Q1.

2(i)	$\alpha+2\alpha+4\alpha=-p$	**B1**	Sum of roots.
	$2\alpha^2+4\alpha^2+8\alpha^2=q$	**B1**	Sum of products in pairs.
	$\frac{14\alpha^2}{7\alpha}=-\frac{q}{p}$	**M1**	Combines equations.
	$\Rightarrow 2p\alpha+q=0$	**A1**	Verifies result (AG).
		4	
2(ii)	$8\alpha^3=-r$	**B1**	Product of roots.
	$\Rightarrow r=\frac{q^3}{p^3}\ \Rightarrow p^3r-q^3=0$	**B1**	Verifies result (AG).
		2	

Q2.

1(i)	$y=\frac{1}{x^2}\Rightarrow x=\frac{1}{\sqrt{y}}$	**M1**	Rearranging to make *x* the subject
	$\frac{1}{y\sqrt{y}}+\frac{2}{y}-3=0\Rightarrow\frac{1}{y\sqrt{y}}=3-\frac{2}{y}$	**M1**	Substituting and squaring
	$\Rightarrow 9y^3-12y^2+4y-1=0$ SR **B1** for finding cubic by manipulating roots	**A1**	OE
	Total:	**3**	
1(ii)	$\frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}=\frac{12}{9}$ or $\frac{4}{3}$	**B1FT**	
	Total:	**1**	
1(iii)	$\frac{1}{\alpha^2\beta^2}+\frac{1}{\beta^2\gamma^2}+\frac{1}{\gamma^2\alpha^2}=\frac{4}{9}$	**B1FT**	
	Total:	**1**	

Q3.

4(i)	$\alpha+\beta+\gamma=\frac{3}{2}$ $\alpha\beta+\beta\gamma+\gamma\alpha=2$ $\alpha\beta\gamma=5+\beta+\gamma=$ $\frac{3}{2}\alpha\beta+\beta\gamma+\gamma\alpha=2\alpha\beta\gamma=5$	**B1**	(Can be awarded in (ii) if not seen here) SOI
	$(\alpha+1)(\beta+1)(\gamma+1)=\alpha\beta\gamma+(\alpha\beta+\beta\gamma+\gamma\alpha)+(\alpha+\beta+\gamma)+1$	**M1A1**	Multiply out **and** group for **M1**
	$=5+2+1\frac{1}{2}+1=9\frac{1}{2}$	**A1FT**	Alt method: Let $x=y-1$ **M1** Sub and expand $2y^3-9y^2\ 16y-19=0$ **M1, A1** Product of roots = 19/2 **A1**
		4	
4(ii)	$(\beta+\gamma)(\gamma+\alpha)(\alpha+\beta)=\left(1\frac{1}{2}-\alpha\right)\left(1\frac{1}{2}-\beta\right)\left(1\frac{1}{2}-\gamma\right)$	**M1**	Alt methods: $=(\Sigma\alpha)(\Sigma\alpha\beta)-\alpha\beta\gamma$ or $\Sigma\alpha^2\Sigma\alpha+2\alpha\beta\gamma-\Sigma\alpha^3$
	$=\frac{27}{8}-\frac{9}{4}(\alpha+\beta+\gamma)+\frac{3}{2}(\alpha\beta+\beta\gamma+\gamma\alpha)-\alpha\beta\gamma$	**A1**	
	$=\frac{27}{8}-\frac{9}{4}\times\frac{3}{2}+\frac{3}{2}\times2-5=-2$	**M1A1**	
		4	

Q4.

6(i)	Substitutes $x=\frac{y+1}{3}$	**M1**	Accept substitution of $y=3x-1$ into given equation and derivation of equation in x.
	Obtains the given result	**A1**	AG.
6(ii)	$S_3=2S_1+7\times3$	**M1**	Uses $y^3=2y+7$. Or uses formula for $\Sigma(3\alpha-1)^3$
	$=21$	**A1**	
6(iii)	$S_{-1}=\frac{(3\alpha-1)(3\beta-1)+(3\alpha-1)(3\gamma-1)+(3\beta-1)(3\gamma-1)}{(3\alpha-1)(3\beta-1)(3\gamma-1)}=\frac{-2}{7}$.	**M1 A1**	Award M1A1 if $S_{-1}=-\frac{2}{7}$ written down directly.
	$7S_{-2}=S_1-2S_{-1}$	**M1**	Uses $7y^{-2}=y-2y^{-1}$.
	$S_{-2}=\frac{4}{49}$	**A1**	
	Alt method: $S_{-2}=\Sigma\frac{1}{(3\alpha-1)^2}=\frac{\Sigma(3\alpha-1)^2(3\beta-1)^2}{(3\alpha-1)^2(3\beta-1)^2(3\gamma-1)^2}=$	**M1 A1**	**Alt method**: Finds cubic with roots $\frac{1}{3\alpha-1}$, etc. M1 $7z^3+2z^2-1=0$ A1 Uses $S_2=(S_1)^2-2x\Sigma\alpha\beta$ M1 $=\frac{4}{49}$ A1
	$\frac{(\Sigma(3\alpha-1)(3\beta-1))^2-2(3\alpha-1)(3\beta-1)(3\gamma-1)(\Sigma(3\alpha-1))}{(3\alpha-1)^2(3\beta-1)^2(3\gamma-1)^2}$	**M1**	
	$=\frac{(-2)2-2(7)(0)}{7^2}=\frac{4}{49}$	**A1**	
		8	