Volume

v3.0

Applied Mathematics | **Curriculum Packet**

Overview:

In this lesson, students will learn how to determine the volume of rectangular prisms and cylinders. Then, students will work in teams to build a custom structure and determine its volume.

Activity Time:
120 Minutes

Targeted Grade Level:
3 - 5

Student Grouping:
Teams of 2

Additional Lesson Materials:
- Teacher Lesson Plan
- Student Engineering Workbook

Kid Spark STEM Lab:
STEM Pathways

***Note:** Two teams can share the engineering materials from one lab.*

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Learning Objectives & NGSS Alignment:

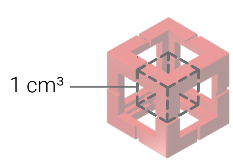
- Define volume.
- Determine the volume of rectangular prisms and cylinders.
- Build a custom structure and then determine its volume.

Scientific/Engineering Practice - Using mathematics
Crosscutting Concept - Scale, proportion, and quantity

Convergent Learning Activity:

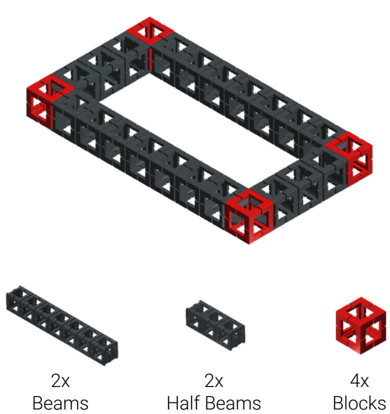
1. **What is Volume?**

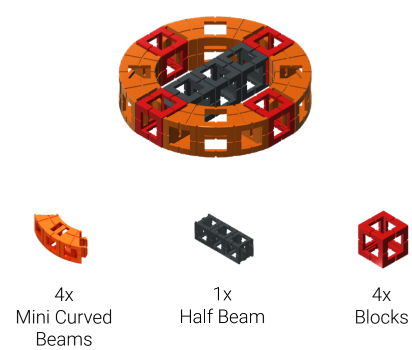
Volume is the amount of three-dimensionsal space an object occupies. Volume is measured in cubic units of a fixed size, such as cubic inches (in³) or cubic centimeters (cm³). For this lesson, we will be using cubic centimeters (cm³) to determine the volume of rectangular prisms and cylinders. Each block represents a volume of 8 cubic centimeters (8 cm³).



= **8 cm³**

Instructions: Assemble the objects shown below.





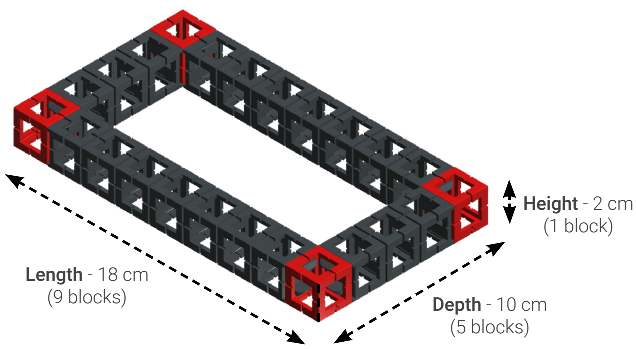
2. Determine the volume of rectangular prisms and cylinders.

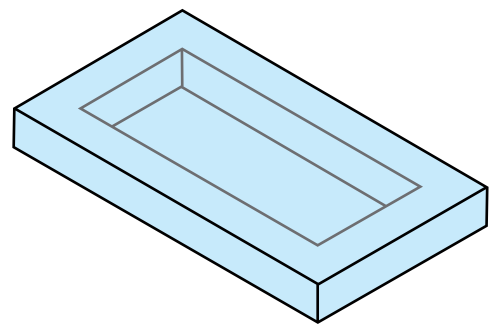
Rectangular Prism

To determine the volume of a rectangular prism, multiply the length by depth by height. This will determine the volume in cubic centimeters (cm^3).

Part A - Determine the volume

The rectangular prism has a length of 18 cm (9 blocks), a depth of 10 cm (5 blocks), and a height of 2 cm (1 block). Multiply 18 cm x 10 cm x 2 cm to get **a total volume of 360 cm^3.**

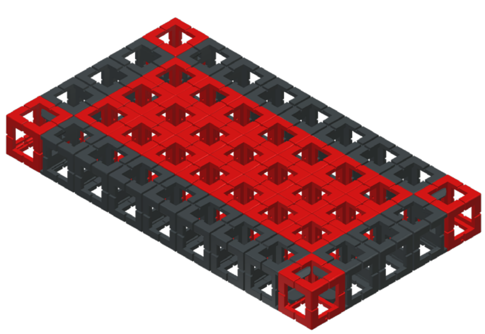


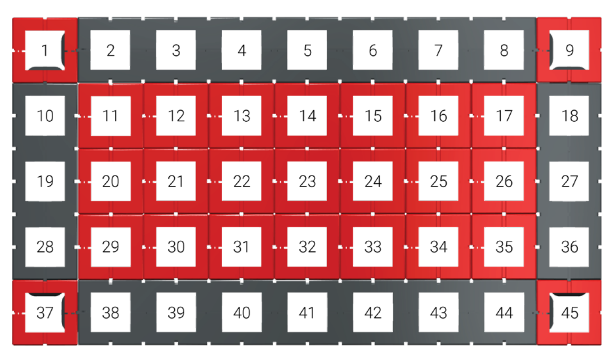


Part B - Check your math

Instructions: Fill the interior of the rectangular prism with extra red blocks as shown. Count the number of blocks that occupy the entire rectangular prism. In this example, there should be a total of 45 block units (9 x 5 = 45). Since each block unit represents 8 cubic centimeters, multiply 45 x 8 to get **a total volume of 360 cm^3.**

Note: *For this step, you may have to share extra red blocks with the other team that is using the same lab.*

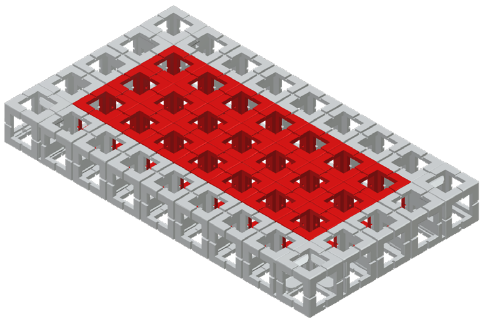


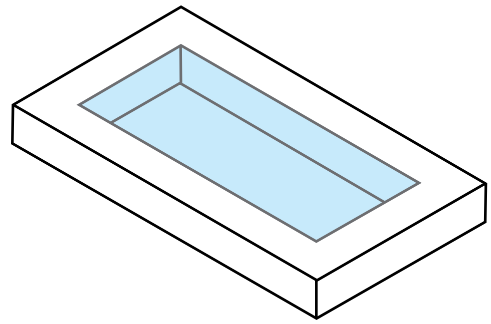


 = **8 cm^3**

Part C - Determine the volume

Instructions: Work with your team to determine the <u>interior volume</u> of the rectangular prism represented by the extra red blocks that were used in Part B.





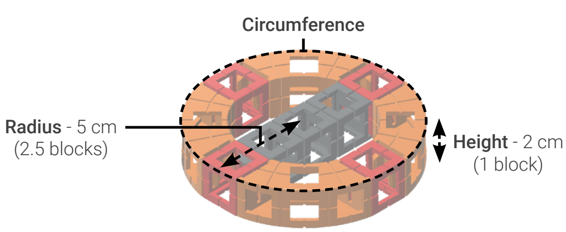
Cylinder

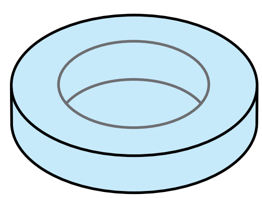
To determine the volume of a cylinder, the following formula can be used:

Volume = $\pi \times r^2 \times h$ ($\pi = 3.14$, r = radius, h = height)

Part A - Determine the volume

The cylinder has a radius of 5 cm (2.5 blocks) and a height of 2 cm (1 block). Multiply (3.14 x (5 x 5)) x 2 to get **a total volume of 157 cm³.**

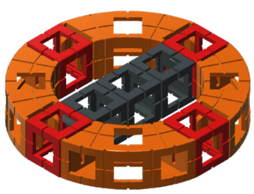


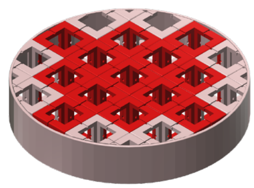


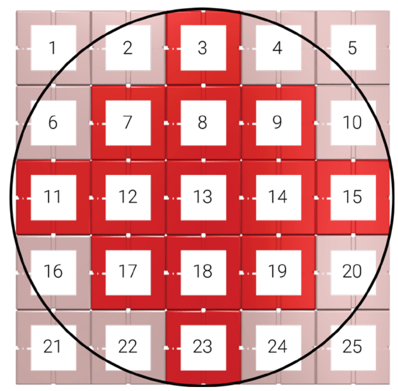
Part B - Check your math

Even though we can't physically fill the entire cylinder with extra blocks, we can still try to visualize how many blocks are used to completely fill the cylinder.

In the illustration below, a total of 25 blocks are used to fill the cylinder. Of the 25 blocks, 13 are full blocks, while the additional 12 are only partial blocks. If you were to try and combine the 12 partial blocks to make full blocks, you would end up with approximately 7 more full blocks. This would bring the total to approximately 20 full blocks needed to fill the cylinder. Since each block represents 8 cubic centimeters, multiply 20 x 8 to get **a total volume of 160 cm³.** This is very close to the total volume of 157 cm³ that was determined in Part A.



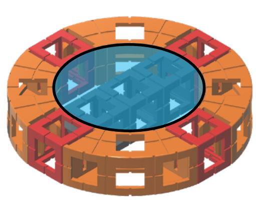


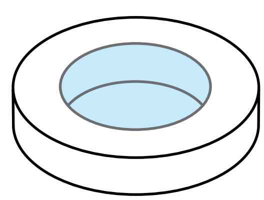


 = **8 cm³**

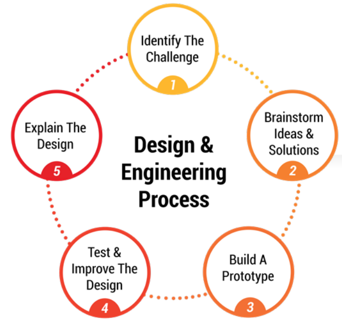
Part C - Determine the volume

Instructions: Work with your team to determine the <u>interior volume</u> of the cylinder represented in the illustration below.





Divergent Learning Activity:



Scenario:

The Spark City Parks and Recreation Department is looking to install a new swimming pool in one of the city parks. They are currently trying to determine an appropriate design that will work well for families of all ages.

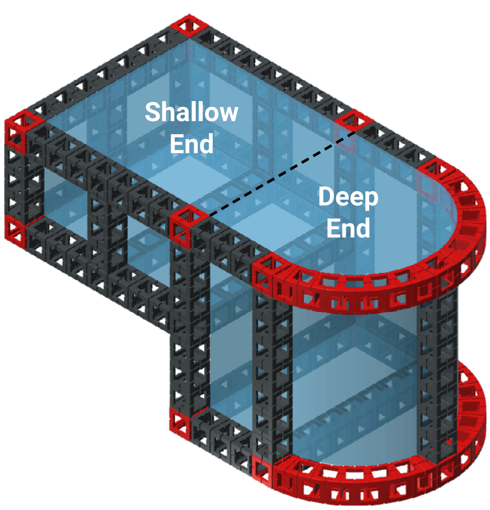
Design & Engineering Challenge:

Design and engineer a structure for a new swimming pool. (See example below)

Specifications/Criteria:

1. Teams can work in teams of two to complete this challenge. Teams should record their progress in their Student Engineering Workbooks.
2. Teams must work through each step of the Design & Engineering Process to design, prototype, and refine a custom structure for a new swimming pool. Teams will present their designs to the class when they are finished.
3. The swimming pool should include a shallow end and a deep end.
4. Teams must determine the total interior volume of the swimming pool.

Example Solution:



Total Interior Volume

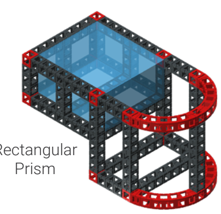
Shallow End - 1792 cm³

Deep End - 2798.88 cm³

1792 cm³ + 2798.88 cm³ = **4590.88 cm³**

Shallow End

The shallow end in this example is a rectangular prism.



Rectangular Prism

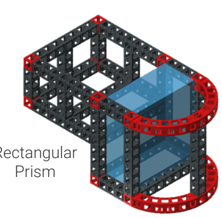
Rectangular Prism

Length - 16 cm, Depth - 14 cm, Height - 8 cm

16 cm x 14 cm x 8 cm = **1792 cm³**

Deep End

To easily calculate the volume of the deep end, split the irregular shape into a rectangular prism and a semi-cylinder. Calculate the volume for each and then add the sums to determine the total volume for the deep end. *Note - To determine the volume for a semi-cylinder, simply determine the volume for a full cylinder first, then divide by two.*

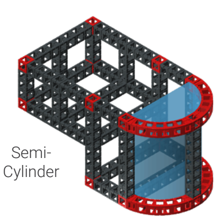


Rectangular Prism

Rectangular Prism

Length - 7 cm, Depth - 14 cm, Height - 16 cm

7 cm x 14 cm x 16 cm = **1568 cm³**



Semi-Cylinder

Semi-Cylinder

Radius - 7 cm, Height - 16 cm

(3.14 x (7 cm x 7 cm)) x 16 = 2461.76 cm³

2461.76 / 2 = **1230.88 cm³**

Total Volume for Deep End - 1568 cm³ + 1230.88 cm³ = **2798.88 cm³**

Challenge Evaluation

When teams have completed the Design & Engineering Challenge, it should be presented to the teacher and classmates for evaluation. Teams will be graded on the following criteria:

- **Specifications:** Does the design meet all specifications as stated in the design brief?
- **Team Collaboration:** How well did the team work together? Can each student describe how they contributed?
- **Design Quality/Aesthetics:** Is the design of high quality? Is it structurally strong, attractive, and well-proportioned?
- **Presentation:** How well did the team communicate all aspects of the design to others?

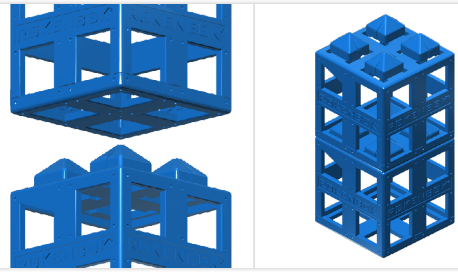
Grading Rubric	Advanced 5 Points	Proficient 4 Points	Partially Proficient 3 Points	Not Proficient 0 Points
Specifications	☐ Meets all specifications	☐ Meets most specifications	☐ Meets some specifications	☐ Does not meet specifications
Team Collaboration	☐ Every member of team contributed	☐ Most members of team contributed	☐ Some members of team contributed	☐ Team did not work together
Design Quality/ Aesthetics	☐ Great design/ aesthetics	☐ Good design/ aesthetics	☐ Average design/ aesthetics	☐ Poor design/ aesthetics
Presentation	☐ Great presentation/ well-explained	☐ Good presentation/ well-explained	☐ Poor presentation/ explanation	☐ No presentation/ explanation
Points	....	....	....	....
Total Points				.... /20

Building Basics

The following tips will be helpful when using Kid Spark engineering materials.

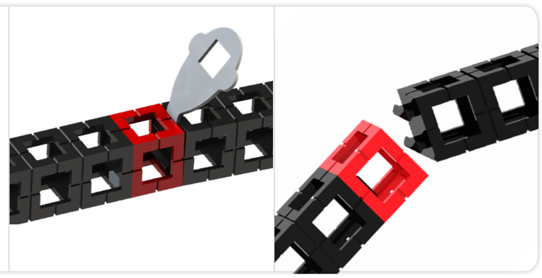
Connecting/Separating ROK Blocks:

ROK Blocks use a friction-fit, pyramid and opening system to connect. Simply press pyramids into openings to connect. To separate blocks, pull apart.



Connecting/Disconnect Smaller Engineering Materials:

Smaller engineering materials use a tab and opening system to connect. Angle one tab into the opening, and then snap into place. To disconnect, insert key into the engineered slot and twist.

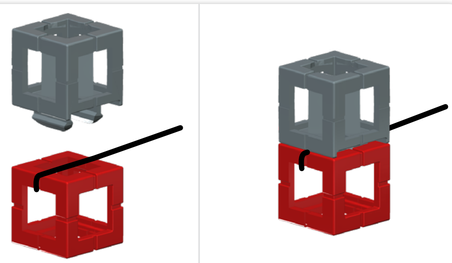


Snapping Across Openings:

Materials can be snapped directly into openings or across openings to provide structural support to a design. This will also allow certain designs to function correctly.

Attaching String:

In some instances, string may be needed in a design. Lay string across the opening and snap any component with tabs or pyramids into that opening. Be sure that the tabs are perpendicular to the string to create a tight fit.



Measuring:

The outside dimensions of a basic connector block are 2 cm on each edge. This means the length, depth, and height are each 2 cm. To determine the size of a project or build in centimeters, simply count the number of openings and multiply by two. Repeat this process for length, depth, and height.