

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 2 Calculator

Monday 17 June 2019

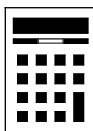
Afternoon

Time allowed: 2 hours

Materials

For this paper you must have:

- a calculator
- mathematical instruments.



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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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 105.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.
- The use of a calculator is expected but calculators with a facility for symbolic algebra must **not** be used.

For Examiner's Use

Pages	Mark
3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
26–27	
28–29	
30	
TOTAL	



J U N 1 9 8 3 6 0 2 0 1

IB/M/Jun19/E6

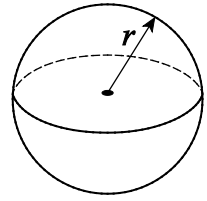
8360/2

Formulae Sheet

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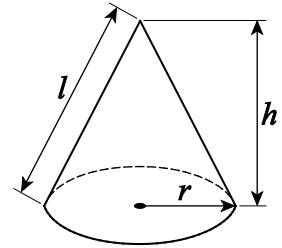
Volume of sphere $= \frac{4}{3} \pi r^3$

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



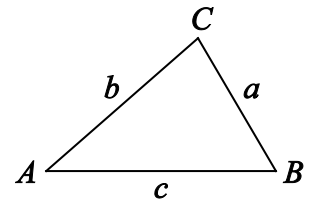
Volume of cone $= \frac{1}{3} \pi r^2 h$

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.

Do not write
outside the
box

1 (a) $a \begin{pmatrix} 3 \\ 5 \end{pmatrix} = 4 \begin{pmatrix} 2a+3 \\ b \end{pmatrix}$

Work out the values of a and b .

[3 marks]

$a =$ _____ $b =$ _____

1 (b) $\begin{pmatrix} m & -1 \\ 1 & 1 \end{pmatrix} \begin{pmatrix} 2 & 2 \\ -2 & -1 \end{pmatrix} = \mathbf{I}$ where $\mathbf{I}$ is the identity matrix.

Work out the value of m .

[2 marks]

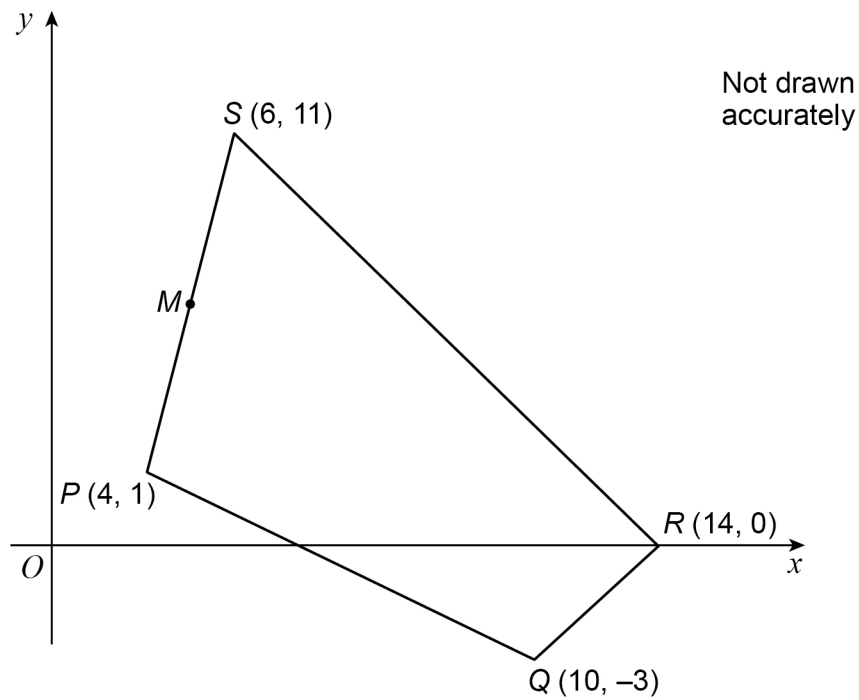
Answer _____

Turn over ►



2 Here is a sketch of quadrilateral $PQRS$.

M is the midpoint of PS .



Use gradients to show that MR is parallel to PQ .

[3 marks]



3 $-2 < a < 0$ and $-1 < b < 1$

Tick the correct box for each statement.

[4 marks]

	Always true	Sometimes true	Never true
$a^2 < 0$	☐	☐	☐
$-1 < b^3 < 1$	☐	☐	☐
$\frac{b}{a} < 0$	☐	☐	☐
$a - b > 0$	☐	☐	☐

Turn over for the next question

Turn over ►



4

P is a point on a curve.

The curve has **gradient function** $\frac{x^5 - 17}{10}$

The tangent to the curve at P is parallel to the line $3x - 2y = 9$

Work out the x -coordinate of P .

[4 marks]

Answer _____



5 (a) Write $\sqrt[4]{a \times a^{-9}}$ as an integer power of a .

[2 marks]

Answer _____

5 (b) Simplify fully $\frac{(4cd^2)^3}{2cd^4}$

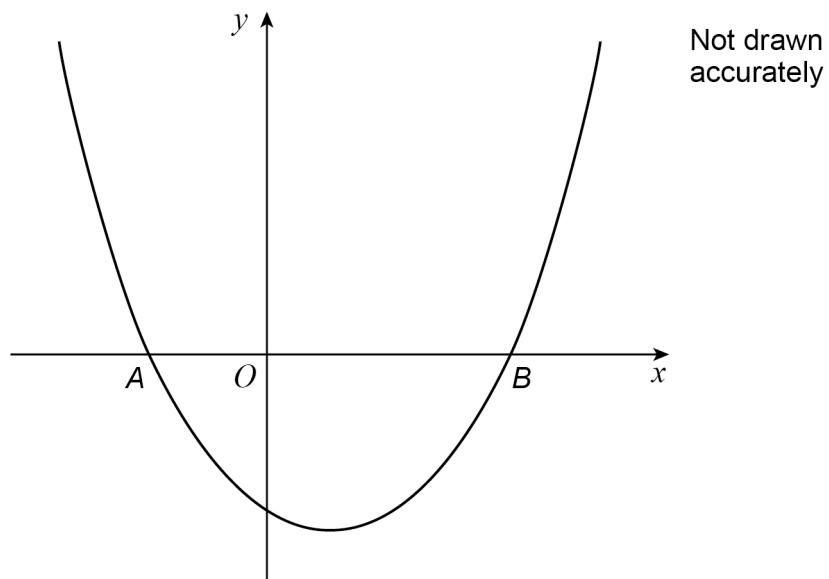
[3 marks]

Answer _____

Turn over for the next question



- 6** Here is a sketch of the curve $y = (2x + 3)(x - 2)$
The curve intersects the x -axis at A and B .



- 6 (a)** Complete the coordinates of A and B .

[2 marks]

A (_____ , 0)

B (_____ , 0)

- 6 (b)** Write down the range of values for x for which $(2x + 3)(x - 2) < 0$

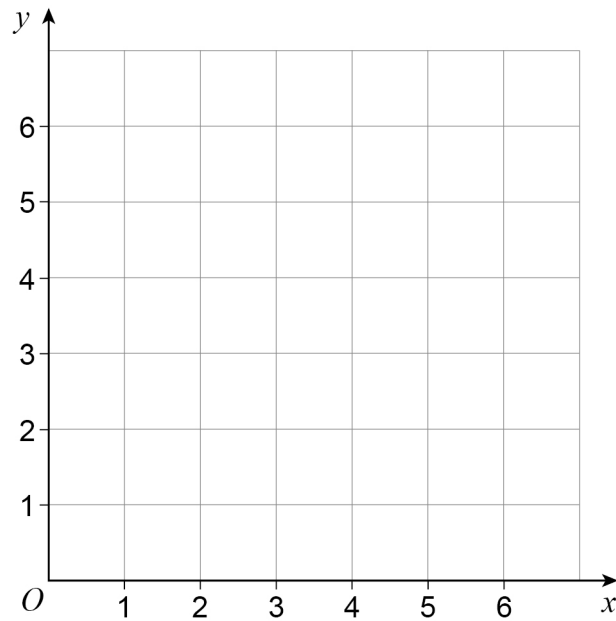
[1 mark]

Answer _____



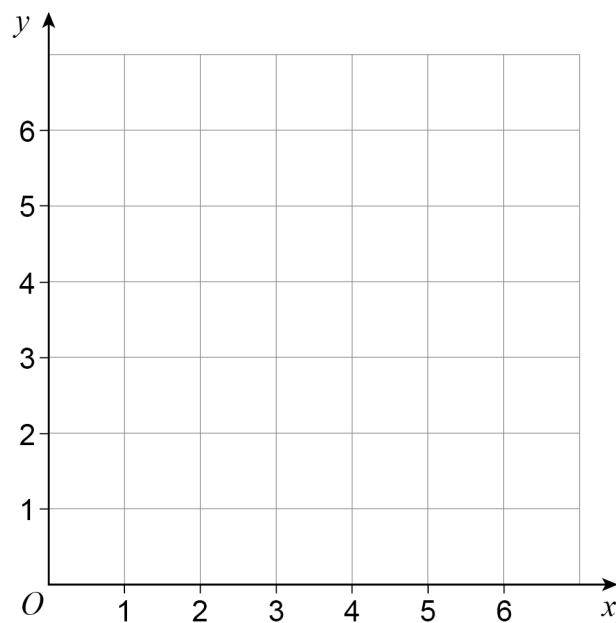
- 7 (a)** On the grid, sketch a graph for which
the rate of change of y with respect to x is always zero.

[1 mark]



- 7 (b)** On the grid, sketch a graph for which
the rate of change of y with respect to x is always a positive constant.

[1 mark]



8 (a) A linear sequence has first term $7 + 12\sqrt{5}$

The term-to-term rule is

add $9 - 2\sqrt{5}$

One term of the sequence is an integer.

Work out the value of this integer.

[2 marks]

Answer _____

8 (b) The n th term of a different sequence is $\frac{3n^2 - 1}{n^2 + 1}$

Work out the sum of the first three terms.

[2 marks]

Answer _____



8 (c) The first four terms of a quadratic sequence are

−3 3 13 27

Work out an expression for the n th term.

[3 marks]

Answer _____

Turn over for the next question



- 9** Factorise fully $(p + 6)^{11} - (p + 6)^{10}$ **[2 marks]**

Answer _____

10 (a) $f(x) = x^3 - 2$

The domain of $f(x)$ is $x \leq 3$

Work out the range of $f(x)$.

[2 marks]

Answer _____

10 (b) $g(x) = 5 - x^2$

The domain of $g(x)$ is $-2 \leq x \leq 1$

Work out the range of $g(x)$.

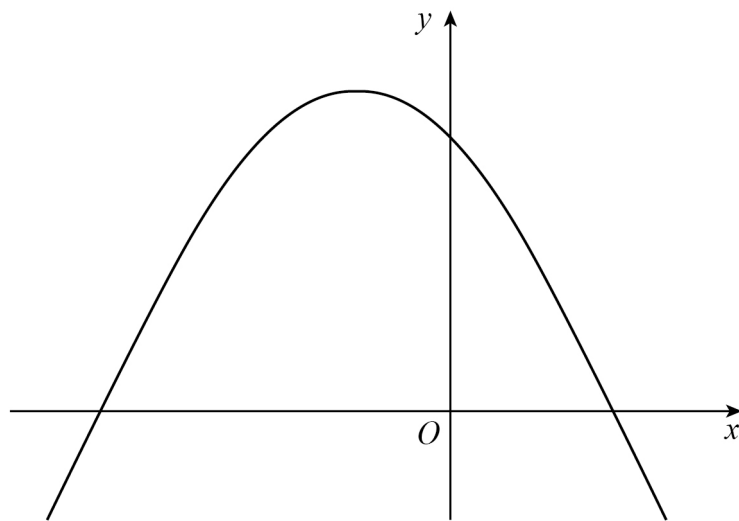
[2 marks]

Answer _____



11

Here is a sketch of a quadratic curve which has a maximum point at $(-2, 5)$



Not drawn
accurately

What is the equation of the normal to the curve at the maximum point?

Circle your answer.

[1 mark]

$x = -2$

$y = 5$

$x = 5$

$y = -2$

Turn over for the next question

Turn over ►

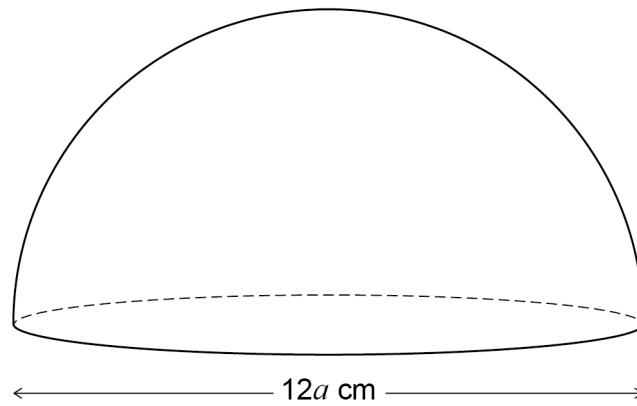


12

The diagram shows a solid hemisphere.

The diameter is $12a$ cm

The volume is 486π cm³



Work out the value of a .

[3 marks]

Answer _____



13

Simplify fully $\frac{x - x^3}{2x + 2x^2}$

You **must** show your working.

[4 marks]

Answer _____

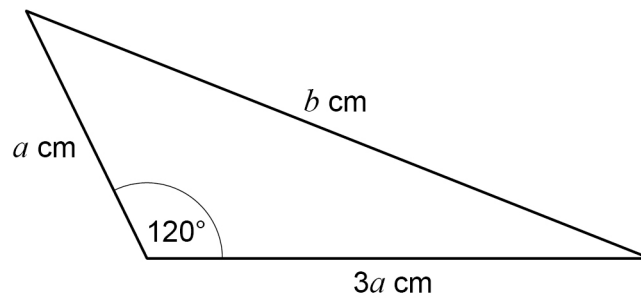
Turn over for the next question

Turn over ►



14

Here is a triangle.

Not drawn
accuratelyUse the cosine rule to work out the ratio $b^2 : a^2$ **[3 marks]**

Answer _____ : _____



- 15 Rearrange $m = \frac{2p+1}{p} + \frac{p+5}{3p}$ to make p the subject.

[4 marks]

Answer _____

- 16 The curve $y = 2\sqrt{x-a} + 5$ passes through the point (1, 8)

Work out the value of a .

[3 marks]

Answer _____



17 Show that $(x + 1)(x + 3)(x + 4) - x(x^2 + 7x + 11)$
can be written in the form $(x + a)(x + b)$ where a and b are positive integers.
[5 marks]

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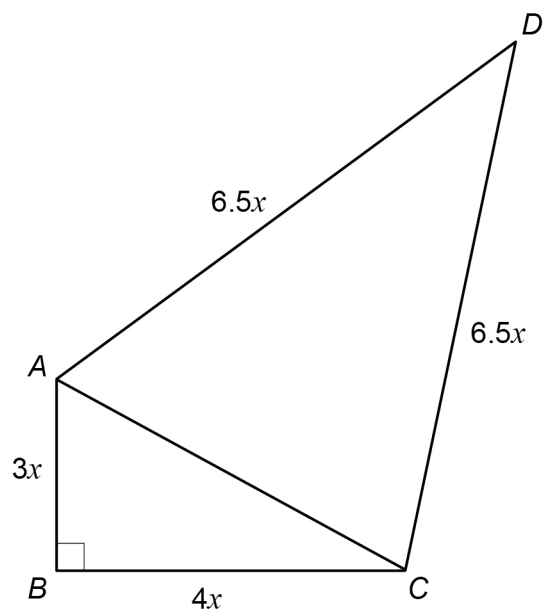
- 18** Solve $4(x - 5)^2 = k^2$ where k is a constant.
Give your answers in their simplest form in terms of k . **[3 marks]**

Answer _____

Turn over for the next question



- 19** ABC is a right-angled triangle.
 ACD is an isosceles triangle.
All dimensions are in centimetres.



Not drawn
accurately

- 19 (a)** Show that $AC = 5x$

[1 mark]



19 (b) Work out an expression, in cm^2 , for the area of quadrilateral $ABCD$.

Give your answer in the form px^2 where p is an integer.

[5 marks]

Answer _____ cm^2

Turn over for the next question



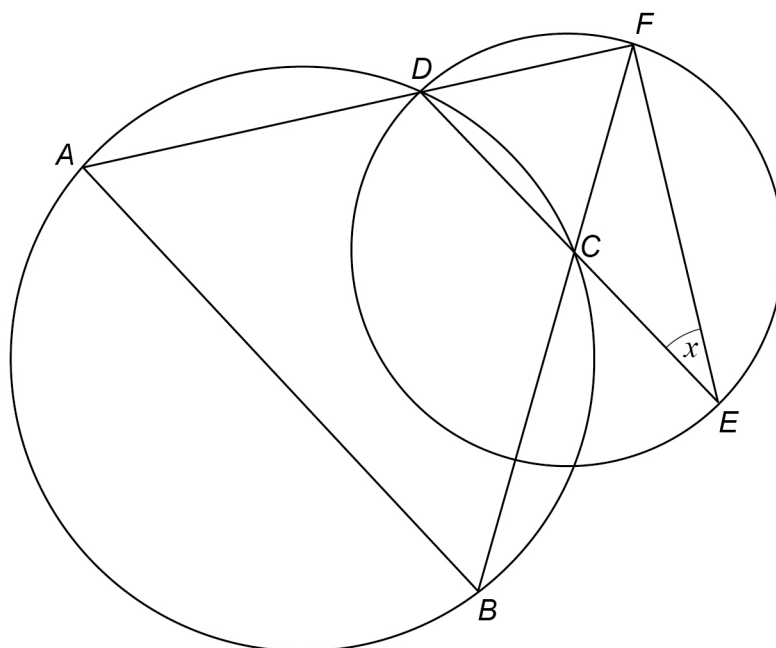
20

A, B, C and D are points on a circle.

D, E and F are points on a different circle, centre C .

DCE, ADF and BCF are straight lines.

angle $DEF = x$



Not drawn
accurately

20 (a) Prove that angle $BAD = 2x$

[3 marks]



20 (b) In the case when AB is parallel to DE , work out the size of angle x .

[2 marks]

Answer _____ degrees

Turn over for the next question



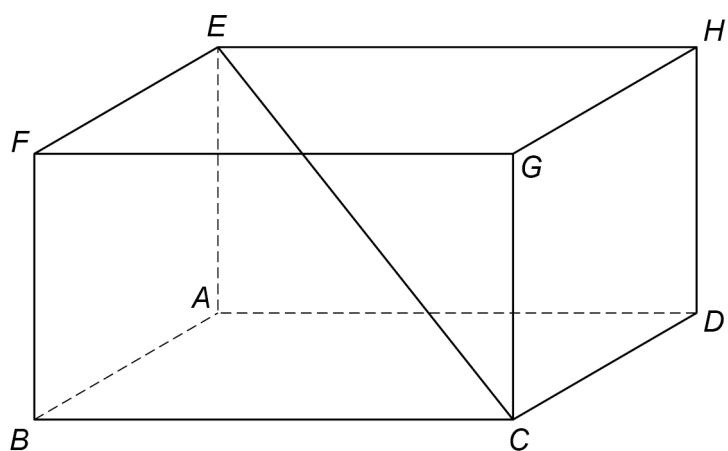
21

 $ABCDEFGH$ is a cuboid.

$BC = 15 \text{ cm}$

$CD = 12 \text{ cm}$

$DH = 8 \text{ cm}$

Work out the size of the angle between the line CE and the plane $CDHG$.**[4 marks]**

Answer _____ degrees



22 (a) Show that $\frac{2\sin^2 x - 1 + \cos^2 x}{\sin x \cos x}$ is equivalent to $\tan x$

[3 marks]

22 (b) Hence solve $\frac{2\sin^2 x - 1 + \cos^2 x}{\sin x \cos x} = -1$ for $0^\circ \leq x \leq 360^\circ$

[2 marks]

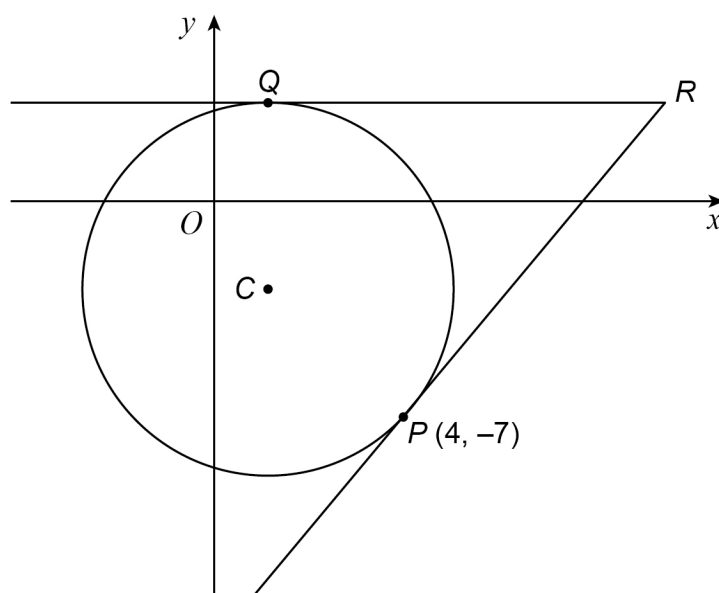
Answer _____



- 23** A circle has centre C and equation $(x - 1)^2 + (y + 3)^2 = 25$
 $P(4, -7)$ and Q are points on the circle.

The tangent at Q is parallel to the x -axis.

The tangents at P and Q intersect at point R .



- 23 (a)** Write down the coordinates of C .

[1 mark]

Answer _____



[1 mark]

[4 marks]

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Answer _____



- 24 Show that the curve $y = \frac{3}{5}x^5 + x^4$ has **exactly two** stationary points.

[4 marks]

- 25 $f(x) = x^3 - 10x - c$ where c is a positive integer.
 $(x + c)$ is a factor of $f(x)$.

Use the factor theorem to work out the value of c .

[3 marks]

Answer _____



26 $f(x)$ is a function with domain all values of x .

$$f(x) = \sqrt{x^2 + 6x - a} \quad \text{where } a \text{ is a constant.}$$

Work out the possible values of a .

Give your answer as an inequality.

[4 marks]

Answer _____

Turn over for the next question



27 The curve $y = f(x)$ has $\frac{dy}{dx} = (x + 2)^6 + (x + 2)^4$

The curve has exactly one stationary point at P where $x = -2$

Use the expression for $\frac{dy}{dx}$ to show that P is a point of inflection.

[3 marks]

END OF QUESTIONS



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Question number	Additional page, if required. Write the question numbers in the left-hand margin.



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