COMMON CORE MATHEMATICS
Integration Activity

Pathway: Agricultural Mechanics and Technology

Lesson: AMT A3–5: Planning and Placing Concrete

Common Core State Standards for Mathematics: 9-12.G-GMD.3

Domain: Geometric Measurement and Dimension G-GMD

Cluster: Explain volume formulas and use them to solve problems.

Standard: 3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Student Objective: Students will use the volume formulas for boxes, cylinders, and cones to determine the amount of concrete necessary for concrete pouring projects.

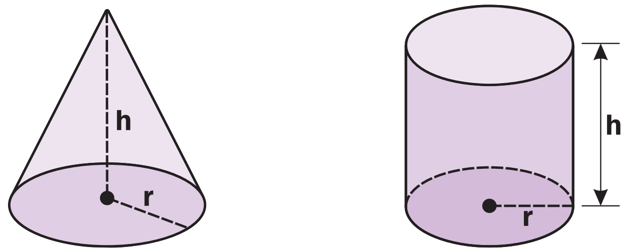
BACKGROUND KNOWLEDGE for Teachers and Students

Math Concepts:

Volume: The amount of space a 3-D object takes up.

Volume of a Cylinder: $V_{cyl} = \pi \times r^2 \times h$ where r is the radius of the base; h is the height

Volume of a Cone: $V_{cone} = {}^1\!/_3\pi \times r^2 \times h$ where r is the radius of the base; h is the height



Calculating Volume of Prisms, Cylinders, and Cones:

(http://www.winpossible.com/lessons/Geometry_Volume_-_Prisms,_Cylinders,_Cones,_Pyramids_and_Spheres.html)

Agriculture Concepts:

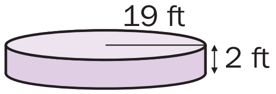
Volumes are used frequently in agricultural construction and production, especially when determining the amount of concrete needed for a particular job. Ordering too much concrete costs extra money, and the excess concrete cannot be taken back to the plant. Ordering too little can cause delays in construction and require starting the job over. Concrete is usually bought and sold in units of cubic yards.

1 cubic yard = 27 cubic feet

Concrete pads are used in grain storage systems to create strong bases for metal grain bins. Grain is typically measured in bushels, with 1 bushel of dry corn weighing 56 pounds and taking up 1.24 cubic feet of space. Grain storage is a crucial part of marketing because it allows a farmer to store and sell grain at better prices.

Guided Practice Exercises:
ANSWER KEY

1.



$r = (36 \div 2) + 1$
$r = 19$

2. $V_c = \pi \times r^2 \times h$
$V_c = \pi \times 19^2 \times 2$
$V_c = 2{,}267.08 \text{ ft}^3$

$2{,}267.08 \div 27 = 83.97 \text{ yd}^3$

3. $V_{cyl} = \pi \times 18^2 \times 44$
$V_{cyl} = 44{,}786.54 \text{ ft}^3 \div 1.24 \text{ ft}^3\text{/bu}$
$V_{cyl} = 36{,}118.18 \text{ bu}$

$V_{cone} = \frac{1}{3}\pi \times 18^2 \times 8$
$V_{cone} = 2{,}714.34 \text{ ft}^3 \div 1.24 \text{ ft}^3\text{/bu}$
$V_{cone} = 2{,}188.98 \text{ bu}$

$V_{bin} = V_{cyl} + V_{cone}$
$V_{bin} = 36{,}118.18 + 2{,}714.34$
$V_{bin} = 38{,}832.52 \text{ bu}$

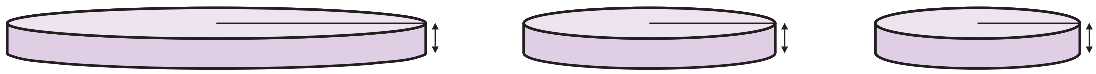
4. No, the extra corn will not fit. There will be almost 6,000 bushels that will not fit.

$120{,}000 - 38{,}000 = 82{,}000 \text{ bu}$

$V_{cone} = \frac{1}{3} \times \pi \times (120 \div 2)^2 \times 25$
$V_{cone} = 94{,}247.78 \text{ ft}^3 \div 1.24 \text{ ft}^3\text{/bu}$
$V_{cone} = 76{,}006.27 \text{ bu}$

Independent Practice Exercises:
ANSWER KEY

1.



r = 27 ft, h = 2 ft　　r = 16 ft, h = 2 ft　　r = 13 ft, h = 2 ft

2. $V_c = \pi \times r^2 \times h$
   $V_c = \pi \times 27^2 \times 2$
   $V_c = 4{,}580.44 \text{ ft}^3$

   $4{,}580.44 \div 27 = 169.64 \text{ yd}^3$

   $V_c = \pi \times r^2 \times h$
   $V_c = \pi \times 16^2 \times 2$
   $V_c = 1{,}608.50 \text{ ft}^3$

   $1{,}608.50 \div 27 = 59.57 \text{ yd}^3$

   $V_c = \pi \times r^2 \times h$
   $V_c = \pi \times 13^2 \times 2$
   $V_c = 1{,}061.86 \text{ ft}^3$

   $1{,}061.86 \div 27 = 39.33 \text{ yd}^3$

3. a. 52-foot diameter

   $V_{cyl} = \pi \times 26^2 \times 24$
   $V_{cyl} = 50{,}969.20 \text{ ft}^3 \div 1.24 \text{ ft}^3/\text{bu}$
   $V_{cyl} = 41{,}104.19 \text{ bu}$

   $V_{cone} = {}^1\!/_3\pi \times 26^2 \times 6$
   $V_{cone} = 4{,}247.43 \text{ ft}^3 \div 1.24 \text{ ft}^3/\text{bu}$
   $V_{cone} = 3{,}425.35 \text{ bu}$

   $V_{bin} = V_{cyl} + V_{cone}$
   $V_{bin} = 41{,}104.19 + 3{,}425.35$
   $V_{bin} = 44{,}529.54 \text{ bu}$

   b. 30-foot diameter

   $V_{cyl} = \pi \times 15^2 \times 24$
   $V_{cyl} = 16{,}964.60 \text{ ft}^3 \div 1.24 \text{ ft}^3/\text{bu}$
   $V_{cyl} = 13{,}681.13 \text{ bu}$

   $V_{cone} = {}^1\!/_3\pi \times 15^2 \times 6$
   $V_{cone} = 1{,}413.72 \text{ ft}^3 \div 1.24 \text{ ft}^3/\text{bu}$
   $V_{cone} = 1{,}140.09 \text{ bu}$

$V_{bin} = V_{cyl} + V_{cone}$
$V_{bin} = 13{,}681.13 + 1{,}140.09$
$V_{bin} = 14{,}821.22$ bu

c. 24-foot diameter

$V_{cyl} = \pi \times 12^2 \times 24$
$V_{cyl} = 10{,}857.34\ ft^3 \div 1.24\ ft^3/bu$
$V_{cyl} = 8{,}755.92$ bu

$V_{cone} = \frac{1}{3}\pi \times 12^2 \times 6$
$V_{cone} = 904.78\ ft^3 \div 1.24\ ft^3/bu$
$V_{cone} = 729.66$ bu

$V_{bin} = V_{cyl} + V_{cone}$
$V_{bin} = 8{,}755.92 + 729.66$
$V_{bin} = 9{,}485.58$ bu

4. $V_{cyl} = \pi \times r^2 \times h$
$V_{cyl} = \pi \times 27^2 \times 2$
$V_{cyl} = 4{,}580.44\ ft^3$

$V_{cone} = \frac{1}{3}\pi \times 27^2 \times 1.5$
$V_{cone} = 1{,}145.11\ ft^3$

$V_{pad} = V_{cyl} - V_{cone}$
$V_{pad} = 4{,}580.44 - 1{,}145.11$
$V_{pad} = 3{,}435.33\ ft^3 \div 27\ ft^3$
$V_{pad} = 127.23\ yd^3$

a. Putting in a conical depression would be more economical (cheaper) because it would save 42 cubic yards of concrete.

b. The shape would allow grain to flow more easily during removal.

Name: ______________________________

Guided Practice Exercises:

Alex is planning to build a new circular grain bin. The grain bin will be 36 feet in diameter and 44 feet high, with a top cone 8 feet high. The concrete pad should be 1 foot larger than the structure and 24 inches thick. How much concrete does Alex need to order?

Shape	Volume Formula
Cylinder	$\pi \times r^2 \times h$
Cone	$\frac{1}{3}\pi \times r^2 \times h$

1. Draw a diagram of the pad for the grain bin, showing the radius and the height.

2. What is the volume of concrete, in cubic yards, needed to pour the pad?

3. How much corn, in bushels, can the bin hold if it is filled to capacity, including the mounding at the top? (Corn weighs 56 lb/bu, and 1 bu takes up 1.24 ft^3 of space.)

4. After building the grain bin, Alex harvested a total of 120,000 bushels of corn. He decided to pile the extra corn on a circular concrete pad he already had and cover it with a tarp. Assuming he stored 38,000 bushels in his bin, will the rest of the corn fit on his 120-foot-diameter pad if it can safely be piled 25 feet high?

Name: ______________________________

Independent Practice Exercises:

Alex is expanding his grain-handling facility. He is planning to build three more bins to hold his grain—one large bin 52 feet in diameter and two smaller ones 30 feet and 24 feet in diameter. Each bin will be 24 feet tall with a 6-foot cone at the top. The pad for each bin should be 24 inches thick and 1 foot larger around than the bin.

Shape	Volume Formula
Cylinder	$\pi \times r^2 \times h$
Cone	$\frac{1}{3}\pi \times r^2 \times h$

1. Draw a diagram of the pad for each grain bin, showing the radius and the height.

2. What is the volume of concrete, in cubic yards, needed to pour the three different pads?

3. How much corn, in bushels, can each bin hold if it is filled to capacity, including the mounding at the top? (Corn weighs 56 lb/bu, and 1 bu takes up 1.24 ft^3 of space.)

4. How much concrete will be needed for the largest bin if a conical depression is put in the pad so that the center of the pad will be only 6 inches thick but the walls will remain 24 inches thick? Think of two reasons why this would be a better design than a flat, circular pad.