## 3.3 - Higher Order Derivatives

## Newton Notation

$1^{\text {st }}$ Derivative
$f^{\prime}$ or $y^{\prime}$
$2^{\text {nd }}$ Derivative $f^{\prime \prime}$ or $y^{\prime \prime}$
$3^{\text {rd }}$ Derivative $\quad f^{\prime \prime \prime}$ or $y^{\prime \prime \prime}$
$4^{\text {th }}$ Derivative $\quad f^{(4)}$ or $y^{(4)}$
$\mathrm{N}^{\text {th }}$ Derivative $f^{(n)}$ or $y^{(n)}$

Ex A: Find the first four derivatives of each function. \#1) $f(x)=x^{4}-x^{3}+6 x^{2}-x+1$ (Use Newton)
\#2) $y=3 x^{-1 / 2}$ (Use Newton)

## Leibniz Notation

$1{ }^{\text {st }}$ Derivative $\quad \frac{d y}{d x}$ or $\frac{d}{d x} f$
$2^{\text {nd }}$ Derivative $\frac{d^{2} y}{d x^{2}}$ or $\frac{d^{2}}{d x^{2}} f$
$3^{\text {rd }}$ Derivative $\quad \frac{d^{3} y}{d x^{3}}$ or $\frac{d^{3}}{d x^{3}} f$
$4^{\text {th }}$ Derivative $\quad \frac{d^{4} y}{d x^{4}}$ or $\frac{d^{4}}{d x^{4}} f$
$\mathrm{N}^{\mathrm{th}}$ Derivative $\frac{d^{n} y}{d x^{n}}$ or $\frac{d^{n}}{d x^{n}} f$
\#3) $f(x)=x^{3}-2 x^{2}+6 x-11$ (Use Leibniz)
\#4) $y=\frac{1}{x}$ (Use Leibniz)
\#5) $\left.\frac{d^{2}}{d x^{2}}\left(x^{3}+x^{2}+x-1\right)\right|_{x=1}$

## Derivative Applications

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## G Pop

The population of Gnadenhutten boomed after the arrival of the Gnaden Family Store. The population of the village is predicted to be $p(t)=\frac{t^{2}-1}{10 t+10}$ thousand people, where $t$ is the number of years after the Gnaden Family Store moved to town.
a. Find $p(8)$ and interpret your answer.
b. Find $p^{\prime}(8)$ and interpret your answer.
c. Find $p^{\prime \prime}(8)$ and interpret your answer.

## Chocolate Fever

The temperature of a chocolate bar is $T(x)=\frac{x}{x+1}$ hundred degrees $F$, where $x$ is the seconds after the chocolate was taken out of the freezer and put under someone's armpit.
a. Find $T(1)$ and interpret your answer.
b. Find $T^{\prime}(1)$ and interpret your answer.
c. Find $T^{\prime \prime}(1)$ and interpret your answer.

