Pearson Edexcel

Mark Scheme (Results)

Summer 2021

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

Question Number	Scheme	Marks
1(a)	$\left(\frac{dy}{dx}=\right) ...x^1 + ...x^{-\frac{3}{2}} + ...x^{-2}$	M1
	$\left(\frac{dy}{dx}=\right) \frac{2}{3}x - 2x^{-\frac{3}{2}} - \frac{8}{3}x^{-2}$	A1A1A1
		(4)
(b)	$\frac{dy}{dx} = "\frac{2}{3}" \times 4 - "2" \times 4^{"-\frac{3}{2}"} - "\frac{8}{3}" \times 4^{"-2"} = \frac{9}{4}$	M1
	$\frac{9}{4} \rightarrow -\frac{4}{9}$	M1
	$y - 3 = "-\frac{4}{9}"(x-4)$	dM1
	$4x + 9y - 43 = 0$	A1
		(4)
		(8 marks)

(a)

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

$...x^2 \rightarrow ...x^1, ...x^{-\frac{1}{2}} \rightarrow ...x^{-\frac{3}{2}}, ...x^{-1} \rightarrow ...x^{-2}, \ 5 \rightarrow 0$

A1 One of $\frac{2}{3}x$, $-2x^{-\frac{3}{2}}$, $-\frac{8}{3}x^{-2}$ or exact simplified equivalent terms eg $\frac{-2}{\left(\sqrt{x}\right)^3}$ or $-\frac{8}{3x^2}$ or $-2.\dot{6}x^{-2}$

Condone $\frac{2}{3}x^1$ and condone double signs such as $+-2x^{-\frac{3}{2}}$ The terms do not need to be on the same line for this mark.

A1 Two of $\frac{2}{3}x$, $-2x^{-\frac{3}{2}}$, $-\frac{8}{3}x^{-2}$ or exact simplified equivalent terms eg $\frac{-2}{\left(\sqrt{x}\right)^3}$ or $-\frac{8}{3x^2}$.

Condone $\frac{2}{3}x^1$ and condone double signs such as $+-2x^{-\frac{3}{2}}$. The terms do not need to be on the same line for this mark.

A1 $\frac{2}{3}x - 2x^{-\frac{3}{2}} - \frac{8}{3}x^{-2}$ or exact simplified equivalent all on one line eg $\frac{2}{3}x - \frac{2}{\left(\sqrt{x}\right)^3} - \frac{8}{3x^2}$.

Do not allow $\frac{2}{3}x^1 - 2x^{-\frac{3}{2}} - \frac{8}{3}x^{-2}$ or double signs and do not isw in this part (including rounding decimals).

(b)

M1 Substitutes $x=4$ into their $\frac{dy}{dx}$ to find the numerical gradient of the tangent at P.
Condone slips in their working. They must proceed as far as finding a value.
It may be implied by their answer or embedded in further work such as finding the equation of the perpendicular line. Do not be too concerned by the labelling of their $\frac{dy}{dx}$ (It may even be labelled as $y = \ldots$)

M1 For a correct attempt at using $m_N = -\frac{1}{m_T}$ or equivalent to find the gradient of the perpendicular.

dM1 It is for the method of finding a line passing through $(4,3)$ with a changed gradient.
Eg $\frac{9}{4} \to \frac{4}{9}$ would be acceptable as a changed gradient.
Look for $(y-3) = \text{changed } m_T (x-4)$ Both brackets must be correct
Alternatively uses the form $y = mx + c$ AND proceeds as far as $c = \ldots$
It is dependent only on the first method mark.

A1 $4x+9y-43=0$ or exact equivalent with all terms on one side = 0.
Accept $\pm A(4x+9y-43=0)$ where $A \in \mathbb{N}$

Question Number	Scheme	Marks
2(a)(i)		

	$-a+6a+8+a^2=32 \Rightarrow a^2+5a-24=0$ $(a+8)(a-3)=0$ $a=3$ or $a=-8$ and chooses $a=3$ with reason *	M1 dM1 A1* cso
		(3)
(ii)	$3x^3+26x^2-9x=0 \Rightarrow x(3x^2+26x-9)=0$ $x(3x-1)(x+9)$ $(x=)\ 0, \frac{1}{3}, -9$	M1 A1
		(2)
(b)(i)	$(y=)\ 0$ $y^{\frac{1}{3}}=\text{"}\frac{1}{3}\text{"}$ or $y^{\frac{1}{3}}=\text{"}-9\text{"} \Rightarrow y=...$ (or $(-9)^3=...$ or $\left(\frac{1}{3}\right)^3=...$) $(y=)\ \frac{1}{27},\ -729$	B1 M1 A1
		(3)
(b)(ii)	$9^z=\text{"}\frac{1}{3}\text{"} \rightarrow z=...$ $(z=)\ -\frac{1}{2}$ only	M1 A1
		(2)
		(10 marks)

(a)(i)

M1 Substitutes in $x=\pm1, y=32$ and proceeds to a 3TQ in terms of *a* with all terms on one side of the equation. Condone the lack of = 0 and condone slips in their rearrangement.

dM1 Attempts to solve their quadratic equation by either factorising, completing the square or the quadratic formula. They cannot just state the roots. It is dependent on the first method mark. In all cases they must show their working to score this mark so:

- Solving by factorising requires the factorised form of their $a^2+5a-24=0$ to be stated before proceeding to the roots i.e $(a+\text{"}8\text{"})(a-\text{"}3\text{"})\ (=0)$
- Solving by using the quadratic formula requires the values for *a*, *b* and *c* to be stated in the formula before proceeding to the roots. They cannot just state the values of *a*, *b* and *c*.

- Solving by completing the square requires eg $\left(a \pm "\frac{5}{2}"\right)^2 \pm ...$ before rearranging to find the roots.

A1* $a = 3$ or $a = -8$ and chooses $a = 3$ with a minimal reason. Eg "as *a* is a positive constant" or "Since $a > 0$", "*a* cannot be negative".
The final mark cannot be scored without the previous method marks being scored and there cannot be any errors even if missing brackets are recovered. Just crossing out -8 without a reason is A0.

(a)(ii)

M1 Takes out a factor of x from the given cubic with $a = 3$ (or divides through by x) and attempts to solve the resulting quadratic equation. You must see at least one intermediate line of working before proceeding to the roots eg the factorised form, values in the quadratic formula or completed square form.

A1 $(x =)\ 0,\ \frac{1}{3},\ -9$ provided M1 has been scored.
Solutions with no working in this part scores 0 marks.

(b)(i)

B1 $(y =)\ 0$

M1 Sets $y^{\frac{1}{3}}$ equal to any of their non-zero solutions from part (a) and attempts to cube their value to find a value for y. You must see at least one stage of working to score this mark.
$(-9)^3 = ...$ on its own scores M1.

A1 $(y =)\ \frac{1}{27}, -729$ and no others other than 0.
Solutions without any working will score a maximum of B1M0A0 in this part.

(ii)

M1 Sets 9^z equal to any of their positive solutions found in part (a) and proceeds to find a value for z. They may write 9^z as 3^{2z} before proceeding to find a value for z.
Alternatively, you may see attempts to link b(i) and b(ii) together:
Eg $y = 9^{3z} \Rightarrow \frac{1}{27} = 729^z \Rightarrow z = ...$ which can score M1.
You must see at least one stage of working to score this mark.
The method may include log statements which is acceptable.

A1 $(z =)\ -\frac{1}{2}$ only (provided M1 has been scored).
Answer stated without working scores 0 marks. Evidence of calculator use will also be A0.

Question Number	Scheme	Marks
3(a)	$\left(2\sqrt{2}\right)^2 = p^2 + q^2 - 2pq\cos 60°$ oe	M1
	$p^2 + q^2 - pq = 8$ *	A1*
		(2)
(b)	$q = p + 2 \Rightarrow 8 = p^2 + ("p+2")^2 - p("p+2")$	M1
	$p^2 + 2p - 4 = 0$ or $q^2 - 2q - 4 = 0$	A1
	$p = \dfrac{-2 \pm \sqrt{2^2 - 4\times1\times(-4)}}{2}$ or $q = \dfrac{2 \pm \sqrt{(-2)^2 - 4\times1\times(-4)}}{2}$	M1
	$p = -1 + \sqrt{5}$ or $q = 1 + \sqrt{5}$	B1 (A1 on EPEN)
	$p = -1 + \sqrt{5}$ and $q = 1 + \sqrt{5}$ only	A1cso
		(5)
(c)	$\text{Area} = \dfrac{1}{2}\times("-1+\sqrt{5}")("1+\sqrt{5}")\times\sin 60°$	M1
	Area = $\sqrt{3}$ (m^2)	A1
		(2)
Alt(a)	Forming a line *BX* which is perpendicular to *AC* where *X* is on the line *AC*. $AX = p\cos 60 = \dfrac{p}{2}$ $BX = \sqrt{p^2 - \left(\dfrac{p}{2}\right)^2} = \dfrac{\sqrt{3}}{2}p$ or $BX = p\sin 60$	
	$\left(\dfrac{\sqrt{3}}{2}p\right)^2 + \left(q - \dfrac{p}{2}\right)^2 = \left(2\sqrt{2}\right)^2$ or $\left(p\sin 60\right)^2 + \left(q - \dfrac{p}{2}\right)^2 = \left(2\sqrt{2}\right)^2$	M1
	$\dfrac{3p^2}{4} + q^2 - pq + \dfrac{p^2}{4} = 8$	
	$p^2 + q^2 - pq = 8$ *	A1*
		(9 marks)

(a)

M1 $\left(2\sqrt{2}\right)^2 = p^2 + q^2 - 2pq\cos 60°$ or $\left(2\sqrt{2}\right)^2 = p^2 + q^2 - 2pq \times \frac{1}{2}$ or $8 = p^2 + q^2 - 2pq\cos 60°$

They may carry this out in two stages by forming two right angled triangles with BX being perpendicular to AC (see Alt(a)). To score this mark they must proceed as far as

$\left(\frac{\sqrt{3}}{2}p\right)^2 + \left(q - \frac{p}{2}\right)^2 = \left(2\sqrt{2}\right)^2$ or $(p\sin 60)^2 + \left(q - \frac{p}{2}\right)^2 = \left(2\sqrt{2}\right)^2$

Condone missing brackets for M1.

A1* Achieves $p^2 + q^2 - pq = 8$ with no errors including omission of brackets. One of the lines above must have been seen for M1A1. If they state = 8 without showing any working then A1 cannot be scored.

(b)

M1 Substitutes $q = p + 2$ (oe) into the given equation

A1 $p^2 + 2p - 4 = 0$ or the equivalent equation in q ($q^2 - 2q - 4 = 0$)

M1 Attempts to solve to find p using the formula or completing the square using their values. Alternatively, they achieve a quadratic equation in q and attempt to solve to find q using their values. Usual rules for solving quadratics apply. If they state the roots or factorise then M0. If they use the quadratic formula then the values must be embedded.

B1 $p = -1 + \sqrt{5}$ **or** $q = 1 + \sqrt{5}$ (ignore any other solutions) Must be exact. This is independent of the previous method mark so if the roots are just stated this mark can be scored.
(Note this is A1 on EPEN)

A1 $p = -1 + \sqrt{5}$ **and** $q = 1 + \sqrt{5}$ only cso (all other marks must have been scored to award A1)

(c)

M1 Attempts to find the area of the triangle using $\frac{1}{2} \times ("-1+\sqrt{5}")("1+\sqrt{5}") \times \sin 60°$. Must see at least one stage of working using their p and their q

A1 $\sqrt{3}$ (m^2) condone lack of units. Do not accept rounded answers.

Question Number	Scheme	Marks
4	$\int \frac{3x^{\frac{3}{2}}-15x^{\frac{1}{2}}+2x-10}{4\sqrt{x}}\,dx=\int \frac{3}{4}x-\frac{15}{4}+\frac{1}{2}x^{\frac{1}{2}}-\frac{5}{2}x^{-\frac{1}{2}}\,dx$	M1A1A1
	$x^n \to x^{n+1}$	dM1
	$\frac{3}{8}x^2-\frac{15}{4}x+\frac{1}{3}x^{\frac{3}{2}}-5x^{\frac{1}{2}}+C$	A1A1
		(6 marks)

M1 Attempts to write as a sum of terms using correct index laws at least once.
Award for any term with a correct index.
Score for any one of:

$\frac{"3x^{\frac{3}{2}}"}{4\sqrt{x}}\to ...x \quad \frac{"-15x^{\frac{1}{2}}"}{4\sqrt{x}}\to \text{const} \quad \frac{+"2x"}{4\sqrt{x}}\to ...x^{\frac{1}{2}} \quad \frac{"-10"}{4\sqrt{x}}\to ...x^{-\frac{1}{2}}$

Cannot be scored for a term with a correct index arising from incorrect work

eg $\frac{"-10"}{4\sqrt{x}}\to ...x^{\frac{1}{2}}$

A1 Two correct terms of $\frac{3}{4}x \quad -\frac{15}{4} \quad +\frac{1}{2}x^{\frac{1}{2}} \quad -\frac{5}{2}x^{-\frac{1}{2}}$ (oe). They do not need to be seen on the same line for this mark and they do not need to be simplified. Eg $\frac{3}{4}x^1$, $\frac{-10x^{-\frac{1}{2}}}{4}$ are acceptable.

Indices must be processed though. Eg $\frac{3x^{\frac{3}{2}}}{4\sqrt{x}}\to\frac{3}{4}x^{1.5-0.5}$ is not acceptable.

A1 All four correct terms of $\frac{3}{4}x-\frac{15}{4}+\frac{1}{2}x^{\frac{1}{2}}-\frac{5}{2}x^{-\frac{1}{2}}$ (oe) Terms do not need to be simplified for this mark and do not need to be on one line.

dM1 Increases the power of any of their terms by 1. ($x^n \to x^{n+1}$). It is dependent on the first method mark.

A1 Any two terms correct unsimplified (see below) but the indices must be processed. Condone $-\frac{15}{4}x^1$ as a correct term for this mark only.

A1 $\frac{3}{8}x^2-\frac{15}{4}x+\frac{1}{3}x^{\frac{3}{2}}-5x^{\frac{1}{2}}+C$ o.e. all on one line (including the constant C and all simplified).

Do not accept $-\frac{15}{4}x^1$ as a correct simplified term.

Accept alternative correct simplified forms such as $\frac{3}{8}x^2-\frac{15}{4}x+\frac{1}{3}x^{\frac{3}{2}}-5\sqrt{x}+C$ or

$\frac{3}{8}x(x-10)+\frac{1}{3}x^{\frac{1}{2}}(x-15)+C$

Question Number	Scheme	Marks
5(a)	$P_B - P_A = 44.2 - \left(53 - 0.4 \times 8^2\right) = ...$	M1
	awrt (£) 16.8 million	A1
		(2)
(b)	(£) 53 (million)	B1
		(1)
(c)	$-1.6t + 44.2 = 53 - 0.4(t-8)^2$	M1
	$\Rightarrow 0.4t^2 - 8t + \frac{84}{5} = 0 \Rightarrow t = ...$	M1
	$t = 10 - \sqrt{58} =$ awrt 2.38 (years)	A1
	$"2.38" < t\ (\leqslant 15)$	A1ft
		(4)
(d)	"The **share value** would be negative" / "the **model** is known to hold for 15 years only (and 20 years is more than 15)."	B1
		(1)
		(8 marks)

(a)

M1 Substitutes $t = 0$ into the equation for P_A and finds the difference between 44.2 and P_A.

A1 awrt (£) 16.8 million.

(b)

B1 (£) 53 million. Condone 53

(c)

M1 Sets $-1.6t + 44.2 = 53 - 0.4(t-8)^2$ They may have already attempted to multiply out $(t-8)^2$ so condone errors that may occur before setting $P_A = P_B$. Also may score for use of any inequality sign.

M1 Rearranges the equation to form a 3TQ on one side of the equation (= 0) or inequality and attempts to solve the quadratic. Condone slips in their working. See general rules for solving a quadratic. They may use a calculator to state the root(s) which is acceptable.

A1 awrt 2.38 (years) o.e. isw after a correct answer

A1ft $"2.38" < t\ (\leqslant 15)$ oe from correct working. You may follow through on their value of t provided $t < 15$. Ignore any reference to an upper limit provided it is $\geqslant 15$

You may see eg $10-\sqrt{58} < t < 10+\sqrt{58}$ which can score this mark.

(d)

B1 "The **share value (or *P*)** would be negative" or "the **model** is known to hold for 15 years only (and 20 is greater than 15)" or equivalent explanations.
Eg "*P* must be greater than (or equal to) zero".

Note "$-4.6 < 0$" is insufficient (it does not refer to the **model** or the **share value** of ***P***)

Question Number	Scheme	Marks
6(a)	$f'(8)=\frac{32}{3\times 8^2}+3-2\sqrt[3]{8}\quad\left(=-\frac{5}{6}\right)$	M1
	$y-2="-\frac{5}{6}"(x-8)$	dM1
	$y=-\frac{5}{6}x+\frac{26}{3}$	A1
		(3)
(b)	$f'(x)=\frac{32}{3x^2}+3-2\sqrt[3]{x}=...x^{-2}+3+...x^{\frac{1}{3}}$	
	$x^{-2}\to x^{-1},\ 3\to 3x,\ x^{\frac{1}{3}}\to x^{\frac{4}{3}}$	M1
	$f(x)=\int\frac{32}{3}x^{-2}+3-2x^{\frac{1}{3}}dx=-\frac{32}{3}x^{-1}+3x-\frac{3}{2}x^{\frac{4}{3}}+c$	A1A1
	$2=-\frac{32}{3}\times 8^{-1}+3\times 8-\frac{3}{2}\times 8^{\frac{4}{3}}+c\Rightarrow c=...$	dM1
	$(f(x)=)\ -\frac{32}{3}x^{-1}+3x-\frac{3}{2}x^{\frac{4}{3}}+\frac{10}{3}$	A1
		(5)
		(8 marks)

Ignore labelling of parts (a) and (b)

(a)

M1 Substitutes $x=8$ to find a value for $f'(8)$. Condone slips in their substitution and $-\frac{5}{6}$ seen will imply this mark.

dM1 It is for the method of finding a line passing though $(8,2)$ using their value for $f'(8)$. Score for $(y-2)="-\frac{5}{6}"(x-8)$ with both brackets correct. If they use $y=mx+c$ they must proceed as far as $c=\ldots$ It is dependent on the previous method mark.

A1 $y=-\frac{5}{6}x+\frac{26}{3}$

(b)

M1 Integrates by raising the power on one of the terms (ie $x^{-2} \to x^{-1}, 3 \to 3x, x^{\frac{1}{3}} \to x^{\frac{4}{3}}$)

A1 Two terms correct of $-\frac{32}{3}x^{-1}$, $+3x$ or $-\frac{3}{2}x^{\frac{4}{3}}$ seen (or unsimplified equivalents). The indices must be processed.

A1 $-\frac{32}{3}x^{-1}+3x-\frac{3}{2}x^{\frac{4}{3}}(+c)$ seen or unsimplified equivalent. Condone the lack of $+c$ for this mark. $-10.7x^{-1}$ is not a correct term but allow $-10.\dot{6}x^{-1}$.

dM1 Substitutes $x=8, y=2$ into their f(x) and proceeds to find c. It is dependent on the previous method mark and condone slips in their rearrangement to find c.

A1 $(\text{f}(x)=)\ -\frac{32}{3}x^{-1}+3x-\frac{3}{2}x^{\frac{4}{3}}+\frac{10}{3}$ or simplified equivalent. isw after a correct answer Eg $-\frac{32}{3x}+3x-\frac{3}{2}x^{\frac{4}{3}}+\frac{10}{3}$ or $-\frac{10.\dot{6}}{x}+3x-1.5x^{\frac{4}{3}}+3.\dot{3}$ but do not accept rounded decimals for the coefficients.

Question Number	Scheme	Marks
7(a)	y coordinate $=12$	B1
		(1)
(b)	Gradient of $l_1 = -\frac{3}{4}$	B1
	$\Rightarrow$ Gradient of $l_2 = \frac{4}{3} \Rightarrow (y-6) = "\frac{4}{3}"(x-8)$	M1
	y coordinate $= -\frac{14}{3}$ *	A1* cso
		(3)
(c)	Radius $= "12" + \frac{14}{3} = \frac{50}{3}$	B1ft
	Length of arc $= "\frac{50}{3}" \times 1.8 = 30$	M1A1cao
		(3)
(d)	Area of sector $= \frac{1}{2} \times ("\frac{50}{3}")^2 \times 1.8 \quad (=250)$	M1
	$"250" + \frac{1}{2} \times "\frac{50}{3}" \times 8 = "250" + "\frac{200}{3}"$	M1
	$= \frac{950}{3}$ (units^2)	A1cao
		(3)
		(10 marks)

Mark all parts together. May work in degrees.

(a)

B1 12 (Check by the question and also on the diagram). If there is a contradiction then their answer in the main solution takes precedence.

(b)

B1 States gradient of l_1 is $-\frac{3}{4}$ but can be implied by further work. Eg sight of a gradient of $\frac{4}{3}$ in their equation for l_2 can also score this mark.
The value must be identified or used so it cannot just be awarded from a rearranged equation for l_1. Circling the coefficient is acceptable but stating $-\frac{3}{4}x$ with no further work is B0.

M1 Attempts to find the gradient of the perpendicular line $"-\frac{3}{4}" \rightarrow \frac{4}{3}$ and attempts to find the equation of l_2. Look for $(y-6) = "\frac{4}{3}"(x-8)$ with both of the brackets correct. If they attempt using $y = mx + c$ then they must proceed as far as $c = ...$

A1* $-\frac{14}{3}$ cso must be clearly stated as the y coordinate with no errors seen after achieving a correct equation for l_2.

(c)

B1ft Finds the radius of the circle following through on their answer to (a). $"12" + \frac{14}{3}$ is acceptable for this mark or it may be implied by their length of the arc. May be seen on the diagram or in other parts.

M1 Attempts to find the length of the arc with $\theta = 1.8$ and their $r = "12" + \frac{14}{3}$

A1 30 cao

(d)

M1 Attempts to find the area of the sector with $\theta = 1.8$ and their $r = "12" + \frac{14}{3}$

M1 **Adds the area of their sector with a correct method to find the area of the triangle**.

There are various ways to find the area of the triangle. They may find the lengths *CD* and *DE* using Pythagoras and proceed to find the area of the triangle:

Eg $CD = \sqrt{6^2 + 8^2} = 10$ and $DE = \sqrt{8^2 + \left(\frac{32}{3}\right)^2} = \frac{40}{3} \Rightarrow \text{Area} = \frac{1}{2} \times 10 \times \frac{40}{3} = \frac{200}{3}$

Alternatively, via the shoelace method:

Eg $\frac{1}{2}\begin{vmatrix} 0 & 12 \\ 8 & 6 \\ 0 & -\frac{14}{3} \\ 0 & 12 \end{vmatrix} = \frac{1}{2} \times \left| \left(8 \times -\frac{14}{3}\right) - (12 \times 8) \right| = \frac{200}{3}$

A1 $\frac{950}{3}$ cao (accept $316\frac{2}{3}$ or $316.\dot{6}$ but not 316.7)

Question Number	Scheme	Marks
8(a)	$3x^2+6x+9=3(x\pm\ldots)^2\pm\ldots \qquad a=3$	B1
	$3x^2+6x+9=3(x+1)^2\pm\ldots \qquad a=3\ \&\ b=1$	M1
	$3x^2+6x+9=3(x+1)^2+6$	A1
		(3)
(b)	$(-1,\ 6)$	B1ft
		(1)
(c)	$y=\alpha(x+4)(x+2)(x-3)$	B1
	$6=\alpha(-1+4)(-1+2)(-1-3)$	M1
	$\alpha=-\frac{1}{2}$	A1
	$y="-\frac{1}{2}"(x+4)(x+2)(x-3)\Rightarrow y=\ldots x^3+\ldots x^2+\ldots x+\ldots$	M1
	$A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$	A1
		(5)
Alt (c)	$-64A+16B-4C+D=0$ $-8A+4B-2C+D=0$ $27A+9B+3C+D=0$	B1
	$-A+B-C+D=6$	M1
	One of $A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$	A1
	Fully solves their simultaneous equations	M1
	$A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$	A1
		(9 marks)

(a)

B1 Achieves $3x^2+6x+9=3(x\pm...)^2\pm...$ or states that $a=3$

M1 Deals correctly with the first two terms of $3x^2+6x+9$
Scored for $3x^2+6x+9=3(x+1)^2\pm...$ or states that $a=3$ & $b=1$

A1 $3x^2+6x+9=3(x+1)^2+6$

This may be done by equating coefficients using the expanded form
$a(x+b)^2+c=ax^2+2abx+ab^2+c$

(b)

B1ft $(-1,6)$ or follow through their $(-b,c)$ from (a). Condone lack of brackets and accept eg $x=-1, y=6$

(c)

B1 Identifies that three factors of the cubic equation are $(x+4)(x+2)(x-3)$

M1 A correct method to find the scale factor by using the minimum point found in part (c). Look for the minimum point to be substituted into their equation for the cubic

A1 Scale factor = $-\frac{1}{2}$

M1 Attempts to multiply $(x\pm4)(x\pm2)(x\pm3)$ to achieve $x^3+........\pm24$. This may have been multiplied by their scale factor so look for $\alpha(x^3+........\pm24)$

A1 $A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$. Accept $y=-\frac{1}{2}x^3-\frac{3}{2}x^2+5x+12$

In the alternative method using simultaneous equations

B1 Three correct equations formed using $x=\ -4,-2$ and 3 with $y=0$ in each case.

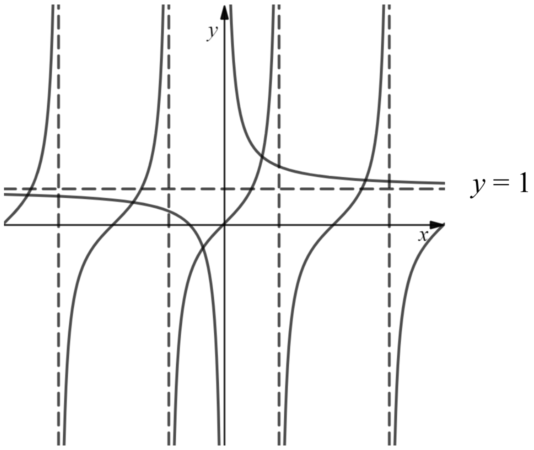
M1 Forms four simultaneous equations using the three intercepts and their point P

A1 One of $A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$

M1 Fully solves their simultaneous equations either using matrices or elimination. This may be done on a calculator which is acceptable.

Eg. Using matrices $\begin{pmatrix}-64 & 16 & -4 & 1\\ -8 & 4 & -2 & 1\\ 27 & 9 & 3 & 1\\ -1 & 1 & -1 & 1\end{pmatrix}^{-1}\begin{pmatrix}0\\0\\0\\6\end{pmatrix}=\begin{pmatrix}A\\B\\C\\D\end{pmatrix}\Rightarrow\begin{pmatrix}A\\B\\C\\D\end{pmatrix}=...$

A1 $A=-\frac{1}{2},\ B=-\frac{3}{2},\ C=5,\ D=12$. Accept $y=-\frac{1}{2}x^3-\frac{3}{2}x^2+5x+12$

Question Number	Scheme	Marks
9(a)	$x = \dfrac{3\pi}{2}$ oe	B1
		(1)
(b)(i)		B1B1
(ii)	5 (solutions)	B1
	Number of solutions are the number of points of intersections between the graphs	B1
		(4)
(c) (i)	(Number of solutions) $= 40$	B1ft
(ii)	(Number of solutions) $= 14$	B1
		(2)
		(7 marks)

(a)

B1 $x = \dfrac{3\pi}{2}$ oe and no others. Do not accept in degrees. It may be labelled on the graph, but it must be an equation. If multiple answers are given then $x = \dfrac{3\pi}{2}$ oe must be identified (eg may be circled)

(b)(i)

B1 For the shape of a $\frac{1}{x}$ type curve in Quadrant 1. It must not cross either axis and have acceptable curvature – do not penalise candidates unless it is clear that a minimum point was intended.

B1 Correct shape and position for both branches with an asymptote in the correct position **and** labelled as $y = 1$ or stated in their work. Again, do not penalise the sketch unless it is clear that turning points are intended. The asymptote line/dashed line does not need to be drawn on the sketch.

(ii)

B1 5 only

B1 Number of solutions are the number of points of intersections between the graphs. (Do not allow if they mention where they cross the *x*-axis).

(c)

(i)

B1ft 40 Follow through from their sketch
(eg number of intersections in first quadrant $\times 20$)

(ii)

B1 14