Question	Scheme	Marks
8(a)	$y=(x-2)(x^2-8x+16) \Rightarrow y=x^3-8x^2+16x-2x^2+16x-32 \Rightarrow$ $y=x^3 \pm ...x^2 \pm ...x \pm 32$	M1
	$=x^3-10x^2+32x-32$	A1
	$\frac{dy}{dx}=3x^2-20x+32$*	M1A1*
		(4)
(b)	$x=6 \Rightarrow y=(6-2)(6-4)^2=16$	B1
	$\frac{dy}{dx}=3(6)^2-20(6)+32=20$	B1
	$y-"16"="20"(x-6)$	M1
	$y=20x-104$	A1
		(4)
(c)	$3x^2-20x+32="20" \Rightarrow 3x^2-20x+12=0$	M1
	$3x^2-20x+12=0 \Rightarrow (3x-2)(x-6)=0 \Rightarrow x=...$	dM1
	$\alpha=\frac{2}{3}$	A1
		(3)
		(11 marks)

Notes

(a)

M1 Attempts to multiply out the three brackets, condoning slips in their working.
Usually $y=(x-2)(x^2-8x+16) \Rightarrow y=x^3-8x^2+16x-2x^2+16x-32 \Rightarrow x^3 \pm ...x^2 \pm ...x \pm 32$
Score for expressions of the form $x^3 \pm ...x^2 \pm ...x \pm 32$. Middle terms do not need to be collected.

A1 $x^3-10x^2+32x-32$ If they do not collect terms together until after differentiating, A1 can be awarded by subsequent work. You would have to see the individual differentiated terms collected rather than implied by the final answer.
They must have attempted to multiply out the brackets for this mark.

M1 $x^n \to x^{n-1}$ correct on one term so either $...x^3 \to ...x^2$ $...x^2 \to ...x$ $Ax \to A$ $B \to 0$

A1* Correct proof with no errors including omission of brackets. At some point they should have had $y=...$ and their final line should finish with $\frac{dy}{dx}=3x^2-20x+32$ including the $\frac{dy}{dx}$ but the terms on the rhs can be in any order.

Alternative method: Product rule - Note the order of marking

2nd M1 $\left(\frac{dy}{dx}=\right)\ (x-2)\times A(x-4)\pm B(x-4)^2$ applies the product rule. Look for this form or equivalent.

1st A1 $\left(\frac{dy}{dx}=\right)\ (x-2)\times 2(x-4)+(x-4)^2$

1st M1 $\left(\frac{dy}{dx}=\right)\ 2x^2-8x-4x+16+x^2-8x+16 \Rightarrow\ 3x^2-20x+32$ attempts to multiply out and collect terms to form a 3TQ

2nd A1* $\frac{dy}{dx}=3x^2-20x+32$* with no errors

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M1 $y=(x-2)(x^2-8x+16) \Rightarrow y=x^3\pm...x^2\pm...x\pm 32$ (does not require middle terms to score M1)

A1 $y=x^3-10x^2+32x-32$ oe

M1 $\int\left(3x^2-20x+32\right)dx=x^3-10x^2+32x+C$ look for correct index on one term

A1* deduce that $C=-32$ and conclude $\frac{dy}{dx}=3x^2-20x+32$ with no errors seen

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(b)

B1 16 is identified as the y coordinate. Beware that $\frac{d^2y}{dx^2}=16$ when $x=6$

B1 20 is identified as the gradient. Eg $\frac{dy}{dx}=20$, $m=20$, $g=20$ or may be used within their equation for the tangent.

M1 Correct straight line method $y-"16"="20"\left(x-6\right)$ using:

- their value of y from substituting in $x=6$ into $y=(x-2)(x^2-8x+16)$ or $y=...$ from (a)
- their gradient found from substituting $x=6$ into $\frac{dy}{dx}=3x^2-20x+32$. This cannot be a changed gradient (eg gradient of a normal)

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

A1 $y=20x-104$ cao

(c)

M1 Equates $3x^2-20x+32$ with their 20 and collects terms to obtain a 3TQ. Condone slips in their rearrangement.

dM1 Attempts to solve their 3TQ (see general guidance for solving quadratics) . If they just state the roots then you may need to check these on a calculator. It is dependent on the previous method mark.

A1 $\alpha=\frac{2}{3}$ (allow $x=\ldots$) Ignore sight of 6. Answer on its own scores full marks.

(Note that values of 4, $\frac{8}{3}$ imply they have solved $3x^2-20x+32=0$ which is 0 marks)

Question	Scheme	Marks
9	$\frac{21x^3-5x}{2\sqrt{x}}=\alpha x^{\frac{5}{2}}+\ldots$ or $\frac{21x^3-5x}{2\sqrt{x}}=\ldots+\beta x^{\frac{1}{2}}$	M1
	$\mathrm{f}(x)=\frac{27}{3}x^3-\frac{21}{2}\times\frac{2}{7}x^{\frac{7}{2}}+\frac{5}{2}\times\frac{2}{3}x^{\frac{3}{2}}(+c)\quad\left(=9x^3-3x^{\frac{7}{2}}+\frac{5}{3}x^{\frac{3}{2}}(+c)\right)$	M1A1A1
	$\mathrm{f}(9)=10\Rightarrow 9(9)^3-3(9)^{\frac{7}{2}}+\frac{5}{3}(9)^{\frac{3}{2}}+c=10\Rightarrow c=\ldots$	dM1
	$\left(\mathrm{f}(x)=\right)\ 9x^3-3x^{\frac{7}{2}}+\frac{5}{3}x^{\frac{3}{2}}-35$	A1
		(6 marks)

Notes

On EPEN it is B1M1A1A1dM1A1. We are marking this as M1M1A1A1dM1A1

M1 Uses correct index laws to obtain at least one correct index from splitting the fraction.
Award for $\alpha x^{\frac{5}{2}}+\ldots$ or $\ldots+\beta x^{\frac{1}{2}}$

M1 $x^n\rightarrow x^{n+1}$ correctly seen on one term (usually the $27x^2\rightarrow\ldots x^3$). The indices do not need to be processed. This mark can also be awarded for integrating terms from incorrect attempts to split the fraction. Eg $\frac{21x^3-5x}{2x^{\frac{1}{2}}}=42x^{\frac{7}{2}}-10x^{\frac{3}{2}}\quad 42x^{\frac{7}{2}}\rightarrow\ldots x^{\frac{9}{2}}$ or $-10x^{\frac{3}{2}}\rightarrow\ldots x^{\frac{5}{2}}$

This mark cannot be awarded for only seeing:

$$\frac{21x^3-5x}{2x^{\frac{1}{2}}}\rightarrow\frac{\ldots x^4\pm\ldots x^2}{\ldots x^{\frac{3}{2}}}$$

A1 Two correct terms simplified or unsimplified, but the indices must have been processed.

A1 All correct simplified or unsimplified (+ *c* not required)

dM1 Uses f (9) = 10 and attempts to find *c*. Do not be too concerned by the mechanics of their arrangement. It is dependent on the previous method mark.

A1 $9x^3-3x^{\frac{7}{2}}+\frac{5}{3}x^{\frac{3}{2}}-35$ All correct and simplified. Accept other simplified equivalent expressions for $\mathrm{f}(x)$ such as $\frac{1}{3}(27x^3-9x^{\frac{7}{2}}+5x^{\frac{3}{2}}-105)$