# Graphs in the Next Dimension

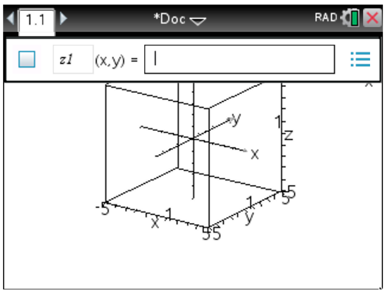
## Student Task Sheet

## Introduction

The aim of this activity is to introduce you to 3D graphs, whilst reinforcing your understanding of some aspects of 2D graphs.

## Task 1 - Familiarisation

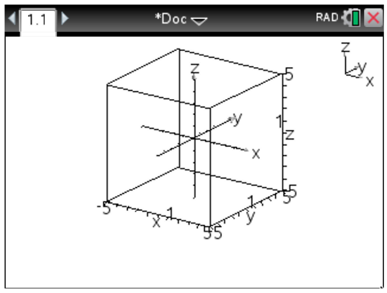
To start off with a blank 3D graphing template, do the following:




1. Start a New Document and select the Graphs application.

2. Press [menu] then select **View ... 3D Graphing** and you will obtain a page similar to that on the left.

3. Close the Graph Entry line by either pressing (esc) or pressing [ctrl] then [G].




4. With your screen looking like the image on the right, you shall first examine what you have....

*Notice the small axes in the top right hand corner, and how they are orientated the same as the main graphing box in the centre of the screen.*

5. Now press any direction on the cursor keypad (▲,▼,◀ or ▶). You can also press and hold each direction.

6. Now press the letter [O]. Can you see what this did?

7. Now press the letter [X]. Again, what did this do?

8. Now press the letters [Y] then [Z].
**Write down** in your jotter, as precisely as you can, explanations for what views you see when you press each of [X], [Y] or [Z].

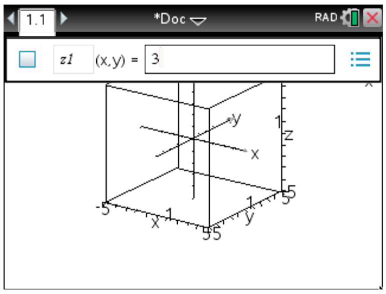
9. Now press [O] to return to the **O**riginal view.
Press [A] to **A**nimate the graph. You can also press the cursor keys whilst it is spinning!
You can stop the animation by pressing (esc).

## Task 2 – Your First Plane

1. Press [O] to return to the Original view.

2. Open the Graph Entry line by either pressing [tab], or pressing [ctrl] then [G].

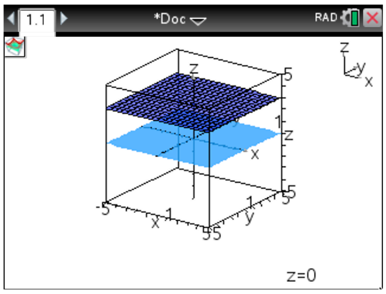
3. Type in the number 3, so that z1(x,y)=3 and press [enter].




4. You now see a plane whose z-coordinate is always 3.
Press [X], [Y], [Z], [O], [A] and the arrow keys to view it from all directions.

*Notice that whilst the view is rotating, the axes labels are re-displayed on the front edges of the graphing box.*

5. You will now introduce a z-trace to the graphing window.




Firstly, press [O] to return to the Original view.
Press [menu] and select **Trace .... z Trace**.
You will see another plane appear, with equation z=0.

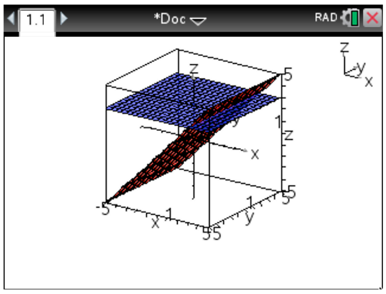
You can move this plane up and down by pressing and holding down [⇧shift] whilst also pressing the cursor directions ▲,▼,◀ or ▶.

You can exit z-trace mode by pressing [esc].

## Task 3 – Slanting Planes

1. Press [O] to return to the Original view.

2. Open the Graph Entry line by either pressing [tab], or pressing [ctrl] then [G].




3. You will have the prompt for z2(x,y) on show.
Type in x, so that z2(x,y)=x and press [enter].
You should see a screen like that shown on the right.

4. You now see a plane whose z-coordinate is controlled by whatever the x-coordinate is.
Press [X], [Y], [Z], [O], [A] and the arrow keys to view it from all directions.

5. Press [O] to return to the Original view.
Can you predict what will happen if z2(x,y)=x becomes z2(x,y)=2x ?

To check your prediction, edit z2(x,y) so that it reads z2(x,y)=2x.

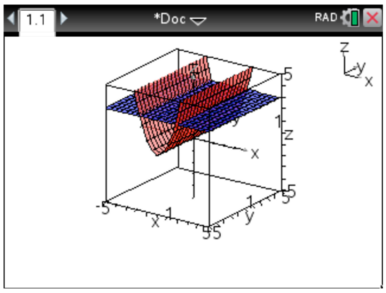
6. You can spend further time predicting and checking what z2(x,y)=3x and z2(x,y)=4x would look like.

7. You can also consider z2(x,y)=-x and z2(x,y)=-2x.

**Write down** any similarities and differences that you have noticed when you compare graphing in 2D and graphing in 3D and you change the *coefficient* of x to different values.

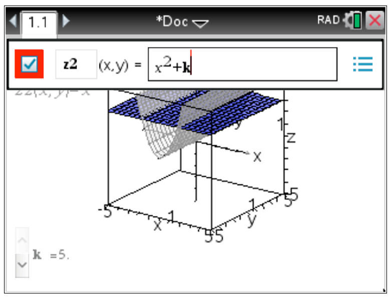
## Task 4 – Curving Planes

1. Press [O] to return to the Original view.




2. Edit z2(x,y) so that it reads z2(x,y)=$x^2$ and press [enter].

3. Predict what z2(x,y)=$x^2$ –3 will look like. Then graph it.

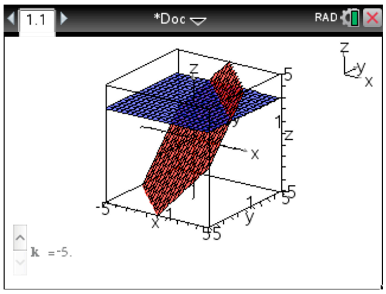



4. Consider z2(x,y)=$x^2$ +**k** where k is an integer.
You could insert a minimised vertical slider, naming the variable as **k**, place it in the bottom left corner of the screen and edit z2 to include the **k**.

**Write down** why changing the value of **k** has the effect that it does on the curved plane.

## Task 5 – Plane equations involving both x and y coordinates.

1. Press [o] to return to the **O**riginal view.




2. Edit z2(x,y) so that it reads z2(x,y)=x+y
View it from all angles, and notice how it lies in relation to the axes and the z1 plane.

3. **Write down** a reason why the z2 plane appears to slant at an angle to the coordinate axes.

4. **Write down** a convincing reason for how you know whether the z2 plane goes through the origin, or not.

5. Look at where the z1 and z2 planes intersect. How many intersection points are there?
And what do all these intersection points combine to create?

**Write down** the (x, y, z) coordinates of one point that lies on both z1 and z2.
**Write down** the (x, y, z) coordinates of four more points that also lie on both z1 and z2.
It is points like these that generate the intersection line of the two planes.

Now compare this 3D situation of two planes intersecting with the 2D graphing equivalent of two lines intersecting. **Write down** any similarities and/or differences between them.

6. Now consider very carefully the next plane equation:

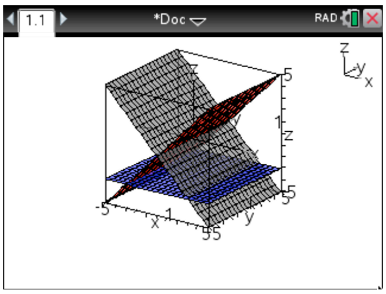
$$z2(x,y)= x^2 +y^2$$

**Before** you graph it on your TI-Nspire, sketch what you think it will look like.
Do spend time on this task – it is very satisfying to correctly predict a graph that is new to you.

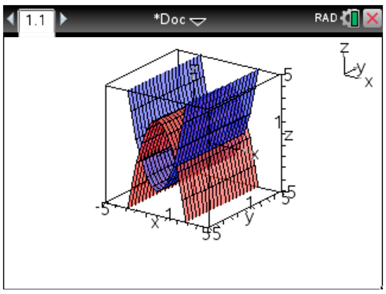
7. Then, in a similar fashion, predict what $z2(x,y)= x^2 +y^2-5$ will look like, and then check it.

## Task 6 – More Challenging Plane Graphing.

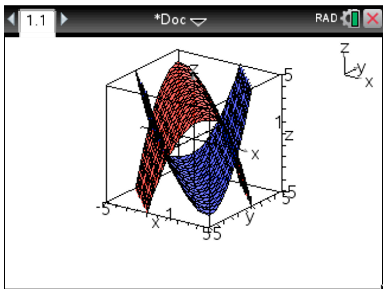
1. Can you discover the equations of the planes that are shown in the following 3 screenshots?
In each, the viewpoint shown comes after pressing [o].




*Planes Problem 1*




*Planes Problem 2*




*Planes Problem 3*

2. Now, for a bit of interest, there are very many other, more complex functions that give rise to interesting graphs. You can try some of these on a new 3D graphing page:

$z1(x,y)= x^2 -y^2$

z1(x,y)= 1/(x+y)

z1(x,y)= sign(x·y) .... can you explain why this 'sign' graph looks the way that it does?

z1(x,y)= abs(x+y) .... can you determine what the 'abs' function does?