Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3300U60-1

A21-3300U60-1

WEDNESDAY, 10 NOVEMBER 2021 – MORNING

MATHEMATICS
UNIT 2: CALCULATOR-ALLOWED
HIGHER TIER

1 hour 35 minutes

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ADDITIONAL MATERIALS

A calculator will be required for this examination.

A ruler, a protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

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

If you run out of space, use the additional page at the back of the booklet. Question numbers must be given for all work written on the additional page.

Take π as 3·14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

In question **9**, the assessment will take into account the quality of your linguistic and mathematical organisation, communication and accuracy in writing.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**3**	
2.	**4**	
3.	**4**	
4.	**5**	
5.	**3**	
6.	**9**	
7.	**3**	
8.	**3**	
9.	**5**	
10.	**6**	
11.	**3**	
12.	**7**	
13.	**4**	
14.	**8**	
15.	**3**	
Total	**70**	

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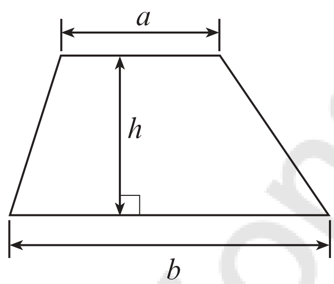
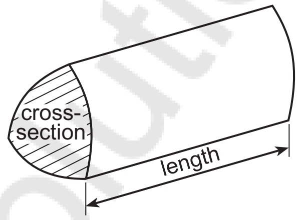
Formula List – Higher Tier

Area of trapezium = $\frac{1}{2}(a+b)h$

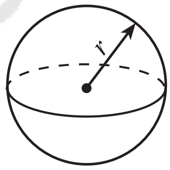


Volume of prism = area of cross-section × length



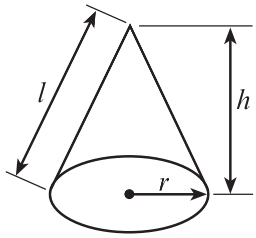
Volume of sphere = $\frac{4}{3}\pi r^3$

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



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

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

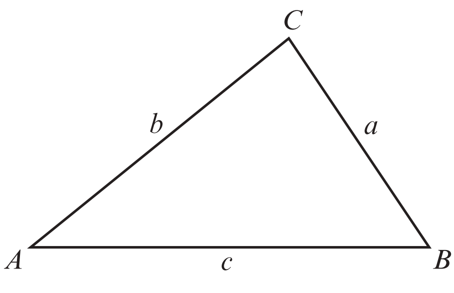


In any triangle ABC

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

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

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



The Quadratic Equation

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

Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula $\left(1+\frac{i}{n}\right)^n - 1$, where i is the nominal interest rate per annum as a decimal and n is the number of compounding periods per annum.

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1. A rectangle has sides of length $2(3a - 7)$ cm and $(5a + 4)$ cm.

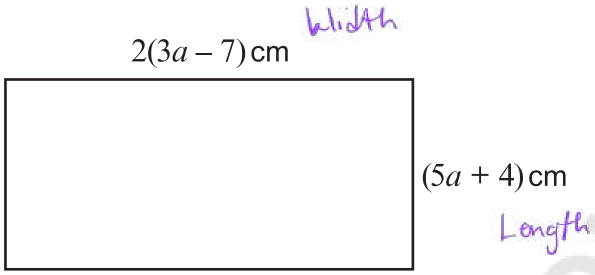

Diagram not drawn to scale

Form an expression, in terms of a, for the perimeter of this rectangle.
You must simplify your expression. [3]

perimeter $= 2 \times (\text{length} + \text{width})$

$= 2 \times (5a + 4 + 6a - 14)$

$= 2 \times (11a - 10)$

$= 22a - 20$ (cm) //

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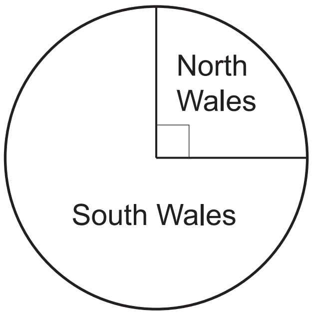
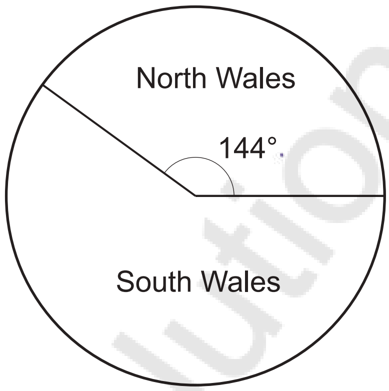
2. A company has two sites.
One is in North Wales and the other is in South Wales.

The pie charts below show the distribution of its 96 part-time staff and its 150 full-time staff.



96 part-time staff



150 full-time staff

A person is chosen at random from the company's 246 staff members.
What is the probability that this person works at the site in North Wales? [4]

No. of Parttimers in NW $= \frac{90°}{360} \times 96 = 24$

No. of fulltimers in NW $= \frac{144}{360} \times 150 = 60$

$60 + 24 = 84$

Probability (NW) $= \frac{84}{246}$

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3. A solution of the equation

$$x^3 + 3x = 20$$

lies between 2 and 3.

Use the method of trial and improvement to find this solution correct to 1 decimal place.
You must show all your working. [4]

If $x = 2 \quad = 2^3 + 3(2) = 14$ ✗

If $x = 3 \quad = 3^3 + 3(3) = 36$ ✗

If $x = 2.1 \quad = 2.1^3 + 3(2.1) = 15.6$

If $x = 2.3 \quad = (2.3)^3 + 3(2.3) = 20$

2.3

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4. Show that the triangle below is **not** a right-angled triangle. [5]

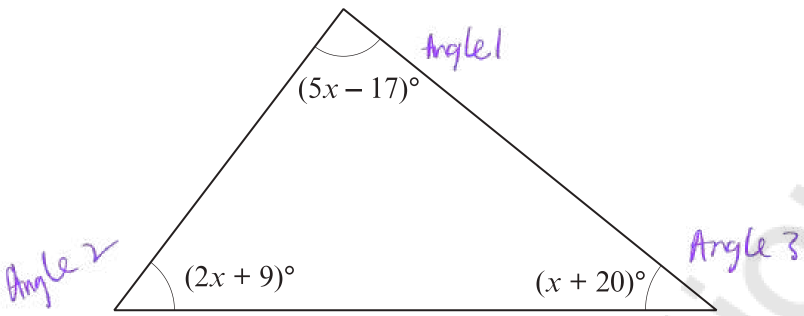

Diagram not drawn to scale

Sum of angles in a triangle = 180

$(5x-17)+(2x+9)+(x+20)=180^\circ$

$5x+2x+x-17+9+20=180$

$8x+12=180$

$8x=180-12$

$\frac{8x}{8}=\frac{168}{8}$ $\quad x=21$

Angle 1: $5x-17 = 5(21)-17=88$

2: $2x+9 = 2(21)+9=51$

3: $x+20 = 21+20=41$

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5. Calculate the length of the side AB in the triangle shown below. [3]

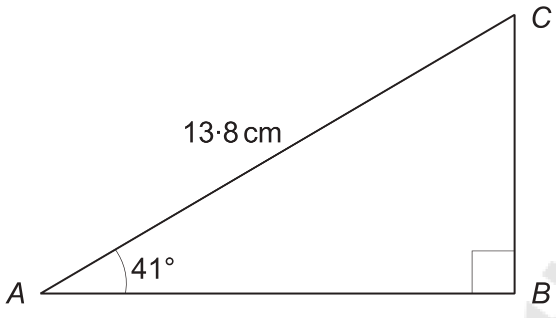

Diagram not drawn to scale

Angle A : $\cos A = \dfrac{\text{Adjacent}}{\text{Hypotenuse}} = \dfrac{AB}{AC}$

$AB = AC \times \cos A$

$AB = 13.8 \times \cos 41^\circ$

$= 13.8 \times 0.7547$

$= 10.4$ cm

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6. *(a)* (i) Expand $x(x^2 + 7)$. [2]

$x \times x^2 = x^{2+1} = x^3$; $x \times 7 = 7x$ $= x^3 + 7x$

(ii) Expand and simplify $(x - 5)(3x - 4)$. [2]

$3x^2 - 4x - 15x + 20 = 3x^2 - 19x + 20$

(b) Sarah buys and sells antique clocks.
On Monday, Sarah had n clocks. n
At the end of the day on Tuesday, she had 5 times as many clocks as she had on Monday. $5n$
On Wednesday, she sold 27 clocks. $5n - 27$

(i) At the end of the day on Wednesday, Sarah had fewer clocks than she had on Monday.
Write an inequality, in terms of n, that shows this information. [2]

$5n - 27 < n$

(ii) Solve your inequality to find the greatest number of clocks that Sarah could have had on the Monday. [3]

$5n - 27 < n$

$5n - n < 27$

$\frac{4n}{4} < \frac{27}{4}$

$n = 6$

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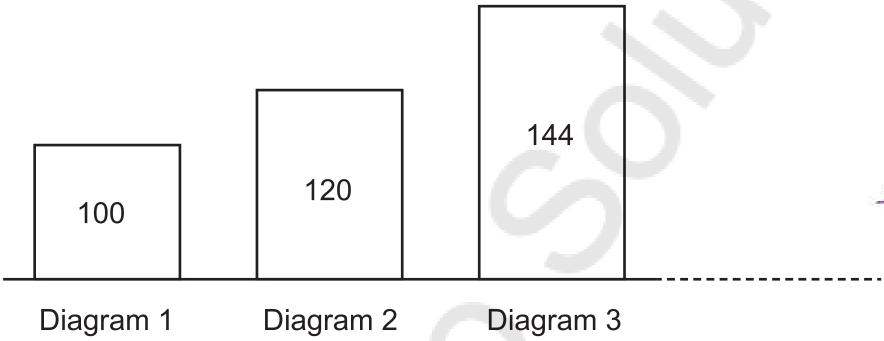
7. *(a)* A number, when increased by 4%, is equal to N.
Which of the following calculations would give you the original number?
Circle your answer. [1]

$N \times 1{\cdot}04$ $\quad N \div 1{\cdot}04$ $\quad N \times 1{\cdot}4$ $\quad N \div 1{\cdot}4$ $\quad N - 4$

$x \times 4\% = N$ $\qquad \frac{4}{100} + 1 = 1{\cdot}04$

$x \times 1{\cdot}04 = N$ $\qquad x = \frac{N}{1{\cdot}04} = N \div 1{\cdot}04$

(b) The number shown on each diagram below is 20% greater than the number shown on the previous diagram.



$\frac{20}{100} = 0{\cdot}2$

Diagram not drawn to scale

Find the number that should be shown on Diagram 6. [2]

D. 1 = $100 \times 0{\cdot}2 = 20 = 20 + 100 = 120$

Diagram 4: $144 \times 0{\cdot}2 = 28{\cdot}8 + 144 = 172{\cdot}8$

5: $172{\cdot}8 \times 0{\cdot}2 = 34{\cdot}56 + 172{\cdot}8 = 207{\cdot}36$

6: $207{\cdot}36 \times 0{\cdot}2 = 41{\cdot}47 + 207{\cdot}36 = 248{\cdot}832$ //

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8. Factorise $x^2 - 4x - 12$, and hence solve $x^2 - 4x - 12 = 0$. [3]

-6×2

$(x-a)(x-b)$

$x^2 - 4x - 12 = (x-6)(x+2) = 0$

$x - 6 = 0$; $x = 6$

$x + 2 = 0$; $x = -2$

$x = 6$ or $x = -2$

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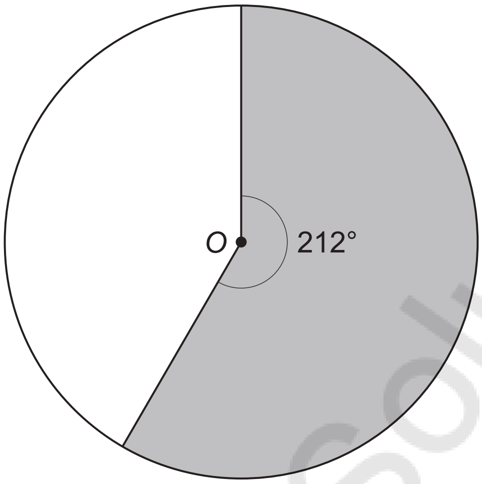
9. *In this question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

A circle with centre *O* is shown below.
The radius of the circle is 7·3 cm.



Center O
R = 7.3cm
Sector angle = 212°

Diagram not drawn to scale

Calculate the perimeter of the shaded region.
You must show all your working. [3 + 2 OCW]

Arc length $= \frac{\theta}{360°} \times 2\pi r$

$= \frac{212}{36} \times 2\pi \times 7.3 \quad = \frac{53}{90} \times (2\pi \times 7.3)$

$2\pi \times 7.3 = 2 \times 3.1416 \times 7.3 = 45.87$

$= \frac{53}{90} \times 45.877 = 27.038$cm

Perimeter of shaded sector = Arc length + 2 × Radius

$= 27.038 + 2 \times 7.3$

$= 27.038 + 14.6$

$= 41.64$cm

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10. *(a)* (i) You are given that y is **inversely** proportional to $\sqrt{x}$.
y = 65 when x = 51·84.
Find an expression for y in terms of x. [3]

$y \propto \frac{1}{\sqrt{x}}$ or $y = \frac{k}{\sqrt{x}}$ $y = 65$ $x = 5 \cdot 84$

$\cancel{66} = \frac{k}{\sqrt{51 \cdot 84}} = \frac{k}{7 \cdot 2}$

$k = 65 \times 7 \cdot 2 = 468$

$y = \frac{468}{\sqrt{x}}$

(ii) Use the expression you found in part (i) to complete the following table. [2]

x	51·84	15·21	36
y	65	120	78

$x = 15 \cdot 21 \quad = \quad y = \frac{468}{\sqrt{15 \cdot 21}} = \frac{468}{3 \cdot 9} = 120$

$y = 120$

$y = 78 \quad x?$

$x = \left(\frac{468}{78}\right)^2 = (6)^2 = 36$

(b) It is known that c is **directly** proportional to the square of d.
What happens to c if d is doubled?
Circle the correct statement below. [1]

c is divided by 2 | c is multiplied by 2 | c is divided by 4 | c is multiplied by 4 | c is squared

$c \propto d^2$ or $c = kd^2$

If d is doubled $= 2d$; $c = k(2d)^2 = k \times 4d^2 = 4kd^2$

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11. The table below shows the value of d and the value of e.
It also shows the degree of accuracy of each value.

Value	Degree of accuracy
$d = 64$	Nearest whole number
$e = 8{\cdot}6$	1 decimal place

Use the formula

$$c = \frac{d^2}{e}$$

to calculate the **least** possible value of c.

You must show all your working. [3]

63.5 — 64.5

d = 64 (nearest whole no.)

e = 8.6 (1 decimal place) 8.55 — 8.65

$c = \frac{d^2}{e} = \frac{63.5^2}{8.65} = \frac{4032.25}{8.65}$

$= 466.12$

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12. The diagram shows a quadrilateral *DEFG*.

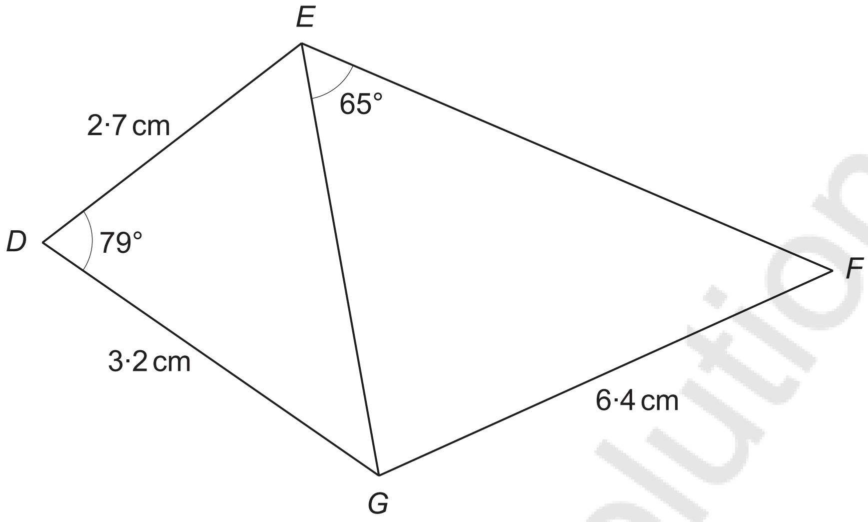

Diagram not drawn to scale

Calculate the size of $E\hat{F}G$. [7]

Use the sine rule to find <EFG

$$\frac{\sin(\angle EFG)}{EG} = \frac{\sin(65^\circ)}{EF}$$

$$EFG = \sin^{-1}\left(\frac{EG \times \sin 65^\circ}{6.4}\right)$$

$= 32$

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13. Simplify the following expression. [4]

$$\frac{6x^2-9x}{4x^2-9}$$

$6x^2 - 9x = 3x(2x - 3)$

$4x^2 - 9 = (2x)^2 - 3^2$

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

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

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14. Triangle *ABC* is shown below.

The length of *AC* is $(x - 1)$ cm.
The length of *BC* is $(2x + 3)$ cm.
The size of $A\hat{C}B$ is 30°.

The area of triangle *ABC* is 6 cm^2.

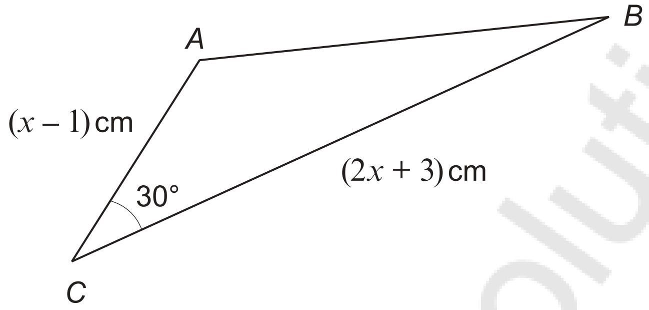

Diagram not drawn to scale

(a) Show that [3]

$$2x^2 + x - 27 = 0.$$

Area $= \frac{1}{2} \times a \times b \times \sin(\theta)$

$a = AC, \quad b = BC, \quad \theta = 30°$

$6\text{cm} = \frac{1}{2} \times (x-1) \times (2x+3) \times \sin(30°)$

$= \frac{1}{4} \times (x-1) \times (2x+3)$

multiply both sides by 4 to eliminate the fraction

$24 = (x-1)(2x+3)$

$24 = 2x^2 + 3x - 2x - 3$

$= 2x^2 + x - 3$

$2x^2 + x - 3 - 24 = 0$

$2x^2 + x - 27 = 0$

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(b) Solve the equation

$$2x^2 + x - 27 = 0.$$

You must use an algebraic method and show all your working.
Give your answers correct to 2 decimal places. [3]

use quadratic formula $= x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$

$a = 2, b = -1, c = -27$

$x = \frac{-1 \pm \sqrt{217}}{2 \times 2} = \frac{-1+14.7309}{4}$ or $\frac{-1-14.7309}{4}$

$x = 3.43$ or $x = -3.93$

(c) Evaluate the length of *AC*.
You must justify any decision that you make. [2]

$AC = x - 1$

If $x = 3.43$ (because x is a part of a length, & -ve lengths are not meaningful in this context, so we won't use $x = -3.93$)

$AC = x - 1 = 3.43 - 1 = 2.43$ cm

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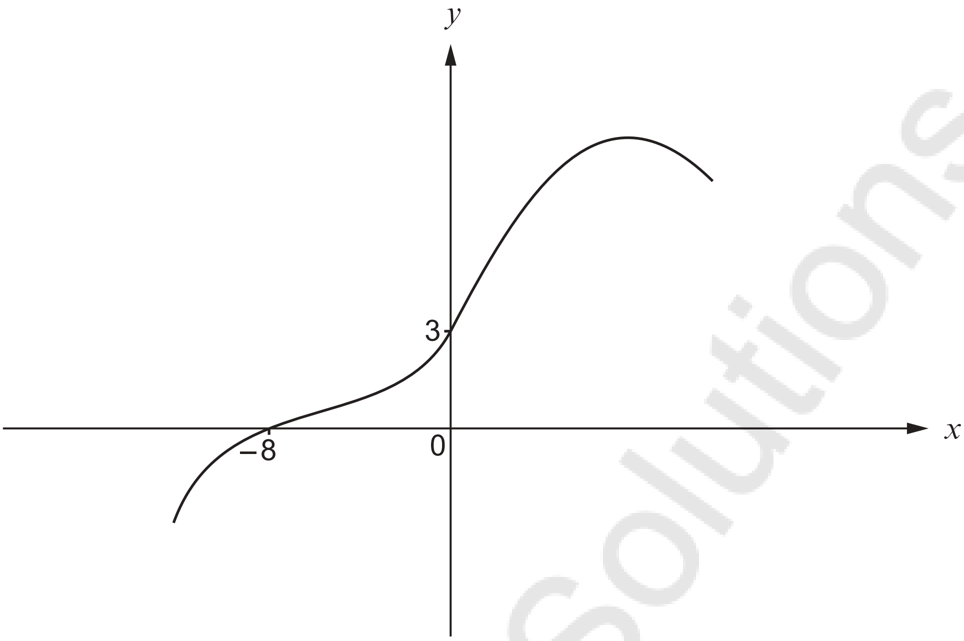
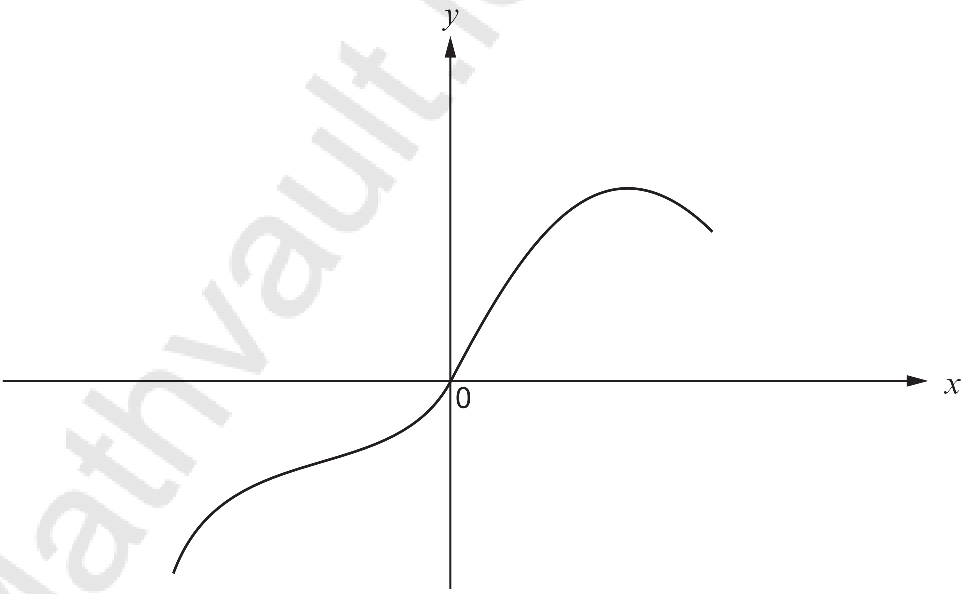
15. The following diagram shows a sketch of the curve $y = f(x)$.



In each of the following questions, the graph of $y = f(x)$ has been transformed.

(a)



Circle the only possible equation of the transformed curve. [1]

$y = f(x) - 3$ $\qquad y = f(x - 3)$ $\qquad y = \frac{1}{3}f(x)$ $\qquad y = f(x + 3)$ $\qquad y = f(x) + 3$

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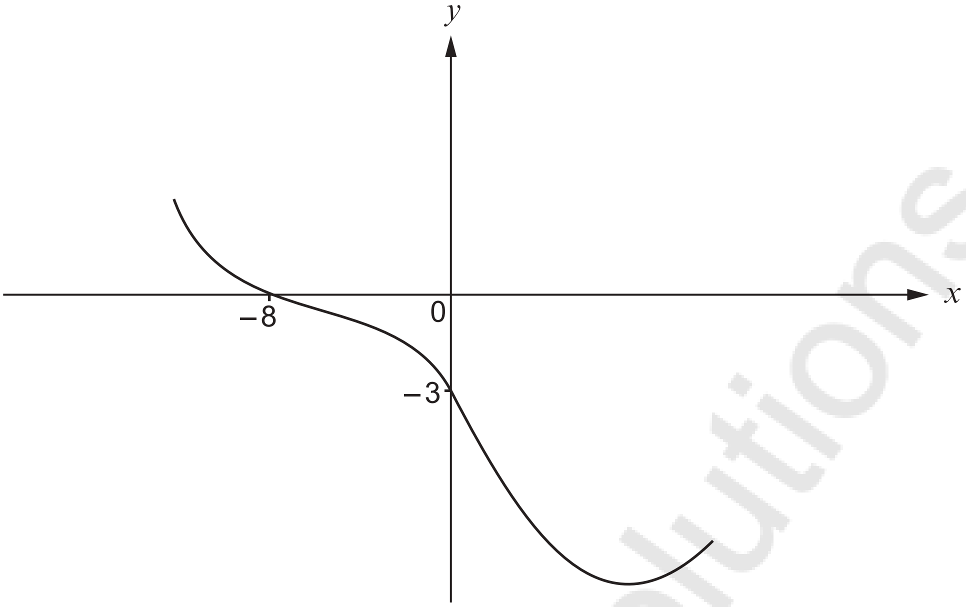
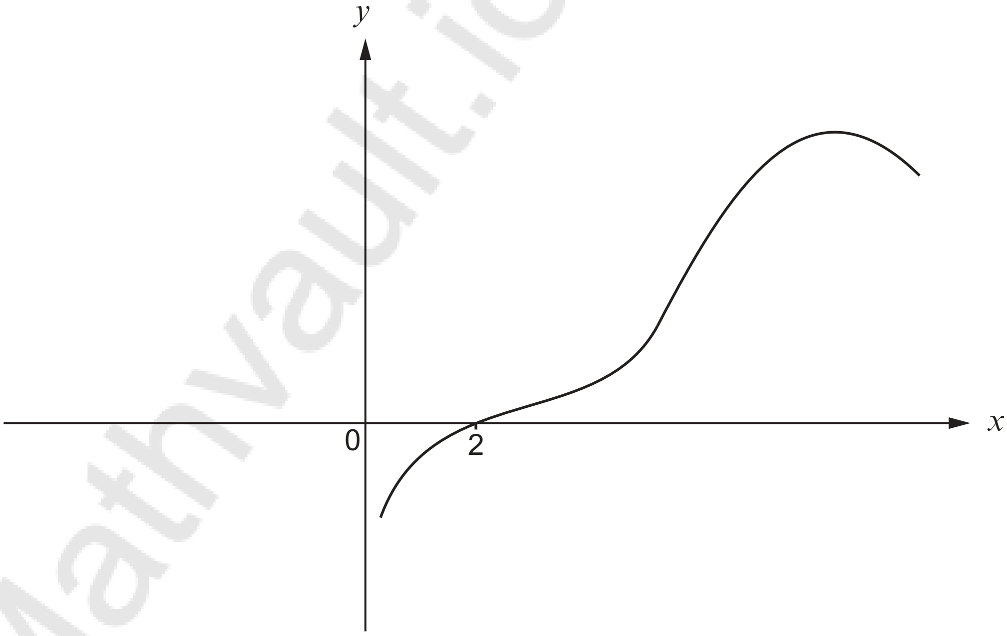
(b)



Circle the only possible equation of the transformed curve. [1]

$y = f(x) - 6$ $\qquad$ $y = -f(x)$ $\qquad$ $y = f(x + 8)$ $\qquad$ $y = f(x) + 6$ $\qquad$ $y = f(-x)$

(c)



Circle the only possible equation of the transformed curve. [1]

$y = f(x) + 10$ $\qquad$ $y = f(x + 10)$ $\qquad$ $y = -4f(x)$ $\qquad$ $y = f(x - 10)$ $\qquad$ $y = f(x) - 10$

END OF PAPER

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

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