

# Alternating Series

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## Alternating Series

$$\sum_{n=1}^{\infty} (-1)^n b_n = b_1 - b_2 + b_3 - b_4 \dots$$

If the following is true:

1.  $b_{n+1} \leq b_n \quad \forall \quad n$
2.  $\lim_{n \rightarrow \infty} b_n \rightarrow 0$

Then:

$$\sum_{n=1}^{\infty} (-1)^n b_n \quad \text{converges}$$

### Example 1

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2n+1}$$

$$b_n = \frac{1}{2n+1}$$

$$b_{n+1} \leq b_n \quad \forall \quad n$$

$$\lim_{n \rightarrow \infty} b_n = \lim_{n \rightarrow \infty} \frac{1}{2n+1} = 0$$

Therefore:

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2n+1} \quad \text{converges}$$

## Example 2

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{\ln(n+4)}$$
$$b_n = \frac{1}{\ln(n+4)}$$
$$b_{n+1} \leq b_n \quad \forall n$$
$$\lim_{n \rightarrow \infty} \frac{1}{\ln(n+4)} = 0$$

Therefore:

$$\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{\ln(n+4)} \quad \text{converges}$$

## Example 3

$$\sum_{n=1}^{\infty} (-1)^{n-1} \frac{3n-1}{2n+1}$$
$$b_n = \frac{3n-1}{2n+1}$$
$$\lim_{n \rightarrow \infty} b_n = \frac{3}{2} \neq 0$$

Therefore:

$$\sum_{n=1}^{\infty} (-1)^{n-1} \frac{3n-1}{2n+1} \quad \text{diverges}$$

## Practice Problem 11

$$\sum_{n=1}^{\infty} (-1)^{n-1} \frac{n^2}{n^3+4}$$
$$b_n = \frac{n^2}{n^3+4}$$
$$b_{n+1} \leq b_n \quad \forall n$$
$$\lim_{n \rightarrow \infty} b_n = 0$$

Therefore:

$$\sum_{n=1}^{\infty} (-1)^{n-1} \frac{n^2}{n^3+4} \quad \text{converges}$$

## Left Comparison Test

$$\lim_{n \rightarrow \infty} \frac{a_n}{b_n} = c$$
$$0 < c < \infty$$

Therefore, both sequences either converge or diverge.

You can find all my notes at <http://omgimanerd.tech/notes>. If you have any questions, comments, or concerns, please contact me at [alvin@omgimanerd.tech](mailto:alvin@omgimanerd.tech)