Question	Scheme	Marks
8(a)	$\alpha+\beta=\frac{k}{3}$ and $\alpha\beta=-\frac{1}{3}$	B1
	$(\alpha+\beta)^2=\alpha^2+2\alpha\beta+\beta^2 \Rightarrow \alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$	M1
	$\alpha^2+\beta^2=\left(\frac{k}{3}\right)^3-2\left(-\frac{1}{3}\right)=\frac{k^2}{9}+\frac{2}{3}=\frac{k^2+6}{9}$ *	A1 cso [3]
(b)	$\alpha^4+\beta^4=(\alpha^2+\beta^2)^2-2\alpha^2\beta^2$	M1
	$\frac{466}{81}=\left(\frac{k^2+6}{9}\right)^2-2\left(-\frac{1}{3}\right)^2$	M1
	$\frac{466}{81}=\left(\frac{k^2+6}{9}\right)^2-2\left(-\frac{1}{3}\right)^2 \Rightarrow k^4+12k^2-448=0$	M1
	$k^4+12k^2-448=(k^2-16)(k^2+28)=0 \Rightarrow k^2=16 \Rightarrow k=4$	M1A1 [5]
(c)	Sum: $\frac{\alpha^3+\beta}{\beta}+\frac{\beta^3+\alpha}{\alpha}=\frac{\alpha^4+\beta^4+2\alpha\beta}{\alpha\beta}$	M1
	$\frac{\alpha^3+\beta}{\beta}+\frac{\beta^3+\alpha}{\alpha}=\frac{\frac{466}{81}+2\left(-\frac{1}{3}\right)}{-\frac{1}{3}}=-\frac{412}{27}$	A1
	Product: $\left(\frac{\alpha^3+\beta}{\beta}\right)\left(\frac{\beta^3+\alpha}{\alpha}\right)=\frac{\alpha^4+\beta^4+(\alpha\beta)^3+\alpha\beta}{\alpha\beta}$	M1
	$\left(\frac{\alpha^3+\beta}{\beta}\right)\left(\frac{\beta^3+\alpha}{\alpha}\right)=\frac{\frac{466}{81}+\left(-\frac{1}{3}\right)^3+\left(-\frac{1}{3}\right)}{\left(-\frac{1}{3}\right)}=-\frac{436}{27}$	A1
	3TQ: $x^2+\frac{412}{27}x-\frac{436}{27}=0 \Rightarrow 27x^2+412x-436=0$	M1A1 [6]
		Total 14 marks

Question	Scheme	Marks
8(a)	$\alpha+\beta=\frac{k}{3}$ and $\alpha\beta=-\frac{1}{3}$	B1
	For the correct algebra on $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$	M1
	For substituting *their* sum and *their* product to give a simplified expression for $\alpha^2+\beta^2=\left(\frac{k}{3}\right)^3-2\left(-\frac{1}{3}\right)=\frac{k^2}{9}+\frac{2}{3}=\frac{k^2+6}{9}$ *	A1 cso [3]

(b)	For the correct algebra on $\alpha^4+\beta^4=\left(\alpha^2+\beta^2\right)^2-2\alpha^2\beta^2$ Or $\alpha^4+\beta^4=(\alpha+\beta)^4-4\alpha\beta(\alpha^2+\beta^2)-6\alpha^2\beta^2$	M1
	For substituting the values for $\alpha^2+\beta^2$ (in terms of k) and $\alpha\beta$ into their $\alpha^4+\beta^4$ and equating to $\frac{466}{81}$ $\frac{466}{81}=\left(\frac{k^2+6}{9}\right)^2-2\left(-\frac{1}{3}\right)^2$ Or for substituting the values for $\alpha^2+\beta^2$ (in terms of k), $\alpha+\beta$ and $\alpha\beta$ into their $\alpha^4+\beta^4$ and equating to $\frac{466}{81}$	M1
	For forming a simplified quadratic. $\frac{466}{81}=\left(\frac{k^2+6}{9}\right)^2-2\left(-\frac{1}{3}\right)^2 \Rightarrow k^4+12k^2-448=0$ Or for $\left(\frac{k^2+6}{9}\right)^2=\frac{448}{81}$ Their quadratic must come from an attempt at $\alpha^4+\beta^4$	M1
	For solving their quadratic. $k^4+12k^2-448=\left(k^2-16\right)\left(k^2+28\right)=0 \Rightarrow k^2=16 \Rightarrow k=4$ Their quadratic must come from an attempt at $\alpha^4+\beta^4$	M1
	For the correct value of $k=4$ If they give $k=\pm 4$ this is A0	A1 [5]
(c)	For the correct algebra on the sum. $\frac{\alpha^3+\beta}{\beta}+\frac{\beta^3+\alpha}{\alpha}=\frac{\alpha^4+\beta^4+2\alpha\beta}{\alpha\beta}$	M1
	For the correct value of the sum. $\frac{\alpha^3+\beta}{\beta}+\frac{\beta^3+\alpha}{\alpha}=\frac{\frac{466}{81}+2\left(-\frac{1}{3}\right)}{-\frac{1}{3}}=-\frac{412}{27}$	A1
	For the correct algebra on the product. $\left(\frac{\alpha^3+\beta}{\beta}\right)\left(\frac{\beta^3+\alpha}{\alpha}\right)=\frac{\alpha^4+\beta^4+(\alpha\beta)^3+\alpha\beta}{\alpha\beta}$	M1
	For the correct value of the product. $\left(\frac{\alpha^3+\beta}{\beta}\right)\left(\frac{\beta^3+\alpha}{\alpha}\right)=\frac{\frac{466}{81}+\left(-\frac{1}{3}\right)^3+\left(-\frac{1}{3}\right)}{\left(-\frac{1}{3}\right)}=-\frac{436}{27}$	A1
	For the 3TQ from their values of the sum and product (used correctly) [= 0 not required for this mark].	M1