

Overview

In this lesson the students will watch a video showing visual models that relate to the concepts of volume and surface area of given solids (rectangular prisms, triangular prisms, cones and cylinders). Given nets they will construct these three-dimensional forms and compute the surface area and volume of each. They will then draw these models in two dimensions and label their dimensions translating the process into formulas for each three-dimensional object. The video will present applications of these mathematical processes in careers making their use come alive.

SC Math Standards Met**Grades 5-8: Geometry and Spatial Sense**

- ✍ construct two- and three-dimensional geometric figures with concrete models
- ✍ develop spatial sense by thinking about and representing geometric figures
- ✍ use measurements and formulas to solve real-world and mathematical problems
- ✍ use technology whenever appropriate to explore concepts and applications of geometry
- ✍ apply the concepts of volume and surface area of three-dimensional figures including prisms, cylinders and cones

Learning Objectives

Students will:

- ✍ understand the concept of surface area and volume and be able to communicate their meaning through written means using pictures of visual models
- ✍ build models of rectangular prisms using nets and blocks and compute the volume and surface area of these figures
- ✍ translate these models into two-dimensional forms using isometric paper appropriately labeling the dimensions
- ✍ use nets to construct triangular prisms, cones and cylinders, and compute the volume and surface area
- ✍ translate these three-dimensional figures into two-dimensional forms by drawing them on paper, labeling their dimensions and describing how to find the surface area and volume

Materials

- ✍ containers that are various shapes and sizes that hold the same volume
- ✍ nets for rectangular prisms, triangular prisms, cones and cylinders
- ✍ Attribute Game
- ✍ a model of a cube or rectangular prism and cubes used to demonstrate how to compute volume (will use centimeter cubes)
- ✍ cubes (will match the net)
- ✍ isometric paper
- ✍ graph paper
- ✍ scissors and tape

ITV Series

Math Vantage: Spatial Sense, Lesson 6, "Containers: Surface Area and Volume"

Previewing Activities

Show students containers in several different shapes and of different sizes that hold the same volume, and ask them "Do you think these containers can hold the same volume? Why or why not?"

Have them write their thoughts as a journal entry and then share a few responses with the whole class.

Play the Attribute Game (Activity Sheet 1) to review the attributes of rectangular prisms, triangular prisms, cylinders and cones

Have the students list each figure and their attributes as a journal entry

Focus for Viewing

Distribute Activity Sheet 2. Have students read the questions prior to starting the video. Tell them that as they watch the video to look for the answers to the questions and to record them on the activity sheet.

Viewing Activities

Start the video at the beginning and pause after the discussion of how to determine the volume of different size containers. Allow students time to answer question one.

1. How could you find the volume of the different size containers as presented in the video? Why is this important when packaging materials?

Resume the video and have students watch the discussion and demonstration of finding the volume of a container of water. At the end of the discussion, pause the video and ask the students to write their answers to the following question on their handout.

2. Explain how you find the volume of an object by throwing this object into a container of water. Draw a picture if it enhances your explanation.

Resume the video. When you hear the question about which container holds more, pause the video and have the students write their answers on their handout.

3. "Which holds more? The cylindrical bucket or the box? Why?"

After students write their answers, discuss them, and then resume the video and ask the students to look for the correct answer.

Pause the video after the discussion of crushed ice versus cubed ice and have students write their answer to the following question on their handout.

4. "Why does crushed ice have more surface area than cubed ice?" Which ice would you choose for your drink? Explain why. Share some ideas with the whole class.

Resume playing the video. Pause after the discussion of the relationship between volume and surface area in losing heat and have students write the answer to the following question on their handout.

5. "Describe the relation between surface area and volume when losing heat. Use examples from the video to support your explanation." After students write down their answers have them share with the whole class.

Play the video to the end. Ask students to explain the difference between surface area and volume. Ask them for ideas on how to compute each.

Post-Viewing Activities

1. Model how to use a cube or rectangular prism to compute the surface area and volume using centimeter cubes that fill one of the containers brought to class (use students to assist you in finding the answers).
2. Distribute the net for a rectangular prism (Activity Sheet 3). Have students construct the prism, and then compute the surface

area and volume. Distribute Activity Sheets 4 and 5 and have students compute the surface area and volume for them.

- Using cubes, have the students construct a figure with the same surface area and volume as the prisms constructed in number 2.
- Using isometric paper (Activity Sheet 6), have students translate these figures onto the paper and label each dimension. By each figure write the surface area and volume.
- Have the students generate at least two more examples of three-dimensional figures using their cubes, finding the surface area and volume for these and then translating this to isometric paper. Have them label each dimension and write the surface area and volume of each.
- Record the students' examples onto an overhead and then see if they can discover or generalize and write a rule (formula) that will work when finding (a) the surface area of a rectangular prism, and (b) the volume of a rectangular prism. Have them record this in their journals.
- Follow this same process for finding the surface area of triangular prisms, cones and cylinders using the nets and transferring these into two dimensional drawings, while labeling each dimension. Generate as many examples as possible, share with the students, and create the formulas.
- At the conclusion of this unit have the students write a general description of how you find the surface area and volume of different three-dimensional figures. For their examples they should use rectangular prisms, triangular prisms, cones and cylinders labeled appropriately with a

description of the process used for each. They should use visual models and drawings in their description.

Action Plan

- Students can have experiences with objects found that have three dimensions. The teacher and students can bring in boxes of many shapes and sizes to create a classroom grocery store. Cereal, such as oatmeal, comes in cylindrical boxes, while others are packaged in rectangular prisms. Pyramids may be used for specialty boxes. Collect as many three-dimensional models that were studied in class. They can later be used for classroom activities to find surface area and volume.
- Students can also go on a geometry walk around the school grounds and identify plane and solid figures. Following the walk they can cut out pictures of solid figures to put in a book of geometry.

Extensions

Technology:

- Go to <http://www.owt.com/gdscott/> This site will provide a Fabric Origami Workshop project which can be used to construct boxes and compute surface area.
- Go to <http://csis.pace.edu/~meyer/origami/> Surface area can be discussed after creating three-dimensional figures.
- Go to <http://forum.swarthmore.edu/midpow/> This site provides math problems for middle school students. The example attached relates to building containers and finding the volume. This can be used as an extension activity for students.

4. Go to <http://forum.swarthmore.edu/workshops/sum98/participants/sanders/Geom3D.html>
Real three-dimensional pictures of buildings are used to portray geometric solids.
5. Go to <http://forum.swarthmore.edu/workshops/sum98/participants/sanders/Isom.html>
Isometric drawings of three-dimensional figures are shown.
6. Go to <http://www.cs.colorado.edu/~eisenbea/hypergami/hg-playground.html>
This site shows rotating polyhedra in three dimensions to show different views.

Activity Sheet 1

The Attribute Game

Directions.

Use index cards to write the question on one side and the answer to another question on the other side. Beginning with the second entry write, "I am a circle " on one side of the card, and "I am a rectangular prism with six congruent faces. What am I?" on the other side of the card. Continue with the next group of two and follow the same procedure until you come to the last entry "I am an octagon." This goes on the card with the first entry "I am a set of points on a plane that are all the same distance from a given point, called the center. What am I?"

Each student is given one card and the game can begin with any student first reading a question with "What am I?" at the end. The student with the answer reads "I am." and then turns the card over to read another "What am I?" question. The game will end when everybody has asked and answered a question. All of the cards must be used.

Place the following questions on index cards (following the above directions):

1. I am a set of points on a plane that are all the same distance from a given point, called the center. What am I? (I am a circle.)
2. I am a rectangular prism with six congruent faces. What am I? (I am a cube.)
3. I am a triangle with three congruent sides. What am I? (I am an equilateral triangle.)
4. I am a three-dimensional figure with only one base. My base is a polygon and the other three faces are triangles. What am I? (I am a pyramid.)
5. I have a square base and three faces that are triangles. What am I? (I am a square pyramid.)
6. I am the number of cubic units needed to fill the space inside of a three-dimensional figure. What am I? (I am the volume of a three-dimensional figure.)
7. I am a parallelogram with four right angles. What am I? (I am a rectangle.)
8. I am a three-dimensional figure with two parallel and congruent polygonal faces, called bases. What am I? (I am a prism.)
9. I have two parallel bases that are pentagons and five faces that are squares. What am I? (I am a pentagonal prism.)

Activity Sheet 1

The Attribute Game (cont.)

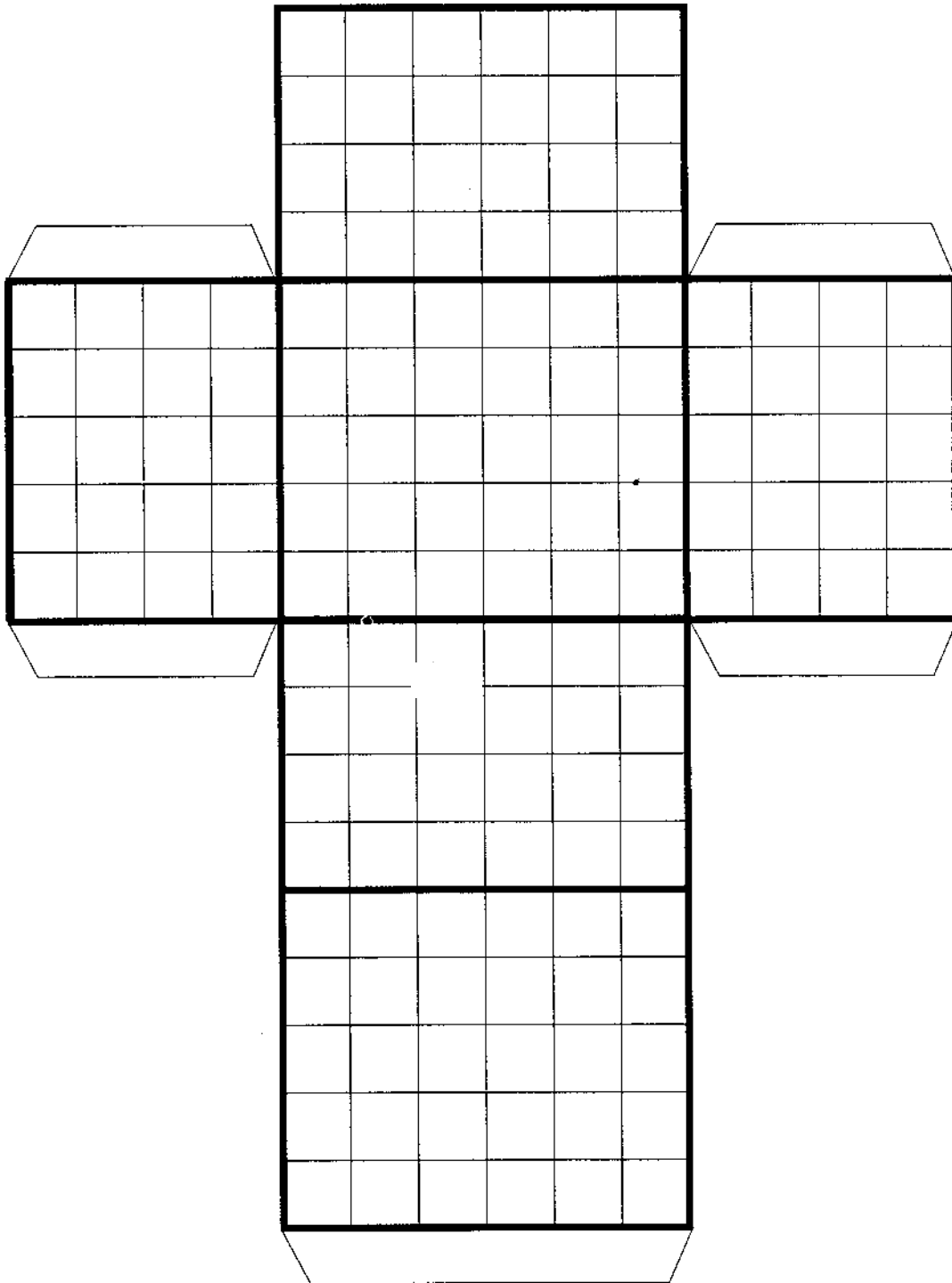
10. I have two parallel bases that are rectangles and four faces. What am I? (I am a rectangular prism.)
11. I have two parallel bases that are triangles and three faces. What am I? (I am a triangular prism.)
12. I have two parallel bases that are congruent circles connected by a rolled connected rectangle. What am I? (I am a cylinder.)
13. I have one circular base, no polygonal faces and one vertice. What am I? (I am a cone.)
14. I am a closed figure formed by three or more line segments that intersect only at their endpoints. What am I? (I am a polygon.)
15. I am a five-sided plane figure. What am I? (I am a pentagon.)
16. I am a six-sided plane figure. What am I? (I am a hexagon.)
17. I am an eight-sided plane figure. What am I? (I am an octagon.)

Activity Sheet 2

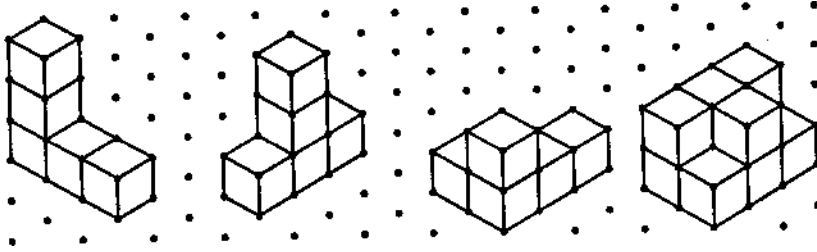
Name _____ Date _____

1. How can you find the volume of the different size containers as presented in the video? Why is this important to know when packaging materials?
2. Explain how you find the volume of an object by throwing this object in to a container of water. Draw a picture if it enhances your explanation.
3. Which holds more? The cylindrical bucket or the box? Why?
4. Why does crushed ice have more surface area than cubed ice? Which ice would you choose for your drink? Why?
5. Describe the relation between surface area and volume when losing heat. Use examples from the video to support your explanation.

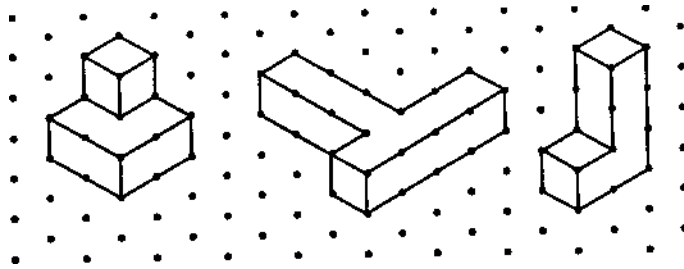
Activity Sheet 3
Net for Rectangular Prism



Activity Sheet 4



Surface Area _____ Surface Area _____ Surface Area _____ Surface Area _____
 Volume _____ Volume _____ Volume _____ Volume _____

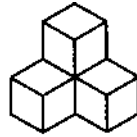


Surface Area _____ Surface Area _____ Surface Area _____
 Volume _____ Volume _____ Volume _____

Activity Sheet 5

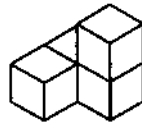
Surface Area _____

Volume _____



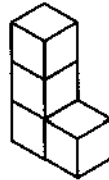
Surface Area _____

Volume _____



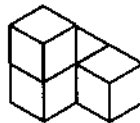
Surface Area _____

Volume _____



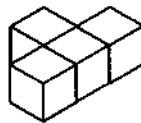
Surface Area _____

Volume _____



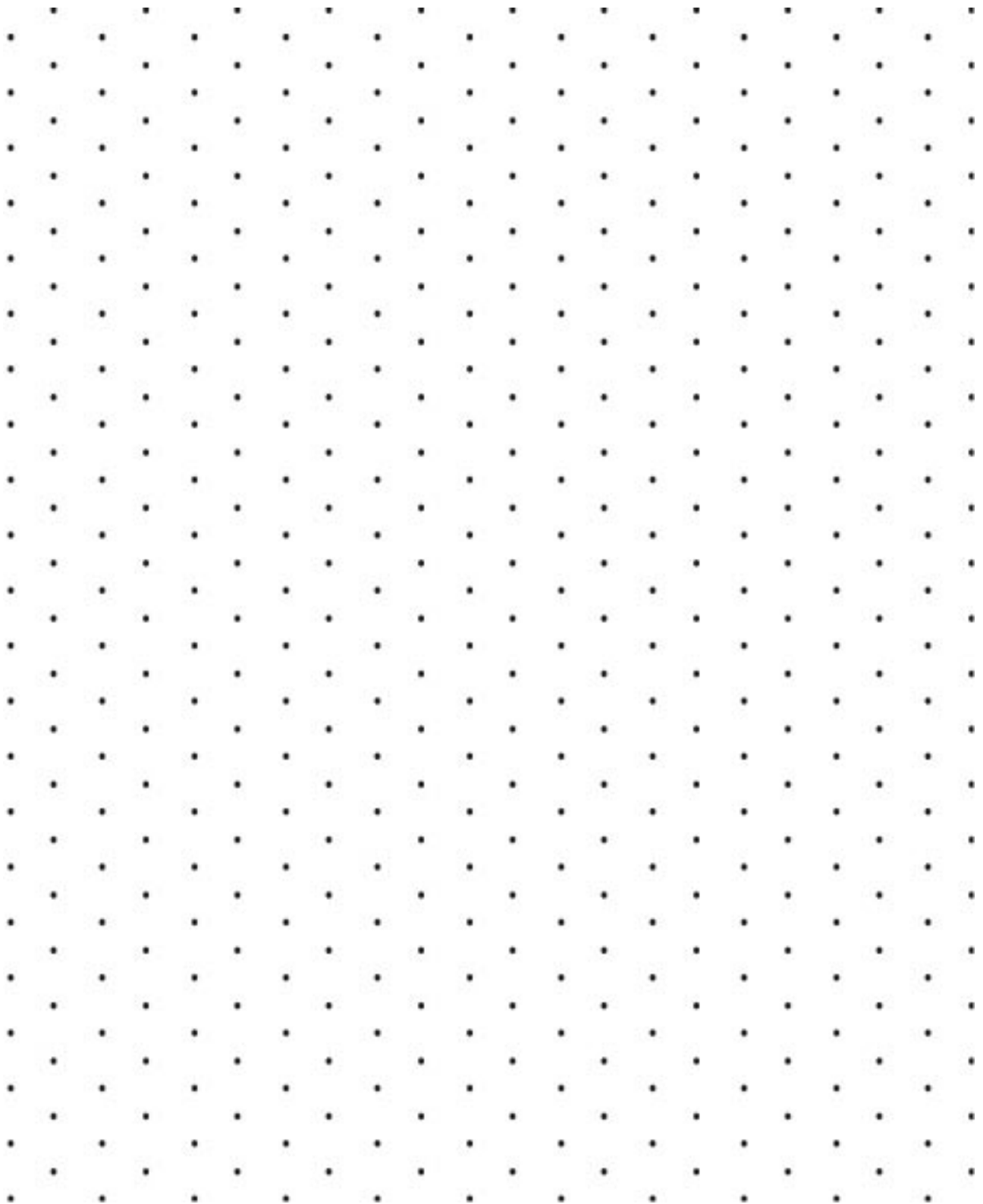
Surface Area _____

Volume _____



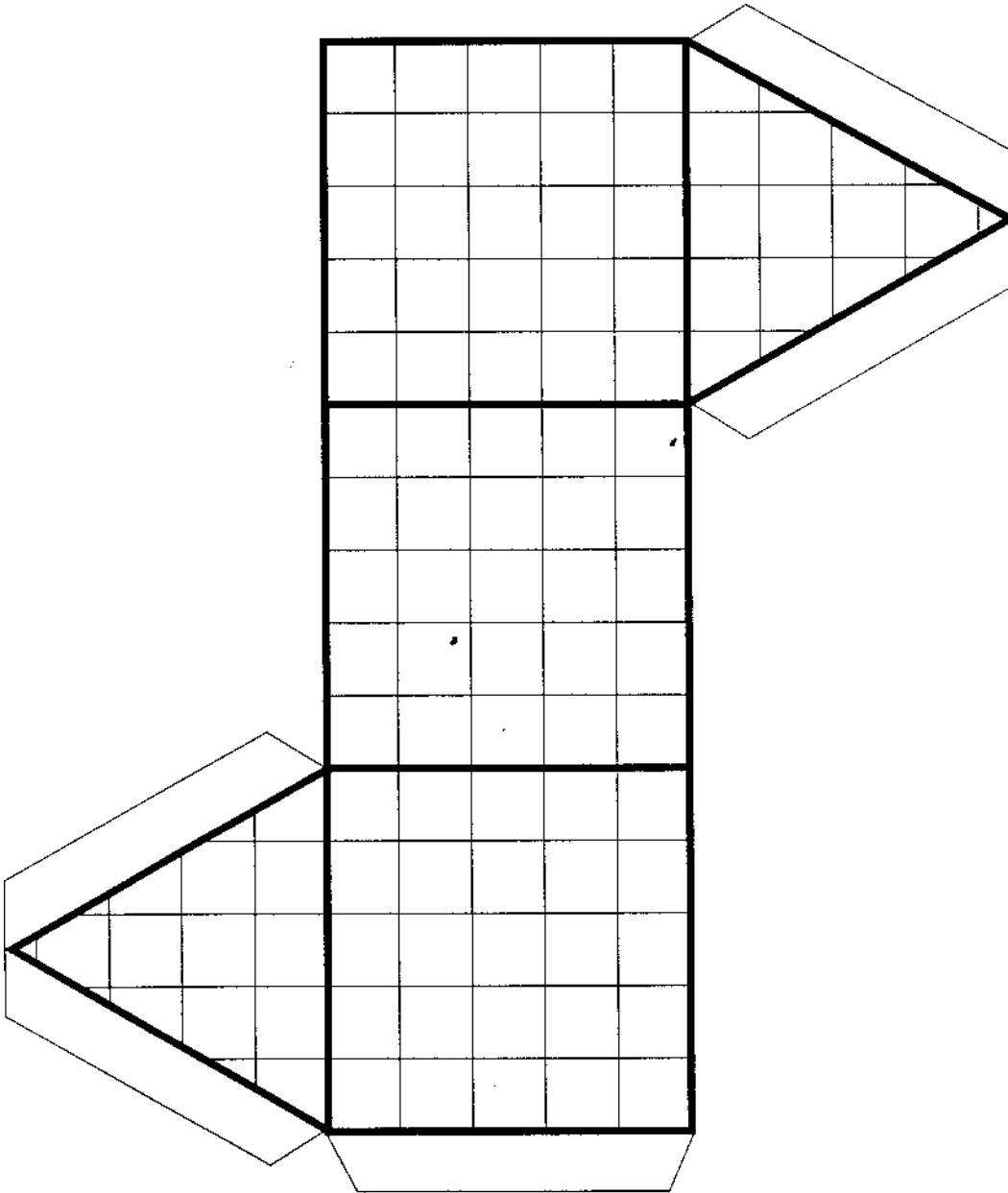
Activity Sheet 6

Isometric Dot Paper

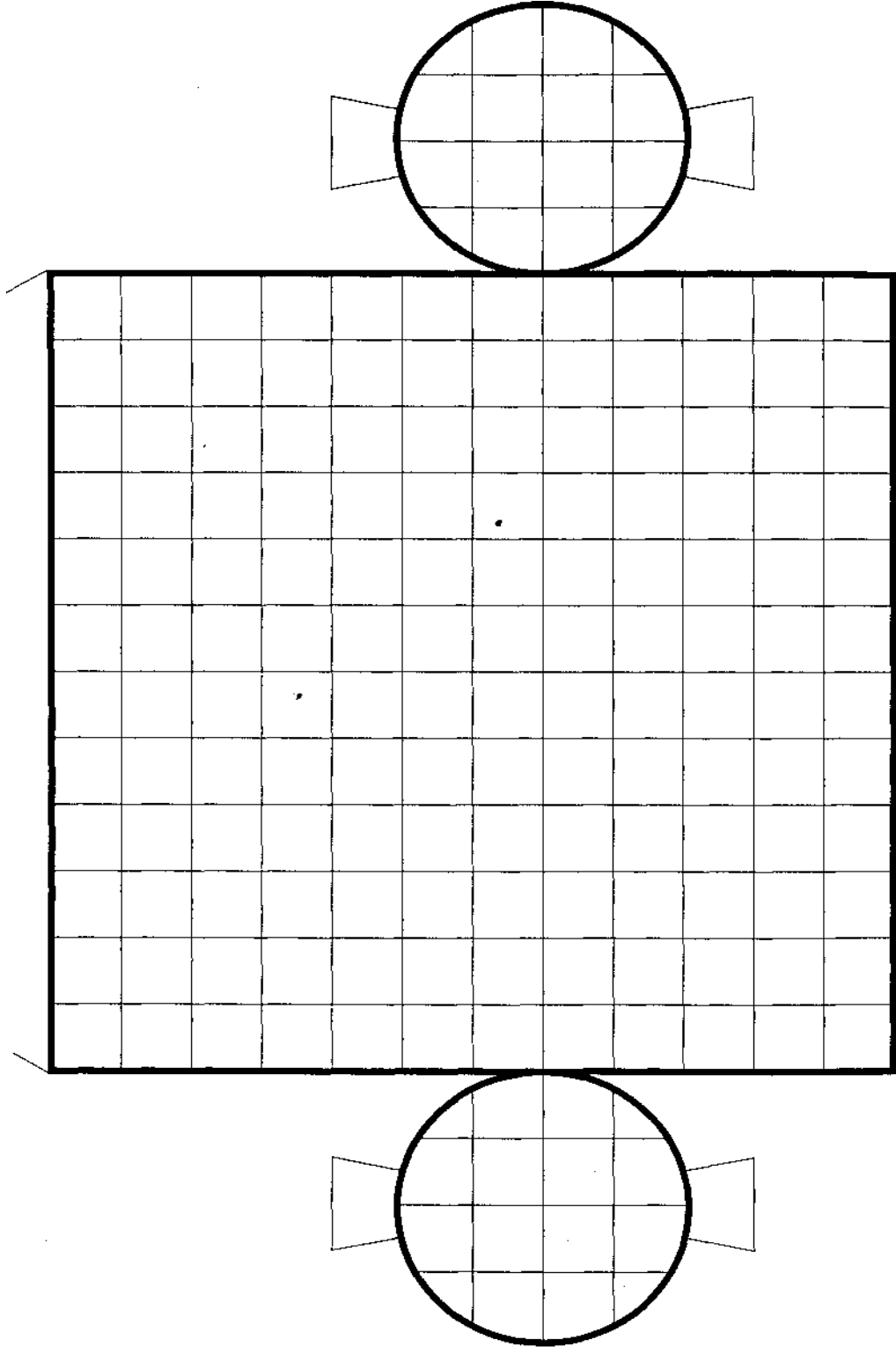


Activity Sheet 7

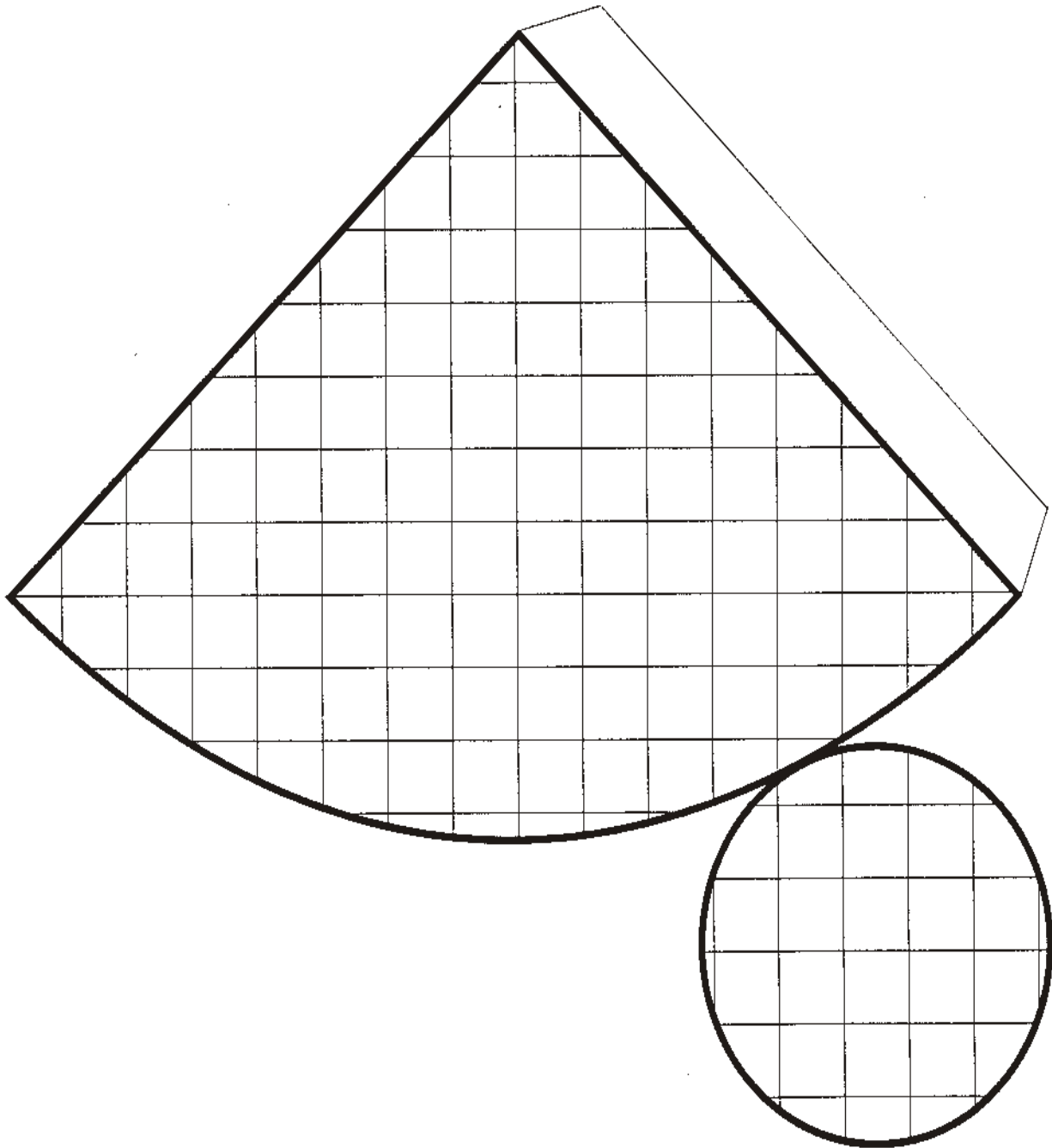
Net for Triangular Prism



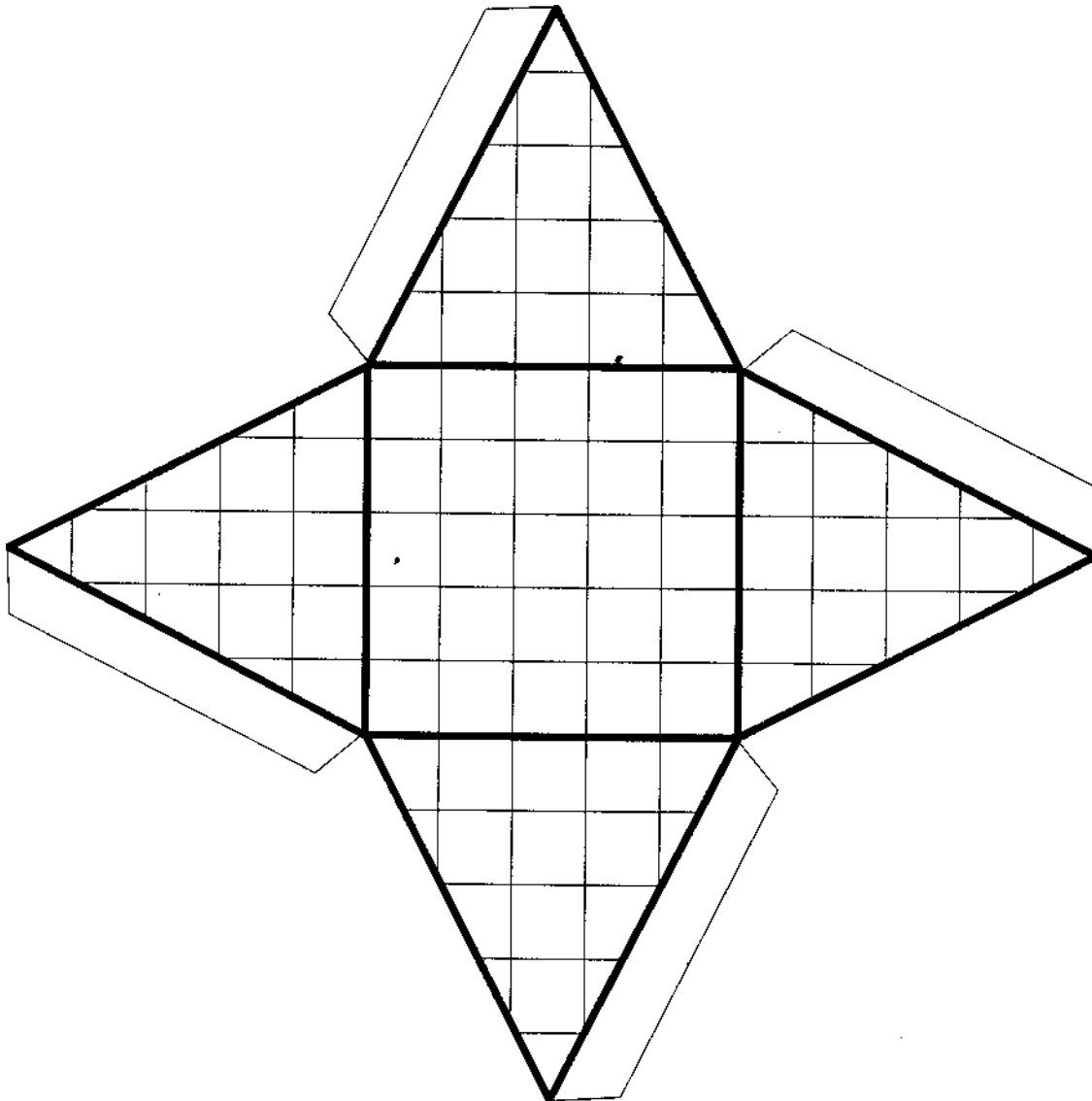
Activity Sheet 8
Net for Cylinder



Activity Sheet 9
Net for Cone



Activity Sheet 10
Net for Square Pyramid



Activity Sheet 11
Net for Cube

