

1. Place your pencil on the graph
2. Trace along the graph...STOP when you are about to hit the point where $x=5$, but you don't actually hit that point (get infinitely close!)
3. What are you about to hit? $\qquad$
4. What is $f(5)=$ $\qquad$
5. Will $\lim _{x \rightarrow a} f(x)$ always be the same value as $f(a)$ ? Can you draw a sketch of a graph in which they are NOT equal?


3 ways to solve a limit:
Tabular
Find $\lim _{x \rightarrow 1} \frac{x^{2}-1}{x-1}$
x approaches 1 from the left $\Rightarrow$
$\Longleftrightarrow$ x approaches 1 from the right

| $x$ | 0.9 | 0.99 | 0.999 | 1 | 1.001 | 1.01 | 1.1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $f(x)$ |  |  |  |  |  |  |  |

## Graphically

## Algebraically



$$
\begin{aligned}
& \lim _{x \rightarrow 2} f(x)= \\
& \lim _{x \rightarrow 0} f(x)= \\
& \lim _{x \rightarrow-1} f(x)=
\end{aligned}
$$

*only works if the function is $\qquad$ or can manipulate function to evaluate

$$
\lim _{x \rightarrow-1} \sqrt{5 x^{2}+4}=
$$

$$
\lim _{x \rightarrow 1} \frac{x^{2}-1}{x-1}=
$$

## One Sided Limits



$$
\begin{aligned}
f(x)= & \frac{x}{|x|} \\
& \lim _{x \rightarrow 0^{-}} f(x)= \\
& \lim _{x \rightarrow 0^{+}} f(x)=
\end{aligned}
$$

## Properties of Limits:

Limits of Sums, Differences, Products, Powers, Roots, and Quotients:

1. Sum Rule

$$
\lim _{x \rightarrow a}[f(x)+g(x)]=
$$

2. Difference Rule

$$
\lim _{x \rightarrow a}[f(x)-g(x)]=
$$

3. Product Rule

$$
\lim _{x \rightarrow a}[f(x) * g(x)]=
$$

4. Constant Multiple Rule

$$
\lim _{x \rightarrow a}[k * f(x)]=
$$

5. Power Rule

$$
\lim _{x \rightarrow a}[f(x)]^{n}=
$$

6. Quotient Rule

$$
\lim _{x \rightarrow a} \frac{f(x)}{g(x)}=
$$

## Sandwich Theorem

Show that $\lim _{x \rightarrow 0} x^{2} \sin x=0$

