Question Number	Scheme	Marks	AOs
10 (a)	$x^2+y^2-8x+5y-20=0$		
	$(x-4)^2+\left(y+\dfrac{5}{2}\right)^2=\left\{16+\dfrac{25}{4}+20\right\}$	M1	1.1b
	Centre $\left(4,-\dfrac{5}{2}\right)$	A1	1.1b
	Radius $=\dfrac{13}{2}$	A1	1.1b
		(3)	
(b)	$x^2-8x-20=0\Rightarrow x=10$	B1	2.2a
	Attempts the gradient of the radius: $\{m_r=\}\ \dfrac{0-"\left(-\dfrac{5}{2}\right)"}{"10"-"4"}$	M1	1.1b
	$=\dfrac{5}{12}$	A1	1.1b
	Forms the equation of the tangent at P: $y-0="-\dfrac{12}{5}"(x-10)$	dM1	2.1
	$12x+5y-120=0$	A1	1.1b
		(5)	
		(8 marks)	

Notes

(a)

M1: Attempts to complete the square on both x and y terms.

Look for $(x\pm4)^2\pm\left(y\pm\dfrac{5}{2}\right)^2\pm...$ where … may be 0. May be implied by a centre of $\left(\pm4,\pm\dfrac{5}{2}\right)$

A1: Correct centre $\left(4,-\dfrac{5}{2}\right)$ which may be given $x=...\ y=...$

A1: Correct exact radius. Allow $\dfrac{13}{2}$ or 6.5 but not e.g. $\sqrt{\dfrac{169}{4}}$

(b)

Watch out: **Using (–2, 0) for *P* gives a gradient of the radius of $-\dfrac{5}{12}$ and leads to**
$12x-5y-24=0$ but will score maximum B0M1A0dM1A0

B1: Deduces that the x coordinate of P is 10. May be implied by use of $x = 10$ in their later work.
If both $x = -2$ and $x = 10$ are found, then they must clearly indicate that P is when $x = 10$ or use the $x = 10$ in their later work.
Condone $P(0, 10)$ if $x = 10$ seen or used.

M1: Attempts the gradient of the radius using their centre and their P which should be $(\lambda, 0)$, where λ comes from a valid method e.g. by solving $x^2-8x-20=0$ or $(x-"4")^2+\left("\dfrac{5}{2}"\right)^2="\dfrac{169}{4}"$

using the usual rules (if using a calculator then λ should be 10 or –2).

Note that they may use Pythagoras to find $P(\lambda, 0)$: $k^2+\left("\dfrac{5}{2}"\right)^2=\left("\dfrac{13}{2}"\right)^2\Rightarrow k=...\{\pm6\}$

followed by $\lambda="4"\pm"6"=...\{10\text{ or }-2\}$

Alternatively, they may differentiate implicitly to reach the form $\pm\alpha x \pm \beta y\frac{\mathrm{d}y}{\mathrm{d}x} \pm \gamma \pm \delta\frac{\mathrm{d}y}{\mathrm{d}x} = 0$

(where $\alpha, \beta, \gamma, \delta$ are non-zero) and substitute their (λ, 0) (λ as above) to find a value for $\frac{\mathrm{d}y}{\mathrm{d}x}$

FYI: $2x + 2y\frac{\mathrm{d}y}{\mathrm{d}x} - 8 + 5\frac{\mathrm{d}y}{\mathrm{d}x} = 0 \rightarrow 2(\text{"10"}) - 8 + 5\frac{\mathrm{d}y}{\mathrm{d}x} = 0 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = ...\left\{-\frac{12}{5}\right\}$

A1: Correct gradient of the radius $= \frac{5}{12}$ which may be implied by later work and may be unsimplified. Note that they might go directly to the gradient of the tangent $\left\{-\frac{12}{5}\right\}$ and find $m_T = -\frac{\text{"10"} - \text{"4"}}{0 - \text{"}\left(-\frac{5}{2}\right)\text{"}}$ o.e. such as through implicit differentiation, which would imply this mark.

dM1: Full method to find the equation of the tangent at *P*. Dependent on the previous method mark.
Must be using the negative reciprocal of their gradient of the radius (note that they may have already found the gradient of the tangent through e.g. use of implicit differentiation).
If using $y = mx + c$ they must proceed as far as $c = \ldots$

A1: $12x + 5y - 120 = 0$ but allow any integer multiple of this. The = 0 must be present.
ISW after a correct equation in the required form seen.
Not scored for just $12x + 5y = 120$.