

Module: Mathematical Reasoning

Lesson Title: Using Nets for Finding Surface Area

Objectives and Standards

Students will:

- Draw and construct nets for 3-D objects.
- Determine the surface area of rectangular prisms, triangular prisms, and right cylinders to solve problems

Prerequisite Skills Common Core State Standards	Mathematical Reasoning 2014 GED® Assessment Targets	Mathematical Practices Common Core State Standards
Classify two-dimensional figures in a hierarchy based on properties. (CCSS.Math.Content.5.G.B.4) Relate area to the operations of multiplication and addition. (CCSS.Math.Content.3.MD.7)	Compute the area and perimeter of triangles and rectangles. Determine side lengths of triangles and rectangles (Q.4.a) Compute the area and circumference of circles. Determine the radius or diameter when given area or circumference. (Q.4.b) Compute volume and surface area of right prisms and pyramids, cylinders, spheres, cones, and composite figures. (Q.5.a, Q.5.b, Q.5.c)	Make sense of problems and persevere in solving them. (CCSS.Math.Practice.MP1) Model with mathematics. (CCSS.Math.Practice.MP4) Use appropriate tools strategically. (CCSS.Math.Practice.MP5) Look for and make use of structure. (CCSS.Math.Practice.MP7)

Materials

- Cereal boxes
- Measurement tools (rulers)
- Paper towel cardboard rolls
- Set of plastic nets or templates for various geometric nets
- Scissors
- **Handout A: Sample 3D Nets**
- **Handout B: Creating a Net**
- **Handout C: Using Nets to Find Surface Area – Step-by-Step**
- **Handout D: Calculating Surface Area Using Nets**
- **Handout E Graph Paper**
- **Handout F: Creating a Net Answer Key**
- **Handout G: Calculating Surface Area Using Nets Answer Key**
- Copies of the Formula Page for the GED® test – located at:
<http://www.gedtestingervice.com/uploads/files/15a951dfbdd875be5a7a73aa7912e2a0.pdf>

Instructional Plan

Overview

This lesson is designed to teach students how to recognize the nets of various three-dimensional figures and how to use nets to calculate surface area. This is one strategy for teaching surface area.

Process

Begin the lesson by sharing with students that there are two ways to determine surface area – by using an area for three-dimensional shapes or by calculating the area of each surface and adding them up. Share with students that today they will “catch” some new skills by using nets to calculate surface area.

Ask student if they recall how to find the area of a two-dimensional shape, such as a rectangle. For example:

Area is the number of square units needed to cover a surface. The area of a rectangle is length x width ($A = lw$).

Share with students that in today’s lesson they will learn how they can represent a three-dimensional figure as a two-dimensional figure.

Show students a cereal box and ask them how much cardboard the company would need to create the cereal box (this will involve some overlapping to get the sides glued together). Students should take the box apart and measure the cardboard. Then, ask how much of the box must be covered by graphics (this will better represent the surface area of the final figure with no need for overlapping of sides). Have the students only measure the six faces of the box. Discuss the difference between the two measurements. Explain that this idea of flattening out a box is called a net, and all three-dimensional figures have nets. Illustrate the net for a cylinder by taking apart a paper towel or toilet-paper roll (the cardboard section). Cut it down one side and unroll it to show the rectangle, and use the open parts on either end to show the two circle bases.

Review with students the terms two-dimensional and three-dimensional. Model for students how to visualize a two-dimensional shape by unfolding a three-dimensional shape. Sample templates are included on

Handout A: Sample 3D Nets.

You may also wish to access the activity from Math Interactives to assist students in visualizing how to unfold a three-dimensional shape into a two-dimensional shape.

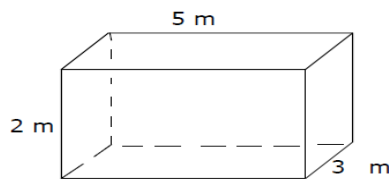
Math Interactives at:

http://www.learnalberta.ca/content/mejhm/index.html?!=0&ID1=AB.MATH.JR.SHAP&ID2=AB.MATH.JR.SHAP.SURF&lesson=html/object_interactives/surfaceArea/use_it.html

Provide each student with **Handout B: Creating a Net**. Have students complete the worksheet by identifying each three-dimensional shape and drawing the net.

When students can visual how to unfold a three-dimensional shape into a two-dimensional shape, model for students how to calculate surface area through the use of formulas with which they are familiar. Model the process by having students visualize unfolding a prism into a net. A process to model is included in **Handout C: Using Nets to Find Surface Area – Step-by-Step**.

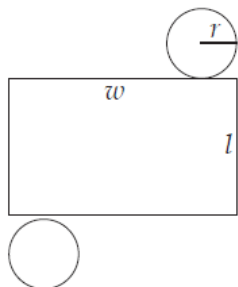
Draw the following prism on the board or chart paper.



Show students how to unfold the prism onto graph paper. **Handout E: Graph Paper** provides a template for graph paper to use during the lesson. Make sure to draw the unfolded shape to scale. Now, count the number of square units in the shape. Next, show students how to calculate the surface area by using the formula $A = l \times w$.

Showing students how you think through the process is an important part of instruction. You may wish to model additional examples of how to calculate the area of a rectangular prism and provide students with additional practice before modeling the steps for determining surface area of other three dimensional shapes.

Demonstrate how to determine the surface area of a cylinder. Show students a closed cylinder (such as a can). Ask students what shapes compose the cylinder. Students should answer that a closed cylinder includes two circles (top and bottom) and a rectangle. Draw the following or show students how a closed cylinder unfolds. Demonstrate how to determine the area of a cylinder by calculating the area of a circle (Area of circle = πr^2) and the area of the rectangle ($A = l \times w$). Note that the length of the rectangle is the same as the circumference of the circle. Then add the three together. You can use any measurement for calculating



The last shape to model for this lesson is to calculate the surface area of a right triangular prism. Show students how to unfold the shape and then calculate the area of the two triangles and the area of the three rectangles. You may need to review how to determine the area of a triangle with students: $b \times h / 2$. Share with students that they may be able to combine some areas if they contain similar measurements.

Provide students with **Handout D: Calculating Surface Area Using Nets** and graph paper. Have students unfold the shape, create a net on the graph paper and determine the surface area of each shape. Share with students that they may wish to cut out the shapes to ensure that they have created the correct net for each shape. Remember that circles may not draw accurately on graph paper, but students should attempt to draw the circles so that they are proportionate to the rectangle.

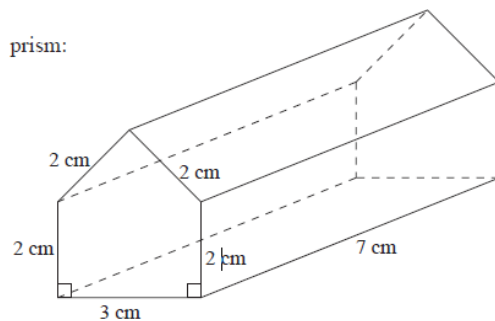
Have students share their results with the class. Discuss any problems that they encountered.

Sample Debriefing Questions

- What was the easiest shape to unfold? The most difficult? Why?
- How can unfolding shapes assist you in calculating the area of composite shapes, which is another skill assessed on the GED® test?
- Where is surface area used in real-world situations? Provide an example.

Assessments/Extensions

1. Provide students with additional shapes to unfold and calculate surface area, such as: pyramids, spheres, and open cylinders.
2. Provide students with additional practice by having them solve real-world word problems using more authentic shapes, such as the following figure.

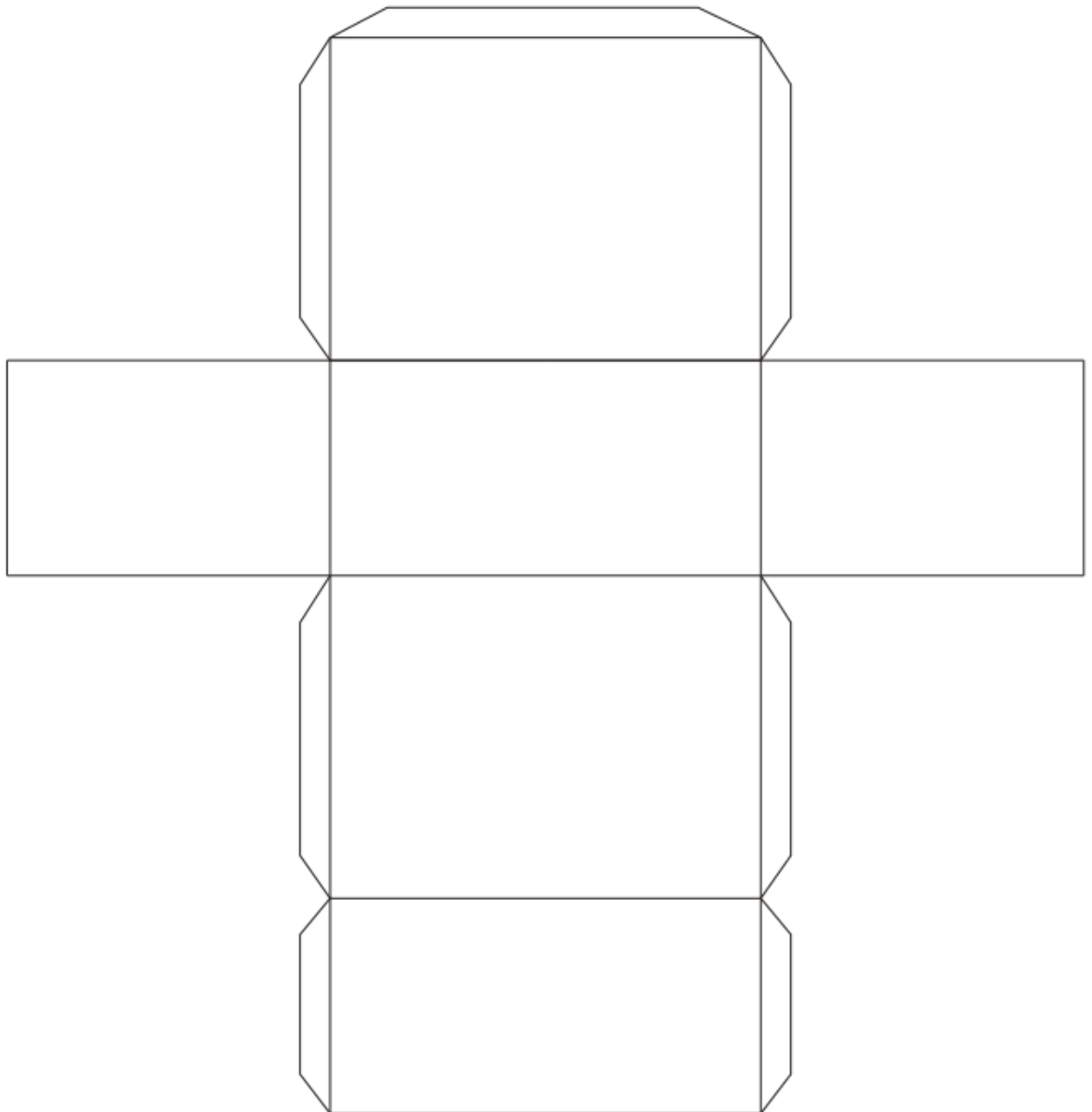


3. Provide students with the formula page from the GED Testing Service®. Have students discuss how determining surface area using nets connects to using surface area formulas. Have students determine which method is easier for them and why.
4. Access the following websites to access additional materials and activities to use in the classroom
 - Math Interactives.
http://www.learnalberta.ca/content/mejhm/index.html?l=0&ID1=AB.MATH.JR.SHAP&ID2=AB.MATH.JR.SHAP.SURF&lesson=html/object_interactives/surfaceArea/use_it.html
 - Interactives Geometry 3D Shapes Annenberg Learner
<http://www.learner.org/interactives/geometry/index.html>
 - Everything Maths
<http://everythingmaths.co.za/maths/grade-10/12-measurement/12-measurement-02.cnxmlplusprism>

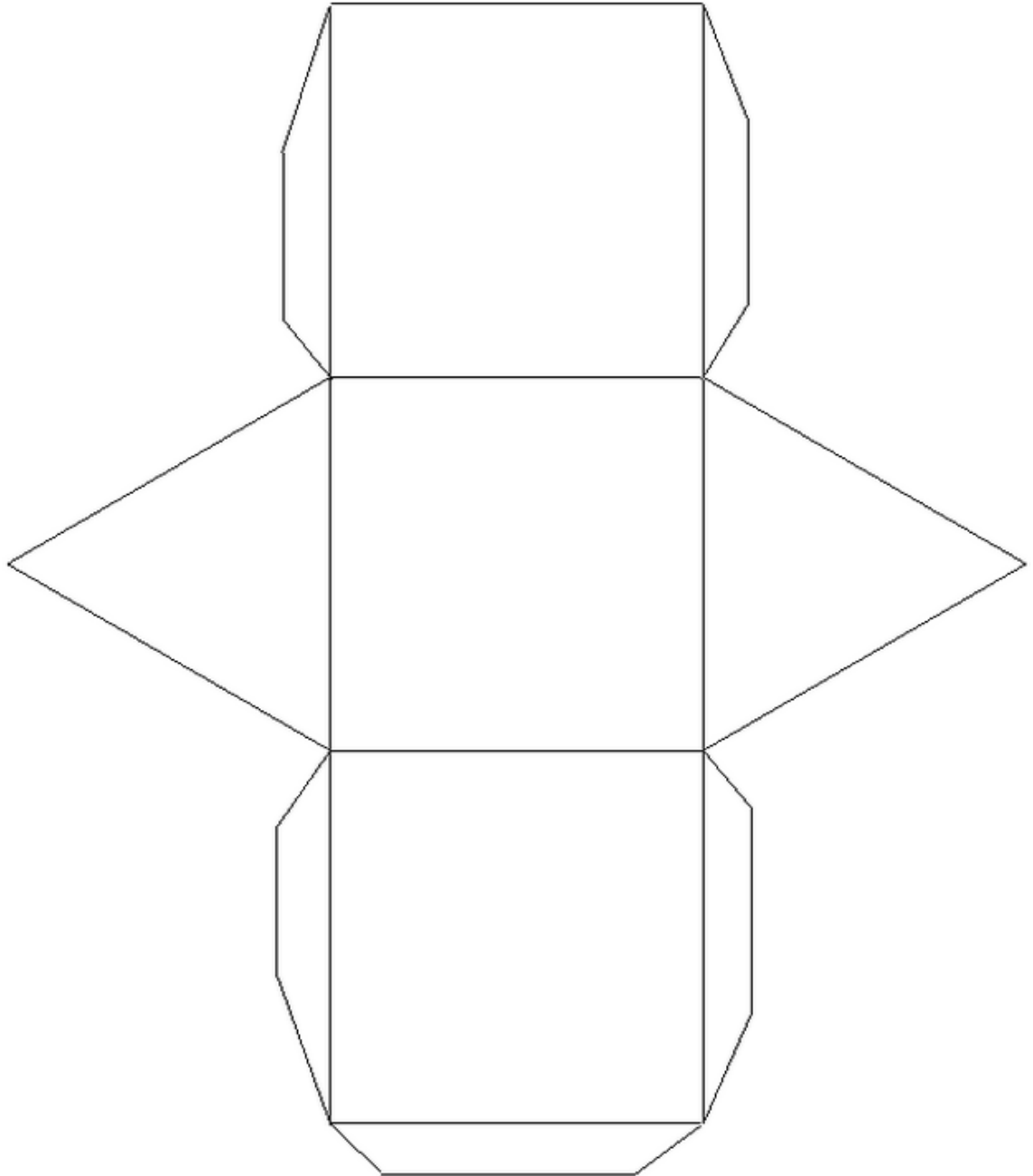
Handout A: Sample 3D Nets

Cut out the figures and put them together. Show students how they can unfold the three-dimensional shape into a two-dimensional shape. Tabs are provided for assistance in “putting” the shape together. You may wish to access other shapes through a search on the Internet.

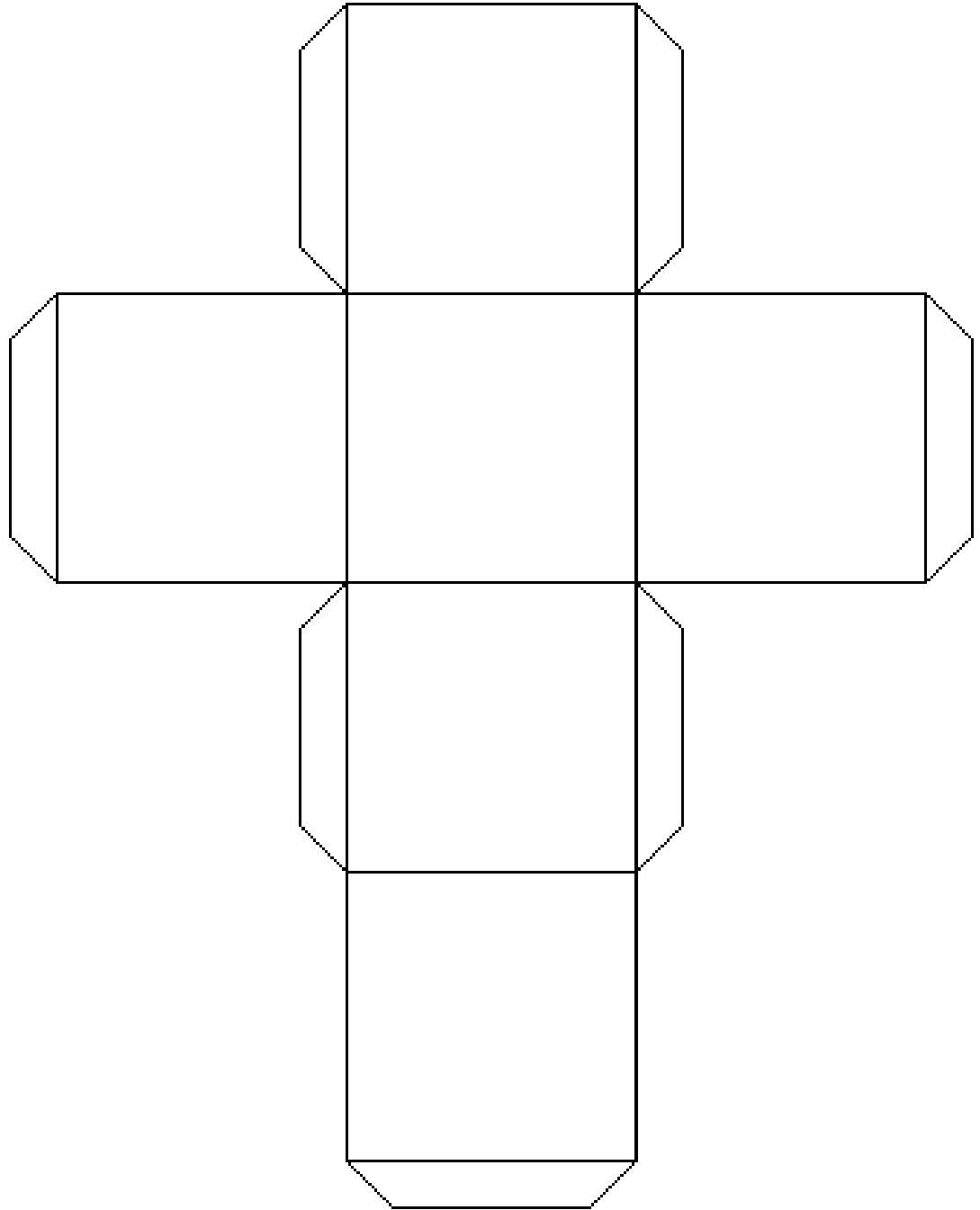
Rectangular Prism



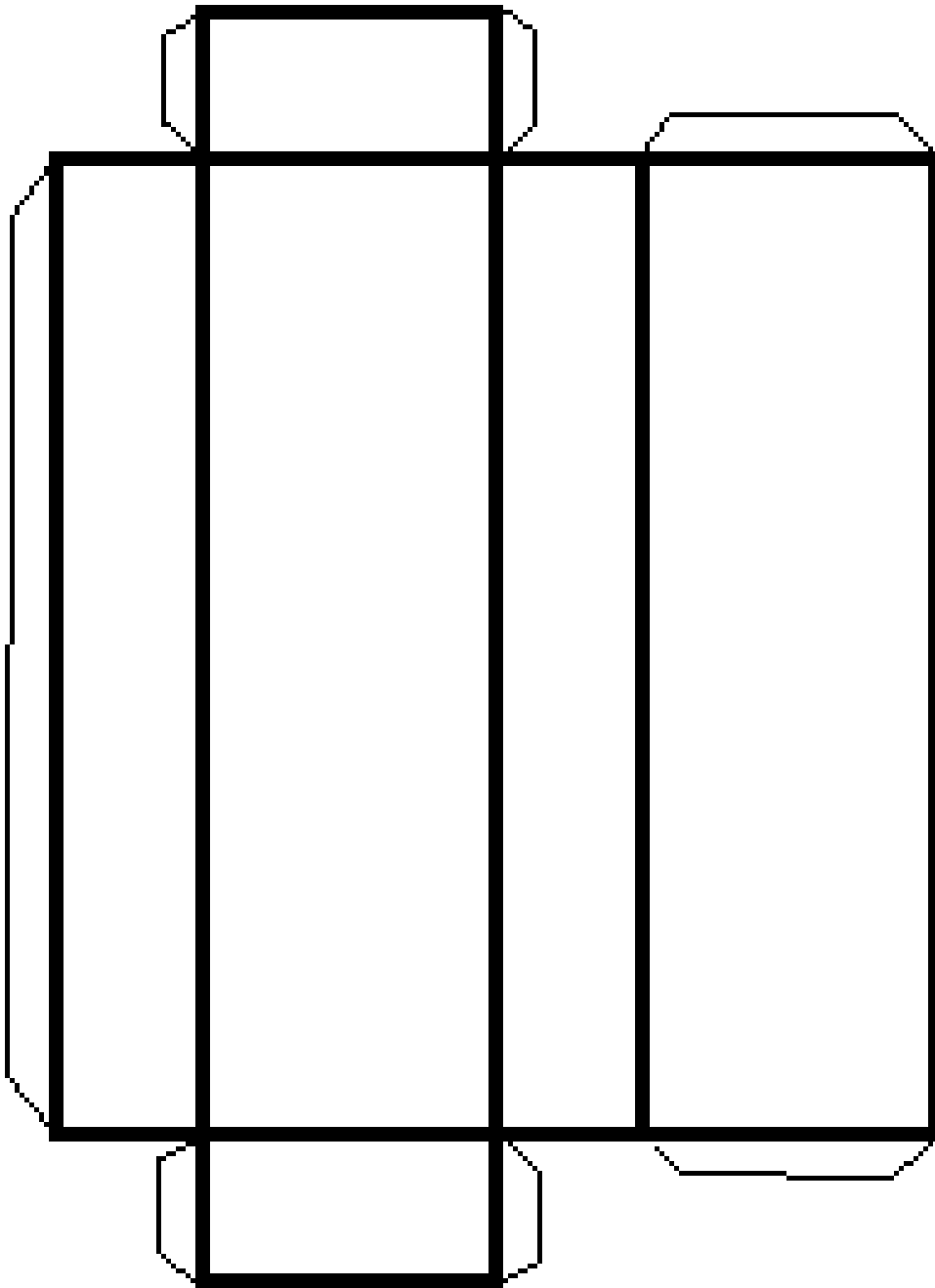
Triangular Prism



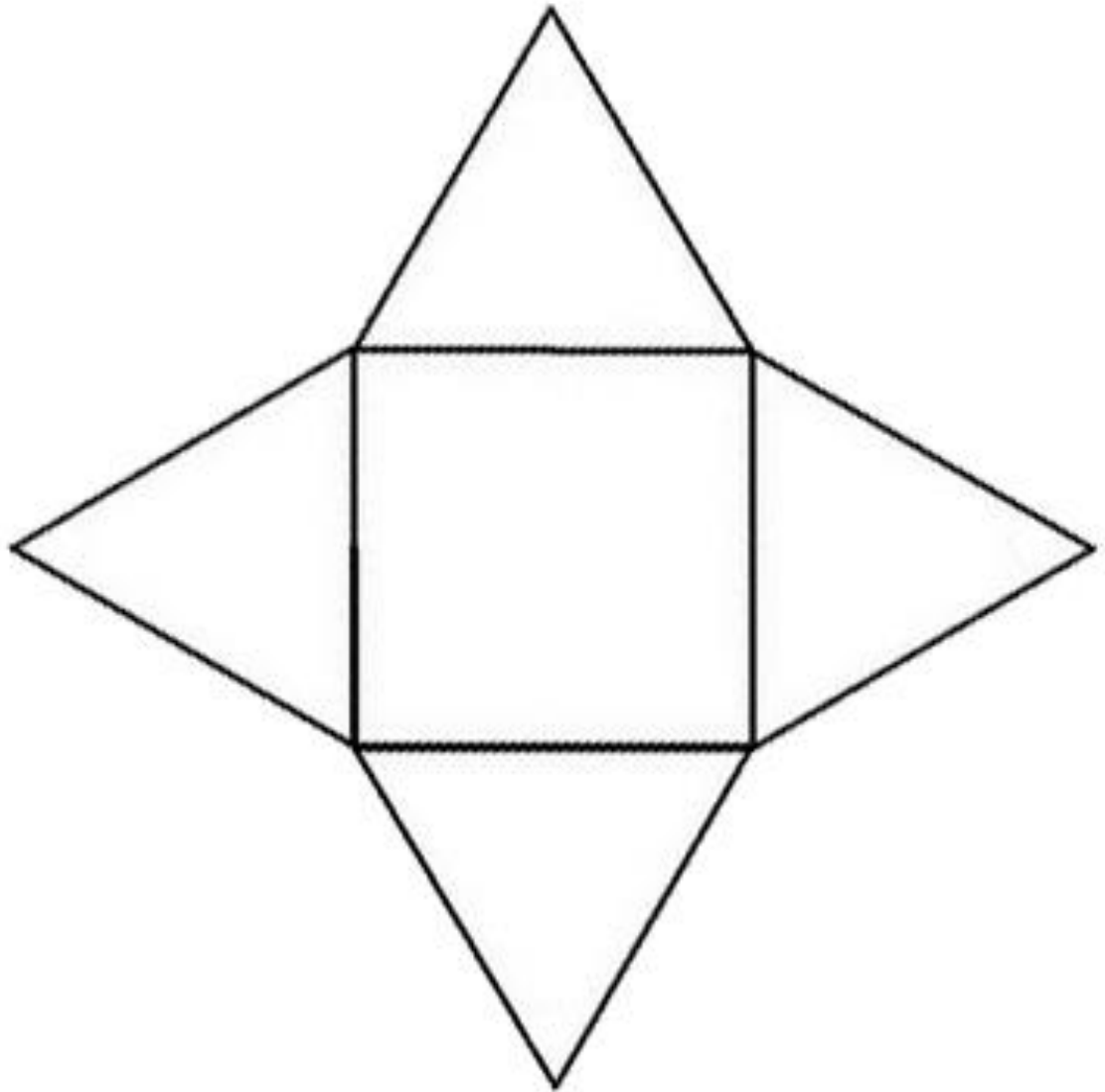
Cube



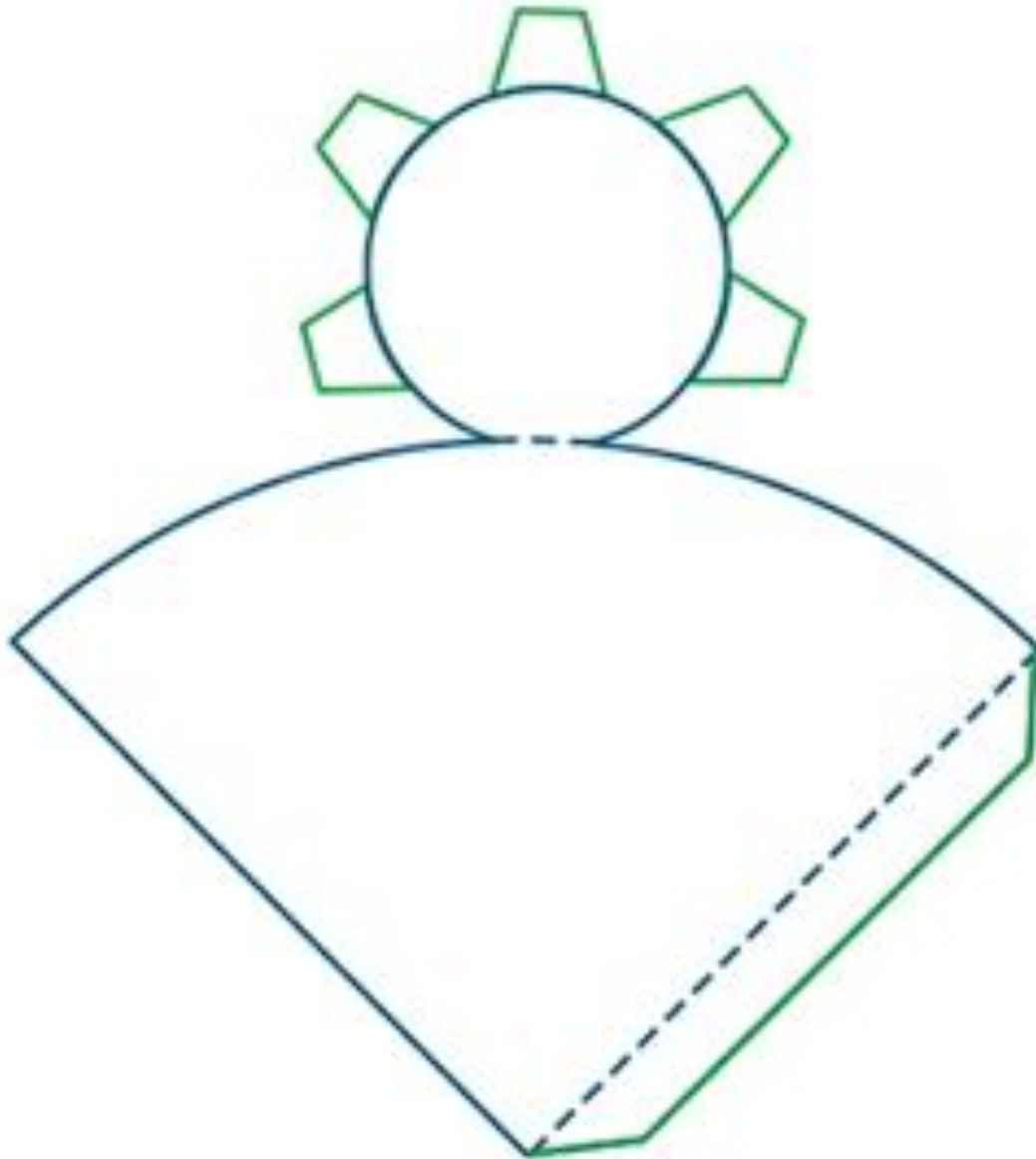
Cuboid



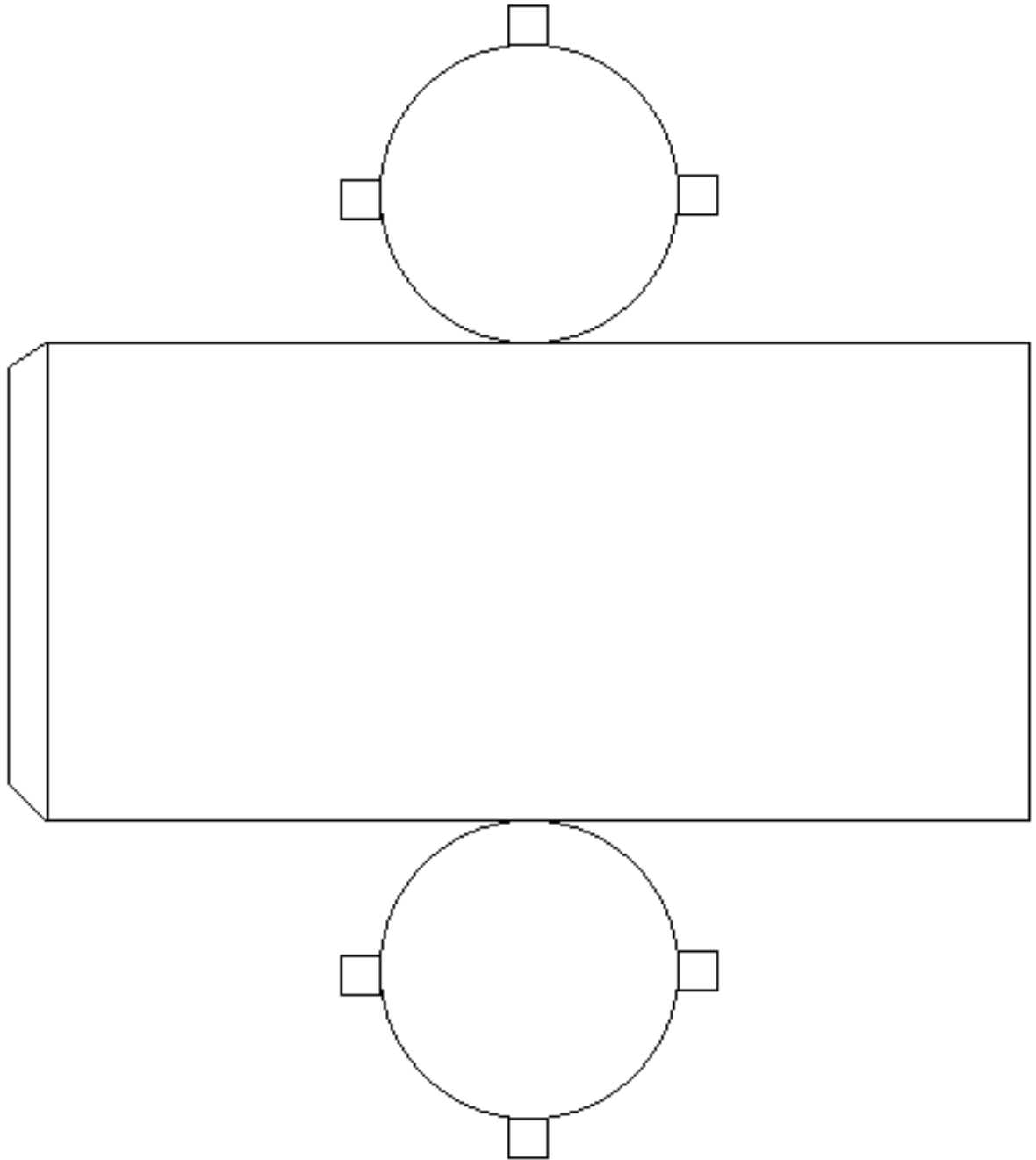
Pyramid (Square Based)



Cone

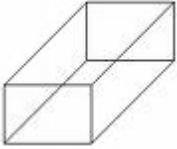
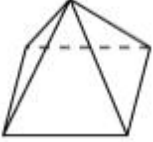
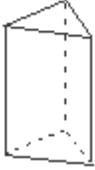
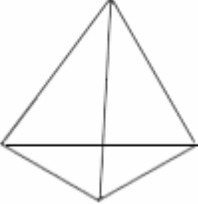
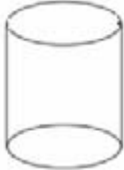



Cylinder



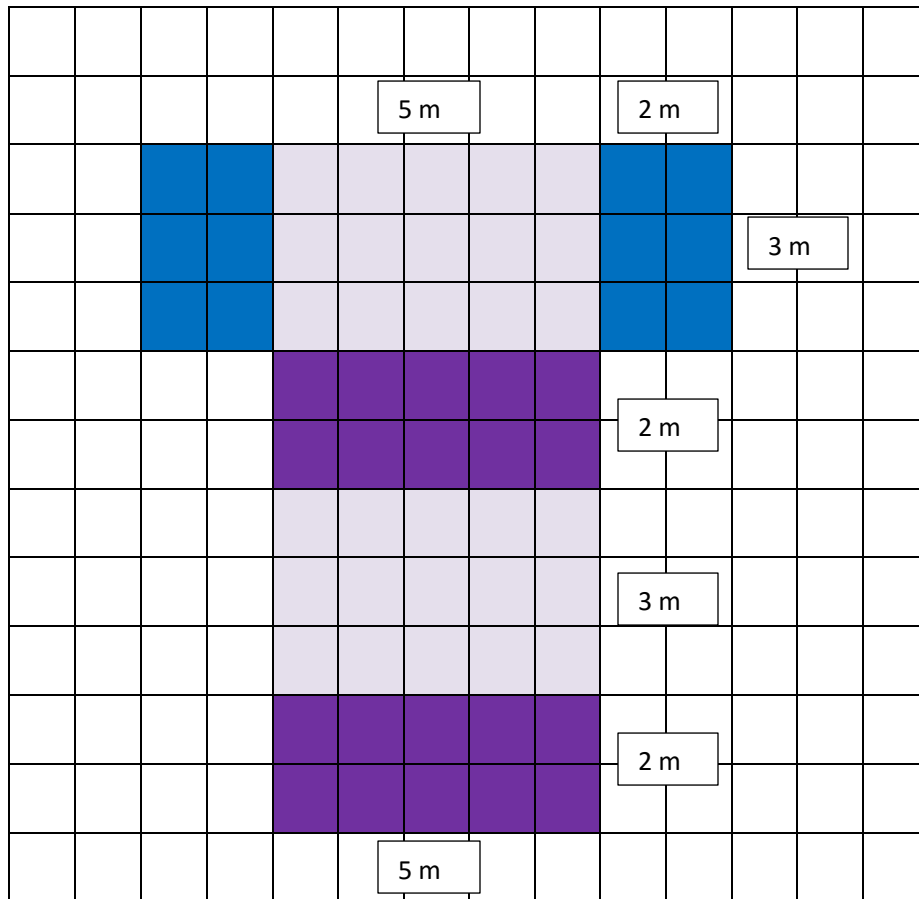
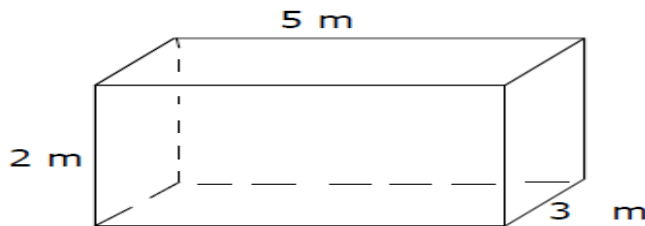
Handout B: Creating a Net

For each shape, write its name and sketch its net.

Shape	Name	Net
		
		
		
		
		
		

Handout C: Using Nets to Find Surface Area – Step-by-Step

Find the surface area of the rectangular prism by using a net. Use graph paper. Note that the shape is 5 m in length with a base of 3m and a height of 2 m



Draw the net to scale (note that the net can be drawn in a different orientation, dependent on how you “unfold” it).

You may wish to cut the net out and show students how it folds into the three-dimensional shape.

Count the squares – 62 square units.

Calculate area and add it up.

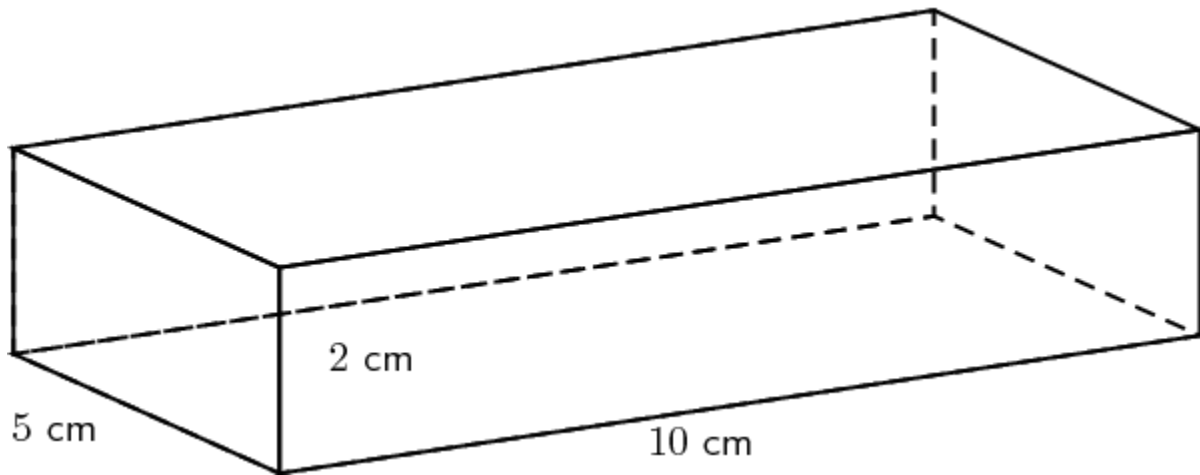
$$(5 \times 3) + (5 \times 3) + (5 \times 2) + (5 \times 2) + (2 \times 3) + (2 \times 3) = 15 + 15 + 10 + 10 + 6 + 6 = 62 \text{ m}^2$$

Show students how to combine different shapes to create larger rectangles. For example, the top three rectangles could be combined to create a 9 x 3 size shape (5 + 2 + 2 = 9 with a height of 3).

Handout D: Calculating Surface Area Using Nets

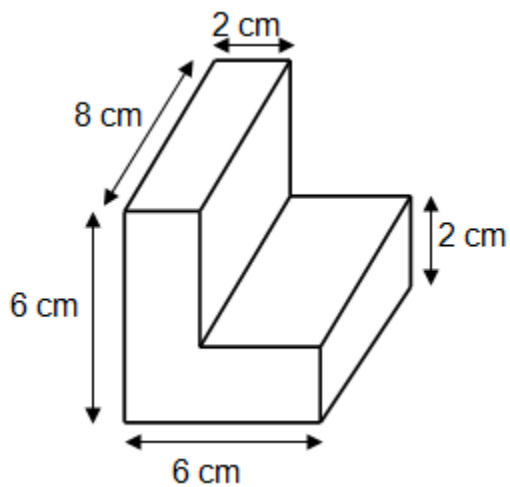
Question 1

The diagram shows a rectangular prism. Use graph paper to draw the net for the solid and mark the lengths. Calculate the surface area of the solid.



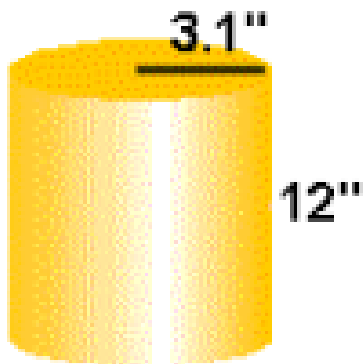
Question 2

The diagram shows a prism constructed from two rectangular prisms. Draw the net for the solid and mark the lengths. Calculate the surface area of the solid.



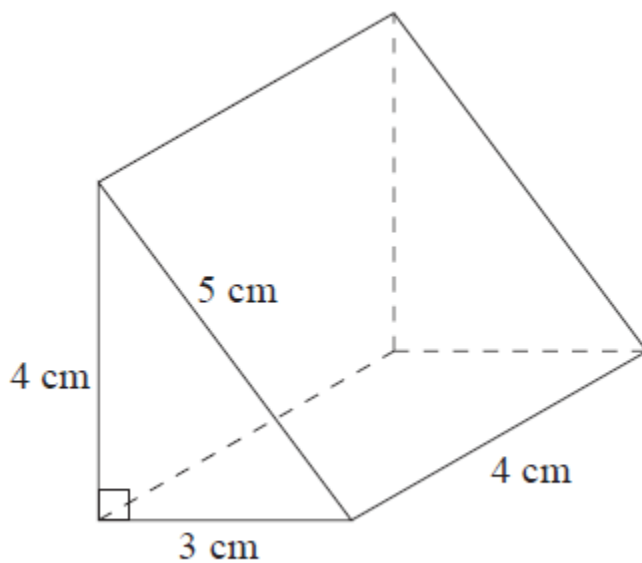
Question 3

The diagram shows a cylinder. Draw the net for the solid and mark the lengths. Calculate the surface area of the cylinder. Round to the nearest tenth.

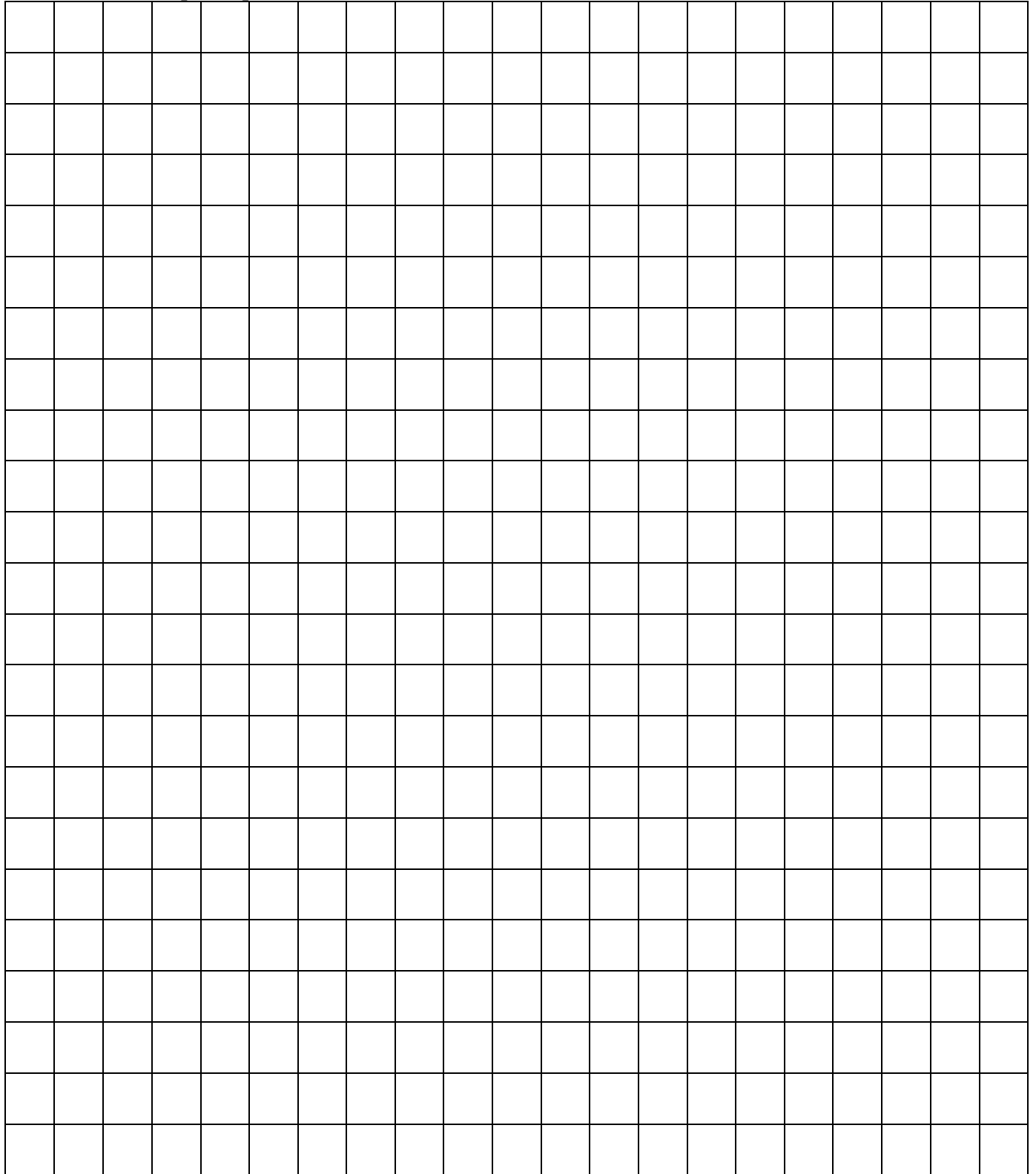


Question 4

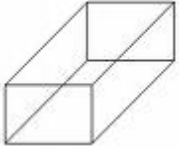

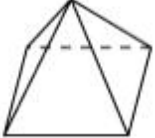

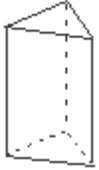

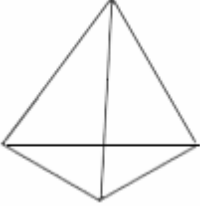

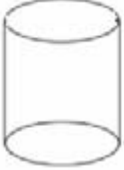
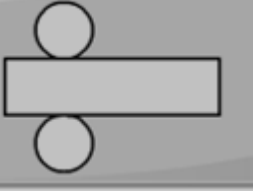


The diagram shows a triangular prism. Draw the net for the solid and mark the lengths. The triangular faces of the prism are right triangles. Calculate the surface area of the solid.



Handout E: Graph Paper

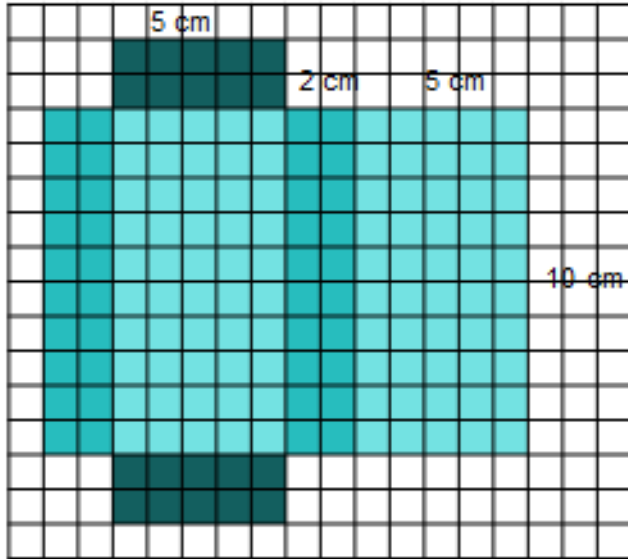


Handout F: Creating a Net Answer Key

Shape	Name	Net
	Rectangular Prism	
	Square-based Pyramid	
	Triangular Prism	
	Triangular Pyramid	
	Cylinder	
	Cone	

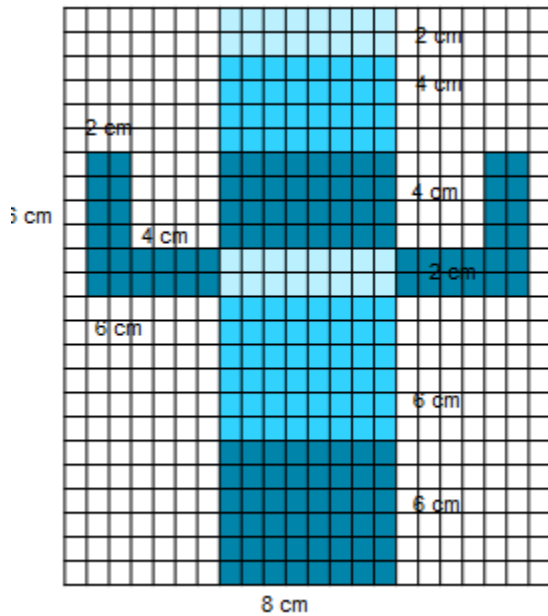
Handout G: Calculating Surface Area Using Nets Answer Key

Sample Answer Key – Question 1



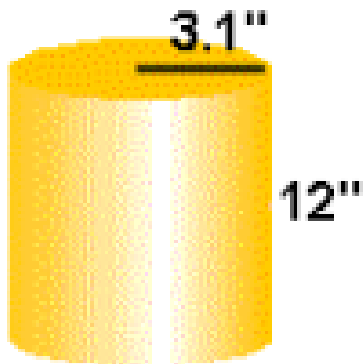
Answer: The surface area is 160 cm^2

Sample Answer Key – Question 2



Answer: The surface area is 232 cm^2

Sample Answer Key – Question 3



Top or bottom circle

$$A = \pi r^2$$

$$A = \pi(3.1)^2$$

$$A = \pi(9.61)$$

$$A = 30.1754$$

Rectangle

$$C = \text{length}$$

$$C = \pi d$$

$$C = \pi(6.2)$$

$$C = 19.468$$

Now the area

$$A = lw$$

$$A = 19.5(12)$$

$$A = 234$$

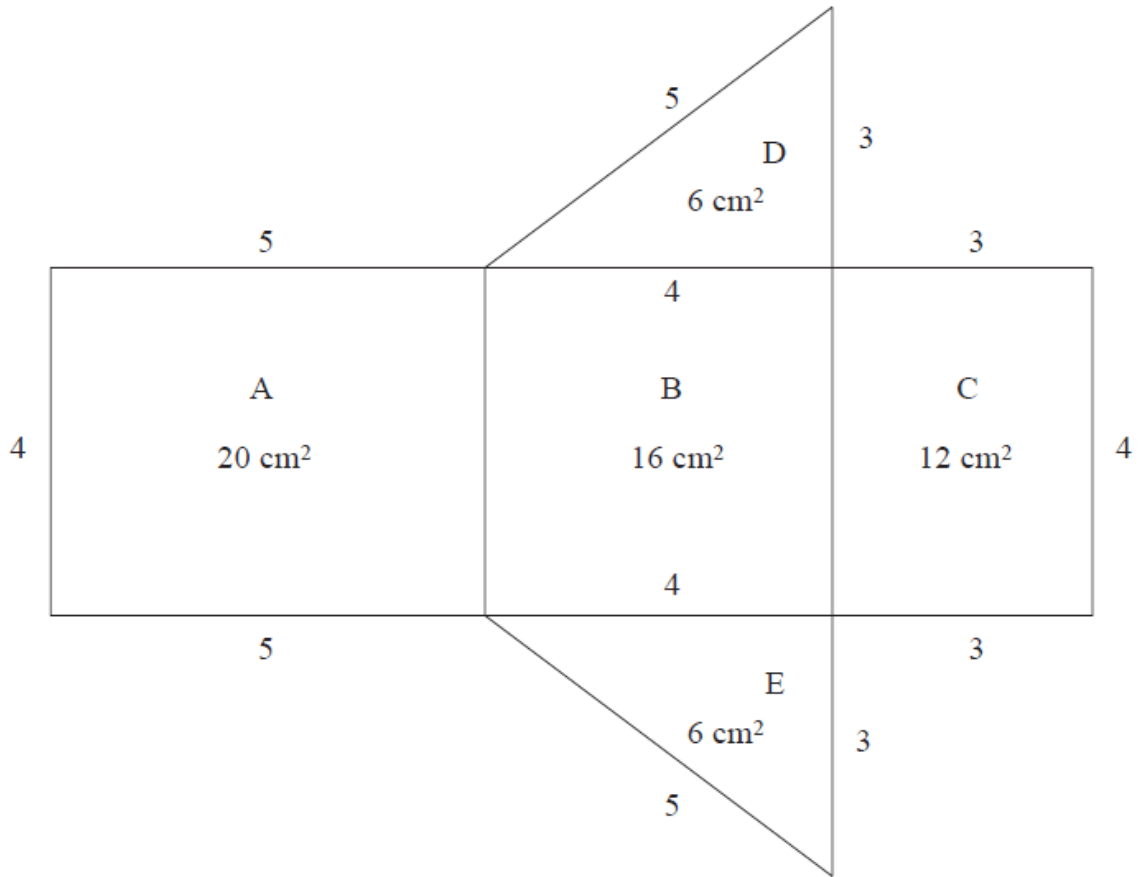
Now add:

$$30.2 + 30.2 + 234 =$$



Answer: SA = 294.4 in²

Sample Answer Key – Question 4



Answer: The surface area is 60 cm^2