

CLASS 12 MATHEMATICS — FORMULA SHEET

Chapter 6 : Application of Derivatives (NCERT)

6.1 Rate of Change

Concept	Formula
Rate of change	dy/dx = rate of change of y w.r.t. x
Related rates	Differentiate w.r.t. time t (chain rule)
Velocity	$v = ds/dt$
Acceleration	$a = dv/dt = d^2s/dt^2$
Marginal cost	$MC = dC/dx$ (rate of change of cost)
Marginal revenue	$MR = dR/dx$

6.2 Increasing & Decreasing Functions

Concept	Condition
Increasing on interval	$f'(x) > 0$ for all x in the interval
Decreasing on interval	$f'(x) < 0$ for all x in the interval
Strictly increasing	$f'(x) > 0$ (no flat parts)
Strictly decreasing	$f'(x) < 0$
Constant function	$f'(x) = 0$ throughout
Critical points	Where $f'(x) = 0$ or $f'(x)$ does not exist
Method	Find $f'(x)$, set $f'(x)=0$, test sign in each interval

6.3 Tangents & Normals

Concept	Formula
Slope of tangent at (x_1, y_1)	$m = (dy/dx)$ at that point
Equation of tangent	$y - y_1 = m(x - x_1)$
Slope of normal	$-1/m$ (perpendicular to tangent)
Equation of normal	$y - y_1 = (-1/m)(x - x_1)$
Horizontal tangent	$dy/dx = 0$
Vertical tangent	dy/dx is undefined ($dx/dy = 0$)
Tangent parallel to x-axis	Slope = 0

6.4 Maxima & Minima

Concept	Detail
Critical points	Solve $f'(x) = 0$
First derivative test	f' changes $+$ to $- \rightarrow$ maximum ; $-$ to $+$ $\rightarrow$ minimum

Concept	Detail
Second derivative test	$f''(c) < 0 \rightarrow \text{maximum}$; $f''(c) > 0 \rightarrow \text{minimum}$
Point of inflection	$f''(x) = 0$ and sign of f'' changes
Local (relative) extrema	Highest/lowest in a neighbourhood
Absolute extrema	Compare values at critical points AND endpoints
If $f''(c) = 0$	Test fails ; use first derivative test

6.5 Working Rule for Absolute Max/Min

Step	Action
Step 1	Find $f'(x)$ and solve $f'(x) = 0$ for critical points
Step 2	Evaluate f at all critical points in $[a, b]$
Step 3	Evaluate f at the endpoints a and b
Step 4	Largest value = absolute maximum ; smallest = absolute minimum
Optimisation problems	Form the function, differentiate, find the extremum

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Increasing/decreasing	$f'(x) > 0 \rightarrow \text{increasing}$; $f'(x) < 0 \rightarrow \text{decreasing}$. Sign of the derivative tells direction.
Tangent & normal	Tangent slope = dy/dx ; normal slope = $-1/(dy/dx)$ (perpendicular).
First derivative test	f' changes $+$ $\rightarrow$ $-$ = maximum ; $- \rightarrow +$ = minimum.
Second derivative test	$f''(c) < 0 \rightarrow \text{max (cap)}$; $f''(c) > 0 \rightarrow \text{min (cup)}$.
Test fails	If $f''(c) = 0$, fall back to the first derivative test.
Absolute extrema	Always check endpoints too, not just critical points.
Related rates	Differentiate w.r.t. time and link the rates via the chain rule.
Optimisation	Express the quantity as ONE variable, then maximise/minimise.