Pearson Edexcel

Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Level In Pure Mathematics P1 (WMA11) Paper 01

Question Number	Scheme	Marks
	$\int (2x-5)(3x+2)(2x+5)\,\mathrm{d}x$	
1.	$(2x-5)(3x+2)(2x+5)=(6x^2-11x-10)(2x+5)=...$	M1
	$=12x^3+8x^2-75x-50$	A1
	$\int (2x-5)(3x+2)(2x+5)\,\mathrm{d}x=3x^4+\frac{8}{3}x^3-\frac{75}{2}x^2-50x+c$	M1, A1ft, A1
		(5 marks)

M1: Attempts to multiply out. Look for an attempt to multiply two brackets together to form a quadratic before the result is combined with the third bracket.
Condone slips and it may be left unsimplified but it must lead to an expression that could be simplified to the form ax^3+bx^2+cx+d where $a,b,c,d\neq 0$
Condone an answer appearing without an intermediate step only if it is of the form (or can be expressed in the form) $12x^3+px^2+qx\pm 50$ where $p,q\neq 0$

A1: For $12x^3+8x^2-75x-50$ but allow this unsimplified with the terms uncollected

M1: For an attempt to integrate scored for $\int x^n\mathrm{d}x\to x^{n+1},\ n\neq 0,$ on any term in x following an attempt to expand. The index must be processed, i.e. $x^3\to x^4$ and not x^{3+1}. Can be scored following a quadratic expansion, so when a = 0

A1ft: Correct follow through on any **two terms** of their ax^3+bx^2+cx+d.
Condone one of a,b,c,d being 0. Can be scored following a quadratic expansion, so when a = 0
The terms must now have been collected

A1: $3x^4+\frac{8}{3}x^3-\frac{75}{2}x^2-50x+c$ or exact equivalent including the + c

I am happy to accept terms like $\frac{8}{3x^{-3}}$ for $\frac{8}{3}x^3$

Ignore/condone spurious additional notation such as $\int\ 3x^4+\frac{8}{3}x^3-\frac{75}{2}x^2-50x+c$

Do not ISW if candidates proceed say to multiply by 6 to get rid of the fractional terms.

Question Number	Scheme	Marks
2.(a)	Attempts $A=\frac{1}{2}ab\sin C \Rightarrow 100=\frac{1}{2}\times 25\times 15\sin BAC$	M1
	$\sin\theta° = \frac{8}{15}$	A1
		(2)
(b)	$\left(BC^2\right) = 15^2 + 25^2 - 2\times 15\times 25\times \cos"\theta°"$ where $\theta° = \arcsin"\frac{8}{15}"$	M1
	$BC^2 = 15^2 + 25^2 - 2\times 15\times 25\times \cos\left(180 - \text{their } '32.2'\right) \Rightarrow BC = ...$	dM1
	$BC^2 = 1484.4... \Rightarrow BC = \text{awrt } 38.5 \text{ cm}$ cso	A1
		(3)
		(5 marks)

(a)

M1: Attempts to use the area formula $"A=\frac{1}{2}ab\sin C"$ with the given information (condoning slips)

The angle used **should** be θ, BAC, CAB or A with or without any degrees symbol but condone, for this mark only, a direct substitution into the formula to achieve $100=\frac{1}{2}\times 25\times 15\sin C$

A1: Achieves $\sin\theta° = \frac{8}{15}$ or **exact** equivalent fraction such as $\frac{200}{375}, \frac{100}{187.5}$ in the form $\frac{a}{b}$ or $0.5\dot{3}$

Condone answers such as $\theta = \arcsin\frac{8}{15}$ or $\sin\theta° = \frac{8\text{ cm}^2}{15\text{ cm}^2}$

Allow θ to be BAC ,CAB or $A \to a$ with or without any degrees symbol.

Allow C to be just "changed" to θ or any of the above for both marks. E.g.

$$100=\frac{1}{2}\times 25\times 15\sin C \Rightarrow \sin\theta° = \frac{8}{15} \qquad \text{ISW after sight of } \sin\theta° = \frac{8}{15}$$

Note that finishing with $\sin \underline{\underline{C}} = \frac{8}{15}$ is A0 but allow all marks to be scored in (b) following this.

(b)

M1: Attempts to use the cosine rule. Ignore the lhs and allow using an acute angle found using part (a)

Look for $15^2 + 25^2 - 2\times 15\times 25\times\cos"\theta°"$ where $\cos\theta°$ is found using their $\sin\theta°$ from part (a)

So allow for $15^2 + 25^2 - 2\times 15\times 25\times\cos"32.2°"$ It can be implied by an answer for BC of 14.7 cm

Their angle must be correct to the nearest degree for their $\sin\theta° = \frac{8}{15}$. Hence marks can only be achieved in part (b) if their $-1 \leqslant \sin\theta° \leqslant 1$.

You may see sight of an exact $\cos\theta°$ being used. E.g. if $\sin\theta° = \frac{8}{15}$ look for $\cos\theta° = (\pm)\frac{\sqrt{161}}{15}$

dM1: Full use of the cosine rule (with lhs correct) and an obtuse angle used (correct to the nearest degree) leading to a value for BC. The obtuse angle must be correct for their part (a), that is $\left(180 - \text{their } '32.2'\right)$

A1: CSO $BC = \text{awrt } 38.5 \text{ cm}$. Condone missing units

SPECIAL CASE

Solutions using radians are possible. So a "correct" solution would be

$$BC^2 = 15^2 + 25^2 - 2\times 15\times 25\times\cos\left(\pi - 0.5625\right) \Rightarrow BC = 38.5 \text{ for M1 dM1 A0}$$

The angle θ given in this question is measured in degrees so this is not a <u>completely</u> correct solution.

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

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

Look for a correct use of their $\left.\frac{dy}{dx}\right|_{x=2}$ 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 = ...

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

....

Alt (a)

Some may have done WMA13 and may attempt the quotient rule

M1, dM1 for an attempt at the quotient rule to obtain $\dfrac{2x^2 \times ax^2 - \left(5x^3 - 8\right) \times bx}{\left(2x^2\right)^2}$ where $a > 0$, $b > 0$

condoning lack of brackets

So allow, for example, if you see $2x^4$ on the denominator.

These two marks are scored together so 1000 is not possible via this route

Then A1 for $\dfrac{2x^2 \times 15x^2 - \left(5x^3 - 8\right) \times 4x}{\left(2x^2\right)^2}$ and finally A1 for $\dfrac{5x^3 + 16}{2x^3}$ or other simplified equivalent

....

Alt (b)

Some may use the $\dfrac{dy}{dx}$ function of their calculator to find the gradient of the tangent at $x = 2$

So if the gradient of $\dfrac{7}{2}$ appears without any working **AND** following an incorrect or missing part (a) score as follows

M0: No sight of using $x = 2$ in their $\dfrac{dy}{dx}$

M1: For sight of $y - 4 = \dfrac{7}{2}\left(x - 2\right)$ or equivalent

A1: For $7x - 2y - 6 = 0$ or integer multiple

....

Question Number	Scheme	Marks
4 (a)	$2\times 4^{x}-2^{x+3}=17\times 2^{x-1}-4$	
	Uses an index law and states or implies any of $4^{x}=p^{2}$, $2^{x+3}=8p$ or $2^{x-1}=\frac{p}{2}$	B1
	Writes the given equation in terms of p $2\times 4^{x}-2^{x+3}=17\times 2^{x-1}-4\Rightarrow 2p^{2}-2^{3}\times p=\frac{17p}{2^{1}}-4$	M1
	Proceeds to $4p^{2}-33p+8=0$ via $2p^{2}-8p=\frac{17p}{2}-4$ * CSO	A1*
		(3)
(b)	$4p^{2}-33p+8=0\Rightarrow(4p-1)(p-8)=0\Rightarrow p=...,...$	M1
	Sets $2^{x}=\frac{1}{4},8\Rightarrow x=...$	M1
	$x=-2,3$	A1
		(3)
		(6 marks)

(a) Watch out here as this is a given answer. All stages of working are required to score the 3 marks

B1: Uses an index law and states or implies any of $4^{x}=p^{2}$, $2^{x+3}=8p$ or $2^{x-1}=\frac{p}{2}$

Allow equivalents such as $4^{x}=p\times p$, $2^{x+3}=8\times p, p\times 8$ or $2^{x-1}=\frac{1}{2}p, p\div 2, 0.5p$

M1: Attempts to write the given equation in x to a quadratic equation in terms of p

$$2\times 4^{x}-2^{x+3}=17\times 2^{x-1}-4\Rightarrow 2p^{2}-2^{3}\times p=\frac{17p}{2^{1}}-4 \quad \text{or} \quad 2p^{2}-2^{3}\times p=17p\times 2^{-1}-4$$

All three index laws must be seen but condone slips on signs or on the 2^{3} if there was an incorrect attempt to process.

$$2\times 4^{x}-2^{x+3}=17\times 2^{x-1}-4\Rightarrow 2p^{2}-6\times p=\frac{17p}{2^{1}}-4$$ would be fine for the M1

Allow a recovery for this M1, e.g. $2^{x+3}=2^{x}+2^{3}=8p$ but not the A1*

Watch for candidates who manipulate the given equation first. This is acceptable.

$$2\times 4^{x}-2^{x+3}=17\times 2^{x-1}-4\Rightarrow 4^{x}-2^{x+2}=17\times 2^{x-2}-2$$

So $$\Rightarrow p^{2}-2^{2}\times p=\frac{17p}{2^{2}}-2$$

A1*: CSO Proceeds to the given answer of $4p^{2}-33p+8=0$ with no errors or omissions.

Condone working such as $4^{x}=2^{x^{2}}$ leading to p^{2}. It is often hard to decipher the relative heights of the indices.

An intermediate line of $2p^{2}-8p=\frac{17p}{2}-4$ o.e. must be seen.

(b) **This is a non-calculator part so the use of a calculator is penalised**

M1: Valid **non calculator** attempt at solving $4p^2 - 33p + 8 = 0$. Allow slips/miscopies on $4p^2 - 33p + 8 = 0$ for example, $4p^2 - 33p - 8 = 0$. The roots cannot just appear.

Examples such as $4p^2 - 33p + 8 = (p-8)\left(p - \frac{1}{4}\right) = 0 \Rightarrow p = 8, \frac{1}{4}$ is obvious calculator work and scores M0

Award for an attempt to

- factorise (usual rules) leading to values for (p)
- use the quadratic formula condoning this calculation $\frac{33 \pm \sqrt{(-33)^2 - 4(4)(8)}}{2(4)}$ followed by $\frac{1}{4}, 8$
- complete the square leading to values for (p)

M1: Valid non calculator attempt at solving an equation of the form $2^x = k, \quad k > 0$

This can be implied for a correct solution for either root.

If the value of k is not a power of 2 then score for $2^x = k \Rightarrow x = \log_2 k$

A1: Both solutions $x = -2, 3$ following the correct quadratic equation in p. There is no need to state $x =$

If they then go on to reject $x = -2$ say then A0

Note that 011 is possible in part (b) for candidates who don't show a non-calculator solution of $4p^2 - 33p + 8 = 0$

Question Number	Scheme	Marks
5 (a)	Attempts the gradient $\frac{\Delta y}{\Delta x}=\frac{9-6}{-2-10}=\left(-\frac{1}{4}\right)$	M1
	Uses the gradient and a point to form an eqn for l_1 $y-9=-\frac{1}{4}(x+2)$	dM1
	$y=-\frac{1}{4}x+\frac{17}{2}$	A1
		(3)
(b)	Eqn of l_2 is $y=4x$	B1ft
	Attempts to solve their $y=4x$ and their $y=-\frac{1}{4}x+\frac{17}{2}$ simultaneously	M1
	$R=(2,8)$	A1, A1
		(4)
(c)	Attempts $(OR)=\sqrt{"2"^2+"8"^2}$ or $(PQ)=\sqrt{3^2+12^2}$	M1
	Full attempt at area $OPQ=\frac{1}{2}\times\sqrt{3^2+12^2}\times\sqrt{2^2+8^2}$	dM1
	$=\frac{1}{2}\times 3\sqrt{17}\times 2\sqrt{17}=51$	A1
		(3)
		(10 marks)

This is a non-calculator question so the use of a calculator is penalised

(a)

M1: Attempts gradient. It must be the "correct way up" with $\Delta y/\Delta x$ and an attempt at differences (seen or implied at least once on either the numerator or denominator). It is implied by a correct answer.

dM1: Uses gradient and one of the points to form a straight line. The coordinates must be in the correct place in the unsimplified equation. It is dependent upon the previous M

A1: $y=-\frac{1}{4}x+\frac{17}{2}$ o.e. but it must be in the form $y=mx+c$. ISW after sight of a correct answer.

Alt (a) via simultaneous equations

M1: Attempts to form two simultaneous equations using both points and either $y=mx+c$ **or** $ax+by+c=0$

dM1: Solves the two simultaneous equations **via a non calculator method** to find both unknowns. It is important to see some working but it can be minimal. For example, $9=-2m+c$ and $6=10m+c$ must be followed by $12m=-3$ o.e before you see $m=-0.25$ oe.

A1: $y=-0.25x+8.5$ o.e. but it must be in the form $y=mx+c$.

Note that 101 is possible for candidates who don't show any working in solving their simultaneous equations but produce the correct equation (in the correct form)

(b)

B1ft: Correct follow through normal equation for their $y=-\frac{1}{4}x+\frac{17}{2}$. Implied by $y=4x+0$ following correct (a). So $y=-\frac{1}{m}x$ for their $y=mx+c$. It may be implied by a solution of $-\frac{1}{m}x=mx+c$

M1: Attempts to solve their $y=4x$ and their $y=-\frac{1}{4}x+\frac{17}{2}$ simultaneously via a non-calculator route.

Look for a value for x or a value for y following an attempt at solving $\pm\frac{1}{m}x=mx+c$

There should be some working, allow as a minimum $"4"x="-0.25x+8.5"\Rightarrow ...x=...\Rightarrow x=...$
Don't be too concerned with accuracy here.....it is a method mark

A1: One correct coordinate, usually x = 2 but could be for y = 8 if solved differently

A1: $R=(2,8)$. May be written separately

Solutions with no working, insufficient working and/ or via use of a calculator

(b)

For the M mark you should expect to see some working. As a minimum look for the two highlighted equations (or their equivalent) where the x terms have been collected

$$y=4x \text{ and } y=-\frac{1}{4}x+\frac{17}{2} \Rightarrow 4x=-\frac{1}{4}x+\frac{17}{2} \Rightarrow 4.25x=8.5 \text{ followed by } (2, 8)$$

If (2, 8) follows the two correct equations without the highlighted working (o.e.) score SC 1011

(c)

M1: States or attempts $\sqrt{2^2+8^2}$ using their coordinates for R or $\sqrt{3^2+12^2}$ using the given P and Q. It can be implied by an exact answer or an answer to 3sf for their coordinates
If two right angled triangles are used to find the area, it would be for attempts at OR, or PR and RQ.

dM1: Full attempt at area of triangle OPQ using $\frac{1}{2}\times \textit{their } OR\times \textit{their } PQ$ o.e.

Both PQ and OR must be attempted via a correct method
This can be awarded for decimal work. It is dependent on the previous M

A1: Correct answer via a correct method with sufficient working to suggest a non-calculator method

Look for $\frac{1}{2}\times 2\sqrt{17}\times 3\sqrt{17}$ (or other correct and relevant work) before you see 51.

Don't allow this to be scored via decimals or from just $\frac{1}{2}\times\sqrt{153}\times\sqrt{68}=51$ unless extra relevant lines are seen as above.

Alternatives to part (c) exist via the cosine rule, the shoelace method

ALT 1: the cosine rule.

One example shown using angle POQ

$$\cos POQ=\frac{136+85-153}{2\sqrt{85}\sqrt{136}}=\frac{1}{\sqrt{10}} \qquad \text{Area triangle } POQ=\frac{1}{2}\sqrt{85}\sqrt{136}\sin POQ=\frac{1}{2}\sqrt{85}\sqrt{136}\times\frac{3}{\sqrt{10}}=51$$

M1: As main scheme for length PQ

dM1: Full method. Likely to involve decimals here and the angle $71.6°$. If decimals are used it will be followed by A0

ALT 2: the shoelace method.

Note that the example below starts at (0, 0). It could start at any of the coordinates

$$\text{Area} = \frac{1}{2}\begin{vmatrix} 0 & -2 & 10 & 0 \\ 0 & 9 & 6 & 0 \end{vmatrix} = \frac{1}{2}\left|(0\times 9)+(-2\times 6)+(10\times 0)-(-2\times 0)-(10\times 9)-(0\times 6)\right| = \frac{1}{2}\times 102 = 51$$

M2: For a full attempt at the area. Score for $\frac{1}{2}\left|(0\times 9)+(-2\times 6)+(10\times 0)-(-2\times 0)-(10\times 9)-(0\times 6)\right|$

A1: 51

ALT 3: Trapezium minus two right-angled triangles

$$\frac{12}{2}(9+6)-\frac{1}{2}\times 10\times 6-\frac{1}{2}\times 2\times 9 = 90-30-9 = 51$$

M2: For a full attempt at area $\frac{12}{2}(9+6)-\frac{1}{2}\times 10\times 6-\frac{1}{2}\times 2\times 9$

A1: 51

ALT 4: Two scalene triangles, *OPC* & *OCQ* (where *C* is where intercept of l_1 with the y -axis)

When $x=0,\ y=\frac{17}{2}$ Area = $\frac{1}{2}\times\frac{17}{2}\times 10+\frac{1}{2}\times\frac{17}{2}\times 2 = \frac{85}{2}+\frac{17}{2} = 51$

M1: Attempts the y intercept of l_1

dM1: For a full attempt at area

A1: 51

Question Number	Scheme	Marks
6. (a)	$(540°, -5)$	B1, B1 **(2)**
(b) (i)	$(360°, 3)$	B1, B1 **(2)**
(ii)	$(180°, 5)$	B1, B1 **(2)** **(6 marks)**

Notes applying to all parts:

Note 1

Score B1 for one correct coordinate, so B0 B1 is NOT possible

So for example (a) $(720°, -5)$ scores B1 B0

Note 2

Coordinates can be given separately

E.g. (a) $x = 540°$, $y = -5$

Note 3

Coordinates may appear within the question. Solutions to (b)(i) for example may well contain two sets of coordinates. E.g. $(360°, 5)$ followed by $(360°, 3)$. This will most likely be their working so in almost all cases you will mark their final set of coordinates

Note 4

Score B1 B0 for a **correct** solution but with the coordinates "flipped".

E.g. (b) (i) $(3, 360°)$ instead of $(360°, 3)$

Note 5

Condone omission of degrees

Note 6

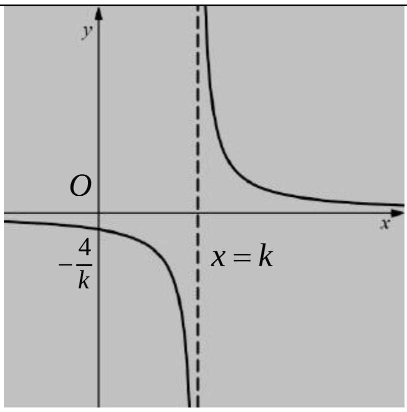
If solutions are given in radians then withhold a mark the first time it happens

E.g. (a) $(3\pi, -5)$ (b)(i) $(2\pi, 3)$ (b)(ii) $(\pi, 5)$ scores (a) B1 B0 (b)(i) B1 B1 (b)(ii) B1 B1

Note 7

If solutions are not in brackets (and not stated as x = y =) then withhold a mark the first time it happens

E.g. (a) $540°, -5$ (b)(i) $360°, 3$ (b)(ii) $180°, 5$ scores (a) B1 B0 (b)(i) B1 B1 (b)(ii) B1 B1

Question Number	Scheme		Marks
7. (a)		Shape in quadrant One	M1
		Fully correct shape and position	A1
		C cuts the y-axis at $-\frac{4}{k}$	B1
		C has a vertical asymptote at $x=k$	B1
			(4)
(b)	$\frac{4}{x-k}=9-x \Rightarrow x^2-(9+k)x+9k+4=0$		M1, A1
	Uses $b^2-4ac<0 \Rightarrow (9+k)^2-4\times1\times(9k+4)<0$		dM1
	$k^2-18k+65<0 \Rightarrow (k-13)(k-5)<0 \Rightarrow 5<k<13$		ddM1, A1
			(5)
			(9 marks)

(a) Marks for intercept and asymptote must be shown on the graph and hence cannot be scored without a sketch

M1: For a monotonically decreasing function in quadrant one. It must not cross either axis but be tolerant of functions that (a) don't go down as far as the x-axis and (b) extend as far left as the y -axis

A1: Correct shape and position (for whole curve). Be tolerant of slips of the pen but the intension should be clear. Look for the curve in quadrants 1, 3 and 4 with a vertical asymptote in quadrant 1 and 4. The left-hand branch should not intentionally dip below the intercept away from the x -axis

B1: C cuts the y-axis once at $-\frac{4}{k}$ which must be on the negative y-axis as $-\frac{4}{k}$, $\left(0,-\frac{4}{k}\right)$ but not $\left(-\frac{4}{k},0\right)$

B1: C must have one vertical asymptote to the right of the y-axis marked $x=k$

(b)

M1: Equates curve with given line and attempts to form a quadratic. The terms do not need to be collected

Look for $\frac{4}{x-k}=9-x$ (condoning slips), cross multiplies and proceeds to a quadratic expression

A1: Achieves a simplified quadratic with collected terms. Look for $x^2-(9+k)x+9k+4=0$ o.e. or else gives the correct values of a, b and c which may be implied by values embedded within b^2-4ac.

dM1: Attempts to use the discriminant $b^2-4ac...0$ for their $ax^2+bx+c=0$ with both b and c expressions in k

ddM1: Solves their quadratic in k resulting from $b^2-4ac=0$ and chooses the inside region for their critical values. Allow calculator solutions here so you may need to check if the method is not apparent.
Condone the boundaries being included in the inequality for this mark.
It is dependent upon both previous M's

A1: CSO $5<k<13$ o.e. The variable must be k.

Accept alternatives such as $k>5$ and $k<13$ $\quad k>5,\ k<13$ $(5,13)$ or $k\in(5,13)$

BUT NOT $k>5$ or $k<13$

Question Number	Scheme	Marks
8 (a)	Attempts to use $S = r\theta \Rightarrow 9 = OD \times 0.8 \Rightarrow OD = 11.25$ or $\frac{45}{4}$	M1, A1
	$AO = \frac{5}{8} \times "11.25" = 7.03\text{ m}$ *	A1*
		(3)
(b)	Attempts $A = 7.03 \times (2\pi - 0.8) = (38.55)$	M1
	Attempts $9 + 2\times(11.25 - 7.03) + 7.03 \times \theta$	M1
	Perimeter = awrt 56.0 m	A1
		(3)
(c)	Attempts $\frac{1}{2} \times "11.25"^2 \times 0.8 = (50.625)$ OR $\frac{1}{2} \times 7.03^2 \times (2\pi - 0.8) = (135.4)$	M1
	Full method for area of platform = $\frac{1}{2} \times "11.25"^2 \times 0.8 + \frac{1}{2} \times 7.03^2 \times (2\pi - 0.8)$	M1
	=awrt 186 m^2	A1
		(3)
		(9 marks)

(a) **This is a show that question and it is important that the method is shown**

M1: Attempts to use $S = "r"\theta \Rightarrow 9 = "r" \times 0.8 \Rightarrow "r" = ...$ Implied by $(r) = \frac{9}{0.8}$

A1: Achieves $\underline{OD} = 11.25$ or $\underline{OC} = 11.25$ but condone $"\underline{r}" = 11.25$. May be implied by $AO = \frac{5}{8} \times \left(\frac{9}{0.8}\right)$ o.e

A1*: Shows that AO is $7.03\,(m)$ via $\frac{5}{8} \times 11.25,\ 11.25 - \frac{3}{8} \times 11.25$ o.e. Units are not required.

You do not need to see *AO* specifically mentioned as long as there was an *OD*, *OC* or *r* stated earlier.
You do not need to see 7.03125 before it being rounded to 7.03.
You can also condone leaving as a more accurate value, e.g. *AO* = 7.03125
Allow a more accurate value of 7.03 to be used in part (b) and (c). E.g. 7.03125

(b)

M1: Attempts arc length *AEB* via $7.03 \times (2\pi - 0.8)$ o.e such as $2\pi(7.03) - 7.03 \times (0.8)$

Allow the angle calculation to be implied by sight of awrt 5.48 so score for 7.03×5.48
If the calculation $(2\pi - 0.8)$ has been seen, allow 5.5 to be used for the angle

M1: Attempts to add the correct parts together E.g. $9 + 2\times("11.25" - 7.03) + 7.03 \times \theta$

The major arc must have been attempted by a correct formula but allow for this mark an incorrect angle to be used for candidates who don't equate 2π to $360°$. So allow for this mark calculations with e.g. $7.03(\pi - 0.8)$

You may see $9 + 2\times\left(\frac{3}{8} \times 11.25\right) + 7.03 \times \theta$. Allow accuracy to 1 dp so $9 + 2\times 4.2 + 38.6$

A1: Perimeter = awrt 56.0m. ISW after a correct answer. Condone 56m following a correct calculation.
The units are not necessary, they can be ignored

(c)

M1: Attempts to find the value of $\frac{1}{2}r^2\theta$ with their r = 11.25 and θ = 0.8

or the value of $\frac{1}{2}r^2\theta$ with r = 7.03 and $\theta = 2\pi - 0.8$ or awrt 5.48 or 5.5 following sight of $2\pi - 0.8$

An alt for the second sector is $\pi \times 7.03^2 - \frac{1}{2}\times 7.03^2 \times 0.8$

dM1: Adds two sectors. See above for how to apply the method for each sector

A1: Awrt 186. The units are not necessary, they can be ignored

Useful diagram

$$DA = 11.25 - 7.03 = 4.22$$

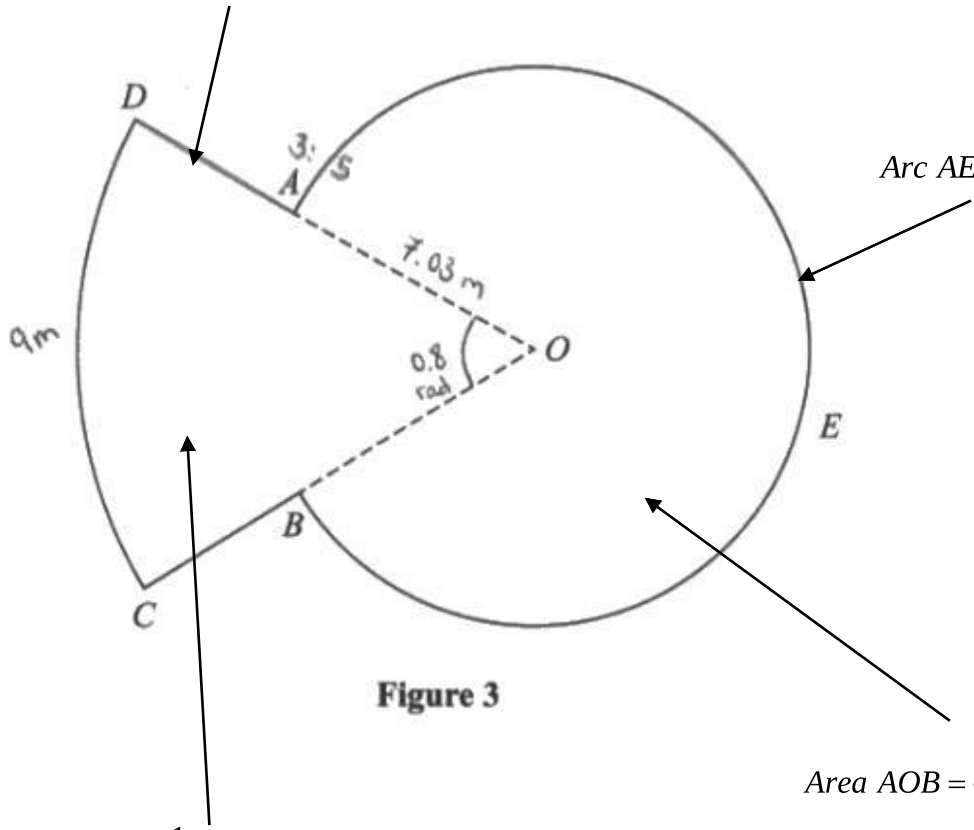


Figure 3

$$Arc\ AEB = 7.03 \times 5.48 = 38.6$$

$$Area\ AOB = \frac{1}{2}\times 7.03^2 \times 5.48 = 135.4$$

$$Area\ DOC = \frac{1}{2}\times 11.25^2 \times 0.8 = 50.6$$

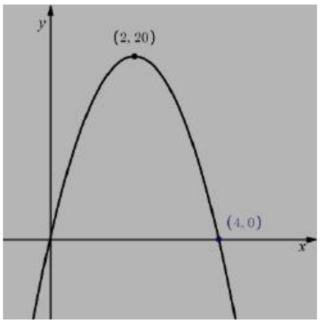
Note: It is possible to do this question in degrees and use the formulae $\frac{\theta}{360}\times 2\pi r$ in (b) and $\frac{\theta}{360}\times \pi r^2$ in (c)

Only allow such a method if the conversion has been attempted by a correct method. Allow for M's awrt 46

(a) 0.8 rad = $0.8\times\frac{180}{\pi} = 45.8°$ so solve $9 = \frac{45.8}{360}\times 2\pi r$ for the first M1

(b) Arc AEB = $\frac{360-45.8}{360}\times 2\pi \times 7.03$

(c) Sector DOC $= \frac{45.8}{360}\times\pi\times 11.25^2$ and Sector AOB $= \frac{360-45.8}{360}\times\pi\times 7.03^2$

Question Number	Scheme	Marks
9 (a)	 Correct shape and position passing through (0, 0)	B1
	Intersection at (4, 0)	B1
		(2)
(b)	Attempts form of equation. E.g. $y = Ax(x-4)$ or $y = 20 \pm C(x-2)^2$	M1
	Full attempt to find equation. E.g. $20 = A \times 2(2-4) \Rightarrow A = ...$	dM1
	Or $0 = 20 + C(4-2)^2 \Rightarrow C = ...$	
	$y = -5x(x-4)$, $y = 20-5(x-2)^2$ o.e.	A1
		(3)
(c)	Sets $x\left(x^2-4\right) = "-5x(x-4)"$	M1
	$x^3+5x^2-24x = 0 \Rightarrow x\left(x^2+5x-24\right) = 0$	dM1
	$(x+8)(x-3) = 0 \Rightarrow$ x coordinate of P is -8	ddM1, A1
	$P = \left(-8, -480\right)$	A1
		(5)
		(10 marks)

(a)

B1: $\cap$ shaped quadratic passing through the origin with maximum on the rhs of the y-axis and an intercept on the + ve x-axis. Be tolerant of slips of the pen. It must appear in quadrants 3, 1 and 4 Ignore extra graphs (e.g. cubics) if they are superimposed on top of this one.

Score if the intention seems correct but do penalise $\wedge$ shaped "curves"

B1: Intersection at (4, 0). Allow 4 marked on the positive x- axis but (0, 4) is B0. Condone graphs that just meet the x-axis at 4 for ones that seem to "sit" on the x -axis and only appear in quadrant 1.

(b)

M1: Attempts form of equation. E.g. $y = \pm Ax(x-4)$ or $y = 20 \pm C(x-2)^2$. Condone with A, C =1

It is possible they could try $y = ax^2+bx+c$ with an attempt to use all three coordinates.

Look for setting up 3 different equations using the given information

- Uses $\left(0, 0\right)$ in $y = ax^2+bx+c \Rightarrow c = 0$
- Uses $\left(2, 20\right)$ in $y = ax^2+bx+c \Rightarrow 20 = 4a+2b$
- Uses $\left(4, 0\right)$ $y = ax^2+bx+c \Rightarrow 0 = 16a+4b$ OR $\left.\frac{dy}{dx}\right|_{x=2} = 2ax+b = 0 \Rightarrow 4a+b = 0$

It is acceptable just to state the rhs of the equation. E.g. $Ax(x-4)$

dM1: Full attempt at equation for $f(x)$ with an attempt at finding values for A or C or a,b c

A1: $y = -5x(x-4)$, $y = 20-5(x-2)^2$ o.e. such as $y = -5x^2+20x$ Allow $f(x) \leftrightarrow y$

The question asks for an expression for $f(x)$ so allow just $5x(4-x)$ o.e.

Allow this to be written down for all 3 marks. ISW after a correct answer.

Allow this to be scored in part (c) if you are certain that this is meant for (b). Use review if unsure.

(c) **All stages of working should be shown in this part so any omissions will be penalised**

M1: Sets $x\left(x^2-4\right)="-5x(x-4)"$ condoning slips

The form of the quadratic must be correct. That is it must pass through (0, 0)

dM1: Multiplies out to reach an equation of the form $px^3+qx^2+rx=0$ from which they factorise (or cancel) out a factor of x. This may be implied as the x may be cancelled out previously, say on their first line

ddM1: Solves the resulting quadratic via an appropriate method.
Condone the use of a calculator for this mark. The solutions must be correct for their quadratic to score this mark via the calculator.

A1: **Chooses** -8 for x coordinate of P. If $x=0,3$ are seen they must be rejected or -8 chosen

Can be awarded **choosing** $x=-8$ following sight of a correct quadratic equation $x^2+5x-24=0$

or for **choosing** $x=-8$ following sight of a correct cubic equation $x^3+5x^2-24x=0$

A1: $P=\left(-8,-480\right)$ which may be given separately x =.., y= ...

Can be awarded for $\left(-8,-480\right)$ following sight of a correct quadratic equation $x^2+5x-24=0$

or for $\left(-8,-480\right)$ following sight of a correct cubic equation $x^3+5x^2-24x=0$

Examples of applying the scheme:

Example 1: M1, M0, M0, A0, A0 for 1 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x=-8\Rightarrow P=\left(-8,-480\right)$$

Example 2: M1, M0, M0, A1, A1 for 3 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x^3+5x^2-24x=0\Rightarrow x=\left(0,3,\right)-8\Rightarrow P=\left(-8,-480\right)$$

Example 3: M1, M1, M1, A1, A1 for 5 out of 5 marks. The solution of the quadratic is implied (calculator)

$$\cancel{x}\left(x^2-4\right)=-5\cancel{x}(x-4)\Rightarrow x^2+5x-24=0\Rightarrow x=\left(3,\right)-8\Rightarrow P=\left(-8,-480\right)$$

Example 4: M1, M1, M1, A1, A1 for 5 out of 5 marks

$$x\left(x^2-4\right)=-5x(x-4)\Rightarrow x^3+5x^2-24x=0\Rightarrow x\left(x^2+5x-24\right)=0\Rightarrow x=\left(0,3,\right)\underline{\underline{-8}}\Rightarrow P=\left(-8,-480\right)$$

Question Number	Scheme	Marks
	$\mathrm{f}'(x)=4\sqrt{x^3}+\dfrac{k}{x^2}=4x^{\frac{3}{2}}+kx^{-2}$	
10 (a)	$\mathrm{f}''(x)=6x^{\frac{1}{2}}-2kx^{-3}$	M1, A1
	$\mathrm{f}''(2)=6\sqrt{2}-2k\times\dfrac{1}{8}=0\Rightarrow k=24\sqrt{2}$	dM1, A1
		(4)
(b)	$\mathrm{f}'(x)=4x^{\frac{3}{2}}+kx^{-2}\Rightarrow\quad \mathrm{f}(x)=4\times\dfrac{2}{5}x^{\frac{5}{2}}-kx^{-1}\left(+c\right)$	M1, A1 ft
	Uses $P\left(2,8\sqrt{2}\right)\Rightarrow 8\sqrt{2}=4\times\dfrac{2}{5}\times 2^{\frac{5}{2}}-\dfrac{k}{2}+c\Rightarrow c=p\sqrt{2}$	dM1
	$\mathrm{f}(x)=\dfrac{8}{5}x^{\frac{5}{2}}-\dfrac{24\sqrt{2}}{x}+\dfrac{68}{5}\sqrt{2}$	A1
		(4) **(8 marks)**

Relevant work must be done in the correct part of the question.
If they are clearly labelled and they just integrate in (a) and they just differentiate in (b) award no marks but if they use their integration that was in part (a) in part (b) for example they can pick up marks in part (b).

(a)

M1: Differentiates $4\sqrt{x^3}+\dfrac{k}{x^2}$ and achieves at least one index correct. Look for $px^{\frac{1}{2}}-qx^{\cdots}$ or $px^{\cdots}-qx^{-3}$

A1: Correct differentiation, which may be left unsimplified. E.g. $4\times\dfrac{3}{2}\times x^{\frac{1}{2}}-2k\times x^{-3}$ or $6x^{\frac{1}{2}}-2kx^{-3}$

dM1: Sets $\mathrm{f}''(2)=0$ and proceeds to a value for *k*. It is dependent upon the previous M mark. Allow even if called something else

A1: $k=24\sqrt{2}$ or exact equivalent. ISW after a correct exact value

(b)

M1: Integrates $4\sqrt{x^3}+\dfrac{k}{x^2}$ and achieves at least one index correct. Look for $px^{\frac{5}{2}}-qx^{\cdots}$ or $px^{\cdots}-qx^{-1}$

A1ft: Correct integration to $4\times\dfrac{2}{5}x^{\frac{5}{2}}-kx^{-1}$. There is no requirement to simplify or have + *c*

Follow through on their value of *k* but also allow with "*k*" as seen above

dM1: Uses $P\left(2,8\sqrt{2}\right)$ and their $k=\ldots\sqrt{2}$ to find *c* as a multiple of $\sqrt{2}$.

It is dependent upon the previous M mark. Both indices must now be correct

The $\ldots x^{\frac{5}{2}}$ term must produce a term in $\sqrt{2}$

A1: Achieves $\dfrac{8}{5}x^{\frac{5}{2}}-\dfrac{24\sqrt{2}}{x}+\dfrac{68}{5}\sqrt{2}$ for $\mathrm{f}(x)$ Accept any other simplified equivalent.

There is no requirement for $\mathrm{f}(x)=$