ClassPad 101

for ClassPad Version 3.00+

Lesson 23

Introduction to 3D Graphing

Welcome

Wow. We have reached lesson 23. The final lesson will give more detail to a topic introduced in Lesson 1: 3D graphing. 3-dimensional graphing is commonly studied in your third semester of calculus and in vector calculus.

Lesson Goals

- To be able to visualize a 2-dimensional graph as 3-dimensional
- To understand how to plot a point in 3-dimensional space
- To be able to recognize the equation of a plane
- To be able to graph in parametric form

In Lesson 23, you will learn how to:

- Think about coordinates of the form (x,y,z)
- Graph a plane in space
- Graph a 3-dimensional curved figure in space
- Rotate a graph
- Display axes

Upon completion of this lesson, you will be able to answer the following questions:

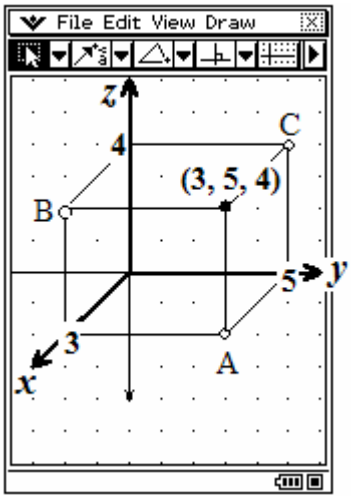
1. What will **z=-x+5y+1** look like when graphed?
2. How can we display two graphs at one time?
3. What does the z=cos(x) look like graphed?
4. If you were to plot (0,4,3), describe where it would be.

Time required

About 40 minutes.

Getting Started

We will begin with a very quick introduction to plotting points in space. If you are familiar with plotting points in the Cartesian plane, plotting in space is just a few more steps!



To plot the point (x, y, z) = (3, 5, 4):

1st Start at the origin (0, 0, 0)

2nd Move in the x-direction (out) 3 units and sketch a light line parallel to the y-axis

3rd Starting at the origin again, move in the y-direction 5 units and sketch a light line parallel to the x-axis to find point A

4th From point A, move in the z-direction (up) 4 units

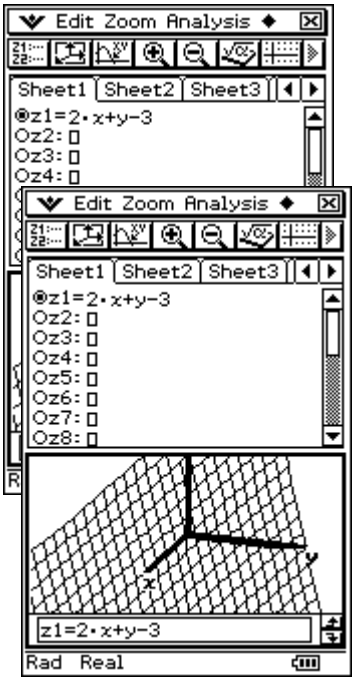
PART I

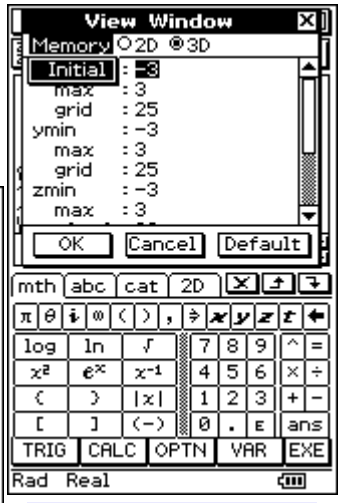
In this part, you will learn how to graph a flat plane in space! Lines (linear equations) in 2D can be written as **y**=a**x**+b; planes in space can be written in the form **z**=a**x**+b**y**+c. **Before beginning**, make sure that you are in radian angle mode (the status bar will show Rad). If you are not in Rad mode, click Deg or Grad until you see Rad!

1. Graphing Planes in Space

a. Open D and clear the window (if needed)
b. For z1, input **2x+y-3**
c. Press **EXE**
d. **Click** % to graph
e. Press on your graph and drag to rotate
f. **Click** the 7 button to open the View Window
g. Select **Memory/Initial**
h. Click **OK**
i. Can you visualize the flat (but tilted) plane?
j. Press the **= sign** to turn on the axes
k. Press = again to turn labels on

Or, click q to toggle!





Try graphing (one at a time):

z=2x

z=2y

z=x+y+1

2. Graphing Parabolic Shapes

a. Open the 2D-Graph Editor (W)

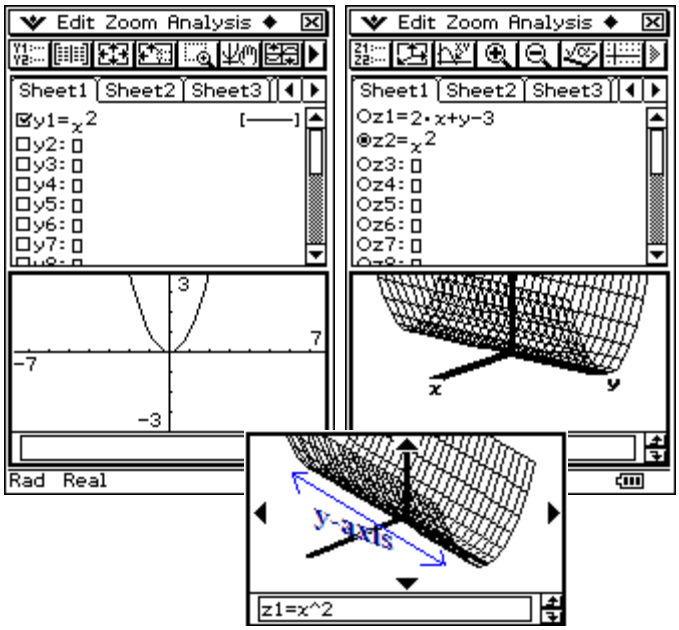
b. Graph **y=x^2**

c. Now **open** the 3D-Graph Editor (D)

d. Graph **z=x^2** (Click 7 and select Memory/ Initial, if needed)

e. **Notice** there is **no y** in **z=x^2** and so our parabola (x^2) is being "pulled" along the y-axis

f. **Remember**, press on your graph and drag to rotate



3. Graphing Parabolic Shapes

a. Clear the 3D Editor

b. Graph **z=y^2**

c. Click 7 and select Memory/Initial, if needed

d. **Notice** there is **no x** in **z=y^2** and so our parabola (y^2) is being "pulled" along the x-axis

e. **Open** the ◆ **menu** and select **Rotating/Top-> Bottom** (Esc to stop)

f. Try other rotations!

You can also store a picture as background

a. Click 7 and select **Memory/Initial**

b. **Open** the ◆ **menu** and select **Store Picture**

c. **Input any name** (8 or fewer characters)

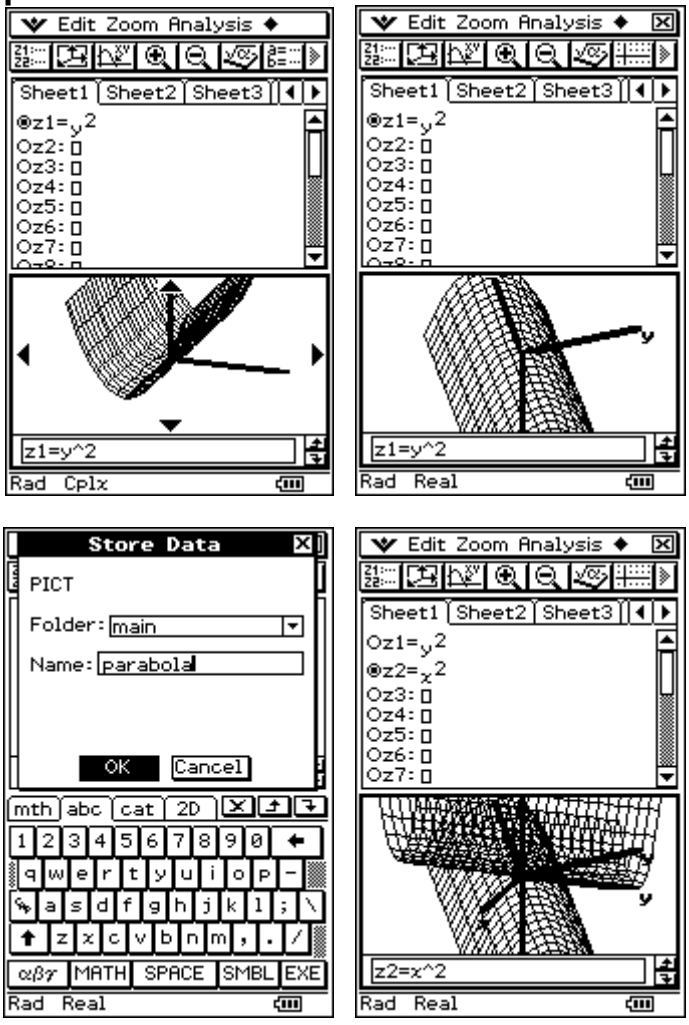
d. Click **OK**

e. **Next,** GRAPH **z=x^2**

f. **Open** the ◆ **menu** and select **Recall Picture**

g. Click **OK**

h. I like this. Math is fun!



PART I
Practice Exercises

Before beginning the practice exercises, open a word document, type in the following information and then *save it as Lesson23 in your CASIO folder within My Documents*:

- Date: (enter today's date)
- To: (put your instructor's name here)
- From: (put your name here)
- Re: Lesson 23

1. Please begin by opening the 3D-Graph application and clearing the editor, if needed.
2. Graph the plane: **z=-2x+3y-1**. Re-initialize the View Window settings.
3. With your graph and equation showing, get a **screen capture**. Paste it into your Lesson23 document (under a title of PART I).
4. Graph the curve: **z=x^2-y^2**.
5. Select **Zoom/View-x**.
6. With the x-view showing, get a **screen capture.** Add two blank spaces following the first screen capture and then paste this one.
7. Select **Zoom/View-z.** Notice that this looks flat because we are looking straight down on the graph.
8. With the z-view showing, get a **screen capture.** Add two blank spaces following the last screen capture and then paste this one.
9. Select **Zoom/View-y.** Interesting.
10. Select **Zoom/View-Init** to return to the original view.

PART II

In this part, we will work with trace. Think about the values as we trace.

1. Exploring the Maximum Value of a Curve

a. Open the **3D-Graph Editor** and clear the window (if needed)

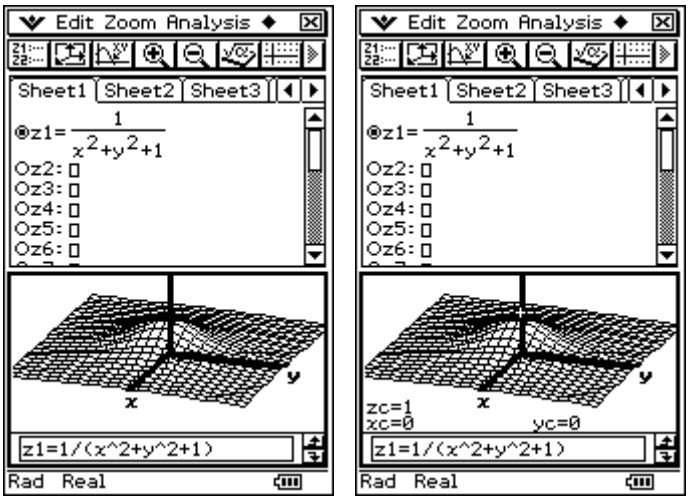
b. Graph:
z=1/(x^2+y^2+1)

c. Turn the **axes off** by **pressing = twice**

d. Think about this fraction…What is the most z will ever be?

e. Select **Analysis/Trace**

f. **Move** the cursor using the arrow keys



2. Changing a Curve

a. **Change** z to:
z=2/(x^2+y^2+1)

b. **Graph again** and resize the graph (**Ctrl+r**)

c. What is the maximum value of z now?

d. Resize again **(Ctrl+r)**

e. **Change** z to:
z=-2/(x^2+y^2+1)

f. What is the minimum value of z?

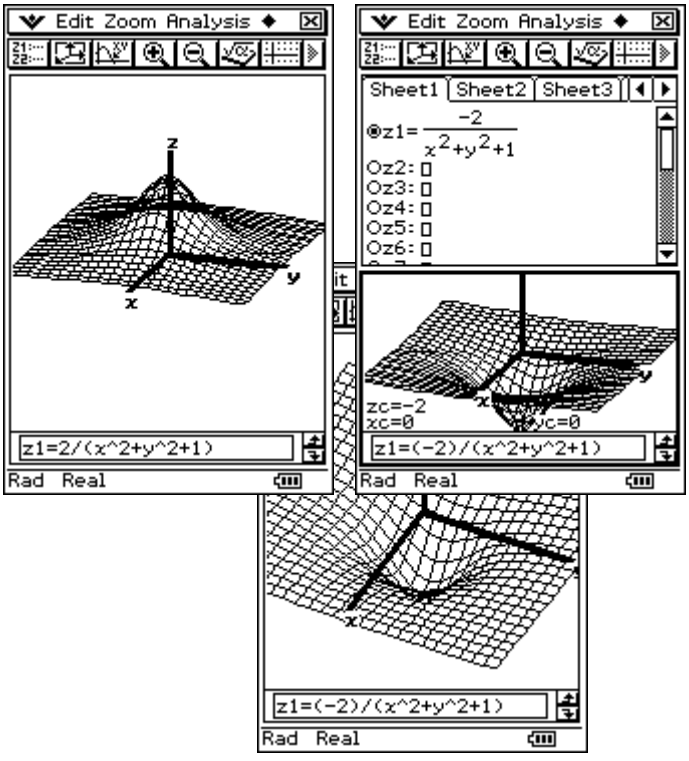
g. Select **Analysis/Trace**

h. Press **Esc** to get out of the trace mode

i. This is a fun curve to rotate around

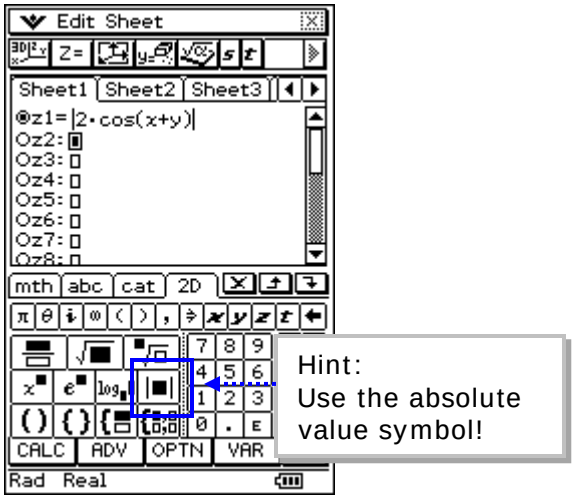
j. Also try: Zooming with the toolbar buttons or the + and – keys

k. Try changing the View Window settings by hand



PART II
Practice Exercises

1. Please begin by opening the 3D-Graph application and clearing the editor, if needed.
2. Graph the equation shown below:



3. Resize the window so that only the graph shows.
4. Rotate the graph until you like the way it looks.
5. With the graph showing, get a **screen capture**. Paste it into your Lesson23 document (under a title of PART II).
6. Graph other equations or modify the current one.
7. When you get one that you like a lot, get a **screen capture**. Add two blank spaces following the first screen capture and then paste this one.
8. That is all for Part II!

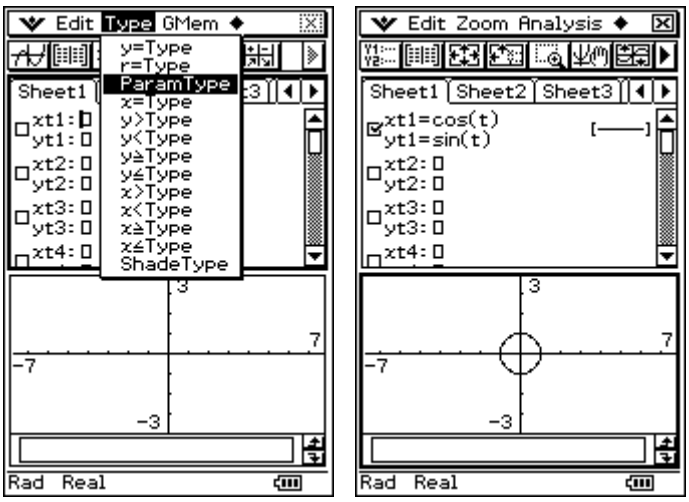
PART III

In this part, we will work with parametric equations. In 2-dimensional space, we have one parameter, t, to map two variables onto a curve. In 3-dimensional space, we have two parameters, s and t, to map three variables onto a surface. The ClassPad makes exploring parametric equations in 2- and 3-dimensions fun and somewhat easy to understand!

1. Exploring the parametric form of a circle in 2-dimensions

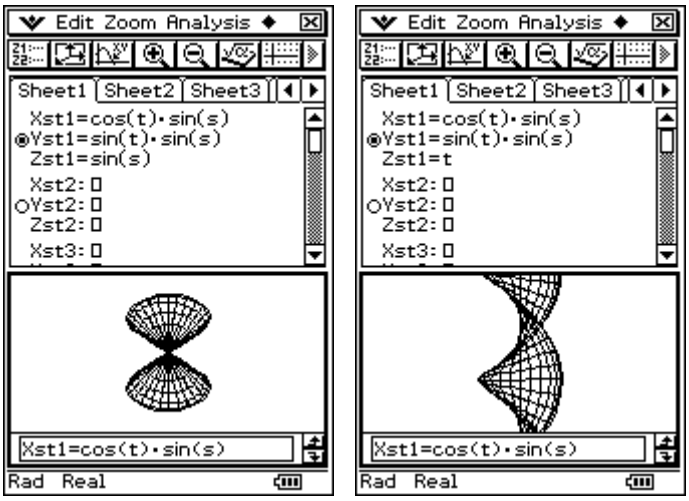
a. Open the **Graph Editor (2D)** and clear the window (if needed)
b. Open the **Type menu** and select **ParamType**
c. For **xt1** input **cos(t)**
d. For **yt1** input **sin(t)**
e. Press **EXE**
f. Click $ to graph

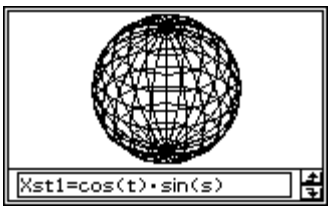
We have a circle of radius one!



2. Exploring the parametric form of a sphere in 3-dimensions

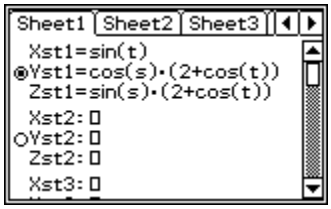
a. Open **3D Graph** (D) and clear the window (if needed)
b. **Click** the **Z=** **button** to change to parametric form (now shows **Xst**)
c. Select 0**/3D Format**
d. Change Labels to **Off**
e. Input:
   Xst1= **cos(t)sin(s)**
   Yst1= **sin(t)sin(s)**
   Zst1=**sin(s)**
f. Not a sphere!
g. Change **Zst1** to **t**
h. Not a sphere!
i. Change **Zst1** to **cos(s)**
j. Press the **+** key a few times to zoom in
k. A sphere!





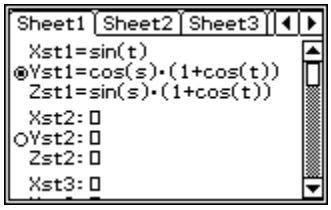
PART III
Practice Exercises

1. Open the 3D-Graph application and clearing the editor, if needed.
2. Graph the parametric equation shown below:



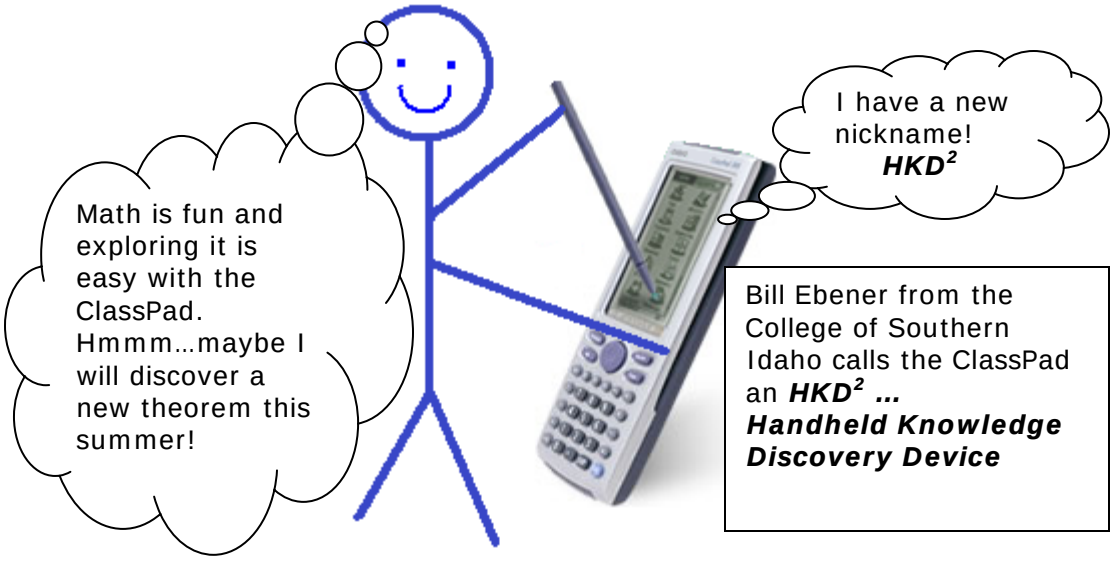
This is a special graph called a "**ring torus**". It looks a lot like a donut!

3. Resize the window so that only the graph shows.
4. Rotate the graph until you like the way it looks.
5. With the graph showing, get a **screen capture**. Paste it into your Lesson23 document (under a title of PART III).
6. Modify your parametric equation by changing the 2's to 1's:



This is another special graph called a "**horn torus**". Notice it is tangent to itself at (0,0,0).

7. Graph again and resize the window so that only the graph shows.
8. Rotate the graph until you like the way it looks.
9. With the graph showing, get a **screen capture**. Add two blank spaces following the first screen capture and then paste this one.
10. Yes, this is an easy lesson! But, you deserve to relax and begin your vacation early. Thank you for completing the course.



PART IV

Reflection Exercises

You have just completed the twenty-first lesson in ClassPad 101. The end! Thank you for completing ClassPad 101 and all your suggestions. Please take a few moments to copy and paste the following four questions at the end of your Lesson23 document and answer them.

1. Approximately how long did it take you to complete this lesson?
2. Is there any area or areas that you think we should have spent more time on?
3. Do you think that you will be comfortable using the ClassPad in your future math classes?
4. Would you recommend this class to others? If so, why? If not, why not?

Assessment 23: Introduction to 3D Graphing

- **Checkpoint**: Your word processed document, titled "Lesson23", should contain the following activities:
  1. Three screen captures from PART I.
  2. Two screen captures from PART II.
  3. Two screen captures from PART III.
  4. Four reflection questions with answers from PART IV.

- **Submit** your **Lesson23 document** to your instructor for grading. Once your lesson is submitted, your lesson for ClassPad 101 “Intro to 3D Graphing” is complete. You are now a ClassPad 101 graduate! Throw your hats high and graph their paths over time using the ClassPad. Thank you and congratulations☺.

