Achievable

# Derivatives

## AP Calc AB dump sheet

### Limit definition of the derivative

- 1. The derivative, or instantaneous rate of change, of a function $f$ is found by taking the limit of the difference quotient

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

- 2. The derivative of $f$ at point $(a, f(a))$ can also be found with the alternate definition

$$f'(a) = \lim_{x \to a} \frac{f(x) - f(a)}{x - a}$$

### Tangent and normal lines

- The equation of a tangent line to $f(x)$ at $(a, f(a))$ is

$$y = f'(a)(x - a) + f(a)$$

where $f'(a)$ is the slope of the tangent line at $x = a$.

- The equation can also be written in point-slope from:

$$y - y1 = m(x - x1)$$

- The normal line at point, $(a, f(a))$ is perpendicular to the tangent line and has a slope of

$$-\frac{1}{f'(a)}$$

### Basic derivative rules

| | |
|---|---|
| 1. Constant rule ($n$ is a constant) | $\frac{d}{dx}[n] = 0$ |
| 2. Constant multiple rule | $\frac{d}{dx}[nf(x)] = nf'(x)$ |
| 3. Power rule | $\frac{d}{dx}[x^n] = nx^{n-1}$ |
| 4. Product rule | $\frac{d}{dx}[f(x)g(x)] = f(x)g'(x) + f'(x)g(x)$ |
| 5. Quotient rule | $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x) \cdot f'(x) - f(x) \cdot g'(x)}{(g(x))^2}$ |
| 6. Chain rule | $\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x)$ |