

10.4 Integral Test for Convergence

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS integral test 积分判别法 • converges 收敛 • diverges 发散
 • geometric series 几何级数 • harmonic series 调和级数

Objective

Build the skills to answer exam questions on the **integral test** for convergence.

You must be able to:

- check the conditions (positive, decreasing, continuous)
- compare $\sum a_n$ with $\int_1^\infty f(x) dx$
- conclude convergence or divergence from the integral

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The integral test

If $a_n = f(n)$ where f is **positive, decreasing, and continuous** for $x \geq 1$, then $\sum a_n$ and $\int_1^\infty f(x) dx$ **both converge or both diverge**.

■ A worked test

$\sum \frac{1}{n^2}$: with $f(x) = \frac{1}{x^2}$, $\int_1^\infty x^{-2} dx = 1$ (finite). The integral converges, so the **series converges**.

■ A divergent case

$\sum \frac{1}{n}$: $\int_1^\infty \frac{1}{x} dx = \lim_{b \rightarrow \infty} \ln b = \infty$. The integral diverges, so the series diverges.

■ Check the conditions first

The function must be positive and decreasing (eventually). The integral's **value** is not the series' sum — only its convergence matches.

2 Practice

Now apply the methods above.

2.1 State the three conditions on f for the integral test. [2]

2.2 Evaluate $\int_1^\infty \frac{1}{x^2} dx$. [2]

2.3 From 2.2, does $\sum \frac{1}{n^2}$ converge? [1]

3 Exam-style questions

3.1 The integral test compares a series with [1]

A	B
C	D

A a geometric series

B an improper integral of the matching function

C the harmonic series

D a partial sum

3.2 Apply the integral test to $\sum_{n=1}^\infty \frac{1}{n^3}$.

(a) Evaluate $\int_1^\infty \frac{1}{x^3} dx$. [3]

(b) State the conclusion. [1]

3.3 Use the integral test to decide whether $\sum_{n=2}^{\infty} \frac{1}{n \ln n}$ converges. (Use the substitution $u = \ln x$.) [4]