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## Geometric Series - Proof of the Sum of n terms

For a geometric series:

$$a + ar + ar^2 + ar^3 + \dots + ar^{n-1}$$

The sum of the first  $n$  terms is given by

$$S_n = \frac{a(1-r^n)}{1-r} \quad \text{or} \quad S_n = \frac{a(r^n-1)}{r-1}$$

Proof:

$$\text{Let } S_n = a + ar + ar^2 + ar^3 + \dots + ar^{n-2} + ar^{n-1} \quad (1)$$

$$\therefore rS_n = ar + ar^2 + ar^3 + ar^4 + \dots + ar^{n-1} + ar^n \quad (2)$$

(1) - (2) gives

$$S_n - rS_n = a - ar^n$$

$$\therefore S_n(1-r) = a(1-r^n)$$

$$\therefore S_n = \frac{a(1-r^n)}{1-r}$$

or

$$S_n = \frac{a(1-r^n)}{1-r} \times \frac{(-1)}{(-1)}$$

$$\therefore S_n = \frac{a(r^n-1)}{r-1}$$

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