1. **Claim:** For all $n \in N$ prove that $\sum_1^n a \cdot r^{n-1} = a \cdot \left(\frac{r^n - 1}{r-1}\right)$

   Let $P(n)$ be the proposition $\sum_1^n a \cdot r^{n-1} = a \cdot \left(\frac{r^n - 1}{r-1}\right)$

   Base Case: for $n = 1$, we have
   LHS

   $$a \cdot r^0 = a$$

   RHS

   $$a \cdot \left(\frac{r^1 - 1}{r - 1}\right) = a$$

   So the LHS = RHS, and we conclude that the Base Case holds.

   Inductive Step: Suppose that $P(n)$ is true. So $P(n+1)$. The LHS becomes

   $$\sum_1^{n+1} a \cdot r^{n-1}$$
   $$= a + a \cdot r + a \cdot r^2 + \cdots + a \cdot r^{n-1} + a \cdot r^n$$
   $$= a \cdot \left(\frac{r^n - 1}{r - 1}\right) + a \cdot r^n$$

   Further Manipulation gives,

   $$a \cdot \left(\frac{r^{n+1} - 1}{r - 1}\right)$$

   which is RHS. Proved.