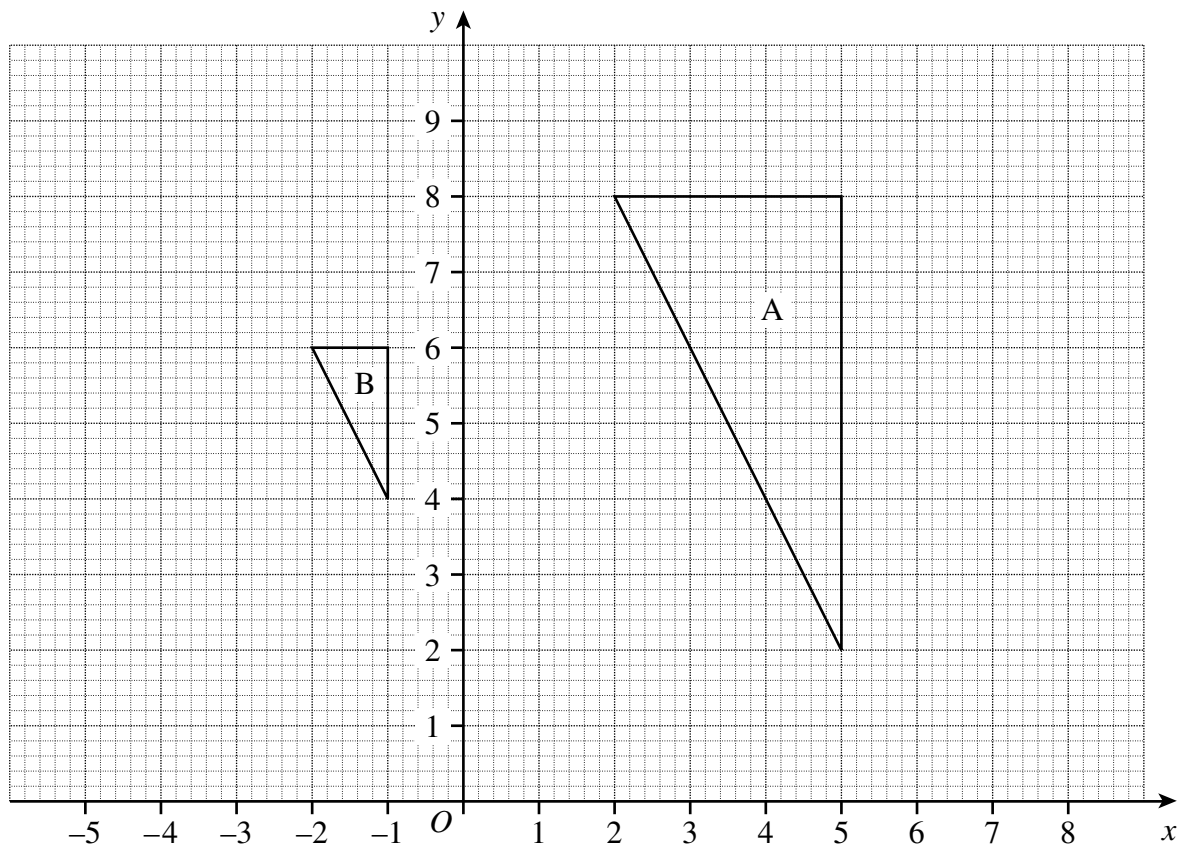
(a) Describe fully the **single** transformation that maps triangle A onto triangle B.

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(3 marks)

(b) On the diagram draw the image of triangle A after it is reflected in the line $y = x$
Label your image C.

(2 marks)

Turn over ▶

10

7 In the expressions in the table *x*, *y* and *z* represent lengths.

	Expression	Length	Area	Volume	None
A	xy		✔		
B	$xy(x + z)$				
C	$xy + z$				
D	y^2				

(a) Complete the table to show whether each expression could represent a length, an area, a volume or none of these.

(2 mark)

(b) Explain your answer for expression C.

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(1 mark)

8 (a) Simplify $x^3 \times x^5$

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Answer .... *(1 mark)*

(b) Simplify $y^{12} \div y^4$

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Answer .... *(1 mark)*

(c) Simplify $(3wt^2)^3$

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Answer .... *(2 marks)*

9 The table gives the diameter, in metres, of planets in the solar system.
The diameters are given to an accuracy of 3 significant figures.

Planet	Diameter (metres)
Mercury	4.88×10^6
Venus	1.21×10^7
Earth	1.28×10^7
Mars	6.79×10^6
Jupiter	1.43×10^8
Saturn	1.21×10^8
Uranus	5.11×10^7
Neptune	4.95×10^7
Pluto	2.39×10^6

(a) Which planet has the largest diameter?

Answer .... *(1 mark)*

(b) Which planet has the smallest diameter?

Answer .... *(1 mark)*

(c) Which planet has a diameter approximately 10 times that of Venus?

Answer .... *(1 mark)*

(d) Write 4.88×10^6 as an ordinary number.

Answer .... *(1 mark)*

(e) What is the diameter of Pluto in kilometres?
Give your answer in standard form.

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Answer .... km   *(2 marks)*

10 (a) A straight line has gradient 3 and passes through the point (–1, –2).

Draw the straight line on the grid below.

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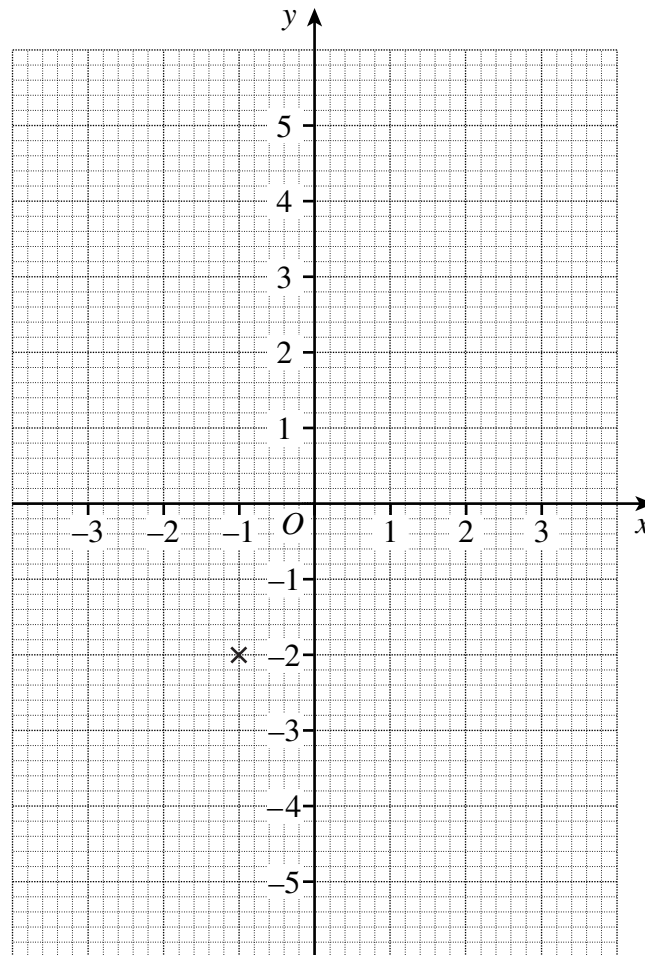
(2 marks)

(b) Work out the equation of the straight line that is perpendicular to the straight line in part (a) and passes through the point (0, 4).

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Answer ....   *(2 marks)*

11 The box plots show the lengths jumped by 50 boys and the lengths jumped by 50 girls in the triple jump.
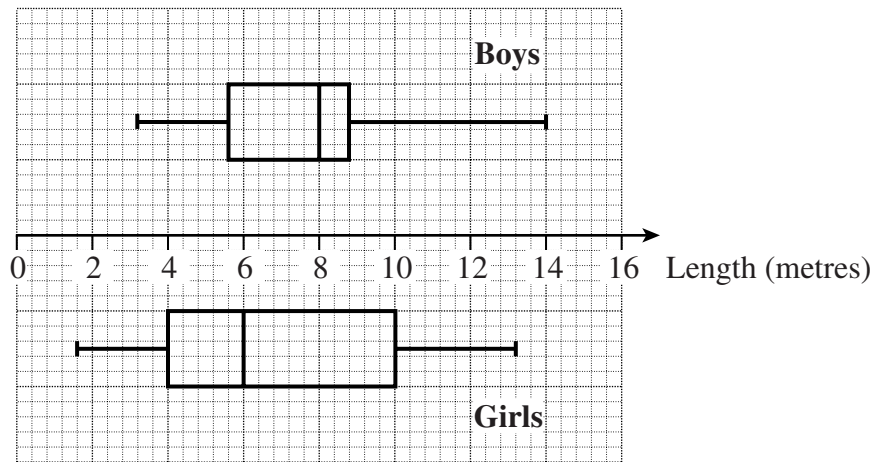
(a) What is the median length jumped by the girls?

Answer .... metres   *(1 mark)*

(b) Give **two** differences between the lengths jumped by the boys and the lengths jumped by the girls.

1st difference ....

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2nd difference ....

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(2 marks)

Turn over for the next question

12 Solve the simultaneous equations

$$5x + 6y = 28$$
$$x + 3y = 2$$

You **must** show your working.
Do **not** use trial and improvement.

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Answer x = ... , y = ...   *(3 marks)*

13 A semi-circle is cut from a circle.
The circle has a diameter of 30 cm.
The semi-circle has a diameter of 20 cm.
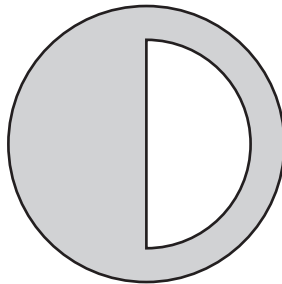
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Calculate the shaded area.
Give your answer in terms of π.
State the units of your answer.

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Answer ....   *(4 marks)*

14 (a) Solve $\frac{x}{4} + 1 = 6$

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Answer $x =$ .... *(2 marks)*

(b) Solve $\frac{4}{y + 1} = 3$

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Answer $y =$ .... *(3 marks)*

(c) Factorise fully $6ab^2 - 2ab$

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Answer .... *(2 marks)*

(d) Factorise $3x^2 + 5x - 12$

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Answer .... *(2 marks)*

Turn over ▶

16

15 *A*, *B* and *C* are three points on the circumference of a circle.
The line *SAT* is a tangent to the circle at *A*.
The line *RBT* is a tangent to the circle at *B*.
These tangents meet at *T*.
Angle *CAB* = 47° and angle *BTA* = 56°
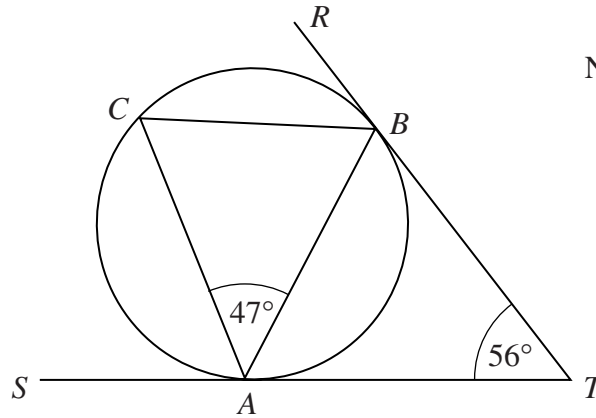
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(a) Calculate the size of angle *BAT*.

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Answer .... degrees   *(2 marks)*

(b) Calculate the size of angle *ABC*.

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Answer .... degrees   *(2 marks)*

16 (a) *P* is inversely proportional to *Q*.
When *P* = 100, *Q* = 32

Express *P* in terms of *Q*.

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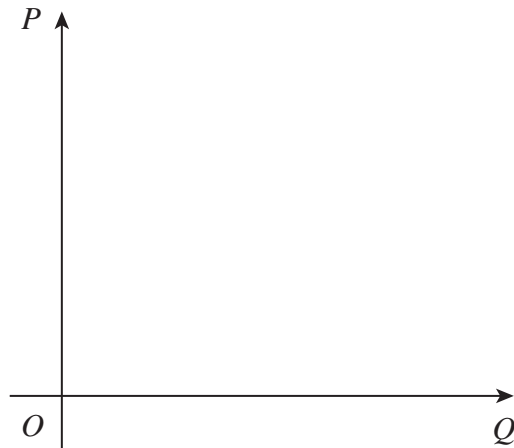
Answer .... *(3 marks)*

(b) *P* and *Q* are positive quantities.
Sketch a graph of the relationship between *P* and *Q* on this diagram.

P

O   *Q*

(1 mark)

(c) Calculate the value of *Q* when *P* is twice as big as *Q*.

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Answer .... *(2 marks)*

17 The diagram shows a square *OAPB*.
M is the mid-point of *AP*.
N is the mid-point of *BM*.
AP is extended to *Q* where $AQ = 1\frac{1}{2} AP$

$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$

Not drawn accurately
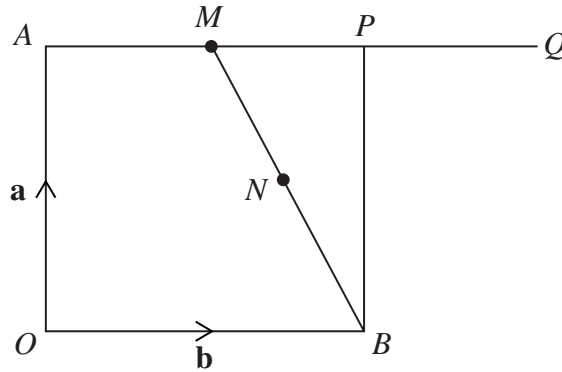
(a) Write these vectors in terms of **a** and **b**.
Give your answers in their simplest form.

(i) $\overrightarrow{OQ}$

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Answer .... *(1 mark)*

(ii) $\overrightarrow{BM}$

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Answer .... *(1 mark)*

(iii) $\overrightarrow{BN}$

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Answer .... *(1 mark)*

(iv) $\overrightarrow{ON}$

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Answer .... *(2 marks)*

(b) What can you deduce about points *O*, *N* and *Q*?
Give a reason for your answer.

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(2 marks)

18 The histogram represents the heights of plants, in centimetres, at a garden centre.

Frequency
density
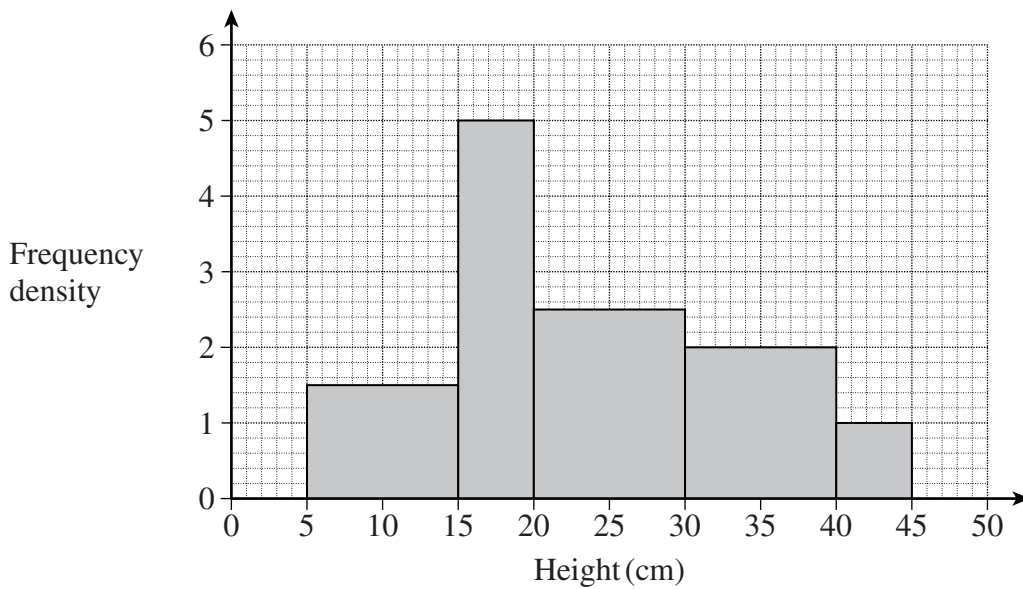
Height (cm)

(a) How many plants are represented by the histogram?

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Answer .... *(2 marks)*

(b) Estimate the median height of the plants.

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Answer .... cm *(2 marks)*

Turn over ▶

11

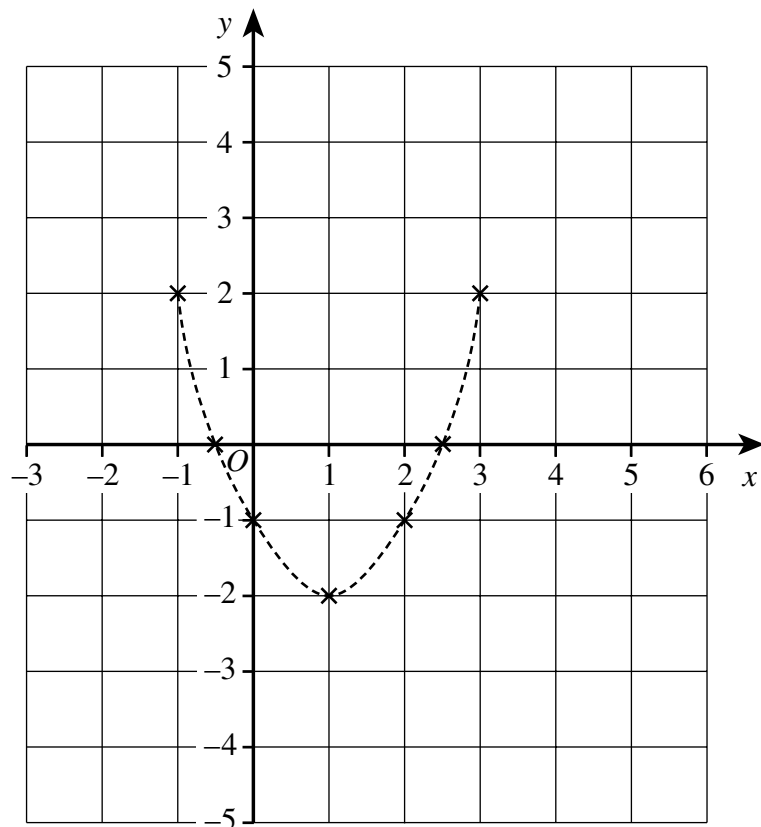**19** The diagram shows the graph of a function $y = f(x)$.
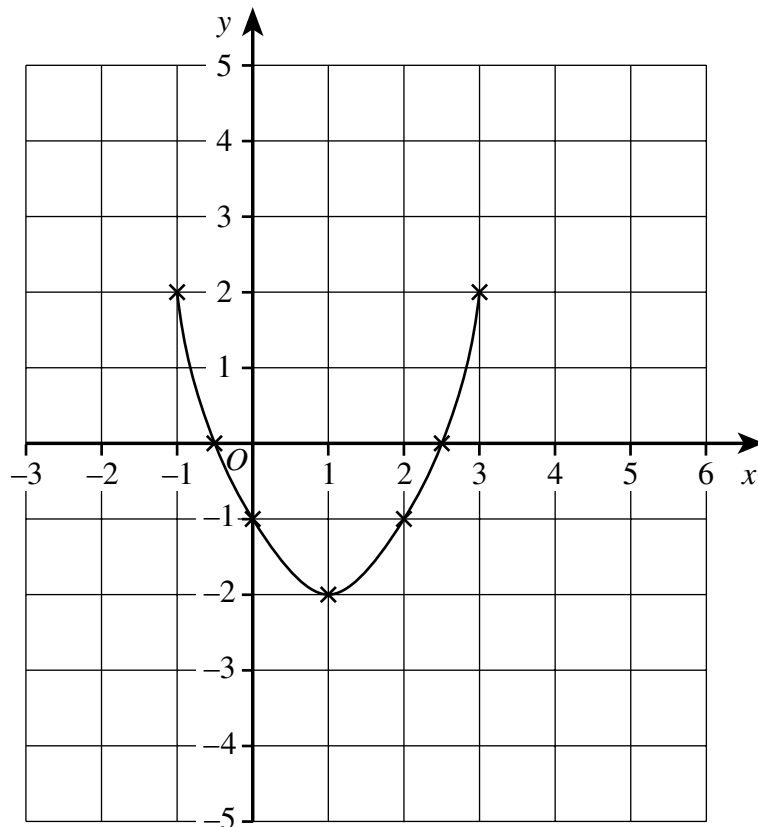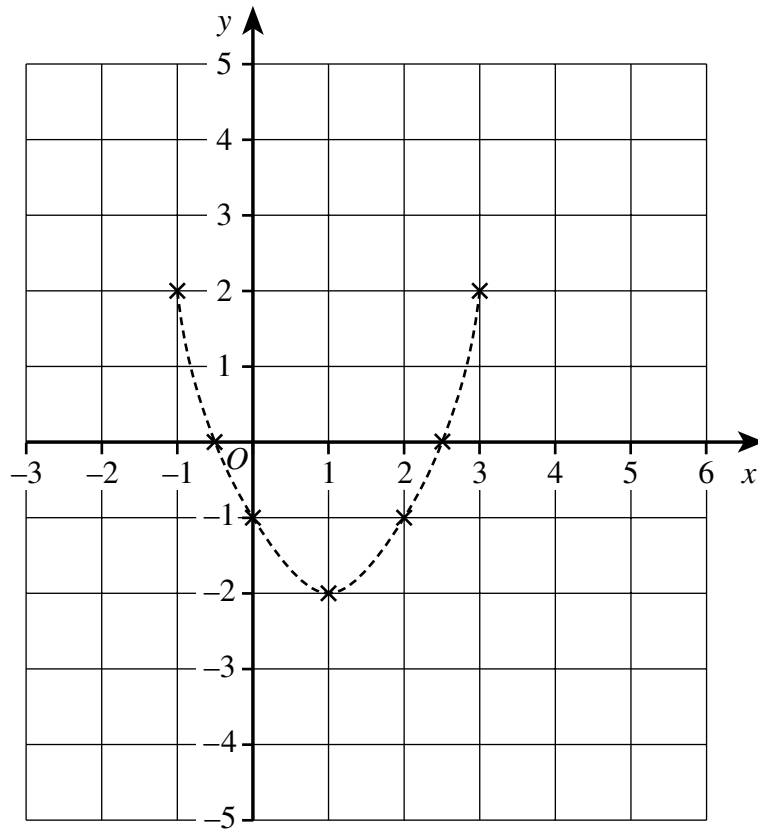

On the axes below sketch the graphs of each of these functions.
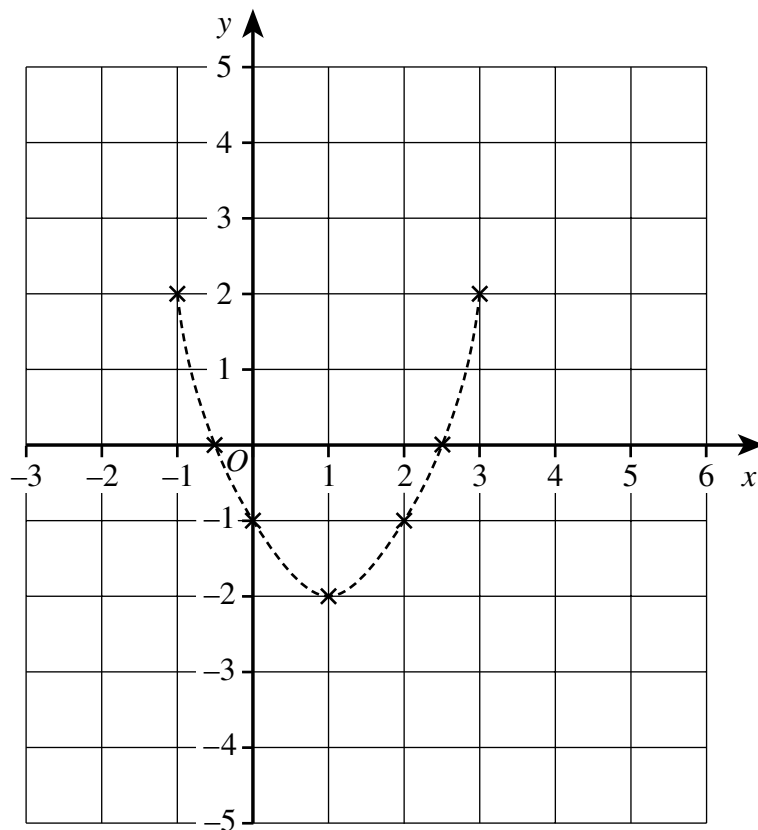In each case, the graph of $y = f(x)$ is shown to help you.

(a) $y = f(x) + 2$

(1 mark)

(b) $y = 2\,\mathrm{f}(x)$

(1 mark)

(c) $y = \mathrm{f}(2x)$

(1 mark)

Turn over ▶

$\boxed{3}$

20 (a) Show that $(\sqrt{32} + \sqrt{2})^2 = 50$

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(2 marks)

(b) The diagram shows a triangle *ABC* of area $30\,\text{cm}^2$.
The length of *AB* is $4\sqrt{3}\,\text{cm}$.
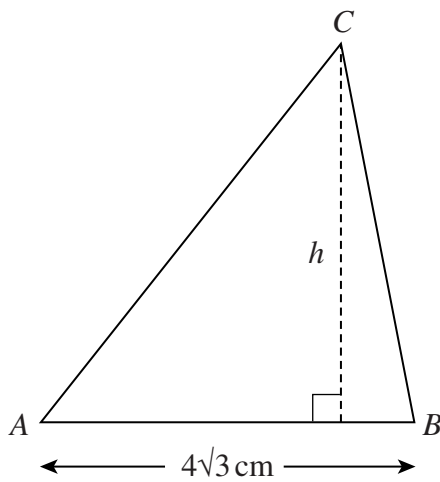
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Calculate the perpendicular height, *h*, of the triangle.
Write your answer in the form $p\sqrt{3}$, where *p* is an integer.

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Answer .... cm   *(3 marks)*

21 (a) Find the values of *a* and *b* such that

$$x^2 + 6x - 11 \equiv (x + a)^2 + b$$

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Answer *a* = ... ,   *b* = ...   *(3 marks)*

(b) Hence, or otherwise, solve the equation $x^2 + 6x - 11 = 0$
Give your answers in surd form.

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Answer ....   *(2 marks)*

Turn over for the next question

Turn over ▶

10

22 In the diagram *ABCD* and *PQRC* are squares.
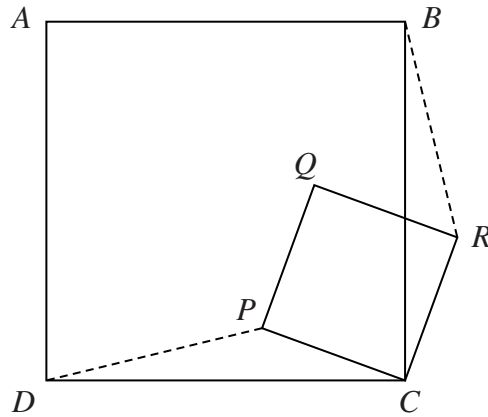
Use congruent triangles to prove that *DP = BR*

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(4 marks)

END OF QUESTIONS

4

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