Question Number	Scheme	Marks
	$y=\frac{1}{2}x^4-3+\frac{10}{x^2}$	
5(a)	$\left(\int \frac{1}{2}x^4-3+\frac{10}{x^2}\,\mathrm{d}x=\right)\frac{1}{10}x^5-3x-\frac{10}{x}+c$	M1A1A1
		(3)
(b)(i)	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=\right)2x^3-\frac{20}{x^3}$	M1A1A1
		(3)
(b)(ii)	$2x^3-\frac{20}{x^3}=3\Rightarrow 2x^6-20=3x^3$	M1
	$2x^6-3x^3-20=0\Rightarrow\left(2x^3+5\right)\left(x^3-4\right)=0\Rightarrow x^3=...\Rightarrow x=...$ or e.g. $x^3=a\Rightarrow(2a+5)(a-4)=0\Rightarrow a=...\Rightarrow x^3=...\Rightarrow x=...$	dM1
	$\Rightarrow x=-\sqrt[3]{\frac{5}{2}},\quad \sqrt[3]{4}$	A1A1
		(4)
		(10 marks)

Notes

(a)

M1: For increasing any power by one. E.g. $\frac{1}{2}x^4\rightarrow ...x^5$ or $-3\rightarrow ...x$ or $\frac{10}{x^2}\rightarrow ...x^{-1}$

Allow unprocessed indices for this mark e.g. $\frac{1}{2}x^4\rightarrow ...x^{4+1}$

A1: For two correct and **simplified** terms of $\frac{1}{10}x^5-3x-\frac{10}{x}$.

Allow $0.1x^5$ for $\frac{1}{10}x^5$ and $-10x^{-1}$ for $-\frac{10}{x}$.

Condone $-3x^1$ for $-3x$ and $-\frac{10}{x^1}$ for $-\frac{10}{x}$ for <u>this</u> mark.

A1: $\frac{1}{10}x^5-3x-\frac{10}{x}+c$. Must include a constant of integration.

Ignore the lhs i.e. ignore what they call their integral.

Allow $0.1x^5$ for $\frac{1}{10}x^5$ and $10x^{-1}$ for $\frac{10}{x}$.

Condone spurious integral signs e.g. $\int \frac{1}{2}x^4-3+\frac{10}{x^2}\,\mathrm{d}x=\int \frac{1}{10}x^5-3x-\frac{10}{x}+c$

Do not allow e.g. $\frac{1}{10}x^5-3x+-\frac{10}{x}+c$.

Mark (b)(i) and (ii) together.

(b)(i)

M1: For decreasing any power by one. E.g. $\frac{1}{2}x^4 \to ...x^3$ or $-3 \to 0$ or $\frac{10}{x^2} \to ...x^{-3}$

Allow unprocessed indices for this mark e.g. $\frac{1}{2}x^4 \to ...x^{4-1}$

A1: For one correct and **simplified** term. $2x^3$ or $-\frac{20}{x^3}$. Allow $20x^{-3}$ for $\frac{20}{x^3}$.

A1: $2x^3 - \frac{20}{x^3}$. Allow $20x^{-3}$ for $\frac{20}{x^3}$.

(b)(ii)

M1: Sets their $2x^3 - \frac{20}{x^3}$ equal to 3 and multiplies to form a **polynomial equation** in *x*.

Allow copying slips but it must be their $\frac{dy}{dx}$ from part (b)(i) and it must be of the form $Ax^m + \frac{B}{x^n}$ where *m* and *n* are integers and $m > 0$ and $n > 0$

It is for proceeding from $Ax^m + \frac{B}{x^n} = 3$ to $Ax^{m+n} + B = 3x^n$ or equivalent work.

dM1: Solves an equation of the form $px^6 + qx^3 + r = 0,\ p, q, r \neq 0$ via **non calculator** means to find at least one value for *x*. It is not for finding a value of x^3 so e.g.

$t = x^3 \Rightarrow 2x^6 - 3x^3 - 20 = 2t^2 - 3t - 20,\ 2t^2 - 3t - 20 = 0 \Rightarrow (2t+5)(t-4) = 0 \Rightarrow t = -\frac{5}{2},\ 4$

on its own scores M0 unless a value of *x* is found by cube rooting. Note we will condone the "cube rooting" done on a calculator for this mark but **not** the solving of their equation.

A1: Either solution of $x = -\sqrt[3]{\frac{5}{2}}, \sqrt[3]{4}$ o.e. such as $-2.5^{\frac{1}{3}},\ 4^{\frac{1}{3}}$

Allow $(-2.5)^{\frac{1}{3}}$ for $-2.5^{\frac{1}{3}}$ and $2^{\frac{2}{3}}$ for $4^{\frac{1}{3}}$

Must come from correct work i.e. from the correct equation $2x^6 - 3x^3 - 20 = 0$ oe

Apply isw once a correct answer is seen.

A1: $x = -\sqrt[3]{\frac{5}{2}}, \sqrt[3]{4}$ o.e. such as $-2.5^{\frac{1}{3}},\ -\frac{\sqrt[3]{20}}{2},\ 4^{\frac{1}{3}}$

Allow $(-2.5)^{\frac{1}{3}}$ for $-2.5^{\frac{1}{3}}$ and $2^{\frac{2}{3}}$ for $4^{\frac{1}{3}}$

Must come from correct work i.e. from the correct equation $2x^6 - 3x^3 - 20 = 0$ oe

Apply isw once correct answers are seen.

<u>Notes on evidence of use of a calculator in (b)(ii):</u>

e.g. $2x^6 - 3x^3 - 20 = 0 \Rightarrow \left(x^3 + 2.5\right)\left(x^3 - 4\right) \Rightarrow x^3 = -2.5,\ 4 \Rightarrow x = ...$

and

$x^3 = a \Rightarrow 2a^2 - 3a - 20 = 0 \Rightarrow (a+2.5)(a-4) \Rightarrow a = -2.5,\ 4 \Rightarrow x^3 = ... \Rightarrow x = ...$

Both score dM0A0A0

Question Number	Scheme	Marks
6.	$(x+5)(3x+2)(2x-5)=(3x^2+17x+10)(2x-5)=...$	M1
	$=6x^3-15x^2+34x^2-85x+20x-50$ $\left(=6x^3+19x^2-65x-50\right)$	A1
	$6x^3+19x^2-65x-50=3x^2-33x-50$ $\Rightarrow 6x^3+16x^2-32x=0$	dM1
	$2x(3x-4)(x+4)=0$	ddM1
	$x=-4,\ 0,\ \frac{4}{3}$	A1
		(5)
		(5 marks)

Notes

M1: For an attempt to multiply out the $(x+5)(3x+2)(2x-5)$.
Must obtain terms in x^3, x^2, x and a constant.

A1: $6x^3+19x^2-65x-50$ but may be left unsimplified e.g. $6x^3-15x^2+34x^2-85x+20x-50$
Award this mark if a correct unsimplified expansion is seen and errors are subsequently made when collecting terms.

dM1: Sets their $6x^3+19x^2-65x-50=3x^2-33x-50,$ collects terms and proceeds to a cubic expression = 0. This may be implied if they cancel the 50's and then divide through by x to obtain a quadratic expression = 0. The "= 0" may be implied by subsequent work.
Depends on the previous method mark.

ddM1: Attempts to solve a cubic of the form $px^3+qx^2+rx=0,\ p,q,r\neq 0$ by **non-calculator** methods
This must involve dividing or factorising out x (or e.g. $2x$) followed by an attempt to solve a quadratic of the form $px^2+qx+r=0,\ p,q,r\neq 0$ by **non-calculator** methods – see General Guidance. Just quoting the quadratic formula followed by roots written down is M0
Depends on both previous method marks.

A1: $x=-4,\ 0,\ \frac{4}{3}$. Allow exact equivalents for $\frac{4}{3}$ including $1.\dot{3}$
Note that the $x = 0$ may appear earlier in their solution so look out for this.

Guidance for the ddM1A1 marks:

$$6x^3+16x^2-32x=0\Rightarrow 6x^2+16x-32=0\Rightarrow (3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

Scores ddM0A0

$$6x^3+16x^2-32x=0\Rightarrow 6x^2+16x-32=0\Rightarrow 2(3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

Scores ddM1A0

$$6x^3+16x^2-32x=0\Rightarrow x\left(6x^2+16x-32\right)=0\Rightarrow x\left(x-\frac{4}{3}\right)(x+4)=0\Rightarrow x=0,\ \frac{4}{3},\ -4$$

Scores ddM0A0

$$3x^3+8x^2-16x=0\Rightarrow (3x-4)(x+4)=0\Rightarrow x=\frac{4}{3},\ -4$$

Scores ddM0A0