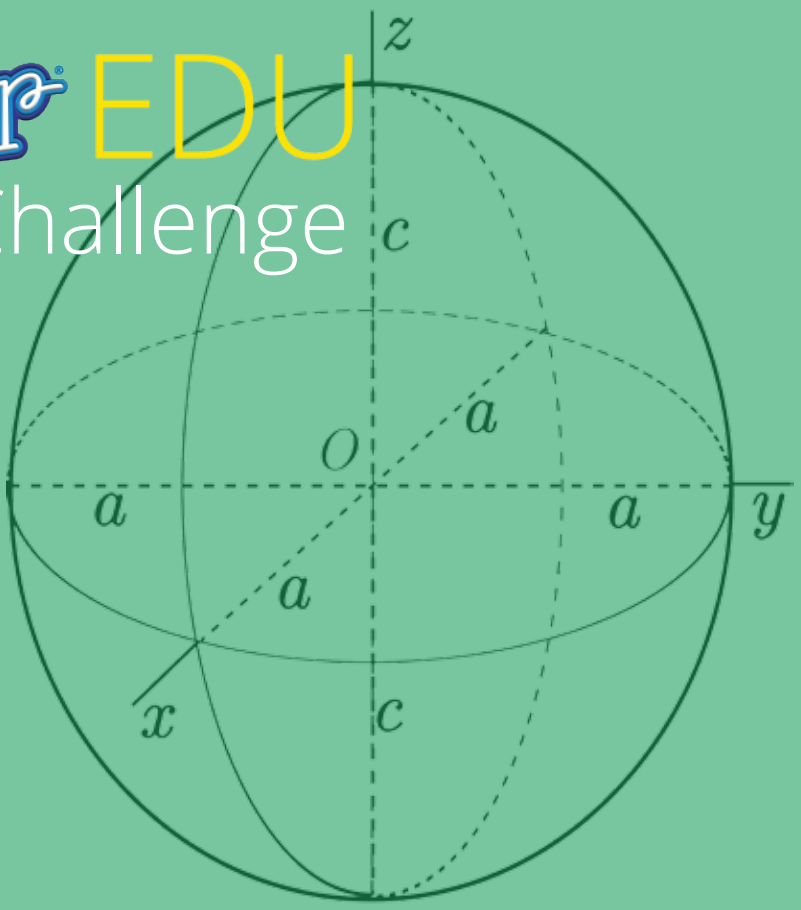
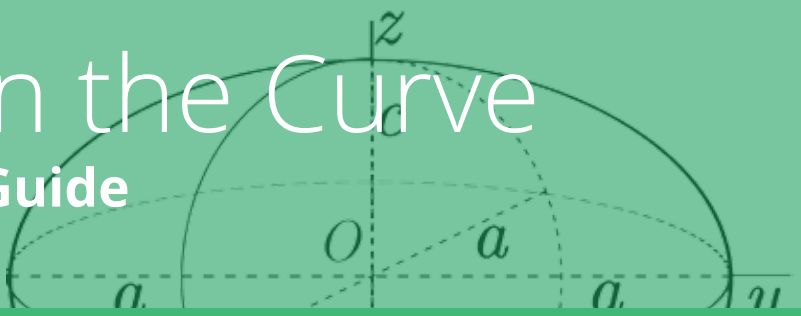
3Doodler EDU

Design Challenge



Math on the Curve

Facilitator's Guide



The Challenge

Explore mathematical equations for spheres and ellipsoids created with the 3Doodler pen and plastic strands.

Overview

Total Time: 100 minutes (2 Class Periods)

This challenge asks participants to use the 3Doodler to create a sphere and an ellipsoid drawing concentric circles and ellipses using planar geometry. Participants will make a string compass to create the circles and ellipses with the 3Doodler pen.

Challenge Background

Challenge Tip
Use graph paper to increase and decrease the size of the circles and ellipses at consistent intervals.


Fig. 1


Fig. 2

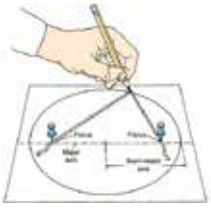
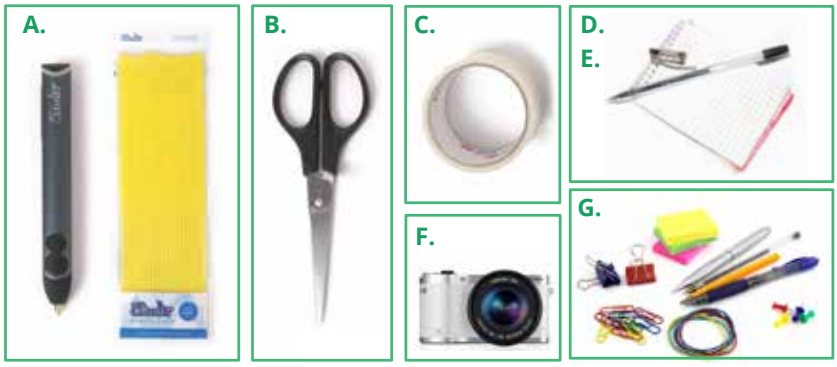


Fig. 3

Circles and ellipses have been created by hand for centuries. A low-tech mechanism of a scribe and a stake were used to make circles large and small. Galileo is credited with making the first mechanical compass to draft complicated shapes consistently. One way to create spheres and ellipsoids is to suspend concentric circles of increasing and decreasing diameter. This is seen in paper lantern construction, where the circles are equally placed and connected with cross pieces and paper.

Materials & Tools

Before You Start Doodling
We recommend using a DoodlePad or clear tape placed over paper as a foundation to keep your Doodles in place and so that you can peel them off with ease.



A. 3Doodler Pens and Plastic Strands of various colors (one per student, or have students work in pairs or small groups)
B. Tools (from your 3Doodler box) plus needle-nose pliers or scissors for snipping plastic ends
C. Clear plastic tape or DoodlePad for Doodling foundation
D. Paper for Doodling foundation and extra sketching/note-taking space
E. Drawing utensils (markers, pens or pencils)
F. Camera or video recording device to document the Challenge and results
G. Graph paper, string, push pins and wood or foam core to make the string compass

Challenge Organization

Challenge Documentation
Take photos & videos of your process using a camera. Document what to do and what not to do. Share your experience with the online community using #3DoodlerEDU!

Challenges are organized into 50-minute periods so they can fit into a traditional classroom structure, or be combined into a single workshop with breaks in between activities. This Challenge is designed to have participants work in short sprints to quickly explore the concepts.

Class 1: Plan & Design

Total Time: 50 min.

Plan & Design (50 min.)

Step 1: Create a sphere and ellipse string compass based on the images in the Challenge Background.

Step 2: Determine the maximum size of the circle and ellipse on an 8.5" x 11" piece of graph paper.

Step 3: Determine the number of circles and ellipses needed to create your volumes.

Step 4: Draw a diagram for reference and provide the calculations for your circle and ellipse shapes.

Step 5: Determine an even spacing scheme for your shapes.

Step 6: Test your sphere and ellipse string compass with graph paper and a pencil. Make any adjustments required.

Step 7: Test out your sphere and ellipse string compass with your 3Doodler pen. (Note: do not build your volume yet, that will come in the next class.)

Facilitator's Notes
In Class 1, have participants work in teams of four to create a circle and an ellipse string compass. Groups members will take turns drawing the planar circles and ellipses to create a sphere. Feel free to give them an initial foci or radius to work from and have them calculate how many spheres or ellipses they will need to create their volume.

Class 2: Build, Present & Reflect

Total Time: 50 min.

Build (40 min.)

Remember to Snip Those Ends
We recommend pliers or scissors for snipping plastic ends. Make sure to keep your plastic ends clean to prevent clogs and jams. Snip plastic after removing it from the 3Doodler pen to make sure it's clean for the next time.

Step 1: Working in teams, choose two team members to work on constructing the ellipse and two team members to work on constructing the circle.

Step 2: Gather your plastic strands and begin making all of the planar shapes for your volumes.

Step 3: Assemble the shapes together using 3Doodler pen and plastic strands to weld the shapes. (Hint: one teammate will be holding the shapes in place while the other will be welding with the 3Doodler pen.)

Step 4: Work the final calculations for your sphere or ellipse volumes.

Facilitator's Notes
Participants will work together to develop their proposal. If working during a class period, meet with each team to assess their progress and offer suggestions or cues to the types of information they may be missing or need to consider.

Present & Reflect (30 min.)

Step 1: Gather participants around a display table and have each participant place their spheres and ellipsoids on the table.

Step 2: Go around the group and have each participant discuss what the process was like for them and what they learned about creating a structure, including the following:

- Discuss the dimensions
- Provide the formulas for the circles and ellipses
- Provide the formulas for the spheres and the ellipsoids

Facilitator's Notes
On the Build day, make sure that there is enough room for teams to work and spread out. Make sure there are ample outlets, power strips and extension cords so that teams can reach all areas of the structure they are creating.

Facilitator's Notes
Have participants provide feedback to each other's teams and make suggestions on improvements. Document the final challenges and note the issues and successes for each team. If time allows, you can add a Re-Iterate phase where students try to improve their Doodled domes based on the test results and group feedback.

More Information:

For more information on ellipse formulas in action, please visit:

- http://www.mathopenref.com/coordgeneralellipse.html

For more information on circles in action, please visit:

- http://www.mathopenref.com/coordbasiccircle.html

For more information on finding the loci of an ellipse, please visit:

- http://www.mathopenref.com/constellipsefoci.html

Images:

Cover Page: https://goo.gl/ET4552

Fig.1: https://upload.wikimedia.org/wikipedia/commons/e/e8/Globe_Lights.jpg

Fig. 2: http://www.sew4home.com/sites/default/files/1693-Circle-Compass.png

Fig. 3: http://britton.disted.camosun.bc.ca/ellipse.gif