A1: Any correct 3 term quadratic equation in a single variable with terms collected but not necessarily all on one side e.g. $2r^2-8r+2=0$ o.e e.g. $r^2-4r=-1$ or $\theta^2-28\theta+4=0$ oe e.g. $\theta^2-28\theta=-4$ The "= 0" may be implied by their attempt to solve.
May be seen embedded e.g. $r\left(2r^2-8r+2\right)=0$

dM1: Solves their 3TQ in r or θ using a **non-calculator** method to produce a surd solution.
See General Guidance for solving a 3TQ.
Note that just quoting the quadratic formula followed by values scores M0 but that e.g. $\theta=\frac{28\pm\sqrt{28^2-4\times1\times4}}{2}=14\pm8\sqrt{3}$ or e.g. $r=\frac{4\pm\sqrt{4^2-4\times1\times1}}{2}=2\pm\sqrt{3}$ is sufficient.

ddM1: Dependent upon the previous M, it is for a correct method to find the other variable from a fraction of the form $\frac{\ldots}{a+b\sqrt{c}}$ where a, b and c are non-zero and $\sqrt{c}$ is irrational using a **non-calculator** method. E.g. multiplies numerator and denominator by the conjugate of the denominator. Note that having found θ, any progress to find r using $r=\sqrt{\frac{2}{\theta}}$ is unlikely as they will have to use a non-calculator method. This mark is for finding r or θ using a correct method and not for finding a value for e.g. r^2.

A1: $r=2+\sqrt{3},\ \theta=14-8\sqrt{3}$ o.e. such as $r=2+\sqrt{3},\ \theta=14-2\sqrt{48}$
Condone the omission of "$r=$" and/or "$\theta=$" if it is clear which is which.
Note that once the rationalisation of the denominator process is shown e.g. $\frac{2}{7+4\sqrt{3}}\times\frac{7-4\sqrt{3}}{7-4\sqrt{3}}$ or $\frac{8\left(16+8\sqrt{3}\right)}{\left(16-8\sqrt{3}\right)\left(16+8\sqrt{3}\right)}$, it is acceptable to write down the final answers.
If there are any extra incorrect values then withhold this mark.

		(7 marks)

Note that in 7(b), some candidates solve simultaneously using $r=\sqrt{\frac{2}{\theta}}$ e.g.

$$\frac{1}{2}r^2\theta=1\Rightarrow r=\sqrt{\frac{2}{\theta}}\Rightarrow\theta\sqrt{\frac{2}{\theta}}+2\sqrt{\frac{2}{\theta}}=8$$

This scores M1 for an equation in one variable and then A1 for

$$\theta\sqrt{\frac{2}{\theta}}+2\sqrt{\frac{2}{\theta}}=8\Rightarrow\sqrt{2}\theta-8\sqrt{\theta}+2\sqrt{2}=0 \text{ oe}$$

i.e. a correct quadratic equation in $\sqrt{\theta}$

They will need to solve this for $\sqrt{\theta}$ using a non-calculator method e.g.

$$\sqrt{2}\theta-8\sqrt{\theta}+2\sqrt{2}=0\Rightarrow\sqrt{\theta}=\frac{8\pm\sqrt{64-16}}{2\sqrt{2}}=\frac{8\pm4\sqrt{3}}{2\sqrt{2}}$$

and then square to obtain a value for θ for **d**M1

$$\theta=\left(\frac{8\pm4\sqrt{3}}{2\sqrt{2}}\right)^2=14\pm8\sqrt{3}$$

and then **dd**M1A1 as in the main scheme.

Question Number	Scheme	Marks
8(a)(i)	$x=\frac{1}{4}\Rightarrow 10+\frac{5\sqrt{x}-4}{2x^2}=10+\frac{5\sqrt{\frac{1}{4}}-4}{2\times\left(\frac{1}{4}\right)^2}=-2$	M1 A1
(ii)	Uses their $k=-2$ and $x=\frac{1}{4}$ in $y=kx+2$ $\Rightarrow y=\frac{3}{2}$	M1 A1
	$y-"\frac{3}{2}"=-\frac{1}{"-2"}\left(x-\frac{1}{4}\right)\Rightarrow y=\frac{1}{2}x+\frac{11}{8}$ or e.g. $\frac{y-"\frac{3}{2}"}{\left(x-\frac{1}{4}\right)}=-\frac{1}{"-2"}\Rightarrow y=\frac{1}{2}x+\frac{11}{8}$ or e.g. $y=-\frac{1}{"-2"}x+c\Rightarrow "\frac{3}{2}"=\frac{1}{2}\times\frac{1}{4}+c\Rightarrow c=...\left(\frac{11}{8}\right)\Rightarrow y=\frac{1}{2}x+\frac{11}{8}$	**d**M1 A1
		(6)

Notes

Mark (a) and (b) together i.e. ignore labelling.

(a)(i)

M1: Attempts to substitute $x=\frac{1}{4}$ into $f'(x)=10+\frac{5\sqrt{x}-4}{2x^2}$

Condone a miscopy of the function as long as the intention is clear e.g. use of $\frac{10+5\sqrt{x}-4}{2x^2}$

A1: $(k=)-2$ The "$k=$" is not required so just look for the correct value and apply isw if they subsequently think that y = their k i.e. they think they have found $f\left(\frac{1}{4}\right)$ rather than $f'\left(\frac{1}{4}\right)$

This mark is for evaluating $10+\frac{\frac{5}{2}-4}{2\times\left(\frac{1}{4}\right)^2}$ to give -2 regardless of what they do with it.

The correct value with no working scores both marks.

(a)(ii)

M1: Uses their value of k (however obtained) and $x=\frac{1}{4}$ in $y=kx+2$ to find y.

May be implied by their value of y but if no method is shown and their value of y is incorrect then score M0

A1: $y=\frac{3}{2}$ oe

dM1: Correct method of finding the equation of the normal using the negative reciprocal of their k with $x=\frac{1}{4}$ and their value of y. If they use "$y = mx + c$" they must reach a value for c.

It is dependent upon the previous M.

A1:	$y=\frac{1}{2}x+\frac{11}{8}$ or exact equivalent but must be in the form $y=mx+c$	
(b)	$\left(\mathrm{f}'(x)=\right)10+\frac{5}{2}x^{-\frac{3}{2}}-2x^{-2}\Rightarrow\quad\left(\mathrm{f}(x)=\right)10x-5x^{-\frac{1}{2}}+2x^{-1}\left(+c\right)$	M1 A1 A1
	Uses $P\left(\frac{1}{4},'\frac{3}{2}'\right)\Rightarrow\frac{3}{2}=\frac{5}{2}-5\times2+2\times4+c\Rightarrow c=...$	**d**M1
	$\left(\mathrm{f}(x)=\right)10x-5x^{-\frac{1}{2}}+2x^{-1}+1$	A1
		(5)

Notes

Condone spurious notation for the A marks e.g. floating integral signs and/or d*x*'s

M1: Attempts to split up the fractional term (into two terms) then integrates with two terms (from the three) having a correct index **after integrating**.

It is for 2 of, $10\rightarrow10x$, $\frac{5\sqrt{x}}{2x^2}\rightarrow...x^{-\frac{3}{2}}\rightarrow...x^{-\frac{1}{2}}$, $\frac{4}{2x^2}\rightarrow...x^{-2}\rightarrow...x^{-1}$

Allow the indices to be unprocessed.

Condone the omission of the + *c*

A1: Two correct terms of $\left(\mathrm{f}(x)=\right)10x-5x^{-\frac{1}{2}}+2x^{-1}$

Allow the indices to be unprocessed and the coefficients to be unsimplified e.g. 2 of

$\left(\mathrm{f}(x)=\right)10x+\frac{\frac{5}{2}x^{-\frac{3}{2}+1}}{-\frac{3}{2}+1}-\frac{2x^{-2+1}}{-2+1}$ The "f(x) =" is not required.

A1: $\left(\mathrm{f}(x)=\right)10x-5x^{-\frac{1}{2}}+2x^{-1}+c$ oe seen on one line but condone the omission of + *c*

Allow the indices to be unprocessed and the coefficients to be unsimplified e.g. allow

$\left(\mathrm{f}(x)=\right)10x+\frac{\frac{5}{2}x^{-\frac{3}{2}+1}}{-\frac{3}{2}+1}-\frac{2x^{-2+1}}{-2+1}$ The "f(x) =" is not required.

dM1: Uses $x=\frac{1}{4}$ and their value of *y* found from substituting their value of *k* and $x=\frac{1}{4}$ in $y=kx+2$ into their integrated function and finds the value of *c*.

Depends on the first method mark.

A1: $\left(\mathrm{f}(x)=\right)10x-5x^{-\frac{1}{2}}+2x^{-1}+1$ or exact equivalent such as $\left(\mathrm{f}(x)=\right)10x-\frac{5}{\sqrt{x}}+\frac{2}{x}+1$

The "f(x) =" is not required but the indices must now be processed and the coefficients simplified.

		(11 marks)