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EDEXCEL INTERNATIONAL A LEVEL MATHS: QUESTIONS BY TOPIC

Algebraic Expressions, Indices & Surds (P1.1)

International A Level Mathematics · P1: Pure Mathematics 1 (WMA11)

15 questions · 82 marks · Mark schemes included

Past papers January 2019 - June 2025 · 2 sub-topics

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

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QUESTIONS

15 questions · 82 marks · 2 sub-topics

SUB-TOPIC P1.1a

INDEX LAWS

Sub-topic P1.1a · 11 questions · 58 marks · lowest tariff first



2. Given

$$\frac{3^x}{3^{4y}} = 27\sqrt{3}$$

find y as a simplified function of x .

(3)

Leave
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1. Given that

$$(3pq^2)^4 \times 2p\sqrt{q^8} \equiv ap^bq^c$$

find the values of the constants a , b and c .

(3)

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Q1

2. Given that

$$a = \frac{1}{64}x^2 \qquad b = \frac{16}{\sqrt{x}}$$

express each of the following in the form kx^n where k and n are simplified constants.

(a) $a^{\frac{1}{2}}$

(1)

$$(b) \quad \frac{16}{b^3}$$

(1)

$$(c) \left(\frac{ab}{2}\right)^{-\frac{4}{3}}$$

(2)

Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 4 marks)



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2. Given $y = 3^x$, express each of the following in terms of y . Write each expression in its simplest form.

$$(a) \quad 3^{3x} \tag{1}$$

$$(b) \frac{1}{3^{x-2}} \quad (2)$$

$$(c) \quad \frac{81}{9^{2-3x}} \qquad (2)$$

Question 2 continued

Leave
blank

Q2

(Total 5 marks)



Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 5 marks)



Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 6 marks)



5.

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

(a) By substituting $p = 3^x$, show that the equation

$$3 \times 9^x + 3^{x+2} = 1 + 3^{x-1}$$

can be rewritten in the form

$$9p^2 + 26p - 3 = 0 \quad (3)$$

(b) Hence solve

$$3 \times 9^x + 3^{x+2} = 1 + 3^{x-1} \quad (3)$$

Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 6 marks)



(Total for Question 4 is 6 marks)



(Total for Question 2 is 6 marks)



Question 6 continued

Lined area for writing the answer to Question 6 continued.



Question 6 continued

Lined area for writing the answer to Question 6 continued.



Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 7 marks)



Question 4 continued

Lined area for writing the answer to Question 4 continued.



Question 4 continued

Lined area for writing the answer to Question 4 continued.



Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 7 marks)



SUB-TOPIC P1.1b

SURDS & RATIONALISING THE DENOMINATOR

Sub-topic P1.1b · 4 questions · 24 marks · lowest tariff first



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2. Answer this question showing each stage of your working.

(a) Simplify $\frac{1}{4 - 2\sqrt{2}}$

giving your answer in the form $a + b\sqrt{2}$ where a and b are rational numbers.

(2)

(b) Hence, or otherwise, solve the equation

$$4x = 2\sqrt{2}x + 20\sqrt{2}$$

giving your answer in the form $p + q\sqrt{2}$ where p and q are rational numbers.

(3)



Question 2 continued

Leave
blank

(Total 5 marks)

Q2



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blank

3. In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

- (i) Show that $\frac{\sqrt{180} - \sqrt{80}}{\sqrt{5}}$ is an integer and find its value.

(2)

- (ii) Simplify

$$\frac{4\sqrt{5} - 5}{7 - 3\sqrt{5}}$$

giving your answer in the form $a + b\sqrt{5}$ where a and b are rational numbers.

(3)

Question 3 continued

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blank

Lined area for writing the answer to Question 3.

(Total 5 marks)

Q3



2.

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

(i) Simplify fully

$$\frac{3y^3(2x^4)^3}{4x^2y^4}$$

(3)

(ii) Find the exact value of a such that

$$\frac{16}{\sqrt{3} + 1} = a\sqrt{27} + 4$$

Write your answer in the form $p\sqrt{3} + q$ where p and q are fully simplified rational constants.

(4)



(Total for Question 2 is 7 marks)



5.

In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.

The line l_1 has equation

$$x - 2y + 25 = 0$$

The line l_2 passes through the origin and is perpendicular to l_1

- (a) Find an equation for l_2 (2)

The lines l_1 and l_2 intersect at the point P .

- (b) Use algebra to find the coordinates of P . (3)

- (c) Hence find the shortest distance from l_1 to the origin.

Write your answer as a fully simplified surd. (2)



Question 5 continued

Lined area for writing the answer to Question 5.



Question 5 continued

Lined area for writing the answer to Question 5.

Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 7 marks)

MARK SCHEMES

official mark schemes, in the same order as the questions



General Principles for Pure Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$

2. Formula

Attempt to use the correct formula (with values for a , b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c = 0$, $q \neq 0$, leading to $x = \dots$

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)



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Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

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Question Number	Scheme	Marks
1(a)	$\left(\frac{dy}{dx} = \dots x^2 + \dots x + \dots x^{-2}\right)$	M1
	$\left(\frac{dy}{dx} = \right) \frac{3}{4}x^2 - 2x - 17x^{-2}$	A1A1
		(3)
(b)	$\left(\frac{dy}{dx} = \right) \frac{3}{4}(2)^2 - 2(2) - 17(2)^{-2} = -\frac{21}{4}$	M1
	$y - \frac{13}{2} = -\frac{21}{4}(x - 2)$	dM1
	$21x + 4y - 68 = 0$	A1
		(3)
		(6 marks)

(a)

M1 Reduces the power by 1 on any of the following terms

$\dots x^3 \rightarrow \dots x^2$, $\dots x^2 \rightarrow \dots x^1$, $\dots x^{-1} \rightarrow \dots x^{-2}$. Be careful not to allow just sight of x^2 . The index does not have to be processed for this mark.

A1 Two of $+\frac{3}{4}x^2$, $-2x$, $-17x^{-2}$ or exact unsimplified equivalent terms. Accept eg $\frac{-17}{x^2}$ but the indices must be processed. Double signs eg $+\frac{-17}{x^2}$ is fine.

A1 $\frac{3}{4}x^2 - 2x - 17x^{-2}$ all on one line or exact simplified equivalent. Allow x^1 . Withhold the final mark if they attempt to multiply all the terms by 4 for example or a $+c$ appears.

(b)

M1 Attempts to substitute $x = 2$ into their $\frac{dy}{dx}$ which must be a changed function to find the gradient of the tangent at P

dM1 It is for the method of finding a line passing through $\left(2, \frac{13}{2}\right)$ using their $\frac{dy}{dx}$ at $x = 2$ eg it cannot be the gradient of the normal.

Score for sight of $y - \frac{13}{2} = -\frac{21}{4}(x - 2)$ with both coordinates substituted in correctly or if they use the form $y = mx + c$ they must proceed as far as $c = \dots$. It is dependent on the previous method mark.

A1 $21x + 4y - 68 = 0$ or any equivalent multiple where the coefficients are integers and all terms are on one side of the equation. If they state values which contradict the equation then the equation takes precedence.



Question Number	Scheme	Marks
2(a)	$a = 2$	B1
	$b = -3$	B1
		(2)
(b)	Any two term of $\int \frac{2x^3 - 3x^2 - 32x - 15}{5\sqrt{x}} dx = \int \frac{2}{5}x^{\frac{5}{2}} - \frac{3}{5}x^{\frac{3}{2}} - \frac{32}{5}x^{\frac{1}{2}} - 3x^{-\frac{1}{2}} dx$	M1A1
	$x^n \rightarrow x^{n+1}$	M1
	$\frac{4}{35}x^{\frac{7}{2}} - \frac{6}{25}x^{\frac{5}{2}} - \frac{64}{15}x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$	A1A1
		(5)
		(7 marks)

- (a) If there is a contradiction between their stated values and the embedded values in a cubic expression then the embedded values take precedence.

B1 $a = 2$ which may be embedded

B1 $b = -3$ which may be embedded

(b)

M1 Attempts to write as a sum of terms. Award for any term with a correct index from correct working. The index does not need to be processed.

A1 Any **two** correct unsimplified or simplified terms of the expression

$$\frac{2}{5}x^{\frac{5}{2}} - \frac{3}{5}x^{\frac{3}{2}} - \frac{32}{5}x^{\frac{1}{2}} - 3x^{-\frac{1}{2}} \quad \text{oe eg } 0.4x^{\frac{5}{2}} - 0.6x^{\frac{3}{2}} - 6.4x^{\frac{1}{2}} - 3x^{-\frac{1}{2}} \quad (\text{indices must be processed})$$

M1 Increases the power of any of their non-integer terms by 1. ($x^n \rightarrow x^{n+1}$) This mark cannot be awarded for just increasing the power by 1 on a numerator or denominator term. The index does not need to be processed.

A1 Any two terms correct unsimplified or simplified (see below). May appear in a list or on separate lines.

A1 $\frac{4}{35}x^{\frac{7}{2}} - \frac{6}{25}x^{\frac{5}{2}} - \frac{64}{15}x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$ all on one line (including the constant c and all simplified)

Allow exact equivalents but not rounded decimals so $\frac{4}{35}$ must be written as a fraction.

Accept $\frac{4}{35}x^{\frac{7}{2}} - 0.24x^{\frac{5}{2}} - 4.26x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$. Also allow terms written as eg $\frac{4}{35}x^3\sqrt{x}$ Withhold this mark if the final answer has the integral sign and dx around it or any other spurious notation.



Question Number	Scheme	Marks
5(a)	$9^x = p^2, 3^{x+2} = 9p \text{ or } 3^{x-1} = \frac{p}{3}$	B1
	$3 \times 9^x + 3^{x+2} = 1 + 3^{x-1} \Rightarrow 3p^2 + 3^2 \times p = 1 + \frac{p}{3}$	M1
	$9p^2 + 26p - 3 = 0 \text{ via } 3p^2 + 9p = 1 + \frac{p}{3} *$	A1*
		(3)
(b)	$9p^2 + 26p - 3 = 0 \Rightarrow (9p-1)(p+3) = 0$	M1
	$3^x = \frac{1}{9}$	A1 M1 in EPEN
	$x = -2$	A1
		(3)
		(6 marks)

(a) Mark (a) and (b) together.

B1: Uses an index law and states or implies any of $9^x = p^2, 3^{x+2} = 9p$ or $3^{x-1} = \frac{p}{3}$ or equivalent forms

e.g. $9^x = p \times p, 3^{x+2} = 3^2 \times p, 3^{x-1} = p \times 3^{-1}$

If awarding for the first term, then it must be from correct work so $3 \times 9^x = 3 \times 3^x \times 3^x = 3p^2$ is fine but $3 \times 9^x = 3 \times 3^2 \times 3^x = 3p^2$ or $3 \times 9^x = 3 \times 3 \times 3^x = 3p^2$ is not, but do check the other terms.

M1: Look for $3 \times 9^x + 3^{x+2} = 1 + 3^{x-1} \Rightarrow 3p^2 \pm kp = 1 \pm \frac{p}{3}$ or **obtained from correct work**, with $k = 6$ or 9

So if e.g. $3p^2$ is obtained from $3 \times 9^x = 3 \times 3^2 \times 3^x = 3p^2$ or $3 \times 9^x = 3 \times 3 \times 3^x = 3p^2$ then score M0.

A1*: Proceeds to the given answer of $9p^2 + 26p - 3 = 0$ with no errors or omissions.

An intermediate line of $3p^2 + 9p = 1 + \frac{p}{3}$ o.e. must be seen.

Note that the following is common in part (a) and scores no marks: $3 \times 9^x + 3^{x+2} = 1 + 3^{x-1} \Rightarrow 3 \times 3p + p^2 = 1 + p^{-1}$

(b)

M1: Valid non-calculator attempt at solving $9p^2 + 26p - 3 = 0$ – see General Guidance.

It must be clear they are solving the given quadratic not their incorrect one.

Answers just written down scores M0

A1(M1 in EPEN): For $3^x = \frac{1}{9}$ seen. It must be clear that it is a value for 3^x and not a value for p or x .

May be implied by e.g. $p = \frac{1}{9} \Rightarrow x = -2$. You can ignore e.g. $3^x = -3$ for this mark.

A1: $x = -2$ only



Question Number	Scheme	Marks
3.(a)	$y = \frac{5x^3 - 8}{2x^2} = \frac{5}{2}x - 4x^{-2}$ $\frac{dy}{dx} = \frac{5}{2} + 8x^{-3}$	M1 dM1 A1 A1 (4)
(b)	Substitutes $x = 2$ into their $\frac{dy}{dx} = \frac{5}{2} + \frac{8}{x^3} \Rightarrow \frac{dy}{dx} = \frac{7}{2}$ Uses their $\frac{7}{2}$ and $(2, 4) \Rightarrow y - 4 = \frac{7}{2}(x - 2)$ $\Rightarrow 7x - 2y - 6 = 0$	M1 M1 A1 (3) (7 marks)

(a)

M1: Attempts to write y as **a sum of two terms** and achieves at least one term with the correct index.Award for $Px + Qx^k$ or $Px^k + Qx^{-2}$. Condone $Qx^{-2} \leftrightarrow \frac{Q}{x^2}$

dM1: Requires both

- the given expression to be written as a sum of two terms with both indices correct
- correct differentiation applied to the indices $Px + Qx^{-2} \rightarrow A + Bx^{-3}$ o.e

A1: One correct term which need not be simplified. Condone $\frac{5}{2}x^0$

Note that 1010 is possible where candidates only form one of the two correct terms and differentiate that correctly

A1: $\left(\frac{dy}{dx}\right) = \frac{5}{2} + 8x^{-3}$ or simplified equivalent such as $\frac{1}{2}\left(5 + \frac{16}{x^3}\right)$. There is no need to have the $\frac{dy}{dx}$

(b)

M1: Substitutes $x = 2$ into their $\frac{dy}{dx}$ and attempts its value. Their $\frac{dy}{dx}$ cannot be the same as their "y"Score for sight of embedded 2's in their $\frac{dy}{dx}$ followed by a value or it may be implied for a correctvalue for their $\frac{dy}{dx}$

M1: Correct method for finding the equation of a tangent.

Look for a correct use of their $\frac{dy}{dx}\bigg|_{x=2}$ and the point $(2, 4)$ to form equation $y - 4 = \frac{7}{2}(x - 2)$.If the form $y = mx + c$ is used it must proceed as far as $c = \dots$ Award this mark if they achieve $\frac{dy}{dx} = \frac{5}{2}$ in part (a) and correctly form the equation using $m = \frac{5}{2}$ and $(2, 4)$. They cannot score the previous mark.A1: $7x - 2y - 6 = 0$ or any multiple thereof

.....



General Principles for Pure Mathematics Marking*(NB specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:**

1. Factorisation

 $(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$ leading to $x = \dots$ $(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$ leading to $x = \dots$

2. Formula

Attempt to use correct formula (with values for a, b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$ leading to $x = \dots$ **Method marks for differentiation and integration:**

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Power of at least one term decreased by 1 ($x^n \rightarrow x^{n-1}$)

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Question	Scheme	Marks
4(a)	$y = \frac{5x^2 + \sqrt{x^3}}{\sqrt[3]{8x}} = \frac{5x^2 + x^{\frac{3}{2}}}{\dots x^{\frac{1}{3}}}$	M1
	$= \frac{5x^{2-\frac{1}{3}}}{2} + \frac{x^{\frac{3}{2}-\frac{1}{3}}}{2}$	M1
	$= \frac{5}{2}x^{\frac{5}{3}} + \frac{1}{2}x^{\frac{7}{6}}$	A1A1
		(4)
(b)	$\left(\frac{dy}{dx} = \dots x^{\frac{2}{3}} + \dots x^{\frac{1}{6}}\right)$	M1
	$\left(\frac{dy}{dx} = \right) \frac{25}{6}x^{\frac{2}{3}} + \frac{7}{12}x^{\frac{1}{6}}$	A1ftA1
		(3)
(7 marks)		
Notes:		
(a)		
M1: Converts the radicals into powers of x, with at least one power correct. E.g. $\sqrt{x^3} \rightarrow x^{\frac{3}{2}}$ or $\sqrt[3]{8x} \rightarrow \dots x^{\frac{1}{3}}$ M1: Correct subtraction index law seen used at least once. May be implied. It is for $\frac{5x^2}{\sqrt[3]{8x}} \rightarrow \frac{\dots x^2}{\dots x^p} \rightarrow \dots x^{2-p}$ or $\frac{\sqrt{x^3}}{\sqrt[3]{8x}} \rightarrow \frac{\dots x^q}{\dots x^p} \rightarrow \dots x^{q-p}$ Indices do not need to be processed for this mark. A1: One term correct (coefficient and index) or both indices correct. E.g. $\frac{5}{2}x^{\frac{5}{3}}$ or $\frac{1}{2}x^{\frac{7}{6}}$ or $\dots x^{\frac{5}{3}} + \dots x^{\frac{7}{6}}$. Depends on both M marks. A1: Fully correct expression in the required form. Depends on all previous marks. $y = \dots$ is not required. Apply isw once a correct expression is seen.		
(b)		
The $\frac{dy}{dx} =$ is not required throughout in part (b) M1: $x^n \rightarrow \dots x^{n-1}$ for at least one term where $n \neq 1$. A1ft: Correct differentiation of one of their terms where $n \neq 1$. Follow through their part (a). But not for $kx \rightarrow k$ May be unsimplified. Depends on both M marks in part (a). A1: Correct derivative, with terms in simplest form. Apply isw once a correct expression is seen. Score A0 if they include “+ c”		

Question	Scheme	Marks
5(a)	$\angle AOB = \cos^{-1} \frac{1.5}{4} = \dots \text{ or } \angle AOB = \tan^{-1} \frac{\sqrt{4^2 - 1.5^2}}{1.5} = \dots$	M1
	or $\angle AOB = \frac{\pi}{2} - \sin^{-1} \frac{1.5}{4} = \dots$	
	or $\angle AOB = \frac{\pi}{2} - \tan^{-1} \frac{1.5}{\sqrt{4^2 - 1.5^2}} = \dots$	
	$= 1.186^*$	A1*
(b)	$l = 4 \times 1.186 (= 4.744)$	M1
	$BC = 6 - 4 \sin 1.186 (= 6 - 3.708\dots = 2.29\dots)$	M1
	or $BC = 6 - 4 \cos \left(\frac{\pi}{2} - 1.186 \right) (= 6 - 3.708\dots = 2.29\dots)$	
	or $BC = 6 - \sqrt{4^2 - 1.5^2} (= 6 - 3.708\dots = 2.29\dots) \left(= \frac{12 - \sqrt{55}}{2} \right)$	
	or $BC = 6 - \frac{1.5}{\tan "0.384"} (= 6 - 3.708\dots = 2.29\dots)$	
	Perimeter is $4 \times 1.186\dots + (6 - 4 \cos 0.384\dots) + 1.5 + 6 + 4 = ..$	ddM1
	$= \text{awrt } 18.5 \text{ (m)}$	A1
(c)	Area sector $= \frac{1}{2} \times 4^2 \times 1.186\dots$	M1
	Area OBCD Examples: $6 \times 1.5 - \frac{1}{2} \times "3.708" \times 1.5 \text{ or } (6 - "3.708") \times 1.5 + \frac{1}{2} \times "3.708" \times 1.5$ $\text{or } \frac{1}{2} (6 + 6 - "3.708") \times 1.5 \text{ or } 6 \times 1.5 - \frac{1}{2} \times 1.5 \times 4 \sin 1.186$ $\text{or } \frac{1}{2} \times 6 \times 1.5 + \frac{1}{2} (6 - "3.708") \times 1.5 (= 6.219\dots)$	M1 A1 on EPEN
	$\frac{1}{2} \times 4^2 \times 1.186 + 6.219\dots =$	ddM1
	$= \text{awrt } 15.7 \text{ (m}^2\text{)}$	A1
		(4)
		(10 marks)



Notes:

**Allow equivalent correct work in degrees.
Ignore any presence or absence of units throughout.**

(a)

M1: For a complete and correct method to find angle AOB in radians or degrees. May attempt angle AOB directly using cosine, or angle BOD using sine then subtract angle BOD from $\frac{\pi}{2}$ or equivalent work using tan.

A1*: Obtains angle $AOB = 1.186$ with no errors.

Example in degrees:

$$\begin{aligned}\sin \angle BOD &= \frac{1.5}{4} \Rightarrow \angle BOD = \sin^{-1} \frac{3}{8} = 22.0243... \\ \angle AOB &= 90 - 22.0243... = 67.9756... \\ &= \frac{\pi \times 67.9756...}{180} = 1.186 *\end{aligned}$$

(b)

M1: Uses the correct arc length formula with $r = 4$ and 1.186 . May be implied by awrt 4.74 or 4.75.

M1: Attempts the length of BC using an appropriate trig function and angle, or Pythagoras. May see $6 - 4\sin 1.186$ or $6 - 4\cos 0.384$ or may use $6 - \sqrt{4^2 - 1.5^2}$. May be implied by awrt 2.3 provided no incorrect working is seen.

ddM1: Depends on both previous marks. Adds the **five** lengths of the sides (or equivalent work) to obtain the perimeter.

A1: Correct answer, accept awrt 18.5. No units required and ignore any given.

(c)

M1: Correct attempt at the sector area. Look for $\frac{1}{2} \times 4^2 \times 1.186...$ but may be implied by e.g. $\frac{1186}{125}$ or awrt 9.5. Allow equivalent expressions in degrees e.g. $\frac{1}{2} \times 4^2 \times 67.9756... \times \frac{\pi}{180}$ but **not** e.g.

$$\frac{1}{2} \times 4^2 \times 67.9756$$

M1: Correct attempt at the area of $OBCD$ – which may be found as the difference of a rectangle and triangle or sum of rectangle and triangle or a trapezium. See scheme for details.

The attempt to find BC , if used, must have involved the use of trigonometry or e.g. Pythagoras.

ddM1: Depends on both previous marks. Correct attempt at the full area, so adds sector area to area of $OBCD$

A1: Correct answer, accept awrt 15.7. No units required and ignore any given.

**Note that some candidates assume $BC = 2$ (i.e. $6 - 4$) which greatly simplifies the question.
The maximum possible marks in (b) and (c) are: (b) M1M0ddM0A0 (c) M1M0ddM0A0**

Question	Scheme	Marks
6(a)	$\left(r - \frac{1}{r}\right)^2 = r^2 - r \times \frac{1}{r} - r \times \frac{1}{r} + \frac{1}{r^2}$	M1
	$= r^2 + \frac{1}{r^2} - 2$	A1
		(2)
(b)	$\frac{1}{3+2\sqrt{2}} = \frac{1}{3+2\sqrt{2}} \times \frac{3-2\sqrt{2}}{3-2\sqrt{2}}$	M1
	$= \frac{3-2\sqrt{2}}{3^2 - (2\sqrt{2})^2} = 3-2\sqrt{2}$	A1
		(2)
(b) ALT	$\frac{1}{3+2\sqrt{2}} = p+q\sqrt{2} \Rightarrow 1 = (p+q\sqrt{2})(3+2\sqrt{2}) = 3p+4q+2p\sqrt{2}+3q\sqrt{2}$ $\Rightarrow 3p+4q=1$ $\Rightarrow 2p+3q=0$	M1
	$\Rightarrow \begin{matrix} 3p+4q=1 \\ 2p+3q=0 \end{matrix} \Rightarrow \begin{matrix} 6p+8q=2 \\ 6p+9q=0 \end{matrix} \Rightarrow q=-2 \Rightarrow 3p-8=1 \Rightarrow p=3$ $\frac{1}{3+2\sqrt{2}} = 3-2\sqrt{2}$	A1
		(2)
(c)	$\left(\sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}}\right)^2 = 3+2\sqrt{2} + \frac{1}{3+2\sqrt{2}} - 2$	M1
	$= 3+2\sqrt{2} + 3-2\sqrt{2} - 2 = \dots (=4)$	dM1
	so $\sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}} = 2$	A1
		(3)
(c) Alt	$\sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}} = 2 \Rightarrow 3+2\sqrt{2} - 1 = 2\sqrt{3+2\sqrt{2}}$	M1
	$\Rightarrow (2+2\sqrt{2})^2 = 4(3+2\sqrt{2})$	dM1
	$\Rightarrow 4+8\sqrt{2}+8 = 12+8\sqrt{2} \checkmark$ Hence true	A1
		(3)
(7 marks)		



Notes:**(a)****M1:** Expands the bracket to obtain 3 or 4 terms with at least 2 correct which may be unsimplified.Allow use of a different variable e.g. x for this mark.**A1:** Correct simplified expansion in terms of r . Accept terms in any order.Accept e.g. $r^2 + r^{-2} - 2$ and accept $r^2 + \left(\frac{1}{r}\right)^2 - 2$. Do **not** isw and mark their final answer.

Note that if a correct simplified expression is seen and they then re-write the expression correctly in a different way then this mark should be awarded provided their expression is correct.

(b)**M1:** Correct process to rationalise the denominator, so look for multiplying numerator and denominator by $3 - 2\sqrt{2}$ or any multiple of this expression. No processing is required so just look for the statement as shown above.**A1:** Shows an intermediate line before obtaining $3 - 2\sqrt{2}$

Examples of an acceptable intermediate line are:

$$\frac{3-2\sqrt{2}}{3^2-(2\sqrt{2})^2}, \frac{3-2\sqrt{2}}{9-8}, \frac{3-2\sqrt{2}}{9-6\sqrt{2}+6\sqrt{2}-(2\sqrt{2})^2}, \frac{3-2\sqrt{2}}{9-6\sqrt{2}+6\sqrt{2}-8}, \frac{3-2\sqrt{2}}{1}$$

Do **not** allow $\frac{3-2\sqrt{2}}{1}$ as the final answer.**(b) ALT****M1:** Sets $\frac{1}{3+2\sqrt{2}} = p + q\sqrt{2}$, multiplies up, compares rational and irrational parts to produce 2 equations in p and q .**A1:** Solves simultaneously **showing working** and obtains $3 - 2\sqrt{2}$.**(c)****M1:** Applies their result from (a) or the correct result to $\left(\sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}}\right)^2$ **dm1: Depends on the first mark.** Applies their result from (b) and cancels $\sqrt{2}$ terms to achieve a constant.**A1:** Reaches the correct answer from correct work. **There is no requirement to justify the positive square root.****(c) ALT****M1:** Multiplies equation through by $\sqrt{3+2\sqrt{2}}$ and applies $\sqrt{3+2\sqrt{2}} \times \sqrt{3+2\sqrt{2}} = 3+2\sqrt{2}$ **dm1: Depends on the first mark.** Squares both sides. May or may not have cancelled the 2 before squaring.**A1:** Achieves similar expression for both sides and gives a (minimal) conclusion.

Note that there will be other methods for 6(c) e.g.:

$$\sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}} = \frac{3+2\sqrt{2}-1}{\sqrt{3+2\sqrt{2}}}$$

M1: Attempts common denominator and applies $\sqrt{3+2\sqrt{2}} \times \sqrt{3+2\sqrt{2}} = 3+2\sqrt{2}$

$$\left(\frac{2+2\sqrt{2}}{\sqrt{3+2\sqrt{2}}} \right)^2 = \frac{12+8\sqrt{2}}{3+2\sqrt{2}} \times \frac{3-2\sqrt{2}}{3-2\sqrt{2}} = \frac{36-32}{9-8} = 4$$

dM1: Squares and attempts to rationalise the denominator

$$\text{So } \sqrt{3+2\sqrt{2}} - \frac{1}{\sqrt{3+2\sqrt{2}}} = 2^*$$

A1*: Fully correct work

Question Number	Scheme	Marks
4(i)	Uses a correct law of indices on 2^{4k-3} or 8^{1-k} The possibilities are endless but some more common examples are: For 2^{4k-3}: $2^{4k} \times 2^{-3}$, $\frac{2^{4k}}{8}$, $8^{\frac{4k-3}{3}}$, $4^{\frac{4k-3}{2}}$, $(\sqrt{2})^{8k-6}$ For 8^{1-k}: 8×8^{-k}, $\frac{8}{8^k}$, $2^{3(1-k)}$, $4^{\frac{2(1-k)}{3}}$, $(\sqrt{2})^{6-6k}$ These may be seen in isolation e.g. not in an equation. But not just e.g. $8 = 2^3$	M1
	e.g. $2^{4k-3} = \frac{8^{1-k}}{4\sqrt{2}} \Rightarrow 2^{4k-3} = \frac{2^{3(1-k)}}{2^{\frac{5}{2}}} \Rightarrow 2^{4k-3} = 2^{3(1-k)-\frac{5}{2}}$ $\Rightarrow 4k-3 = 3(1-k) - \frac{5}{2} \Rightarrow k = \dots$	dM1
	$k = \frac{1}{2}$	A1
		(3)

Notes

Part (i) can be solved using many different approaches.

Please follow the general guidelines below and seek advice from your Team Leader if necessary.

Note that it is acceptable to use logs within their solution as long as the first mark is scored but they should have a base that is a power of 2 (see note below*)

(i)

M1: This is effectively a B mark and is for applying a correct law of indices on 2^{4k-3} or 8^{1-k}
See scheme for some examples.

Note that this may be implied by e.g. $x = 2^k \Rightarrow 2^{4k-3} = \frac{x^4}{8}$

dM1: For this mark they must

- reach a value for k
- reach an equation of a form so that the indices in terms of k can be compared e.g.

$\alpha^{f(k)} = \alpha^{g(k)} \Rightarrow f(k) = g(k)$ **or** of the form $\alpha^{f(k)} = \beta$ where $f(k)$ and $g(k)$ are linear

Note that the second bullet point may be implied by e.g. $2^{4k-3} = \frac{2^{3(1-k)}}{2^{\frac{5}{2}}} \Rightarrow 4k-3 = 3(1-k) - \frac{5}{2}$

A1: Obtains $k = \frac{1}{2}$ from a correct equation of one of the forms above.

Note that correct work leading to $128^k = 8\sqrt{2} \Rightarrow k = \frac{1}{2}$ or e.g. $k = \log_{128} 8\sqrt{2} = \frac{1}{2}$ is acceptable.

*But note that e.g. $7k = \frac{\log_{10} 8\sqrt{2}}{\log_{10} 2} \Rightarrow k = \frac{1}{2}$ is not acceptable without justification and scores a maximum of M1dM1A0

Correct answers with no working in (i) score no marks.



(ii)	$\frac{x\sqrt{3}+2}{\sqrt{3}-1} = x\sqrt{3}-4 \Rightarrow x\sqrt{3}+2 = (x\sqrt{3}-4)(\sqrt{3}-1)$ $\Rightarrow x\sqrt{3}+2 = 3x+4-4\sqrt{3}-x\sqrt{3}$ $\Rightarrow 2\sqrt{3}x-3x = 2-4\sqrt{3}$	M1
	$\Rightarrow x(2\sqrt{3}-3) = 2-4\sqrt{3}$	A1
	$\Rightarrow x = \frac{2-4\sqrt{3}}{2\sqrt{3}-3} \times \frac{2\sqrt{3}+3}{2\sqrt{3}+3}$	dM1
	$= -6 - \frac{8}{3}\sqrt{3}$	A1
		(4)
Alternative		
	$\frac{x\sqrt{3}+2}{\sqrt{3}-1} = x\sqrt{3}-4 \Rightarrow \frac{x\sqrt{3}+2}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1} = x\sqrt{3}-4$ $\Rightarrow \frac{3x+2\sqrt{3}+x\sqrt{3}+2}{3-1} = x\sqrt{3}-4$ $\Rightarrow 3x+2\sqrt{3}+x\sqrt{3}+2 = 2x\sqrt{3}-8 \Rightarrow \sqrt{3}x-3x = 10+2\sqrt{3}$	M1
	$\Rightarrow x(\sqrt{3}-3) = 10+2\sqrt{3}$	A1
	$x = \frac{10+2\sqrt{3}}{\sqrt{3}-3} \times \frac{\sqrt{3}+3}{\sqrt{3}+3}$	dM1
	$= \frac{10\sqrt{3}+30+6+6\sqrt{3}}{3-9} = -6 - \frac{8}{3}\sqrt{3}$	A1

(ii)

M1: Attempts to form a linear equation in x with x terms on one side and constants on the other. The x does not need to be factorised out from the x terms for this mark.

A1: A **correct** linear equation in x with terms collected and x factorised out.

Possible correct equations are: $x(2\sqrt{3}-3) = 2-4\sqrt{3}$ or $x(\sqrt{3}-3) = 10+2\sqrt{3}$

May be unsimplified e.g. $x(\sqrt{3}+\sqrt{3}-3) = 4-2-4\sqrt{3}$

dM1: Makes x the subject and correctly rationalises the denominator of x of the form $\alpha + \beta\sqrt{3}$ where α and β are non-zero.

e.g. $x = \frac{\dots}{\alpha + \beta\sqrt{3}} \times \frac{\alpha - \beta\sqrt{3}}{\alpha - \beta\sqrt{3}}$ or proceeds to an answer of the form $a + b\sqrt{3}$ or $\frac{a + b\sqrt{3}}{c}$

Sight of e.g. $x = \frac{2-4\sqrt{3}}{2\sqrt{3}-3} \times \frac{2\sqrt{3}+3}{2\sqrt{3}+3}$ is sufficient but may be implied by e.g.

$$x = \frac{2-4\sqrt{3}}{2\sqrt{3}-3} = \frac{4\sqrt{3}+6-24-12\sqrt{3}}{12-9}$$

A1: Reaches $-6 - \frac{8}{3}\sqrt{3}$ following dM1

Allow equivalents e.g. $-\frac{36}{6} - \frac{16}{6}\sqrt{3}$ but not e.g. $\frac{-18-8\sqrt{3}}{3}$

Apply isw once the correct answer is seen.



(ii) Alternative method: Attempts to rationalise first

M1: Multiplies the left hand side of the equation by $\frac{\sqrt{3}+1}{\sqrt{3}+1}$ leaving the rhs unchanged and then

attempts to form a linear equation in x with x terms on one side and constants on the other. The x does not need to be factorised out from the x terms for this mark.

Condone invisible brackets even if not recovered e.g.

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

A1: A **correct** linear equation in x with terms collected and x factorised out.

dM1: Makes x the subject and correctly rationalises the denominator of x of the form $\alpha + \beta\sqrt{3}$ where α and β are non-zero.

e.g. $x = \frac{\dots}{\alpha + \beta\sqrt{3}} \times \frac{\alpha - \beta\sqrt{3}}{\alpha - \beta\sqrt{3}}$ oe and proceeds to an answer of the form $a + b\sqrt{3}$.

Sight of e.g. $x = \frac{10+2\sqrt{3}}{\sqrt{3}-3} \times \frac{\sqrt{3}+3}{\sqrt{3}+3}$ is sufficient but may be implied by e.g.

$$x = \frac{10+2\sqrt{3}}{\sqrt{3}-3} = \frac{10\sqrt{3}+30+6+6\sqrt{3}}{3-9}$$

A1: Reaches $-6 - \frac{8}{3}\sqrt{3}$ following dM1

Allow equivalents e.g. $-\frac{36}{6} - \frac{16}{6}\sqrt{3}$ but not e.g. $\frac{-18-8\sqrt{3}}{3}$

Apply isw once the correct answer is seen.

General Principles for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$

2. Formula

Attempt to use correct formula (with values for a , b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$

Method marks for differentiation and integration:1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.



General Principles for Pure Mathematics Marking*(But note that specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:**1. Factorisation $(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$ $(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$ 2. FormulaAttempt to use correct formula (with values for a , b and c).3. Completing the squareSolving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$, leading to $x = \dots$ **Method marks for differentiation and integration:**1. DifferentiationPower of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)2. IntegrationPower of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)**Use of a formula**

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.**Exact answers**Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.**Answers without working**The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice

Question	Scheme	Marks
1	$\int 10x^5 + 6x^3 - \frac{3}{x^2} dx = 10 \times \frac{x^6}{6} + 6 \times \frac{x^4}{4} - 3 \times \frac{x^{-1}}{-1} (+c).$	M1 A1
	$= \frac{5x^6}{3} + \frac{3x^4}{2} + \frac{3}{x} + c$	A1A1
		(4)
(4 marks)		
Notes:		

M1: For raising any power by 1, e.g. $x^5 \rightarrow ..x^6$, $x^3 \rightarrow ..x^4$ or $x^{-2} \rightarrow ..x^{-1}$.

Accept unprocessed indices such as x^{5+1} etc

A1: For two of the three terms in x correctly integrated (but may be left unsimplified). See below

Accept for this mark terms like $10 \times \frac{x^6}{6}$ and $-3 \times \frac{x^{-1}}{-1}$

This may be implied by a correct simplified answer.

Do NOT accept for this mark "unprocessed terms" such as $10 \times \frac{x^{5+1}}{5+1}$

A1: For two correct and simplified terms in x all on one line.

Accept for this mark equivalent terms such as $3x^{-1}$ for $\frac{3}{x}$ and $1.5x^4$ for $\frac{3x^4}{2}$

Do NOT accept for this mark terms like $-3 \times \frac{x^{-1}}{-1}$ and $1.67x^6$

A1: Fully correct and simplified with $+c$ all on one line.

Accept simplified equivalents, e.g. $3x^{-1}$ for $\frac{3}{x}$.

Do NOT accept with spurious symbols like $\left(\frac{5x^6}{3} + \frac{3x^4}{2} + \frac{3}{x} + c \right) dx$ or $\int \left(\frac{5x^6}{3} + \frac{3x^4}{2} + \frac{3}{x} + c \right)$

Do NOT allow if they then go on and multiply to get rid of fractions



Question	Scheme	Marks
2(a)	$AB = 21 \text{ cm}, BC = 13 \text{ cm}, \angle BAC = 25^\circ, \angle ACB = x^\circ$	
	$\frac{\sin x^\circ}{21} = \frac{\sin 25^\circ}{13}$ o.e	M1
	$\sin x^\circ = 0.6827$ (awrt)	A1
		(2)
(b)	$\sin^{-1}(0.6827) = \dots (43.05^\circ)$	M1
	$(AC < AB \text{ so } \angle ABC < \angle ACB \text{ so})$ required angle is $180^\circ - \sin^{-1}(0.6827) = \dots$	M1
	So $x =$ awrt 136.95	A1
		(3)
(5 marks)		
Notes:		
Condone the omission of the $^\circ$ symbol. Mark (a) and (b) as one		

(a)

M1: A correct statement of the sine rule with sides and angles in the correct position.Implied by $\sin x^\circ =$ awrt 0.68**A1:** $\sin x^\circ =$ awrt 0.6827ISW for instance if they go on to find the value of x in (a)

(b)

M1: Applies inverse sine to their value found in part (a) to find the angle in degrees (using degree mode) correct to nearest degree. For a correct (a) awrt 43° is sufficientImplied by a correct answer for their value of $\sin x$, either for the acute or the obtuse angle..**M1:** Attempts to find the correct angle, $180^\circ - \arcsin(0.6827)^\circ$. Award even if other angles are given. No reasoning need be given, but may see diagram drawn, size of angles, or comparison of sides used.**A1:** awrt 136.95 but it is A0 if two angles are given.....
There are alternative methods so look at the candidates work carefully.

E.g.

Uses the cosine rule once to find AC

$$13^2 = 21^2 + y^2 - 2 \times 21 \times y \cos 25$$

$$y^2 - 38.1..y + 272 = 0$$

$$y = 9.533\dots$$

...and then a second time to find x

$$\cos x = \frac{13^2 + 9.533^2 - 21^2}{2 \times 13 \times 9.533} \Rightarrow x = 136.95^\circ$$

In this solution both M's in part (b) are scored together.

To score marks in (a) (even though they haven't used the sine rule) they would need to simply find $\sin$ (their 136.95) for M1, and A1 for an accurate answer.

General Principles for Pure Mathematics Marking*(NB specific mark schemes may sometimes override these general principles)***Method mark for solving 3 term quadratic:**

1. Factorisation

 $(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$ leading to $x = \dots$ $(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$ leading to $x = \dots$

2. Formula

Attempt to use correct formula (with values for a, b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$ leading to $x = \dots$ **Method marks for differentiation and integration:**

1. Differentiation

Power of at least one term decreased by 1 ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1 ($x^n \rightarrow x^{n+1}$)**Use of a formula**

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.

Question Number	Scheme	Marks
1. (a)	$p^{\frac{1}{2}} = \left(\frac{1}{16}x^4\right)^{\frac{1}{2}} = \frac{1}{4}x^2$	B1 (1)
(b)	$(pq)^{-1} = \left(\frac{1}{16}x^4 \times \frac{40}{x^3}\right)^{-1} = \left(\frac{5}{2}x\right)^{-1} = \frac{2}{5}x^{-1}$	M1, A1 (2)
(c)	$p q^2 = \frac{1}{16}x^4 \times \left(\frac{40}{x^3}\right)^2 = \frac{1600}{16} \times \frac{x^4}{x^6} = 100x^{-2}$	M1, A1 (2) (5 marks)

(a)

B1: For $\frac{1}{4}x^2$. Allow $\frac{x^2}{4}$ or $0.25x^2$ Condone $\pm \frac{1}{4}x^2$

Note: **final** answer below for (b) and (c) does not include going on to give alternative correct forms for the same answer. If further incorrect work follows a correct answer then do not isw but take the final expression as their answer.

(b)

M1: A **final** answer with a correct simplified coefficient or index. E.g $\frac{2}{5}x^n$, $0.4x^n$, kx^{-1} or $\frac{k}{x^1}$ (or equivalent variations) Also allow $(kx)^{-1}$

A1: A **final** answer of $\frac{2}{5}x^{-1}$ or $0.4x^{-1}$ but isw $\frac{2}{5x}$ following this. Incorrect “simplifications” will be A0, though.

(c)

M1: A **final** answer with a correct simplified coefficient or index. E.g $100x^n$, kx^{-2} or $\frac{k}{x^2}$

A1: A **final** answer of $100x^{-2}$ but isw $\frac{100}{x^2}$ following this. Incorrect “simplifications” will be A0, though.

Question Number	Scheme	Marks
2. (a)	$y = 2x^{\frac{5}{2}} - 4x + 3$ $\left\{ \frac{dy}{dx} \right\} = 5x^{\frac{3}{2}} - 4$	M1, A1 (2)
(b)	$5x^{\frac{3}{2}} - 4 = 16 \Rightarrow x^{\frac{3}{2}} = 4$ $\Rightarrow x = 4^{\frac{2}{3}} = 2^{\frac{4}{3}} \quad \Rightarrow k = \frac{4}{3}$	M1, A1 A1 (3) (5 marks)

Note: Allow benefit of doubt if some fractional indices look like they are inline but it is clear that powers are intended.

(a)

M1: For decreasing a correct power by one including $3 \rightarrow 0$

A1: For $5x^{\frac{3}{2}} - 4$

(b)

M1: Sets their $\frac{dy}{dx} = \alpha x^{\frac{3}{2}} + \beta = 16$ and proceeds to $x^{\frac{3}{2}} = \delta$ or $\frac{dy}{dx} = \alpha (2^k)^{\frac{3}{2}} + \beta = 16$ and proceeds with correct index work to $(2^k)^{\frac{3}{2}} = q$ or $2^{pk} = q$ (oe)

A1: Achieves $x^{\frac{3}{2}} = 4$ or $(2^k)^{\frac{3}{2}} = 4$ or $2^{3k} = 16$ (oe in form $2^{pk} = q$)

A1: $k = \frac{4}{3}$ (oe) but accept $x = 2^{\frac{4}{3}}$ as long as no incorrect statement for k follows. Note if a decimal is given it must be recurring, not rounded.

They may use logs to solve, do not be concerned about use of rounded values in working. If $x^{\frac{3}{2}} = 4$ is achieved and they reach $k = \frac{4}{3}$ from log work even with incorrect rounding shown, assume full calculator accuracy was kept in working and award the mark.