# Integrals of Exponentials and Logs

## Part 1: The rules

Recall that $\frac{d}{dx} e^{u(x)} = u'(x) \cdot e^{u(x)}$. So:

> Integral of an exponential
>
> $$\int u'(x) \cdot e^{u(x)} \, dx = e^{u(x)} + C$$

And recall that $\frac{d}{dx} \ln(u(x)) = \frac{u'(x)}{u(x)}$. So:

> Integral of a logarithm
>
> $$\int \frac{u'(x)}{u(x)} \, dx = \ln|u(x)| + C$$

Question: Why is there an absolute value?

## Part 2: Examples

**Example 1**: $\int 4 e^x \, dx$

**Example 2**: $\int 250\, e^{-\frac{1}{2}x}\, dx$

**Example 3**: $\int \frac{x^3\, dx}{e^4\, x^4}$

**Example 4**: $\int \frac{3x^2}{x^3+4}\, dx$

**Example 5**: $\int \frac{x^2\,dx}{x^3-9}$

**Example 6**: $\int \frac{2\,x^3+x}{x^4+x^2}\,dx$

Not every example will clearly lead to the natural logarithm. Some examples involve creativity. One of these creative approaches is to use polynomial long division.

**Example 7**: $\int \frac{x^3-x^2+1}{x-1} \, dx$

**Example 8**: $\int \frac{x^4-2\,x^2+x}{x^2-2} \, dx$

## Part 3: Review problems

**Example 9**: $\int \left( 3\, x^8 + \frac{4}{x^8} - \frac{5}{\sqrt[5]{x}} \right) d\,x$

**Example 10**: $\int \frac{5\, x^3\, d\,x}{\left( x^4 - 8 \right)^3}$

**Example 11**: $\int \frac{x^2 + 1}{\sqrt{x^3 + 3\, x + 10}}\, d\,x$

**Example 12**: $\int \left( xe^{3x^2} - \frac{5}{e^{\frac{x}{3}}} \right) dx$

**Example 13**: $\int \frac{x+2}{x^2+4x-9} \, dx$

**Example 13**: $\int \frac{x^4-2x^2+x}{x^2-2} \, dx$