APCalc Date:________________
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Unit 2: Differentiation
2.3 Basic Differentiation Rules

Theorem – The Constant Rule

The derivative of a constant function is 0.
ie. if c is a real number then

$$\boxed{\frac{d[c]}{dx} = 0}$$

ex. $f(x) = 3$
*horizontal line with slope 0 – since the derivative is the slope of the function $f'(x) = 0$.

Theorem – The Power Rule

If n is a rational number, then the function x^n is differentiable and

$$\boxed{\frac{d[x^n]}{dx} = nx^{n-1}}$$

ex. $f(x) = x^4$

$$f'(x) = \boxed{4x^3}$$

ex. $y = \frac{1}{x^3}$

rewrite: $y = x^{-3}$

$$\frac{dy}{dx} = -3x^{-4} = \boxed{\frac{-3}{x^4}}$$

ex. $g(x) = \sqrt{x}$

rewrite: $g(x) = x^{1/2}$

$$g'(x) = \frac{1}{2}x^{-1/2} = \boxed{\frac{1}{2\sqrt{x}}}$$

corollary:

$$\boxed{\frac{d[x]}{dx} = 1}$$

proof

if $f(x) = x^1$ then by the power rule $f'(x) = 1x^0 = 1$

Theorem – The Constant Multiple Rule

If $f(x)$ is differentiable and c is a real number then $c \cdot f(x)$ is also differentiable and

$$\boxed{\frac{d[c \cdot f(x)]}{dx} = c \cdot \frac{d[f(x)]}{dx}}$$

ex. $y = 4x^2$

$$\frac{dy}{dx} = \frac{d[4x^2]}{dx} = 4\frac{d[x^2]}{dx} = 4(2x) = \boxed{8x}$$

ie. When applying the power rule, any exponent you "drop" down is multiplied by any existing coefficient.

ex. $f(x) = \frac{x^3}{3}$

$$f'(x) = \frac{3x^2}{3} = \boxed{x^2}$$

Theorem – Sum/Difference Rule

$$\boxed{\frac{d}{dx}[f(x) \pm g(x)] = \frac{d}{dx}[f(x)] \pm \frac{d}{dx}[g(x)]}$$

ie. the derivative of a function made up of a series of terms can be found by differentiating each term in the function separately.

ex. $f(x) = 2x^3 - 4x + 5$

$$f'(x) = \boxed{6x^2 - 4}$$

Derivative of Sine & Cosine

$$\boxed{\frac{d}{dx}[\sin x] = \cos x \qquad \frac{d}{dx}[\cos x] = -\sin x}$$

ex. $y = 5x + 3\cos x$

$$\frac{dy}{dx} = \boxed{5 - 3\sin x}$$

NOTE:

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] \neq \frac{\frac{d}{dx}f(x)}{\frac{d}{dx}g(x)}$$

ex.

$$f(x) = \frac{5x^3 - 3x + 2}{x}$$

rewrite:

$$f(x) = 5x^2 - 3 + 2x^{-1}$$

$$f'(x) = \boxed{10x - \frac{2}{x^2}}$$

Practice Questions

Pg. 110/ # 3 – 16, 23 – 41 odd, 47, 49, 61 – 64