11.3 Graphing with Technology.

Take f, where $f(x) = 2x + 5$

Survey of tools...

<u>GeoGebra</u>, <u>Desmos</u>, <u>WolframAlpha</u>, <u>TI-89 or other graphing calc.</u>

Move & Zoom

Find intersection points

Calculate $f(7)$, $f(-2/3)$

Solve equations like $f(x) = 12$...

by introducing "$y = 12$".

Make Tables

<u>Ex</u> $g(x) = 2000x + 5000$.

Find a good viewing window for g.

x... -5 to 5 y... -10000 to 10000

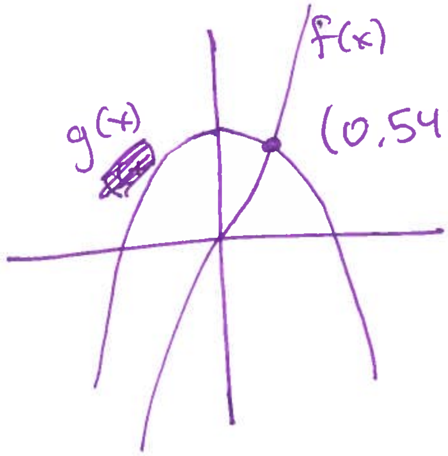
$[-5, 5] \times [-10000, 10000]$

<u>Ex</u> $q(x) = \dfrac{x^3}{100} - 2x + 1$.

Find a good viewing window.

$[-20, 30] \times [-15, 15]$

Ex Solve $\underbrace{x^3+x}_{f(x)=x^3+x} = \underbrace{1-x^2}_{g(x)=1-x^2}$ ... graphically.



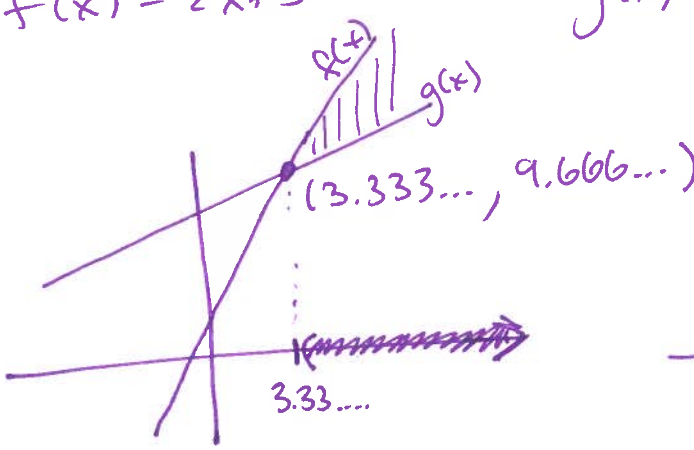
$(0.543689\ldots, 0.7044\ldots)$

Report what x equals... or what x could equal.

The solution set is $\{0.543689\ldots\}$.

$x = 0.54689\ldots$

Ex Solve $\underbrace{2x+3}_{f(x)=2x+3} > \underbrace{\tfrac{1}{2}x+8}_{g(x)=\frac{1}{2}x+8}$



Report x-values

$(3.333\ldots, \infty)$

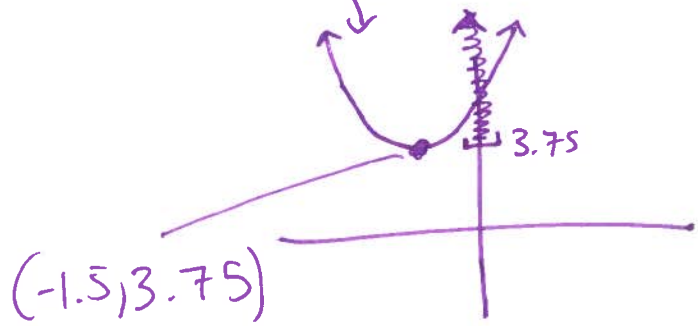
__Ex__ $f(x) = x^2 + 3x + 6$

Find f's domain and range.

$(-\infty, \infty)$

on most functions, need a graph!

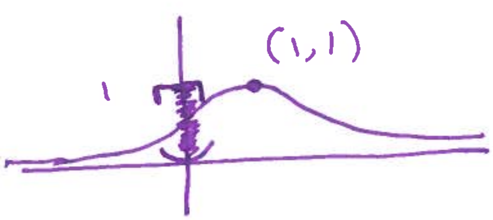
use technology



The range is $[3.75, \infty)$

__Ex__ $g(x) = \dfrac{1}{x^2 - 2x + 2}$

Find g's domain and range using a graph.

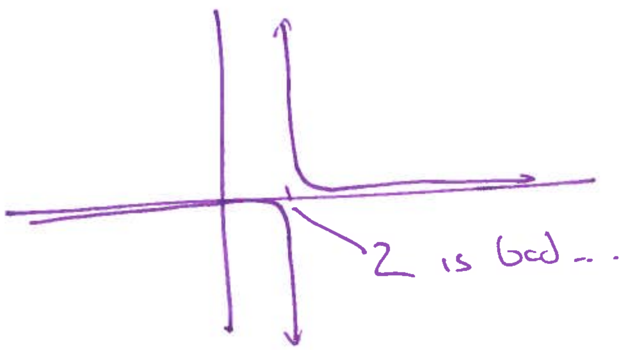


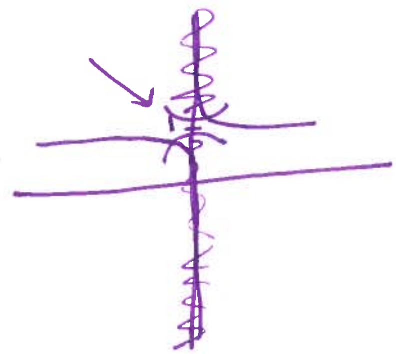
domain is $(-\infty, \infty)$.

The range is $(0, 1]$.

Ex $k(x) = \dfrac{x+3}{x-2}$.

Find k's domain and range, using graphing tech.





$(-\infty, 2) \cup (2, \infty)$ is the domain.

The range is $(-\infty, 1) \cup (1, \infty)$.

Graphing Technology

1. Use graphing technology (a graphing calculator or an app) to find a good viewing window for these functions. There is not just "one" correct answer for a question like this. Any viewing window that shows all of this function's features will work. A good way to write down a viewing window is like this: $[-10, 10] \times [-10, 10]$. The first interval is the visible portion of the *horizontal* axis, and the second interval is the visible portion of the *vertical* axis.

   a) f, where $f(x) = x^3 + 20x^2 - x - 40$

   One good window is

   $[-30, 20] \times [-400, 1400]$

   b) g, where $g(x) = \dfrac{9x + 450}{x - 60}$

   One good window is

   $[-1000, 1000] \times [-50, 50]$

   c) h, where $h(x) = \dfrac{x^{30}}{x^{40} + 1}$

   One good window is

   $[-5, 5] \times [-1, 1]$

   d) k, where $k(x) = \dfrac{1.08^x}{\sqrt{x - 80}}$

   One good window is

   $[-80, 280] \times [-4000, 10000]$

2. Use graphing technology to find the coordinates of all "interesting" points on the graph of these functions. An "interesting" point is a point where the graph crosses one of the axes, or where the graph reaches a high point or a low point. It is OK to round any decimal answers your technology provides you with. We encourage you to round to four significant digits.

   a) q, where $q(x) = x^2 - 5x + 1$

   y-intercept at $(0, 1)$

   x-intercepts at $\approx (0.2087, 0)$

   and $\approx (4.791, 0)$

   low point at $(2.5, -5.25)$

   b) r, where $r(x) = x^3 - x^2$

   y-intercept at $(0, 0)$

   x-intercepts at

   and $(1, 0)$

   low point at $\approx (0.6667, -0.1481)$

   high point at

   c) s, where $s(x) = \dfrac{x}{x^2 + 1}$

   y-intercept at $(0, 0)$

   x-intercept at

   low point at $(-1, -\frac{1}{2})$

   high point at $(1, \frac{1}{2})$

   d) t, where $t(x) = \dfrac{x^2 + 3x - 5}{1.5^x}$

   y-intercept at $(0, -5)$

   x-intercepts at $\approx (-4.193, 0)$

   and $\approx (1.193, 0)$

   low point at $\approx (-2.685, -17.36)$

   high point at $\approx (4.618, 4.64)$

3. Use graphing technology to solve these equations. Find all of the solutions. It is OK to round any decimal answers your technology provides you with. We encourage you to round to four significant digits.

a) $x = x^2 - 3x - 8$

$x \approx -1.464$ or $x \approx 5.464$

b) $\frac{1}{x} = \sqrt{x+2}$

$x \approx 0.618$

c) $x^3 = \frac{1}{x^2+1}$

$x \approx 0.8376$

d) $5 - 0.2x^2 = \cos(x)$

("cos" is a function from trigonometry. Don't worry if you are unfamiliar with it. Just use your technology's ability to plot and solve with it.)

$x \approx -4.904$ or $x \approx 4.904$

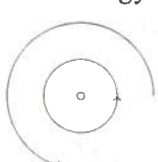
4. Use graphing technology to solve the inequality $x^2 - 3x < x + 1$. Express the solution set using interval notation. It is OK to round any decimal answers your technology provides you with. We encourage you to round to four significant digits.

The solution set is, rounding... $(-0.2361, 4.236)$.

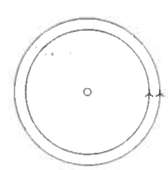
5. Normally if you place something in orbit around the sun and you put it closer to the sun than the Earth, it travels faster than Earth and takes less than a year to go around one time. The image on the left illustrates this.

There is a special point in space between the Earth and the sun where you could place a satellite and something special would happen. The pull of gravity from Earth would partly cancel out the pull of gravity from the sun, and the satellite would take exactly one year to go around, just like the Earth does. The satellite would permanently be directly between the Earth and sun. The image on the right illustrates this.

When physicists factor in the mass of the sun and the Earth, it leads to the following equation. The solution to this equation is how far away from the Earth the satellite should be placed, in millions of kilometers, so that it always stays directly between the Earth and the sun. Use technology to solve the equation and find how far should the satellite be placed.



$$\frac{1000000}{(147.45 - x)^2} - \frac{1000000}{147.45^2} = \frac{1}{0.333054x^2} - 0.312x$$



$x \approx 1.47$

The satellite should be placed 1.47 million km away from Earth toward the sun.