

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

Level 2 Certificate FURTHER MATHEMATICS

Paper 1 Non-Calculator

Thursday 15 June 2017

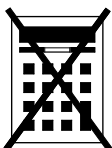
Morning

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- mathematical instruments.
- You must **not** use a calculator.



Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

For Examiner's Use

Pages	Mark
3	
4 – 5	
6 – 7	
8 – 9	
10 – 11	
12 – 13	
14 – 15	
16 – 17	
18 – 19	
20	
TOTAL	

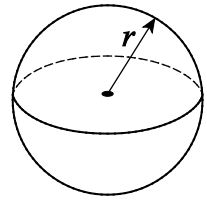


J U N 1 7 8 3 6 0 1 0 1

Formulae Sheet

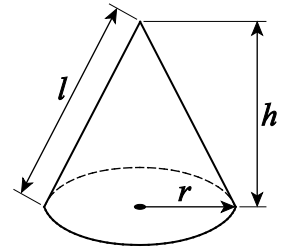
Volume of sphere $= \frac{4}{3} \pi r^3$

Surface area of sphere $= 4\pi r^2$



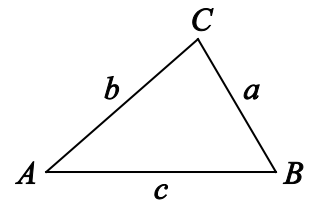
Volume of cone $= \frac{1}{3} \pi r^2 h$

Curved surface area of cone $= \pi r l$



In any triangle ABC

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



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

Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$, where $a \neq 0$, are given by $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Trigonometric Identities

$$\tan \theta \equiv \frac{\sin \theta}{\cos \theta} \quad \sin^2 \theta + \cos^2 \theta \equiv 1$$



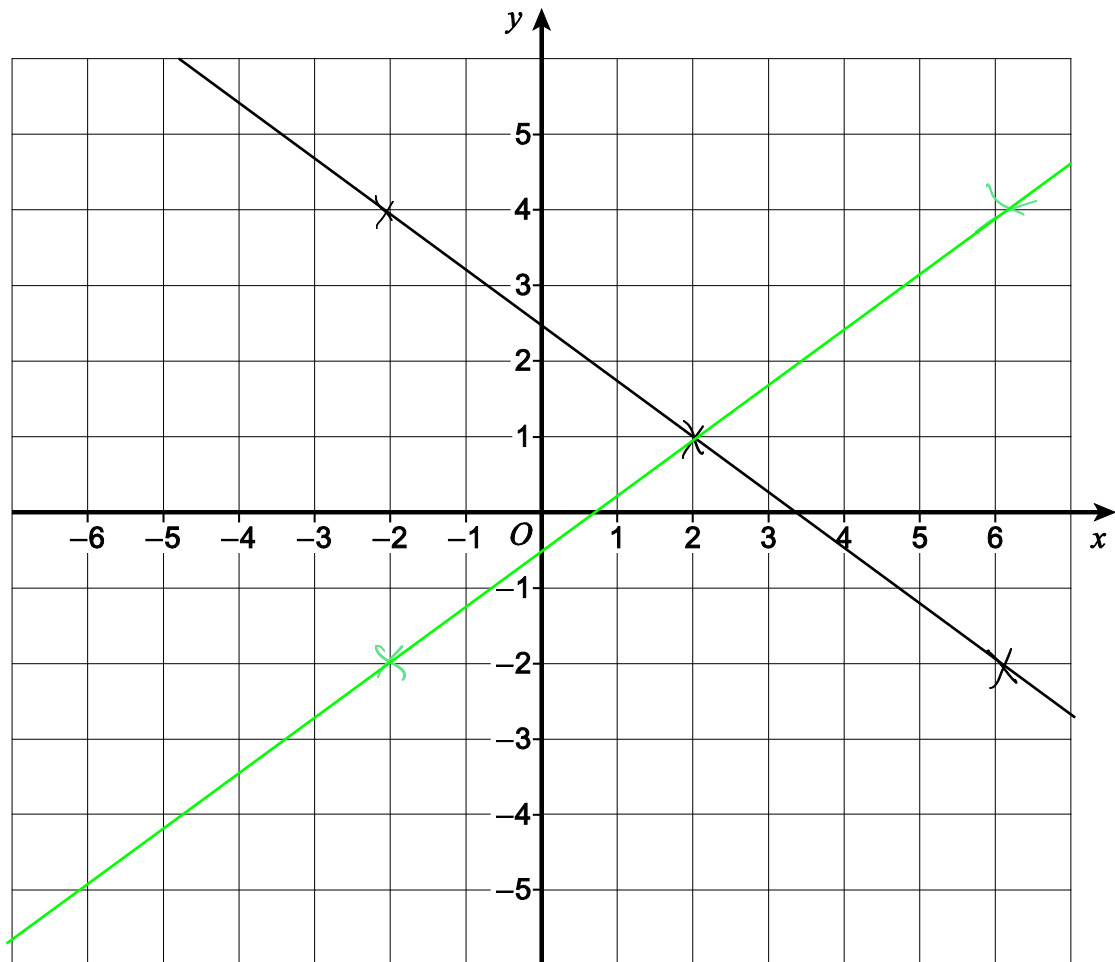
Answer **all** questions in the spaces provided.

1

On the grid below, draw a straight line through (2, 1) with gradient $\frac{3}{4}$

[2 marks]

$$\frac{3}{4} \text{ is } -\frac{3}{4}$$



Turn over ►



2 A curve has equation $y = ax^2 + 3x$ where a is a constant.

When $x = -1$, the gradient of the curve is -5

Work out the value of a .

[3 marks]

$$\frac{dy}{dx} = 2ax + 3$$

$$2ax + 3 = -5$$

$$-2a + 3 = -5$$

$$-2a = -8$$

$$a = 4$$

$a =$ _____



- 3 (a) On the axes below, sketch the graph of $y = x^2 + 7x - 18$

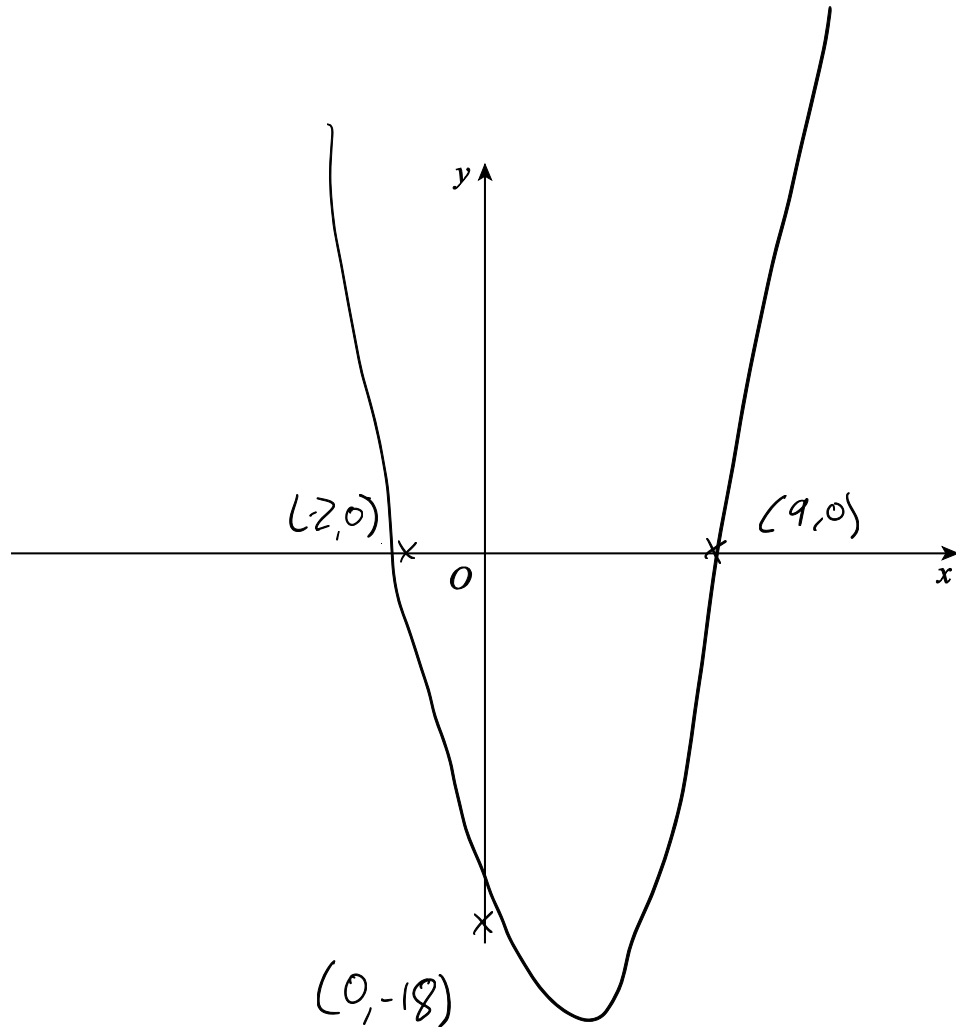
Label all points of intersection with the axes.

You do **not** need to work out the coordinates of any stationary points.

$$(x-9)(x+2)$$

$$+9 \quad -2$$

[3 marks]



- 3 (b) Work out the equation of the line of symmetry of the graph of $y = x^2 + 7x - 18$

[1 mark]

$$\frac{-2+9}{2} = 3.5$$

$$x = -3.5$$

Answer $y = 3.5$

Turn over ►



4

A straight line passes through the points $(-4, 7)$, $(6, -5)$ and $(8, t)$

Use an algebraic method to work out the value of t .

You **must** show your working.

[3 marks]

$$m = \frac{dy}{dx} = \frac{-5-7}{6-(-4)} = \frac{-12}{10} = -\frac{6}{5}$$

$$y = -\frac{6x}{5} + c$$

$$7 = \frac{-6(-4) + c}{2}$$

$$7 = 12 + c$$

$$c = -5$$

$$c = -2.2$$

$$y = -\frac{6x}{5} - 5$$

$$t = -\frac{6 \times 8}{5} - \frac{25}{5}$$

$$= \frac{48-25}{5}$$

$$= \frac{23}{5} = 4\frac{3}{5}$$

$t =$ _____

①



5 $(x + 4)(x^2 - kx - 5)$ is expanded and simplified.

The coefficient of the x^2 term is twice the coefficient of the x term.

Work out the value of k .

[3 marks]

$$= x^3 - kx^2 - 5x + 4x^2 - 4kx - 20$$

$$= x^3 + (4 - k)x^2 - (5 + 4k)x - 20$$

$$4 - k = 2 \times (5 + 4k)$$

$$4 - k = 10 + 8k$$

$$-14 = 7k$$

$$k = -2$$

$$k = -2$$

Turn over for the next question



6

Factorise fully $(x+6)^4 + (x+6)^3(3x+4)$
Do **not** attempt to expand the brackets.

①
[3 marks]

$$= (x+6)^3 ((x+6)(3x+4))$$

$$= (x+6)^3 (x+6)(3x+4)$$

$$(x+6)^3 (4x+10)$$

$$FA: 2(x+6)^3 (2x+5)$$

Answer _____



7 The function f is given by $f(x) = \sqrt{2x - 5}$

- 7 (a) Which of these inequalities is a possible domain for $f(x)$?
Circle the inequality.

$$x \geq 0$$

$$x \geq \frac{2}{5}$$

$$x \geq 2$$

$$x \geq \frac{5}{2}$$

[1 mark]

- 7 (b) Work out x when $f(x) = 1.2$

$$\sqrt{2x-5} = 1.2 = \frac{6}{5}$$

$$2x-5 = \frac{36}{25}$$

$$2x = \frac{36+25}{25} = \frac{61}{25}$$

$$x = \frac{61}{50}$$

$$x =$$

[2 marks]

- 7 (c) Work out the value of $f\left(2\frac{5}{8}\right) = \frac{21}{8}$

Give your answer as a fraction in its simplest form.

$$= \sqrt{2x-5} = \sqrt{\frac{21}{4}-5}$$

$$= \sqrt{\frac{21}{4}-5}$$

$$= \sqrt{\frac{1}{4}} = \frac{\sqrt{1}}{\sqrt{4}} = \frac{1}{2}$$

[3 marks]

Answer _____



8

The first four terms of a quadratic sequence are

$\begin{array}{ccccccc} & & +8 & & +8 & & \\ & \nearrow & & \nwarrow & \nearrow & & \nwarrow \\ +23 & & +31 & & +39 & & \\ \nwarrow & & \nearrow & & \nwarrow & & \nearrow \\ 10 & 33 & 64 & 103 & \dots \end{array}$

Work out an expression for the n th term.

[4 marks]

P_{nth} : 10 33 64 103

n^2 : 4 16 36 64

Off : 6 17 28 39

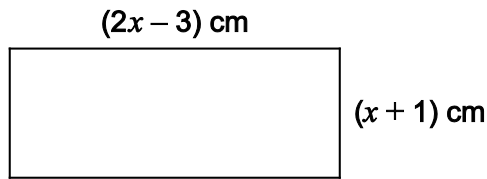
$\begin{array}{ccccccc} & +11 & & +11 & & +11 & & +11 \\ & \nearrow & & \nwarrow & \nearrow & & \nwarrow & \nearrow \\ -5 & 6 & 17 & 28 & 39 & & & \end{array}$

$$= n^2 + 11n - 5$$

Answer _____



- 9 Here is a rectangle.



Not drawn
accurately

- 9 (a) Show that the area of the rectangle is $2x^2 - x - 3 \text{ cm}^2$

$$A = wh$$

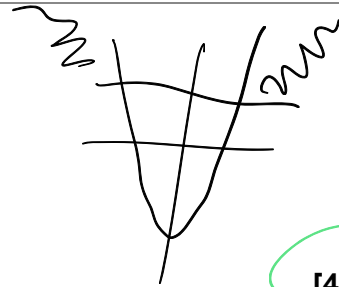
$$= (2x - 3)(x + 1)$$

$$= 2x^2 - x - 3$$

[1 mark]

- 9 (b) The area of the rectangle is greater than 7 cm^2

Work out the range of possible values of x .
Give your answer as an inequality.



[4 marks]

$$2x^2 - x - 3 > 7$$

$$2x^2 - x - 10 > 0$$

$$(2x - 5)(x + 2) > 0$$

$$x < -2, x > 2.5$$

$2x - 5$ cannot be neg,
so discard

Answer

$$x > 2.5$$



10

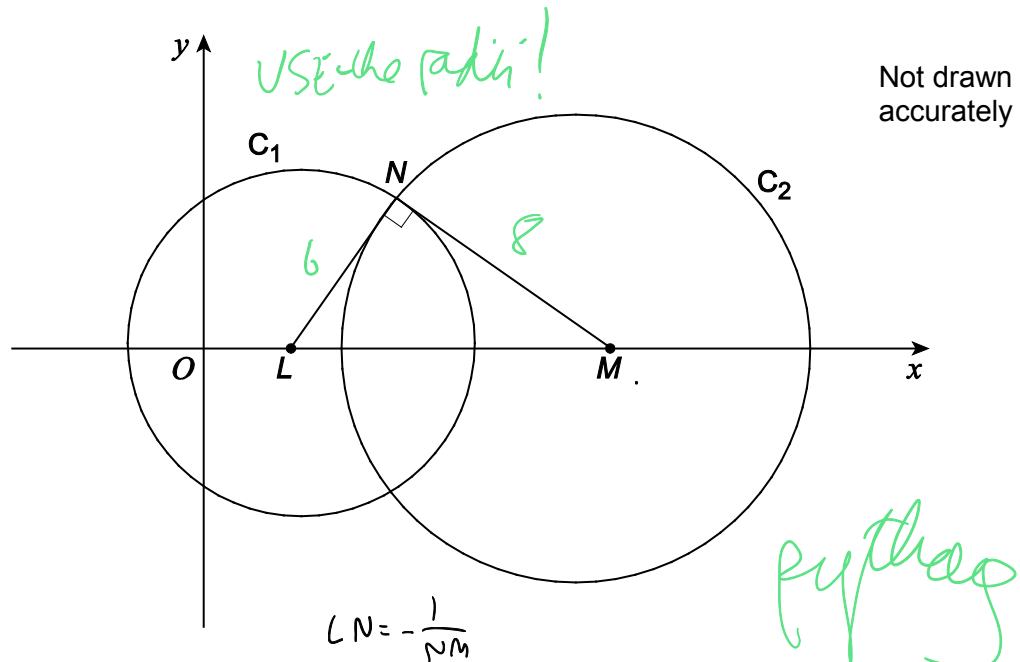
Circle C_1 has centre L and equation $(x-3)^2 + y^2 = 36$ AKA: $x^2 - 6x - 27 + y^2 = 0$

Circle C_2 has centre M and equation $(x-h)^2 + y^2 = 64$ where h is a constant.

AKA: $x^2 - 2hx - 64 + h^2 + y^2 = 0$

The circles intersect at N .

LN is perpendicular to MN .



$$LN = -\frac{1}{NM}$$

$$\frac{N_x - 3}{N_y} = \frac{h - N_x}{-N_y}, \quad N_x - 3 = N_x - h$$

Work out the value of h .

[4 marks]

$$x^2 - 6x - 27 + y^2 = x^2 - 2hx - 64 + h^2 + y^2$$

$$-6x - 27 + 64 + 2hx + h^2 = 0$$

$$h^2 + (2h-6)x = 37$$

$h = 3$



11

Simplify fully $\frac{x}{x-3} + \frac{6}{(x-3)(x-5)}$

[4 marks]

$$= \frac{x \cancel{(x-3)}(x-5) + 6 \cancel{(x-3)}}{(x-3)^2(x-5)} = \frac{x(x-5)+6}{(x-3)(x-5)}$$

$$= \frac{x^2-5x+6}{x^2-8x+15} = \frac{\cancel{(x-3)}(x-2)}{\cancel{(x-3)}(x-5)} = \frac{x-2}{x-5}$$

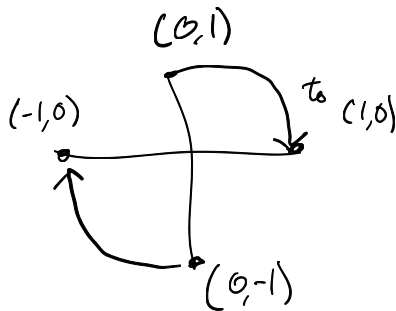
Answer _____

Turn over ►



12 The transformation matrix **M** represents a 90° clockwise rotation about the origin.

12 (a) Write down the matrix **M**.



$$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \rightarrow \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} \quad [1 \text{ mark}]$$

$$\mathbf{M} = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$$

12 (b) Describe fully the **single** transformation represented by \mathbf{M}^2 .

[2 marks]

Rotate 180° around the origin

12 (c) Write down the matrix for the **single** transformation represented by \mathbf{M}^2 .

[1 mark]

$$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$\mathbf{M}^2 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$



13

Solve $x^{-\frac{1}{4}} = 0.2$

[3 marks]

$$\frac{1}{\sqrt[4]{x}} = \frac{1}{5}$$

$$\sqrt[4]{x} = 5$$

$$x = 5^4 = 25 \times 5^2 = 125 \times 5 = 625$$

x =

625

Turn over for the next question

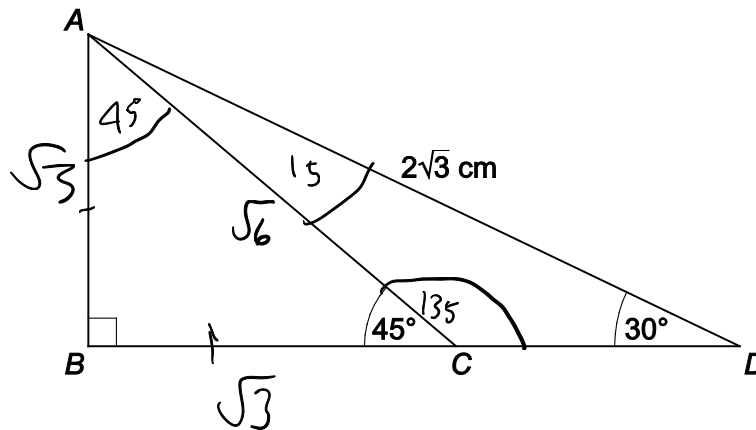
Turn over ►



14

In the diagram, BCD is a straight line.

$$AD = 2\sqrt{3} \text{ cm}$$

Not drawn
accuratelyWork out the exact length of CD .Give your answer in the form $a + b\sqrt{3}$ where a and b are integers.

[4 marks]

$$\frac{a}{\sin A} = \frac{b}{\sin B} \quad \frac{2\sqrt{3}}{\sin 90} = \frac{AB}{\sin 30} \quad AB = 2\sqrt{3} \times \frac{1}{2} = \sqrt{3}$$

$$a^2 + b^2 = c^2$$

$$AC = \sqrt{3+3} = \sqrt{6}$$

$$a^2 + b^2 = c^2, \quad b^2 = c^2 - a^2$$

$$BD = \sqrt{12-3} \quad CD = BD - \sqrt{3}$$

$$= \sqrt{9} = 3$$

$$= 3 - \sqrt{3}$$

$$CD = \underline{\hspace{2cm}}$$



15

The continuous curve $y = f(x)$ has exactly three stationary points.

The three stationary points are

a minimum point P at (a, b) where $a < 0$ and $b < 0$

a point of inflection Q at $(0, 3)$

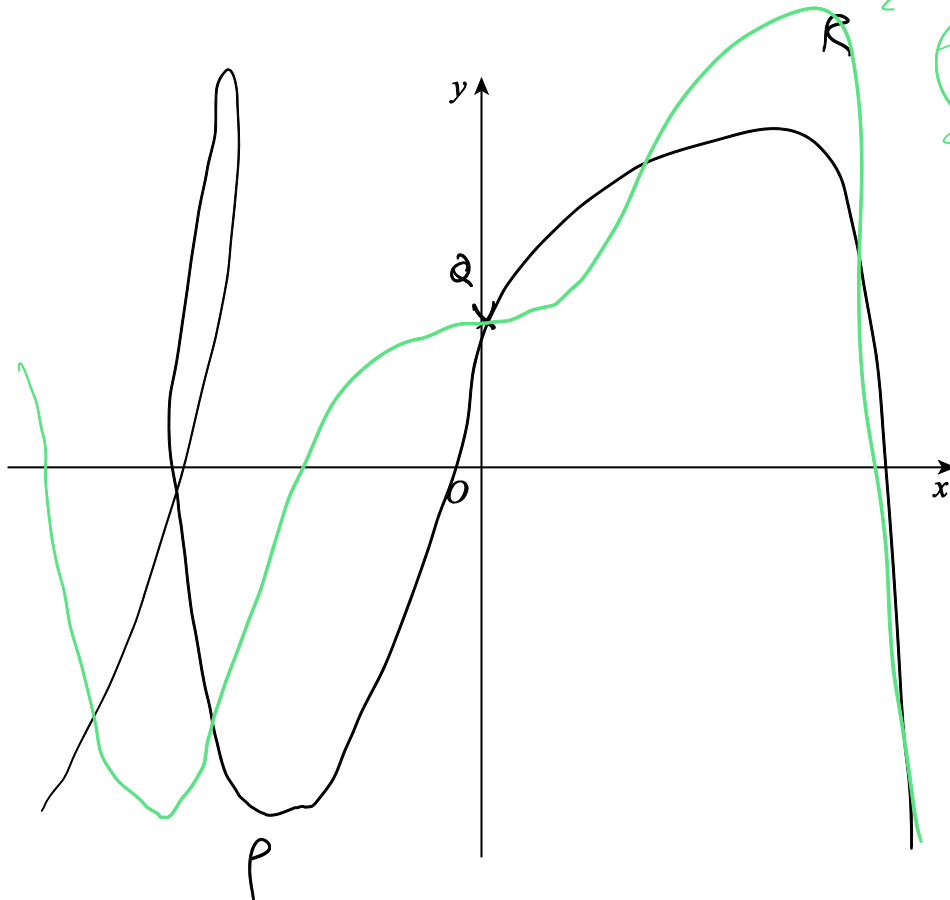
a maximum point R at (c, d) where $c > 0$ and $d > 3$

The curve cuts the x -axis at three distinct points.

On the axes below, sketch the curve.

Label the points P , Q and R on your sketch.

[4 marks]



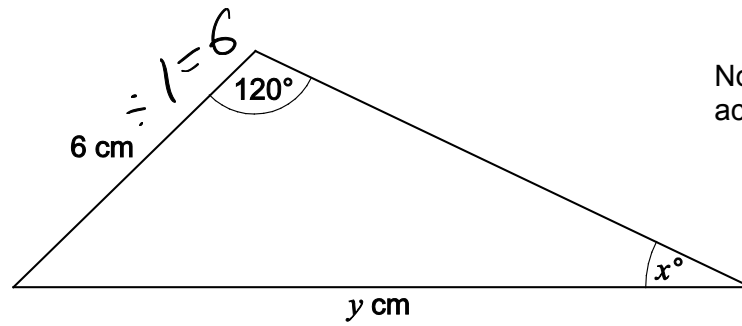
Turn over for the next question

Turn over ►



16

Here is a triangle.

Not drawn
accurately

$$\sin x^\circ = \frac{1}{\sqrt{12}}$$

$$\sin \theta = \frac{0}{4}$$

$$= \sqrt{12} \times 6 = 12\sqrt{3}$$

Work out the value of y .

NOT RAT
use sin rule

[4 marks]

$$y = 12\sqrt{3} \quad 18$$



17 (a) Factorise $2x^2 + 7x + 5$

[2 marks]

Answer $(2x+5)(x+1)$

17 (b) Hence, or otherwise, work out the value of θ between 0° and 360° for which

$$2\sin^2\theta + 7\sin\theta + 5 = 0$$

$$\sin\theta = -1$$

$$\theta = 270^\circ$$

[3 marks]

$$(2\sin\theta + 5)(\sin\theta + 1) = 0$$

$$2\sin\theta = -5$$

$$\sin\theta = -5/2$$

$|\sin\theta|$ cannot be > 1 , so discard

$$\theta = 270^\circ$$

Turn over ►



18

Simplify fully $\frac{24 - \sqrt{300}}{4\sqrt{3} - 5}$ Give your answer in the form $a\sqrt{b}$ where a and b are integers.

[5 marks]

$$\begin{aligned}
 &= \frac{24 - \sqrt{300}}{4\sqrt{3} - 5} \times \frac{-5 - 4\sqrt{3}}{-5 - 4\sqrt{3}} = \frac{-120 - 96\sqrt{3} + 5\sqrt{300} + 4\sqrt{900}}{25 - 48} \\
 &= \frac{-120 - 96\sqrt{3} + 50\sqrt{3} + 120}{-23} \\
 &= \frac{-46\sqrt{3}}{-23} \\
 &= 2\sqrt{3}
 \end{aligned}$$

Answer $2\sqrt{3}$ **END OF QUESTIONS****Copyright Information**

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