Question Number	Scheme	Notes	Marks
7.	$3x^2 + px - 5 = 0$ has roots α, β ; p is a constant (c) $\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right)=2\left(\alpha+\frac{1}{\beta}\right)\left(\beta+\frac{1}{\alpha}\right)$		
(a) (i)	$\alpha\beta = -\frac{5}{3}$	$\alpha\beta = -\frac{5}{3}$	B1
(ii)	$\left(\alpha+\frac{1}{\beta}\right)\left(\beta+\frac{1}{\alpha}\right)$ $= \alpha\beta + 2 + \frac{1}{\alpha\beta} = -\frac{5}{3} + 2 + \frac{1}{\left(-\frac{5}{3}\right)}$	Expands to give $\frac{1}{\alpha\beta}+1+1+\alpha\beta$; and uses their value of $\alpha\beta$ at least once in a resulting expression	M1
	$= -\frac{4}{15}$	$-\frac{4}{15}$	A1
			(3)
(b)(i)	$\alpha + \beta = -\frac{p}{3}$	$\alpha + \beta = -\frac{p}{3}$ (may be recovered from (a))	B1
(ii)	$\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right) = \alpha+\beta+\frac{\alpha+\beta}{\alpha\beta}$	Evidence of $\frac{1}{\beta}+\frac{1}{\alpha}$ rewritten as $\frac{\alpha+\beta}{\alpha\beta}$ Can be implied	M1
	$= -\frac{p}{3} + \frac{-\frac{p}{3}}{-\frac{5}{3}}$ or $-\frac{p}{3}+\frac{p}{5}$ or $-\frac{2p}{15}$	$-\frac{p}{3} + \frac{-\frac{p}{3}}{-\frac{5}{3}}$ or $-\frac{p}{3}+\frac{p}{5}$ or $-\frac{2p}{15}$ or an equivalent fraction in terms of p **Note:** You can apply isw	A1
			(3)
(c)	$-\frac{2p}{15} = 2\left(-\frac{4}{15}\right) \Rightarrow p = 4$	Correctly obtains $p = 4$	B1
			(1)
(d)	$\sum = 2\left(-\frac{4}{15}\right) = -\frac{8}{15}$; $\prod = -\frac{4}{15}$		
	$x^2 - -\frac{8}{15}x - \frac{4}{15} = 0$	Valid method for finding (their sum) **and applies** $x^2 - (\text{their sum})x + \text{their product}$ (can be implied), for their numerical values of the sum and product. **Note:** " $=0$ " is not required for this mark **Note:** E.g. Using $(\text{their sum}) = \alpha + \beta = -\frac{p}{3} = -\frac{4}{3}$ is not considered a valid method for finding (their sum)	M1
	$15x^2 + 8x - 4 = 0$	***Any integer multiple*** of $15x^2 + 8x - 4 = 0$, including the " $=0$ "	A1 **cso**
			(2)
			9

Question Number	Scheme	Notes	Marks
(a)(ii) **Way 2**	$\left(\alpha+\frac{1}{\beta}\right)\left(\beta+\frac{1}{\alpha}\right)$ $=\frac{(\alpha\beta+1)(\alpha\beta+1)}{\alpha\beta}=\frac{\left(-\frac{5}{3}+1\right)\left(-\frac{5}{3}+1\right)}{\left(-\frac{5}{3}\right)}=\frac{\frac{4}{9}}{-\frac{5}{3}}$	Expands to give $\frac{(\alpha\beta+1)(\alpha\beta+1)}{\alpha\beta}$ and uses their value of $\alpha\beta$ at least once in a resulting expression	M1
	$=-\frac{4}{15}$	$-\frac{4}{15}$	A1
(b)(ii) **Way 2**	$\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right)$ $=\frac{(\alpha\beta+1)}{\beta}+\frac{(\alpha\beta+1)}{\alpha}=\frac{\alpha^2\beta+\alpha+\alpha\beta^2+\beta}{\alpha\beta}$	Embedded evidence of $\frac{1}{\beta}+\frac{1}{\alpha}$ rewritten as $\frac{\alpha+\beta}{\alpha\beta}$ Can be implied	M1
	$=\frac{\alpha\beta(\alpha+\beta)+\alpha+\beta}{\alpha\beta}$		
	$=\frac{(-\frac{5}{3})(-\frac{p}{3})+(-\frac{p}{3})}{(-\frac{5}{3})}$ or $\frac{\frac{5p}{9}-\frac{p}{3}}{-\frac{5}{3}}$ or $\frac{\frac{2p}{9}}{-\frac{5}{3}}$ or $-\frac{2p}{15}$	Correct expression in terms of p **Note:** You can apply isw	A1

	Question 7 Notes	
7. (d)	**Note**	Valid method for finding (their sum) includes • applying their $p=...$ in (c) to $\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right)=$ their $-\frac{2p}{15}$ found in (b)(ii) • applying $\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right)=2\left(\text{their } -\frac{4}{15} \text{ from (a)(ii)}\right)$
	Note	Defining a quadratic equation $px^2+qx+r=0$ and a correct method leading to $p=15, q=8, r=-4$ without writing a final answer of $15x^2+8x-4=0$ is final M1 A0
	Note	Give M0 for $\sum=-\frac{8}{15}$, $\mathbf{\Pi}=-\frac{4}{15}$ leading to $x^2+\frac{8}{15}-\frac{4}{15}=0$ (without recovery)
	Note	Allow M1 for $\sum=-\frac{8}{15}$, $\mathbf{\Pi}=-\frac{4}{15}$ with $x^2-(\text{sum})x+(\text{product})$ leading to $x^2+\frac{8}{15}-\frac{4}{15}=0$
	Note	Give A1 for $15y^2+8y-4=0$ (i.e. writing their answer completely in another variable)
	Note	$\alpha, \beta=\frac{-2\pm\sqrt{19}}{3}$ and $\alpha+\frac{1}{\beta}, \beta+\frac{1}{\alpha}=\frac{-4\pm2\sqrt{19}}{15}$ may be used in (d) to find the sum and product of $\alpha+\frac{1}{\beta}$ and $\beta+\frac{1}{\alpha}$

	Question 7 Notes Continued	
7.	**ALT**	For finding $\alpha, \beta = \frac{-p+\sqrt{p^2+60}}{6}, \frac{-p-\sqrt{p^2+60}}{6}$
(a) (i)	**Note**	Give B1 for $\alpha, \beta = \frac{-p+\sqrt{p^2+60}}{6}, \frac{-p-\sqrt{p^2+60}}{6}$ and then finding $\alpha\beta = -\frac{5}{3}$ or $-\frac{60}{36}$
(b) (i)	**Note**	Give B1 for $\alpha, \beta = \frac{-p+\sqrt{p^2+60}}{6}, \frac{-p-\sqrt{p^2+60}}{6}$ and then finding $\alpha+\beta = -\frac{p}{3}$
	Note	Allow B1 for writing $\alpha+\beta = \frac{-p+\sqrt{p^2+60}}{6} + \frac{-p-\sqrt{p^2+60}}{6}$
(b)(ii)	**Note**	Allow M1 A1 for writing $\left(\alpha+\frac{1}{\beta}\right)+\left(\beta+\frac{1}{\alpha}\right)$ as $\frac{-p+\sqrt{p^2+60}}{6} + \frac{-p-\sqrt{p^2+60}}{6} + \frac{6}{-p+\sqrt{p^2+60}} + \frac{6}{-p-\sqrt{p^2+60}}$