Cabinetmaking (48.0703) T-Chart

Determine surface area of a cabinet =	**Apply geometric concepts to model and solve real world problems**

Program Task: Determine the surface area of a cabinet in order to determine the amount of stain or paint needed to complete the project.

PA Core Standard: CC.2.3.HS.A.14

Description: Apply geometric concepts to model and solve real world problems.

Program Associated Vocabulary:
DIMENSION, INCH, FOOT,SQUARE INCH/FOOT, COVERAGE, PI, RADIUS, DIAMETER

Math Associated Vocabulary:
AREA, CROSS SECTION, LENGTH, WIDTH, ROUND, BASE, HEIGHT, RADIUS, RECTANGULAR PRISM

Program Formulas and Procedures: A cabinetmaker has completed a custom cabinet with the dimensions below. Calculate the amount of coverage area (surface area) of the cabinet. In this project, you have two cylinder shapes. One makes up the top of the cabinet and the other makes up the base. (The small lip on the bottom will not make a difference).

Dimensions	Height	Diameter
Base	3 ½ ft.	2 ft.
Top	2 in.	2 ½ ft.

Formulas and Procedures:
Surface Area:

Cylinder:
$SA = 2\pi r^2 + 2\pi rh$

Cone:
$SA = \pi r^2 + \pi r \sqrt{(r^2+h^2)}$

Rectangular Prism:
$SA = 2lw + 2wh + 2hl$

Sphere:
$SA = 4\pi r^2$

Pyramid:
SA = (area of the base) + ½ ℓ (perimeter of base)
b = base   h = height
ℓ = slant length or slant height

Step 1: Formula for surface area of a cylinder is:

$SA = 2\pi r^2 + 2\pi rh$ ($\pi = 3.14$)

Step 2: Solve for the surface area of the base cabinet.

Cylinder $SA = 2\pi r^2 + 2\pi rh$ $r = ½ \cdot 2' = 1'$ $h = 3.5'$
$SA = 2\pi(1)^2 + 2\pi(1)(3.5)$
$SA = 2\pi + 7\pi$
$SA = 9\pi$
$SA \approx 28.26 \text{ ft}^2$

Step 3: Subtract the top of this cylinder from the total because we do not need to paint the top of the base. The top is a circle and the area of a circle is πr^2. The area of the top is $\pi(1)^2 = 3.14 \text{ ft}^2$.
$28.26 \text{ ft}^2 - 3.14 \text{ ft}^2 = 25.12 \text{ ft}^2$ The stain needed for base.

Step 4: Solve for top of cabinet (2" height ≈ .167 feet)
        $r = ½ \cdot 2.5' = 1.25'$ $h = .167'$
Cylinder $SA = 2\pi r^2 + 2\pi rh$
$SA = 2\pi(1.25)^2 + 2\pi(1.25)(.167)$
$SA = 3.125\pi + .4175\pi$
$SA = 3.5425\pi$
$SA \approx 11.12 \text{ ft}^2$ The stain needed for the top. (Since the top sticks out beyond the base, we must stain the top and bottom.)

Step 5: Total surface area to be stained is $25.12 \text{ ft}^2 + 11.12 \text{ ft}^2 = 36.24 \text{ ft}^2$. When purchasing the stain, you would round up to 37 ft^2
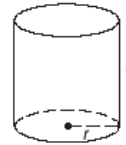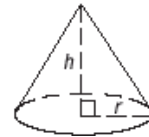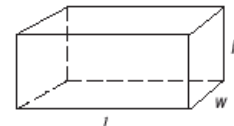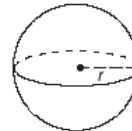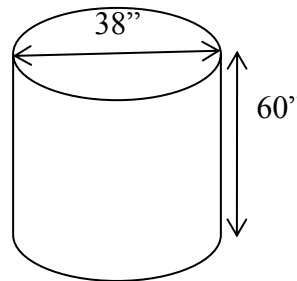
38"

60"

Example: Find the surface area of the cylinder above.
$r = ½ \cdot 38" = 19"$ $h = 60"$
Cylinder $SA = 2\pi r^2 + 2\pi rh$
    $SA = 2\pi(19)^2 + 2\pi(19)(60)$
    $SA = 722\pi + 2280\pi$
    $SA = 3002\pi$
    $SA \approx 9426.28 \text{ in}^2$

Instructor's Script - Comparing and Contrasting
Solving for surface area is just a matter of choosing the correct formula for the shape that is given. I chose the example problem for two reasons: (1) because it is a different shape than the basic rectangular prism, and (2) because it has a side that does not need to be painted. The calculations may vary if you chose to use the π key on the calculator. This is actually more accurate than using the 3.14 that I used. Once a student learns how to identify the shape, identify its parts, and decide which parts of the surface need to be covered then he/she will understand any problem for any surface area.

Common Mistakes Made By Students
Using Incorrect Formula: Correctly identify the type of object you are dealing with and use the appropriate formula. Two formulas may be needed for complex objects.

Not "Removing" Unnecessary Surface Areas from Calculations: Depending on the problem, not all surface areas included in formula may be needed. Identify the areas that are required for the calculation and remove from formula as needed.

Using Consistent Units: If the problem wants square feet instead of square inches, be sure to convert your given measurements into feet first (inches ÷ 12 = sq. feet) or convert your square inch answer into square feet (sq. inches ÷ 144 = sq. feet).

CTE Instructor's Extended Discussion
This problem is a good example of how we use all types of surface areas in cabinetmaking. The only limiting factor in creating a cabinet is the customer's imagination and the ability to manipulate the wood. Since we work with rectangular prisms all the time, this example extends our math problem solving skills.

	Problems	Occupational (Contextual) Math Concepts	Solutions
1.	A cabinetmaker needs to stain a base cabinet with these dimensions: Length: 3' Width: 24" Height: 36". If every surface needs to be stained, what is the surface area to be stained?		
2.	A cabinetmaker has been asked to make a 5 ft. high wooden ice cream cone for an ice cream shop sign. What is the surface area? (Diameter = 4 ft.)		
3.	Each can of stain covers 75 sq. ft. If a cabinetmaker has to cover a cylinder cabinet with a height of 8 feet and a diameter of 60 inches, will two cans of stain be enough?		

	Problems	Related, Generic Math Concepts	Solutions
4.	You need fabric to cover a 4 sided pyramid with base sides of 12' & slant length of 20'. How many square feet of fabric will you need to cover all sides of the pyramid? How many square yards? Note: $1 yd^2 = 9 ft^2$.		
5.	One soup can has a radius = 3" and height = 4"; another soup can has a radius = 4" and a height = 3". Which can will have a greater total surface area?		
6.	A size 7 regulation basketball has a diameter = 9.39". A size 6 regulation basketball has a diameter = 9.07". What is the surface area of each basketball?		

	Problems	PA Core Math Look	Solutions
7.	Find the surface area of a cylinder with a diameter of 13.75 ft. and a height of 28.45 ft.		
8.	Find the surface area of a sphere that has a diameter of 27.75".		
9.	Find the total surface area of cone with base diameter of 15.50" and a height of 22".		

	Problems	Occupational (Contextual) Math Concepts	Solutions
1.	A cabinetmaker needs to stain a base cabinet with these dimensions: Length: 3' Width: 24" Height: 36". If every surface needs to be stained, what is the surface area to be stained?	$SA = 2lw + 2wh + 2hl$ *** Change all dimensions to feet. $SA = 2(3)(2) + 2(2)(3) + 2(3)(3)$ $SA = 12 + 12 + 18$ $SA = 42$ square feet	
2.	A cabinetmaker has been asked to make a 5 ft. high wooden ice cream cone for an ice cream shop sign. What is the surface area? (Diameter = 4ft.)	$SA = \pi 2\sqrt{(2^2+5^2)}$ *** Take the cone formula and delete $SA = \pi 2\sqrt{(4+25)}$ the πr^2 because an ice cream cone $SA = 2\pi\sqrt{(29)}$ does not have a top on it. $SA \approx 2\pi(5.39)$ Open $SA \approx 10.78\pi$ $SA \approx 33.85$ ft^2	
3.	Each can of stain covers 75 sq. ft. If a cabinetmaker has to cover a cylinder cabinet with a height of 8 feet and a diameter of 60 inches, will two cans of stain be enough?	$SA = 2\pi(2.5)^2 + 2\pi(8)(2.5)$ 60 inches = 5 feet $SA = 12.5\pi + 40\pi$ $SA = 52.5\pi$ $SA \approx 164.85$ ft^2 No, two cans of stain x 75sq. ft. only cover 150 ft^2	

	Problems	Related, Generic Math Concepts	Solutions
4.	You need fabric to cover a 4 sided pyramid with base sides of 12' & slant length of 20'. How many square feet of fabric will you need to cover all sides of the pyramid? How many square yards? Note: 1yd^2 = 27 ft^2.	Pyramid: SA = (base area) + ½ ℓ (perimeter of base) $SA = (12)(12) + ½ (20)(48)$ $SA = 144 + 480$ $SA = 624$ ft^2 $SA = 624$ ft$^2 \div 9 \approx 69.3$ yd^2.	
5.	One soup can has a radius = 3" and height = 4"; another soup can has a radius = 4" and a height = 3". Which can will have a greater total surface area?	Can 1: Can 2 has the largest SA. $SA = 2\pi(3^2) + 2\pi(3)(4)$ $SA = 2\pi(4^2) + 2\pi(4)(3)$ $SA = 57 + 75$ $SA = 101 + 75$ $SA \approx 132$ in^2 $SA \approx 176$ in^2	
6.	A size 7 regulation basketball has a diameter = 9.39". A size 6 regulation basketball has a diameter = 9.07". What is the surface area of each basketball?	Ball 1: r = 4.695 Ball 2: r = 4.535 $SA = 4\pi(4.695^2)$ $SA = 4\pi(4.535^2)$ $SA = 4\pi(22.04)$ $SA = 4\pi(20.57)$ $SA \approx 277$ in^2 $SA \approx 259$ in^2	

	Problems	PA Core Math Look	Solutions
7.	Find the surface area of a cylinder with a diameter of 12.75 ft. and a height of 28.45 ft.	Cylinder SA = $2\pi r^2 + 2\pi rh$ Radius = ½ d = 6.375' $SA = 2\pi(6.375)^2 + 2\pi(6.375)(28.45)$ $SA = 81.28125\pi + 362.7375\pi$ $SA = 444.01875\pi$ $SA \approx 1394.22$ ft^2.	
8.	Find the surface area of a sphere that has a diameter of 27.75".	One Sphere SA = $4\pi r^2$ Radius = 27.75/2 = 13.875" $SA = 4\pi(13.875)^2$ $SA = 770.0625 \pi$ (used pi key on calculator) $SA \approx 2419.2$ in^2	
9.	Find the total surface area of cone with base diameter of 15.50" and a height of 22".	$SA = \pi r^2 + \pi r\sqrt{r^2 + h^2}$ $SA = \pi(7.75)^2 + \pi(7.75)\sqrt{(7.75)^2 + 22^2}$ $SA = 60.0625\pi + \pi(7.75)\sqrt{60.0625 + 484}$ $SA \approx 60.0625\pi + \pi(7.75)(23.325)$ $SA \approx 60.0625\pi + 180.769\pi$ $SA \approx 240.83\pi$ $SA \approx 756.2$ in.^{2}	