Maximum and Minimum Values

If $c$ is a number in the domain of $f(x)$. Then:

1. Global or absolute maximum is $f(c) \geq f(x)$ for all $x$ in the domain.
2. Global or absolute minimum is $f(c) \leq f(x)$ for all $x$ in the domain.

Now if $c$ is a number in the open interval $(a, b)$ also in the domain $f(x)$. Then:

3. Local or relative maximum is $f(c) \geq f(x)$ for all $x$ in $(a, b)$.
4. Local or relative minimum is $f(c) \leq f(x)$ for all $x$ in $(a, b)$.

*Note: Local max/min cannot be endpoints!*

**Example 1**

Identify each point as a local maximum or minimum value, global maximum or minimum value, or none.

![Graph of a function with points labeled A through H and the equation $y = f(x)$]
**First Derivative Test**

Extrema (maximum and minimum values) occur at critical points or at endpoints. A critical point is an $x$ value where $f'(x) = 0$ or where the derivative is undefined (as long as this $x$ value is in the function’s domain).

**Note:** When the problem asks you to find where the extrema are, they’re asking you to find the $x$ values.

When they ask you to find what the extrema are, they’re asking you to find the $y$ values.

**Example 2**

Using the first derivative test, find where the local maximum and minimum values of $f(x) = x^3 - 3x + 1$ occur.
Example 3
Let $f(x) = x^4 - 8x^2 + 16$.
(a) Find all intervals where $f(x)$ is increasing/decreasing.
(b) Find all local extrema.