Question Number	Scheme	Notes	Marks
5(a)	$\mathrm{f}(r)=\dfrac{1}{r(r+1)}=\dfrac{1}{r}-\dfrac{1}{r+1}$	Correct partial fractions	**B1**
			(1)
(b)	e.g., $\mathrm{g}(r)=\dfrac{r(r+1)\left(12r^2+k\right)+1}{r(r+1)}=12r^2+k+\dfrac{1}{r(r+1)}\Rightarrow \mathrm{h}(r)=12r^2+k$ * **or** $\mathbf{h(r)=g(r)-f(r)=\frac{12r^4+12r^3+kr^2+kr+1}{r(r+1)}-\frac{1}{r(r+1)}=\frac{r(r+1)(12r^2+k)}{r(r+1)}=12r^2+k}$ Obtains $\mathrm{h}(r)=12r^2+k$ with factorisation seen or via long division. Can follow B0 in (a) - ft their partial fractions if necessary.		**B1***
			(1)
(c)	$\displaystyle\sum_{r=1}^{n}\left(\frac{1}{r}-\frac{1}{r+1}\right)=\frac{1}{1}-\frac{1}{2}+\frac{1}{2}-\frac{1}{3}+\ldots+\frac{1}{n}-\frac{1}{n+1}$	Attempts the differences on the result of (a)	**M1**
	$\displaystyle\sum_{r=1}^{n}\mathrm{g}(r)=12\times\frac{1}{6}n(n+1)(2n+1)+nk+1-\frac{1}{n+1}$	Applies a standard formula on h(r) Fully correct expression	**M1** **A1**
	$\begin{aligned}(n+1)\sum_{r=1}^{n}\mathrm{g}(r)&=2n(n+1)^2(2n+1)+kn(n+1)+n+1-1\\&=2n(2n+1)(n^2+2n+1)+kn^2+kn+n\\&=2n(2n^3+5n^2+4n+1)+kn^2+kn+n\\&=4n^4+10n^3+(k+8)n^2+(k+3)n\end{aligned}$		**ddM1** **A1**
			(5)
(d)	$n(n+2)(4n^2+2n-1)=\{4n^4+2n^3+8n^3\}-n^2+4n^2-2n$ $\Rightarrow k+8=-1+4\Rightarrow k=\ldots\ \{-5\}$ or $k+3=-2\Rightarrow k=\ldots\ \{-5\}$ Either sets their $k+8=-1+4$ or $k+3=-2$ and solves for k		**M1**
	$k=-5$	$k=-5$ only, with no incorrect work	**A1**
			(2)
			Total 9

Further Notes

(b) Other method such as use of long division are possible. Any correct method can score the mark but must be complete – e.g. by long division they must reach remainder 0 to score the mark.

(c)

M1: Uses the difference method with their partial fractions of the correct form (if using their partial fractions they must produce a difference). Implied by a correct expression for their fractions otherwise 3 rows from $r=1,\ 2,\ n-1,\ n$ must be attempted. Note extraction is not required and the rows may be embedded within working for the full summation.

M1: Replaces $\displaystyle\sum_{r=1}^{n}r^2$ with $\dfrac{1}{6}n(n+1)(2n+1)$ or $\displaystyle\sum_{r=1}^{n}k$ with kn

A1: Correct expression for $\displaystyle\sum_{r=1}^{n}\mathrm{g}(r)$

ddM1: Must have scored both previous M marks. Obtains $(n+1)\displaystyle\sum_{r=1}^{n}\mathrm{g}(r)=$ an expanded quartic expression.

A1: Correct expression.

(d)

Alt: M1 substitutes $n = 1$ or other appropriate value to generator and solve an equation in k from setting expressions equal.