

Techniques of Integration: math practice, College – download the PDF

22 problems graded by difficulty (★ easy, ★★ medium, ★★★ hard). Try first, without looking at the solutions!

1 Parts with cosine



Find $\int x \cos x \, dx$.

2 Parts with sin 2x



Find $\int x \sin 2x \, dx$.

3 Odd power of cosine



Find $\int \cos^3 x \, dx$.

4 Sine times a fourth power



Find $\int \sin x \cos^4 x \, dx$.

5 Simple partial fractions



Find $\int \frac{dx}{x^2 - 4}$.

6 A first improper integral



Evaluate $\int_1^\infty x^{-3} dx$.

7 Pick the technique



Name the most efficient method for each integral (do not compute them).

a. $\int x e^{x^2} dx$

b. $\int x e^{3x} dx$

c. $\int \frac{dx}{x^2 - 9}$

d. $\int \sin^2 x dx$

8 Double parts



Evaluate $\int_0^1 x^2 e^x dx$.

9 Root times logarithm



Evaluate $\int_1^4 \sqrt{x} \ln x dx$.

10 Even powers



Find $\int \sin^2 x \cos^2 x dx$.

11 Area of a quarter disk



Use a trigonometric substitution to evaluate $\int_0^2 \sqrt{4-x^2} dx$, then explain the answer geometrically.

12 Two linear factors



Find $\int \frac{2x+3}{x^2+x-2} dx$.

13 An exponential tail



Evaluate $\int_0^\infty x e^{-3x} dx$.

14 Integral of $\ln x$ near zero

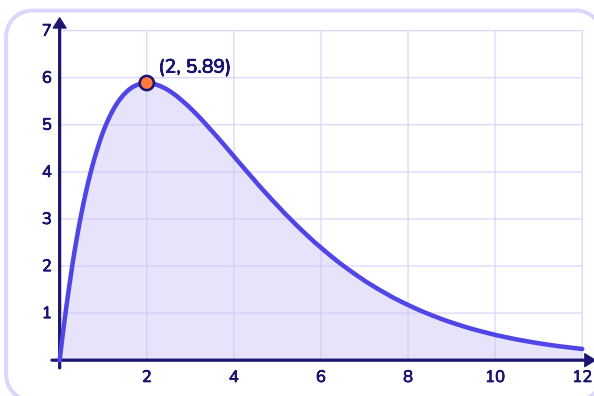


Evaluate $\int_0^1 \ln x dx$. The integrand is unbounded at 0.

15 Drug exposure



After an injection, a drug's concentration in the blood is $C(t) = 8te^{-0.5t}$ mg/L, where t is in hours. The total exposure is $\int_0^\infty C(t) dt$ (in mg·h/L). Compute it.



16 A cycle of exponential and cosine

★★★

Find $\int e^{2x} \cos x \, dx$.

17 Tangent substitution with a square

★★★

Find $\int \frac{dx}{x^2 \sqrt{x^2 + 9}}$.

18 Substitution then parts

★★★

Find $\int x^3 e^{x^2} \, dx$.

19 Partial fractions and a limit

★★★

Show that $\int_1^\infty \frac{dx}{x(x^2 + 1)}$ converges and find its value.

20 Estimating pi

★★★

Since $\int_0^1 \frac{4}{1+x^2} \, dx = \pi$, use $n = 4$ to compute T_4 and S_4 for this integral. Compare each with $\pi \approx 3.14159$.

21 Telescoping improper integral

★★★

Evaluate $\int_1^\infty \frac{dx}{x(x+1)}$, and use the result to explain why $\int_1^\infty \frac{dx}{x^2 + x + 1}$ converges.

22 A slow divergence

★★★

Show that $\int_2^\infty \frac{dx}{x \ln x}$ diverges, even though the integrand tends to 0. Use a substitution.



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