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**(Sections 2.1-2.4)**

# Pros and Cons of Graphing Calculators

- Pro: Graphing calculators can plot lots of points quickly.
  - This can give us a good idea of the shape of a graph.
  - They can do graphical calculations quickly
- Con: Graphing calculators do not know mathematics.
  - They can miss the subtelties of a graph.
  - They can produce incorrect graphs.
  - At best, they can provide approximations.
  - You always need to be smarter than your calculator.

# Connecting the Dots. Is This Always a Good Plan?

- Graphing calculators usually work by plotting lots of points and connecting the dots.
- This is how students first learn to sketch graphs.
- This works pretty well if the graph is what you will call *continuous* in your Calculus class.
- This will not work well at all if there are breaks or *discontinuities* in the graph.

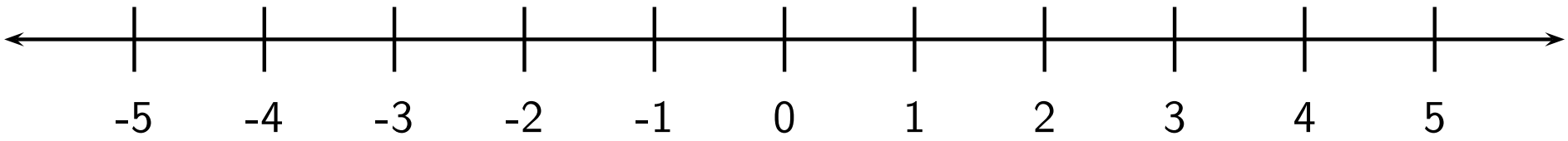
# Connecting the Dots. Is This Always a Good Plan?

Recall:

**Definition 1**

$[\![x]\!]$ is the **greatest integer** less than or equal to $x$.

For example $[\![2.5]\!] = 2$, $[\![-2.5]\!] = -3$, $[\![2]\!] = 2$, and $[\![-2]\!] = -2$.



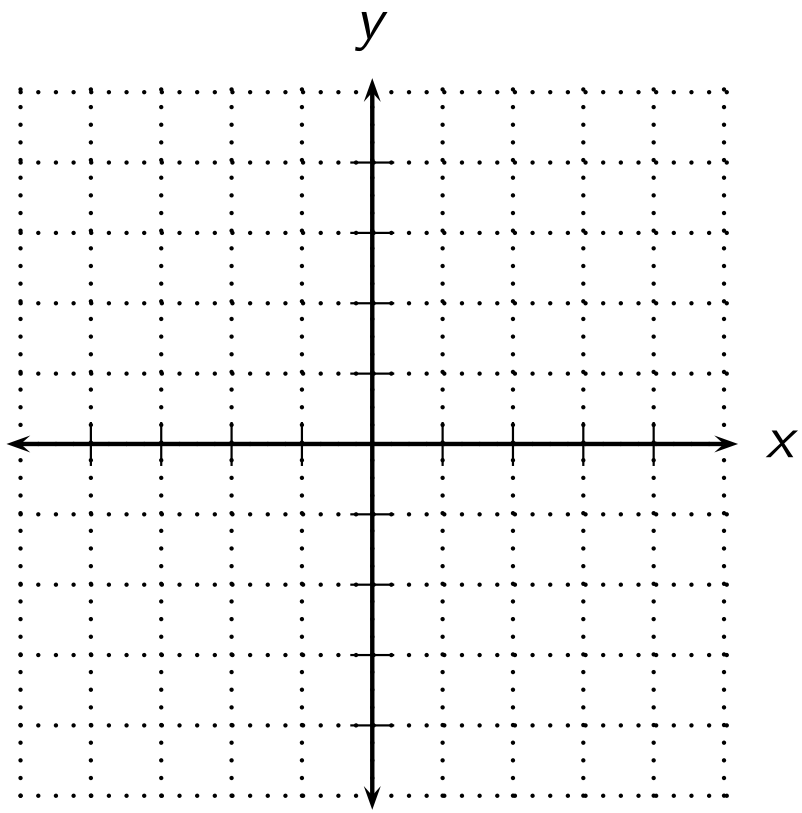
# Connecting the Dots. Is This Always a Good Plan?

## Example 2 (Plotting Points Can Lead to Errors)

Sketch the graph of $y = [\![x]\!]$.

Some solution points:

| $x$ | $y$ | Solution Point |
|---|---|---|
| | | |




Should we connect the dots to obtain the graph of $y = [\![x]\!]$? Explain.

# Basic Instructions for the Graphing Calculator

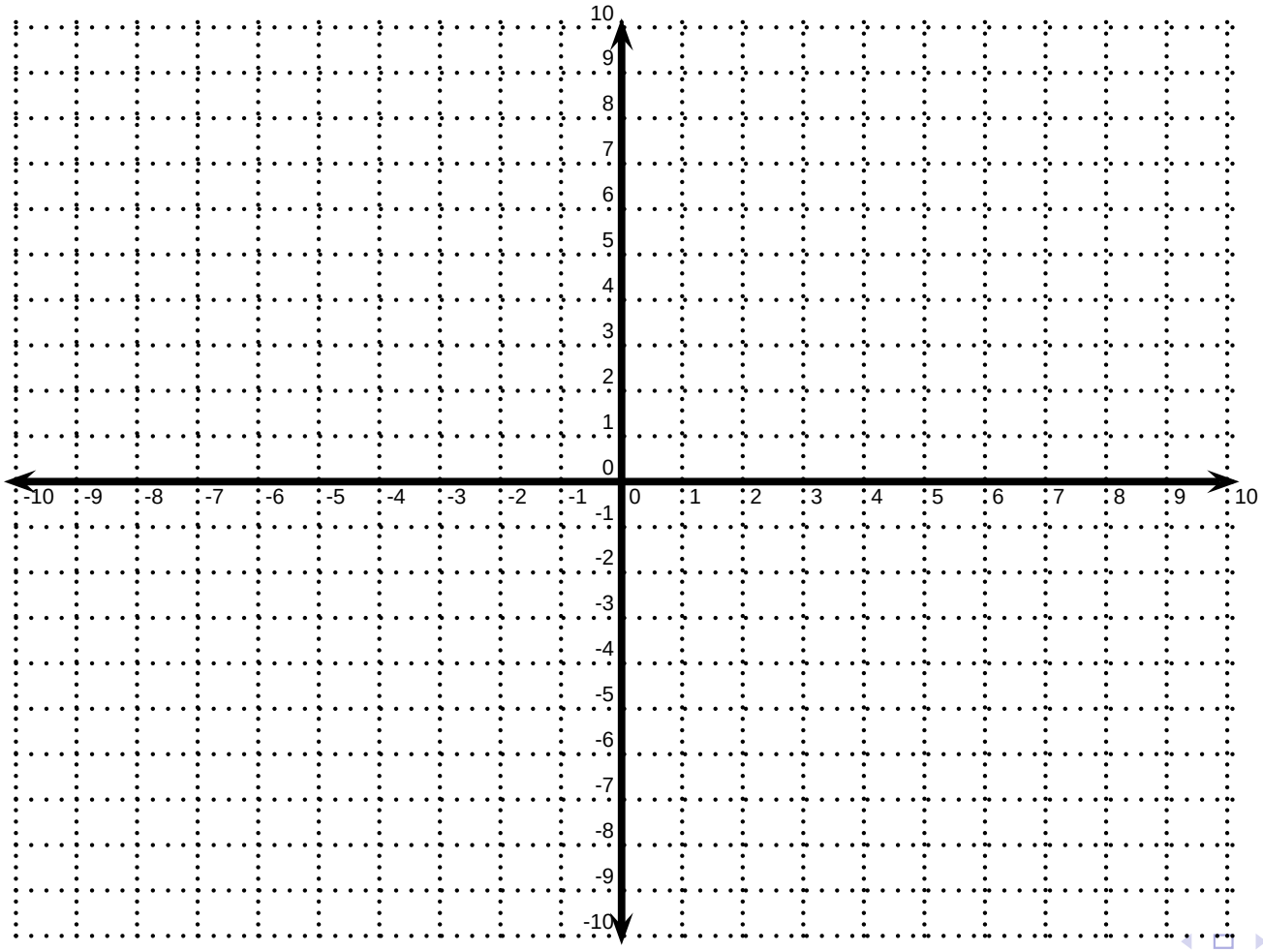
In order to see an approximate graph of an equation in the variables $x$ and $y$, you need to:

1. Solve the equation for $y$ in terms of $x$.
2. Hit $\boxed{y =}$ on your calculator.
3. Enter the equation you wish to graph. You should use the $\boxed{X, T, \theta, n}$ key for $X$.
4. Hit the $\boxed{\text{GRAPH}}$ key.

# Graphing Calculator Examples

## Example 3 (A Basic Example)

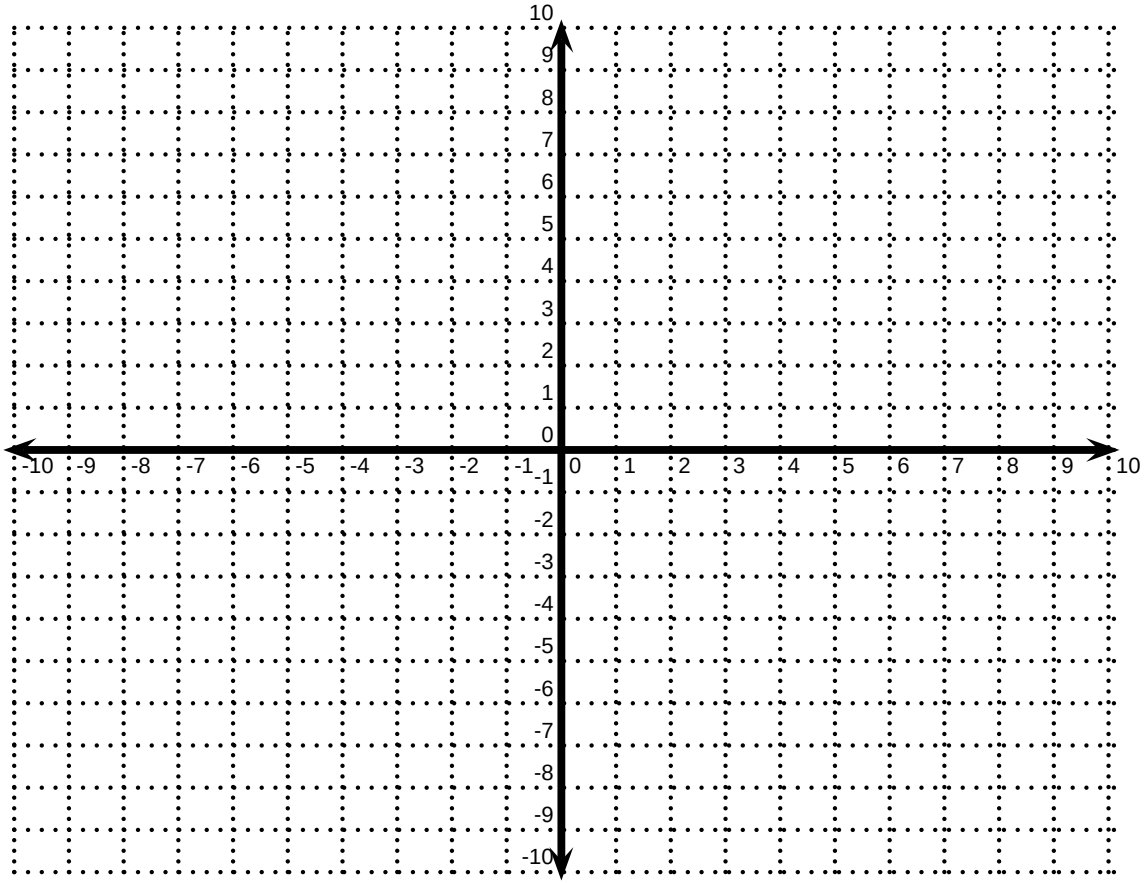
Sketch the graph of $y = x^5 + 3x^2 + 1$.



# Graphing Calculator Examples

## Example 4 (Changing the Viewing Window)

Sketch the graph of $y = 100\sqrt[5]{x}$




Why is this not a great picture?

# Graphing Calculator Examples

## Seeing the Coordinates of Points on a Graph

There are two options for seeing points on the graph.

1. Looking at values in a table.
   - 1.1 Hit [2nd] TABLE. (TABLE is above the [GRAPH] key.)
   - 1.2 Use the UP and DOWN arrows to see some of the solution points.
   - 1.3 The default for TABLE is to start at $x = 0$ and to change or increment the $x$ value by 1 unit at each step. This can be modified by hitting [2nd] TBLSET. (TBLSET is above the [WINDOW] key.) Then you can modify TblStart and $\Delta$Tbl to change the initial $x$ value and the increment value, respectively.
2. Looking at points along the graph.
   - 2.1 Hit [TRACE]
   - 2.2 Use the right and left arrow keys to move along a graph.
   - 2.3 Use the up and down arrow keys to move from one graph to a different graph.

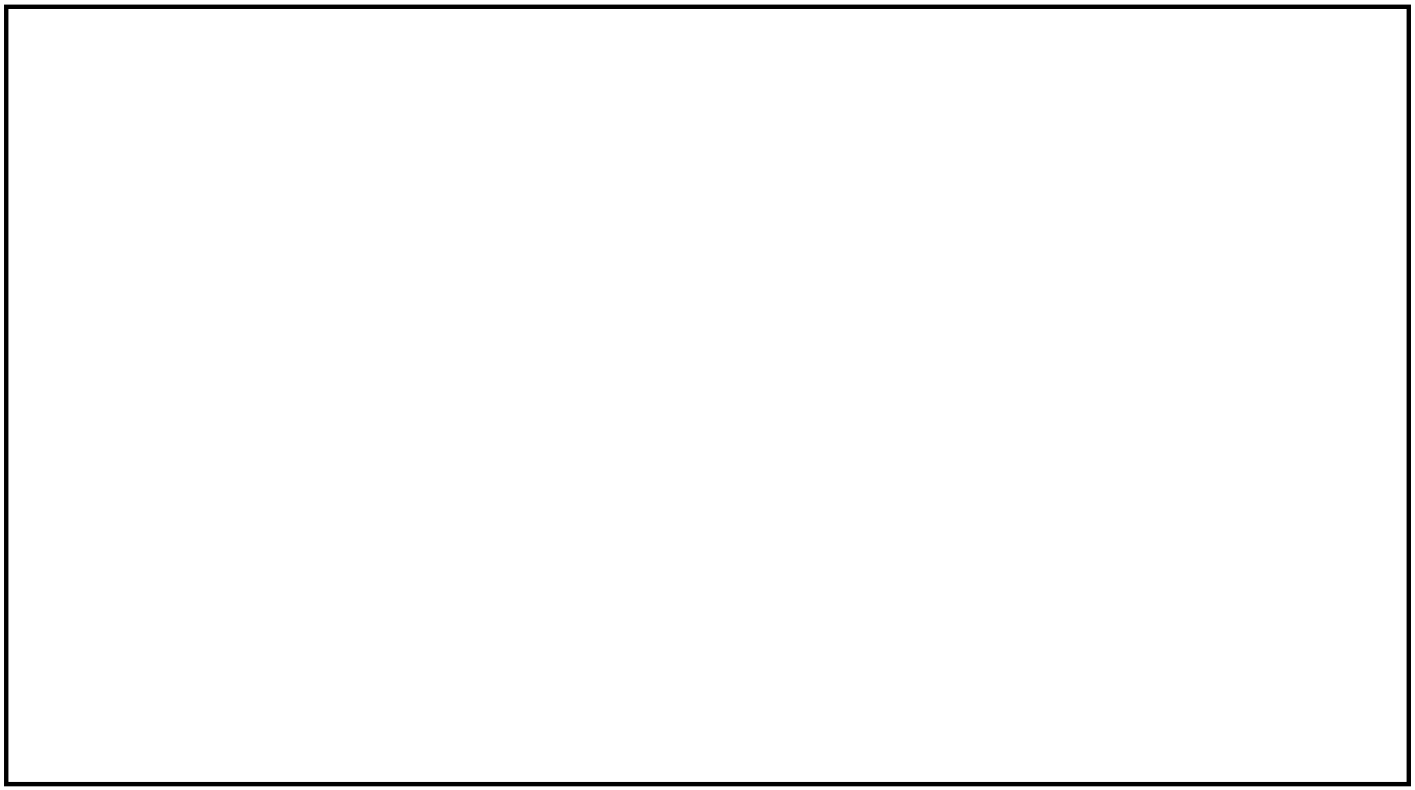
# Graphing Calculator Examples

**Changing the Viewing Window.**

1. Hit the WINDOW key.
2. Change the following values as necessary.
   - 2.1 Xmin
   - 2.2 Xmax
   - 2.3 Xscl
   - 2.4 Ymin
   - 2.5 Ymax
   - 2.6 Yscl
3. To exit, hit 2nd QUIT. (QUIT is above the MODE key.)

# Graphing Calculator Examples

A better graph:



When you sketch a graph in this class, **ALWAYS LABEL THE VIEWING WINDOW**.

# Graphing Calculator Examples

## Example 5 (Graphing Circles)

Sketch the graph of $(x+1)^2 + y^2 = 4$.

Should you be using technology to sketch this graph? Explain.

What do you need to enter into the calculator to sketch this graph?

# Graphing Calculator Examples

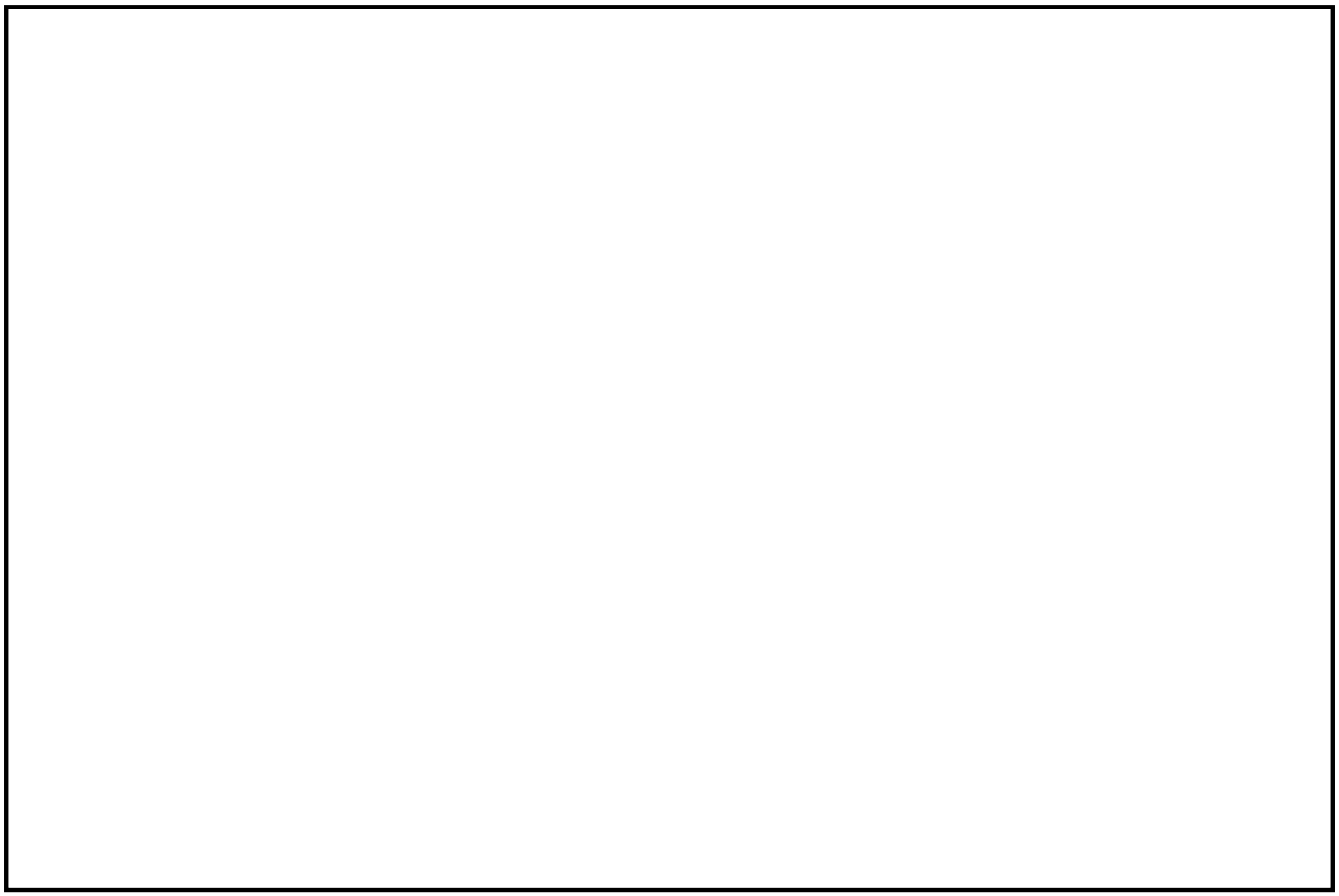
Let's see what goes wrong when we use technology to sketch this graph.

We will first look at this graph in a standard viewing window ($x \in [-10, 10]$, $y \in [-10, 10]$). We know that we can return to a standard viewing window by changing the viewing window. There is another alternative that is faster.

**The Standard Viewing Window:**
To return to the standard viewing window ($x \in [-10, 10]$, $y \in [-10, 10]$), you can:

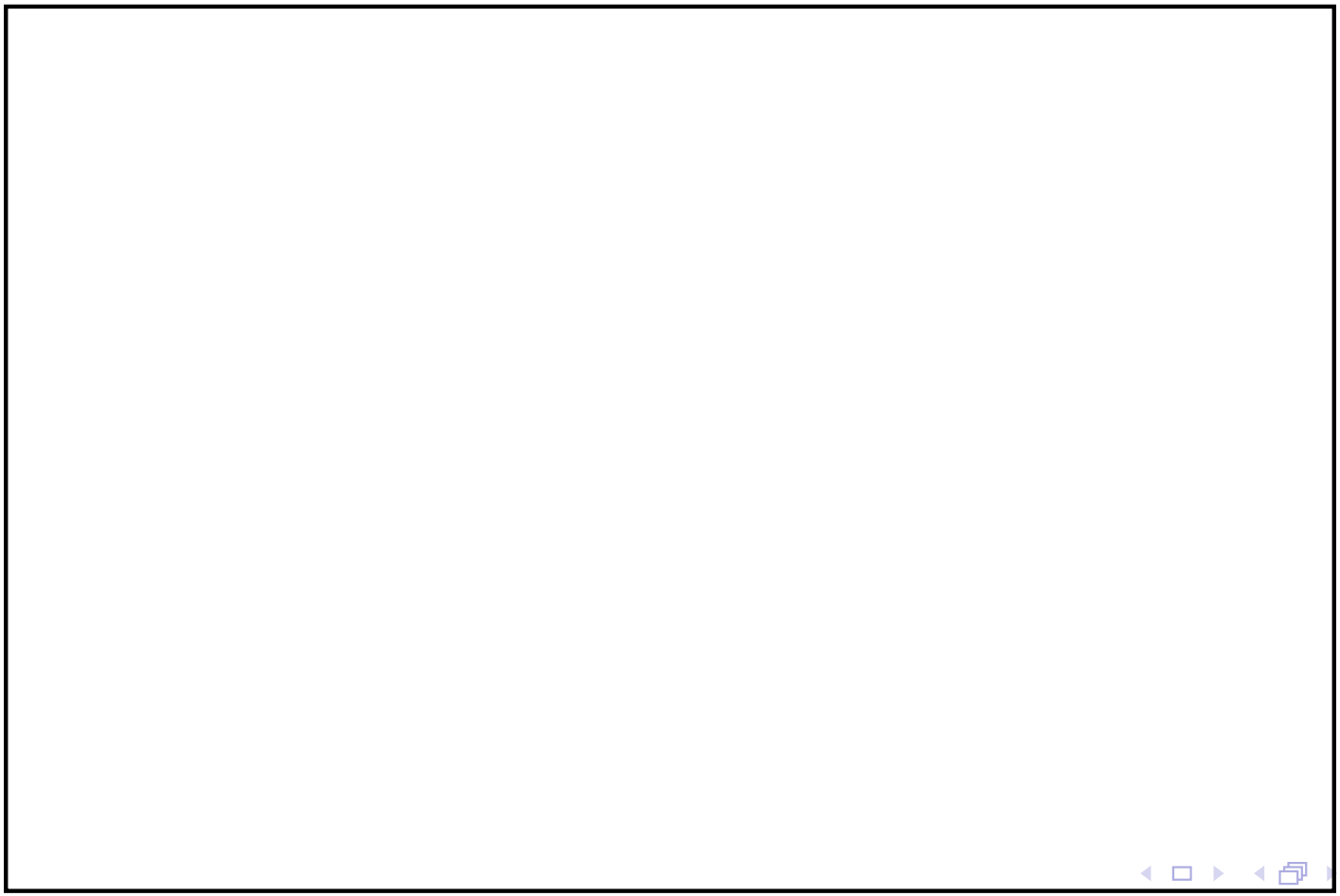
- follow the procedure to change the viewing window OR
- Hit ZOOM. Use the arrow keys to select ZStandard. Hit ENTER.

# Graphing Calculator Examples



# Graphing Calculator Examples

Sketch the graph after you hit ZOOM →ZSquare. Use the Window key to find the new viewing window of the graph. What is the approximate ratio of the width of the screen to the height of the screen?



# The ZOOM Key

To use the ZBox feature:

1. Hit [ZOOM].
2. Select ZBox.
3. Use the arrow keys to position the cursor at one corner of the rectangle.
4. Hit [ENTER].
5. Use the arrow keys to position the cursor at the opposite corner of the rectangle.
6. Hit [ENTER].

The [ZOOM] key has several other features including Zoom In and Zoom Out. You should experiment with these to see how they work.

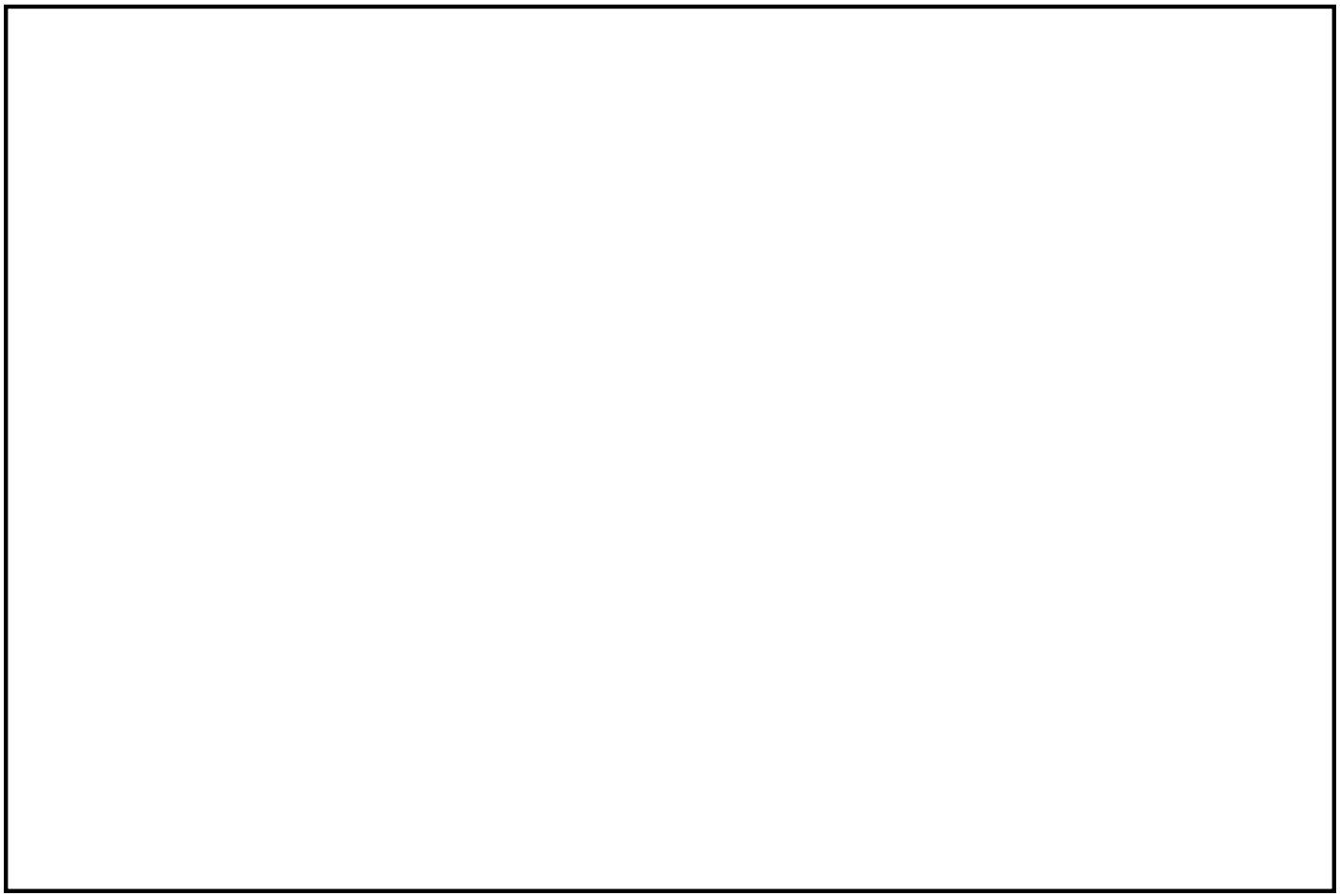
# Graphing Calculator Examples

## Example 6 (What can go wrong?)

Sketch the graph of $y = \dfrac{1}{x+4}$.

# Graphing Calculator Examples

Let's see what goes wrong when we use technology to sketch this graph.



# Graphing Calculator Examples

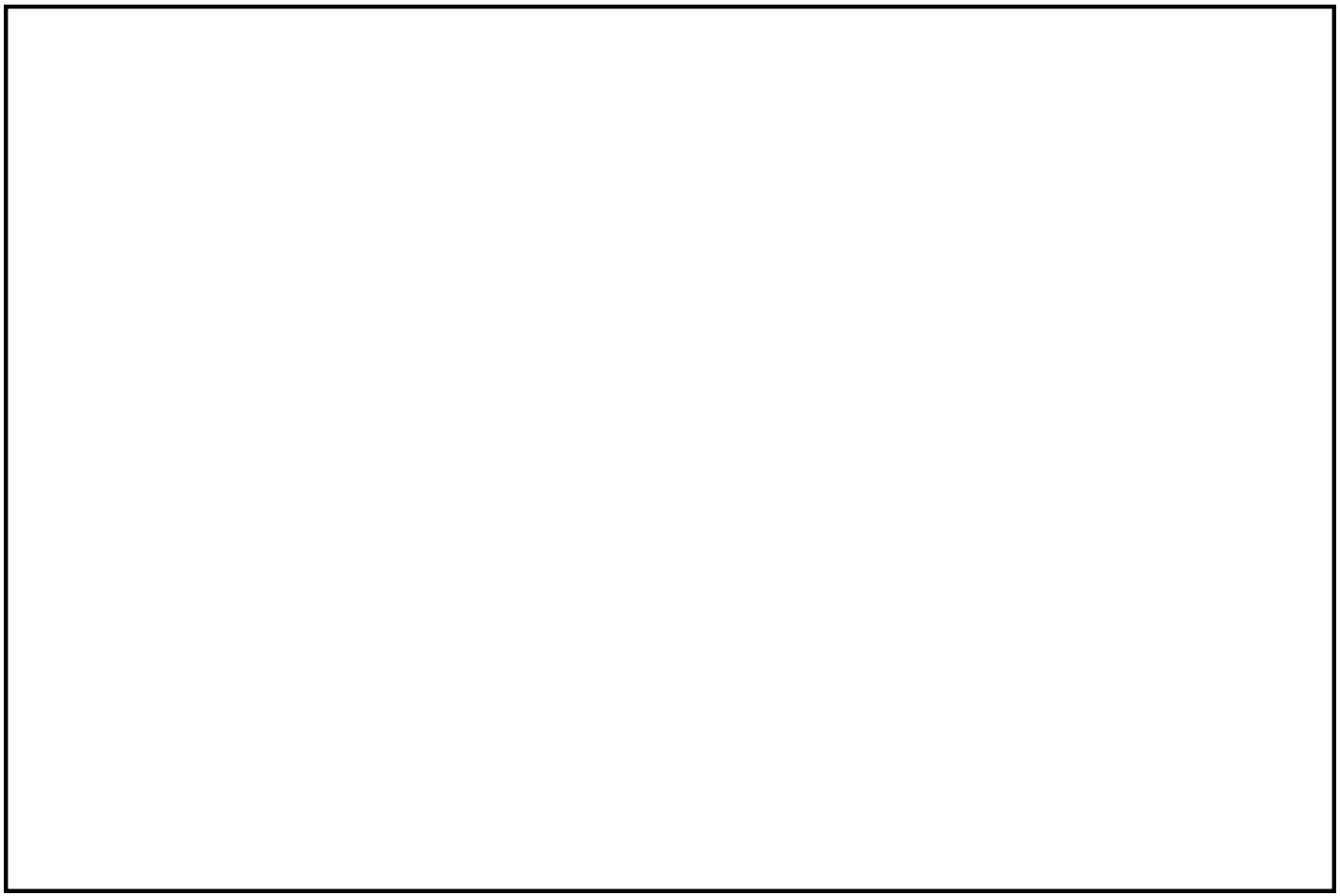
**Connected vs. Dot Mode:**
In Connected mode, the calculator will connect the points that it plots. In Dot mode, the calculator will not connect the points.

To change between Connected mode and Dot mode:

1. Hit MODE,
2. Use the arrow keys to highlight *Connected* or *Dot*.
3. Hit ENTER

# Graphing Calculator Examples

Change to Dot mode and sketch the new graph.



Is this a better graph? Is this graph correct? Explain.

# Using Technology to Find Approximate Solutions of Equations in One Variable

Methods for Approximating Solutions of Equations in One Variable:

- The Intercept Method
- The Intersection Method

Why would we want to approximate a solution of an equation?

There are two functions on the graphing calculator that can be used to approximate the coordinates of intersection points and $x$-intercepts.

# Finding Approximate Coordinates for Intersection Points:

1. Enter the equation for the first graph in $Y_1$.
2. Enter the equation for the second graph in $Y_2$.
3. Hit GRAPH. Make sure that you can see the intersection point on the graph. If you cannot see it, adjust the viewing window.
4. Hit 2nd CALC. (CALC is above the TRACE key.)
5. Use the arrow keys to select *intersect*. Hit ENTER.
6. If necessary, use the up and down arrow keys to select the first graph. Hit ENTER. (You may not need to use the arrow keys. The calculator will probably place the cursor on the first graph.)
7. If necessary, use the up and down arrow keys to select the second graph. Hit ENTER. (You may not need to use the arrow keys. The calculator will probably place the cursor on the second graph.)
8. Use the right and left arrow keys to place the cursor close to the intersection point. (This is your Guess.) Hit ENTER.

# Finding Approximate Coordinates for $x$-intercepts:

1. Enter the equation for the graph in $Y_1$.
2. Hit GRAPH. Make sure that you can see the $x$-intercept on the graph. If you cannot see it, adjust the viewing window.
3. Hit 2nd CALC. (CALC is above the TRACE key.)
4. Use the arrow keys to select *zero*. Hit ENTER.
5. If necessary, use the up and down arrow keys to select the graph. (You may not need to use the arrow keys. The calculator will probably place the cursor on the first graph.)
6. Use the right and left arrow keys to place the cursor to the left of the $x$-intercept. Hit ENTER.
7. Use the right and left arrow keys to place the cursor to the right of the $x$-intercept. Hit ENTER.
8. Use the right and left arrow keys to place the cursor close to the $x$-intercept. (This is your Guess.) Hit ENTER.

# Using Technology to Find Approximate Solutions of Equations in One Variable

## Example 7 (The Intesection Method)

Use the Intersection Method to approximate the solution of $x^4 - 3x^2 + x = 5 - 2x$ in the interval $(-5, 0)$. Draw an appropriate graph to illustrate how you approximated the solution. Be sure to label the graph.

# Using Technology to Find Approximate Solutions of Equations in One Variable

## Example 8 (The Intecept Method)

Use the Intercept Method to approximate the solution of $x^4 - 3x^2 + x = 5 - 2x$ in the interval $(0, 5)$. Draw an appropriate graph to illustrate how you approximated the solution. Be sure to label the graph.

# Using Technology to Find Approximate Solutions of Equations in One Variable

## Example 9 (Choosing a Method for Solving an Equation)

Which of the following equations should be solved algebraically and which should be solved graphically?

$$3 - x + 2x^2 = 5 + x$$

$$x^5 + 3\sqrt{x} = 7$$

$$\frac{1}{x+2} = 5x$$

$$x^4 + 2x^2 - 1 = 0$$

$$x^4 + 2x - 1 = 0$$