Appalachian State University Math Walk
Teacher Guide

Section 1: Answers

Activities 1-16 can be found in the "Appalachian State Math Walk" handout document. Activities S1 and S2 can be found in the "Schaefer Center Activities (Indoor)" document.

Problem 1 Solutions:

a) *Total volume = Volume of the rectangular solid + Volume of the triangular solid*
*Vol = (48*84*106) +0.5 *(16*106)*84 = 498624 cubic inches .*

b) *498624 cubic inches times* 2.54^3 *= 8170983.4 cubic cm which is 22061655.18 g or approximately 48,593.95 lb.*

Problem 2A Solutions:

a) *Handrails:2*(13+42.5)=111" or 9.25 ft, which is almost 1.2 pieces of 8ft (2x4s).*
Steps: Since each step is 48 inches wide(4ft) we need 32 ft which is 4 pieces of 8ft (2x6s).
Posts: 30.5x8=244 inches or approximately 20.33 ft. This will require 2.5 pieces of 8ft(2x4s).
So, overall, for the handrails and the posts we can use 4 pieces of (2x4s) and 4 pieces of (2x6s) for the steps.

b) *2x4s: 4 x $3.07 = $12.28. For the 2x6s: 4 x $5.27 = $21.08. So, for the materials (wood) total = $33.36 plus tax (7%) = $35.7. This total is just for the material not including nails, concrete for the base, labor or the rest of the wood for the structure!*

Problem 2B Solutions:

$\frac{35000 gal}{1} \times \frac{3.79\ L}{1\ gal} \times \frac{1000\ mL}{1\ L} \times \frac{1\ cm^3}{1\ mL} \times \frac{1\ m}{100\ cm} \times \frac{1\ m}{100\ cm} \times \frac{1\ m}{100\ cm} \times \frac{1\ g}{1\ m^3} = 132.65$ grams of methylparaben

Problem 3 Solutions:

a) Yosef's optimum stride length would be 208" using a 2.6 multiplier.

Problem 4 Solutions:

a) 10
b) 10
c) 11
d) 0.4
e) 0.52
f) No
g) 100 inches or 8 feet and 4 inches
h) For the bottom staircase, $\tan\theta = 5/12.5$ *or* $\theta \cong 21.8°$ *and for the top staircase,* $\tan\theta = 6/11.5$ *or* $\theta \cong 27.55°$

Problem 5 Solutions:

a) 4 (sides) x(3.5 x 40) = 560 in^2
b) Square Pyramid

Problem 6 Solutions:

Total Volume = $V_1 + V_2$

a) $V_1 = \frac{1*41\pi}{3} * (33^2 + 24.75*33 + 24.75^2) = 108,124.00\ in^3$

$V_2 = \frac{1*76\pi}{3} * (60^2 + 60*33 + 33^2) = 530,765.8\ in^3$

Total volume = 108, 124 in^3 + 530, 765.8 in^3 = **638,889.8 in^3**

b) 369.73 cubic ft
c) Four

Problem 7A Solutions:
Based off of the pictorial representation of the bike rack and the placing of the axes the bike rack best represents a cosine function (see image below). Currently there are 11 slots, which would fit 11 bikes and adding an extra loop would add 2 more slots making it 13.

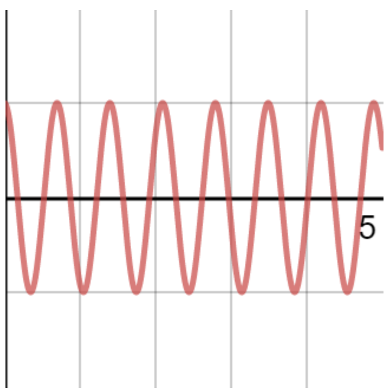


Image was created using https://www.desmos.com/

Problem 7B Solutions:
The volume of one post is $5^2\ \pi(30) + 4^2\ \pi(4) = 814\ \pi = 2557\ in^3 = .0419\ m^3$, it weighs 222 lb. rounded to the nearest pound. You would need 6 first graders that weighed 40 lb. to outweigh the post.

Problem 8 Solutions:
There is no definitive solution. This is about creativity and thought.

Problem 9 Solutions:

a) $\frac{\$65000}{1} \times \frac{1\ kWh}{\$0.06} \times \frac{1\ year}{5782\ kWh} = 187.363\ years$. *So, roughly 187.4 years.*

b) *1554 x 36 = 55944 square inches. 5782 kWh divided by 55944 means each square inch of the panel produces .103 kWh of energy annually or 103 watts/yr.*

Problem 10 Solutions:

a) *Area of one block = 64 square inches.*

Total area in square ft = (64x10384)/144 = 4615.11

Number of cans of paint = 4615.11/20 = 230.76 (round up to 231 cans).

b) *231 x* \$6.25 = \$1443.75.

Problem 11 Solutions:

a) *63 in. – 24 in. = 39 in. or 3.25 ft. So the incline of theta can be found by doing arcsin(3.25/30) = 6.2 degrees.*

b) *To find the slope: $3.25^2 + x^2 = 30^2$. Solving for x, we get x =29.82 ft (357.84 inches). The slope is 3.25/x so the slope = 0.109.*
c) *The area of the triangle is* $\frac{1}{2}(3.25\ ft)(29.82ft) = 48.46\ ft^2$ *or* $6978.24\ in^2$.
d) *The area of the entire ramp is the area of the triangle and the area of the two adjacent rectangles. Total area = (30x63* in^2 *+ 24x357.84* in^2 *+6978.24* in^2 *) = 17,456.4* in^2.
e) *360*
f) *2142*

Problem 12 solutions:

a) *The volume of the rotunda is* $\pi(16)^2(125) = 100{,}531\ cubic\ feet$. *The volume of a book is* $8 \times 12 \times 2 = 192\ cubic\ inches.\ \frac{192\ in^3}{1} \times \frac{1\ ft}{12\ in} \times \frac{1\ ft}{12\ in} \times \frac{1\ ft}{12\ in} = 0.111\ cubic\ feet$. *If the volume of the rotunda is 100, 531 cubic feet and each book is 0.111 cubic feet it would take* $\frac{100{,}531}{0.111} \approx 905{,}685$ *books rounded up to fill the rotunda.*
b) *Yes, there are enough books in the library to fill the rotunda.*
c) *939291/18000 = 52.18 so each student would have to carry roughly 52 to 53 books to move the entire library.*

Problem 13 Solutions:

a) 54 degrees
b) 108 degrees
c) 11 children

Problem 14 Solutions:

a) $\frac{\textbf{30 Min}}{\textbf{1}} \times \frac{\textbf{60 sec}}{\textbf{1 Min}} \times \frac{\textbf{12m}^3}{\textbf{1 sec}} \times \frac{\textbf{100 cm}}{\textbf{1 m}} \times \frac{\textbf{100 cm}}{\textbf{1 m}} \times \frac{\textbf{100 cm}}{\textbf{1 m}} \times \frac{\textbf{1 mL}}{\textbf{1 cm}^3} \times \frac{\textbf{1 L}}{\textbf{1000 mL}} \times \frac{\textbf{0.0001 g}}{\textbf{1 L}} = 2{,}160\ \text{g}$
b) $\frac{\textbf{4 L}}{\textbf{1}} \times \frac{\textbf{0.0001 g}}{\textbf{1 L}} \times \frac{\textbf{1000 mg}}{\textbf{1 g}} = 0.4\ \text{mg}$
c) *No. The fish is moved away from you by the water faster than it can swim.*

Problem 15 Solutions:

a) *22.5 degrees*
b) *Since one revolution of the blade = circumference, it goes 69π inches in 1 revolution times 990 rpm gives 214602" per minute and dividing by 12 gives you 17883.5 feet per minute.*

Problem 16 Solutions:

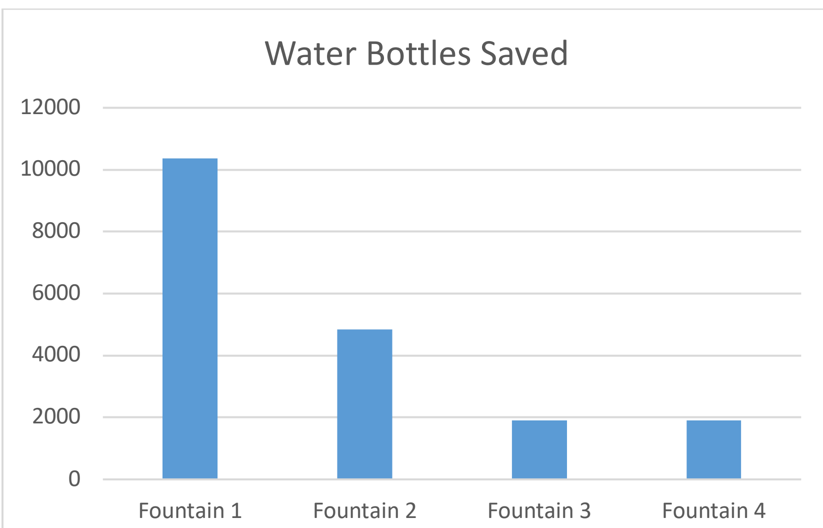
a) *if the base is 36"x36" and the height is 93.5", then the line from the tip of the pyramid down the side to the middle of the base is =* $\sqrt{(18)^2 + (93.5)^2}$*,which is approximately 95" so the surface area is .5(36 base)(95 height of slant)(4 sides) or 6840 sq. inches or 47.5 square feet (1 sq ft = 144 sq in).*
b) *93.5/69.2 = 1.35 – 1 = 0.35 x 100 = 35 % taller than the average American male.*

Problem S1 Solutions:

a) 6
b) Hexagon
c) 22 Panels
d) 176 Rivets
e) P = (22.3×2) + (11.75×4) = 91.6 feet
f) 91.6 ft $\times \frac{\$50}{1 \text{ foot}} = \$4{,}580$
g) Total Area = Area of rectangle + 2(Area of triangle)
   Area = (22.3 × 22) + 2(4.13 × 11)
   Area = 581.46 ft^2
h) 97 inches $\times \frac{1 \text{ ft}}{12 \text{ in}} = 8.08$ feet
   Volume=Area × height
   Volume = 536.03 ft^2 × 8.08 ft
   Volume = 4698.20 ft^3

Problem S2 Solutions:

a) 400 + 20 + 6
b) Answers may vary. Example: 3 hundreds, 12 tens, 6 ones
c) Answer with sample values: 19,008
d) Example with sample values:



e) Answer with sample values: (mean) 4752, (median) 3374
f) $15000 \times \frac{20 \text{ cm}}{1 \text{ bottle}} \times \frac{1 \text{ foot}}{30.48 \text{ cm}} \times \frac{1 \text{ mile}}{5280 \text{ feet}} = 1.86$ miles (Yes!)
g) Answers may vary. Example: we assumed that all bottles will be lined up in a perfectly straight line.

Section 2: Activities to Standards

Activities 1-16 can be found in the “Appalachian State Math Walk” handout document. Activities S1 and S2 can be found in the “Schaefer Center Activities (Indoor)” document.

Note: Some tasks did not meet a particular North Carolina standard. These tasks have been labeled with some custom “Additional Mathematical Concepts” (AMC) standards, listed below:

- **AMC.1** – Convert between units to solve real world problems, including:
  - Multi-step unit conversions
  - Non-standard units (e.g. number of students)
  - Non-standard conversion factors (e.g. weight of concrete per cubic meter)
- **AMC.2** – Convert between units of area and volume given length conversion factors
- **AMC.3** – Identifying 3 dimensional shapes – rectangular pyramids

Activity	Part	Standards
1) The Rock	a	NC.7.G.6
	b	NC.M3.G-GMD.3, NC.M3.G-MG.1, AMC.2
2A) It’s “Stairing” You in the Face … Or is it?	a	NC.7.NS.3, NC.7.EE.3, NC.7.EE.4
	b	NC.7.NS.3, NC.7.EE.3, NC.7.EE.4
2B) The Duck Pond	a	AMC.1
3) Measure Yosef!	a	NC.4.OA.1, NC.6.RP.4
	b	NC.5.NBT.6, NC.6.RP.4, NC.7.RP.2
	c	NC.5.NBT.7
4) A New Slant on Stairs	a	NC.K.CC.3, NC.K.CC.4, NC.K.CC.5
	b	NC.K.CC.3, NC.K.CC.4, NC.K.CC.5
	c	NC.K.CC.3, NC.K.CC.4, NC.K.CC.5, NC.K.CC.6
	d	NC.8.F.4, NC.M1.F-IF.6

	e	NC.8.F.4, NC.M1.F-IF.6
	f	NC.8.F.4, NC.M1.F-IF.6
	g	NC.8.F.4, NC.M1.A-CED.2, NC.M1.A-REI.1, NC.M1.A-REI.3, NC.M1.F-IF.2, NC.M1.F.BF.1, NC.M1.F-LE.1
	h	NC.M2.A-CED.1, NC.M2.G-SRT.8
5) Wooden You Know, Another Post Problem!	a	NC.6.G.4, NC.7.G.6
	b	AMC.3
6) The Volume of Art	The sculpture at this stop was removed, so standards were not aligned.	
7A) What Do a Bike Rack and Trig Have in Common?	a	NC.M3.F-IF.7
	b	NC.K.CC.3, NC.K.CC.4, NC.K.CC.5
	c	NC.K.CC.5
7B) Posts and Chains	a	NC.8.G.9, NC.M3.G-GMD.3
	b	AMC.2
	c	AMC.1
	d	AMC.1
8) Park it Here		NC.4.MD.3, NC.7.G.6
9) Making Molehills into Mountains	a	AMC.1
	b	AMC.1
10) Peacock Hall's Glass Semi-circle	a	AMC.2, NC.7.G.6
	b	AMC.1, NC.5.NBT.7
	a	NC.M2.A-CED.1, NC.M2.G-SRT.8

11) Ramping Up: the handicap ramp by Chapell-Wilson Hall	b	NC.8.F.4, NC.M1.F-IF.6
	c	NC.6.G.1
	d	NC.7.G.6
	e	NC.5.MD.1
	f	AMC.1
12) The Library Atrium	a	NC.8.G.9, NC.M3.G-GMD.3, AMC.1
	b	NC.8.G.9, NC.M3.G-GMD.3, AMC.1
	c	NC.6.RP.2, AMC.1
13) The Outdoor Classroom	a	NC.8.G.5, NC.M3.G-CO.14
	b	NC.8.G.5, NC.M3.G-CO.14
	c	NC.3.OA.1, NC.3.OA.3, NC.5.OA.2
14) Going with the Flow	a	AMC.1, AMC.2, AMC.1
	b	AMC.1
	c	NC.M1.F-IF.6
15) I Came, I Saw, I Conquered	The sculpture at this stop was removed, so standards were not aligned.	
16) Pyramid Sculptures	a	NC.6.G.4, NC.7.G.6
	b	NC.6.RP.4
S1) Schaefer Center - Balcony	a	NC.K.CC.3, NC.K.CC.4, NC.K.CC.5
	b	NC.K.G.1, NC.K.G.2

	c	NC.3.OA.1, NC.3.OA.3, NC.5.OA.2
	d	NC.3.OA.1, NC.3.OA.3, NC.5.NBT.5
	e	NC.3.MD.8, NC.4.MD.3
	f	NC.4.MD.3, AMC.1
	g	NC.6.G.1, NC.7.G.6, NC.8.G.7, NC.M2.G-SRT.8
	h	NC.7.G.6
S2) Schaefer Center – Water Bottle Refill Stations	a	NC.2.NBT.3
	b	NC.2.NBT.1
	c	NC.3.MD.3, NC.4.MD.4
	d	NC.3.MD.3, NC.4.MD.4
	e	NC.6.SP.3
	f	AMC.1
	g	AMC.1

Section 3: Standards to Activities

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- **AMC.2** – Convert between units of area and volume given length conversion factors
- **AMC.3** – Identifying 3 dimensional shapes – rectangular pyramids

Grade	Standard	Activities
Kindergarten	NC.K.CC.3	4a, 4b, 4c, 7A.b, S1a
	NC.K.CC.4	4a, 4b, 4c, 7A.b, S1a
	NC.K.CC.5	4a, 4b, 4c, 7A.b, 7A.c, S1a
	NC.K.CC.6	4c
	NC.K.G.1	S1b
	NC.K.G.2	S1b
Grade 1	None	
Grade 2	NC.2.NBT.1	S2b
	NC.2.NBT.3	S2a
Grade 3	NC.3.OA.1	13c, S1c, S1d
	NC.3.OA.3	13c, S1c, S1d
	NC.3.MD.8	S1e

	NC.3.MD.3	S2c
Grade 4	NC.4.OA.1	3a
	NC.4.MD.3	8, S1e, S1f
	NC.4.MD.4	S2d
Grade 5	NC.5.NBT.5	S1d
	NC.5.NBT.6	3b
	NC.5.NBT.7	3c, 10b
	NC.5.MD.1	11e
	NC.5.OA.2	13c, S1c
Grade 6	NC.6.RP.4	3a, 3b, 16b
	NC.6.RP.2	12c
	NC.6.G.1	11c, S1g
	NC.6.G.4	5a, 16b
	NC.6.SP.3	S2e
Grade 7	NC.7.G.6	1a, 5a, 8, 10a, 11c, 16a, S1g, S1h
	NC.7.NS.3	2A.a, 2A.b,
	NC.7.EE.3	2A.a, 2A.b,
	NC.7.EE.4	2A.a, 2A.b,
	NC.7.RP.2	3b
Grade 8	NC.8.F.4	4d, 4e, 4f, 4g, 11b

	NC.8.G.9	7B.a, 12a, 12b
	NC.8.G.5	13a, 13b
	NC.8.G.7	S1g
Math 1	NC.M1.F-IF.6	4d, 4e, 4f, 11b, 14c
	NC.M1.F-IF.2	4g
	NC.M1.A-CED.2	4g
	NC.M1.A-REI.1	4g
	NC.M1.A-REI.3	4g
	NC.M1.F.BF.1	4g
	NC.M1.F-LE.1	4g
Math 2	NC.M2.A-CED.1	4h, 11a
	NC.M2.G-SRT.8	4h, 11a, S1g
Math 3	NC.M3.G-GMD.3	1b, 7B.a, 12a, 12b
	NC.M3.G-MG.1	1b
	NC.M3.F-IF.7	7A.a
	NC.M3.G-CO.14	13a, 13b
Additional Mathematical Concepts	AMC.1	2B.a, 7B.c, 7B.d, 9a, 9b, 10b, 11f, 12a, 12b, 12c, 14a, 14b, S1f, S2f, S2g
	AMC.2	1b, 7B.b, 10a, 14a
	AMC.3	5a

Section 4: Standards Rationale

Activities 1-16 can be found in the "Appalachian State Math Walk" handout document. Activities S1 and S2 can be found in the "Schaefer Center Activities (Indoor)" document.

Activities #1-16

#1) The Rock

a)

NC.7.G.6
Solve real-world and mathematical problems involving:

- Volume and surface area of pyramids, prisms, or three-dimensional objects composed of cubes, pyramids, and right prisms.

Rationale: Given the drawing, students can approximate the real world volume of "The Rock" by finding the volume of 2 prisms.

b)

NC.M3.G-GMD.3
Use the volume formulas for prisms, cylinders, pyramids, cones, and spheres to solve problems.
Rationale: Given the drawing, students can approximate the real world volume of "The Rock" by finding the volume of 2 prisms. They can use this volume to solve the problem of finding "The Rock's" weight.

NC.M3.G-MG.1
Apply geometric concepts in modeling situations.

- Use geometric and algebraic concepts to solve problems in modeling situations:
- Use geometric shapes, their measures, and their properties, to model real-life objects.
- Use geometric formulas and algebraic functions to model relationships.
- Apply concepts of density based on area and volume.

Rationale: Students model the real-life, imperfectly shaped rock with 2 prisms. They then use the formulas for volume of prisms to model the rock's true volume. Finally, they use the density of granite to estimate the weight of the rock given the geometric model.

AMC.2
Convert between units of area and volume given length conversion factors.

Rationale: Assuming that students calculate the volume in cubic inches, they must use a cubed conversion factor to find the volume in cubic centimeters so they can use the density (measured in grams per cubic centimeter).

2A) Duck Pond Stairs

a)

NC.7.NS.3
Solve real-world and mathematical problems involving numerical expressions with rational numbers using the four operations.
NC.7.EE.3
Solve multi-step real-world and mathematical problems posed with rational numbers in algebraic expressions.

- Apply properties of operations to calculate with positive and negative numbers in any form.
- Convert between different forms of a number and equivalent forms of the expression as appropriate.

Rationale: This real world problem involves setting up expressions with rational numbers and the four operations to find the amount of wood needed for each part of the structure (handrails, steps, posts)

NC.7.EE.4
Use variables to represent quantities to solve real-world or mathematical problems.
a. Construct equations to solve problems by reasoning about the quantities.

- Fluently solve multistep equations with the variable on one side, including those generated by word problems.
- Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach.
- Interpret the solution in context.

Rationale: Instead of (or in addition to) solving the problem algorithmically using expressions, students can set up equations with a variable on one side that relates the total amount of wood with the pieces of each part of the stairs.

b)

NC.7.NS.3
NC.7.EE.3
Rationale: This real world problem involves setting up expressions with rational numbers (money and tax) and the two operations (multiplication and addition) to calculate the price of the needed wood.
NC.7.EE.4

Rationale: Instead of (or in addition to) solving the problem algorithmically using expressions, students can set up equations with a variable on one side that relates the total price of wood with the amount of wood for each piece of the stairs.

2B) Duck Pond

AMC.1
Convert between units to solve real world problems, including:
- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students must use a unit conversion strategy and the given factors to convert 35,000 gallons of water into grams of methylparaben.

#3) Measure Yosef!

a)

NC.4.OA.1
Interpret a multiplication equation as a comparison. Multiply or divide to solve word problems involving multiplicative comparisons using models and equations with a symbol for the unknown number. Distinguish multiplicative comparison from additive comparison.
Rationale: When students estimate how many times taller Yosef is than they are, they can write this comparison as a multiplication equation. To solve the equation, students will need to divide in part b).

NC.6.RP.4
Use ratio reasoning to solve real-world and mathematical problems with percents by:
• Finding the whole, given a part and the percent.
Rationale: When students calculate Yosef's true height, they are finding the whole, given a part (ground to hip height) and the percent.

b)

NC.5.NBT.6
Find quotients with remainders when dividing whole numbers with up to four-digit dividends and two-digit divisors using rectangular arrays, area models, repeated subtraction, partial quotients, and/or the relationship between multiplication and division. Use models to make connections and develop the algorithm.
Rationale: Students divide Yosef's height and their height (or the respective ground to hip heights) to find how many times taller Yosef is. The divisor and dividend (if measured in

inches) are both multi-digit whole numbers. Students are likely to find remainders when they divide as well.

NC.6.RP.4
Use ratio reasoning to solve real-world and mathematical problems with percents by:
• Understanding and finding a percent of a quantity as a ratio per 100.
• Using equivalent ratios, such as benchmark percents (50%, 25%, 10%, 5%, 1%), to determine a part of any given quantity.
Rationale: Students use ratio reasoning to find out what percentage their ground-to-hip height is out of their actual height.

NC.7.RP.2
Recognize and represent proportional relationships between quantities.
a. Understand that a proportion is a relationship of equality between ratios.
o Represent proportional relationships using tables and graphs.
o Recognize whether ratios are in a proportional relationship using tables and graphs.
o Compare two different proportional relationships using tables, graphs, equations, and verbal descriptions.
Rationale: Students see a real world example of a proportion as a relationship of equality between 2 ratios - the ratio of ground-to-hip height and the ratio of total heights.

c)

NC.5.NBT.7
Compute and solve real-world problems with multi-digit whole numbers and decimal numbers
• Multiply decimals with a product to thousandths using models, drawings, or strategies based on place value.
• Use estimation strategies to assess reasonableness of answers.
Rationale: To solve the real world problem of what their (and Yosef's) optimum stride length is, students will need to multiply their leg length (a multi-digit whole number) by the given decimal values.

#4) A New Slant on Stairs

a)

NC.K.CC.3
Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20, with 0 representing a count of no objects.
Rationale: Students can count the number of stairs and represent that number as a written numeral.

NC.K.CC.4
Understand the relationship between numbers and quantities.
• When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object (one-to-one correspondence).
• Recognize that the last number named tells the number of objects counted regardless of their arrangement (cardinality).
Rationale: Students can build a one-to-one correspondence by pairing one number name with one step, thus saying the number names in the standard order. When the last number is named, students use cardinality to report the number of stairs.

NC.K.CC.5
Count to answer "How many?" in the following situations:
• Given a number from 1–20, count out that many objects.
• Given up to 20 objects, name the next successive number when an object is added, recognizing the quantity is one more/greater.
• Given 20 objects arranged in a line, a rectangular array, and a circle, identify how many.
• Given 10 objects in a scattered arrangement, identify how many.
Rationale: The question asks students to identify how many stairs there are, and they are arranged in a line.

b)

NC.K.CC.3
NC.K.CC.4
NC.K.CC.5
Rationale: See part a).

c)

NC.K.CC.3
NC.K.CC.4
NC.K.CC.5
Rationale: See part a).

NC.K.CC.6
Identify whether the number of objects, within 10, in one group is greater than, less than, or equal to the number of objects in another group, by using matching and counting strategies.
Rationale: Students make a guess for how many stairs will be in the third staircase. In doing so, they must decide if they think the 3rd staircase has more stairs or less stairs than the other staircases.

d)

NC.8.F.4

Analyze functions that model linear relationships.
• Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of the slope and y-intercept of its graph or a table of values
Rationale: Students calculate the slope of the staircase and interpret it as a rate of change - change in height (output) over forward distance (input; or number of steps). Students can also consider how to interpret the y-intercept.

NC.M1.F-IF.6
Calculate and interpret the average rate of change over a specified interval for a function presented numerically, graphically, and/or symbolically.
Rationale: The stairs represent a linear function relationship between height (output) and forward distance (input; or number of steps). Students can make measurements to represent this linear function numerically. Then, students calculate the slope of the staircase and interpret it as a rate of change - change in height over forward distance.

e)

NC.8.F.4
NC.M1.F-IF.6
Rationale: See part d).

f)

NC.8.F.4
NC.M1.F-IF.6
Rationale: See part d).

g)
NC.8.F.4
Analyze functions that model linear relationships.
• Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of the slope and y-intercept of its graph or a table of values
Rationale: With guidance, students can use their interpretation of the slope of each staircase to calculate the total height of each staircase. Then, they can add the heights to find the solution.

NC.M1.A-CED.2
Create and graph equations in two variables to represent linear, exponential, and quadratic relationships between quantities.
NC.M1.F.BF.1
Write a function that describes a relationship between two quantities.
a. Build linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two ordered pairs (include reading these from a table).
Rationale: In solving this problem, students can model the relationship between distance (or number of steps) and height with a linear equation/function.

NC.M1.F-LE.1
Identify situations that can be modeled with linear and exponential functions, and justify the most appropriate model for a situation based on the rate of change over equal intervals.
Rationale: In previous parts, students found slope values. They can then identify these stairs as a situation that can be modeled with a linear function.

NC.M1.A-REI.3
Solve linear equations and inequalities in one variable.
NC.M1.F-IF.2
Use function notation to evaluate linear, quadratic, and exponential functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
NC.M1.A-REI.1
Justify a chosen solution method and each step of the solving process for linear and quadratic equations using mathematical reasoning.
Rationale: Once students have built linear equations/functions to model this situation, they can find the needed outputs (heights) by evaluating the functions for given inputs. In doing so, they can represent their solution using function notation and justify their chosen solution method.

h)

NC.M2.A-CED.1
Create equations and inequalities in one variable that represent quadratic, square root, inverse variation, and right triangle trigonometric relationships and use them to solve problems.
NC.M2.G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve problems involving right triangles in terms of a context.
Rationale: To find the indicated angle, students need to create an equation that represents a right triangle trigonometric relationship/ratio. Then, they will solve the problem by using an inverse trigonometric function.

#5) Wooden You Know, Another Post Problem!

a)

NC.6.G.4
Represent right prisms and right pyramids using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.
Rationale: Students can measure a real world object (a post) and draw a net of the prism section. They can then use the net to find the surface area.

NC.7.G.6

Solve real-world and mathematical problems involving:
• Volume and surface area of pyramids, prisms, or three-dimensional objects composed of cubes, pyramids, and right prisms.
Rationale: After measuring, students can approximate the surface area of the prism part of the post. Students can also go further and find the surface area of the entire post by finding the surface area of the pyramid at the top.

b)

AMC.3
Identify 3 dimensional shapes – rectangular pyramids
Rationale: Students identify the shape of the top of the post, which is a square pyramid.

#7A) What Do a Bike Rack and Trig Have in Common?

a)

NC.M3.F-IF.7
Analyze piecewise, absolute value, polynomials, exponential, rational, and trigonometric functions (sine and cosine) using different representations to show key features of the graph, by hand in simple cases and using technology for more complicated cases, including: domain and range; intercepts; intervals where the function is increasing, decreasing, positive, or negative; rate of change; relative maximums and minimums; symmetries; end behavior; period; and discontinuities.
Rationale: Students identify which trigonometric function (sine/cosine) the bike rack most closely resembles. To do so, they must know the key differences between sine and cosine functions.

b)

NC.K.CC.3
Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20, with 0 representing a count of no objects.
Rationale: Students can count the number of bike slots and represent that number as a written numeral.

NC.K.CC.4
Understand the relationship between numbers and quantities.
• When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object (one-to-one correspondence).
• Recognize that the last number named tells the number of objects counted regardless of their arrangement (cardinality).

Rationale: Students can build a one-to-one correspondence by pairing one number name with one bike slot, thus saying the number names in the standard order. When the last number is named, students use cardinality to report the number of slots.

NC.K.CC.5
Count to answer "How many?" in the following situations:
• Given a number from 1–20, count out that many objects.
• Given 20 objects arranged in a line, a rectangular array, and a circle, identify how many.
Rationale: The question asks students to identify how many bike slots there are, and they are arranged in a line.

c)

NC.K.CC.5
Count to answer "How many?" in the following situations:
• Given up to 20 objects, name the next successive number when an object is added, recognizing the quantity is one more/greater.
Rationale: Given their answer to part b, students can name the next successive number when one slot will be added.

#7B) Posts and Chains

a)

NC.8.G.9
Understand how the formulas for the volumes of cones, cylinders, and spheres are related and use the relationship to solve real-world and mathematical problems.
Rationale: Students solve the real world problem of finding the volume of the post by applying the formula for the volume of a cylinder. Students can further apply the formula by subtracting the missing part of the cylinder on the post.

NC.M3.G-GMD.3
Use the volume formulas for prisms, cylinders, pyramids, cones, and spheres to solve problems.
Rationale: Students solve the real world problem of finding the volume of the post by applying the formula for the volume of a cylinder. Students can further apply the formula by subtracting the missing part of the cylinder on the post.

b)

AMC.2 – Convert between units of area and volume given length conversion factors
Rationale: Assuming that students calculate the volume in cubic inches, they must used a cubed conversion factor to find the volume in cubic meters.

c)

AMC.1
Convert between units to solve real world problems, including:
- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How much does each post weigh in pounds?" by using the conversion factor given for the weight of concrete per cubic meter.

d)

AMC.1
Convert between units to solve real world problems, including:
- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How many first grade students outweigh the post?" by using the conversion factor given for the weight per first grader.

#8) Park it Here (Brainstorm and Concept Problem)

NC.4.MD.3
Solve problems with area and perimeter.
• Apply the area and perimeter formulas for rectangles in real world and mathematical problems.
Rationale: This problem allows students to brainstorm about how to estimate the perimeter and area of a unique, real world shape. To do so, students will apply concepts they already know relating to area and perimeter of rectangles.

NC.7.G.6
Solve real-world and mathematical problems involving:
• Area and perimeter of two-dimensional objects composed of triangles, quadrilaterals, and polygons.
Rationale: This problem allows students to brainstorm about how to estimate the perimeter and area of a unique, real world shape. To do so, students will apply concepts they already know relating to area and perimeter of triangles, quadrilaterals, and polygons.

#9) Making Molehills into Mountains

a)

AMC.1

Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How long will it take to pay for this solar panel?" by using conversion factors for the monetary value per kWh and kWh produced per year.

b)

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How much energy comes from 1 square inch of panel per year?" by using conversion factors such as the area per square.

#10) Peacock Hall's Glass Semi-circle

a)

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

AMC.2
Convert between units of area and volume given length conversion factors
Rationale: Students can solve the problem of "How much paint is needed to paint the blocks?" by converting area from square inches to square feet and by converting area to number of cans.

NC.7.G.6
Solve real-world and mathematical problems involving:
• Area and perimeter of two-dimensional objects composed of triangles, quadrilaterals, and polygons.
• Volume and surface area of pyramids, prisms, or three-dimensional objects composed of cubes, pyramids, and right prisms.
Rationale: To solve the real world problem of finding the number of paint cans required to paint the glass, students will need to approximate the total area of the semi-circle by finding the area of each of the 10,384 glass blocks. Students may need extra support to convert units and calculate the number of cans.

b)

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How much will the paint cost?" by converting number of cans to a cost.

NC.5.NBT.7
Compute and solve real-world problems with multi-digit whole numbers and decimal numbers
• Multiply decimals with a product to thousandths using models, drawings, or strategies based on place value.
• Use estimation strategies to assess reasonableness of answers.
Rationale: If students are given the number of cans calculated in part a), they can multiply decimals to calculate the cost. They could also start by estimating the cost to check if their answer is reasonable.

#11) Ramping Up: the handicap ramp by Chapell-Wilson Hall

a)

NC.M2.A-CED.1
Create equations and inequalities in one variable that represent quadratic, square root, inverse variation, and right triangle trigonometric relationships and use them to solve problems.
NC.M2.G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve problems involving right triangles in terms of a context.
Rationale: To find the indicated angle, students need to create an equation that represents a right triangle trigonometric relationship/ratio. Then, they will solve the problem by using an inverse trigonometric function.

b)

NC.8.F.4
Analyze functions that model linear relationships.
• Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of the slope and y-intercept of its graph or a table of values
Rationale: Students calculate the slope of the ramp and interpret it as a rate of change - change in height (output) over forward distance (input). Students can also consider how to interpret the y-intercept.

NC.M1.F-IF.6
Calculate and interpret the average rate of change over a specified interval for a function presented numerically, graphically, and/or symbolically.
Rationale: The ramp represents a linear function relationship between height (output) and forward distance (input). Students can make measurements to represent this linear function numerically. Then, students calculate the slope of the staircase and interpret it as a rate of change - change in height over forward distance.

c)

NC.6.G.1
Create geometric models to solve real-world and mathematical problems to:
• Find the area of triangles by composing into rectangles and decomposing into right triangles.
Rationale: Students can find the area of the real world triangle pictured by composing into rectangles and decomposing into right triangles.

d)

NC.7.G.6
Solve real-world and mathematical problems involving:
• Area and perimeter of two-dimensional objects composed of triangles, quadrilaterals, and polygons.
Rationale: Students can find the area of the entire ramp shape by decomposing it into triangles and quadrilaterals.

e)

NC.5.MD.1
Given a conversion chart, use multiplicative reasoning to solve one-step conversion problems within a given measurement system.
Rationale: In this problem, students do a one-step unit conversion problem which can be solved with the help of a conversion chart.

f)

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students can solve the problem of "How many bricks are needed?" by using the given conversion factor from area to bricks.

#12) The Library Atrium

a)

NC.8.G.9
Understand how the formulas for the volumes of cones, cylinders, and spheres are related and use the relationship to solve real-world and mathematical problems.
Rationale: Students use the volume formula for a cylinder to solve the real world problem of "How many books would fill the rotunda?".

NC.M3.G-GMD.3
Use the volume formulas for prisms, cylinders, pyramids, cones, and spheres to solve problems.
Rationale: Students use the volume formula for a prism and a cylinder to solve the real world problem of "How many books would fill the rotunda?".

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

AMC.2
Convert between units of area and volume given length conversion factors
Rationale: Students can solve the problem of "How many books would fill the rotunda?" by converting the areas of a book and the rotunda into the same unit (volume conversion) and then converting volume into number of books.

b) (same standards as a)

c)

NC.5.NBT.6
Find quotients with remainders when dividing whole numbers with up to four-digit dividends and two-digit divisors using rectangular arrays, area models, repeated subtraction, partial quotients, and/or the relationship between multiplication and division. Use models to make connections and develop the algorithm.
Rationale: To solve this problem, students must divide two multi-digit whole numbers (books and students) and will find an answer with a remainder.

NC.6.RP.2
Understand that ratios can be expressed as equivalent unit ratios by finding and interpreting both unit ratios in context.
Rationale: Students must find how many books out of the 939,291 each student must carry, and this is equivalent to finding the unit ratio for books to one student.

#13) The Outdoor Classroom

a)

NC.8.G.5
Use informal arguments to analyze angle relationships.
• Recognize relationships between interior and exterior angles of a triangle.
• Solve real-world and mathematical problems involving angles.
Rationale: To find the measure of the angle θ given the central angle, students must analyze angle relationships in a triangle. The angle θ is represented in the real world on the statue base.

NC.M3.G-CO.14
Apply properties, definitions, and theorems of two-dimensional figures to prove geometric theorems and solve problems.
Rationale: To find the measure of the angle θ given the central angle, students must apply the properties of an isosceles or right triangle.

b)

NC.8.G.5
Use informal arguments to analyze angle relationships.
• Solve real-world and mathematical problems involving angles.
Rationale: To find the measure of the angle α given the central angle and θ from part a, students must analyze angle relationships within the pictured triangle and pentagon. The angle α is represented in the real world on the statue base.

NC.M3.G-CO.14
Apply properties, definitions, and theorems of two-dimensional figures to prove geometric theorems and solve problems.
Rationale: To find the measure of the angle α given the central angle and θ from part a, students must apply the properties of triangles and pentagons which relate to angles.

c)

NC.3.OA.1
For products of whole numbers with two factors up to and including 10:
• Interpret the factors as representing the number of equal groups and the number of objects in each group.
• Illustrate and explain strategies including arrays, repeated addition, decomposing a factor, and applying the commutative and associative properties.
Rationale: At this statue, students can physically represent the calculation of 3x3=9 and 2x1=2 by sitting on 3 benches in groups of 3 and 2 benches in groups of 1. They can use

this interpretation and multiplication strategies to solve two multiplication problems, and then add the answers together to find the solution.

NC.3.OA.3
Represent, interpret, and solve one-step problems involving multiplication and division.
• Solve multiplication word problems with factors up to and including 10. Represent the problem using arrays, pictures, and/or equations with a symbol for the unknown number to represent the problem.
Rationale: Students can solve 2 separate one step multiplication problems while representing them with their own bodies on the benches.

NC.5.OA.2
Write, explain, and evaluate numerical expressions involving the four operations to solve up to two-step problems. Include expressions involving:
• Parentheses, using the order of operations.
• Commutative, associative and distributive properties.
Rationale: Students can write an expression and then solve this three step problem. The expression $3(3) + 2(1)$ includes addition and multiplication, and students can apply order of operations and the commutative property to solve it.

#14) Going with the Flow

a)

AMC.1
Convert between units to solve real world problems, including:
- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

AMC.2
Convert between units of area and volume given length conversion factors
Rationale: Students will solve the problem "How many grams of calcium carbonate is moved in 30 minutes?" by using the conversion factors given to convert minutes to grams of calcium carbonate. In doing so, students will need to convert the volume unit of cubic meters to cubic centimeters.

b)

AMC.1
Convert between units to solve real world problems, including:
- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students convert 4 liters of water to grams of calcium carbonate using the given conversion factors.

c)

NC.M1.F-IF.6
Calculate and interpret the average rate of change over a specified interval for a function presented numerically, graphically, and/or symbolically.
Rationale: To decide if the fish can reach them, students interpret the average rate of change of the fish and of the water. They make this decision by considering how the rates of change affect the fish's movement in the real world.

#16) Pyramid Sculptures

a)

NC.6.G.4
Represent right prisms and right pyramids using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.
Rationale: Students can represent the real-world, right pyramid sculptures using nets of rectangles and triangles. They can then find the area of these nets to represent the surface area of the sculptures.

NC.7.G.6
Solve real-world and mathematical problems involving:
• Volume and surface area of pyramids, prisms, or three-dimensional objects composed of cubes, pyramids, and right prisms.
Rationale: Students can solve the real world problem of finding the sculptures' surface area by finding the surface area of a pyramid.

b)

NC.6.RP.4
Use ratio reasoning to solve real-world and mathematical problems with percents by:
• Understanding and finding a percent of a quantity as a ratio per 100.
• Using equivalent ratios, such as benchmark percents (50%, 25%, 10%, 5%, 1%), to determine a part of any given quantity.
Rationale: To find how much taller the statue is in percentage than an American male, students take the ratio of the statue's height to the man's height and convert it to a percent. This percent represents a ratio per 100.

Schaefer Center Activities (S1-S2)

S1) Schaefer Center - Balcony

a)

NC.K.CC.3
Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20, with 0 representing a count of no objects.
Rationale: Students can count the number of lights and represent that number as a written numeral.

NC.K.CC.4
Understand the relationship between numbers and quantities.
• When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object (one-to-one correspondence).
• Recognize that the last number named tells the number of objects counted regardless of their arrangement (cardinality).
Rationale: Students can build a one-to-one correspondence by pairing one number name with one light, thus saying the number names in the standard order. When the last number is named, students use cardinality to report the number of stairs.

NC.K.CC.5
Count to answer "How many?" in the following situations:
• Given a number from 1–20, count out that many objects.
• Given up to 20 objects, name the next successive number when an object is added, recognizing the quantity is one more/greater.
• Given 20 objects arranged in a line, a rectangular array, and a circle, identify how many.
• Given 10 objects in a scattered arrangement, identify how many.
Rationale: The question asks students to identify how many lights there are, and they are arranged in a rectangular array.

b)

NC.K.G.1
Describe objects in the environment using names of shapes, and describe the relative positions of objects using positional terms.
NC.K.G.2
Correctly name squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres regardless of their orientations or overall size.
Rationale: Students describe the balcony in the environment using the name of the shape (hexagon).

c)

NC.3.OA.1
For products of whole numbers with two factors up to and including 10:
• Interpret the factors as representing the number of equal groups and the number of objects in each group.

• Illustrate and explain strategies including arrays, repeated addition, decomposing a factor, and applying the commutative and associative properties.
Rationale: This task involves 2 multiplications. In each, students can interpret one factor as representing the number of equal groups - long sides (2) and short sides (4). The other factor represents the number of objects in each group - glass panels. They can use this interpretation and multiplication strategies to solve the two problems, and then add the answers together to find the solution. Teachers can ask students to illustrate and explain their multiplication strategies.

NC.3.OA.3
Represent, interpret, and solve one-step problems involving multiplication and division.
• Solve multiplication word problems with factors up to and including 10. Represent the problem using arrays, pictures, and/or equations with a symbol for the unknown number to represent the problem.
Rationale: Students can solve 2 separate one step multiplication problems while representing them using the methods in the standard.

NC.5.OA.2
Write, explain, and evaluate numerical expressions involving the four operations to solve up to two-step problems. Include expressions involving:
• Parentheses, using the order of operations.
• Commutative, associative and distributive properties.
Rationale: Students can write an expression and then solve this three step problem. The expression $2(5) + 4(3)$ includes addition and multiplication, and students can apply order of operations and the commutative property to solve it.

d)

NC.3.OA.1
For products of whole numbers with two factors up to and including 10:
- Interpret the factors as representing the number of equal groups and the number of objects in each group.
- Illustrate and explain strategies including arrays, repeated addition, decomposing a factor, and applying the commutative and associative properties.

Rationale: Students can interpret one factor as representing the number of equal groups (glass panels) and the other as the number of objects in each group (rivets). They can use this interpretation and multiplication strategies to solve the problem. Teachers can ask students to illustrate and explain their multiplication strategies. Note: this task goes beyond the standard because one factor (number of glass panels) is above ten.

NC.3.OA.3
Represent, interpret, and solve one-step problems involving multiplication and division.
- Solve multiplication word problems with factors up to and including 10. Represent the problem using arrays, pictures, and/or equations with a symbol for the unknown number to represent the problem.

Rationale: Students can solve the one step multiplication problem by representing it using the methods in the standard. Note: this task goes beyond the standard because one factor (number of glass panels) is above ten.

NC.5.NBT.5
Demonstrate fluency with the multiplication of two whole numbers up to a three-digit number by a two-digit number using the standard algorithm.
Rationale: Students can use the standard multiplication algorithm to solve the problem of how many rivets are needed for the railing.

e)

NC.3.MD.8
Solve problems involving perimeters of polygons, including finding the perimeter given the side lengths, and finding an unknown side length.
NC.4.MD.3
Solve problems with area and perimeter.
• Apply the area and perimeter formulas for rectangles in real world and mathematical problems.
Rationale: In this task, students find the perimeter of the balcony given the long and short side lengths in the picture. As a real world problem, students can interpret the solution as the total length of the railing.

f)

NC.4.MD.3
Solve problems with area and perimeter.
Apply the area and perimeter formulas for rectangles in real world and mathematical problems.
AMC.1
Convert between units to solve real world problems, including:

- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: Students apply the perimeter found in task e) to solve the real world problem of "How much does the railing cost?" In solving this, students use the non-standard conversion factor given in the problem ($50 per foot) to convert to dollars.

g)

NC.6.G.1
Create geometric models to solve real-world and mathematical problems to:
• Find the area of special quadrilaterals and polygons by decomposing into triangles or rectangles.
NC.7.G.6
Solve real-world and mathematical problems involving:
• Area and perimeter of two-dimensional objects composed of triangles, quadrilaterals, and polygons.

Rationale: Students solve the real world problem of “How much floor area had to be removed?” by finding the area of the hexagon, which is composed of triangles and a rectangle. Note: To solve this problem without the Pythagorean Theorem (see NC.8.G.7 below), teachers will need to provide students with the “height” of the triangles (~4.13 feet), assuming the base is 22 feet.

NC.M2.G-SRT.8
Use trigonometric ratios and the Pythagorean Theorem to solve problems involving right triangles in terms of a context.
NC.8.G.7
Apply the Pythagorean Theorem and its converse to solve real-world and mathematical problems.
Rationale: Students solve the real world problem of “How much floor area had to be removed?” by finding the area of the hexagon. As part of this process, students use the Pythagorean Theorem to find the “height” of the triangles (~4.13 feet) that compose the hexagon (assuming the base is 22 feet).

h)

NC.7.G.6
Solve real-world and mathematical problems involving:
• Volume and surface area of pyramids, prisms, or three-dimensional objects composed of cubes, pyramids, and right prisms.
Rationale: In this task, students find the volume of the (real world) space surrounded by balcony given the long/short side lengths in the picture and the height. Students can also find the volume by decomposing the hexagonal prism into triangular and rectangular prisms.

S2) Water Bottle Refill Stations

a)

NC.2.NBT.3
Read and write numbers, within 1,000, using base-ten numerals, number names, and expanded form.
Rationale: Students write the number 426 in expanded form.

b)

NC.2.NBT.1
Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones.

- Compose and decompose numbers using various groupings of hundreds, tens, and ones.

Rationale: In this task, students decompose 426 with other groupings of hundreds, tens, and ones.

c)

NC.3.MD.3
Represent and interpret scaled picture and bar graphs:
• Collect data by asking a question that yields data in up to four categories.
NC.4.MD.4
Represent and interpret data using whole numbers.
• Collect data by asking a question that yields numerical data.
Rationale: Students collect data for the question "How many water bottles have been saved" that yields data from four water fountains. Students then find and interpret the sum of the 4 data values.

d)

NC.3.MD.3
Represent and interpret scaled picture and bar graphs:
• Make a representation of data and interpret data in a frequency table, scaled picture graph, and/or scaled bar graph with axes provided.
NC.4.MD.4
Represent and interpret data using whole numbers.
• Make a representation of data and interpret data in a frequency table, scaled bar graph, and/or line plot.
Rationale: Students use the data collected in task e) to make a representation in the form of a bar graph.

e)

NC.6.SP.3
Understand that both a measure of center and a description of variability should be considered when describing a numerical data set.
a. Determine the measure of center of a data set and understand that it is a single number that summarizes all the values of that data set.

- Understand that a mean is a measure of center that represents a balance point or fair share of a data set and can be influenced by the presence of extreme values within the data set.
- Understand the median as a measure of center that is the numerical middle of an ordered data set.

Rationale: Students first collect numerical data by writing down the number of bottles saved at each fountain. Then, they find two measures of center (mean and median) that summarize the number of bottles saved at the water fountains. Students can use the real values to discuss the concepts of mean and median (especially if the values are like the given sample values with the outlier 10,358).

f)

AMC.1
Convert between units to solve real world problems, including:

- Multi-step unit conversions
- Non-standard units (e.g. number of students)
- Non-standard conversion factors (e.g. weight of concrete per cubic meter)

Rationale: To determine if the number of bottles could reach a mile, students convert from bottles to centimeters, feet, and finally miles. This is a multi-step unit conversion with a non-standard unit (bottles) and a non-standard conversion factor (20 cm per bottle).

g)

AMC.1
Rationale: Students extend the content in this standard by considering the assumptions made in task f). This process supports students' understanding of the mathematical modeling process.