Question Number	Scheme	Marks
7ai	$f'(4)=\dfrac{4(4)^2+10-7(4)^{\frac{1}{2}}}{4(4)^{\frac{1}{2}}}=\dfrac{15}{2}$	B1
ii	$"\dfrac{15}{2}"\rightarrow-\dfrac{2}{15}$	M1
	$y+1="-\dfrac{2}{15}"(x-4)$	M1
	$2x+15y+7=0$	A1
		(4)
b	$\dfrac{4x^2+10-7x^{\frac{1}{2}}}{4x^{\frac{1}{2}}}=\pm...x^{\frac{3}{2}}\pm...x^{-\frac{1}{2}}\pm...$	M1
	Two of the terms of $x^{\frac{3}{2}}+\dfrac{5}{2}x^{-\frac{1}{2}}-\dfrac{7}{4}$	A1
	$\int\left(x^{\frac{3}{2}}+\dfrac{5}{2}x^{-\frac{1}{2}}-\dfrac{7}{4}\right)\mathrm{d}x=\dfrac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\dfrac{7}{4}x\ (+c)$	dM1A1ft
	$\dfrac{2}{5}(4)^{\frac{5}{2}}+5(4)^{\frac{1}{2}}-\dfrac{7}{4}(4)+c=-1\Rightarrow c=...$	ddM1
	$\left(f(x)=\right)\dfrac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\dfrac{7}{4}x-\dfrac{84}{5}$	A1
		(6)
		(10 marks)

Mark (a) and (b) together so do not be concerned with labelling of the parts

(a)

(i)

B1: $\dfrac{15}{2}$ oe stated (as the gradient of f(x) at P).

(ii)

M1 Finds the negative reciprocal of their gradient in part (i). If they do not have a gradient in (i) then only allow $-\dfrac{2}{15}$ or an attempt at $-\dfrac{1}{f'(4)}$

M1 Attempts to find the equation of the normal using a changed gradient to that found in (i) and $(4,\ -1)$ with the coordinates in the correct positions. If they do not have a gradient in (i) then allow any gradient $\neq\dfrac{15}{2}$. If they use $y=mx+c$ they must proceed as far as $c=...$

A1: $2x+15y+7=0$ or any multiple of this where all the coefficients are integers and all terms are on the same side of the equation. e.g. $30y+14+4x=0$ scores A1

(b)

M1: Splits into **three** separate terms with at least one term with the correct index. The index does not need to be processed. e.g. $x^{2-\frac{1}{2}}$

A1: Two of $x^{\frac{3}{2}}+\frac{5}{2}x^{-\frac{1}{2}}-\frac{7}{4}$ (unsimplified but the indices must be processed). May appear as a list of terms on different lines. May be implied by a correctly integrated expression.

dM1: Attempts to increase the power by one on at least one term. It is dependent on the previous method mark. The index does not need to be processed for this mark. It cannot be scored for attempting to integrate individual terms on the numerator or denominator.

A1ft: $\frac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\frac{7}{4}x$ or exact unsimplified equivalent (indices processed). e.g. $\frac{x^{\frac{5}{2}}}{\frac{5}{2}}+\frac{\frac{5}{2}x^{\frac{1}{2}}}{\frac{1}{2}}-\frac{7}{4}x$

Follow through on an expression of the form $Ax^{\frac{3}{2}}+Bx^{-\frac{1}{2}}+C\rightarrow\frac{Ax^{\frac{5}{2}}}{\frac{5}{2}}+\frac{Bx^{\frac{1}{2}}}{\frac{1}{2}}+Cx$ where A, B and C are all non-zero.
Do not be concerned with the presence or omission of the constant of integration.
Accept x^1 for x.
Ignore any spurious notation including the presence of the integral sign.

ddM1: Attempts to substitute $x=4$ into their changed expression (condone one slip in substituting in), sets equal to -1 and attempts to find c.
This mark cannot be scored if they do not have a constant of integration.
It is dependent on both of the previous method marks.
Do not be concerned by the mechanics of the rearrangement and condone arithmetical slips, but they must achieve a value.

The substitution may be implied by a correct value for c for their integrated expression if no working is shown (you may need to check this), or allow for $\pm\frac{84}{5}$

A1: $\left(\mathrm{f}(x)=\right)\frac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\frac{7}{4}x-\frac{84}{5}$ or any equivalent expression e.g. $0.4x^{\frac{5}{2}}+5x^{\frac{1}{2}}-1.75x-16.8$
Accept x^1 for x. Condone equivalent fractions for the coefficients provided both numerator and denominator are integers. e.g. $\left(\mathrm{f}(x)=\right)\frac{x^{\frac{5}{2}}}{2.5}+5x^{\frac{1}{2}}-\frac{7}{4}x-\frac{84}{5}$ is A0
Withhold the final mark if there is still integration notation around the answer or if it is set equal to 0

Question Number	Scheme	Marks
8a	$x\left(x^3-\frac{7}{2}x-5\right)=\frac{15}{2}-5x$ $\Rightarrow 2x^4-7x^2-15=0$ *	M1 A1*
		(2)
b	$(2x^2+3)(x^2-5)=0\Rightarrow\left(x^2=\right)...$	M1
	$\left(x=\right)\ \ (\pm)\sqrt{5}$	B1
	$y=\frac{15}{2\times"\pm\sqrt{5}"}-5=...$ or $y=\left("\pm\sqrt{5}"\right)^3-\frac{7}{2}\left("\pm\sqrt{5}"\right)-5$	M1
	$\left(-\sqrt{5},-\frac{3}{2}\sqrt{5}-5\right)\quad\left(\sqrt{5},\frac{3}{2}\sqrt{5}-5\right)$ $PQ=\sqrt{("2\sqrt{5}")^2+("3\sqrt{5}")^2}=...$	dM1
	$PQ=\sqrt{65}$	A1cao
		(5)
		(7 marks)

(a)

M1: Sets up a correct equation in x. Invisible brackets may be implied by further work.

e.g. $x^4-\frac{7}{2}x^2-5x=\frac{15}{2}-5x$

A1*: Multiplies out and rearranges the equation to achieve the given answer with no errors seen including invisible brackets. Condone the implied = 0 in their working, provided it is present in their final answer. There must be at least one stage of intermediate working between their starting equation and proceeding to the given answer.

$x^4-\frac{7}{2}x^2-5x=\frac{15}{2}-5x\Rightarrow 2x^4-7x^2-15=0$ is M1A0*

(b) **Work for (b) may be seen in (a) which can score**

M1: Attempts to solve the quadratic equation in x^2 by either

- factorising
- completing the square
- quadratic formula

Usual rules apply. Do not be too concerned by the labelling e.g. it is acceptable to use a different variable as well as condoning $y=x^2$ and $x=x^2$

This mark cannot be awarded from directly using a calculator and stating the roots.

B1: At least one of $\sqrt{5}$ and $-\sqrt{5}$ (and no others)

M1: **Note that if they do not square root their solution to the quadratic in x^2 then this mark cannot be scored (and no further marks).**

Attempts to substitute in $\pm\sqrt{"5"}$ (which must be of the form $+k\sqrt{b}$ and $-k\sqrt{b}$ where k may be 1) into either of the equations of the curves and proceeds to find irrational expressions for the y coordinates of P and Q of the form $\pm5\pm n\sqrt{"5"}$ (which may be the same for both). They cannot be decimals.

May be seen as e.g. $\left(-\sqrt{5},\frac{-3\sqrt{5}-10}{2}\right)\quad\left(\sqrt{5},\frac{3\sqrt{5}-10}{2}\right)$