**Hershey Kiss Volume Estimation Lab**

**Objective:**

Students will understand the concepts of volume of cones and pyramids, as well as approximation methods used in calculus.

**Grade Level:**

High School (Geometry, Algebra II, Pre-Calculus, Calculus)

**Materials:**

Real Hershey's Kisses

Rulers or measuring tapes

Computers/Tablets with internet access

GeoGebra 3D Calculator (online or app)

AR-capable device with KissLab\* preloaded in GeoGebra 3D calculator app

**Pre-lesson Activities:**

Provide a brief review of the formulas for the volumes of cones and pyramids.

Introduce the concept of approximation and its relevance to calculus, particularly the method of limits.

**Lesson Activities:**

*Introduction to Modeling (10 minutes):*

Introduce the task of modeling a Hershey's Kiss using the GeoGebra 3D Calculator.

Demonstrate accessing the provided GeoGebra link and explain the interface briefly.

*Setting Variables (10 minutes):*

The scale must be set to the value the AR app provides in the scale legend. This will make the scale measurements in GeoGebra match the real measurements.

Students will input values for Diameter, Scale, and number of sides to approximate the shape of a real Kiss

Discuss the significance of these variables in modeling real-world objects.

Ensure students understand how the number of sides affects the shape and accuracy of the model.

*Pyramid Creation and Volume Calculation (20 minutes):*

Have students make a table of values listing the sides of the polygon and the Volume of the Pyramid formed.

AR Alignment and Adjustment (20 minutes):

Have students align the virtual Kiss with a real Hershey's Kiss using AR.

Instruct students to adjust the diameter until the virtual model matches the real candy.

*Discussion and Analysis (15 minutes):*

Discuss the results and the approximation of the volume.

Compare the calculated volume with the actual volume provided.

The diameter of the base of a Kiss is .819 inches and the diameter and height are the same. Therefore the volume is .14382 in^3 Reference: https://www.physicsforums.com/threads/volume-of-a-hershey-kiss.403646/

Extend the discussion to Jumbo Kisses and explore the relationship between diameter and volume.

*Extension Questions (10 minutes):*

What happens to the volume as the number of sides increases? Why?

How does this modeling process relate to the concept of limits in calculus?

Closure (10 minutes):

Summarize the day's activities and findings.

Discuss the real-world applications of volume approximation.

Assign homework or additional problems for practice if needed.

Assessment:

Students demonstrate the ability to create and manipulate geometric figures in GeoGebra.

Students calculate and compare volumes of approximations to actual values.

Students engage in discussion and answer extension questions accurately.

Homework:

Provide a worksheet with several objects to model using GeoGebra, calculating their volumes and comparing them to given actual volumes.

Teacher Notes:

Kiss Lab creation:

1. Create some variables-

 Diameter[.01 1], Scale [1,10], number sides [4,50]

2) Create some calculated values

 diameterScaled (Diameter/Scale)

 circumference = diameterScaled\* pi

3) Make a polygon using the following calculations

 poly1 = Polygon ((0,0-(circumference/(2\*numberOfSides)),0), (0,0+(circumference/(2\*numberOfSides)),0),numberOfSides,xOyPlane)

The resulting value is the area of the base

4) Create a Pyramid based on the poly1

 b = Pyramid(poly1,diameterScaled)

5) Calculate the Volume

 Volume = b Scale^3

\*Kiss Lab - <https://www.geogebra.org/m/uyw2ttb2>

**Hershey Kiss Volume Estimation Lab Sheet**

\*\*Hershey Kiss Volume Estimation Lab - Student Instruction Sheet\*\*

\*\*Objective:\*\*

To estimate the volume of a Hershey's Kiss using geometric modeling and understand the concept of approximation and percent error in measurements.

\*\*Materials:\*\*

- Hershey's Kisses

- Ruler

- Device with internet access and AR capability

- GeoGebra 3D Calculator

\*\*Instructions:\*\*

1. \*\*Introduction:\*\*

 - Review the concept of volume for cones and pyramids.

 - Understand the significance of approximation in measuring real-world objects.

2. \*\*Modeling in GeoGebra:\*\*

 - Access the GeoGebra 3D Calculator through this link: [GeoGebra 3D](https://www.geogebra.org/3d/uyw2ttb2).

 - Familiarize yourself with the variables `Diameter`, `Scale`, and `number of sides`.

3. \*\*Setting Variables:\*\*

 - Enter values for `Diameter` (0.01 to 1 inch), `Scale` (1 to 10), and `number of sides` (4 to 50) to start modeling.

4. \*\*Building the Pyramid and Calculating Volume:\*\*

 - Create a pyramid with the polygon base and calculate its volume.

 - Note that the volume should be scaled appropriately using the formula `Volume = b \* Scale^3`.

5. \*\*Using AR for Alignment:\*\*

 - Open the KissLab on your AR-capable device.

 - Align the virtual Kiss with a real Hershey's Kiss using the AR function.

 - Adjust the `Scale` value to match the real Kiss.

6. \*\*Adjusting the Diameter:\*\*

 - Manipulate the `Diameter` until the virtual Kiss matches the size of the actual Hershey's Kiss.

7. \*\*Discussion:\*\*

 - Reflect on how increasing the number of sides (faces of the pyramid) improves the volume approximation.

8. \*\*Creating a Table of Values:\*\*

 - In a table, list the number of sides of your polygon, the volume of the pyramid, and the percent of error from the approximate value compared to the actual value of 0.14382 in³.

 

9. \*\*Analysis and Conclusion:\*\*

 - Complete your table with the necessary calculations.

 - Answer the following questions:

 - What trend do you notice as the number of sides increases?

 - How does the percent error change with an increased number of sides?

10. \*\*Submission:\*\*

 - Submit your completed table and answers to the analysis questions to your teacher.

\*\*Note:\*\*

Be sure to save your work periodically in GeoGebra to avoid any loss of data. Enjoy exploring the relationships between geometry, calculus, and the real world!

Performance Assessment:

**Instructions:**

1. **Model the Following Objects:**

a. **Cone (Ice Cream Cone):**

* + Diameter of base: 2.5 inches
	+ Height: 6 inches
	+ Actual Volume: 9.82 in³

b. **Cylinder (Soda Can):**

* + Diameter of base: 2.6 inches
	+ Height: 4.8 inches
	+ Actual Volume: 25.12 in³

c. **Sphere (Tennis Ball):**

* + Diameter: 2.7 inches
	+ Actual Volume: 10.36 in³

d. **Light Bulb (Standard Incandescent):**

* + Diameter of bulb: 2.4 inches (sphere part)
	+ Diameter of base: 1 inch (cylinder part)
	+ Height of base: 0.75 inches (cylinder part)
	+ Actual Volume: 4.5 in³ (combined volumes of the sphere and cylinder)
1. **Worksheet Table:**

| **Object** | **Estimated Volume (in³)** | **Actual Volume (in³)** | **Percent Error (%)** |
| --- | --- | --- | --- |
| Ice Cream Cone |  | 9.82 |  |
| Soda Can |  | 25.12 |  |
| Tennis Ball |  | 10.36 |  |
| Light Bulb |  | 4.5 |  |

To Model things in geogebra you will need to build some objects in 3d

Here are the steps we used to create a kiss, Modify these steps to make each shape to model:

1. Create some variables-

 Diameter[.01 1], Scale [1,10], number sides [4,50]

2) Create some calculated values

 diameterScaled (Diameter/Scale)

 circumference = diameterScaled\* pi

3) Make a polygon using the following calculations

 poly1 = Polygon ((0,0-(circumference/(2\*numberOfSides)),0), (0,0+(circumference/(2\*numberOfSides)),0),numberOfSides,xOyPlane)

The resulting value is the area of the base

4) Create a Pyramid based on the poly1 (if making cylinder use the cylinder tool

 b = Pyramid(poly1,diameterScaled)

5) Calculate the Volume

 Volume = b Scale^3

Gegebra tools to use

Draw a Cylinder with a circle and a height

Circle(point,radius)

Cylinder(circleA,height)

Draw a sphere with a point and a radius

Sphere ((x,y),radius)

**Note:** For the light bulb, you will model two separate parts and then calculate their volumes individually. The spherical part represents the glass bulb, and the cylindrical part represents the metal base. You will need to add the two volumes to get the total volume of the light bulb. Remember to account for the parts' dimensions accurately in your model for the best approximation.