Write an equation for the translation of $y = \frac{3}{x}$ that has the given asymptotes.

1. y = 4 and x = -3

$\frac{3}{x+3} + 4$

2. y = 0 and x = 9

no vert trans 9 RT

$y = \frac{3}{x-9}$

3. y = -5 and x = 0

5 down

$y = \frac{3}{x} - 5$

Write the equation of each transformation of the reciprocal function: $y = \frac{1}{x}$

1. 5 units left, twice as tall, branches are in quadrants I and III

$y = \frac{2}{x+5}$

2. 8 units up, half as tall, branches are in quadrants II and IV

$y = \frac{-.5}{x} + 8$

3. 3 units right, 2 units down, branches are in quadrants II and IV

$y = \frac{-1}{x-3} - 2$

You can now finish Hwk #2

Sec 9-2

Practice Sheet.

Due tomorrow

When the denominator of a rational function is zero the function is undefined.

Because this value of x can never be used this leads to a break in the graph (it's not continuous)

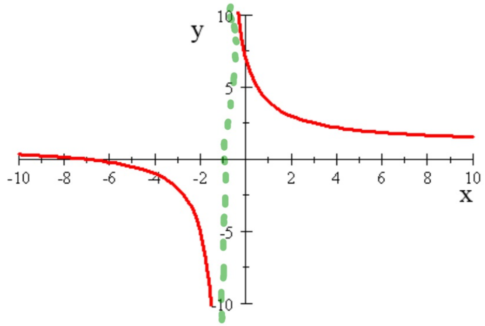
These breaks in the graph are one of two types:

Vertical Asymptotes

Holes

Graph the rational function f(x) in a standard window.

$$f(x) = \frac{x+7}{x+1}$$



There is a break in the graph at x = -1

This kind of break in the graph is called a

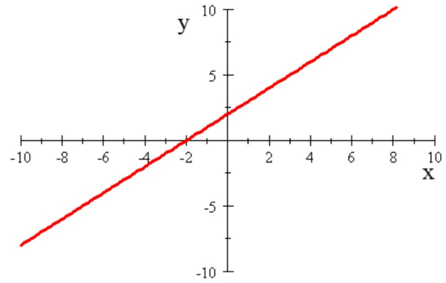
Vertical Asymptote

Graph the rational function f(x) in a standard window.

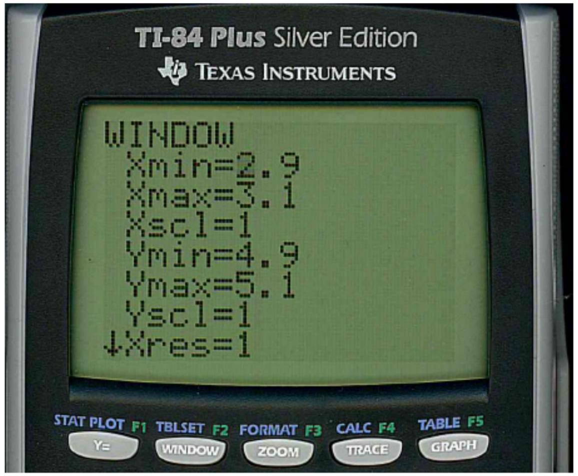
$$f(x) = \frac{(x-3)(x+2)}{(x-3)}$$

Do you see a vertical asymptote?

Why do you think that there isn't a vertical asymptote at x = 3?

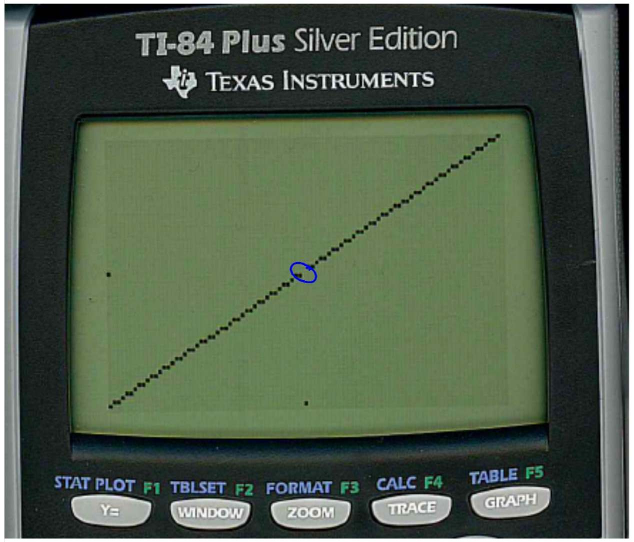


Look at the graph in the following window:



What do you see?

This kind of break in the graph is called a **Hole**



There is a hole in the graph when x=3 because it makes the function undefined.

Why did this graph have a Vertical Asymptote at x = -1

$$f(x) = \frac{x+7}{x+1}$$

and

this graph have a hole at x = 3?

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

$$f(x) = x+2$$

The original equation simplifies to the line y=x+2. This is why the graph looks like a line but has a hole when x=3.

Breaks in the graph are caused by zeros of the denominator and are called:

Points of Discontinuity

Holes or **Vertical Asymptotes**

Holes: Occur at values of x that are zeros of $\boxed{\text{both}}$ the denominator AND numerator

Vertical Asymptotes: Occur at values of x that are zeros of $\boxed{\text{the denominator ONLY.}}$

An exception to this rule:

difference of perfect squares

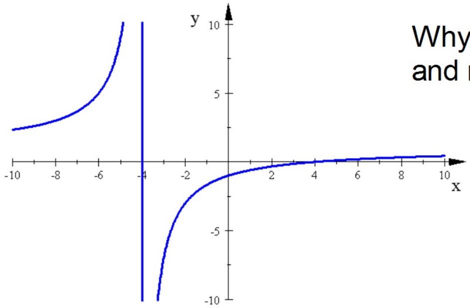
$$y = \frac{x^2-16}{\underbrace{x^2+8x+16}} = \frac{(x+4)(x-4)}{(x+4)(x+4)}$$

16

4 4

8

$$y = \frac{x^2-16}{x^2+8x+16} = \frac{\cancel{(x+4)}(x-4)}{\cancel{(x+4)}(x+4)}$$



Why is there a VA at x=-4 and not a hole?

Even though the factors (x+4) are common to the numerator and denominator, when you cancel them there is still (x+4) left in the denominator.

Properties **Vertical Asymptotes**

The rational function $f(x) = \frac{P(x)}{Q(x)}$ has a point of discontinuity for each real zero of $Q(x)$.

If $P(x)$ and $Q(x)$ have no common real zeros, then the graph of $f(x)$ has a vertical asymptote at each real zero of $Q(x)$.

If $P(x)$ and $Q(x)$ have a common real zero a, then there is a hole in the graph or a vertical asymptote at $x = a$.

Find any points of dicontinuity and classify them as Vertical Asymptotes or Holes.

1. $y = \frac{2x(x+1)(x-6)}{(x-1)(x-6)}$

Pts of Discontinuity: $x = 1, 6$
zeros of the denominator

VA: $x = 1$

Holes: $x = 6$

2. $y = \frac{3x^2 - 6}{x^2 - 4}$ $\quad 3(x^2-2)$ $\quad (x+2)(x-2)$

Pts of Discontinuity: ± 2
zeros of the denominator

VA: $x = 2, -2$

Holes: NONE

3. $y = \frac{x^2 - x - 12}{x^2 - 16}$ $\quad (x-4)(x+3)$ $\quad (x+4)(x-4)$

Pts of Discontinuity:
$x = -4, 4$

VA: $x = -4$

Holes: $x = 4$

4. $y = \frac{x^2 - 10x + 25}{x^2 - 4x - 5}$ $\quad (x-5)(x-5)$ $\quad (x-5)(x+1)$

Pts of Discontinuity:
$x = -1, 5$

VA: $x = -1$

Holes: $x = 5$

5. $y = \frac{2x^2}{x^2 + 3}$

VA:

There are no points of discontinuity because the denominator has no real zeros!

Holes: