Question Number	Scheme	Marks
	$y=\dfrac{9x^2\left(5-\sqrt{x}\right)}{5}$	
9(a)	$y=9x^2-\dfrac{9}{5}x^{\frac{5}{2}}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=18x-\dfrac{9}{2}x^{\frac{3}{2}}$	M1, A1
	$18x-\dfrac{9}{2}x^{\frac{3}{2}}=0\Rightarrow x^{\frac{1}{2}}=(4)$	dM1
	$(16, 460.8)$	A1, A1
		(5)
(b)	$5-\sqrt{x}=0\Rightarrow x=25$	M1, A1
		(2)
(c)	$\int 9x^2-\dfrac{9}{5}x^{\frac{5}{2}}\mathrm{d}x=3x^3-\dfrac{18}{35}x^{\frac{7}{2}}$	M1A1
	Shaded area $=\underline{(25-16)\times 460.8}-\left[3x^3-\dfrac{18}{35}x^{\frac{7}{2}}\right]_{16}^{25}$	<u>M1</u>, dM1
	$=1312.7$	A1
		(5)
		(12 marks)

(a)

M1: Attempts to differentiate. In most cases this will involve multiplying out and differentiating each term. Look for a sum of two terms with one correct index.

So, score for either $y=ax^2\pm...\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=px\pm....$ or $y=...\pm bx^{\frac{5}{2}}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=...\pm qx^{\frac{3}{2}}$

It is possible to differentiate using the product rule.

In this case look for the correct form. E.g $y=\dfrac{9x^2\left(5-\sqrt{x}\right)}{5}\Rightarrow\dfrac{\mathrm{d}y}{\mathrm{d}x}=\left(5-\sqrt{x}\right)\times...x+...x^2\times...x^{-\frac{1}{2}}$

You may see attempts using the product or quotient rules so look carefully at what is written

A1: $\dfrac{\mathrm{d}y}{\mathrm{d}x}=18x-\dfrac{9}{2}x^{\frac{3}{2}}$ o.e but allow this un-simplified.

FYI, using the product rule, the correct unsimplified answer is $\left(5-\sqrt{x}\right)\times\dfrac{18x}{5}+\dfrac{9x^2}{5}\times-\dfrac{1}{2}x^{-\frac{1}{2}}$

dM1: Sets their $px\pm qx^{\frac{3}{2}}=0$ or $px\pm qx^{\frac{1}{2}}=0$ (from a slip on the fractional index) and proceeds using correct index work to $\alpha x^{\pm\frac{1}{2}}=\beta$

Other methods exist, such as squaring, but look for correct index work with the coefficients squared as well. The demand of candidates is to show their working and it will be applied in this question on this mark.

If candidates go from $18x-\dfrac{9}{2}x^{\frac{3}{2}}=0$ to $x=16$ without intermediate working they will lose this mark.

They can be awarded the next two marks however.

A1: x coordinate of 16 **following correct differentiation and** $\dfrac{\mathbf{d}y}{\mathbf{d}x}=0$.

Note that errors stemming from a misunderstanding of the $\div 5$ can lead to $x = 16$ but should be scored A0

A1: $(16, 460.8)$ following award of previous A1. Allow this to be scored from correct coordinate in part (c)

Also allow this to be given separately as $x = 16$, $y = \frac{2304}{5}$ o.e.

(b)

M1: Deduces that $5 - \sqrt{x} = 0$ or $\sqrt{x} = 5$. Squaring methods are also possible (with coefficients squared) usually leading to $25 - x = 0$ o.e.

A1: $x = 25$ following award of the M1

25 on its own without any working scores M0 A0

(c) In epen this is marked M, A, M, A, A but is now being scored M, A, M, dM, A

Method integrating just curve

M1: Attempts to integrate. In most cases this will involve multiplying out and integrating each term. Look for a sum of two terms with one correct index. Ignore any spurious integral signs if it is obvious they have integrated.

So score for either $\int \left(ax^2 \pm ... \right) dx \Rightarrow rx^3 \pm .... \text{ or } \int \left(... \pm bx^{\frac{5}{2}} \right) dx \Rightarrow ... \pm sx^{\frac{7}{2}}$

This can be scored in a similar way if they have attempted (line – curve)

A1: $3x^3 - \frac{18}{35}x^{\frac{7}{2}}$ but allow this unsimplified

If (line – curve) has been attempted look for $... - \underline{\underline{\left(3x^3 - \frac{18}{35}x^{\frac{7}{2}} \right)}}$ OR $... \underline{\underline{-3x^3 + \frac{18}{35}x^{\frac{7}{2}}}}$

M1: Correct method of finding the **area of rectangle** or **area of right-angled triangle** (with *MP* as the hypotenuse).

E.g. For the rectangle look for $('25' - '16') \times '460.8'$ or $\int_{16}^{25} ('460.8' - ....)\, dx = \left['460.8' x - ...\right]_{16}^{25} = ...$

dM1: Complete attempt to find area of *R* involving the correct combination of areas, usually (area of rectangle –area under curve) or (2 × area of triangle –area under curve).

It is dependent upon both previous M's. For the area under the curve look for a minimum of one term being correctly integrated and limits of their 16 from (a) and their 25 from (b)

A1: AWRT 1312.7

……..

Other more complicated methods are possible; If they integrate (line – curve) we score as follows

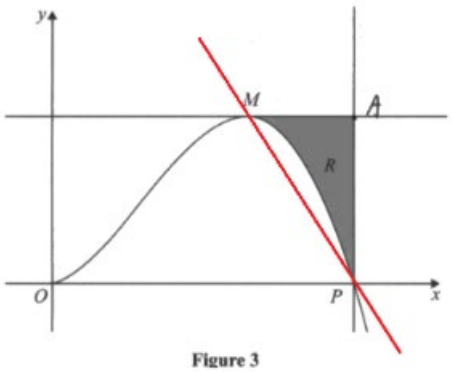

Figure 3

The first M1, A1 can be awarded as in the main method.
The following M1 is a correct method for triangle AMP
The dM1is for the full method to find area of R as before.

Question Number	Scheme	Marks
10 (a)	Uses $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ o.e. E.g. $\cos\theta\left(3\tan\theta + \dfrac{2}{\tan\theta}\right) \equiv \cos\theta\left(3\dfrac{\sin\theta}{\cos\theta} + \dfrac{2\cos\theta}{\sin\theta}\right)$	M1
	Uses $\sin^2\theta + \cos^2\theta = 1$ E.g. $\equiv 3\sin\theta + \dfrac{2\cos^2\theta}{\sin\theta} \equiv 3\sin\theta + \dfrac{2\left(1-\sin^2\theta\right)}{\sin\theta}$	dM1, A1
	$\equiv 3\sin\theta + \dfrac{2}{\sin\theta} - 2\sin\theta \equiv \sin\theta + \dfrac{2}{\sin\theta}$	A1*
		(4)
(b)	$\sin x + \dfrac{2}{\sin x} = 4\sin x - 5 \Rightarrow 3\sin^2 x - 5\sin x - 2 = 0$	M1, A1
	$\Rightarrow \sin x = 2, -\dfrac{1}{3} \Rightarrow x = 3.5$ for example.	dM1
	$\Rightarrow x = 3.48, 5.94$	A1
		(4)
		(8 marks)

(a) Allow use of = for ≡ within this question.

Allow workings on consecutive lines to follow without equals signs or with arrows.

M1: Uses $\tan\theta \equiv \dfrac{\sin\theta}{\cos\theta}$ o.e. correctly at least once

dM1: Uses $\cos^2\theta \equiv \pm 1 \pm \sin^2\theta$ following the award of the previous M1

You may see $\cos\theta\left(\dfrac{3\sin^2\theta + 2\cos^2\theta}{\sin\theta\cos\theta}\right) \equiv \cos\theta\left(\dfrac{3\sin^2\theta + 2\left(\pm 1 \pm \sin^2\theta\right)}{\sin\theta\cos\theta}\right)$ condoning slips in coefficients

A1: A correct intermediate line in just $\sin\theta$ E.g. $3\sin\theta + \dfrac{2\left(1-\sin^2\theta\right)}{\sin\theta}$

A1*: Proceeds correctly to the given answer with no errors or omissions.

Withold this mark for notational errors. E.g writing $\sin^2\theta$ as $\sin\theta^2$

Withold this mark if you don't see both sides of the identity (or their equivalents e.g. LHS and RHS) within their solution.

Condone one or two missing θ's or changes of variable in say, $\sin\theta$, but penalise persistent offences, i.e. > 2 occurrences.

(b)

M1: Uses part (a) and proceeds to a 3TQ in sin*x*. Condone slips in coefficients.

The multiplication by sin*x* must be seen/have occurred on at least three of the four terms

Allow restarts that essentially proceeds to the same equation

A1: Correct quadratic equation. The = 0 may be implied by subsequent work

dM1: Solves their quadratic equation in sin*x* and proceeds to one solution in the range to 1dp

If their quadratic equation in sin*x* is incorrect you may need to use a calculator to check their roots and their value for *x*. Allow this method to be scored for angles in degrees.

So, for example, $\sin x = -\dfrac{1}{3} \Rightarrow x =$ awrt 199.5 or 340.5 but not -0.339 radians as it is not in the range

A1: AWRT $3.48, 5.94$ and no others in the range.

This can only be awarded after the award of all previous marks in (b)

Answers without working scores 0 marks