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Public Education Department

8.G: GEOMETRY

Cluster Statement: C: Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.

Major Cluster (Students should spend the large majority of their time (65-85%) on the major work of the grade/course. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade).

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.G.C.9: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.	SMP 1: Students make sense of problems and persevere in solving them by finding the volume of composite shapes. SMP 3: Students construct viable arguments and critique the reasoning of others by explaining the relationship between the cylinder, cone, and sphere. Students will discuss and determine the shapes that construct a composite shape. SMP6: Students attend to precision by labeling volumes with units cubed and areas as units squared. They approximate a precise volume working with pi.	• Write formulas from memory for finding the volume of cones, spheres, and cylinders. are special equations that are specific in use. • Make connections between the 3-D figures and their formulas. • Use formulas to calculate volumes of cones, cylinders and spheres. • Explain the relationship in their volumes. • Apply the formulas to solve real world application problems related to volume. **Webb's Depth of Knowledge:** 1-3 **Bloom's Taxonomy:** Understand, Apply, Evaluate

<u>Previous Learning Connections</u>	**<u>Current Learning Connections</u>**	**<u>Future Learning Connections</u>**
• In 5th and 6th grade, students find the volumes of right rectangular prisms. In 7th grade, students find the area of a circle and solve real-world problems involving area and volume.	• In 8th grade, students continue this work using square root and cube root symbols	• In high school, students use geometric shapes and their measurements to describe objects and solve design problems.

Clarification Statement:
Students know and apply the volume formulas of a cylinder, cone, and a sphere.

Common Misconceptions
Errors may occur if students do not substitute lengths correctly. Students may confuse the volume solids for different solids. They may forget how height, radius, and diameter relate to volume, confuse diameter and radius, forget the approximate value of pi.

Multi-Layered System of Supports (MLSS)/Suggested Instructional Strategies

Pre-Teach

Pre-teach (targeted): *What pre-teaching will prepare students to productively struggle with the mathematics for this cluster within your HQIM?*

- For example, some learners may benefit from targeted pre-teaching that provides additional time for confusion to happen with new mathematical ideas when studying how to solve real world mathematical problems involving volume of cylinders, cones and spheres because students will be expected to know and understand how to use formulas for finding volume of cylinders, cones and spheres.

Pre-teach (intensive): *What critical understandings will prepare students to access the mathematics for this cluster?*

- 8.EE.A.2: This standard provides a foundation for work with solving real world mathematical problems involving volume of cylinders, cones and spheres because students must understand how to use square root and cubed root symbols in order to represent solutions to equations . If students have unfinished learning within this standard, based on assessment data, consider ways to provide intensive pre-teaching support prior to the start of the unit to ensure students are ready to access grade level instruction and assignments.

Core Instruction

Access

Interest: *How will the learning for students provide multiple options for recruiting student interest?*

- For example, learners engaging with solving real world mathematical problems involving cylinders, cones, and spheres benefit when learning experiences include ways to recruit interest such as providing contextualized examples to their lives because the idea of cylinders, cones and spheres can seem abstract until a context is assigned to these figures. For example, students may relate this to the task of shipping a package that has cylinder containers of oats. Students may know the dimensions of the cylinder containers but need to figure out the dimensions for the box to ship them in this provides a real-world context and builds interest for the learner.

Build

Effort and Persistence: *How will the learning for students provide options for sustaining effort and persistence?*

- For example, learners engaging with solving real world mathematical problems involving cylinders, cones, and spheres benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as generating relevant examples with students that connect to their cultural background and interests because students will be able to attach their own experiences and prior knowledge to the task. For example, if students are asked to think of shipping items that are either cylinders, cones, or spheres, they might take time to brainstorm what kinds of items come in those shapes. Some students may think of basketballs or cans of soda. This allows the learner to think of a context that they can relate to and therefore help them to stay focused on the task.

Language and Symbols: *How will the learning for students provide alternative representations to ensure accessibility, clarity and comprehensibility for all learners? (e.g., a graph illustrating the relationship between two variables may be informative to one learner and inaccessible or*

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puzzling to another; picture or image may carry very different meanings for learners from differing cultural or familial backgrounds)

- For example, learners engaging with solving real world mathematical problems involving cylinders, cones, and spheres benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as presenting key concepts in one form of symbolic representation (e.g., math equation) with an alternative form (e.g., an illustration, diagram, table, photograph, animation, physical or virtual manipulative) because if students are not able to visualize the figures that are being described by dimensions only or do not have a realistic interpretation of those figures, students may find this concept too abstract and therefore unrelatable. For example, use of geometry manipulatives or illustrative software that can be manipulated to represent vocabulary and terms may be helpful.

Expression and Communication: *How will the learning provide multiple modalities for students to easily express knowledge, ideas, and concepts in the learning environment?*

- For example, learners engaging with solving real world mathematical problems involving cylinders, cones, and spheres benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as providing virtual or concrete mathematics manipulatives (e.g., base-10 blocks, algebra blocks) because this allows learners to have another opportunity to develop a wider range of expression that is familiar to them. Learners may find it hard to express their ideas in words alone. The ability to "show" using composition of their ideas is another form of expressing their learning.

Internalize

Comprehension: *How will the learning for students' support transforming accessible information into usable knowledge, knowledge that is accessible for future learning and decision-making?*

- For example, learners engaging with solving real world mathematical problems involving cylinders, cones, and spheres benefit when learning experiences attend to students by intentionally building connections to prior understandings and experiences; relating important information to the learning goals; providing a process for meaning making of new learning; and, applying learning to new contexts such as incorporating explicit opportunities for review and practice because as students complete tasks for review and practice, they will have multiple opportunities to transfer the information they have learned to new situations. This practice will make the learning more memorable and accessible to the learner.

Re-teach

Re-teach (targeted): *What formative assessment data (e.g., tasks, exit tickets, observations) will help identify content needing to be revisiting during a unit?*

- For example, students may benefit from re-engaging with content during a unit on solving real world mathematical problems involving volume of cylinders, cones and spheres by providing specific feedback to students on their work through a short mini-lesson because while students are engaged in using formulas to find volume for these figures, errors may occur that are small but will result in a learner not achieving a correct solution. This would be a good time for the instructor to provide immediate feedback to the learner during this process that will then help the learner correct his/her process.

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Re-teach (intensive): *What assessment data will help identify content needing to be revisited for intensive interventions?*

- For example, some students may benefit from intensive extra time during and after a unit for solving real world mathematical problems involving volume of cylinders, cones and spheres by addressing conceptual understanding because if a learner is demonstrating an incorrect solution, it can be assumed that the student is either having conceptual misunderstandings or procedural misunderstandings. If students are attending to precision in their work, then it may help to focus on attaching meaning to the concept that is being learned.

Extension

What type of extension will offer additional challenges to 'broaden' your student's knowledge of the mathematics developed within your HQIM?

- For example, some learners may benefit from an extension such as open ended tasks linking multiple disciplines when studying solving real world mathematical problems involving volume of cylinders, cones and spheres because students can use different forms of expression to show what they have learned about volume of cylinders, cones and spheres by working on a project to display or build a silo and demonstrate the volume. They will calculate the volume of a real-world silo and use their model to explain.

Culturally and Linguistically Responsive Instruction:

Validate/Affirm: How can you design your mathematics classroom to intentionally and purposefully legitimize the home culture and languages of students and reverse the negative stereotypes regarding the mathematical abilities of students of marginalized cultures and languages?
Build/Bridge: How can you create connections between the cultural and linguistic behaviors of your students' home culture and language the culture and language of school mathematics to support students in creating mathematical identities as capable mathematicians that can use mathematics within school and society?

Supporting Productive Struggle in Learning Mathematics: The standard for mathematical practice, makes sense of mathematics and persevere in solving them is the foundation for supporting productive struggle in the mathematics classroom. "Too frequently, historically marginalized students are overrepresented in classes that focus on memorizing and practicing procedures and rarely provide opportunities for students to think and figure things out for themselves. When students in these classes struggle, the teacher often tells them what to do without building their capacity for persistence." Teachers need to provide tasks that challenge students and maintain that challenge while encouraging them to persist. This encouragement or "warm-demander" requires a strong relationship with students and an understanding of the culture of the students. For example, when studying how to solve real world mathematical problems involving volume of cylinders, cones and spheres supporting productive struggle is critical because it will allow students to move past only trying to attain correct solutions, but instead focus on the struggle of working through a difficult problem. Working through a task should help the learner attach meaning to the answers they are getting as well as determine the relationship between the solutions they are getting and the work they are doing. When finding the volume of cylinders, cones and spheres, students can engage in a meaningful task that is relevant and therefore encourages the student to persist.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: http://tasks.illustrativemathematics.org/content-standards/8/G/C/9/tasks/517

8.G.C.9: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

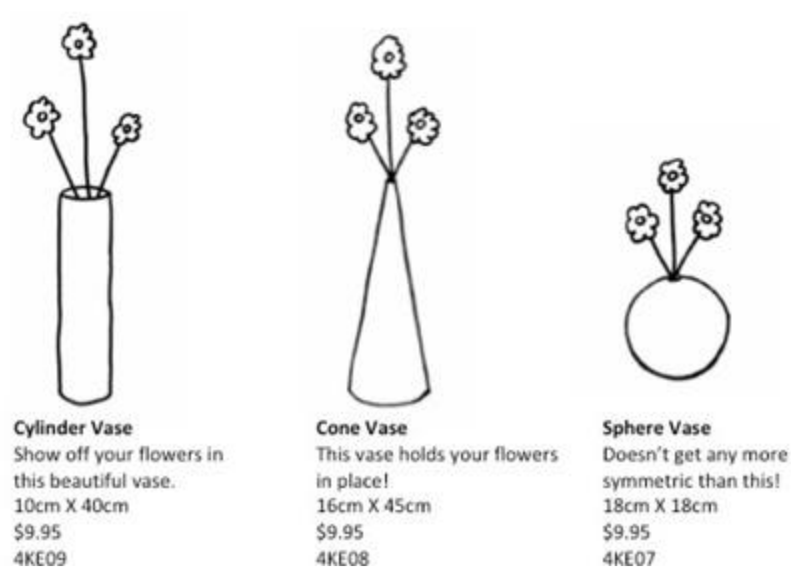
- Learning Target: I can solve volume in the real world, using formulas.
- Webb's Depth of Knowledge: 2

- The purpose of this task is to give students practice working the formulas for the volume of cylinders, cones and spheres, in an engaging context that provides an opportunity to attach meaning to the answers. When used in a classroom setting, the task could be supplemented by questions that ask students to thinking about the relationship between volume and liquid capacity. For example, after part (b), the teacher could ask the students for other ways to determine which vase holds the most water, with the expectation that students might respond with the idea of pouring water from one vase into another.

Task

My sister's birthday is in a few weeks and I would like to buy her a new vase to keep fresh flowers in her house. She often forgets to water her flowers and needs a vase that holds a lot of water. In a catalog there are three vases available and I want to purchase the one that holds the most water. The first vase is a cylinder with diameter 10 cm and height 40 cm. The second vase is a cone with base diameter 16 cm and height 45 cm. The third vase is a sphere with diameter 18 cm.

a. Which vase should I purchase?
b. How much more water does the largest vase hold than the smallest vase?
c. Suppose the diameter of each vase decreases by 2 cm. Which vase would hold the most water?



Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on how to solve real world mathematical problems involving volume of cylinders, cones and spheres , consider options for learning from your families and communities the cultural and linguistic ways this mathematics exists outside of school to create stronger home to school connections for students, for example, students can create their own tasks for finding volume that include spheres, cylinders and cones that they are familiar with in their own home culture. They can take these abstract figures and assign items that they come in contact within other	Art: Students are given a 3-D glass shape to create sand art. They can calculate the amount of sand needed to create their art piece.

situations and develop scenarios in which they would need to find the volume of these items.	