\]

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1 | Arc length

$$dr = \sqrt{dx^2 + dy^2}$$

$$= \sqrt{dx^2 + dy^2} \cdot \frac{dx}{dx}$$

$$= \sqrt{\frac{dx^2 + dy^2}{dx^2}} \cdot dx$$

$$= \sqrt{1 + \frac{dy^2}{dx^2}} dx$$

$$= \sqrt{(\frac{dy}{dx})^2 + 1} dx$$

Next, we will integrate to find the arc length as a whole $L(x_0,x_1)=\int_{x_0}^{x_1}dr$

 $= \int_{x_0}^{x_1} \sqrt{(\frac{dy}{dx})^2 + 1} \, dx$

Given that the arc length is of function f:

$$= \int_{x_0}^{x_1} \sqrt{f'x^2 + 1} \, dx$$

In the case of the arc length of $f(x) = x^2$ from 5 to 20:

$$\begin{split} L(5,20) &= \int_5^{20} \sqrt{4x^2 + 1} \, dx \\ &= [\frac{1}{2} \sqrt{4x^2 + 1} x + \sinh^{-1} 2x]_5^{20} \\ &= 375.346 \end{split}$$

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