**The Chain Rule**

**w-up:** AP Multiple Choice #4(non-calculator) and #89(calculator)

The Chain Rule is used to differentiate Composite Functions!

**The Chain Rule**

$$\frac{dy}{dx}\left[\, f(g(x))\right] = f'(g(x)) \bullet g'(x)$$

To find derivatives of composite functions:

1) Identify the composite functions as ***inner function***(usually inside parentheses or grouping symbols) and an ***outer function***.

2) Differentiate the *outer function* letting the *inner function* "tag along" as one quantity or expression.

3) Differentiate the *inner function* and multiply by the expression from #2.

EX) Differentiate $\frac{dy}{dx}(2x-1)^4$

1) Inner function is $2x$-1 and outer function is $x^4$

2) $4(2x-1)^3$

3) $4(2x-1)^3 \bullet 2 \quad =$

$8(2x-1)^3$

Reminder: $\sin^2 x$ means $(\sin x)^2$

EX) Find the derivative of each function

A) $f(x)=\sin(2x)$ B) $f(x)=\sin^2 x$ C) $f(x)=\sin^2 2x$

D) $f(x)=\sqrt[3]{x^2+2}$ E) $f(x)=\sqrt{\csc x}$ F) $f(x)=x^2\bullet\sqrt[3]{1-x^2}$

EX) Use calculus and algebra to find the **coordinates** of all points which have horizontal tangent lines to $f(x)$.

$$f(x)=x^2(4x-12)^2$$

Note: Rational Expressions can be differentiated using the quotient rule OR the product rule(denominator written in numerator using negative exponents).

EX) Differentiate $f(x)=\dfrac{x}{\sqrt{x^2+4x}}$