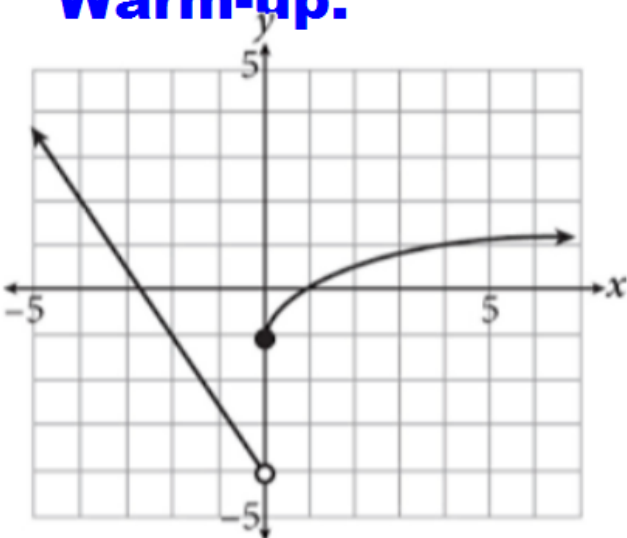


Warm-up:

4) Given that $P(x) = (2x^3 + kx^2 + 7x - 1)$ and when divided by $(x - 2)$ has a remainder of 1. What is the remainder when $P(x)$ is divided by $(x + 2)$?

- 1) Find the minimum.**
- 2) Find the end behavior.**
- 3) Find the domain and range.**

SWBAT find all roots

Agenda

Warm-up

Finding all roots notes

Practice

Finding ALL roots of a polynomial

1. Graph the equation
2. Find one root to use
3. Use synthetic division to find a lower degree polynomial.
4. Continue until you have a quadratic.
5. Solve the quadratic.
6. List all roots.

Find all roots

$$y = x^3 - x^2 + 4x - 4$$

1. Graph
2. Find a root
3. Synthetic Division
4. Get quadratic
5. Solve
6. List all roots

Find all roots

$$**y = x^3 - 18x + 27**$$

Find all roots

$$**y = x^3 - 6x^2 + 13x - 10**$$

Find all roots

$$y = x^4 - 5x^2 - 36$$

Practice. Find all roots

1) $x^3 - 5x^2 + 17x - 13$

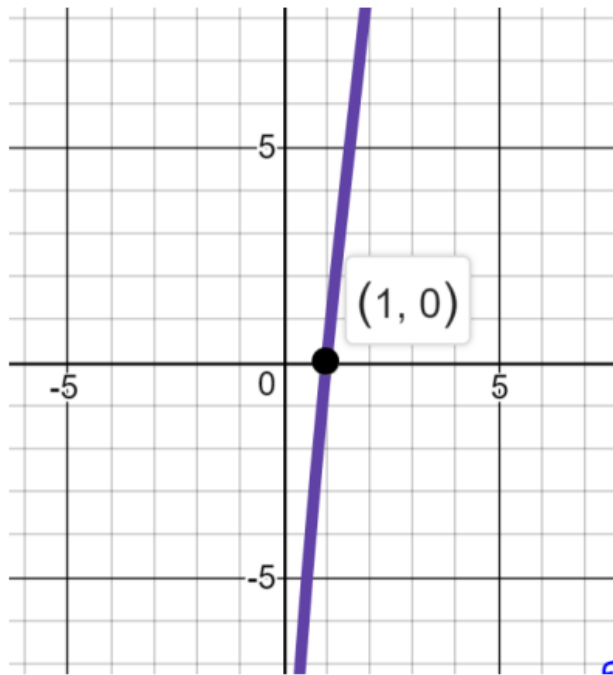
2) $x^3 - 8x^2 - 200$

3) $x^4 - 7x^2 + 12$

4) $9x^4 + 5x^2 - 4$

$$x^3 - 5x^2 + 17x - 13$$

Roots: $1, 2 \pm 3i$

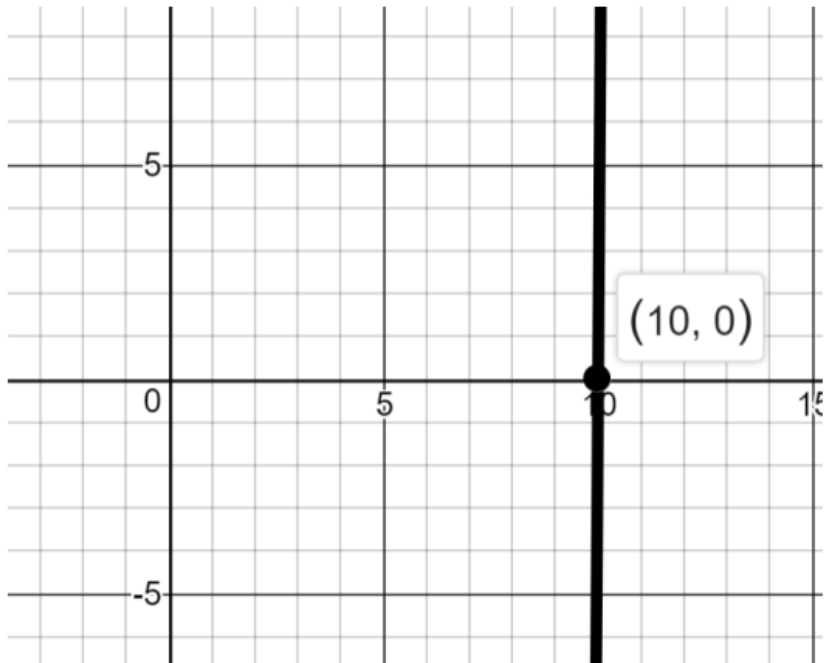


$$\begin{array}{r} \underline{\underline{1}} \quad 1 \quad -5 \quad 17 \quad -13 \\ \quad \quad 1 \quad -4 \quad 13 \\ \hline 1 \quad -4 \quad 13 \quad 0 \end{array}$$

$$x = \frac{4 \pm \sqrt{(-4)^2 - 4(1)(13)}}{2} = \frac{4 \pm \sqrt{-36}}{2}$$

$$x = \frac{4 \pm 6i}{2} = 2 \pm 3i$$

$$x^3 - 8x^2 - 200$$



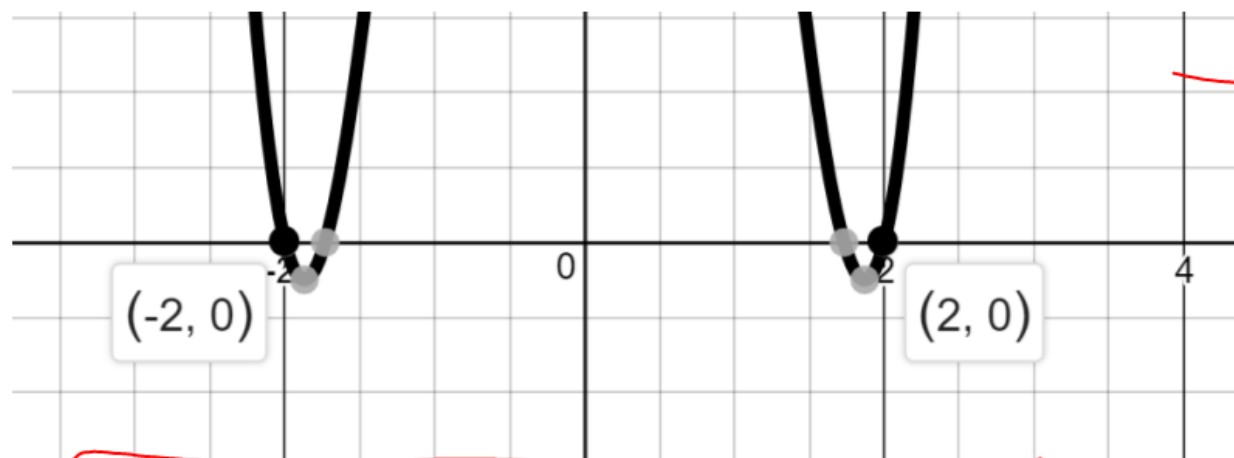
$$\begin{array}{r|rrrr} 10 & 1 & -8 & 0 & -200 \\ & & 10 & 20 & 200 \\ \hline & 1 & 2 & 20 & 0 \end{array}$$

$$X = \frac{-2 \pm \sqrt{4 - 4(1)(20)}}{2} = \frac{-2 \pm \sqrt{-76}}{2}$$

$$= \frac{-2 \pm 2i\sqrt{19}}{2} = -1 \pm i\sqrt{19}$$

Roots: $10, -1 \pm i\sqrt{19}$

$$x^4 - 7x^2 + 12$$



Roots: $\pm 2, \pm\sqrt{3}$

$$\begin{array}{r} -2 \overline{) 1 \ 0 \ -7 \ 0 \ 12} \\ \underline{-2 \ 4 \ 6 \ -12} \\ 1 \ -2 \ -3 \ 6 \ 0 \end{array}$$

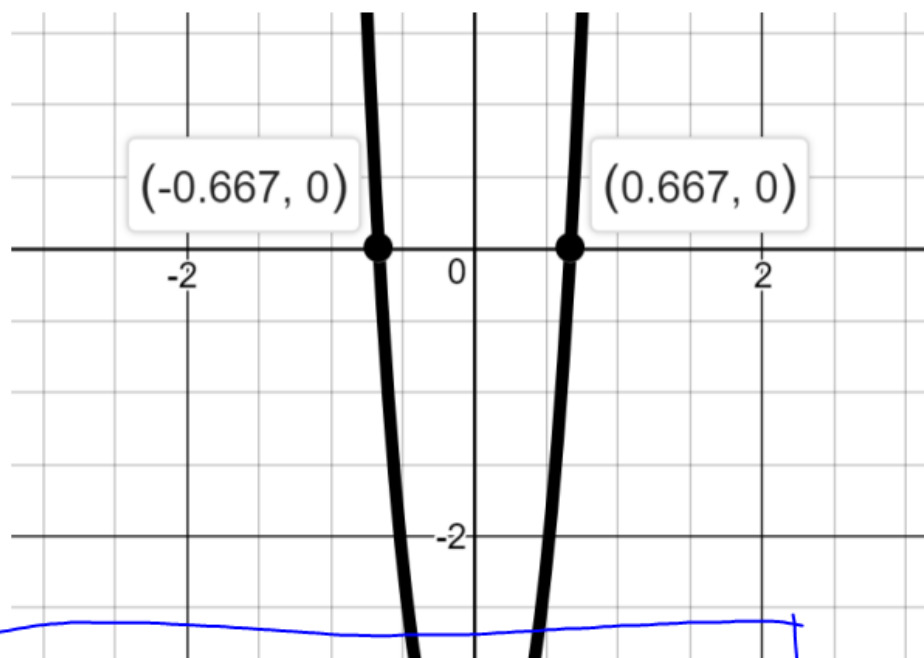
$$\begin{array}{r} 2 \overline{) 1 \ -2 \ -3 \ 6 \ 0} \\ \underline{2 \ 0 \ 6} \\ 1 \ 0 \ -3 \ 0 \end{array}$$

$$x^2 - 3 = 0$$

$$x^2 = 3$$

$$x = \pm\sqrt{3}$$

$$9x^4 + 5x^2 - 4$$



Roots: $\pm \frac{2}{3}, \pm i$

$$-\frac{2}{3} \overline{) \begin{array}{r} 9 \ 0 \ 5 \ 0 \ -4 \\ -6 \ 4 \ -6 \ 4 \\ \hline \end{array}}$$

$$\frac{2}{3} \overline{) \begin{array}{r} 9 \ -6 \ 9 \ -6 \ 0 \\ 6 \ 0 \ 6 \\ \hline \end{array}}$$

$$\begin{array}{r} 6 \ 0 \ 6 \\ \hline 9 \ 0 \ 9 \ 0 \end{array}$$

$$9x^2 + 9 = 0$$

$$9x^2 = -9$$

$$x^2 = -1$$

$$x = \pm i$$