Integration by parts is a technique for performing indefinite integration $\int u \, dv$ or definite integration $\int_a^b u \, dv$ by expanding the differential of a product of functions $d(uv)$ and expressing the original integral in terms of a known integral $\int v \, du$. A single integration by parts starts with

$$d(uv) = u \, dv + v \, du, \tag{1}$$

and integrates both sides,

$$\int d(uv) = uv = \int u \, dv + \int v \, du. \tag{2}$$

Rearranging gives

$$\int u \, dv = uv - \int v \, du. \tag{3}$$

For example, consider the integral $\int x \cos x \, dx$ and let

$$u = x \quad dv = \cos x \, dx \tag{4}$$
$$du = dx \quad v = \sin x, \tag{5}$$

so integration by parts gives

$$\int x \cos x \, dx = x \sin x - \int \sin x \, dx \tag{6}$$
$$= x \sin x + \cos x + C, \tag{7}$$

where C is a constant of integration.
The procedure does not always succeed, since some choices of u may lead to more complicated integrals than the original. For example, consider again the integral $\int x \cos x \, dx$ and let

$$u = \cos x \quad dv = x \, dx \tag{8}$$
$$du = -\sin x \, dx \quad v = \frac{1}{2} x^2.$$

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