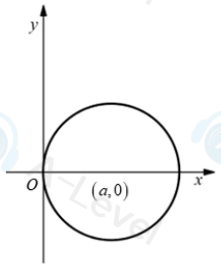
| Question Number | Scheme | Marks |
|---|---|---|
| **10 (a)** | Uses $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$ o.e. E.g. $\cos\theta\left(3\tan\theta + \dfrac{2}{\tan\theta}\right) \equiv \cos\theta\left(3\dfrac{\sin\theta}{\cos\theta} + \dfrac{2\cos\theta}{\sin\theta}\right)$ | M1 |
| | Uses $\sin^2\theta + \cos^2\theta = 1$ 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)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **9(a)** |   | B1 |
| | | **(1)** |
| **(b)** | $(x \pm a)^2 + y^2 = \ldots$ | M1 |
| | $(x \pm a)^2 + y^2 = a^2$ | A1 |
| | Uses $(5, 6)$ in $(x \pm a)^2 + y^2 = a^2$ to form and solve an equation in $a$ | dM1 |
| | E.g. $(5-a)^2 + 36 = a^2 \Rightarrow 10a = 61 \Rightarrow a = 6.1$ | |
| | $(x-6.1)^2 + y^2 = 6.1^2$ | A1 |
| | | **(4)** |
| | | **(5 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **9(a)** | $\left(2\tan\theta = 3\cos\theta \Rightarrow\right) \dfrac{2\sin\theta}{\cos\theta} = 3\cos\theta$ | M1 |
| | $\dfrac{2\sin\theta}{\cos\theta} = 3\cos\theta \Rightarrow 2\sin\theta = 3\cos^2\theta = 3\left(1-\sin^2\theta\right)$ | M1 |
| | $2\sin\theta = 3\left(1-\sin^2\theta\right) \Rightarrow 3\sin^2\theta + 2\sin\theta - 3 = 0$* | A1* |
| | | **(3)** |
| **(b)** | $\left(\sin\left(2x+\dfrac{\pi}{3}\right) =\right) \dfrac{-1\pm\sqrt{10}}{3}$ (May only see positive root)<br>NB decimal roots are: $-1.387\ldots$, $0.7207\ldots$ | M1 |
| | $2x+\dfrac{\pi}{3} = \sin^{-1}(0.7207\ldots) \Rightarrow x = \ldots$ | M1 |
| | $-0.121, -2.50, 0.645, 3.02$ | A1A1 |
| | | **(4)** |
| | | **Total 7** |

| Question Number | Scheme | Marks |
|---|---|---|
| **3 (a)** | $2\tan\theta + 3\sin\theta = 0$<br>States or uses $\tan\theta = \dfrac{\sin\theta}{\cos\theta} \rightarrow 2\dfrac{\sin\theta}{\cos\theta} + 3\sin\theta = 0$ | M1 |
| | $\sin\theta\left(2+3\cos\theta\right) = 0$ | |
| | $2+3\cos\theta = 0$ | dM1 |
| | $\cos\theta = -\dfrac{2}{3} \Rightarrow \theta =$ awrt $132°$ or awrt $228°$ | A1 |
| | $\cos\theta = -\dfrac{2}{3} \Rightarrow \theta =$ awrt $131.8°$ and awrt $228.2°$ | A1 |
| | $\sin\theta = 0 \Rightarrow \theta = 180°, 360°$ | B1 |
| | | **(5)** |
| **(b)** | Sets $2x + 40° =$ their $131.8° \Rightarrow x = \ldots$ | M1 |
| | $x =$ awrt $45.9°$ | A1 |
| | | **(2)** |
| | | **(7 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **5(i)** | $4\tan\theta+5\sin\theta=0$ | |
| | States or uses $\tan\theta=\dfrac{\sin\theta}{\cos\theta}\rightarrow 4\dfrac{\sin\theta}{\cos\theta}+5\sin\theta=0$ | M1 |
| | $\sin\theta\left(4+5\cos\theta\right)=0$ | |
| | $\cos\theta=-\dfrac{4}{5}$ | dM1 |
| | $\cos\theta=-\dfrac{4}{5}\Rightarrow\theta=$ awrt 143° or awrt 217° | A1 |
| | $\cos\theta=-\dfrac{4}{5}\Rightarrow\theta=$ awrt 143.1° and awrt 216.9° | A1 |
| | $\sin\theta=0\Rightarrow\theta=180°,360°$ | B1 |
| | | **(5)** |
| **(ii)** | $\dfrac{\sin x}{\cos x}+\dfrac{\cos x}{\sin x}=\dfrac{5}{\cos x}\overset{\times\sin x\cos x}{\Rightarrow}\sin^2 x+\cos^2 x=5\sin x$ | |
| | $5\sin x=1$ | M1, A1 |
| | $x=$ awrt 0.201, 2.94 | dM1, A1 |
| | | **(4)** |
| | | **(9 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **6 (i) (a)** | Uses $\sin^2\theta+\cos^2\theta=1$ with $\cos\theta=\dfrac{1}{\sqrt{5}}\Rightarrow\sin^2\theta=\dfrac{4}{5}$ | M1 |
| | $\Rightarrow\sin\theta=-\dfrac{2}{\sqrt{5}}$ | A1 |
| **(b)** | Uses $\tan\theta=\dfrac{\sin\theta}{\cos\theta}$ with $\cos\theta=\dfrac{1}{\sqrt{5}}$ and their $\sin\theta=-\dfrac{2}{\sqrt{5}}$ | M1 |
| | $\Rightarrow\tan\theta=-2$ | A1 |
| | | **(4)** |
| **(ii) (a)** | 1 (m) | B1 |
| | | **(1)** |
| **(b)** | $30t-40=180\Rightarrow t=7.33$ Hence 7:20 **am** | M1, A1, A1 |
| | | **(3)** |
| **(c)** | $4+3\cos(30T-40)°=3.5\Rightarrow\cos(30T-40)°=-\dfrac{1}{6}$ | M1 |
| | $\Rightarrow 30T-40=99.6, 260.4, \underline{\underline{459.6}}$ | A1 |
| | $\Rightarrow T=\dfrac{"459.6"+40}{30}=16.65$ | dM1, A1 |
| | | **(4)** |
| | | **(12 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **2.(a)** | Attempts $(x\pm 2)^2+(y\pm 5)^2 \ldots\ldots = 0$ | M1 |
| | (i) Centre $(-2,5)$ | A1 |
| | (ii) Radius $\sqrt{50}$ or $5\sqrt{2}$ | B1 |
| | | **(3)** |
| **(b)** | Gradient of radius $= \dfrac{(5)-4}{(-2)-5} = -\dfrac{1}{7}$ which needs to be in simplest form | B1ft |
| | Uses $m_2 = -\dfrac{1}{m_1}$ to find gradient of tangent | M1 |
| | Equation of tangent $y-4="7"(x-5) \Rightarrow y=7x-31$ | M1 A1 |
| | | **(4)** |
| | | **(7 marks)** |

| Question Number | Scheme | Marks |
|---|---|---|
| **10(a)** | $x^2+y^2+4x-30y+209=0$<br>$\Rightarrow (x\pm 2)^2+(y\pm 15)^2 \ldots = 0$ | M1 |
| **(i)** | Centre $(-2, 15)$ | A1 |
| **(ii)** | Radius $\sqrt{20}$ | A1 |
| | | **(3)** |
| **(b)** | $y=mx+1 \Rightarrow (x+2)^2+(mx+1-15)^2 = 20$<br>or<br>$y=mx+1 \Rightarrow x^2+(mx+1)^2+4x-30(mx+1)+209=0$ | M1 |
| | $x^2+m^2x^2+4x-28mx+180=0$<br>$b^2-4ac=0 \Rightarrow (4-28m)^2-4(1+m^2)\times 180=0$ | **d**M1 |
| | $(4-28m)^2-4(1+m^2)180=0 \Rightarrow 16-224m+784m^2-720-720m^2=0$<br>$\Rightarrow 2m^2-7m-22=0$* | A1* |
| | | **(3)** |
| **(c)** | $2m^2-7m-22=0 \Rightarrow m=\dfrac{11}{2}, -2$ | M1 |
| | $m=\dfrac{11}{2} \Rightarrow \dfrac{125}{4}x^2-150x+180=0 \Rightarrow x=\dfrac{12}{5} \Rightarrow y=\dfrac{71}{5}$<br>or<br>$m=-2 \Rightarrow 5x^2+60x+180=0 \Rightarrow x=-6 \Rightarrow y=13$ | M1 |
| | $\left(\dfrac{12}{5}, \dfrac{71}{5}\right)$ **or** $(-6, 13)$ oe | A1 |
| | $\left(\dfrac{12}{5}, \dfrac{71}{5}\right)$ **and** $(-6, 13)$ oe | A1 |
| | | **(4)** |
| | | **Total 10** |

| 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)** |

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| **6(a)** | Examples:<br>$m_{PQ} = \dfrac{14+30}{23-15}$, $m_{QR} = \dfrac{-30+26}{15+7} \Rightarrow m_{PQ} \times m_{QR} = ..$<br>or<br>$PQ^2 = 8^2 + 44^2, QR^2 = 22^2 + 4^2$, $PR^2 = 30^2 + 40^2$<br>$PQ^2 + QR^2 = ..$ | Correct strategy to show that $\angle PQR = 90°$. E.g. attempts gradient of *PQ* and gradient of *QR* and attempts product or finds side lengths and attempts Pythagoras. | M1 |
| | $m_{PQ} \times m_{QR} = \dfrac{11}{2} \times \left(-\dfrac{2}{11}\right) = -1 \Rightarrow \angle PQR = 90°$<br>Or<br>$PQ^2 = 2000$, $QR^2 = 500$, $PR^2 = 2500$<br>$2000 + 500 = 2500 \Rightarrow \angle PQR = 90°$ | Correct proof and conclusion | A1 |
| | | | **(2)** |
| **(b)(i)** | Centre is $(8, -6)$ | Correct coordinates | B1 |
| **(b)(ii)** | $r = \sqrt{(23-8)^2 + (14+6)^2}$<br>or e.g.<br>$r = \dfrac{1}{2}\sqrt{(23+7)^2 + (14+26)^2}$ | Fully correct method for the radius | M1 |
| | $r = 25$ | Cao | A1 |
| | | | **(3)** |
| **(c)** | $S$ is $(1, 18)$ **or** $m_T = \dfrac{7}{24}$ | Correct coordinates for *S* or correct gradient for the tangent. | B1 |
| | $m_N = \dfrac{18+6}{1-8} \Rightarrow m_T = \dfrac{8-1}{18+6} \Rightarrow y - 18 = \dfrac{7}{24}(x-1)$<br>Uses a correct straight line method for the tangent using their *S* and the negative reciprocal of the radius gradient | | M1 |
| | $7x - 24y + 425 = 0$ | Allow any integer multiple | A1 |
| | | | **(3)** |
| | | | **Total 8** |

| Question Number | Scheme | Marks |
|---|---|---|
| **3(a)** | Attempts to complete the square for both variables $\left(x+4\right)^2, \left(y-7\right)^2$ | M1 |
| | Centre $\left(-4, 7\right)$ | A1 |
| | Radius = 12 | A1 |
| | | **(3)** |
| **(b)** | Attempts $"\pm\left(12"-\sqrt{"4"^2+"7"^2}\right)$ | M1 |
| | $12-\sqrt{65}$ | A1 ft |
| | | **(2)** |
| | | **Total 5** |

| Question Number | Scheme | Marks |
|---|---|---|
| **9 (i)** | States or uses $\tan x = \dfrac{\sin x}{\cos x}$ | B1 |
| | $\sin x \tan x = 5 \Rightarrow \sin^2 x = 5\cos x \Rightarrow 1-\cos^2 x = 5\cos x$ | M1A1 |
| | $\cos^2 x + 5\cos x - 1 = 0 \Rightarrow \left(\cos x = \right)\dfrac{-5\pm\sqrt{29}}{2} \Rightarrow x =$ awrt $78.9°, 281.1°$ | M1dM1A1 |
| | | **(6)** |
| **(ii)** | (a) $A = 5$ | B1 |
| | | **(1)** |
| | (b) $2\theta - \dfrac{3\pi}{8} = \dfrac{3\pi}{2} \Rightarrow \theta = ...$ | M1 |
| | $\theta = \dfrac{15\pi}{16}$ | A1 |
| | $y$ coordinate $Q = -3$ (or $2-"A"$) | B1ft |
| | | **(3)** |
| | (c) Sets $0 = "5"\sin\left(2\theta - \dfrac{3\pi}{8}\right)+2 \Rightarrow \sin\left(2\theta-\dfrac{3\pi}{8}\right) = \pm\dfrac{2}{"5"}$ | M1 |
| | $\sin\left(2\theta-\dfrac{3\pi}{8}\right) = \pm\dfrac{2}{5} \Rightarrow \left(2\theta-\dfrac{3\pi}{8}\right) = \arcsin\left(\pm\dfrac{2}{5}\right) = ...$ | dM1 |
| | One of $\theta = 0.38,\ 2.4,\ 3.5,\ 5.5,\ 6.7,\ 8.6,\ 9.8....$ | A1 |
| | $\theta =$ awrt $5.51$ | A1 |
| | | **(4)** |
| | | **Total 14** |

| Question Number | Scheme | Marks |
|---|---|---|
| **9(a)** **(i)** | Centre $= (k, 2k)$ | B1 |
| **(ii)** | Radius $= \sqrt{k+7}$ | B1 |
| | | **(2)** |
| **(b)(i)** | $(2-k)^2 + (3-2k)^2 = k+7 \Rightarrow 4-4k+k^2+9-12k+4k^2 = k+7$ | M1 |
| | $5k^2 - 17k + 6 = 0$ * | A1* |
| **(ii)** | $(k =)\frac{2}{5}, 3$ | B1 |
| | | **(3)** |
| **(c)** | | |
| | Centre is $\left(\frac{2}{5}, \frac{4}{5}\right)$ | B1ft |
| | Gradient of tangent $\pm\frac{2-"\frac{2}{5}"}{3-"\frac{4}{5}"} = \left(-\frac{8}{11}\right)$ | M1 |
| | $y-3 = "-\frac{8}{11}"(x-2) \Rightarrow$ sets $y=0 \Rightarrow x = ...$<br>Alternatively, $\tan \angle PTO = \frac{8}{11} \Rightarrow XT = \frac{3}{8/11} = ...$ where $X$ is (2,0) | M1 |
| | Area $OPT = \frac{1}{2} \times "\frac{49}{8}" \times 3 = ...$<br>Alternatively, Area $OPT = \frac{1}{2} \times 2 \times 3 + \frac{1}{2} \times "\frac{33}{8}" \times 3 = ...$ | dM1 |
| | $= \frac{147}{16}$ oe | A1 |
| | | **(5)** |
| | | **(10 marks)** |