

SERIES CONVERGENCE/DIVERGENCE FLOW CHART

TEST FOR DIVERGENCE

Does $\lim_{n \rightarrow \infty} a_n = 0$?

NO

$\sum a_n$ Diverges

YES

p-SERIES

Does $a_n = 1/n^p, n \geq 1$?

YES

Is $p > 1$?

YES

$\sum a_n$ Converges

NO

$\sum a_n$ Diverges

NO

GEOMETRIC SERIES

Does $a_n = ar^{n-1}, n \geq 1$?

YES

Is $|r| < 1$?

YES

$\sum_{n=1}^{\infty} a_n = \frac{a}{1-r}$

NO

$\sum a_n$ Diverges

NO

ALTERNATING SERIES

Does $a_n = (-1)^n b_n$ or $a_n = (-1)^{n-1} b_n, b_n \geq 0$?

YES

Is $b_{n+1} \leq b_n$ & $\lim_{n \rightarrow \infty} b_n = 0$?

YES

$\sum a_n$ Converges

NO

TELESCOPING SERIES

Do subsequent terms cancel out previous terms in the sum? May have to use partial fractions, properties of logarithms, etc. to put into appropriate form.

YES

Does $\lim_{n \rightarrow \infty} s_n = s$ finite?

YES

$\sum a_n = s$

NO

$\sum a_n$ Diverges

NO

TAYLOR SERIES

Does $a_n = \frac{f^{(n)}(a)}{n!} (x-a)^n$?

YES

Is x in interval of convergence?

YES

$\sum_{n=0}^{\infty} a_n = f(x)$

NO

$\sum a_n$ Diverges

NO

Try one or more of the following tests:

COMPARISON TEST

Pick $\{b_n\}$. Does $\sum b_n$ converge?

YES

Is $0 \leq a_n \leq b_n$?

YES

$\sum a_n$ Converges

NO

Is $0 \leq b_n \leq a_n$?

YES

$\sum a_n$ Diverges

NO

LIMIT COMPARISON TEST

Pick $\{b_n\}$. Does $\lim_{n \rightarrow \infty} \frac{a_n}{b_n} = c > 0$ finite & $a_n, b_n > 0$?

YES

Does $\sum_{n=1}^{\infty} b_n$ converge?

YES

$\sum a_n$ Converges

NO

$\sum a_n$ Diverges

INTEGRAL TEST

Does $a_n = f(n), f(x)$ is continuous, positive & decreasing on $[a, \infty)$?

YES

Does $\int_a^{\infty} f(x) dx$ converge?

YES

$\sum_{n=a}^{\infty} a_n$ Converges

NO

$\sum a_n$ Diverges

RATIO TEST

Is $\lim_{n \rightarrow \infty} |a_{n+1}/a_n| \neq 1$?

YES

Is $\lim_{n \rightarrow \infty} \left| \frac{a_{n+1}}{a_n} \right| < 1$?

YES

$\sum a_n$ Abs. Conv.

NO

$\sum a_n$ Diverges

ROOT TEST

Is $\lim_{n \rightarrow \infty} \sqrt[n]{|a_n|} \neq 1$?

YES

Is $\lim_{n \rightarrow \infty} \sqrt[n]{|a_n|} < 1$?

YES

$\sum a_n$ Abs. Conv.

NO

$\sum a_n$ Diverges

**This chart is missing the test for absolute convergence:

■ If $\sum_{n=1}^{\infty} |a_n|$ converges, then $\sum_{n=1}^{\infty} a_n$ converges absolutely.