Question Number	Answer	Notes	Marks
10	(a) $\alpha+\beta=-(k-3) \qquad \alpha\beta=4$ $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$ $=(k-3)^2-8$ (b) $\dfrac{1}{\alpha^2}+\dfrac{1}{\beta^2}=\dfrac{\alpha^2+\beta^2}{\alpha^2\beta^2}, \quad =\dfrac{7}{4}$ $\dfrac{1}{\alpha^2\beta^2}=\dfrac{1}{16}$ Eqn: $x^2-\dfrac{28}{16}x+\dfrac{1}{16} \ (=0)$ $16x^2-28x+1=0$ (c) $4(k^2-6k+1)=7\times16$ $k^2-6k-27=0$ $(k-9)(k+3)=0$ $k=9 \ \ k=-3$	 B1 M1 A1 M1,A1 B1 M1 A1ft M1A1 M1d A1A1	**(13)**

Notes

(a)

B1 for BOTH $\alpha+\beta=-(k-3)$ oe, AND $\alpha\beta=4$

M1 for the correct algebra on $(\alpha+\beta)^2$ to give $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$ oe

A1 for $\alpha^2+\beta^2=(k-3)^2-8$ or $\alpha^2+\beta^2=k^2-6k+1$
Simplification not required

(b)

M1 for an attempt at a sum of roots $\dfrac{1}{\alpha^2}+\dfrac{1}{\beta^2}=\dfrac{\alpha^2+\beta^2}{\alpha^2\beta^2}$

A1 for sum $=\dfrac{7}{4}$ oe

B1 for correct product $= \frac{1}{16}$

M1 for using $x^2 -$ their sum $\times x$ + their product (= 0 not required for this mark)
The sum and product must be numerical values only.
A1ft for $16x^2 - 28x + 1 = 0$ oe integer values
(follow through their values for this mark) Note: = 0 must be seen, but simplification is not required for this mark.

(c)

M1 for using 4 × (their $\alpha^2 + \beta^2$) = 7 × their $\alpha^2\beta^2$
A1 for $k^2 - 6k - 27 = 0$
M1d for attempting to solve their 3TQ (usual rules) this is dependant on first M mark being awarded
A1 for **either** $k = 9$ or $k = -3$
A1 for **both** $k = 9$ or $k = -3$

Question Number	Answer	Notes	Marks
11	(a)		
	Through $(p,8)$ $40=4(p^2+1)$	M1	
	$10=p^2+1$ $p=3$	A1	
	At P $(3,8)$ $40-72+q=0$	M1	
	$q=32$	A1	
	(b) $5\frac{\mathrm{d}y}{\mathrm{d}x}=8x$, $p=3$ $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{24}{5}$	M1,A1	
	grad normal $=-\frac{5}{24}$	A1ft	
	Eqn. normal: $y-8=-\frac{5}{24}(x-3)$	M1	
	$24y+5x=207$ o.e.	A1	
	(c)		
	normal meets x-axis at $\frac{207}{5}$ tangent meets x-axis at $\frac{32}{24}$ $\left(=\frac{4}{3}\right)$	M1	
	Area of $\Delta=\frac{1}{2}\left(\frac{207}{5}-\frac{4}{3}\right)\times 8=160\frac{4}{15}$	M1A1	
	(d)		
	Vol of curve $=\pi\int_0^3\left[\frac{4}{5}(x^2+1)\right]^2\mathrm{d}x$	M1	
	$=\frac{16}{25}\pi\int_0^3(x^4+2x^2+1)\mathrm{d}x=\frac{16}{25}\pi\left[\frac{x^5}{5}+\frac{2}{3}x^3+x\right]_0^3$	M1	
	$=\frac{16}{25}\pi\left[\frac{3^5}{5}+\frac{2}{3}\times 3^3+3\right]$	A1	
	Cone $=\frac{1}{3}\pi\times 8^2\left(3-\frac{4}{3}\right)$	B1	
	Reqd. vol $=\frac{16}{25}\pi\left[\frac{3^5}{5}+\frac{2}{3}\times 3^3+3\right]-\frac{1}{3}\pi\times 8^2\times\frac{5}{3}$, $=28$	M1,A1	
			(18)

Notes

(a)

(i)

M1 for substituting coordinates $(p,8)$ to get $40=4\left(p^2+1\right)$ (or $40=4\left(x^2+1\right)$)

A1 for solving $40=4\left(p^2+1\right)$ to give $p=3$ Note: this is a show question, all working must be seen.

(ii)

M1 for using (3 , 8) in line l to give $40-72+q=0$

A1 for q = 32

(b)

Either Method 1

M1 for an attempt at differentiating $5y=4(x^2+1)$ to give $5\frac{\mathrm{d}y}{\mathrm{d}x}=8x$ oe.

A1 for $\frac{24}{5}$ (accept $\frac{24}{5}$ embedded in the equation of the line provided it is used correctly later for the gradient of the normal = $-\frac{5}{24}$

A1ft for the gradient of the normal $-\frac{5}{24}$ or their negative inverted gradient of tangent.

M1 for an attempt at the equation of the normal using their gradient of the normal, which must be a numerical value, and which must be a changed value from the gradient of the tangent. The formula must be seen first if there are errors in substitution.
Or, as above for the gradient using a complete method for $y=mx+c$ to achieve a value for c.

A1 for $24y+5x=207$ oe.

Or Method 2

M1 for dividing through by 5 and extracting the gradient

A1 for $m=\frac{24}{5}$ (accept $\frac{24}{5}$ embedded in the equation of the line provided it is used correctly later for the gradient of the normal = $-\frac{5}{24}$

A1ft for the gradient of the normal $-\frac{5}{24}$ or their negative inverted gradient of tangent.

M1 for an attempt at the equation of the normal using their gradient of the normal, which must be a numerical value, and which must be a changed value from the gradient of the tangent. The formula must be seen first if there are errors.
Or, as above for the gradient using a complete method for $y=mx+c$ to achieve a value for c.

A1 for $24y+5x=207$ oe.

(c)

M1 for using their equations for line l and their normal to substitute $y = 0$ to find the intersections with the x axis at $\frac{32}{24}$ and $\frac{207}{5}$ respectively.

M1ft for using Area of $\Delta = \frac{1}{2}\left(\frac{207}{5} - \frac{4}{3}\right) \times 8 = 160\frac{4}{15}$ follow through their values, but the value of 8 for the height must be used.

A1 for area = $160\frac{4}{15}$ or $\frac{2404}{15}$ oe

(d)

M1 for the correct expression of the Volume of revolution of the given curve. Volume $= \int \pi y^2 \mathrm{d}x$. Limits must be seen (not necessarily correct) for this mark.

M1 for an attempt at squaring and integrating the given curve. Ignore missing π

A1 for a correct integration and attempt at evaluation, (simplification not required) of

$$= \frac{16}{25}\pi\left[\frac{3^5}{5} + \frac{2}{3} \times 3^3 + 3\right] \text{ oe } \quad \pi \text{ may be missing.}$$

(Volume of revolution of curve = $\frac{5568}{125}\pi$)

B1 for using a correct formula for the volume of a cone and values for x of $x = 3$ and their intersection of the tangent with the x axis, with a height of 8.

M1 for the required volume $= \frac{16}{25}\pi\left[\frac{3^5}{5} + \frac{2}{3} \times 3^3 + 3\right] - \frac{1}{3}\pi \times 8^2 \times \frac{5}{3}$

A1 for Volume = 28 (2sf) 28.23803103..

Alternative

M1 for the expression of the Volume of revolution of the region using the given equation in Volume $= \int_0^3 \pi\left[\frac{4}{5}(x^2+1)\right]^2 \mathrm{d}x - \int_{\frac{4}{3}}^{3} \pi\left[\frac{1}{5}(24x - 32)\right]^2 \mathrm{d}x$

Limits must be seen (not necessarily correct) for this mark, **although the limits for the curve and line must be different.** The correct expression for volume must be used. ie.,Volume of revolution $= \pi\int y^2 \mathrm{d}x$

M1 for an attempt at squaring and integrating the **given curve**. A combined expression for the curve and line gets M0 even if there is some correct integration. Ignore missing π

A1 for a fully correct integration of **either** the curve or the line.

$$\text{Vol} = \frac{16}{25}\pi\left[\frac{x^5}{5} + \frac{2}{3}x^3 + x\right]_0^3 - \frac{\pi}{25}\left[192x^3 - 768x^2 + 1024x\right]_{\frac{4}{3}}^{3}$$

B1 For a fully correct integration of the volume of revolution of **both** the curve and line.

M1d for substitution of x values (into integrated expressions) **of the curve and line separately** and an attempt at evaluation.

(Volume = $\frac{5568}{125}\pi - \frac{320}{9}\pi$)

A1 for Volume = 28 (2sf) 28.23803103..

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE