Question Number	Scheme	Marks
3a(i)	$r=\sqrt{(8-2)^2+(-3-5)^2}=10$	M1A1
(ii)	$(x-2)^2+(y-5)^2=100$	A1ft
		(3)
b	Gradient between centre and P $=-\frac{4}{3}$	B1
	Perpendicular gradient $=\frac{3}{4}$	M1
	$y+3=\frac{3}{4}(x-8)$	M1
	$3x-4y-36=0$	A1
		(4)
		(7 marks)

(a)(i) **Mark (i) and (ii) together**

M1 Attempts to find the radius. Score for the values embedded in the expression e.g. $\sqrt{(8-2)^2+(-3-5)^2}$ or $\sqrt{(2-8)^2+(5+3)^2}$. They must be attempting to find the difference in the x coordinates and the difference in the y coordinates.

A1 $(r=)\ 10$ ignore any units ± 10 is A0 Do not accept $\sqrt{100}$ for this mark. isw once a correct answer is seen.

(ii) **Note that if M0 is scored in (a)(i) then this is A0 in (ii)**

A1ft $(x-2)^2+(y-5)^2="100"$ o.e. e.g. $(x-2)^2+(y-5)^2="10^2"$ or $x^2+y^2-4x-10y="71"$ Follow through on their positive single value of r. isw once a correct equation is seen.

(b)

B1 Gradient between centre and P is $-\frac{4}{3}$ (may be implied by their gradient of the tangent)

M1 Attempts to find the negative reciprocal for their gradient. May be embedded within their equation of the tangent.

M1 Attempts to find the equation of the tangent at P using a changed gradient (cannot just be a stated gradient of the tangent which is incorrect and does not follow from any earlier work) and $(8,-3)$

Score for $y+3="\frac{3}{4}"(x-8)$. The coordinates $(8,-3)$ must be correctly placed.

If they use $y=mx+c$ they must proceed as far as $c=...$

A1 $3x-4y-36=0$ o.e. (provided all the coefficients are integers and all terms are on one side of the equation) isw once a correct equation is seen.

Alt (b)
Alternative method using differentiation

B1 $\frac{dy}{dx} = \frac{4-2x}{2y-10}$ o.e. such as $2(x-2)+2(y-5)\frac{dy}{dx} = 0$ or

e.g. $y = \left(100-(x-2)^2\right)^{\frac{1}{2}} \Rightarrow \frac{dy}{dx} = -(x-2)\left(100-(x-2)^2\right)^{-\frac{1}{2}}$ (may be implied by $\frac{3}{4}$)

M1 Attempts to find the gradient of the tangent at *P* using their $\frac{dy}{dx}$ and the given coordinate(s).

Do not be concerned with poorly differentiated equations for this mark and just look for the *x* (and possibly *y*) coordinate(s) to be substituted into a differential equation leading to a value for the gradient. Condone sign slips substituting in.

M1 As above in main scheme notes

A1 As above in main scheme notes

Alternative method using formula to find the equation of the tangent at a point on a circle

Using the formula $(x-a)(x_1-a)+(y-b)(y_1-b) = r^2$ with centre (a,b) and point $(x_1,\ y_1)$

B1 $(x-2)(x_1-2)+(y-5)(y_1-5)...$ (may be implied by further work)

M1 Sets equal to their radius: $(x-2)(x_1-2)+(y-5)(y_1-5) = "100"$

M1 Uses the point *P* and sets equal to their radius: $(x-2)(8-2)+(y-5)(-3-5)... = "100"$

A1 $3x-4y-36=0$ oe (provided all the coefficients are integers and all terms are on one side of the equation)

Question Number	Scheme	Marks
4a	3^5 or 243	B1
		(1)
bi	$(B=)5\times3^4p\ (=405p)$ $\quad(D=)10\times3^2p^3\ (=90p^3)$	M1A1
	$B=18D \Rightarrow= 405p=18\times90p^3 \Rightarrow p^2=\frac{1}{4}\Rightarrow p=-\frac{1}{2}$	M1A1
ii	$(C=)\ {}^5C_2\times3^3\times\left(-\frac{1}{2}\right)^2=\frac{135}{2}$	M1A1
		(6)
		(7 marks)

(a) **Mark (a) and (b) together**

B1 3^5 or 243 seen. Do not award if it is outside the bracket as $3^5\left(1+\frac{px}{3}\right)^5$, but allow if some of the terms of the binomial expansion are found and 243 is the constant term.
e.g. $243+405px+...$ Do not accept e.g. ${}^5C_0\times243\times(px)^0$ for this mark.

(b)(i)

M1 $(B=)5\times3^4p\ (=405p)$ or $(D=)10\times3^2p^3\ (=90p^3)$ (simplified or unsimplified including unprocessed indices).
The coefficients of *B* or *D* may be embedded within the binomial expansion such as $...+5\times3^4px+...+10\times3^2(px)^3$. Also allow e.g. $\binom{5}{1}3^4p$ or $\binom{5}{3}3^2p^3$ or ${}^5C_1 3^4p$ or ${}^5C_3 3^2p^3$

A1 $(B=)5\times3^4p\ (=405p)$ and $(D=)10\times3^2p^3\ (=90p^3)$ (simplified or unsimplified) Allow this mark if the coefficients have not been isolated from *x* and x^3, but the brackets around (px) and $(px)^3$ must be correctly removed. Binomial notation such as ${}^5C_1$ or ${}^5C_3$ must have been evaluated.

M1 Uses $"B"=18"D"$ to form a cubic equation in *p* and attempts to take out a factor of *p* or divide by *p* leading to $p^2=...$ (or may be implied by their value of *p*). $"B"="D"$ is M0
Condone equations involving *x* and x^3 as long as they are removed as they proceed to $p^2=...$
Note that equations may have been simplified before they are formed by cancelling factors e.g. 3^2, 3, 5 or *p* so look carefully at equations which are acceptable such as $5\times3^2p=180p^3$ or $9=36p^2\Rightarrow p^2=...$ (condone if negative)

Note $405p=90p^3\Rightarrow p=\pm\frac{3\sqrt{2}}{2}$ **scores M1A1M0A0 in (b)(i)** (did not use $"B"=18"D"$)
They can proceed in (b)(ii) to score M1A0.

A1 $p=-\frac{1}{2}$ only following correct coefficients for *B* and *D* (the positive root and $p=0$ must be rejected if found / a clear choice of $p=-\frac{1}{2}$) Watch out for notation rejecting the positive root such as:

