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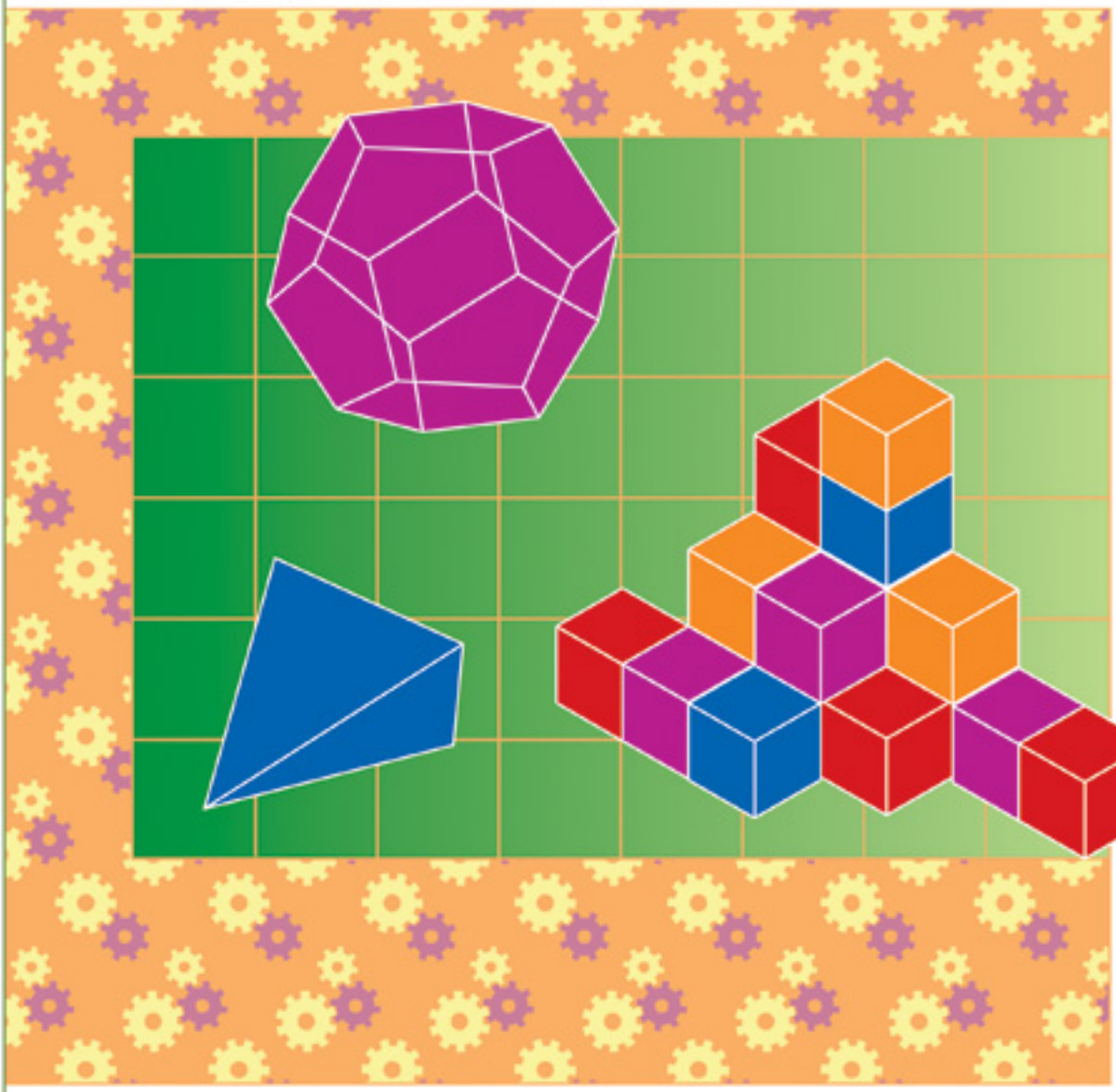
SOLID GEOMETRY



A Journey into Real-World Concepts of Solid Geometry

Let's Investigate!
Solid Geometry

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V1.1

About the authors

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Welcome to
Let's Investigate! Solid Geometry

One of the most effective learning tools for students is discovering knowledge for themselves. This project-based unit will take you and your students on an adventure investigating solid (three-dimensional) geometric concepts. It encompasses the eight abilities and skills all students should develop, as stated in the Common Core State Standards. (These can be found under "Why Use *Let's Investigate! Solid Geometry*.") The unit supports and reinforces classroom instruction, or can be used to introduce geometry concepts before standardized testing. It provides an opportunity for your students to use their knowledge and skills to solve real-life situations.

Students will be responsible for their choice of investigations and will sign a contract along with their parent and teacher stating their goal for a grade on the project. Students develop their organizational skills as they plan how they will collect information from their investigations and record their completed work. They will design a means of sharing their new knowledge with their classmates and the teacher. The difficulty and level of success of the work will determine each student's evaluation (grade/ rubric score).

Note: These investigations are ideal for students in home school.

Investigations are based on the hierarchy of levels of Bloom's Taxonomy. They are designed to encourage students to use higher-order thinking skills and, in addition, use a variety of learning styles: written, oral, visual, and tactile. Each investigation is separate from the others and does not depend on knowledge gained from other investigations in the unit.

Students from grades 4–8 will benefit from this unit. It will provide a variety of experiences with solid (three-dimensional) geometry, reinforce skills, and help students needing review.

All people ever have is their own understanding; you can tell them all sorts of things, but you can't make them believe it unless they also construct it for themselves
—Eleanor Duckworth Harvard

Contents

Purpose and Overview

What Is *Let's Investigate! Solid Geometry*?

Let's Investigate! Solid Geometry is a collection of project-based activities that enhance the instruction of mathematic ideas and content. These tasks provide support for:

- ongoing teaching of geometry
- review of previously taught material
- chances to investigate ideas of interest
- opportunities to make real-world connections in mathematics
- situations where individual students can make their own choices, work with others, and have fun with math, while communicating their learning in written, oral, or visual form

The selection of investigations will vary according to the needs of the individual. Each investigation sets up a situation or poses a problem where students will work with one or more mathematical ideas.

What Are Students Learning?

In the current climate toward Common Core standards, developing an understanding of geometry skills is increasingly important. Specifically, students will be enhancing their knowledge of the following:

Knowledge

- Developing understanding of the characteristics of three dimensional geometric shapes
- Evaluating previous information in making decisions
- Understanding the need to make sense of problems and to persevere in solving them
- Connecting math to real-world applications
- Understanding surface area and volume, and how they relate to each other in 3D shapes

Skills

- Developing geometric thinking and spatial sense
- Organizing and writing about mathematical information
- Setting goals and making a contract commitment

- Using appropriate tools including technology to gather data
- Using higher-order thinking skills
- Communicating mathematically using appropriate geometric vocabulary
- Identifying, classifying, and naming geometric figures using specific attributes and properties

Attitudes

- Feeling at ease with analyzing shapes and making predictions
- Developing a positive attitude toward mathematics
- Developing confidence in mathematical abilities
- Having a sense of accomplishment when the contract goals are successfully completed

How Are Students Organized?

Students should be allowed to choose to work on their own or with a partner or group of three to complete their contract. Students individually or with their partner(s), make their own decisions about what investigations they want to do, and thereby the grade they want to achieve.

How Much Time Do I Require?

Teaching tip
The Mid-Investigation Report form will help with assessing progress.

The number of investigations and the duration of the unit will depend on the way you choose to use the unit and the needs of your students. There are a variety of ways to approach these investigations. The contract can take up to three or more weeks to complete depending on the number of investigations you decide will be required and the amount of class time used by students to complete the activities. If you decide to allow more time, it's important to build in time to meet with students weekly to assess progress on completion of the contract.

How Is Learning Assessed?

Let's Investigate! Solid Geometry contains a rubric for the completion of projects, assigning the point value for each category of investigations based on the level of thinking (difficulty). The Observation Checklist is available to use to record student performance during their investigations. Students are expected to reflect on their finished work with the teacher or their classmates in written, oral, or some form of visual presentation.

Why Use *Let's Investigate! Solid Geometry*?

The investigations included support the nationally recommended Common Core State Standards for Mathematical Practice. These are:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Using this unit promotes your students' discovery of basic geometry concepts to support their understanding. The unit provides a way to use a wide variety of mathematical skills and apply the mathematics students have already learned. Investigations by their very nature promote higher-level thinking skills. As students understand and gather information, then transform it by analyzing, evaluating, and applying, they are moving toward the life skills they will use in all careers and in managing family responsibilities.

Differentiation

The Investigation Contract offers students the opportunity to make choices and to work at their own pace individually, or in pairs or groups, to solve problems. It accommodates multi-ability levels in that you can modify the contract for students who need more time, or have mastered what you are currently teaching and need to go farther. You can select specific investigation choices that you think are most appropriate for students.

Let's Investigate! Solid Geometry is centered on Bloom's levels of thinking and the scoring (grade) is based on the number, levels, and quality of the final products completed by the student. The unit is also designed to incorporate a variety of learning styles including writing, oral communication, visual, and tactile experiences.

Teaching tip
Home school teachers will appreciate the flexibility and various challenges this unit provides..

Motivation

When using *Let's Investigate! Solid Geometry*, students are empowered by choosing their activities, making predictions, collecting data, and interpreting their results. They are encouraged to experiment with various shapes, use tools that are appropriate to solve their problem, such as a compass, examine coordinate systems, and discover information using technology. When they share the strategies they have developed after completing activities, it clarifies their thinking, which increases the chance that the strategy will be used to solve future problems, and helps students develop confidence in their ability to be successful mathematicians.

Flexibility

The number of assignments is based on teacher judgment and the amount of time allowed. The number of points can be predetermined by you to make it optimal for the class level. You can modify investigation selections by using the material on the CD and select only the activities under each heading you feel are appropriate for your entire class or for individual students.

This unit is composed of three increasingly challenging sections based on Bloom's levels of thinking. You may choose to have all students complete their selection(s) in the first section before going on to section two and so forth. You could also set up centers with the investigations you feel are appropriate for your class, beginning with those in the first section.

Ease of Use

This unit supports classroom management by offering independent work time for individuals to enrich and extend classroom instruction in mathematics. You can designate time to work on the contracts in class, allowing you to work with individuals or with small groups, or they can be assigned as long-term projects to allow students to explore a math concept in greater depth. The investigations also give you an opportunity to expose students to the content of a standard that may not be covered in depth prior to standardized testing. Since the contract work can be organized to be ongoing, you can plan for students to work on it if you need to be out of the classroom.

Students are given the list of suggested investigations and make their own choices. Even when working in pairs or groups of three, they complete their individual contract and then submit it to you. The time spent on the investigations can be during regular math time, when other work is finished, or done at home. Your role is primarily as a facilitator, allowing students to discover and develop an intuitive sense of geometric concepts as they work through their selected activities.

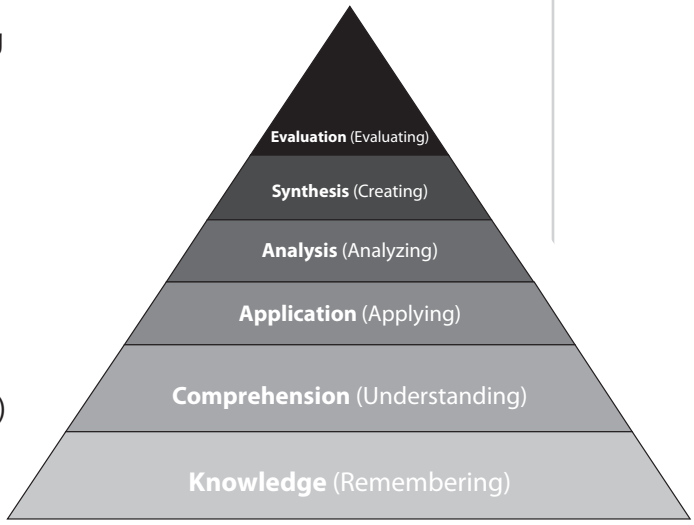
Why Study Geometry?

Every day we are exposed to shapes. We use geometry whenever we ask questions about size, shape, or position. Shapes depend on their dimensionality. In Plane Geometry, a point has no dimension. A line has one dimension: its length. Shapes, such as squares or circles, have two dimensions. Solid geometry adds the third dimension, giving depth to shapes. Learning about geometric properties helps students to become more able to understand their environment. Geometry is a fundamental subject relating to many other areas of mathematics, such as algebraic thinking through developing patterns, and problem solving involving area and perimeter. As students use models, they learn more about spatial relationships, reasoning, representing, and connections.

Bloom's Levels of Thinking

Bloom's Taxonomy has long been used to identify a hierarchy of thinking skills, starting from the simplest behavior to the most complex. The cognitive domain of the taxonomy used in this unit involves knowledge and development of intellectual skills. There are six categories of this domain listed in order of difficulty below.

- Knowledge (Remembering)
- Comprehension (Understanding)
- Application (Applying)
- Analysis (Analyzing)
- Synthesis (Creating)
- Evaluation (Evaluating)



Current thought regarding the Bloom's hierarchy places "application" at a higher level. For purposes of this simulation, categories are combined, giving three levels of investigation difficulty, as follows:

1. Knowledge and Comprehension
2. Analysis and Synthesis
3. Application and Evaluation

The individual investigations in this unit are each connected with the levels of difficulty. This will enable you to better assist students in choosing contract projects according to their abilities. The difficulty of each investigation will also be reflected in the assessment process.

Components

The Teacher's Guide has everything you will need to run a successful simulation, including preparation instructions, daily directions, reproducibles, and "notes and solutions" for the investigations.

Organizing for Learning

Take time before the simulation to read the materials thoroughly to get an understanding of how the unit works and how to prepare. Be sure that you have all the materials needed for the investigations you select.

Decisions to Make

How will you decide on investigation choices?

Consider your students' skills. Then examine the investigations in this Teacher's Guide and select those you think appropriate. The tasks do not need to be completed in any particular order because they do not conceptually build on each other. If you want students to choose from the list as presented, simply make a copy for students' use. If you want to modify the list, you can use the material on the CD and select the investigations you feel are appropriate for your class or individual students. Limit the choices based on the level of your students, the amount of time allowed, and the content you want them to learn. Students should do a minimum of one investigation from each section. If time permits, students can be challenged to investigate two from each section. It is up to you to make decisions about the appropriate investigations for each individual.

Teaching tip

You may want to create a class record bulletin board to facilitate checking individuals' progress. For example, you can have individual students put their name on an ice cream cone, color a scoop, and put it on their cone as they complete an investigation. This will give you a quick visual of where your students are at any time during the unit. For upper grade students, you could post a chart with student names, possible investigations, and completed investigations using 3-D shapes.

How will you group students?

Some students work better when paired with another or in groups of three, while some prefer to work on their own. If students choose to work with others, each student is responsible for recording their individual involvement and signing their individual contract. The record of how much of the work each student did will help when evaluating the work.

How will you organize the classroom?

This unit can be used as a whole class unit, assigned as extra credit or homework, or as individualized projects to be done when students have extra time in class. Students need to have items such as scissors, scratch paper, tape, compasses, and rulers available for the investigations. If they are to work on their own, the time in class would be an independent work time, but most of the work would be done on the student's own unassigned time. The unit could also be set up as a learning center.

How will you schedule the unit?

As independent work, this unit can be scheduled at any time during the school year. The investigations also give you an opportunity to expose students to the content of a standard that commonly comes at the end of your curriculum plan, or that you know will not be covered in depth prior to standardized testing. Each investigation will normally take from 2 to 5 days, depending on how much class time is allowed to work on them.

How can students use technology resources to support their investigations?

A digital camera can be helpful in recording investigations and sharing findings with the class. Many of the investigations can be enhanced through activities found online at sites such as NCTM Illuminations, The Math Forum, and IXL.com. Students can put together a PowerPoint presentation or use a SMART Board to illustrate their findings.

How will students demonstrate their findings?

Students should be encouraged to show their investigations in a variety of ways: posters, charts, oral presentations, graphs, PowerPoint, Gallery Walk, or in small groups.

Final presentation suggestion from a field test teacher:

"We use a Gallery Walk format. It is perfectly timed—two thirty-minute rotations. Half of the students from each group stay and present, while the other half rotate around, with about three minutes at each 'station.' All of the students get to present and evaluate each other. In the first thirty minutes, half the group stayed with their projects, while the others rotate through. After three minutes, I ring my bell, and they head to the next project. The students presenting have a two to three minute presentation ready, although they may adlib based on the questions that are asked by the rotating students, or the evaluators. After thirty minutes, all nine groups have presented, so then we switch. The evaluators become the presenters, and the same format is used for the next thirty minutes. A couple of parents there observed and really enjoyed the learning, and the geometry interactions."

Teaching tip
If you plan for your whole class to complete each section before moving onto the next, you will want to have these presentations at the end of each section.

Assessment

Assessment Standards

Based on your individual and state requirements, establish your own level of what meets standards for your grade level. Meeting standards depends on the ability of students to understand, articulate, and communicate their understanding of their investigation of solid geometry. If a student has written-language difficulties, have the student explain orally her or his thinking. Students who do not meet standards on any part of the assessment should be required to redo that section. Sometimes students need more instruction and a second chance to demonstrate what they know.

Teaching tip

When completing performance assessments, focus on "student work." This work is not limited to written work. It includes demonstrated skills, oral exchanges, processes, strategies, and any other evidence that proves that the students have learned the targeted content or skill, and can apply what they know.

Performance Assessment

Evaluate work completed by students by using the scoring rubric provided, or devise one of your own. The rubric should be discussed or developed with the whole class so they all know what is expected in a finished product, as well as the number of points needed for a certain grade. It will be helpful to use the bullets listed under each investigation to check for completion.

Rubric

Teaching tip

You may wish to adjust the number of points each student should receive from the various investigations based on the level of your students, the number of investigations required, and the time allowed for completion of the contract.

Always go through the rubric before beginning work so students will understand how they will be graded. After the first evaluation, students generally attend to their tasks better and work to improve their rubric scores for the next evaluation.

Suggested Contract Points

Students will need to complete a minimum of three investigations. One from each category with a rubric score of "meets" or "exceeds" expectations will entitle a student to receive a grade of C. That would give the student a minimum of eighteen points. A total of twenty points on investigations with meets or exceeds rubric score would give a grade of B. Twenty two or more points on investigations with meets or exceeds rubric scores would give a grade of A. If students are doing six investigations, just double the number of points for each grade.

Scoring Rubric for Geometry Investigations

Expectations		Section I Knowledge and Comprehension	Section II Analysis and Synthesis	Section III Application and Evaluation	Goal
Exceeds expectations: Fully accomplishes the purpose of the task; demonstrates clear understanding of the geometric concepts involved in the investigation; recorded work communicates thinking clearly, using some combination of written, symbolic, or visual means.	Complete. Clear and well-communicated	4	8	12	
Meets expectations: Substantially completes the purpose of the task; displays essential grasp of the geometric concepts involved in the investigation; recorded work communicates a large part of the thinking.	Complete	3	6	9	
Approaching expectations: Partially accomplishes the task with limited grasp of the geometric concepts involved in the investigation; recorded work may be incomplete, misdirected, or not clearly presented; strategies may be ineffectual or not appropriate.	Mostly complete with some understanding	2	4	6	
Falls far below expectations: Little or no progress toward accomplishing the task; approach may lead away from task completion; shows little evidence of appropriate reasoning or understanding of the geometric concepts involved in the investigation.	Incomplete with little understanding	1	2	3	

Preparation

Gather additional materials:

- Scissors
- Markers
- Pencils
- Rulers
- Compasses (for Investigation #5)
- Scratch paper
- Construction paper
- Coordinate grid paper
- 1-inch grid paper
- 1-inch cubes
- Sample cylinders

Teaching tip

If your students do not have access to materials at home, you may want to put together some materials kits for students to check out for at-home investigations. These can be plastic zip bags and the contents depend on students' choices.

There are blackline masters in the reproducibles of the following:

- Blackline Master 1: Pictures of Nets
- Blackline Master 2: Tetrahedron Directions
- Blackline Master 3: Pictures of Structures
- Blackline Master 4: Pictures of Cube Nets
- Blackline Master 5: "Making Boxes" Figures
- Blackline Master 6: No-Paste Die
- Blackline Master 7: Viewing Structures

Teaching tip

It would be helpful to find pictures of city scenes or some other pictures featuring several shapes in nature or architecture to use when you introduce the unit.

Identify the Investigations you feel are appropriate for your class. These can be gathered from the CD. You can use all of the choices, or narrow the selection to as few as two or three in each section.

Make copies of the following reproducibles prior to beginning the simulation:

Teaching tip

It is helpful to copy different levels of questions on to variously colored paper. This helps both students and teachers to be more aware of what level they are working on.

- Investigations (all or selections from written copy or CD)
- Letter to Parents
- Investigation Contract
- Scoring Rubric for Investigations
- Instructions for Individual or Group Presentations
- Mid-Investigation Report (if needed)
- Reflection (self-evaluation)
- Observation Checklist
- Investigation Blackline Masters as needed (based on student choices)

Daily Directions

Day One

Introducing the Unit

Promote student excitement by explaining that they will be investigating an important area of mathematics: geometry. They may be working with partners or groups for their investigations.

Read or Tell Students:

"Today we are going to start a unit where we will explore the nature of 'solid' geometry. Solid geometry is the study of three-dimensional shapes, those that have length, width, and depth."

"We find all kinds of shapes all around us every day. (*Show pictures*) Sometimes you know the name of the shape, but suppose you were talking to someone who didn't know. How could you define the shape so that everyone has the same knowledge about it?"

Have students look at the pictures you have collected and discuss the shapes that occur in the real world.

"Geometry is one of the areas of mathematics that has its own specific vocabulary. In mathematics, in order to understand geometry, we need to know and understand the vocabulary. In this unit, we will discover how and why a variety of shapes have gotten their names, including their number of sides, or the shape of their sides."

"You are allowed to work alone, with a partner, or in a group. You and your partner(s) will choose the investigations that you will be responsible for completing. If you choose to work on your own, you will make your own choices. You will be expected to complete one (or more) investigation from each of the three levels of investigation."

"Once you have decided which investigations you want to do, you will sign the contract with the list of choices and have your parents sign it as well. Each of you is responsible for completing an individual contract, even if you are working with others. The contract will list your choices, the completion date, the rubric for your grade, and how you plan to present the finished investigation."

Discuss with students how they will manage their time. Explain whether the investigations are to be done in class, at home, or both. Also tell them what materials you will provide for them to use. Many students have access to and may use investigation materials they have at home. However, for students who

Teaching tip
Change the number and levels of investigations required at your discretion.

Teaching tip
You will want to brainstorm how the final products could be presented, including: an oral report, chart, poster, PowerPoint, SMART Board, demonstration, written report, game, or a combination of any of these or another idea that may come from the students. Time is often limited for these presentations, so student(s) may be expected to present one investigation to the whole class and the rest to a small group of classmates. Or a Gallery Walk would allow students to share projects within a limited timeframe.

Teaching tip

It is up to you if you want to allow students to change their choices after the contract is signed. You may want to do it on a case-by-case basis. Some students may choose an activity that is too difficult for them or it may be something they have done before.

may have few or no materials, you can prepare some sets of materials that they can take home. You may find that as a student get involved in an investigation, s/he may wish to change the plan for presentation or the selected investigation. This is a teacher decision.

If you are doing a bulletin board such as the ice cream cones, have students color their cone and put their names on them. These can be put up on the board. If you choose to use a chart, prepare it before the unit so you can show students how you will track their progress.

Give out the list of investigations to the students as well as the Investigation Contracts. Go over the different levels, and discuss the investigations. Be sure to tell the students you will be available if they have further questions once they have gone over the list. Give students time to choose their partner(s) if they want one, and to go over the list of investigations before they complete their contracts. Have the students make an extra choice in each of the three sections. When you meet with students to sign their contracts, you can discuss and determine the appropriate investigations to be included in the contract.

Develop/review the Scoring Rubric for Geometry Investigations so students will understand the expectations.

Very important for final assessment: When discussing their final products, tell students to be sure to state the investigation they are working on when they do their final write up, as well as describing their findings. Findings should include:

- The design of their investigation
- The outcome of their investigation
- What they discovered about the area of geometry they explored

If you are giving the students more than two to three weeks to complete their investigations, tell them you will expect a brief Mid-Investigation Report (included in the reproducibles and on the CD) stating where they are in completing the investigations, how many they have completed, and what their plans are for completion.

Have students take the list and contract home, along with the Letter to Parents (included in the reproducibles and on the CD) to discuss with their parents. Expect the signed contracts back the next day.

Daily Directions

After Day One

Encourage students to use their extra time to work on their investigations. As time permits, check with students about their progress toward completion. See if they are having any problems or questions. Be sure to carefully monitor students who are not self-starters.

Some questions you can use to get them started or monitor their progress are:

- What tools can you use to help with this investigation?
- Do you understand the vocabulary?
- What happened?
- What new information did you learn today?
- How can you write about this or present your findings?

Daily Directions

Last Day

Schedule a time for students to do an oral presentation of at least one of their investigations to the class and allow time for them to present their other findings in small groups.

Some questions to help students mentally process their learning and help you evaluate the products are:

- What have you discovered?
- Why do you think you got these results?
- How does this relate to previous information?
- What are the most important things you discovered?
- How might you use this information in a real-life application?

You may want to have a place for students to display any posters they have made.

Have students complete the Reflection (self-evaluation).

Standards

Geometry Standards (National Council of Teachers of Mathematics)

Analyze the characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships

Grades 3–5 Expectations: In grades 3–5 all students should

- identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes
- classify two- and three-dimensional shapes according to their properties and develop definitions of classes of shapes, such as triangles and pyramids
- investigate, describe, and reason about the results of subdividing, combining, and transforming shapes
- explore congruence and similarity
- make and test conjectures about geometric properties and relationships and develop logical arguments to justify conclusions

Grades 6–8 Expectations: In grades 6–8 all students should

- precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties
- understand relationships among the angles, side lengths, perimeters, areas, and volumes of similar objects
- create and critique inductive and deductive arguments concerning geometric ideas and relationships, such as congruence, similarity, and the Pythagorean relationship

Apply transformations and use symmetry to analyze mathematical situations

Grades 3–5 Expectations: In grades 3–5 all students should

- predict and describe the results of sliding, flipping, and turning two-dimensional shapes
- describe a motion or a series of motions that will show that two shapes are congruent
- identify and describe line and rotational symmetry in two- and three-dimensional shapes and designs

Grades 6–8 Expectations: In grades 6–8 all students should

- describe sizes, positions, and orientations of shapes under informal transformations such as flips, turns, slides, and scaling
- examine the congruence, similarity, and line or rotational symmetry of objects using transformations

Use visualization, spatial reasoning, and geometric modeling to solve problems

Grades 3–5 Expectations: In grades 3–5 all students should

- build and draw geometric objects
- create and describe mental images of objects, patterns, and paths
- identify and build a three-dimensional object from two-dimensional representations of that object
- identify and draw a two-dimensional representation of a three-dimensional object
- use geometric models to solve problems in other areas of mathematics, such as number and measurement
- recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or in everyday life

Grades 6–8 Expectations: In grades 6–8 all students should

- draw geometric objects with specified properties, such as side lengths or angle measures
- use two-dimensional representations of three-dimensional objects to visualize and solve problems, such as those involving surface area and volume
- use visual tools, such as networks, to represent and solve problems
- use geometric models to represent and explain numerical and algebraic relationships
- recognize and apply geometric ideas and relationships in areas outside the mathematics classroom, such as art, science, and everyday life

Investigation Notes and Solutions

Section I: Knowledge and Comprehension

1. These give students many of the vocabulary words that are unique to geometry. Encourage students to use sources on the Internet or in math books.

• Base	The face on which a shape or solid stands.
• Cone	A solid with a circular base and a curved surface with one vertex.
• Congruence	Having exactly the same size and shape.
• Cube	A prism, shaped like a box, where faces are all congruent squares.
• Cylinder	A solid in the shape of a can with two parallel and congruent circles joined by a curved surface that lies perpendicular to the circles.
• Dodecahedron	A polyhedron with twelve (12) faces.
• Edge	A line segment where two faces of a polyhedron meet.
• Face	A plane figure that is one side of a solid figure bounded by edges.
• Net	A two-dimensional pattern that can be folded to form a solid.
• Octahedron	A polyhedron with eight (8) sides.
• Platonic Solid	Polyhedron whose faces are regular (meaning all the sides are the same shape and size), congruent polygons with the same number of edges meeting at each vertex. The solids are Tetrahedron, Regular Hexahedron (cube), Octahedron, Dodecahedron, and Icosahedron.
• Polyhedron	A three-dimensional shape with plane faces.
• Prism	A polyhedron that has two congruent and parallel faces, called bases, joined by faces that are parallelograms. Often these are box-shaped.
• Pyramid	A solid with a polygon as a base and triangles for all the other faces that meet at a point; most often the base is a square.
• Sphere	A three-dimensional shape that looks like a ball; all points on the surface are the same distance from the sphere's center.
• Surface Area	The sum of all the areas of the faces and any curved surfaces of a solid.

- Tetrahedron — A solid with four (4) faces, also called triangular pyramid; if all sides are congruent it is called "regular" and belongs to the group of platonic solids.
- Vertex — A point where two or more adjacent lines form an angle or corner.
- Volume — The amount of space inside a solid measured in cubic units.

2. Use **Blackline Master 1: Pictures of Nets (Figures 1–5)**. The shapes can be indentified by the type and number of surfaces. Three-dimensional shapes are solid figures that enclose a region of space. They are classified by the types of surfaces they have. The surfaces may be flat, curved, or both. See the chart in number 5 below for names of the figures.
3. Have cylinders available (i.e. oatmeal boxes, cans). The chart numbers may vary depending on the cylinders used. Some students may see that the ratio between the circumference and the diameter is approximately 3.14 (pi).
4. A polyhedron is a solid made with polygons to totally enclose a single region of space. "Polyhedra" is the plural of Polyhedron. Research on the Internet will produce many ideas for these.
5. This activity helps with spatial awareness. Use **Blackline Master 1: Pictures of Nets (Figures 1–6)**. Construction of these figures is easier if they are printed on thicker paper (i.e. construction paper).

Shape	Number of sides
Tetrahedron	4
Hexahedron (cube)	6
Rectangular Prism	6
Octahedron	8
Dodecahedron	12
Icosahedron	20

6. The hands-on experience will add to their comprehension of how two-dimensional shapes make three-dimensional shapes. A dodecahedron has 12 faces, 20 vertices, and 30 edges.

7. This is a good chance to have students work with geometric tools. They can see how circles and solids work together. A tetrahedron is a solid with four faces. It's also called a triangular pyramid. A regular tetrahedron has four congruent triangular sides and is one of the platonic solids. Use **Blackline Master 2: Tetrahedron Directions**.

8. This activity has students use a two-dimensional coordinate system to view a three-dimensional figure. The resulting figure is a rectangular prism.

Section II: Analysis and Synthesis

9. An excellent way for students to integrate spatial thinking and analysis. Students should notice that different figures can have the same volume with different surface area. Use **Blackline Master 3: Pictures of Structures**.

Figure Number	Surface Area (Sum of the area of all the faces)	Volume (Cubic Units needed to build the figure)
1	22	6
2	32	12
3	38	12
4	40	12
5	36	12
6	34	12
7	40	12
8	54	22
9	58	19

10. Have students use the big square paper for this one. They should find ten nets without turning or flipping.

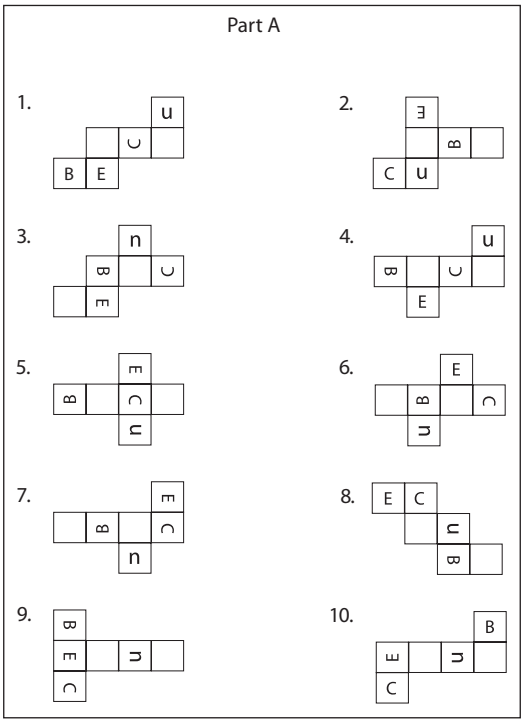
11. The long, thin box will contain seven 1-inch cubes. The short, fat one will hold twelve 1-inch cubes. This is an opportunity for students to explore how surface area and volume can vary. Number 12 extends this learning.

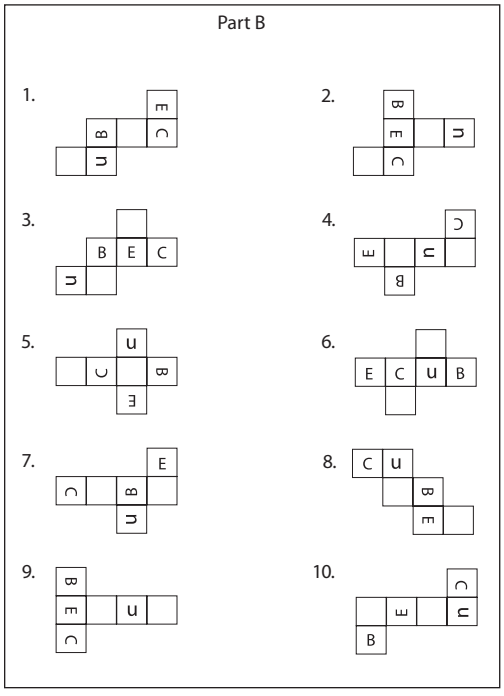
12. Answers will vary for the first four bullets. The volume of the biggest closed top box that can be made with one 12-inch by 18-inch piece of construction paper is a $6 \times 6 \times 6$ cube.

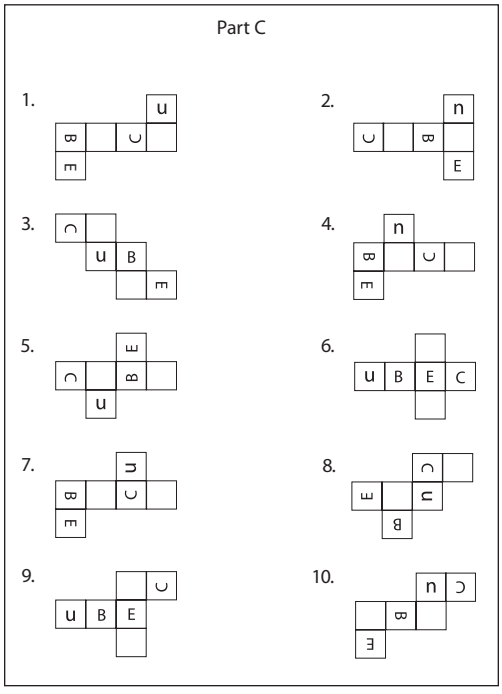
13. The relationship between the vertices, faces, and edges is written as:
$e = v + f - 2$ or $e + 2 = v + f$

Figure	Number of faces	Number of Vertices	Number of Edges
Tetrahedron	4	4	6
Square Pyramid	5	5	8
Triangular Prism	5	6	9
Rectangular Prism	6	8	12
Hexahedron	6	8	12
Octahedron	8	6	12

14. This activity will encourage students to look at three dimensional figures pictured in nets a new way. Use **Blackline Master 4: Pictures of Cube Nets**.







15. This activity builds thinking about comparisons between volume and surface area. Students should notice that as the cube gets larger the ratio changes from small to greater than one.

Cube Size	Volume	Surface Area	Ratio
$1 \times 1 \times 1$	1 Cubic Unit	6 Square Units	1:6
$2 \times 2 \times 2$	8 Cubic Units	24 Square Units	1:3
$3 \times 3 \times 3$	27 Cubic Units	54 Square Units	1:2
$4 \times 4 \times 4$	64 Cubic Units	96 Square Units	2:3
$5 \times 5 \times 5$	125 Cubic Units	150 Square Units	5:6
$6 \times 6 \times 6$	216 Cubic Units	216 Square Units	1:1
$7 \times 7 \times 7$	343 Cubic Units	294 Square Units	7:6
$8 \times 8 \times 8$	512 Cubic Units	384 Square Units	4:3

Section III: Application and Evaluation

16. Gift-box questions

    - Volume: 360 cubic inches
    - Surface Area: 324 square inches
    - Tape around length and width: 37 inches (12 + 12 + 6 + 6 + 1)

17. Answers will vary.

18. This hands-on activity will show students that varying proportions do make a difference. They should come out of this understanding that the short, fat cylinder will hold more than the tall, skinny one. Rice works well to fill the cylinders.

19.

		Number of unit cubes with paint on exactly . . .			
Size	Number of Unit Cubes	0 Faces	1 Face	2 Faces	3 Faces
3 × 3 × 3	27	1	6	12	8
4 × 4 × 4	64	8	24	24	8
5 × 5 × 5	125	27	54	36	8

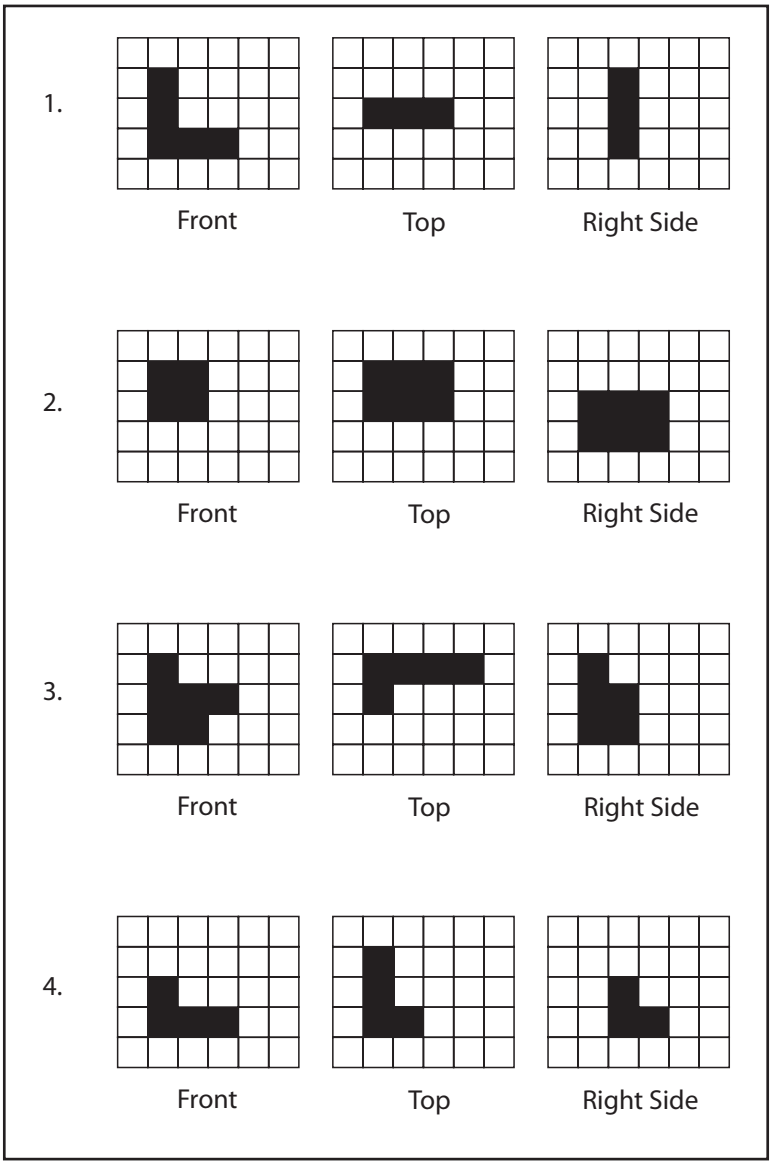
20. Use **Blackline Master 5: "Making Boxes" Figures** (eight figures). Students should make predictions on this one and then test their predictions. This supports their study of spatial relationships. Numbers 1, 4, 6, 7, and 8 will make a cube. Use **Blackline Master 6: No-Paste Die** as a challenge part of this question. Hint: Opposite sides on a die add up to seven.

21. Projects will vary.

22.

Height	Base Radius	Volume
6 cm	3 cm	56.52 cc
12 cm	3 cm	113.04 cc
18 cm	3 cm	169.56 cc

23. A great way for students to look at objects in a three-dimensional way and record them in two-dimensions. If available, students may want to draw their figures on isometric paper. Use **Blackline Master 7: Viewing Structures** and **1-Inch Square Grid Paper**



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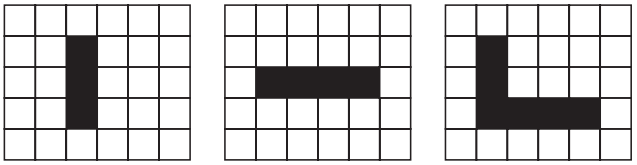

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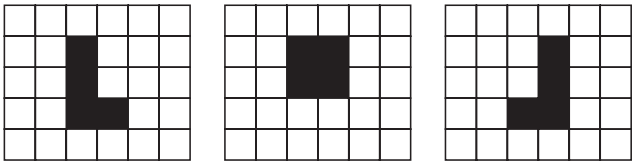

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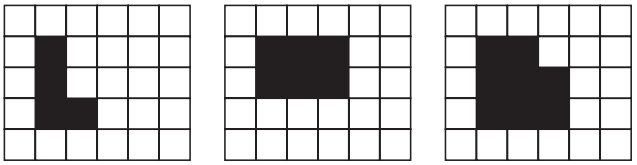

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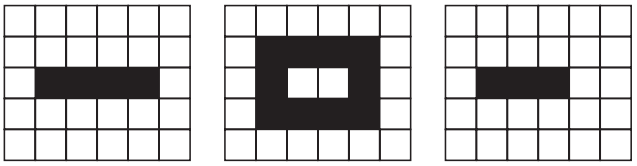

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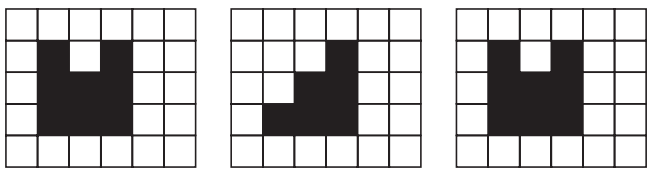

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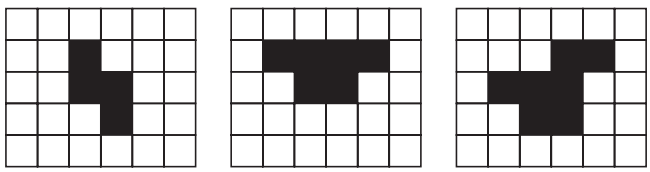

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Handout

Name: _____ Date: _____

Investigations

Section I: Knowledge and Comprehension

1. Define and illustrate each term.

Base		
Cone		
Congruence		
Cube		
Cylinder		

Dodecahedron		
Edge		
Face		
Net		
Octahedron		
Platonic solid		
Polyhedron		

Prism		
Pyramid		
Sphere		
Surface area		
Tetrahedron		
Vertex		
Volume		

2. You have been asked to help a third grade class that is learning about three-dimensional shapes. (Blackline Master 1)

- Make and label regular three-dimensional shapes with 4, 6, 8, and 12 sides. Hang them on strings or make them into a mobile.
- Write an explanation of how you made the shapes and how you identified the name of each one.
- You are making three-dimensional figures. Be sure to explain what three-dimensional means.

3. Which is greater: the circumference of a cylinder or the measure of its diameter?

- Find a cylinder, then make and record your prediction as to which will be greater, the diameter or distance around.
- Use a piece of string or a measuring tape to find the diameter and circumference of your cylinder.
- Find other cylinders. Try the same measurements. Enter your findings in a chart showing name of cylinder, diameter, and circumference. Were they the same or was one greater?
- Do you think that will be true for all cylinders? Why or why not?
- Write about and illustrate your findings. Explain what you discovered.

4. Let's find out about polyhedrons (polyhedra).

- Research and write a definition of polyhedrons.
- Make a chart or poster illustrating as many different types as you can find.
- Describe where you might find samples of polyhedrons in the world around you.

5. What solid can be constructed from the following nets? (Blackline Master 1)

- Make a guess, then cut them out and check your guess.
- Write about how you knew what the shape was going to be before you cut them out and put them together.

6. Construct a dodecahedron.

- Draw twelve congruent regular pentagons.
- Cut them out.
- Make the bottom of the dodecahedron by attaching five pentagons around the edges of a sixth one in the middle.
- Fold them up and attach the sides of the pentagons to each other with tape.
- Do the same with the other set of six pentagons.
- Fit the two sections together and tape.
- Tell your group all you know about a dodecahedron, including what the name means, and the number of vertices, faces, and edges.

7. Construct a tetrahedron from circles. (Blackline Master 2)

- Use a compass, ruler, scissors, and construction paper to construct the model.
- Why is it called a "tetrahedron"?
- Share with your class how you built the model.

8. Mystery figure.

- On a coordinate grid, plot the following coordinates then connect them in order.

–2, 3; 1, 5; 4, 3; 1, 1

- On the same grid, connect these points in order.

–2, 0; 1, –2; 4, 0

- Now connect –2, 3 to –2, 0; 1, 1 to 1, –2; 4, 3 to 4, 0; –2, 3 to 1, 1
- What have you made?
- Color your figure.
- Try to make other similar shapes on the grid paper.

Section II: Analysis and Synthesis

9. Analyze and compare surface area and volume. (Blackline Master 3)

- Find the surface area (sum of the area of its faces) and volume (sum of the number of cubes in the structure) of these structures. It will be helpful if you build the structures with cubes.
- Support your findings by writing about how you determined the surface area and volume.

10. How many ways are there to make a cube?

- Cut out six congruent squares. Tape them together to make a cube.
- Once the cube is made, cut it apart at some of the edges so that the squares are still connected, but also create a flat pattern for a cube. This is called a net.
- Find all the different possible nets for your cube by taping it back together and cutting apart different edges.
- Make a chart with drawings of all the different nets you find. Do you think you found them all? Are any of the ones you found the same if you flip them over or turn them?

11. Which has the greatest volume: a tall, thin rectangular prism (box) or a short, fat rectangular prism each made from the same size paper?

- Fold a 4 × 8 piece of 1-inch grid paper to make a tall, thin five-sided open top box.
- Fold another piece of 4 × 8 grid paper to make a short, wide five-sided box
- Use 1-inch cubes to fill each box. Which holds more or do they hold the same?
- Make a poster or chart showing your two boxes and explaining your results.

12. Make the biggest box.

- Use a piece of 12" × 18" construction paper to make an open-topped box.
- If you cut the same sized squares with whole-numbered sides (like 3") from each corner and fold up the sides, what is the greatest volume box you can make?
- What is the surface area of your box with the greatest volume?
- What is the smallest volume? Surface area?
- Can you make a box with a larger volume if you can cut squares with fractional numbered sides, such as 2 ½"?
- What is the biggest box you can make by volume with this piece of paper if you have to include a top?
- Explain to your class how you found the greatest and least volume, and anything else you discovered.

13. Euler was a famous mathematician who discovered a famous formula dealing with three-dimensional shapes. Can you discover his formula?

- Construct several different three-dimensional shapes using mini-marshmallows or clay and toothpicks (tetrahedron, square pyramid, triangular prism, rectangular prism, hexahedron, and octahedron).
- Count and record on a chart the number of faces (f), vertices (v), and edges (e) for each shape.
- Look for a pattern. Is there a relationship between the number of faces, vertices, and edges? Can you write a formula for the relationship?
- Explain your findings. Did your formula work with all your shapes? Will it work with irregular polyhedrons?

14. Test your spatial ability. (Blackline Master 4) The following nets each have the letters C U B E spelled out around the middle of the cube. Each letter is right side up.

- Fill in the missing letter(s) where you think they belong.
- Cut out the net and fold it into a cube. Was each letter in the correct place and facing the right direction?
- Make a poster of the nets you were able to solve.

15. Comparing Volume and Surface Area.

- Use unit cubes to build cubes.
- Calculate the surface area and volume of each cube.
- Record the ratio of surface area to volume in lowest terms.
- Do you see any pattern?
- How do you think the ratio would change if the cube size was 8 × 8 × 8?

Cube Size	Volume	Surface Area	Ratio
$1 \times 1 \times 1$	1 Cubic Unit	6 Square Units	1:6
$2 \times 2 \times 2$			
$3 \times 3 \times 3$			
$4 \times 4 \times 4$			
$5 \times 5 \times 5$			
$6 \times 6 \times 6$			
$7 \times 7 \times 7$			

Section III: Application and Evaluation

16. You have a gift for an aunt who lives in another state and you need to send it to her. The gift has the following dimensions; 10" L; 4" W, and 3" H.

- Make a box with the smallest volume that will hold the gift with 1-inch of padding on the top bottom and all sides.
- What is the volume of your box?
- What is the surface area of the box?
- If you put tape around the length and width of the box with a 1" overlap, how much tape would you need?
- Write a description of how you solved the problem.

17. The book* The Greedy Triangle *by Marilyn Burns is about a triangle who is not satisfied with having only three sides. It keeps going to the shape-shifter and asking for more sides. Eventually it finds it was happiest with the triangle shape.

- If you could be any three-dimensional shape, what shape would you be?
- Make a model of your shape. Write a story telling about the shape you chose and why you would be that shape.

18. Are all cylinders made from the same amount of material equal in volume? The formula for the volume of a cylinder is $\pi r^2 h$.

- Roll an 8½" × 11" piece of paper lengthwise. Form a tall, thin cylinder by taping the edges together.
- Roll another piece of 8½" × 11" piece of paper along its width. Form a short, wide cylinder by taping the edges together.
- Make a prediction about which shape cylinder will have the greatest volume.
- Find a material to fill each cylinder. Do they both hold the same or does one hold more?
- Make a chart or poster showing your cylinders and explaining your findings, including what this result might have to do with the way many things are packaged.

19. Painted cubes.

- Build a 3 × 3 × 3 cube with twenty-seven smaller cubes.
- If you painted all the faces of the combined cube, how many of the twenty-seven cubes would only have one face painted?
- How many with two faces painted? Three faces? Would any cubes have four faces painted, or zero faces painted?
- Make a chart of the number of painted faces.
- What if you had a 4 × 4 × 4 cube or a 5 × 5 × 5 cube? How many small cubes would have painted faces and how many (0, 1, 2, 3) painted faces?

20. Making cubes. (Blackline Master 5)

- Which of these figures can be folded into a cube?
- Check your answers by cutting and folding.
- Challenge: A regular die is a cube. Challenge yourself to see if you can make a die from the three pieces on the No-Paste Die page (Blackline Master 6).

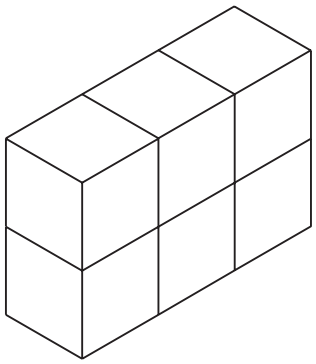
21. Make up a crossword puzzle, or a game such as Jeopardy (For example: The answer is "A three-dimensional shape with one vertex and no straight sides." Question: "What is a cone?" or "I Have, Who Has?" using the vocabulary for three-dimensional shapes.)

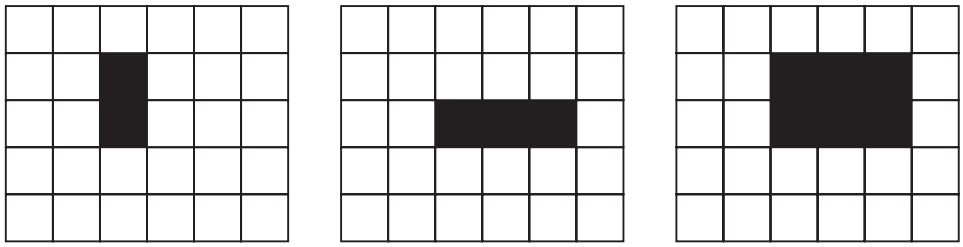
- Challenge your friends to solve the puzzle or play the game.
- Write a letter to your teacher telling how you created your puzzle or game.

22. Volume is measured in cubic units. Volume of a cone is ⅓ the volume of a cylinder, $\pi r^2 h$, of the same base and height.

- If you have an ice cream cone that is 6 cm high and the base radius is 3 cm, what is the volume?
- If you have a cone that is 12 cm high with a base radius of 3 cm, what is the volume?
- If the height were 18 cm with 3 cm radius what would you predict the volume would be?
- Check your prediction and make a chart that shows your results.

23. Identifying shapes from different views. (Blackline Master 7) This structure was built with cubes. Three views of the structure are shown on the graph paper so you can see where the cubes are. One view is from the front, one from the top, and one from the right side.





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- There are pictures of ten structures
- Make the structures with cubes if you need to.
- On graph paper, show the front, top, and right side views of each of the ten structures.
- Design your own building with cubes and draw the front, top, and right side on the graph paper.
- Challenge a friend to build your structure.

Let's Investigate! Solid Geometry

Dear Parents,

We are starting an independent investigation unit on three-dimensional or Solid Geometry. In this unit, students are responsible for their choice of investigations. They will sign a contract along with you, stating their goal for a grade on the projects. This unit is intended to help students develop their organizational skills as they plan how they will collect information from their investigations and keep the record of their completed work. They are responsible for designing a means of sharing their new knowledge with their classmates and the teacher. The difficulty and level of success of the work will determine each student's evaluation (grade/rubric score).

Students can choose to work on their own, with a partner, or in a small group. Again, the choice is theirs. The contract they share with you reflects their choices for investigations they have chosen to complete, as well as their goal for a final grade. They are expected to complete a minimum of _____ investigations from each of three levels by _____(date).

We have chosen to do this unit to complete the study of Solid Geometry prior to the time for testing. With this unit, students will have a chance to discover many properties of the content area on their own, as well as do projects that interest them.

Please discuss the choices your student has made with him/her. By signing the contract, you will let your student know you support the choices s/he has made and you know the date the finished projects are due.

Thank you for your help and support,

_____

(S)

Handout

Name: _____ Date: _____

Investigation Contract

I understand that I will need to complete _____ activities by _____ (date). I will complete the following activities selected from three different categories. My goal is to get _____ total points for my projects.

Here is my plan for presenting my findings using written or oral format or using technology.

_____

_____

Knowledge and Comprehension (Remembering and Understanding)

Investigation #	Completion Date	Points Possible	Points Earned

Analysis and Synthesis (Analyzing and Creating)

Investigation #	Completion Date	Points Possible	Points Earned

Application and Evaluation (Applying and Evaluating)

Investigation #	Completion Date	Points Possible	Points Earned

Total points: _____

Student signature _____

Parent signature _____

Teacher signature _____

Handout

Name: _____ Date: _____

Scoring Rubric for Investigations

Expectations		Section I Knowledge and Comprehension	Section II Analysis and Synthesis	Section III Application and Evaluation	Goal
Exceeds expectations: Fully accomplishes the purpose of the task; demonstrates clear understanding of the geometric concepts involved in the investigation; recorded work communicates thinking clearly, using some combination of written, symbolic, or visual means.	Complete. Clear and well-communicated	4	8	12	
Meets expectations: Substantially completes the purpose of the task; displays essential grasp of the geometric concepts involved in the investigation; recorded work communicates a large part of the thinking.	Complete	3	6	9	
Approaching expectations: Partially accomplishes the task with limited grasp of the geometric concepts involved in the investigation; recorded work may be incomplete, misdirected, or not clearly presented; strategies may be ineffectual or not appropriate.	Mostly complete with some understanding	2	4	6	
Falls far below expectations: Little or no progress toward accomplishing the task; approach may lead away from task completion; shows little evidence of appropriate reasoning or understanding of the geometric concepts involved in the investigation.	Incomplete with little understanding	1	2	3	

Handout

Instructions for Individual or Group Investigations

1. Read and discuss your investigation.
2. Decide the best way to carry out the investigation and how you will record your findings. Record the investigations you decided to do on your contract.
3. Carry out your investigation.
4. If working with another person or a group, decide how you will present your findings to the class and who will do what when you do your presentations.
5. When presenting your findings:
   - Describe your investigation by topic, not just by number.
   - Explain how you or your group decided to carry out the investigation.
   - Tell about your results/findings. Share any work you created.
   - Be sure to include what the investigation taught you about Geometry.

Name:_____ Date: _____

Mid-Investigation Report

Student(s) I am working with: _____ _____

I (we) have completed _____ investigations

I (we) need help with:

_____

_____

_____

_____

_____

_____

_____

I (we) will present my findings on (date): _____

Handout

Name:_____ Date: _____

Let's Investigate! Solid Geometry

Reflection

Three things I learned about Solid Geometry are:

_____

_____

_____

The investigation I liked the most was:

_____

I liked this one because:

_____

_____

_____

Another Solid Geometry topic I might want to explore more if I had more time is:

_____

The hardest part of this assignment was:

_____

_____

The easiest part of this assignment was:

_____

_____

What advice do you have for students doing this assignment next year?

_____

_____

_____

Handout

Name: _____ Date: _____

Observation Checklist

Use this chart to record your observations of student performance during lesson activities.

Students' names	Cooperative participation	Understanding of task	Comments

Rating Scale:

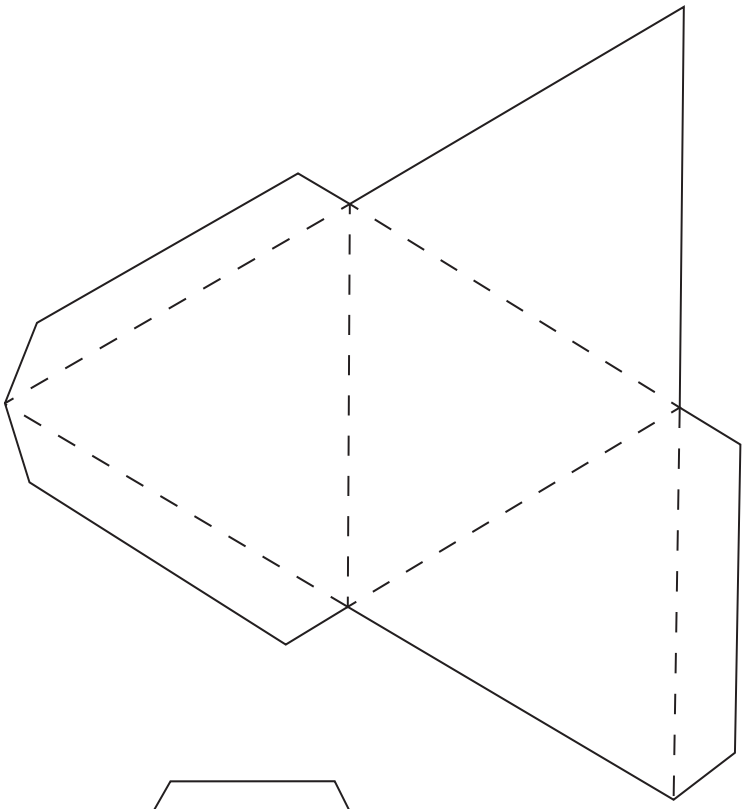
10 = Student fully accomplished the task
6 = Student substantially accomplished the task
3 = Student shows partial or limited progress toward accomplishing the task
1 = Student shows little or no progress toward accomplishing the task

Handout

Name:_____ Date: _____

Blackline Master 1: Pictures of Nets

1.



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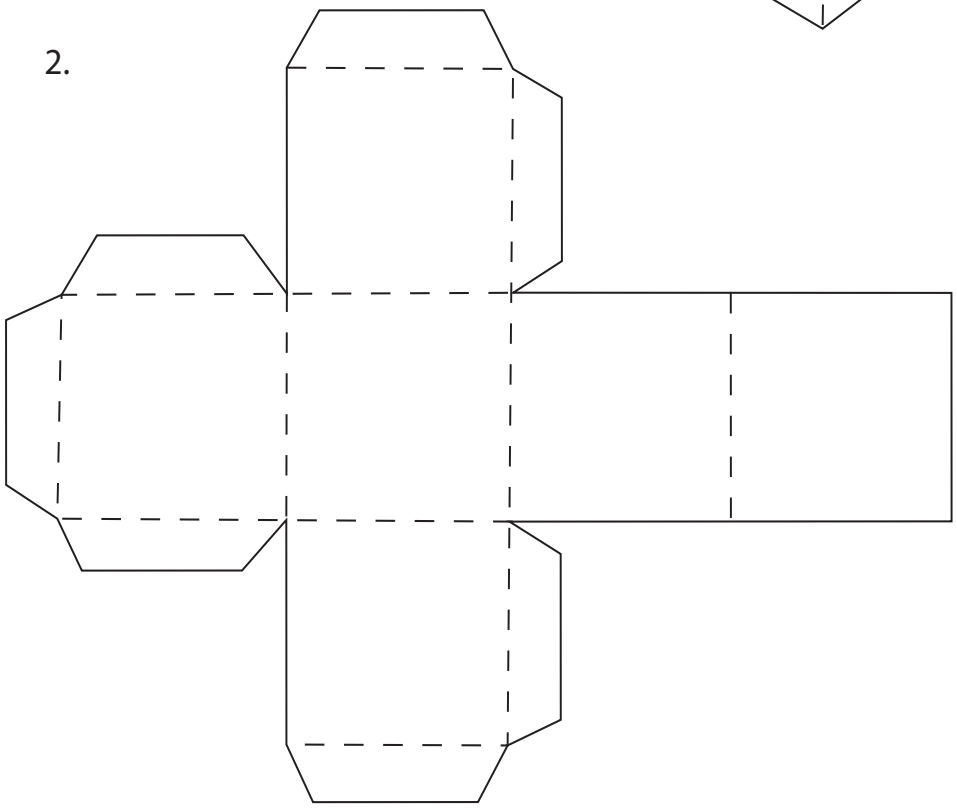

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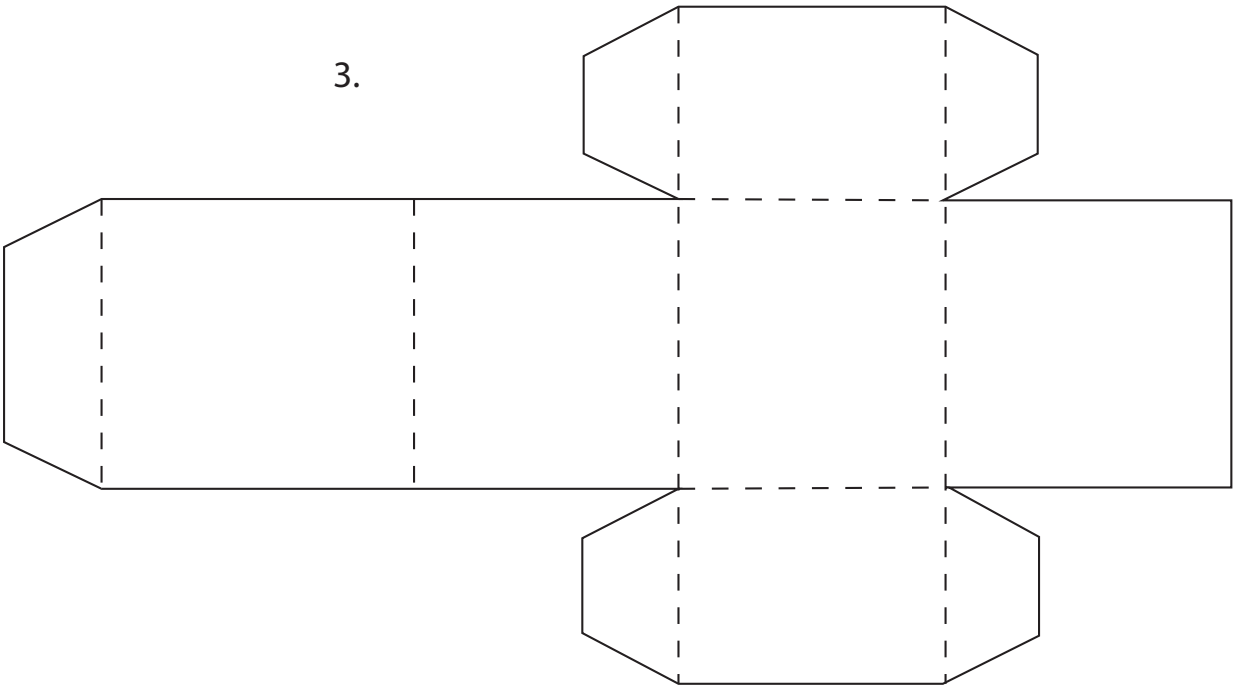
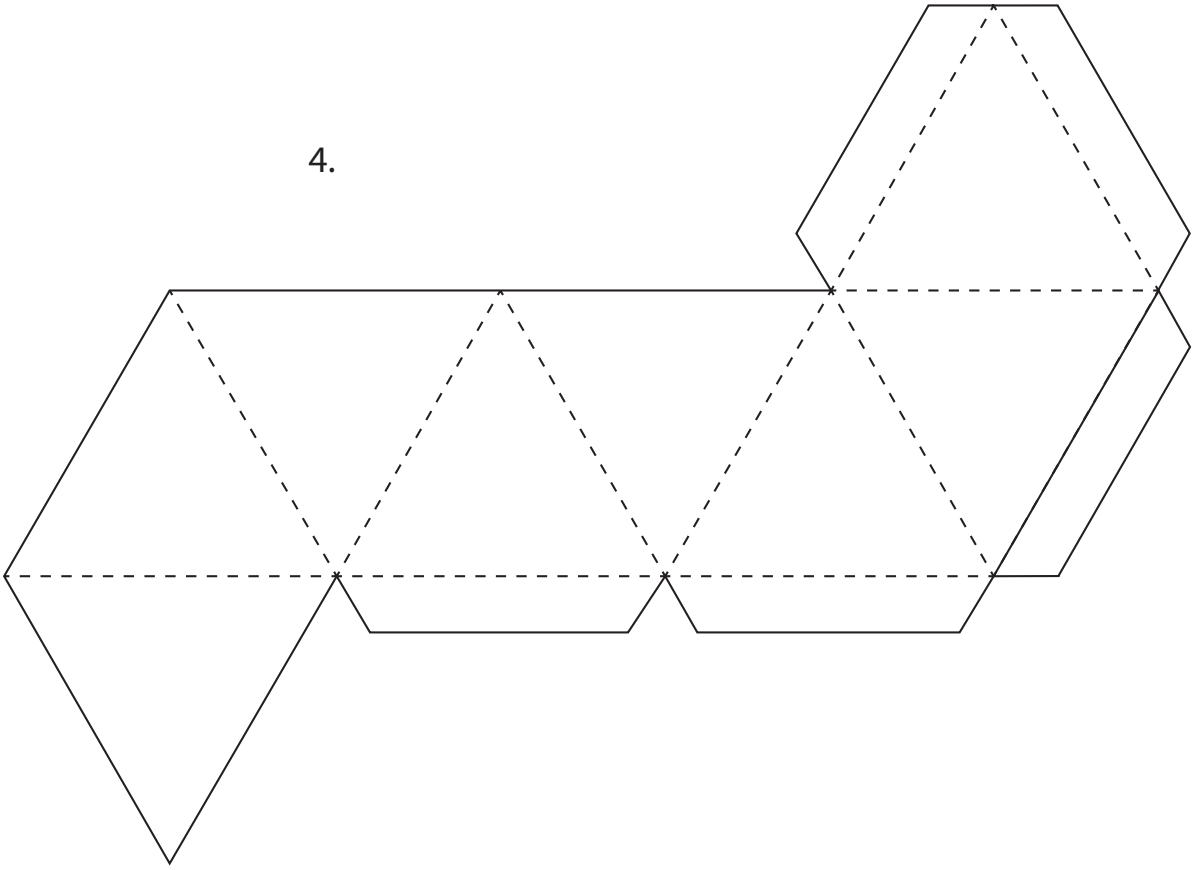


4.



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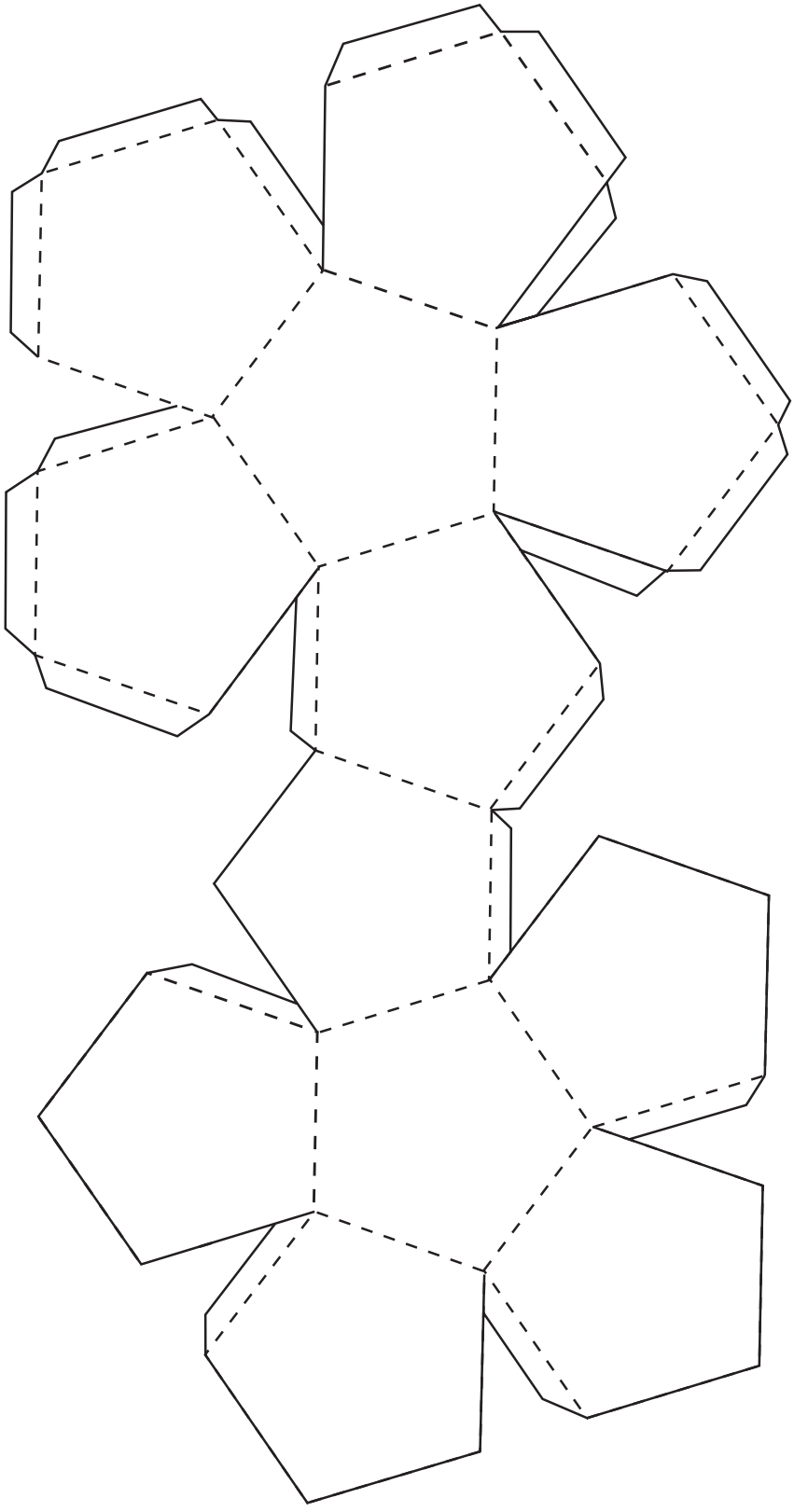

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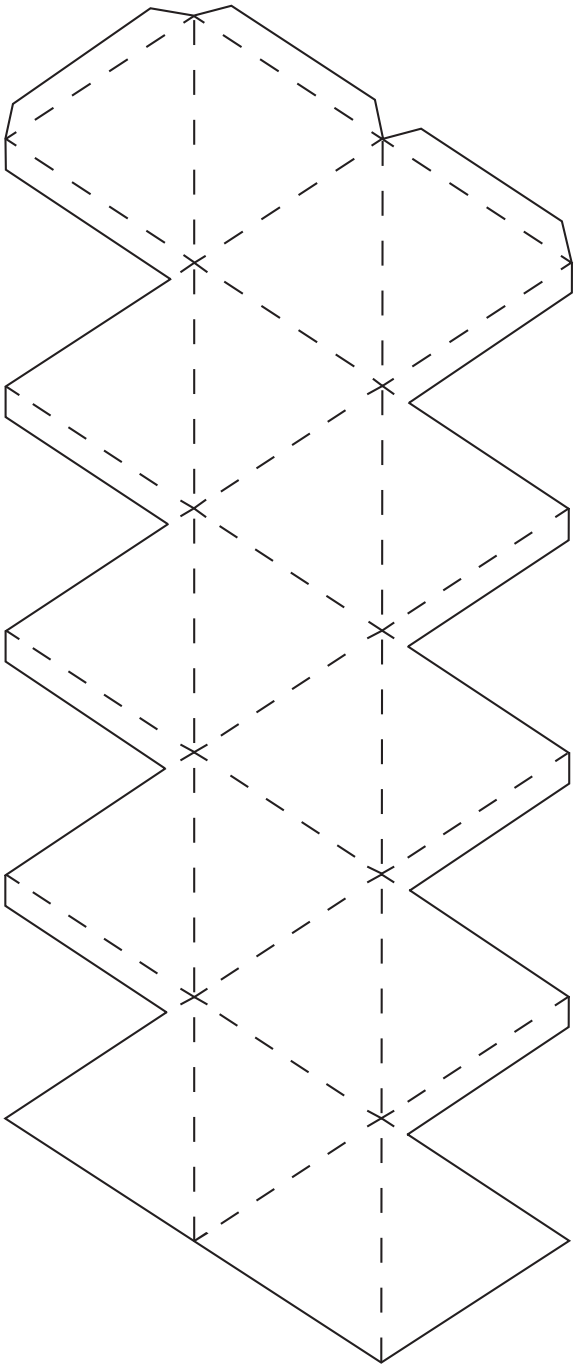


Handout

Name:_____ Date: _____

Blackline Master 2: Tetrahedron Directions

Materials needed: Compass, ruler, scissors, pencil, construction paper or other stiff paper (4 colors is best)

1. Set your compass to 1 ½ inch radius and draw 4 circles.

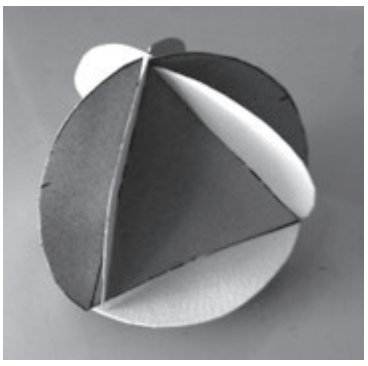
2. For each of the four circles: Keeping the radius of the circle at 1 ½ inches, put the point of the compass anywhere on the circumference. Swing the compass to intersect the circumference and make a tick mark. Then move the compass to the mark you made and do the same thing all around the circle. You should have 6 marks. Number them 1–6. (See Diagram I)

3. In each circle, use a ruler to connect even numbered marks to make a triangle in the center. These lines will make an equilateral triangle. (See Diagram II)

4. Using the ruler, line up the tick marks on opposite sides of the circles. These will meet in the center of the circles and pass through the midpoint of the sides of the triangles. Put marks at these three midpoints. (See Diagram III)

5. Cut out the circles. Then, make three cuts from each of the three vertexes to the midpoint of the triangle side. (See Diagram IV, the dash lines show where to make the cuts.)

6. By sliding the cut on one of the circles over the cut side of another circle, you will be able to connect all four circles to form a closed three-dimensional figure. The triangles will form a four-sided figure and the curved portions will be on the outside. The four-sided figure is a tetrahedron.



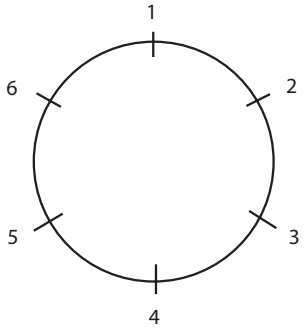


Diagram I

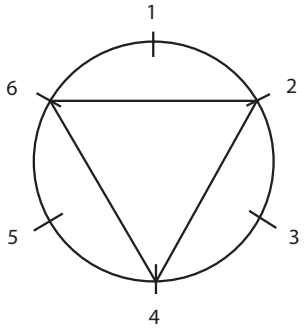


Diagram II

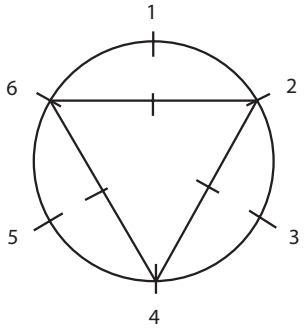


Diagram III

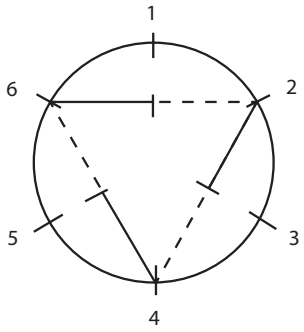


Diagram IV

Name:_____ Date: _____

Blackline Master 3: Pictures of Structures

1.

Surface area (sum of all the faces) = 22 square units
Volume (number of cubes used to build the figure) = 6 cubic units

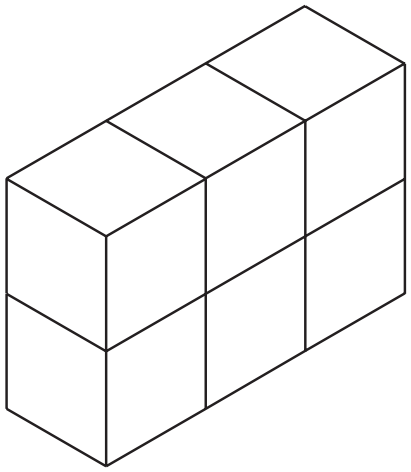
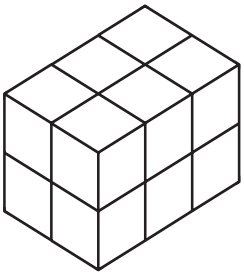


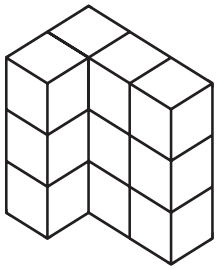
Figure Number	Surface Area (Sum of the area of all the faces	Volume (Cubic Units needed to build the figure)
1	22	6
2		
3		
4		
5		
6		
7		
8		
9		

2.



Surface Area _____
Volume _____

3.



Surface Area _____
Volume _____

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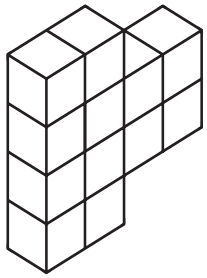
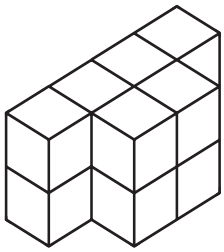


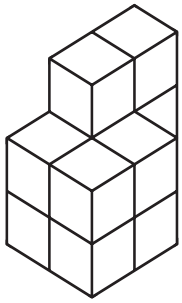
Surface Area _____
Volume _____

5.



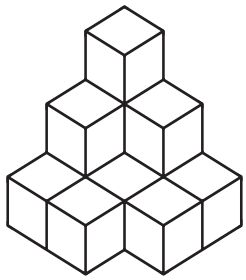
Surface Area _____
Volume _____

6.



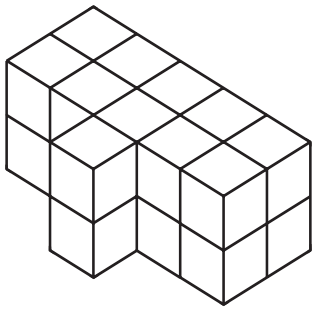
Surface Area _____
Volume _____

7.



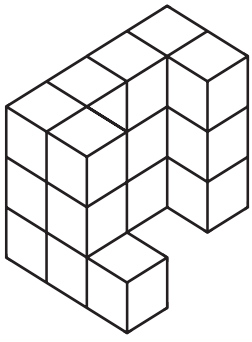
Surface Area _____
Volume _____

8.



Surface Area _____
Volume _____

9.



Surface Area _____
Volume _____

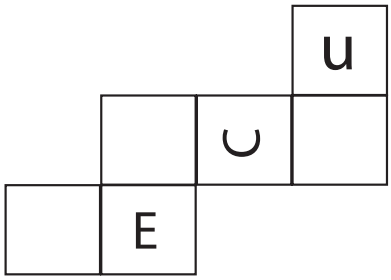
Handout

Name:_____ Date: _____

Blackline Master 4: Pictures of Cube Nets

Part A

1.



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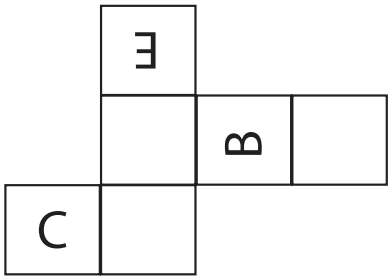

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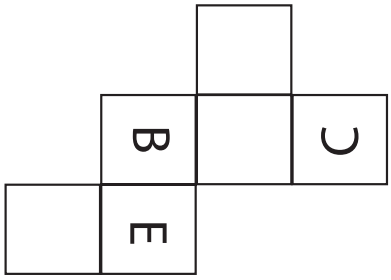

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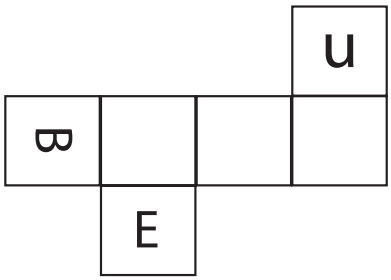

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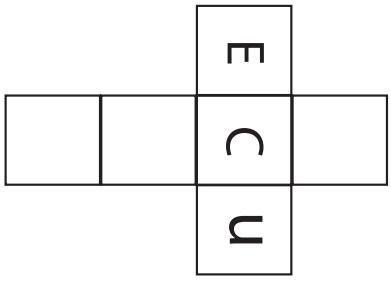

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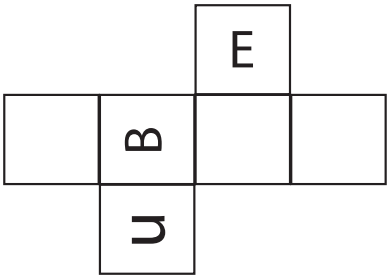

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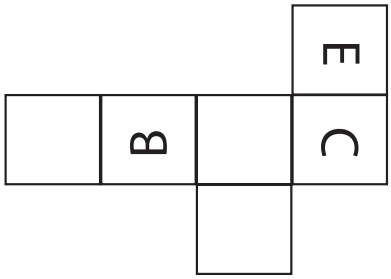

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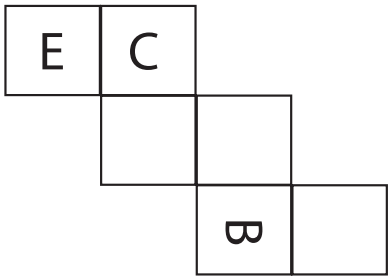

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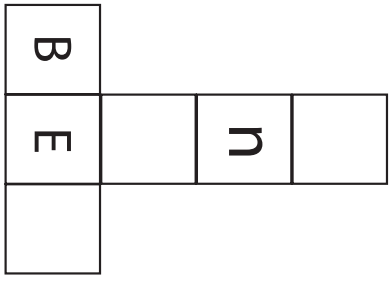

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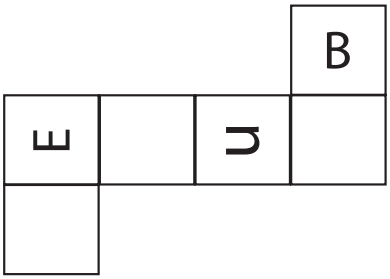

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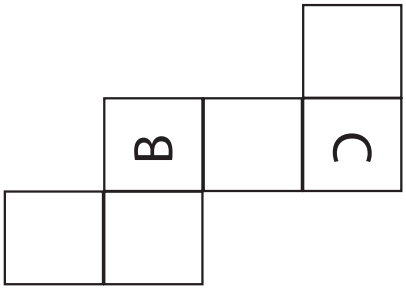

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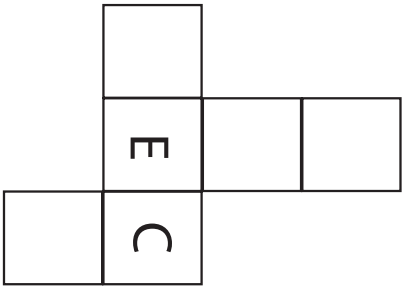

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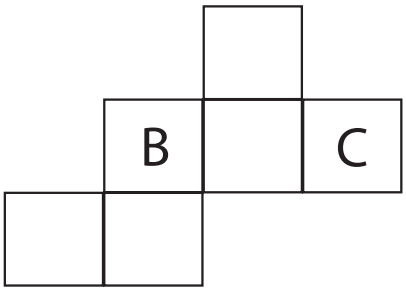

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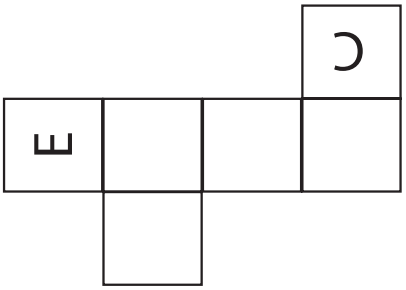

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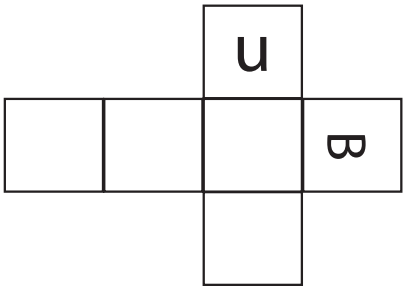

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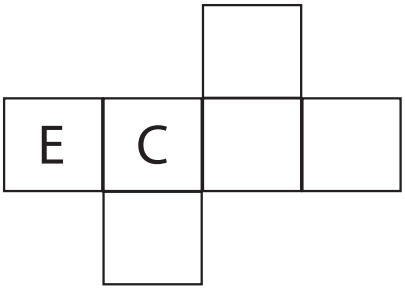

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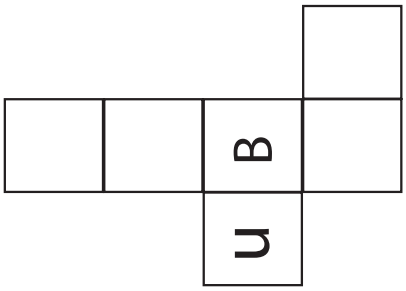

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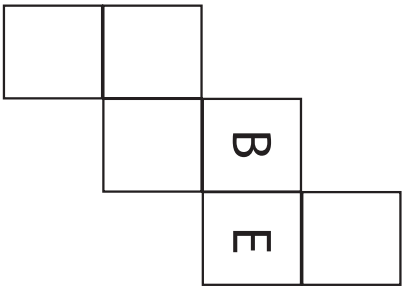

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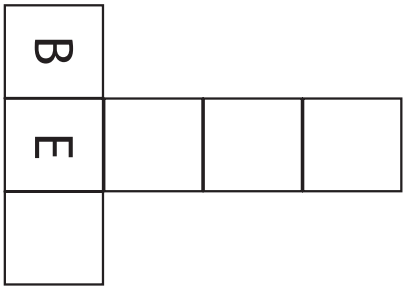

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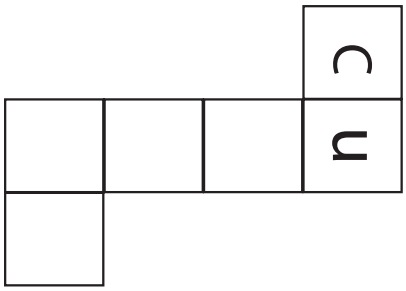
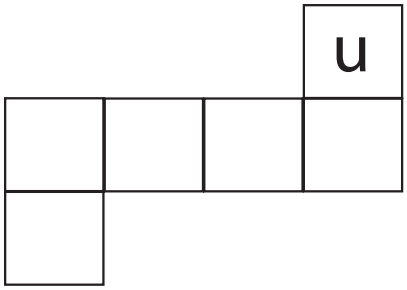
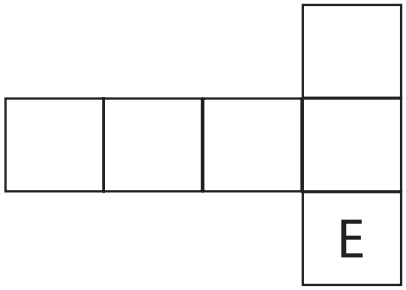
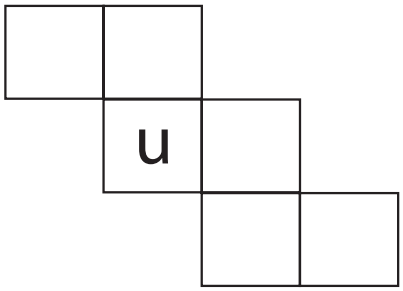
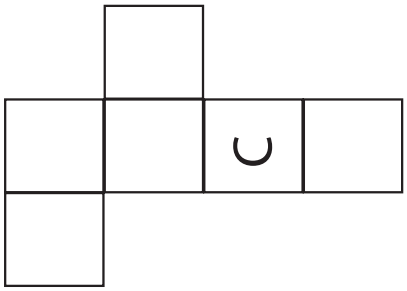


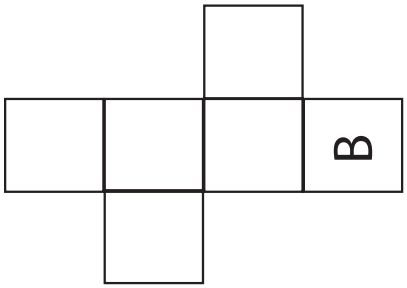
Part C

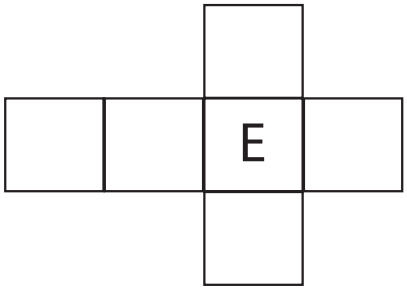
1. 

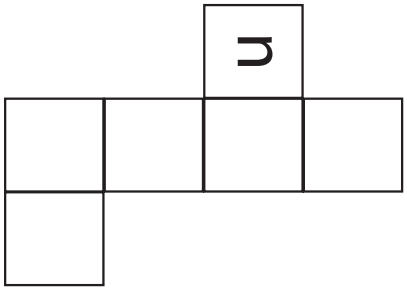
2. 

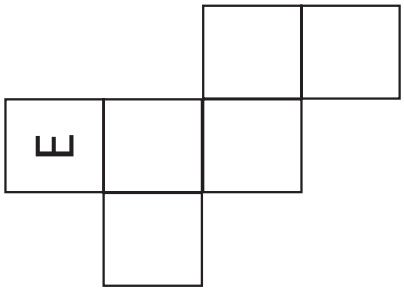
3. 

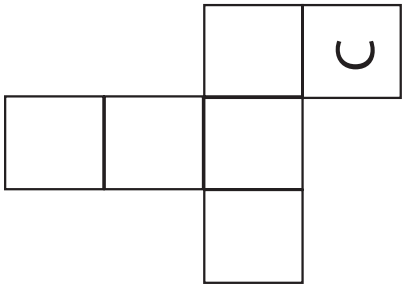
4. 

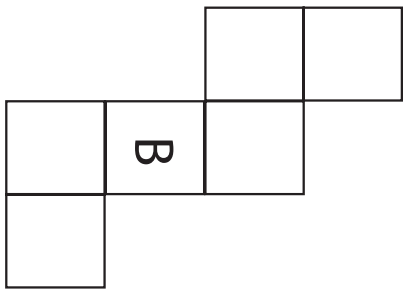
5. 

6. 

7. 

8. 

9. 

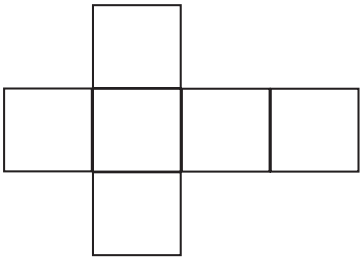
10. 

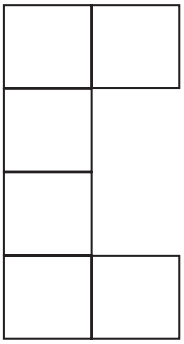
Handout

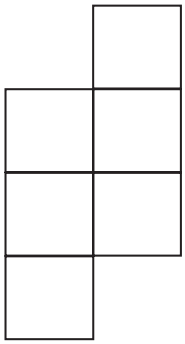
Name:_____ Date: _____

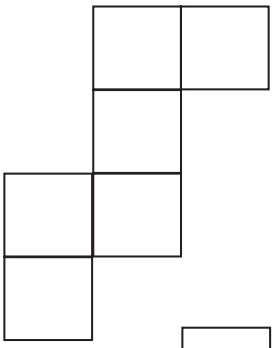
Blackline Master 5: "Making Boxes" Figures

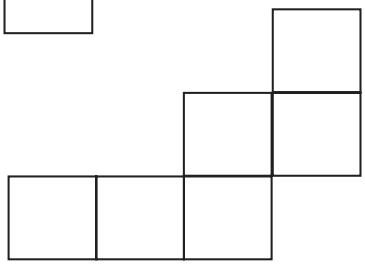
Which of these figures can be folded into a box? Check your answer(s) by cutting and folding.

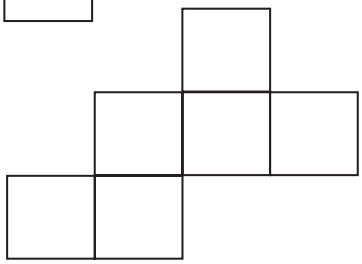
1. 

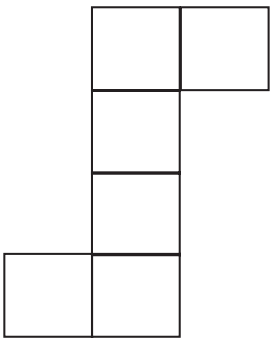
2. 

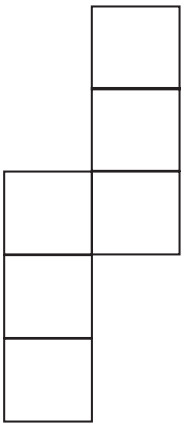
3. 

4. 

5. 

6. 

7. 

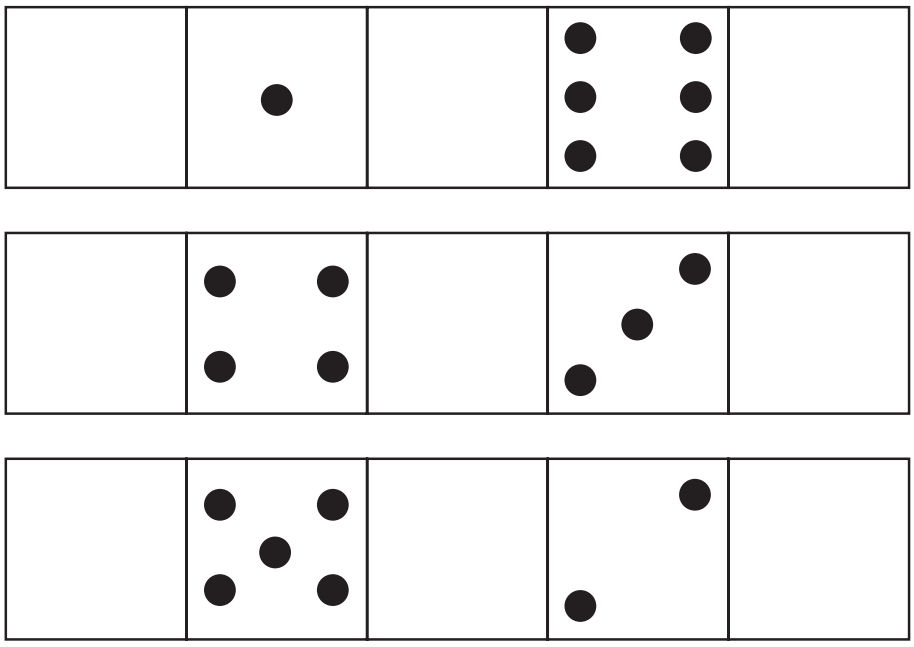
8. 

Name:_____ Date: _____

Blackline Master 6: No-Paste Die

No-Paste Dice

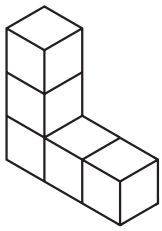
1. Cut each of the three nets.
2. Fold and crease each piece sharply on the solid lines.
3. Fold one net so the blank sides are together.
4. Fold a second net and place it around the first one.
5. Tuck the blank sides in, making sure the sides with dots are not covered.
6. Continue steps 4 and 5 with the third net.

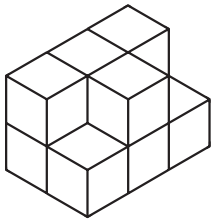


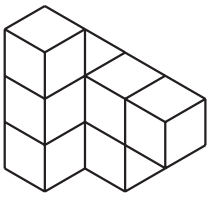
Handout

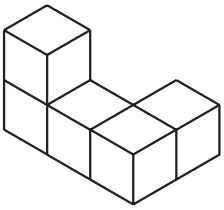
Name:_____ Date: _____

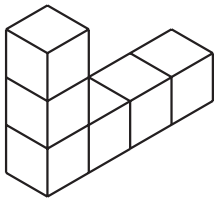
Blackline Master 7: Viewing Structures

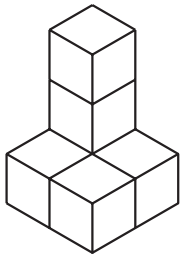
1. 

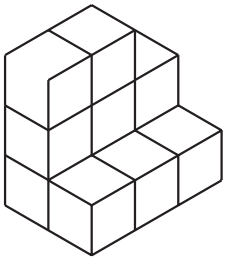
2. 

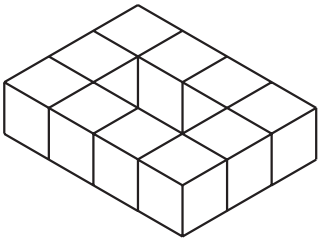
3. 

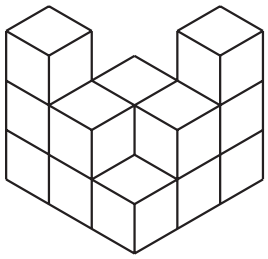
4. 

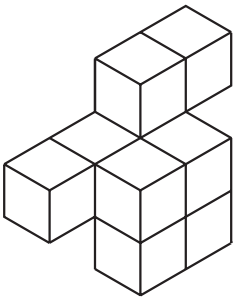
5. 

6. 

7. 

8. 

9. 

10. 

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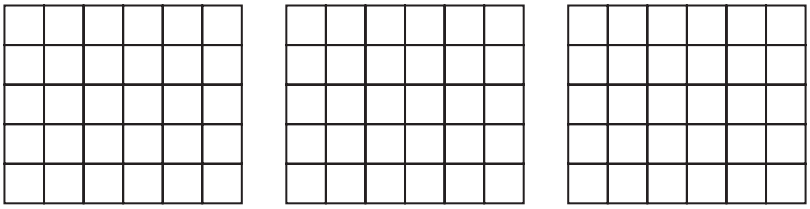

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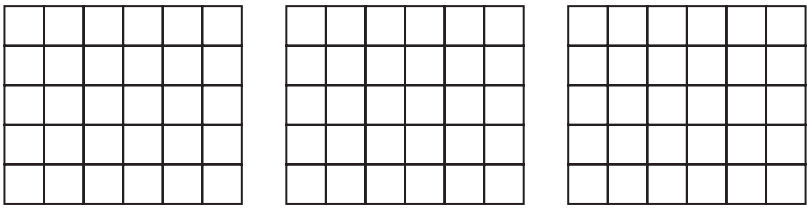

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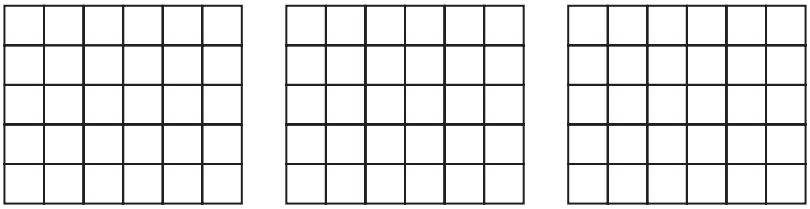

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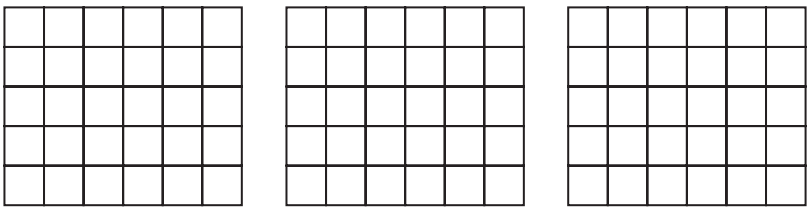

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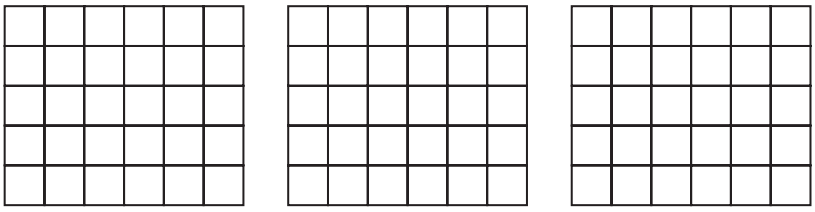

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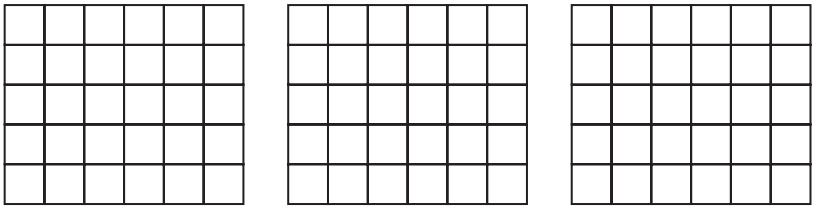

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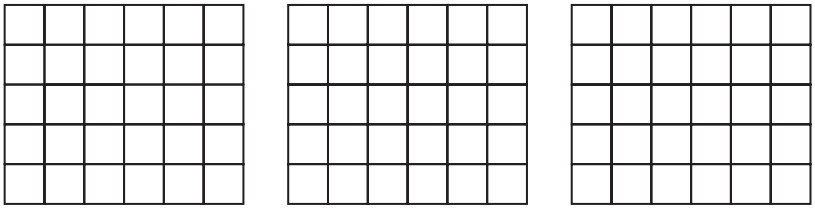

Front Top Right Side

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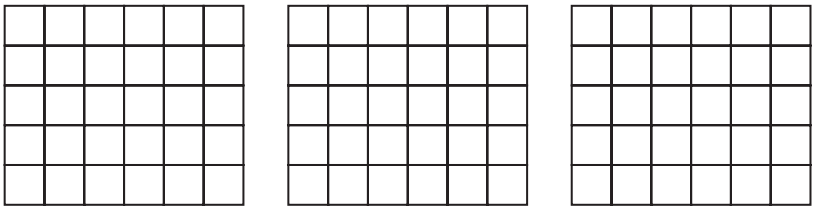

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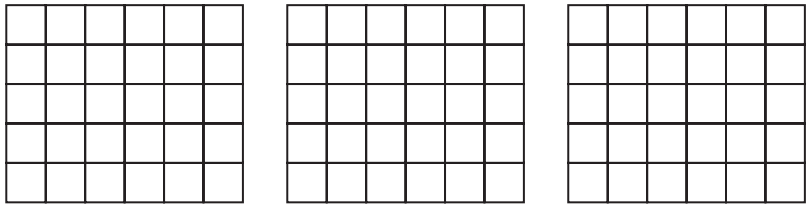

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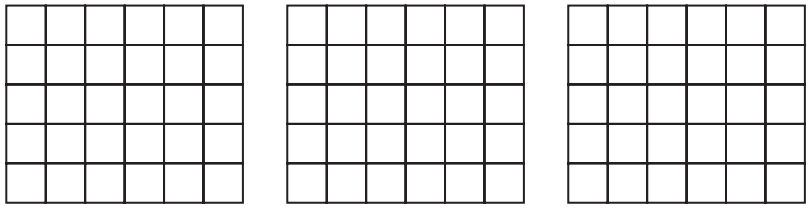
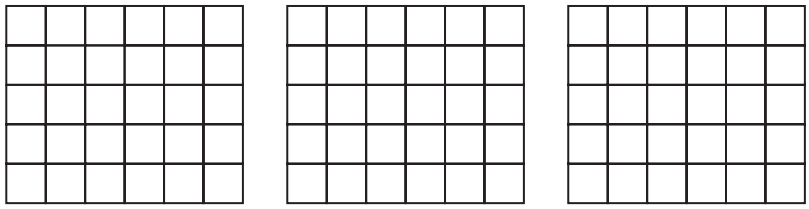


Front Top Right Side

For Your Design



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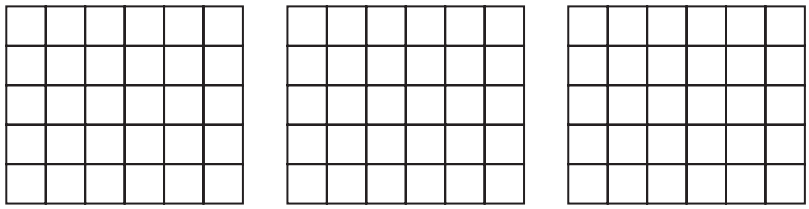
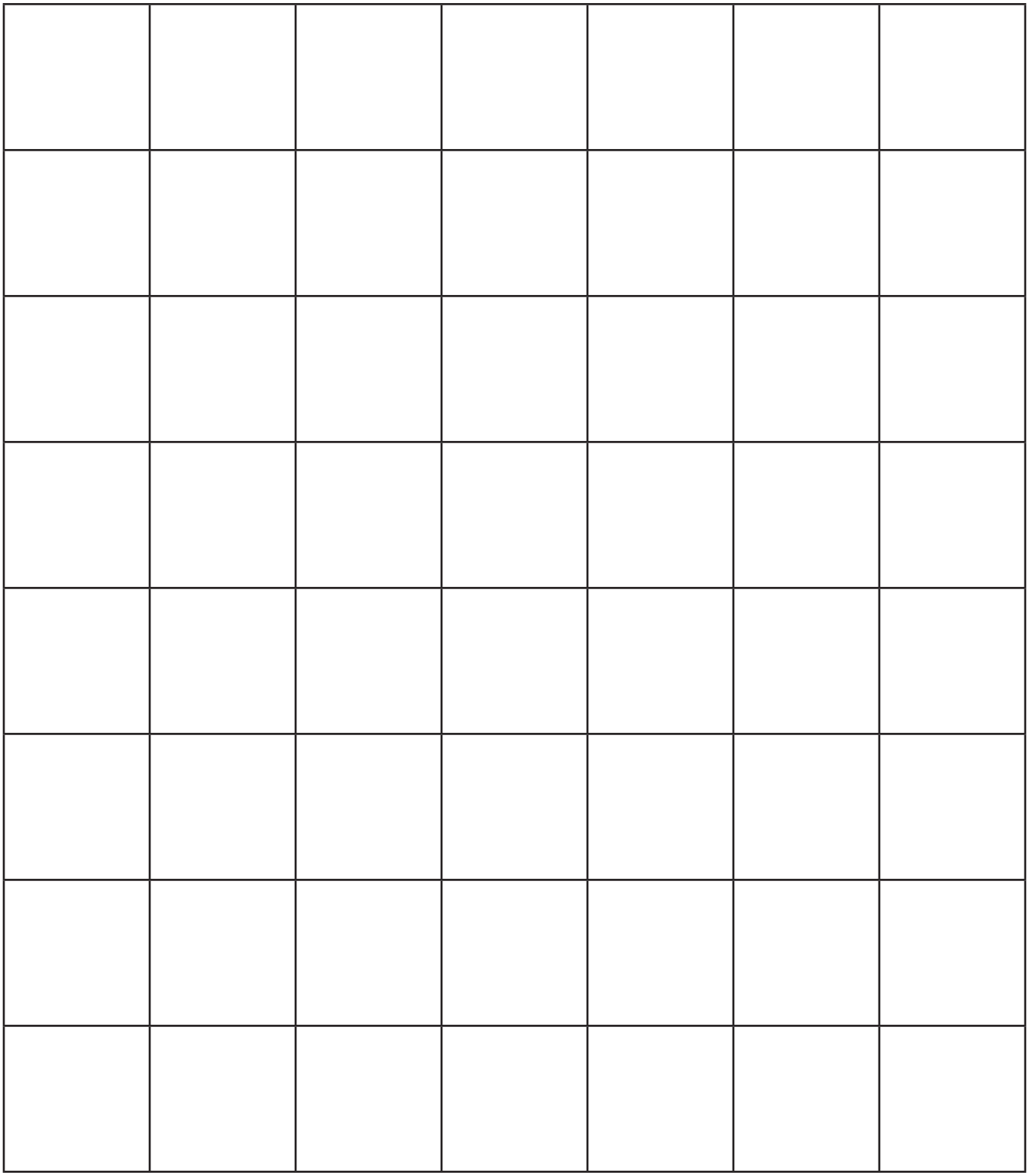


Front Top Right Side

Handout

Name:_____ Date: _____

One-Inch Grid Paper



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Parent or guardian: _____ (print)

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Address:

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