A function $f(x)$ has a derivative function $F(x) = 2x + 2$.
What is $f(x)$?

$f(x) = x^2 + 2x + C$

Integration

An integral is the opposite to a derivative.

Integrating is the opposite operation of differentiating.

$$\text{if} \quad F'(x) = f(x) \quad \text{then} \quad \int f(x)\,dx = F(x) + c.$$

Example #1

Find each of the following:

a) $\int 4x\,dx$

$= 2x^2 + c$

b) $\int (4x^3 - 6x^2 + 11)\,dx$

$= x^4 - 2x^3 + 11x + C$

c) $\int \sqrt{x}dx$

$= \frac{2}{3}x^{\frac{3}{2}} + C$

d) $\int \frac{-1}{3x^2}dx$

$= \frac{1}{3}x^{-1} + C$

$= \frac{1}{3x} + C$

e) $\int 2\sin 2x dx$

$= -\cos 2x + C$

f) $\int e^{3x}dx$

$= \frac{1}{3}e^{3x} + C$

g) $\int \frac{1}{2x-1}dx$

$= \frac{1}{2}\ln|2x-1| + C$

h) $\int \frac{-6}{\sqrt{1-x^2}}dx$

$= \int -6(1-x^2)^{-\frac{1}{2}}dx$

$= -6\arcsin x + C$

or

$6\arccos x + C$

Standard Integrals

$$\int x^n \, dx = \frac{x^{n+1}}{n+1} + C, \; n \neq -1$$

$$\int a^x \, dx = \frac{1}{\ln a} a^x + C$$

$$\int \frac{1}{x} \, dx = \ln |x| + C$$

$$\int \frac{1}{a^2 + x^2} \, dx = \frac{1}{a} \arctan\left(\frac{x}{a}\right) + C$$

$$\int \sin x \, dx = -\cos x + C$$

$$\int \frac{1}{\sqrt{a^2 - x^2}} \, dx = \arcsin\left(\frac{x}{a}\right) + C, \quad |x| < a$$

$$\int \cos x \, dx = \sin x + C$$

$$\int e^x \, dx = e^x + C$$