

14	(a)		$\frac{16}{x^2} + \frac{3}{x} = 0$ $(-\frac{16}{3}, 0)$ and no others	M1 A1 [2]	1.1 sets equal to 0 and obtains value(s) for x 1.1 allow $(-5.3, 0)$ or better; allow eg $x = -5.3, y = 0$ if M0 allow SC1 for exact coordinates unsupported
14	(b)	(i)	$\left[\frac{dy}{dx}\right] = -2 \times 16x^{-3} - 3x^{-2}$ oe $\left[\frac{dy}{dx}\right] = -32x^{-3} - 3x^{-2}$ or $-\frac{32}{x^3} - \frac{3}{x^2}$ isw	M1* A1 [2]	1.1 allow one sign error in coefficient; 1.1 both terms correct and no extras
	(b)	(ii)	their $-32x^{-3} - 3x^{-2} = 0$ used to obtain value(s) for x $(-\frac{32}{3}, -\frac{9}{64})$ or $(-10\frac{2}{3}, -\frac{9}{64})$ cao	M1dep* A1 [2]	1.1 1.1 allow eg -0.140625 ; allow eg $x = -\frac{32}{3}, y = -\frac{9}{64}$
14	(c)	(i)	$\left[\frac{d^2y}{dx^2}\right] = 96x^{-4} + 6x^{-3}$ or $\frac{96}{x^4} + \frac{6}{x^3}$	M1 A1 [2]	1.1 differentiation of their $\frac{dy}{dx}$, dependent on award of M1 in 14 (b)(i) ; allow one sign error in coefficient 1.1 both terms correct

Question			Answer	Marks	AO	Guidance
14	(c)	(ii)	$96x^{-4} + 6x^{-3} < 0$ $x < -16$ or $-16 > x$ cao	M1 A1 [2]	2.1 1.1	putting their expression for $\frac{d^2y}{dx^2} < 0$ or $\frac{d^2y}{dx^2} = 0$ or $\frac{d^2y}{dx^2} \leq 0$ to find value(s) for x
14	(d)		$\int \frac{16}{x^2} + \frac{3}{x} dx = -\frac{16}{x} + 3\ln x $ oe $\left[\frac{-16}{-\frac{1}{2}} + 3\ln -\frac{1}{2} \right] - \left[\frac{-16}{-4} + 3\ln -4 \right]$ $3\ln -\frac{1}{2} = 3\ln\frac{1}{2}$ and $3\ln -4 = 3\ln 4$ $28 - 9\ln 2$ cao	M1* A1 M1dep* M1dep* A1 [5]	1.1 2.1 1.1 2.1 1.1	one term correct; allow omission of modulus sign both terms correct; ignore + c; allow omission of modulus sign allow omission of modulus sign; allow one incorrect sign but do not allow eg $F\left[-\frac{1}{2}\right] + F[-4]$ oe ; modulus seen and used to deal with both terms may see eg $32 - 4 - 3\ln 2 - 6\ln 2$ oe as intermediate step
14	(d)		<i>Alternatively</i> $\int_{-4}^{-\frac{1}{2}} \frac{16}{x^2} + \frac{3}{x} dx = \int_{\frac{1}{2}}^4 \frac{16}{x^2} - \frac{3}{x} dx$ $\int \frac{16}{x^2} + \frac{3}{x} dx = -\frac{16}{x} - 3\ln x$ oe $\left[\frac{-16}{4} - 3\ln 4 \right] - \left[\frac{-16}{\frac{1}{2}} - 3\ln \frac{1}{2} \right]$ $28 - 9\ln 2$ cao	M1* M1* A1 M1dep* A1		by reflecting in y-axis and working with $f(-x)$ oe ; may be awarded before first M1 ; condone incorrect reason eg reflection in x-axis; M0 for use of $\int_{\frac{1}{2}}^4 \frac{16}{x^2} + \frac{3}{x} dx$ by symmetry one term correct; allow omission of modulus sign both terms correct; ignore + c; allow omission of modulus sign dependent on correct integration and correct transformation may see eg $32 - 4 - 3\ln 2 - 6\ln 2$ oe as intermediate step
				[5]		