# Maximum and Minimum Values of a Function

**Ex. 1) For what value of x, $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 5$ has maximum or minimum values.**

**Solution:** Let,

$f(x) = x^4 - 8x^3 + 22x^2 - 24x + 5$ ... ... ... ... ... ... ... ... ... ... ... ... ... ... (i)

$f'(x) = 4x^3 - 24x^2 + 44x - 24$ ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... (ii)

For maximum and minimum values,

$f'(x) = 0$

$\Rightarrow 4x^3 - 24x^2 + 44x - 24 = 0$

$\Rightarrow x^3 - 6x^2 + 11x - 6 = 0$

$\Rightarrow x^3 - x^2 - 5x^2 + 5x + 6x - 6 = 0$

$\Rightarrow x^2(x - 1) - 5x(x - 1) + 6(x - 1) = 0$

$\Rightarrow (x - 1)(x^2 - 5x + 6) = 0$

$\Rightarrow (x - 1)(x - 2)(x - 3) = 0$

$\Rightarrow x = 1,2,3$

**Ex. 2) Find the maximum and minimum values of $f(x) = x^3 - 3x^2 - 45x + 13$.**

**Solution:** Let,

$f(x) = x^3 - 3x^2 - 45x + 13$ ... ... ... ... ... ... ... ... ... ... ... ... ... ... (i)

$f'(x) = 3x^2 - 6x - 45$ ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... (ii)

$f''(x) = 6x - 6$ ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... (iii)

For maximum and minimum values,

$f'(x) = 0$

$3x^2 - 6x - 45 = 0$

$\Rightarrow x^2 - 2x - 15 = 0$

$\Rightarrow (x - 5)(x + 3) = 0$

$\Rightarrow x = 5, -3$

Now,

$f''(x) = 6x - 6$

$\Rightarrow f''(5) = 6.5 - 6 = 24 > 0$; the value is minimum.

The minimum value is,

$f(x) = x^3 - 3x^2 - 45x + 13$

$\Rightarrow f(5) = 5^3 - 3.5^2 - 45.5 + 13 = -162$

And,

$f''(x) = 6x - 6$

$\Rightarrow f''(-3) = 6.(-3) - 6 = -24 < 0$; the value is maximum.

The maximum value is,

$f(x) = x^3 - 3x^2 - 45x + 13$

$\Rightarrow f(-3) = (-3)^3 - 3.(-3)^2 - 45.(-3) + 13 = 94$

**H.W:**

1)Find the maximum and minimum values of $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 5$.

2)Find the maximum and minimum values of $f(x) = 2x^3 - 21x^2 + 36x - 20$.

3)Find the maximum and minimum values of $f(x) = x^5 - 5x^4 + 5x^3 - 1$.

4)Find the maximum and minimum values of $f(x) = 2x^3 - 9x^2 + 12x + 5$