Applied Mathematics

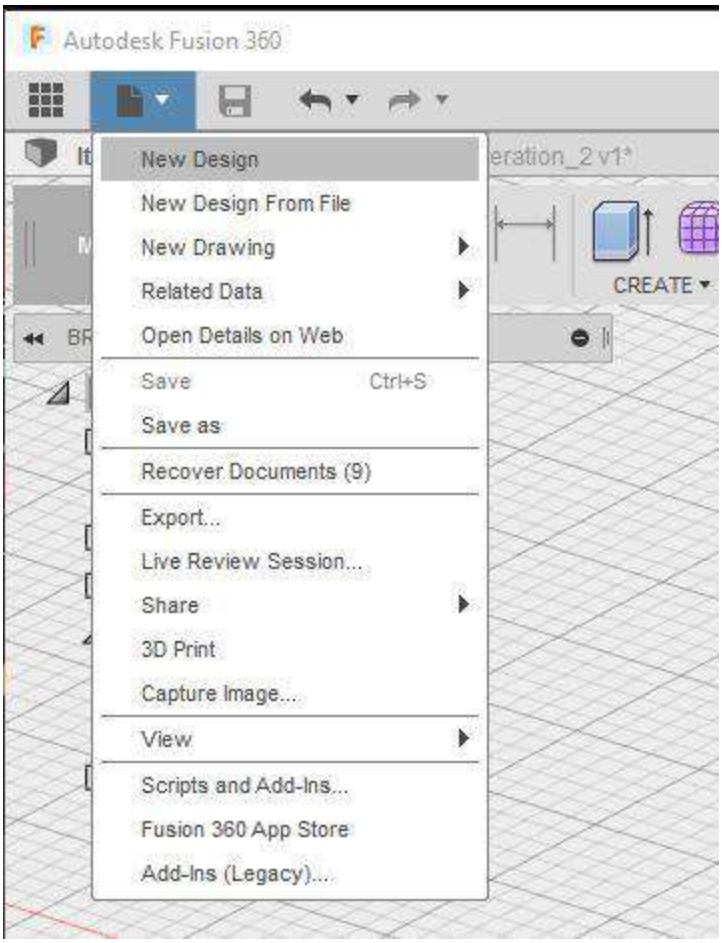
Classroom Copy!
Please do not take unless given permission.

Fractal Geometry in Autodesk Fusion 360

1. Open Autodesk Fusion 360

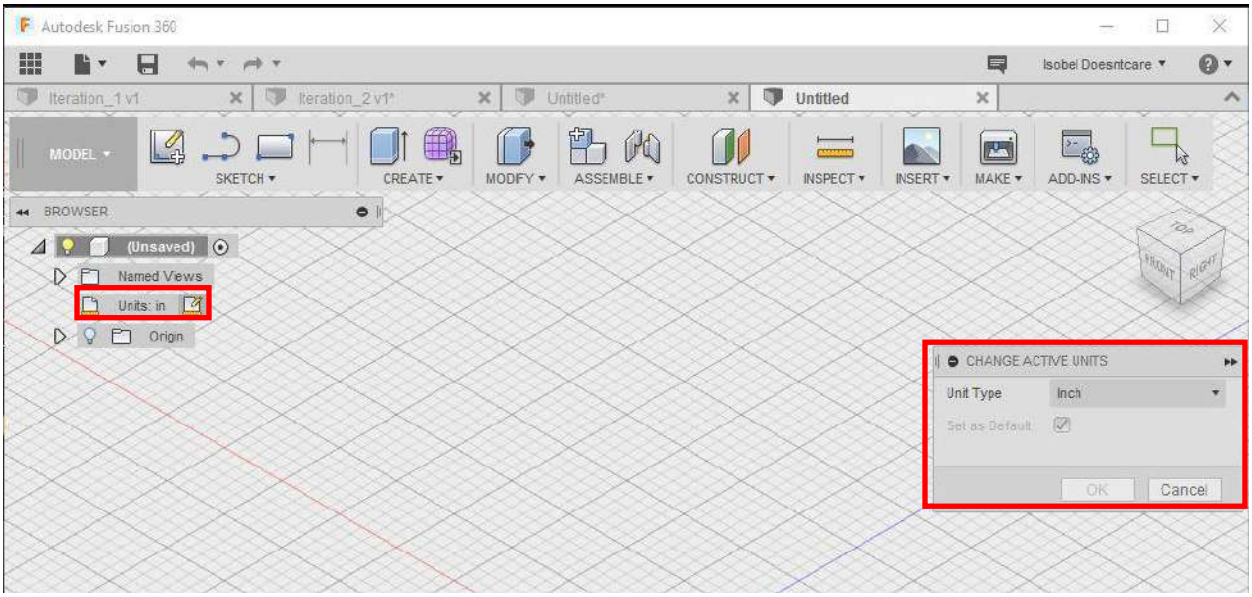
2. Click **FILE -> NEW DESIGN**

This will open a new CAD (Computer Aided Design) file for you to work on.

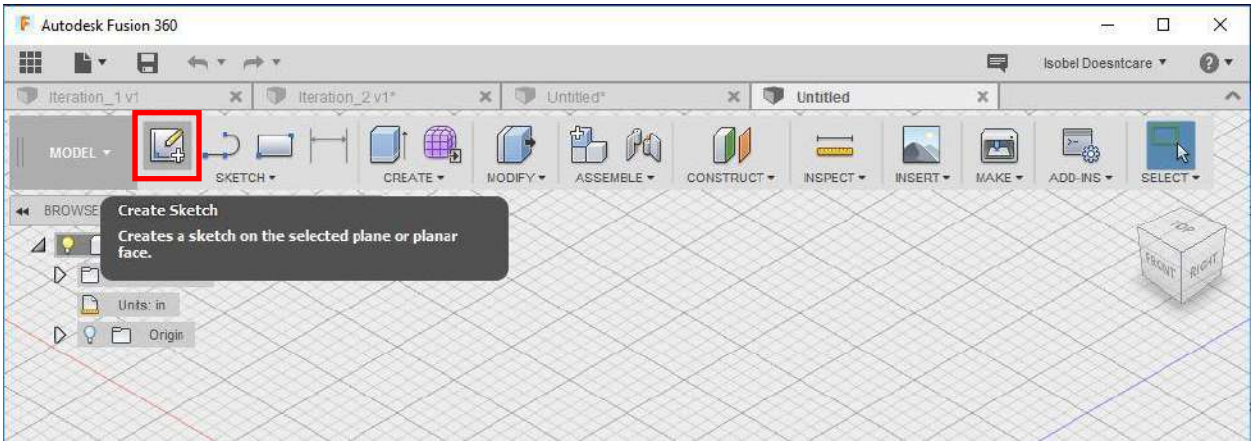


3. Confirm/change your measurement units to be **INCHES**.

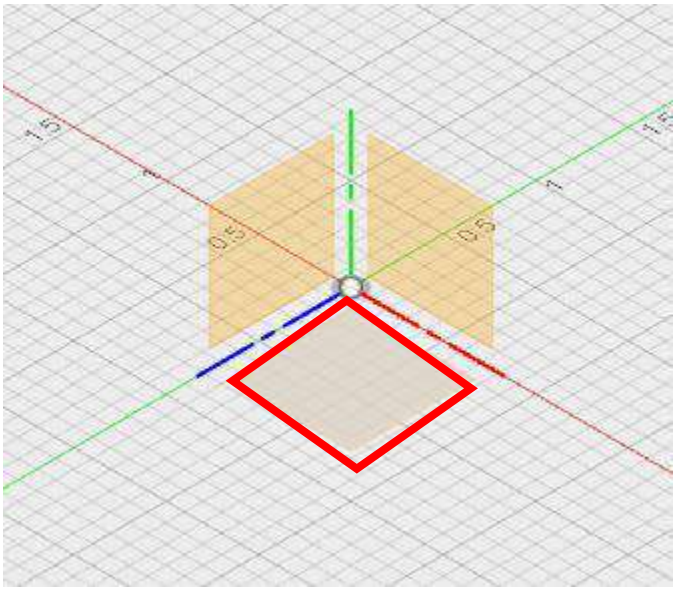
Click on the icon to the right of “Units:in” (the piece of paper with the pencil icon) to bring up the larger **CHANGE ACTIVE UNITS** menu.



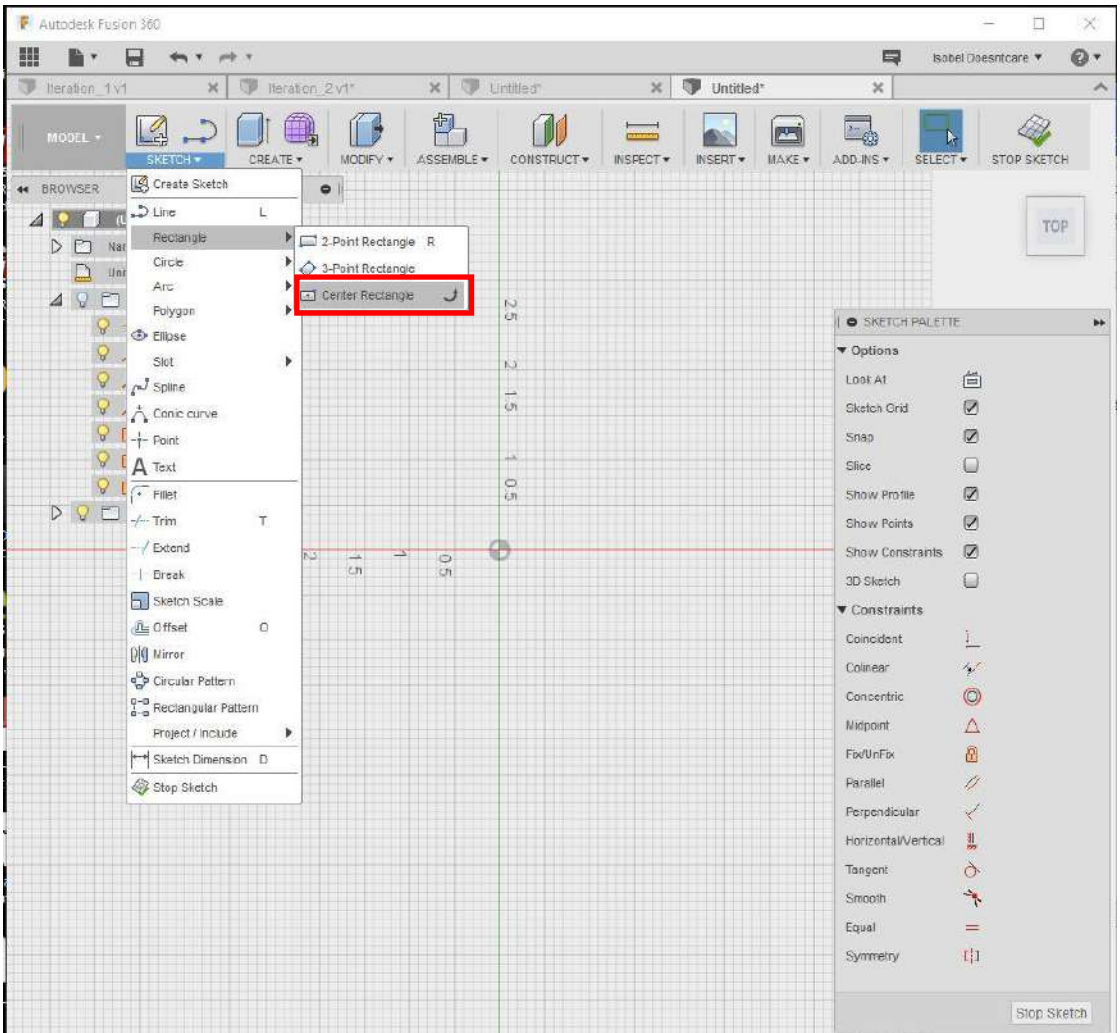
4. **CREATE A SKETCH** by selecting the sketch tool selected in **RED** below



5. Select the plane you want to begin sketching on. In this case, we are sketching on the **XZ PLANE**. This plane is shown below and consists of a **BLUE X AXIS** and a **RED Z AXIS**.

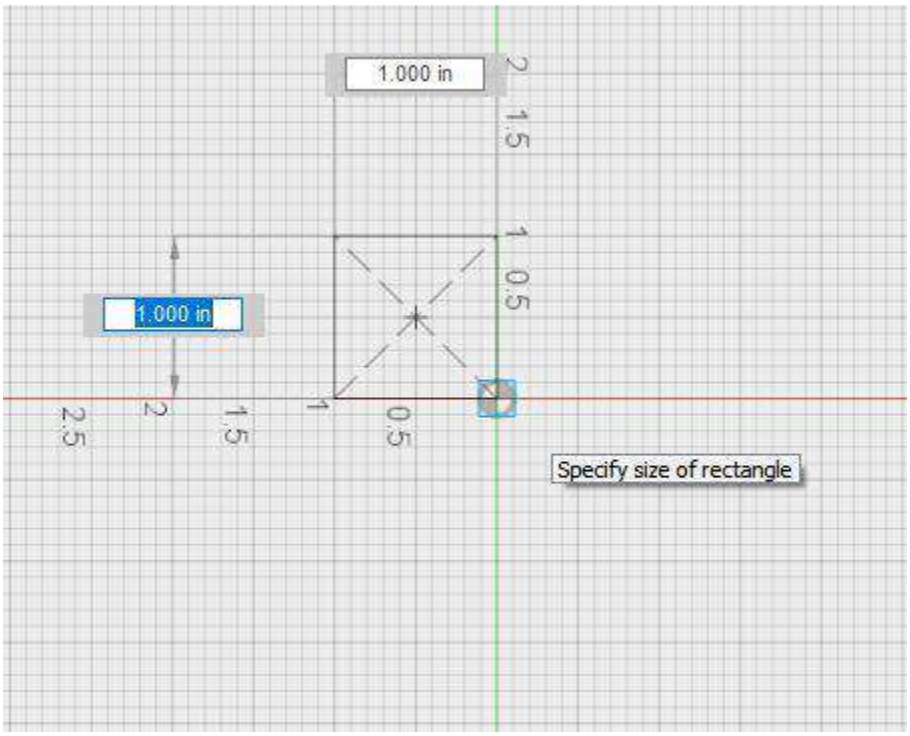


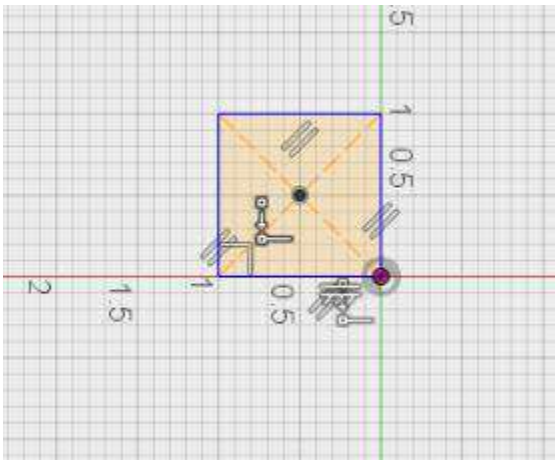
6. Select the **CENTER RECTANGLE TOOL** as shown below.



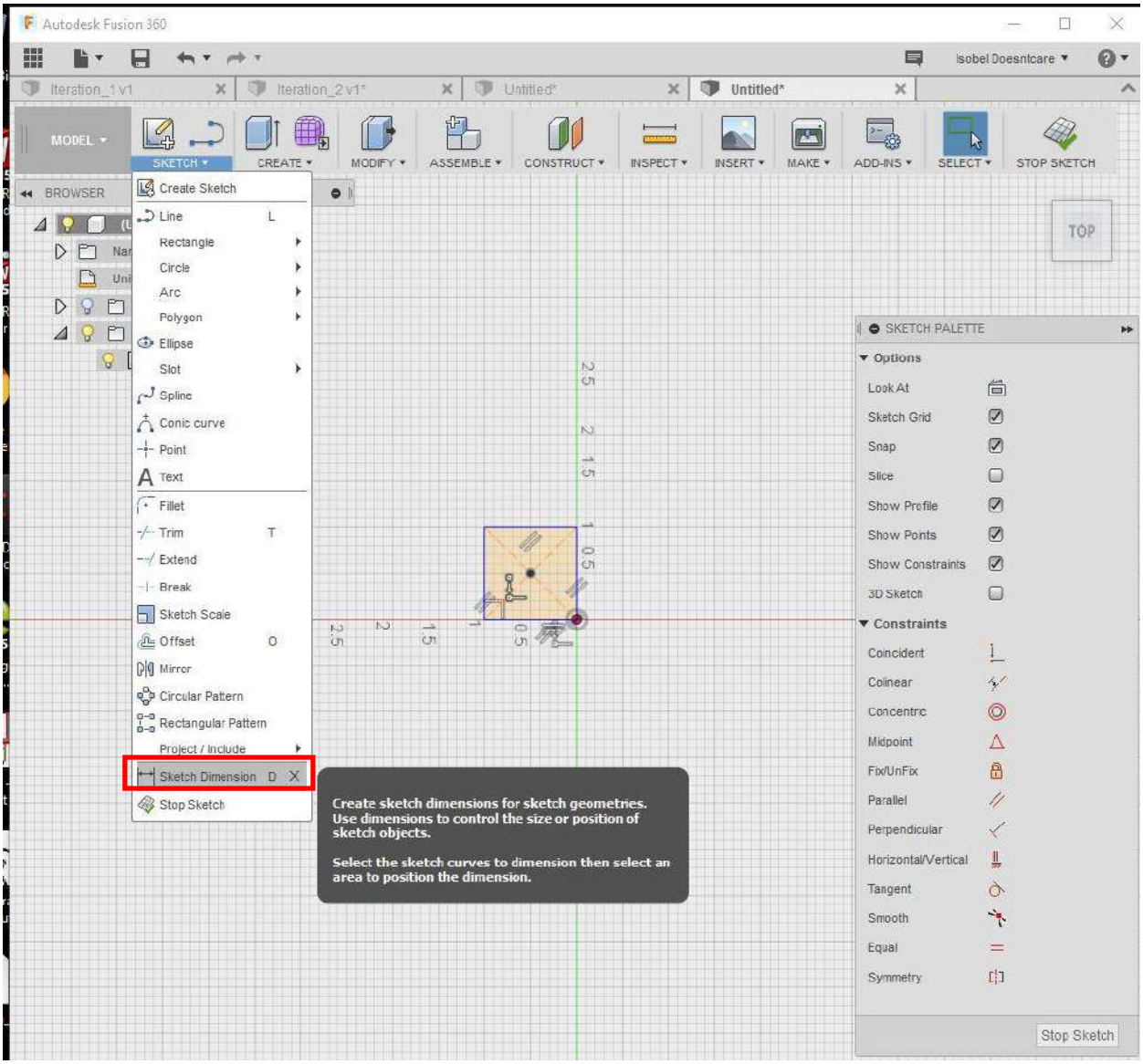
7. **SKETCH** the following center rectangle as shown.

Click the center point (0.5, 0.5) by hovering your cursor over the point. The cursor should “snap” to the point. Once the center point of the rectangle has been placed, your cursor is automatically attached to a corner of the rectangle. You will drag, stretch, and position this corner to define the rest of the rectangle. In this case we are defining this rectangle to be a square with a side length of 1 inch. Click to place the corner point of the rectangle. Your screen should now resemble the picture two in this step.

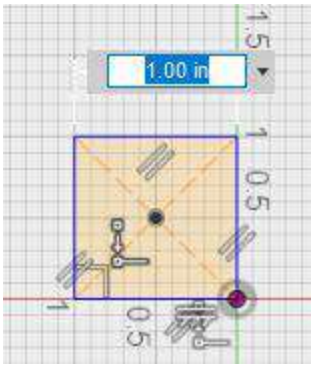


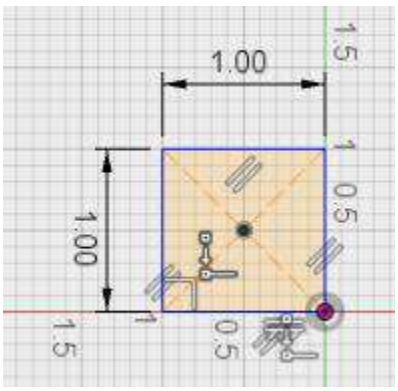


8. **DIMENSION** the rectangle to lock in or “define” the size of the rectangle you sketched in step 7. Follow the menu tree in the picture below to find the **SKETCH DIMENSION** tool. Alternatively you can click the letter “D” on your keyboard.

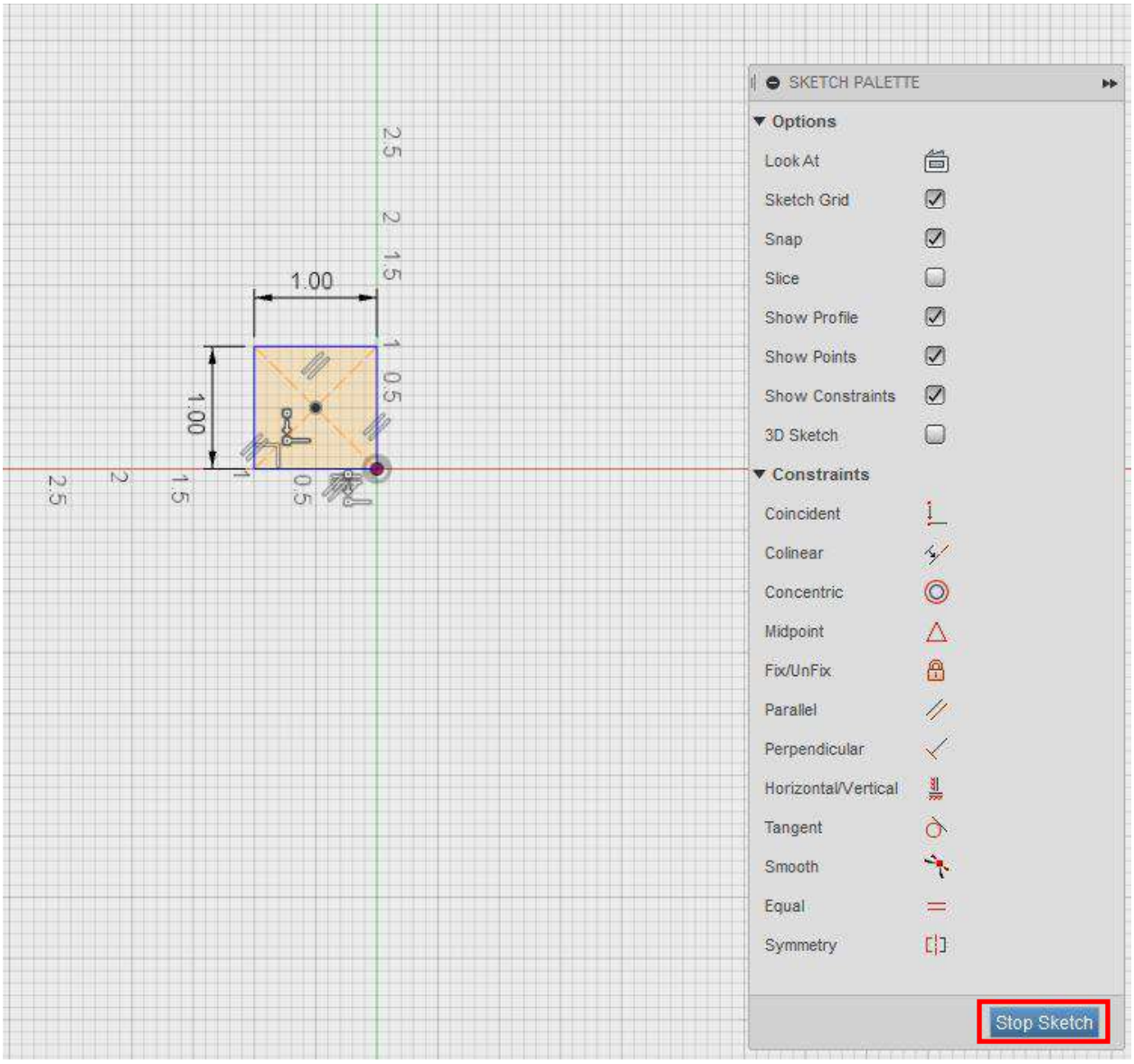


9. Select the side you wish to dimension and either accept the dimension that exists by clicking “enter” on your keyboard, or change the value to the desired value then click “enter” on your keyboard. Repeat this step until your screen looks like the second picture in this step.

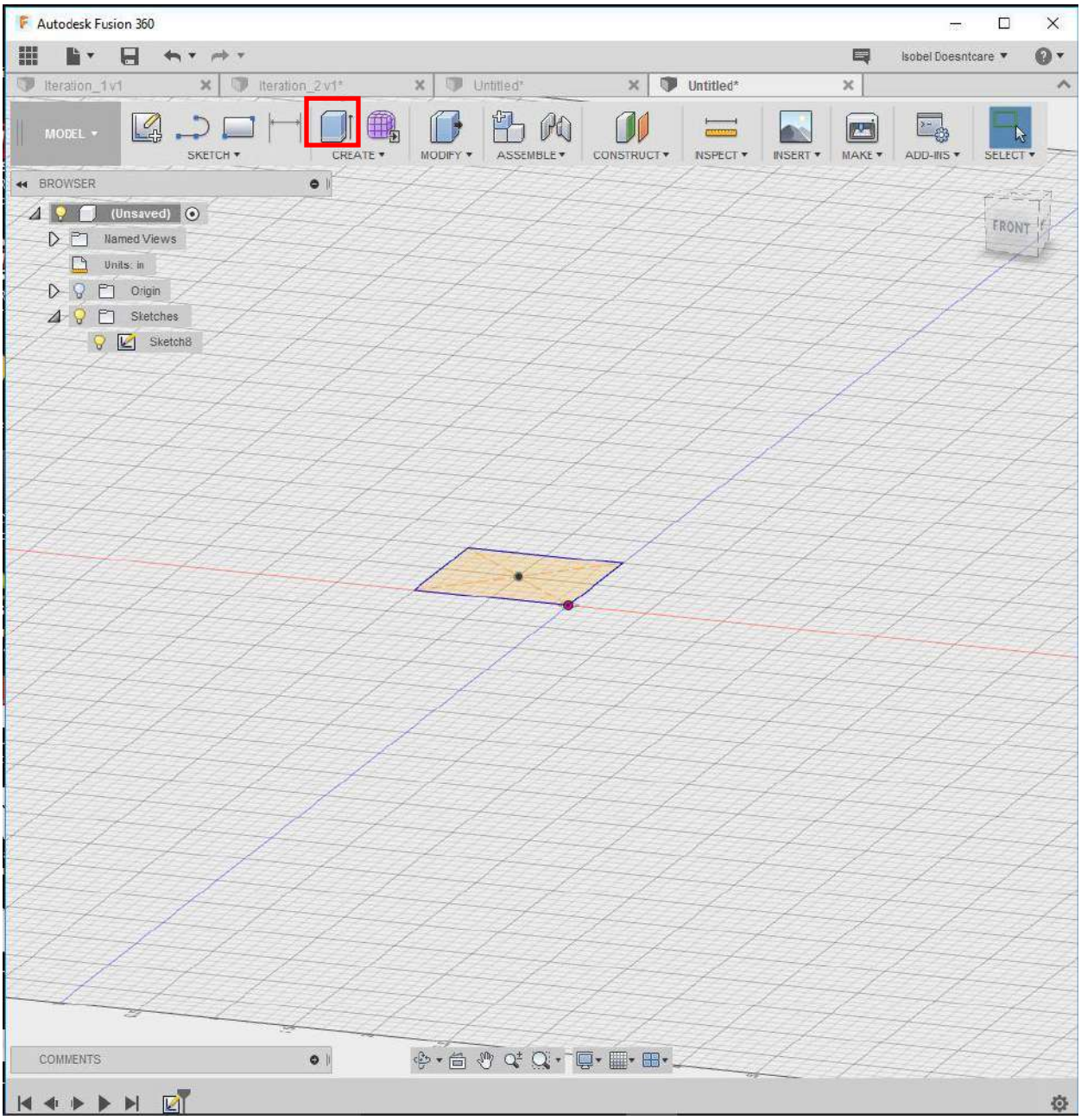




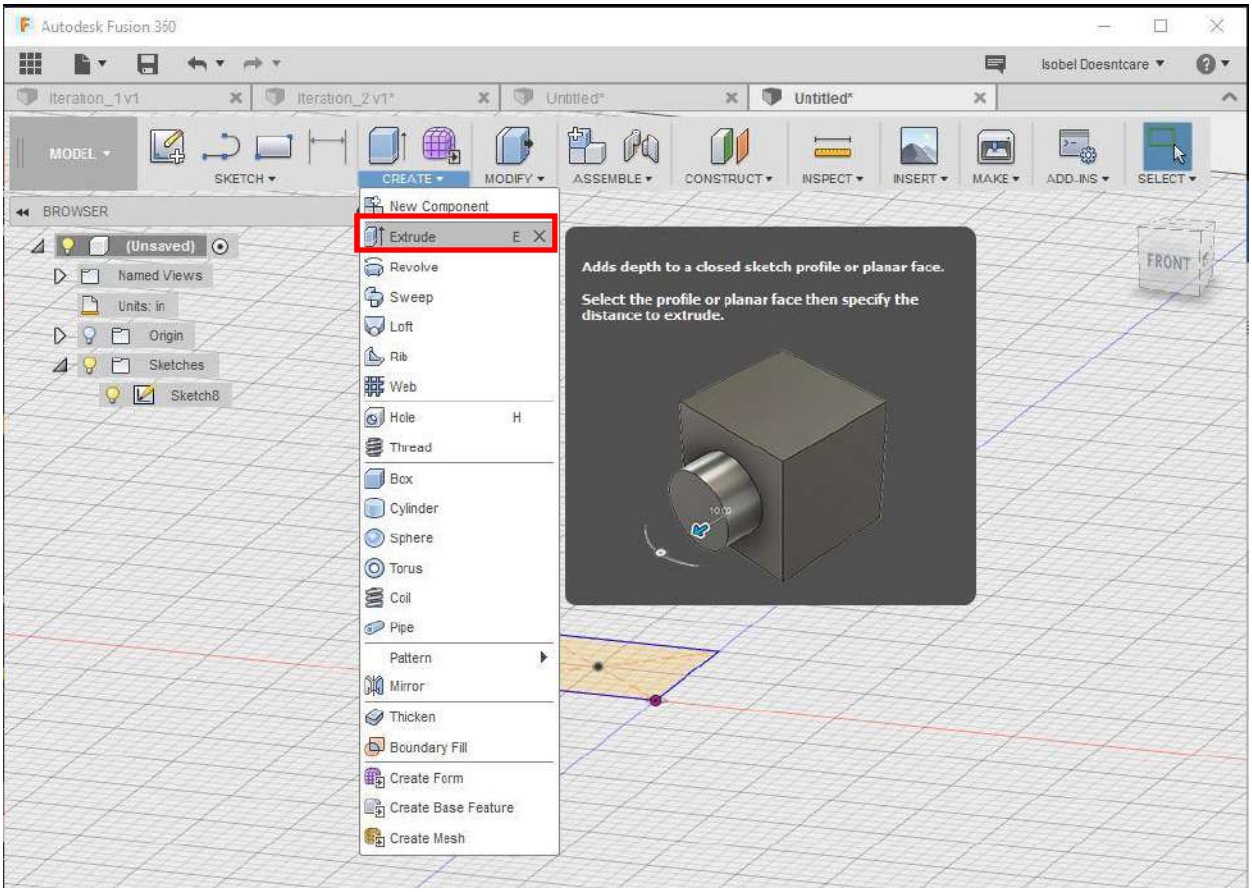
10. Confirm that you are finished with the sketch by clicking **STOP SKETCH** in the bottom corner of the **SKETCH PALLETE** shown below.



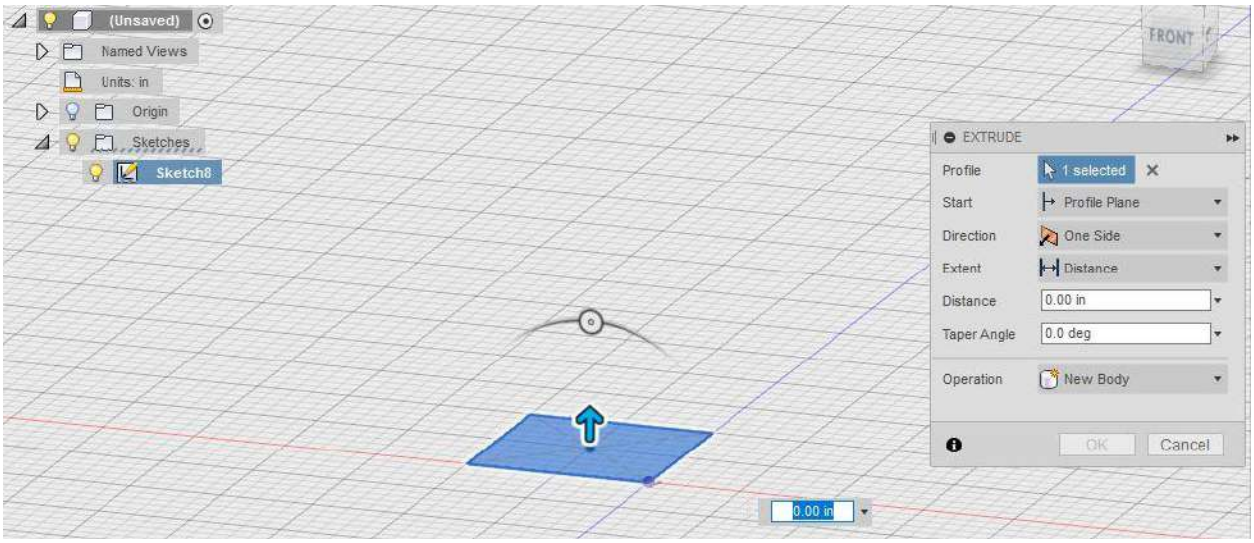
11. Click on the specified icon in the **CREATE** tab

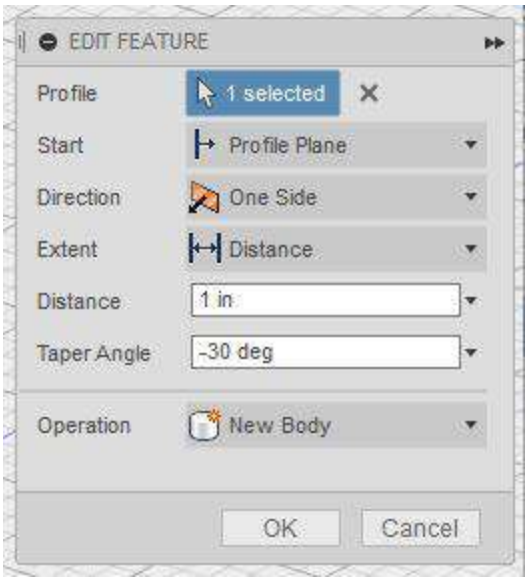


12. Select the **EXTRUDE FUNCTION** highlighted below to extrude the created sketch.

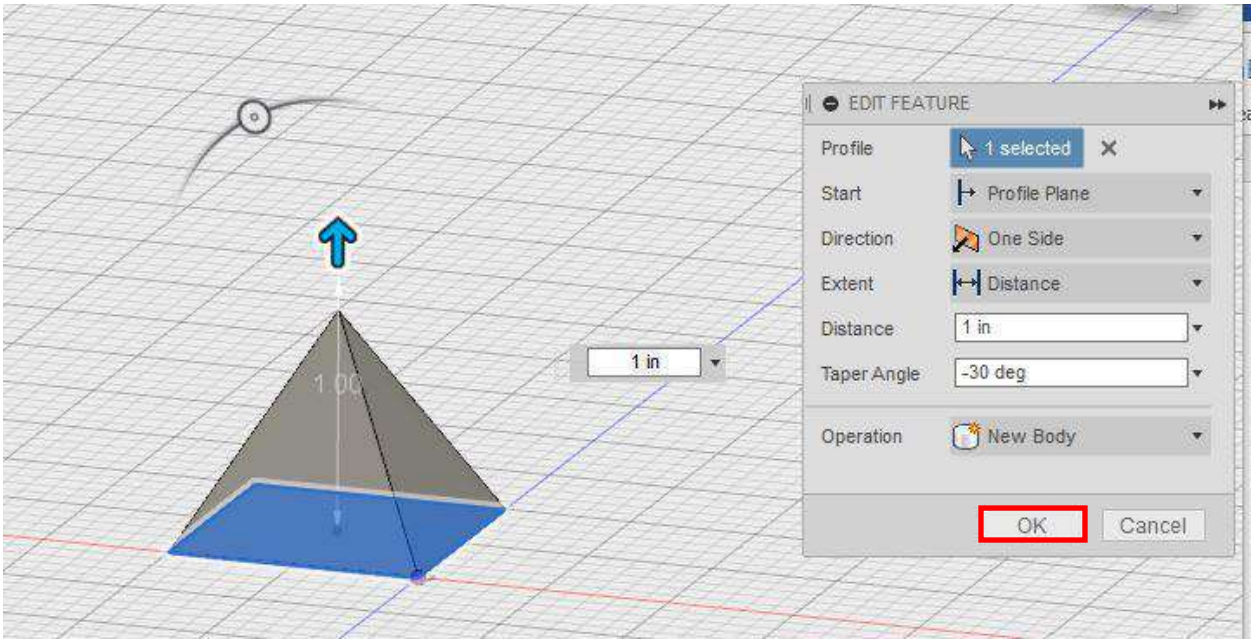


13. Select the sketch so that it becomes **BLUE** as shown in the picture below. Enter the parameters from the second picture in this step into the **EXTRUDE** to create the Tetrahedron shape. For the sake of this exercise the geometry has already been worked out for you.

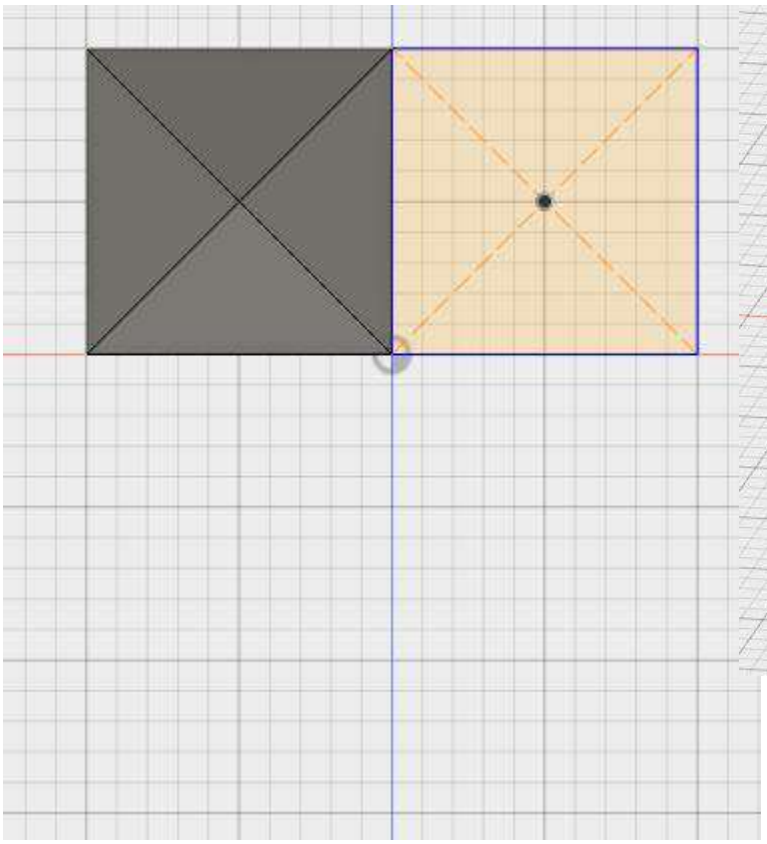


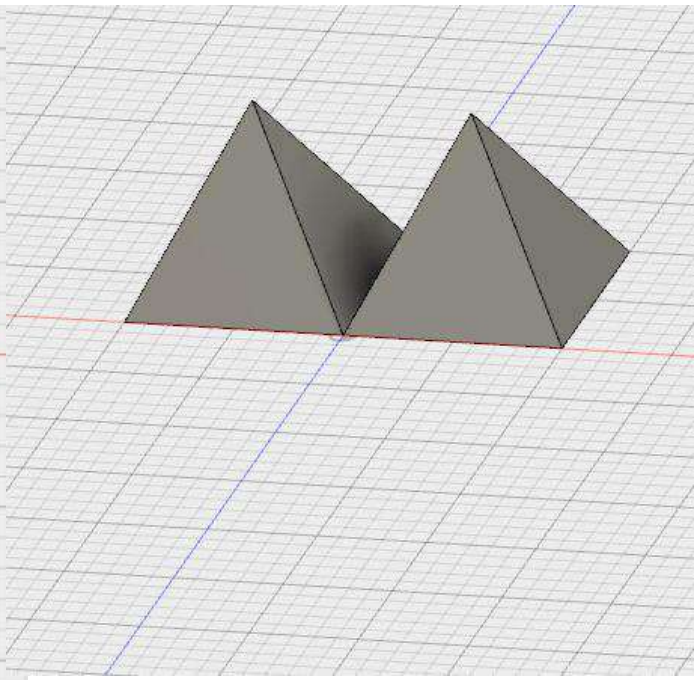


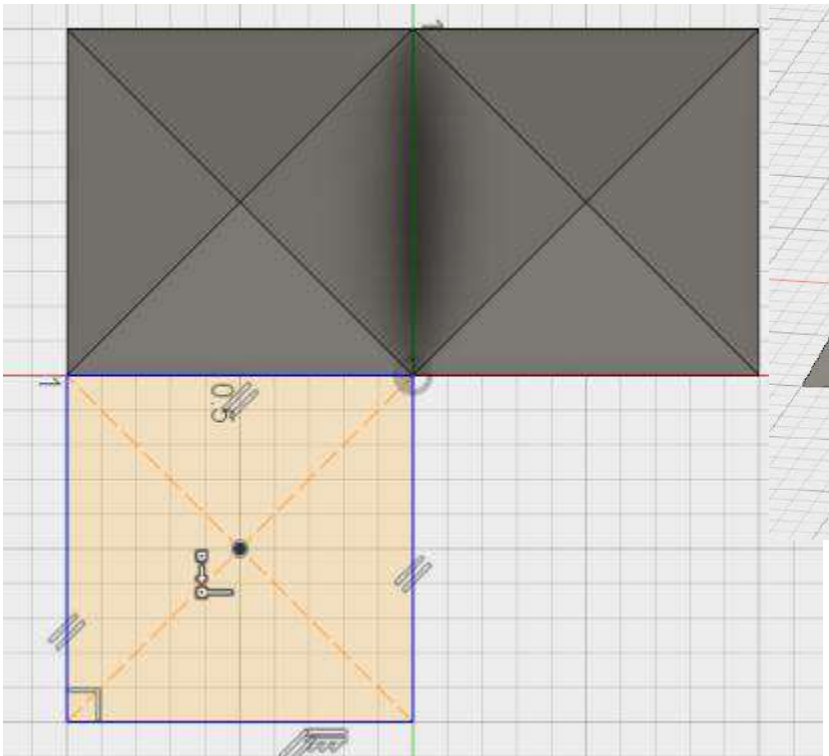
14. Your screen should now resemble the screen below. Click **OK** to exit the **EDIT FEATURE** menu and continue creating your part. The Tetrahedron will now become a solid object in the software.

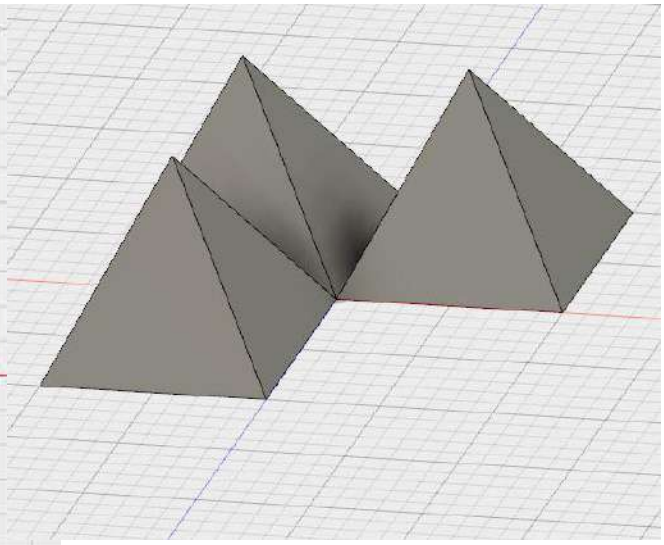


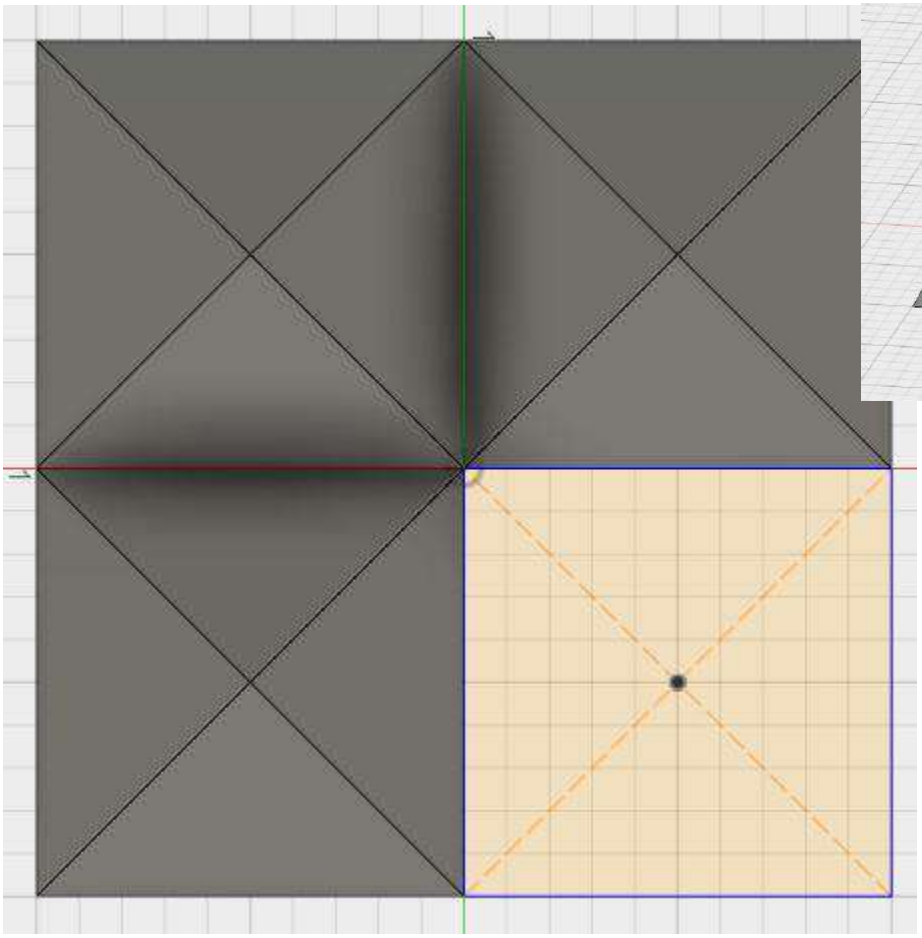
15. Now that we have learned how to create one Tetrahedron, we will repeat steps 5 through 14 to create an array of solid Tetrahedrons as shown below. The general process is iterated (**SKETCH -> EXTRUDE**).

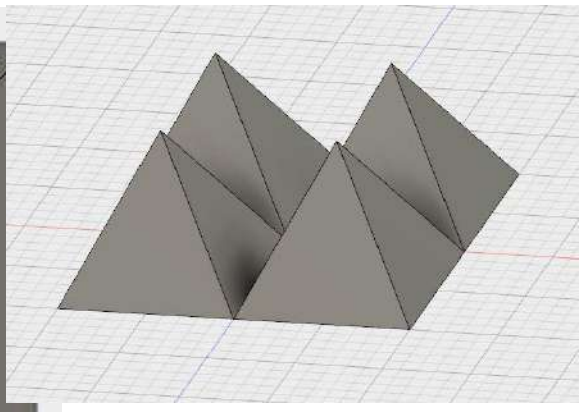




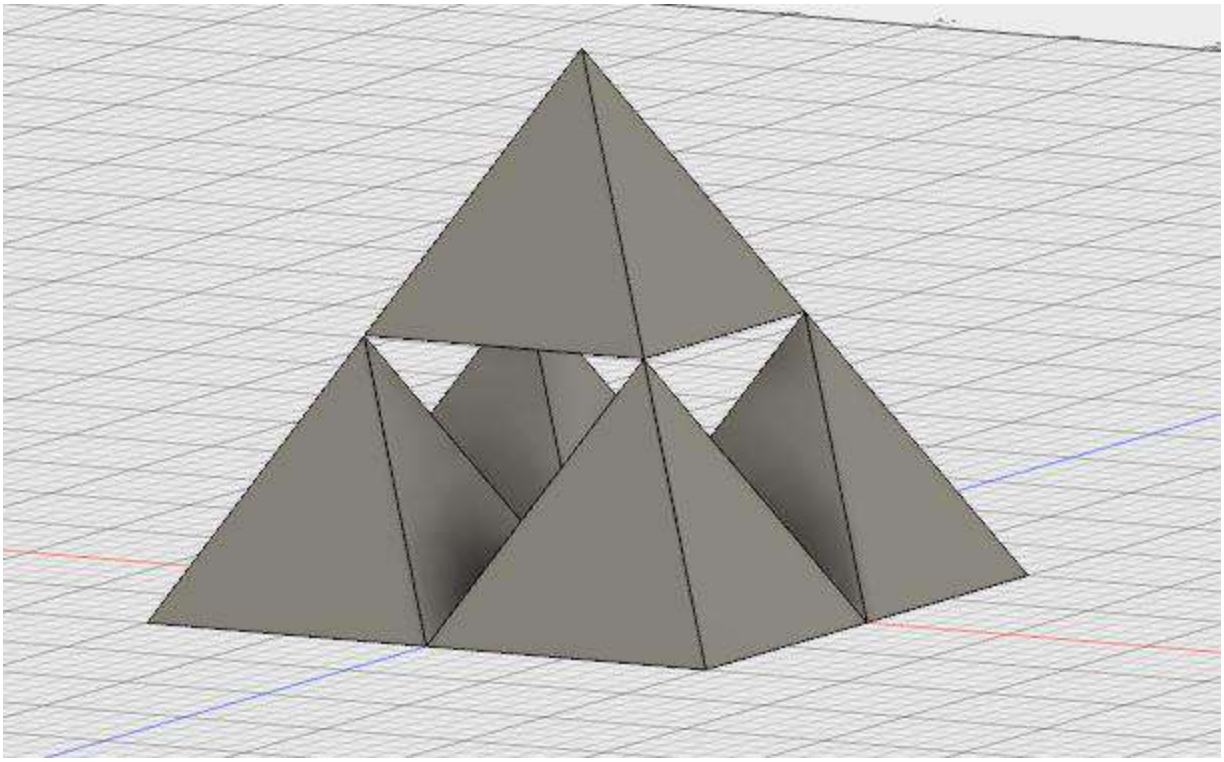




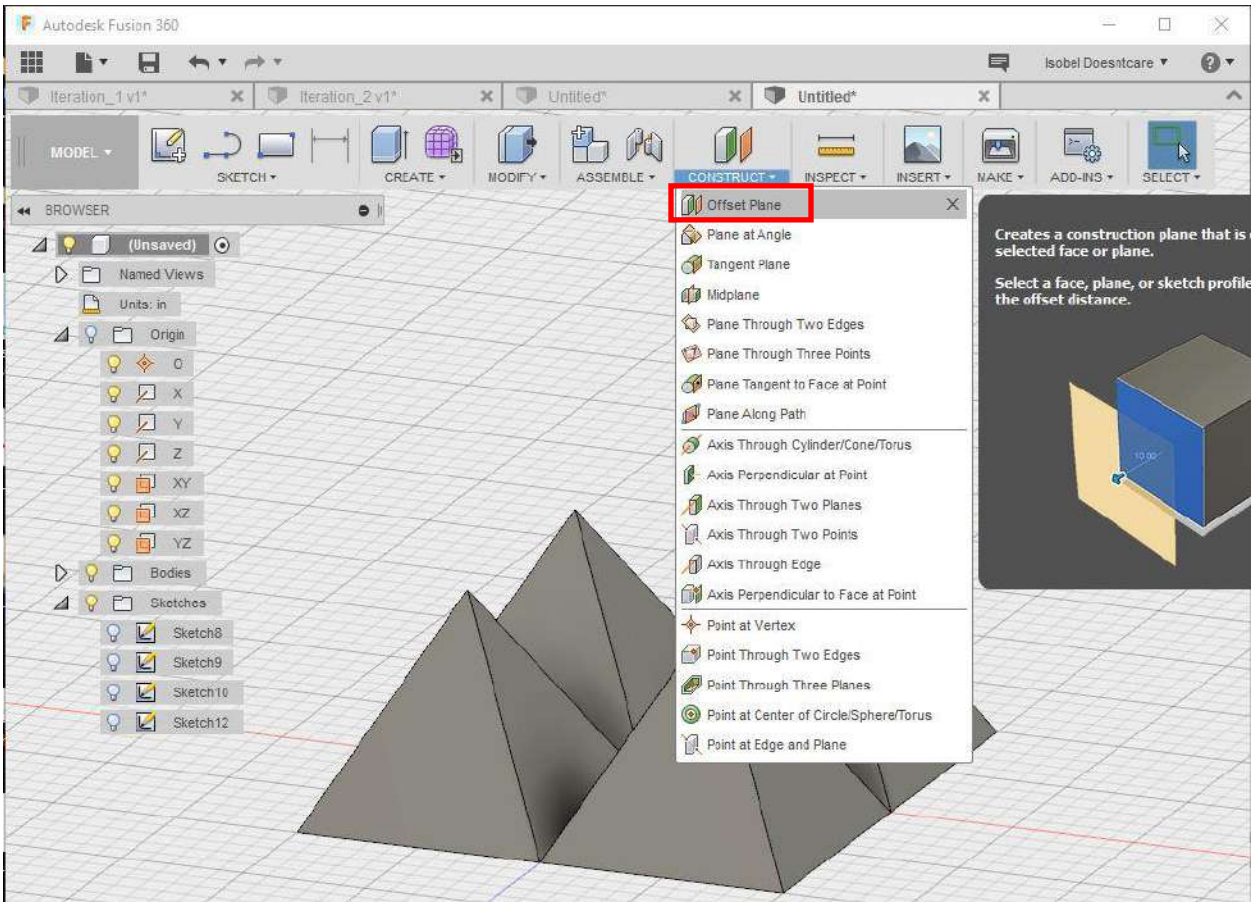




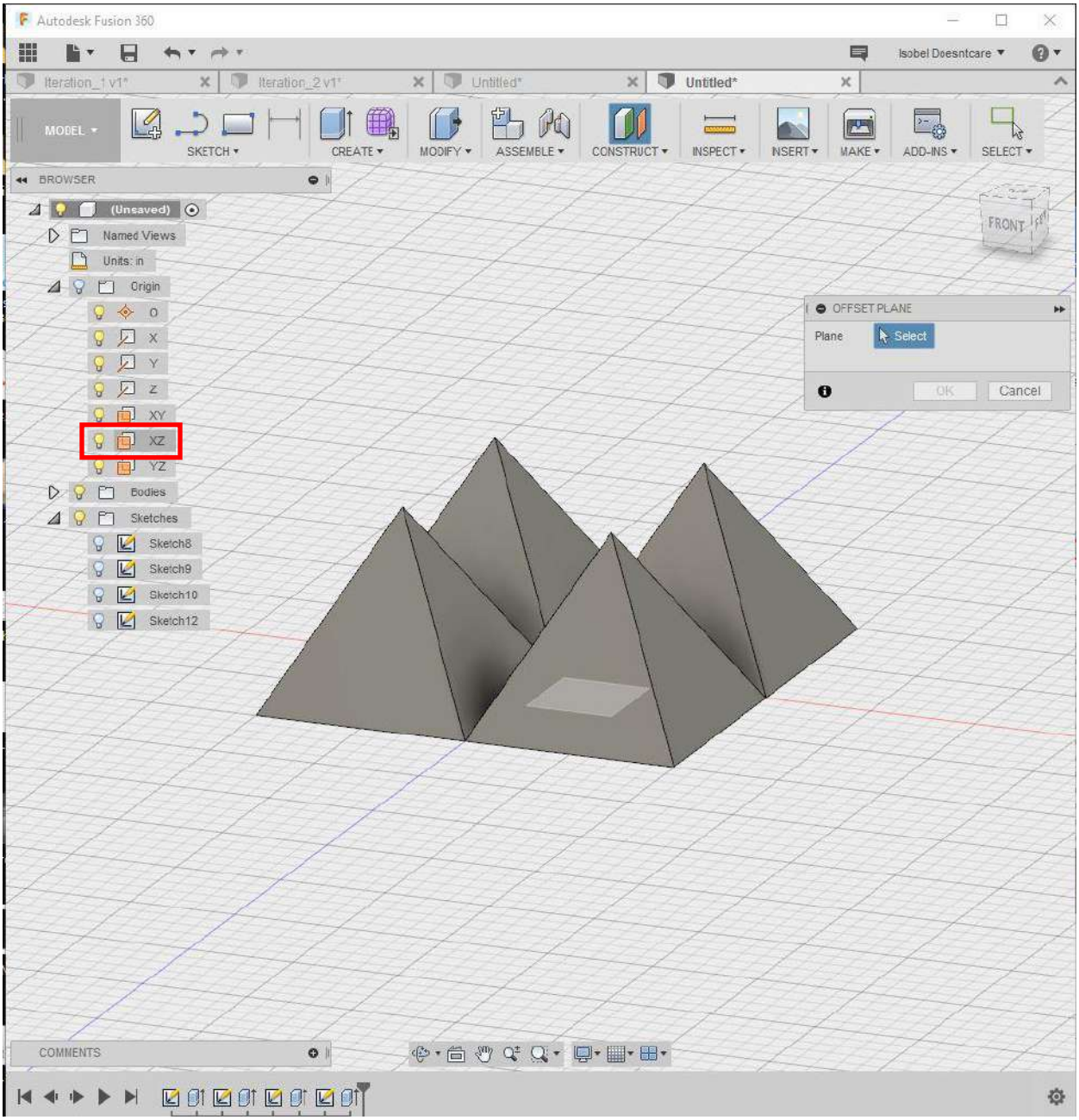
16. Once your screen resembles the last picture of step 15, the array of 4 Tetrahedrons, we will begin creating the Tetrahedron that will be placed on top of the array with 4 corners coincident with the 4 “points” of the array of 4 Tetrahedrons as shown below.



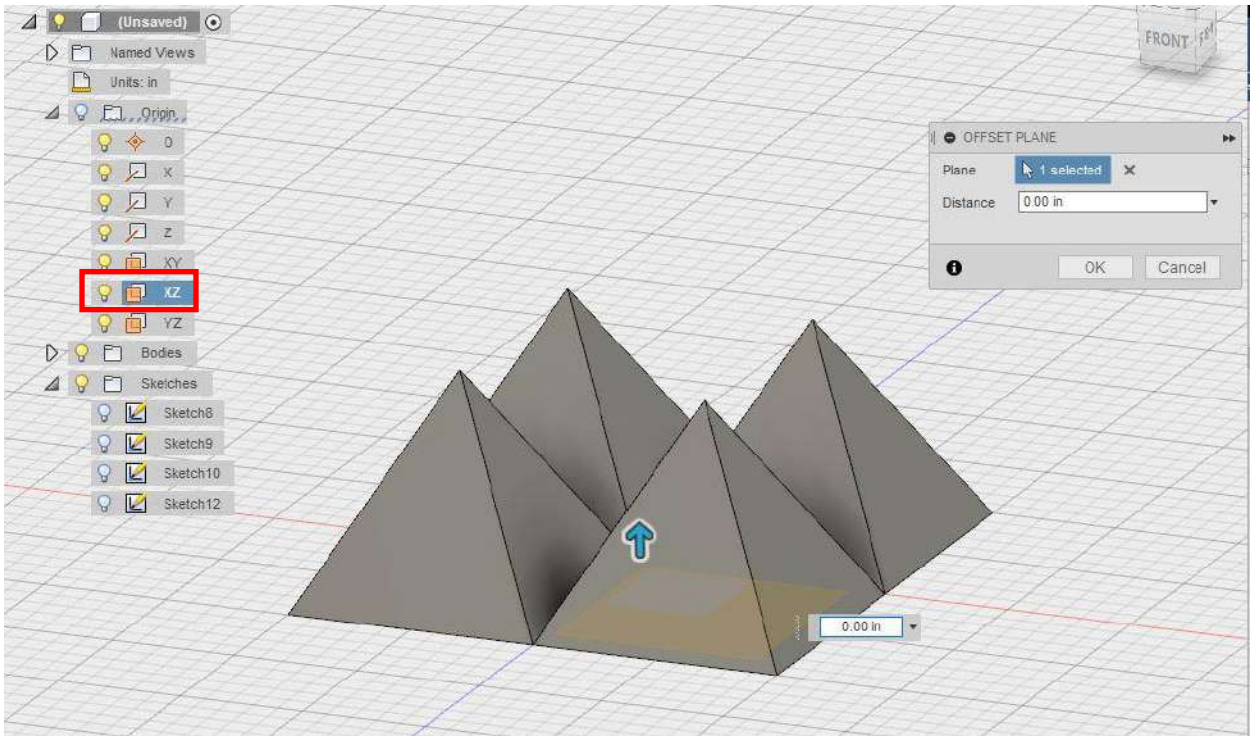
17. To **LOCATE** the top Tetrahedron in space, we must create a **REFERENCE PLANE** that is coincident with the top points of all 4 Tetrahedrons in the array. Because the software knows that all 4 existing Tetrahedrons of the array are identical we will define this **REFERENCE PLANE** as parallel to the **XZ PLANE** and coincident with the top point of one of the existing Tetrahedrons in the array.

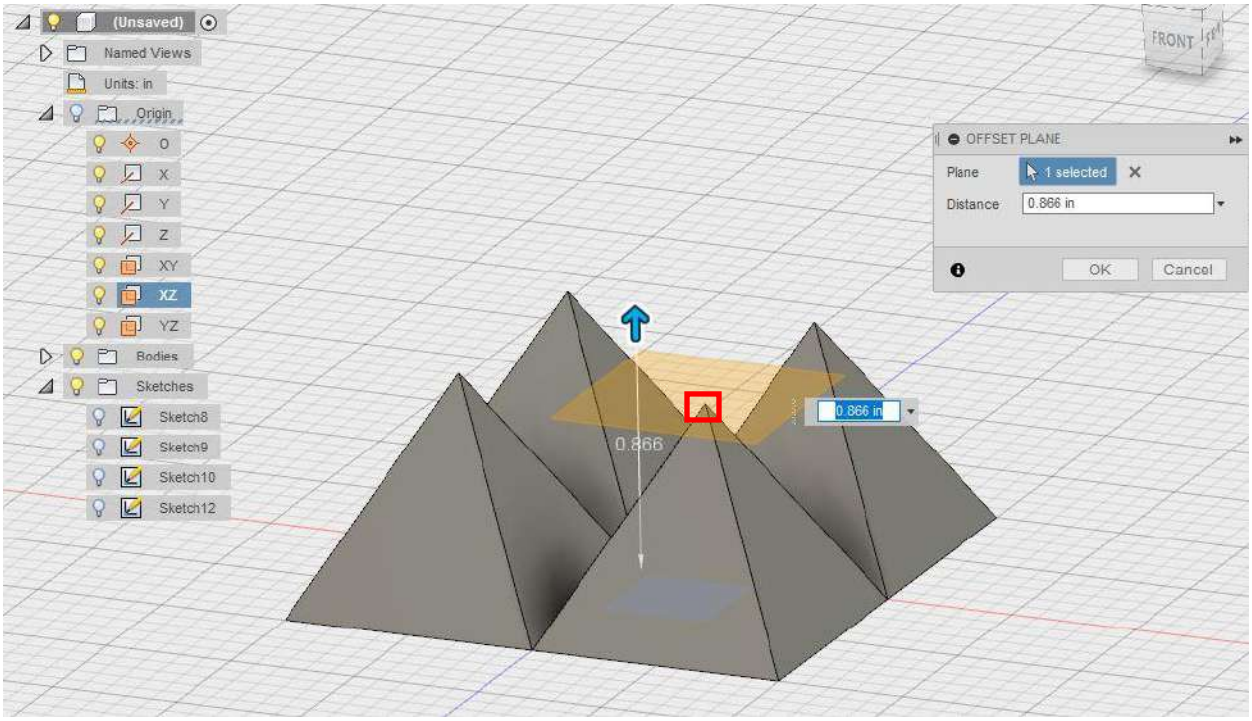


18. Click on **ORIGIN** on the left-hand side bar to expand the menu. Select the **XZ PLANE** as shown in the picture below. Notice how the plane becomes visible in the model window when you “roll over” or “select” the **XZ PLANE**.

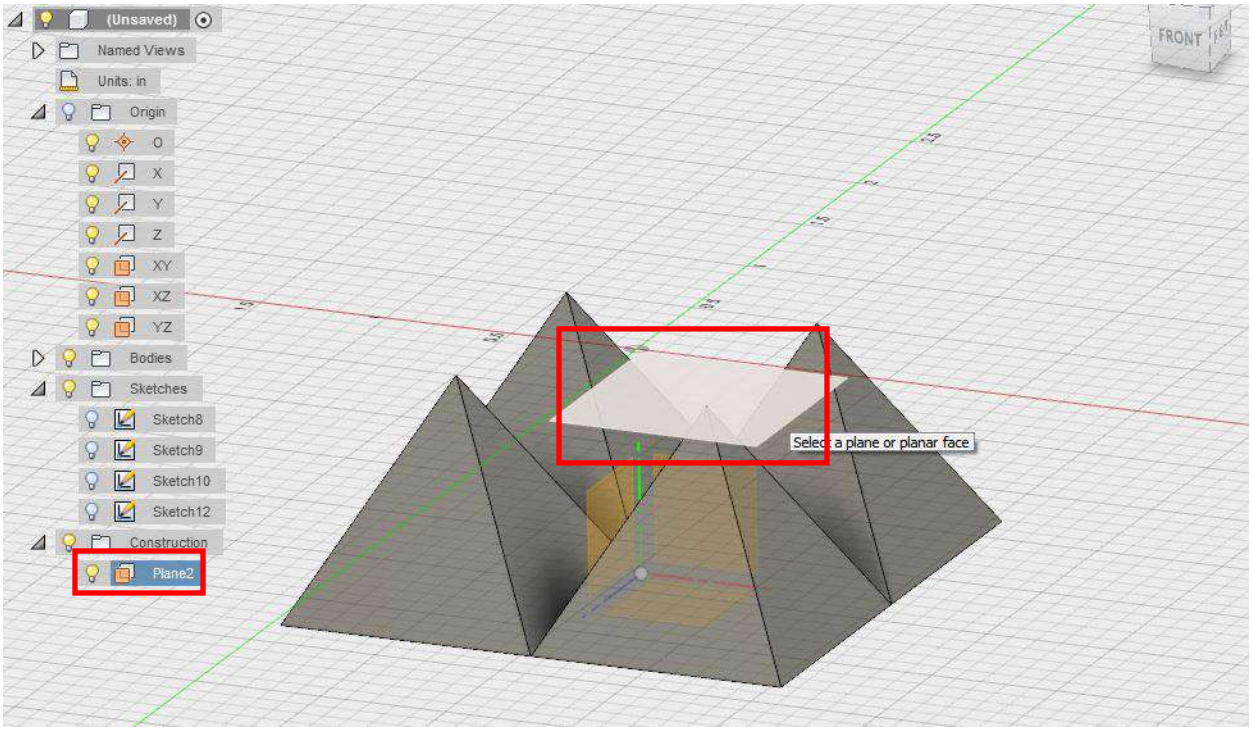


19. Now that the **XZ PLANE** has been selected, the offset from the **XZ PLANE** must be defined. Rather than manually enter a number, we will let the computer program do the work for us. Simply select the top point of one of the Tetrahedrons in the array to automatically define the **REFERENCE PLANE** as coincident to that point. The two images below walk through this step.

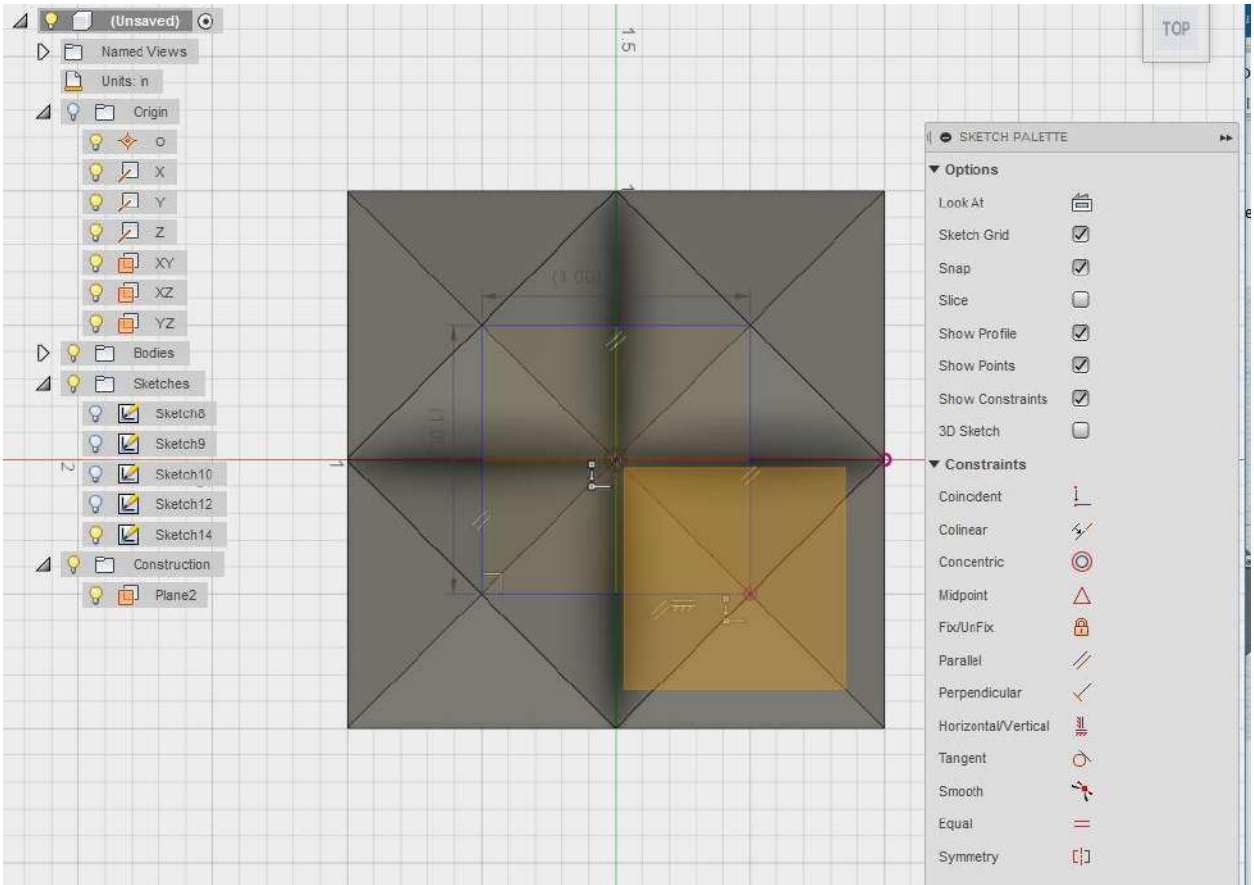




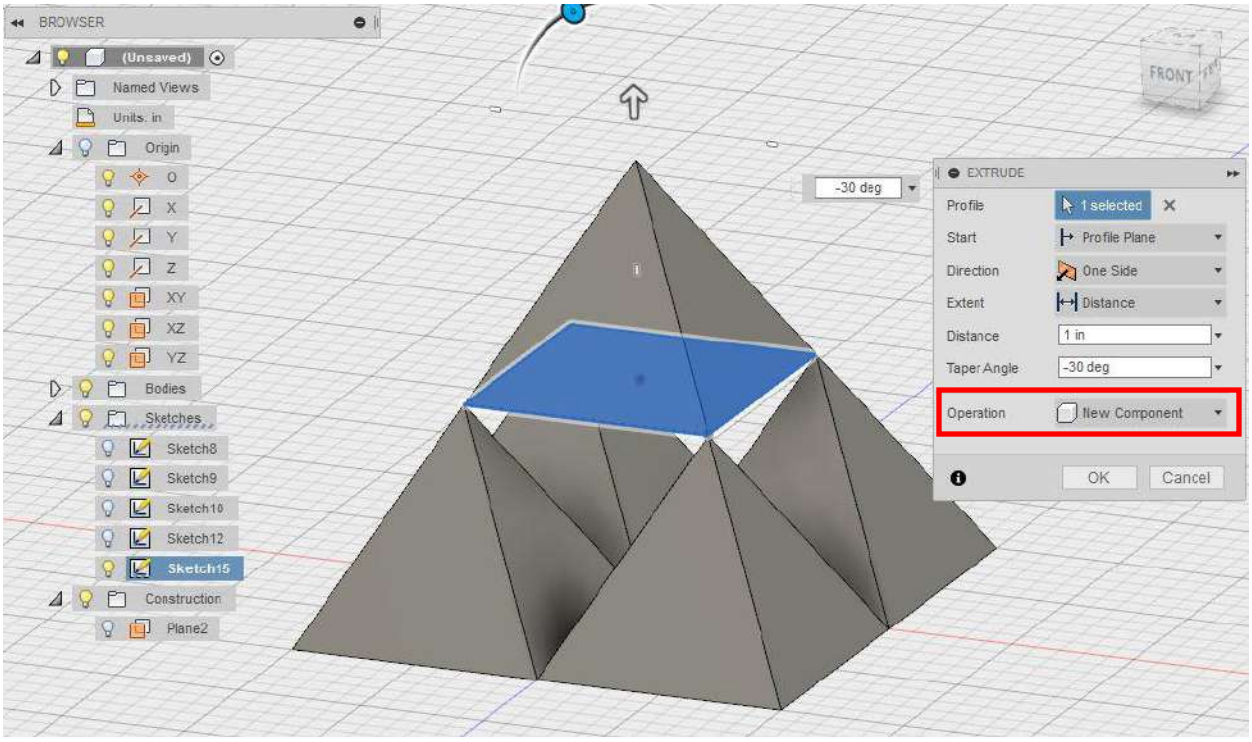
20. Create a sketch on the **REFERENCE PLANE** we just created using the same methods described in the previous steps to create the 4 base Tetrahedrons.



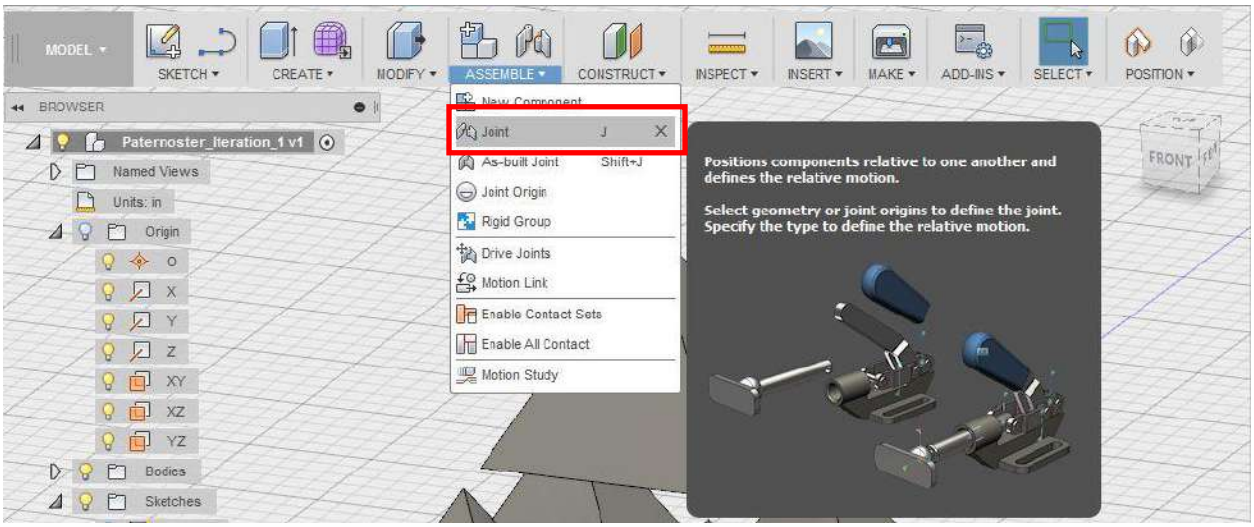
21. Sketch a center point rectangle as shown in the picture below. Again, the side dimension should be 1.00 inch by 1.00 inch.



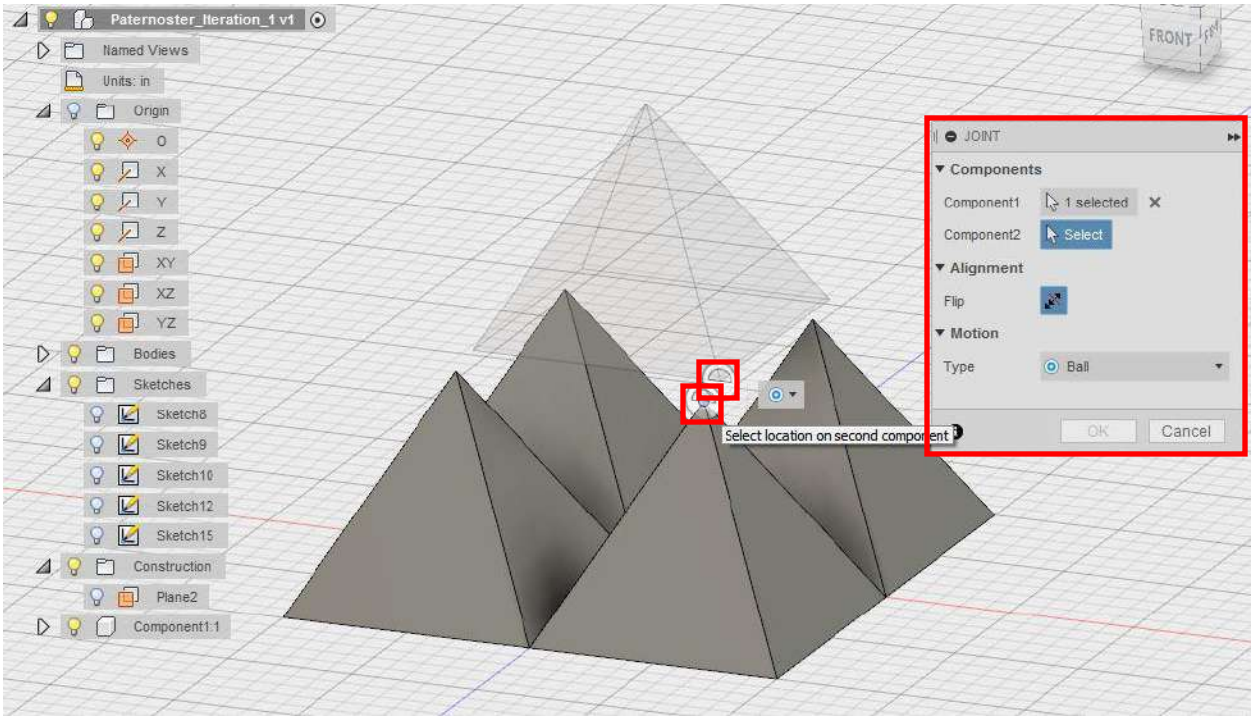
22. **EXTRUDE** the sketch on the **REFERENCE PLANE** so that it is exactly the same as the other 4 Tetrahedrons of the base array. **BE SURE THAT THE OPERATION "NEW COMPONENT" IS SELECTED IN THE "OPERATION" WINDOW** (I have selected the area of interest in **RED**).



23. **JOIN** 3 bottom points of the top Tetrahedron with any 3 top points of the bottom 4 Tetrahedrons.

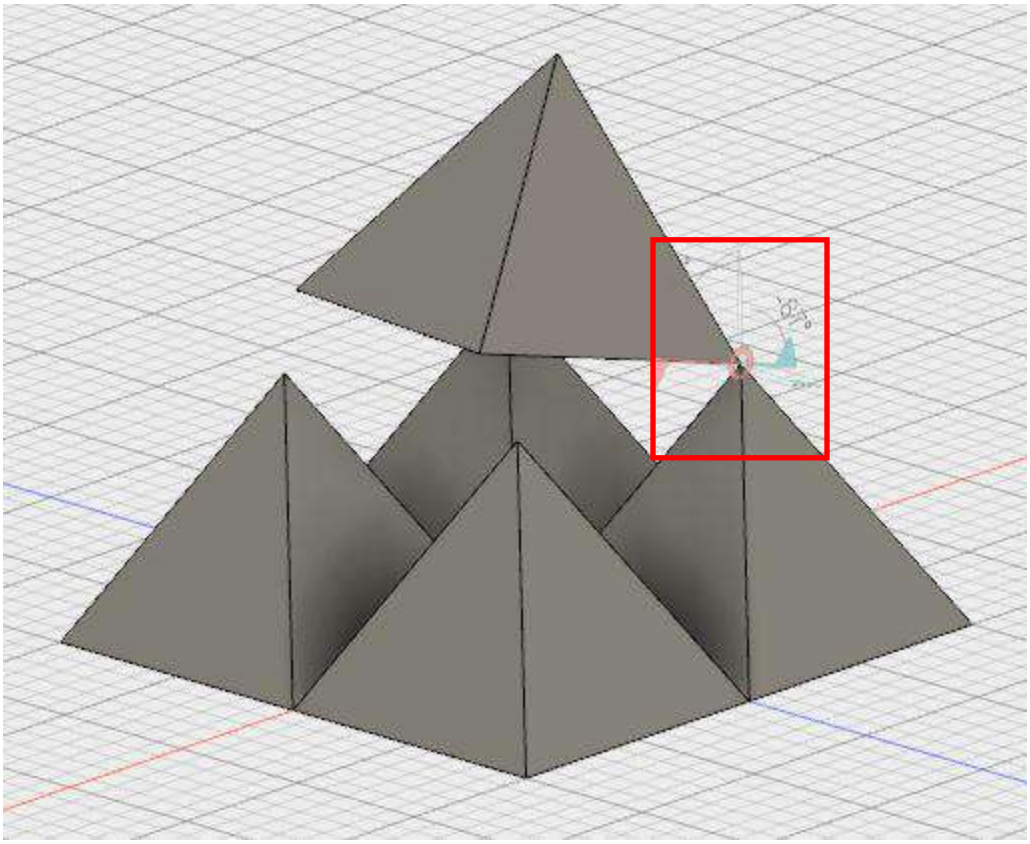


IF YOU GET A POP-UP WINDOW ABOUT "SOME COMPONENTS HAVE MOVED" SELECT "CAPTURE NEW POSITION."

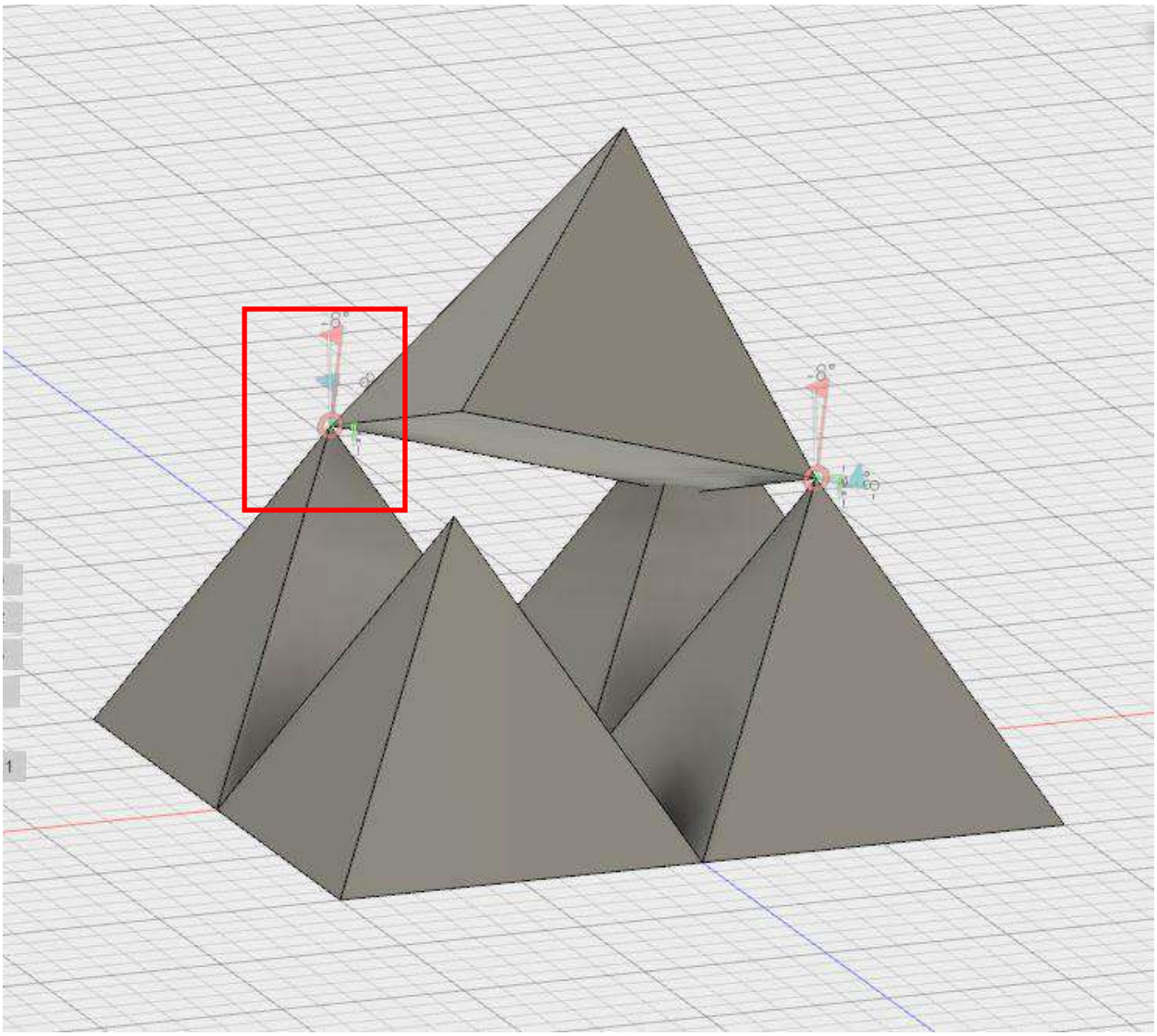


BE SURE THAT THE "JOINT" TOOLBAR LOOKS EXACTLY AS ABOVE

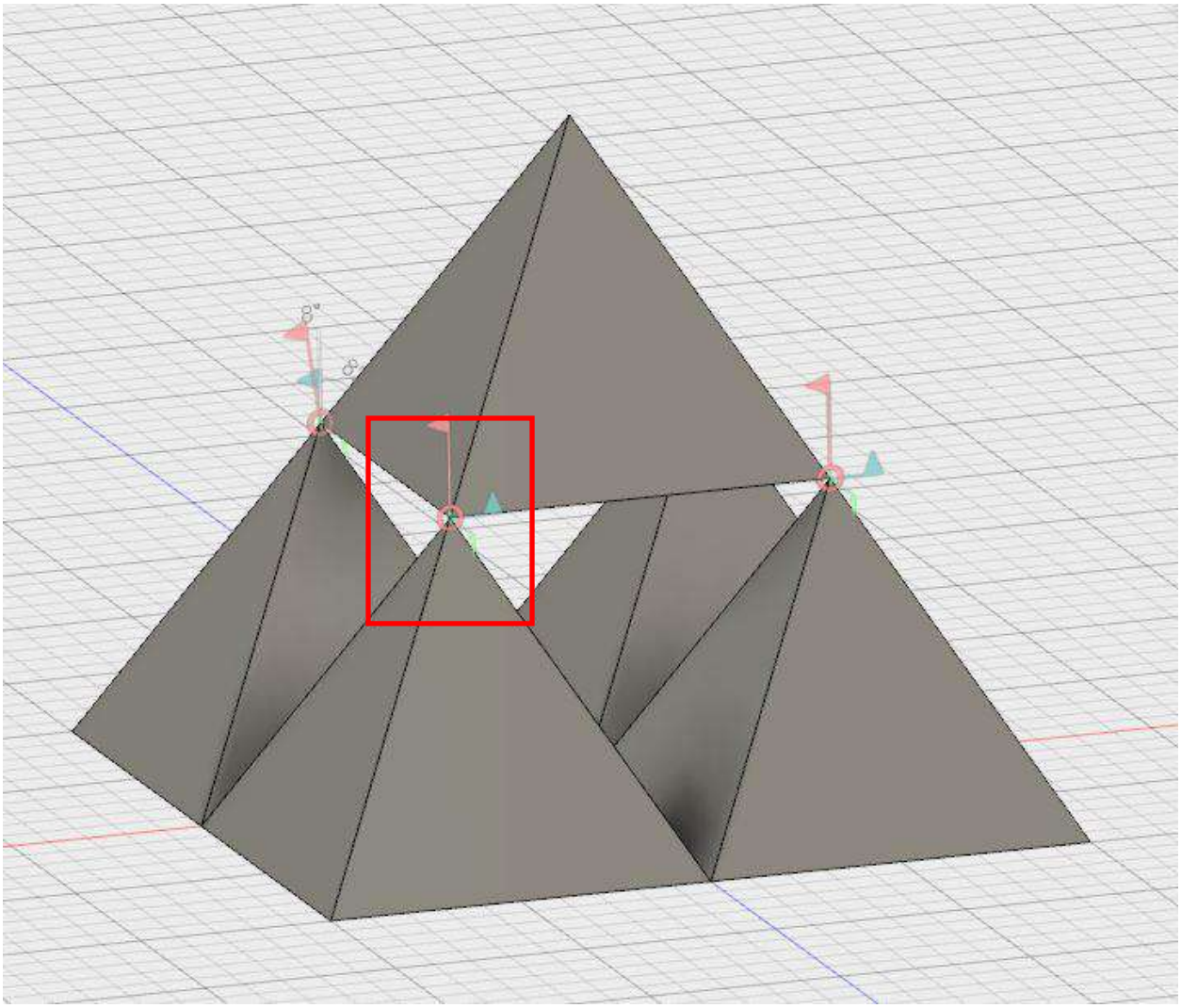
24. **CLICK** and **DRAG** the top Tetrahedron so that it appears as in the picture below.



25. **CREATE** another **JOINT** using the same method as pictured below.

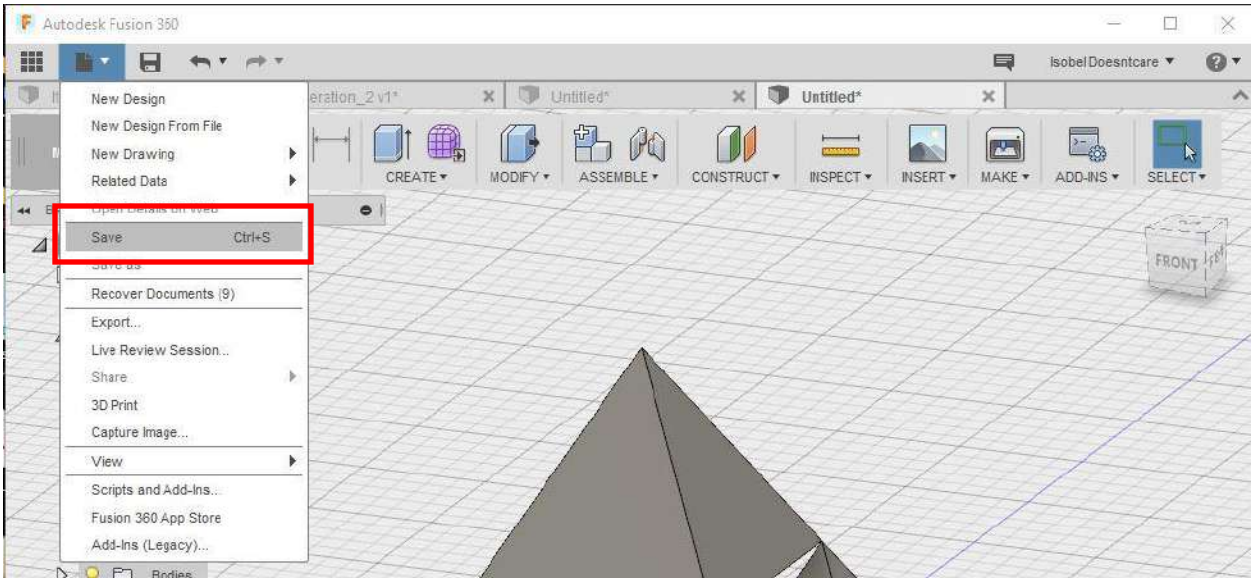


26. **CREATE** another **JOINT** using the same method as pictured below.

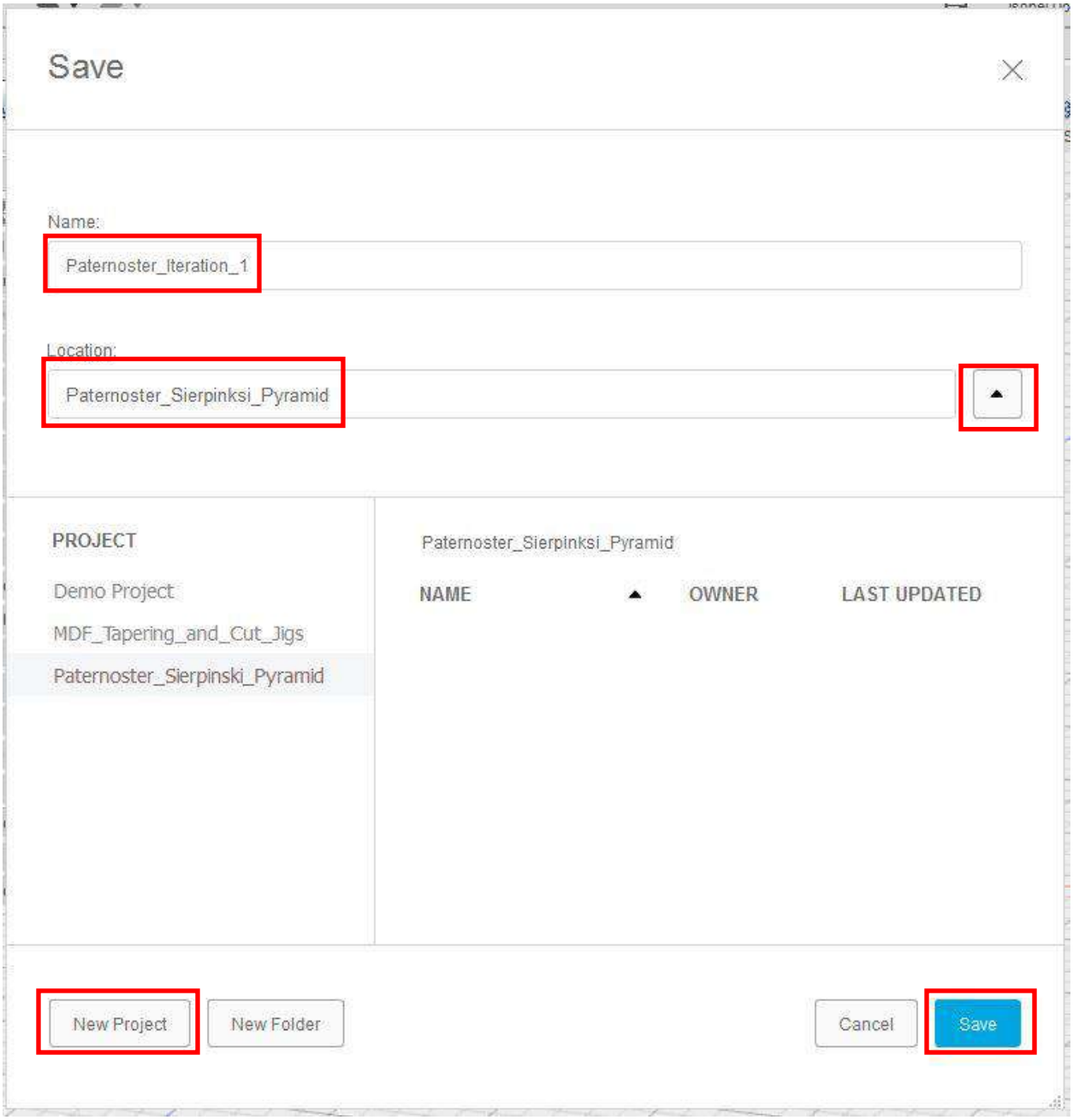


27. Congratulations! You have completed the Sierpinski Tetrahedron!

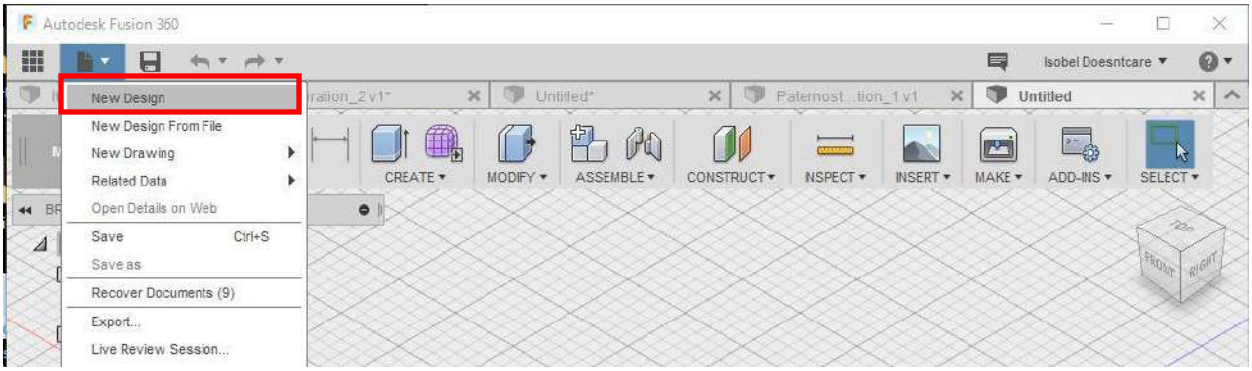
28. **SAVE** your document as follows in the picture below. You **MUST** use the file name with your own last name **EXACTLY** as follows: “Lastname_Iteration_1”



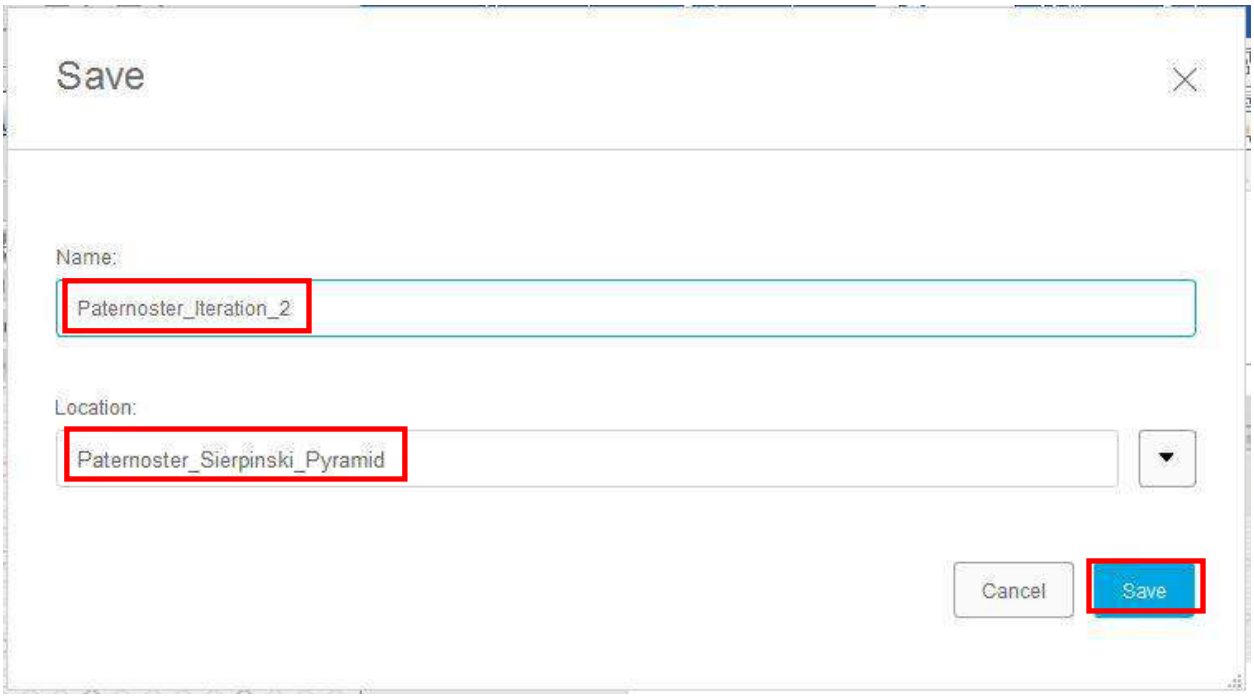
Click the **DOWN ARROW** highlighted in the picture below and select **NEW PROJECT**. Label the project "Lastname_Sierpinski_Tetrahedron" **IF YOUR FILE IS NOT SAVED OR STORED CORRECTLY IT CAN NOT BE PRINTED**.



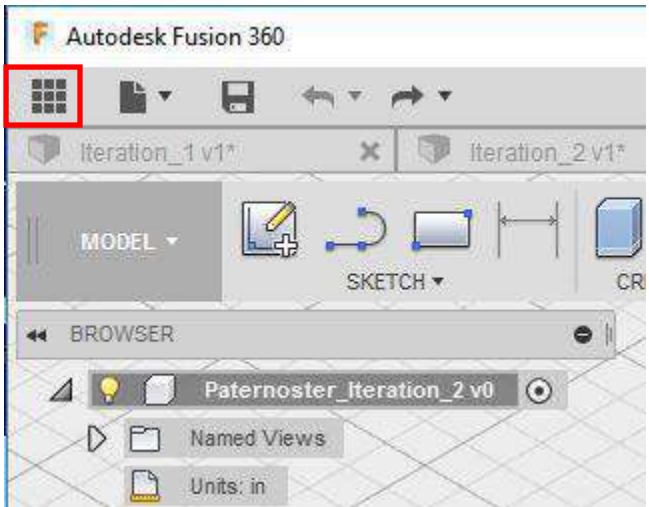
29. Start a **NEW DESIGN** the same way as **STEP 2**. **CONFIRM YOUR UNITS ARE INCHES!**



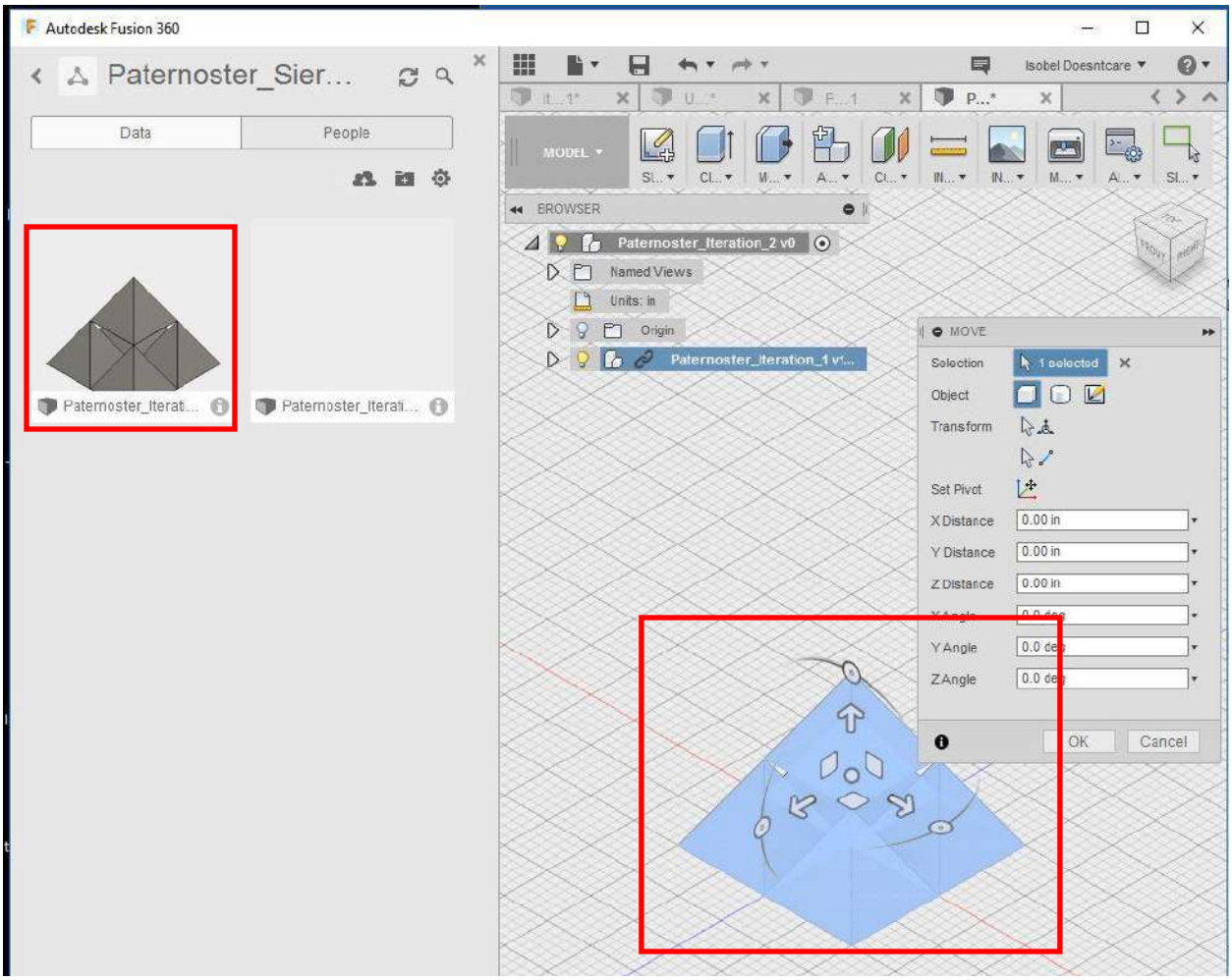
30. **SAVE** this file as "Lastname_Iteration_2" in the same **PROJECT**.



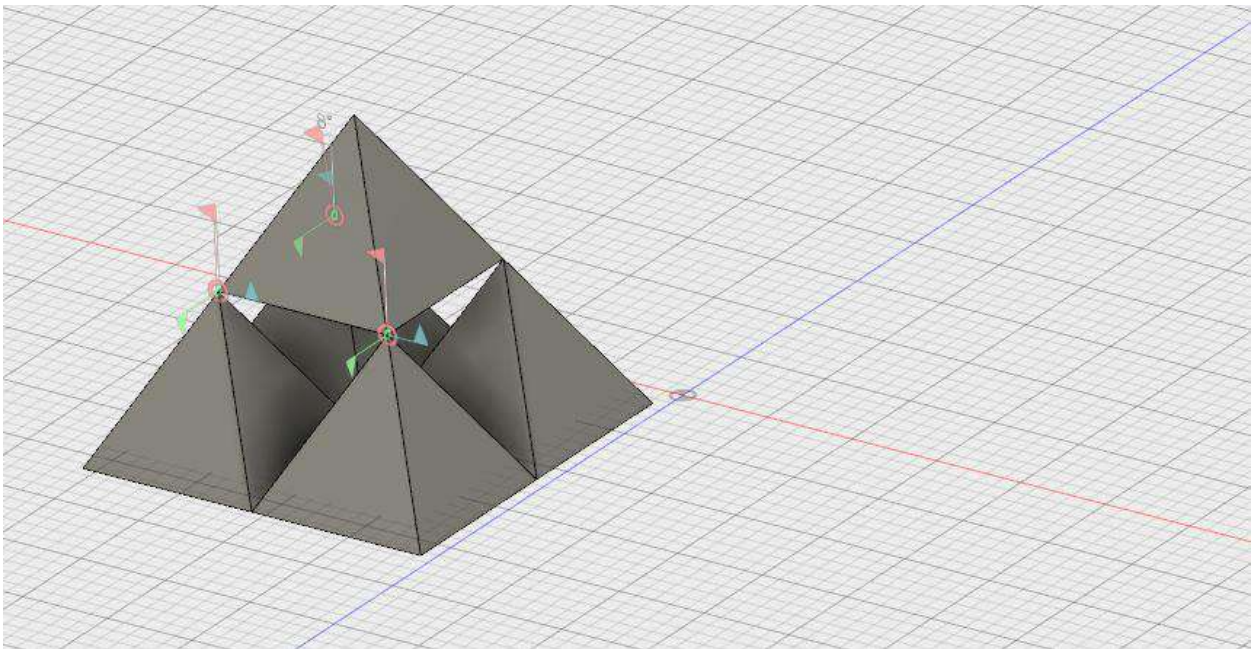
31. **CLICK** on the **ARRAY OF 9 SQUARES** in the top left corner of the screen to open the project window. Here you should see your file labeled "Lastname_Iteration_1"



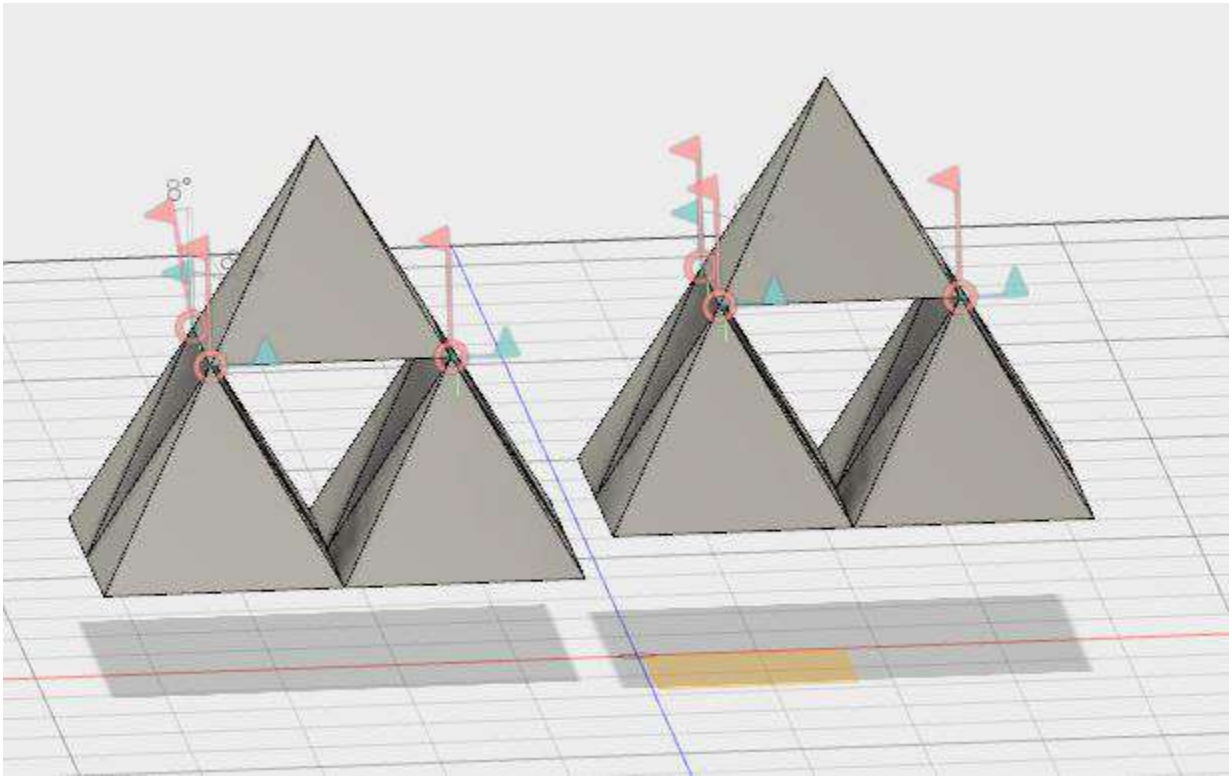
32. **DRAG AND DROP** the file labeled “Lastname_Iteration_1” from the left hand tool bar into the design screen on the right hand side.



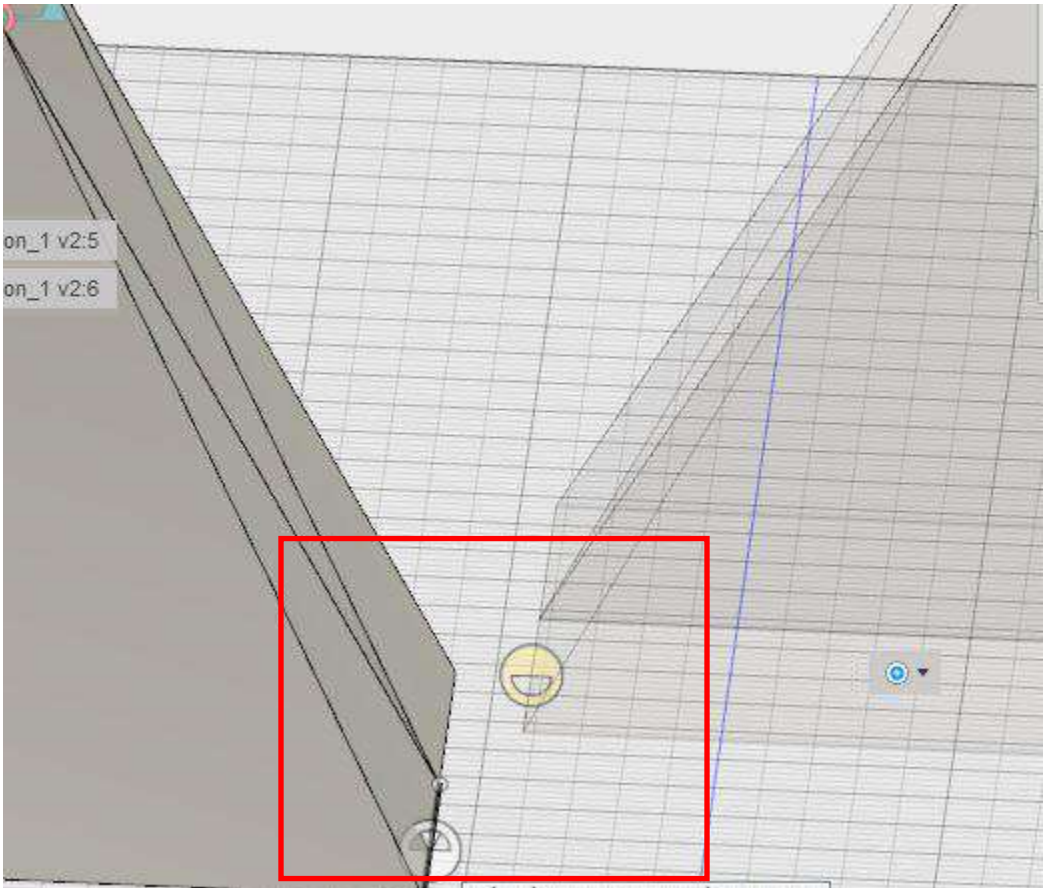
33. **DRAG** and **DROP** the Tetrahedron as shown in the picture below so that the foot print of the Tetrahedron only occupies 1 quadrant of the **XZ PLANE**.

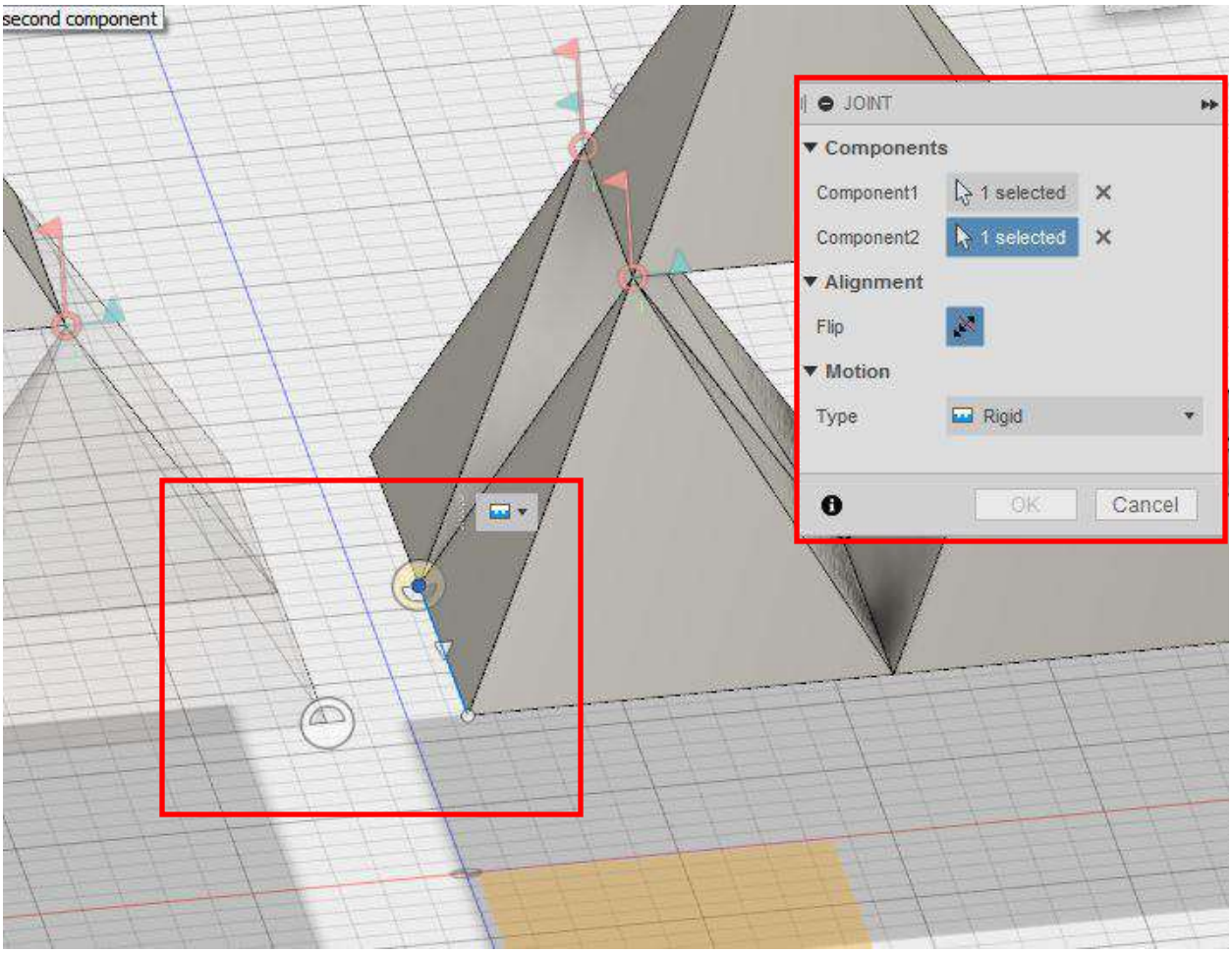


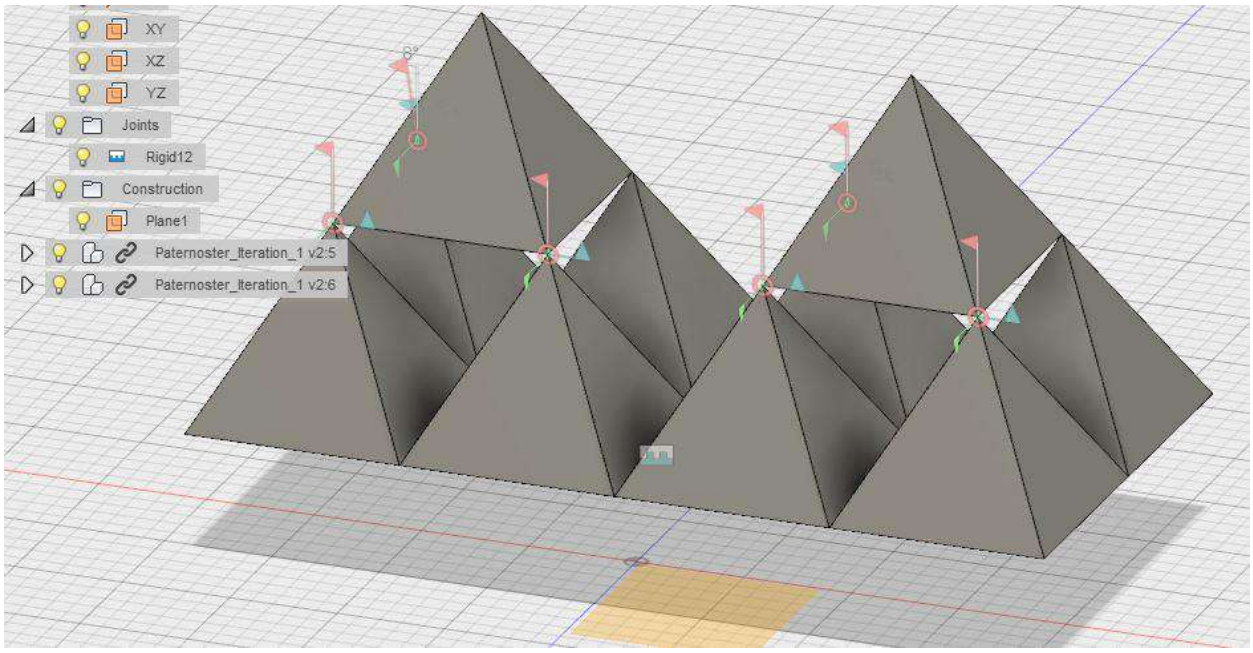
34. **DRAG** and **DROP** another Tetrahedron as shown in the picture below so that the foot print of the Tetrahedron only occupies 1 **OTHER** quadrant of the **XZ PLANE**.



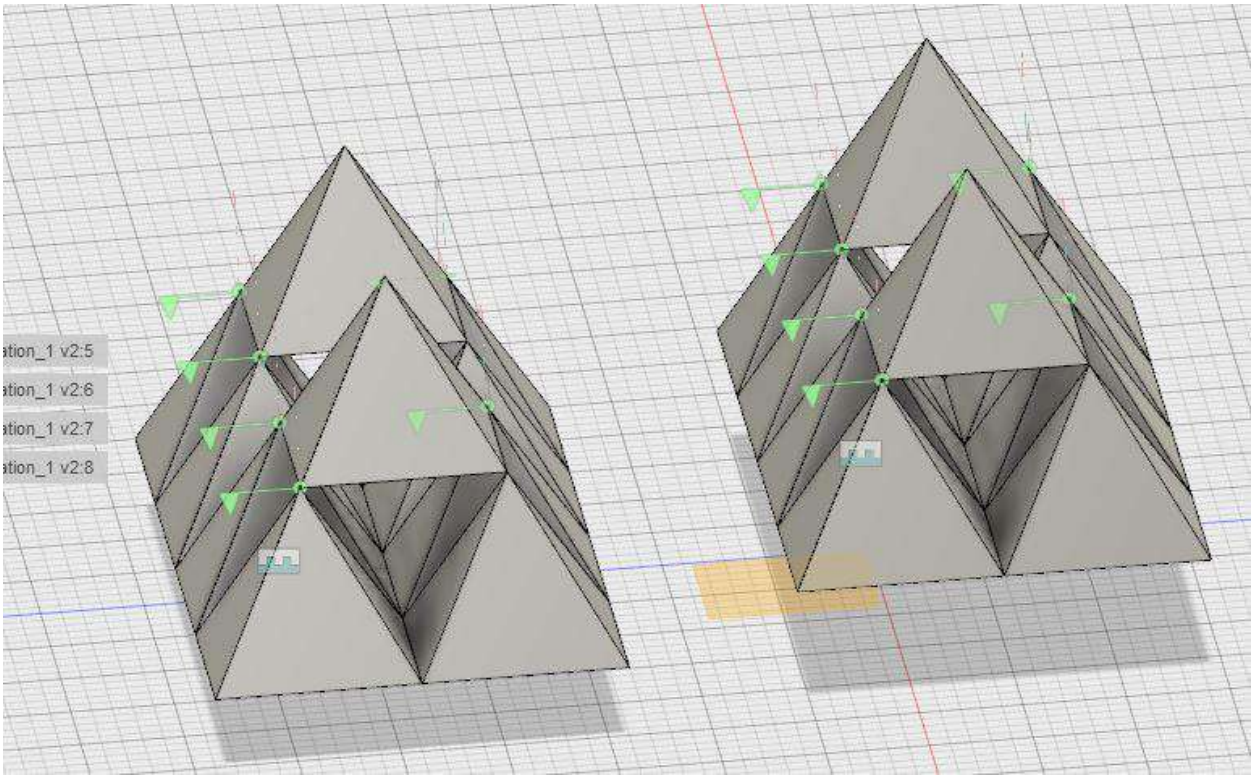
35. **JOIN** two bottom edges of the Tetrahedrons together as shown in the picture below using the **JOIN** tool. Be sure that your **JOIN** window looks exactly like the join window in the second picture in this step.



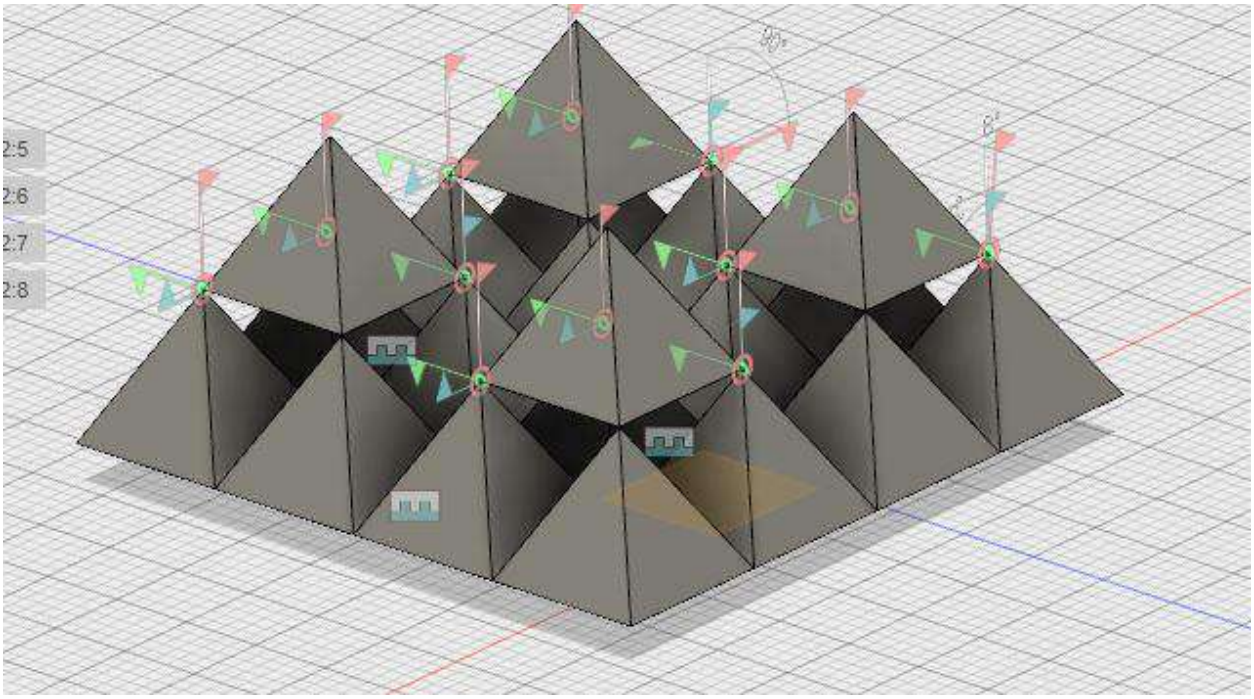

second component
JOINT
Components
Component1
1 selected
Component2
1 selected
Alignment
Flip
Motion
Type
Rigid
OK
Cancel


XY
XZ
YZ
Joints
Rigid12
Construction
Plane1
Paternoster_Iteration_1 v2:5
Paternoster_Iteration_1 v2:6

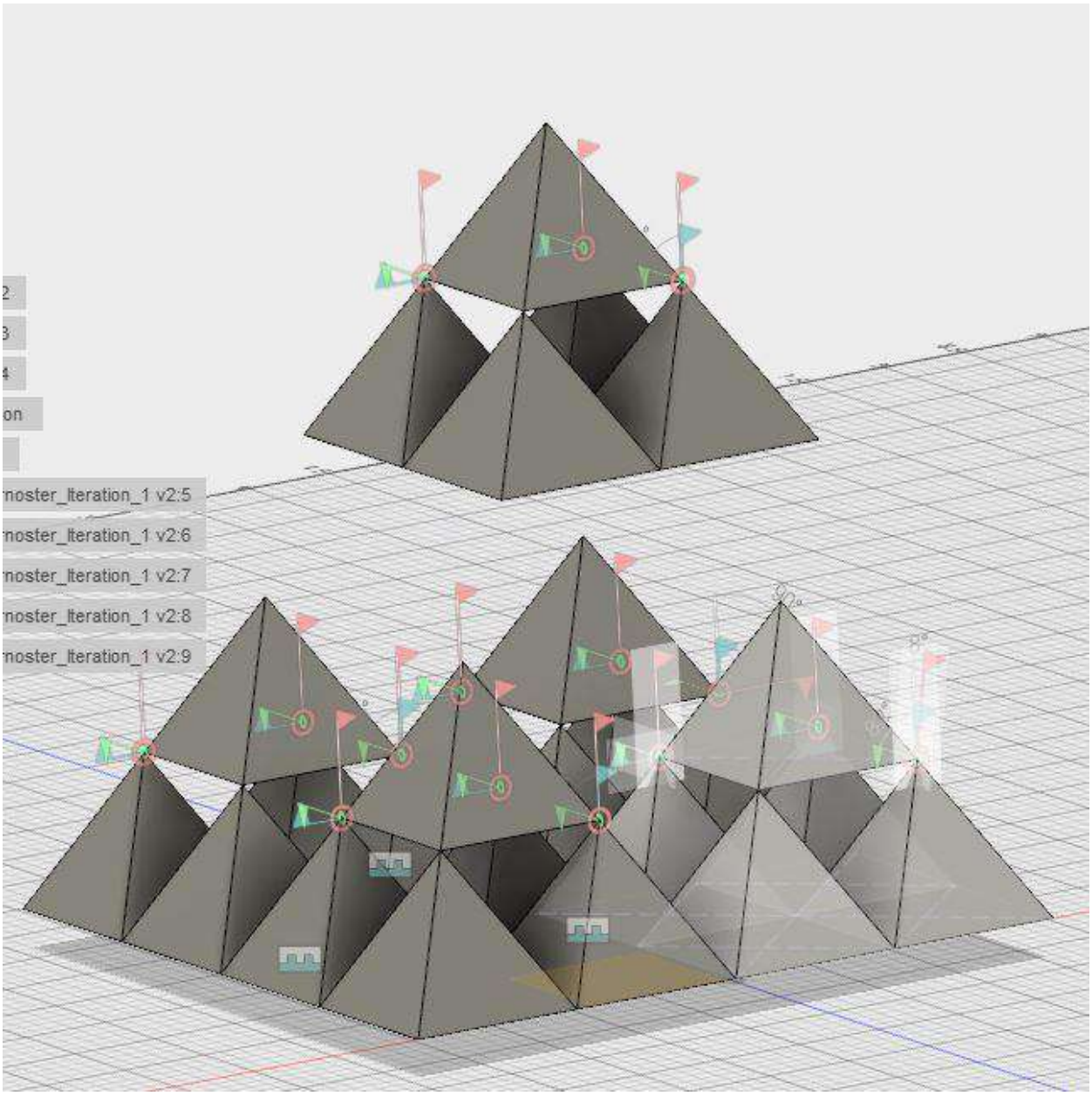
36. **REPEAT** steps 33 – 35. Insert 2 more Tetrahedrons and join them together separately. Your screen should look like the picture below.



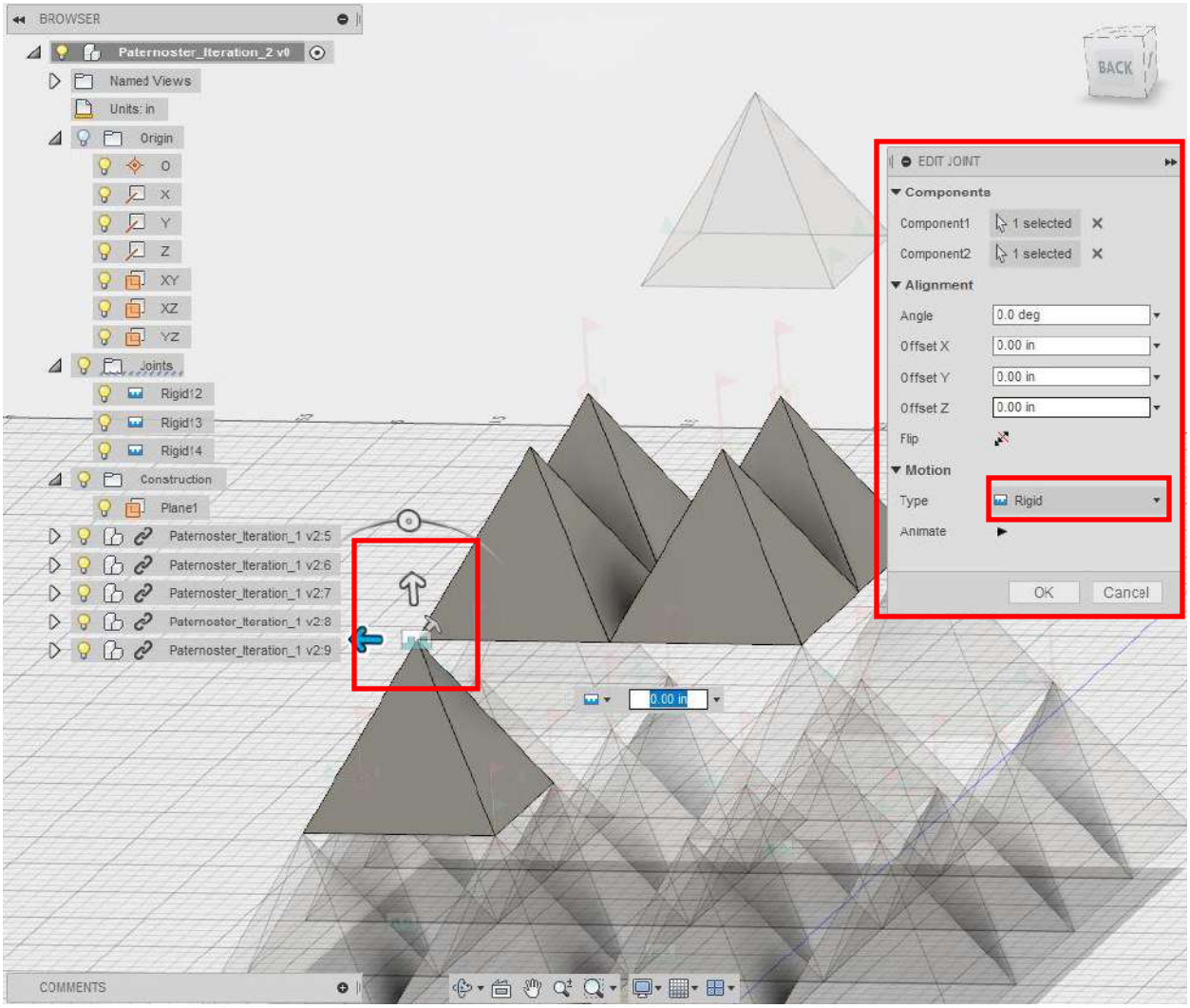
37. **JOIN** the 2 arrays of 2 Tetrahedrons together using the **JOIN** tool as shown in the picture below.



38. **DRAG** and **DROP** one last Tetrahedron into the **DESIGN SPACE** as shown in the picture below. Move this last Tetrahedron roughly centered above the array of the 4 bottom Tetrahedrons by clicking and dragging it around the **DESIGN SPACE**.



39. **JOIN** the one bottom point of the top Tetrahedron one of the top points of the bottom Tetrahedron using the **JOIN** tool as shown in the picture below.



40. Step back and relax! You should have a completed 2 iterations of Sierpinski's Tetrahedron Model! Be sure to save your work!