

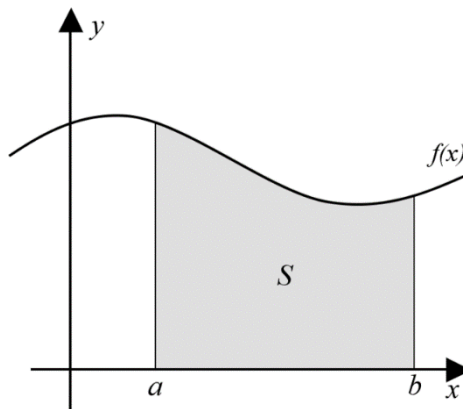
# Definite Integrals, **AREA**, and the Fundamental Theorem of Calculus

*Integrals occur frequently in Engineering, Science and Economics.*

*In these situations, integrals usually appear as **definite integrals**. Definite integrals are integrals with **boundaries**.*

*When we calculate **definite** integrals we are calculating the **area** between a particular function and the x-axis (but only between two boundaries such as **a** and **b** –see diagram below).*

*Determining **areas** is a useful procedure necessary for common calculations in Science, Mathematics and Science.*



Notation of a definite integral:

$$\int_a^b f(x) dx$$

Diagram illustrating the notation of a definite integral with labels:

- Right-hand boundary of area (points to  $b$ )
- Left-hand boundary of area (points to  $a$ )
- Function which we wish to find area under (points to  $f(x)$ )
- Remaining boundary (x or y axis) (points to the  $dx$  term)

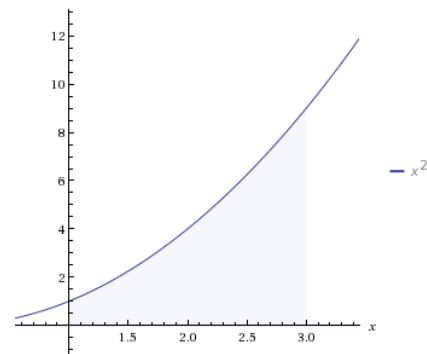
# Fundamental Theorem of Calculus

(how evaluate a **Definite** integral)

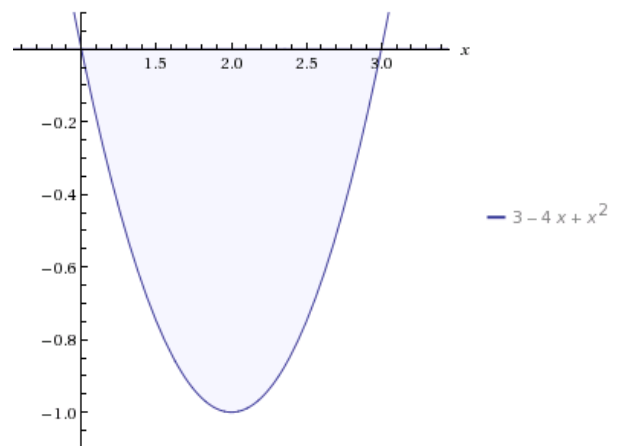
$$\text{Area} \equiv \int_a^b f(x) dx = F(b) - F(a)$$

**IMPORTANT!!!** Capital F indicates:  
Antiderivative of  $f(x)$

**Ex. 1**  $\int_1^3 x^2 dx$

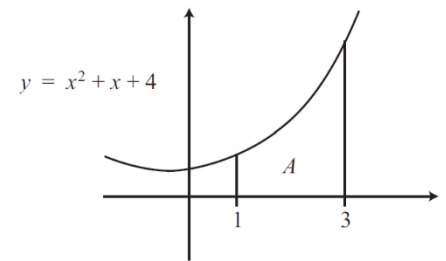


**Ex. 2**  $\int_1^3 x^2 - 4x + 3 dx$



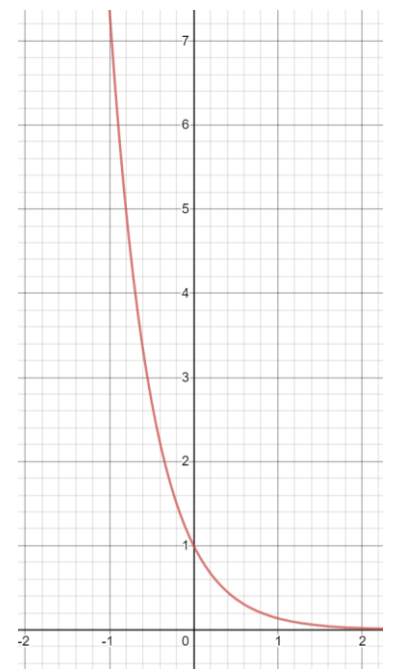
**Ex. 3**

Find the area bounded by the curve  $y = x^2 + x + 4$ , the  $x$ -axis and the ordinates  $x = 1$  and  $x = 3$ .

**Ex. 4**

Find the area expressed by the following definite integral

$$\int_{-1}^1 e^{-2x} dx$$

**Ex. 5**

Find the area expressed by the following definite integral

$$\int_0^\pi \sin\left(\frac{x}{2}\right) dx$$

