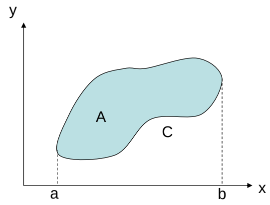
The fundamental theorem of calculus: f = f(x)

$$\int_{x_1}^{x_2} \left(\frac{df}{dx}\right) dx = \int_{x_1}^{x_2} df = f(x_2) - f(x_1)$$

In 1-D only one way to integrate this.

In 2-D infinite paths possible

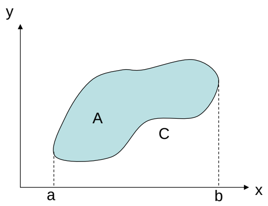
z = z(x,y)



For an exact differential

$$\oint_C dz = \int_a^b dz + \int_b^a dz = \int_a^b dz - \int_a^b dz = 0$$

Green's theorem



$$\oint_C Mdx + Ndy = \iint_A \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right) dxdy$$

In general, the differential *dz = Mdx + Ndy* is '<u>exact</u>' if:

$$1. \frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$$

$$2. \oint_C dz = 0$$

$$3. \int_a^b dz$$ Is path independent

e.g. state variables, P = P(V,T)

Inexact differentials do not satisfy these conditions

e.g. $\bar{d}z = ydx - xdy$

Sum of two inexact differentials can be exact.

<u>Heat:</u> Spontaneous flow of energy caused by the temperature difference between two objects

<u>Work:</u> Any other kind of energy transfer

<u>Internal Energy:</u> Total energy in a system

First law of thermodynamics (in words)

Increase in internal energy = Heat added + work done on the system

$\Delta U = \Delta Q + \Delta W$

(ΔW is the work done ON the system)