Extrema

If f is a continuous function on the interval (p, q) and [a, b] is contained in (p, q), then f has a maximum value and a minimum value on [a, b]. These values are called **Absolute Extrema** or **Extrema**.

If c is on (d, e) and f(c) > f(x) for all x in (d, e), then f(c) is a **Relative Maximum**.
If c is on (d, e) and f(c) < f(x) for all x in (d, e), then f(c) is a **Relative Maximum**.

The Derivative of a continuous function at these **Relative Extrema** is either **Zero** or **The Derivaive Does Not Exist**.

If f '(c) = 0, or If f '(c) does not exist on a function that is continuous at c, then c is called a **Critical Number**.

Relative Extrema only occur at **Critical Numbers**.

To find Extrema of f on a closed interval [a, b]:
1. Find the critical values on (a, b). These are values where f ' = 0 or f ' does not exist.
2. Evaluate each f at each critical value.
3. Evaluate f at each endpoint of [a, b].
4. The least of these value is the minimum and the greatest of these values is the maximum.

Find the extrema of $f(x) = 3x^4 - 4x^3$ on [-1, 2].
1. $f'(x) = 12x^3 - 12x^2$ $12x^3 - 12x^2 = 0$ □ $12x^2(x - 1) = 0$ □ $x = 0$ & $x = 1$
   These are the **Critical Values**.
2. f(0) = 0 and f(1) = -1.
3. f(-1) = 7 and f(2) = 16
4. The minimum value is -1 and the maximum value is 16.

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