Integration by Parts

$$\int u(x)v'(x)dx = u(x)v(x) - \int u'(x)v(x)dx$$

Justification: This method is designed to undo the product rule.

$$\frac{d}{dx}[u(x) \cdot v(x)] = u'(x)v(x) + u(x)v'(x).$$

This means that

$$\int (u'(x)v(x) + u(x)v'(x))dx = u(x)v(x).$$

Using the properties of integrals

$$\int u'(x)v(x)dx + \int u(x)v'(x)dx = u(x)v(x),$$

or

$$\int u(x)v'(x)dx = u(x)v(x) - \int u'(x)v(x)dx$$

Examples: Compute the following indefinite integrals:

- $\int xe^{-x}dx$
- $\int x\sin x dx$
- $\int x\ln x dx$
- $\int x^2e^{-x}dx$
- $\int \ln x dx$
- $\int x(\ln x)^4 dx$
- $\int e^x \sin x dx$
- $\int \cos^2(x) dx$