Title: Cover Your Bases and Faces

Brief Overview:

Students will create solid figures using nets in order to determine the attributes of a three dimensional figure. They will use the protractor to measure the angles in polygons and to calculate the sum of the interior angles.

NCTM Content Standard/National Science Education Standard:

Geometry: Solid Figures
Measurement: Measuring Angles

Grade/Level:

Grade 4/5

Duration/Length:

3-4 days 60 minute periods

Student Outcomes:

Students will:

- Create solid figures using nets.
- Identify polygons that make up the solid figures as well as calculate the number of faces, vertices and edges for various polyhedron figures.
- Classify as acute, obtuse and right angles and measure interior angles of the polygons by using a protractor.
- Create a polyhedron.

Materials and Resources:

Teacher Materials
Solid figures (models for the class): Cube, Rectangular Prism, Pyramid, Cone, Triangular Prism, Cylinder, Sphere
T- Chart
At least one net as a transparency
Vocabulary on chart paper or sentence strip
Vocabulary Term Sheet (Teacher Resource)
Rubric for BCR/ECR and Kids Speak version
Transparency of Angle worksheet

Individual Student Materials
Brief Constructed Response (BCR): Prism vs. Pyramid

Exit Card
Chart: edges, faces, vertices and shapes
Chart: Interior angles
Measure angles worksheet
Protractors
Shapes worksheet with cardstock

Group Materials
A set of Net Worksheets
Color pencils or Crayons, Tape, Scissors
Letters spelling the word protractor in an envelope

Development/Procedures:

Lesson 1

Preassessment – See Launch

Launch – (Teacher Talk: The purpose of the launch is to use concept attainment to classify the solid figure as a pyramid vs. another solid figure*)*. Using your geometric solids, make a "yes" group of solids and a "no" group. Starting with a square pyramid, place it in the yes group. Then take a rectangular prism and place it in the no group. Take each solid, one by one and show it to students. As you display solids to the students ask them to predict whether the solid is an example of a "yes" or "no" and place it in the correct group. Your last example should be the cone that is a "no". (Inform students that cones and cylinders are solid figures, but not polyhedrons because of the curved surfaces).

Teacher Facilitation – To activate prior knowledge have students identify solid figures. Have students explain the difference between two-dimensional shapes and three-dimensional solid figures. Introduce the vocabulary for this concept development unit to your class, by displaying it on chart paper or sentence strips *(*see **vocabulary term sheet – Teacher Resource Sheet 1***)***. Using the solid figures explain to the students that in order to identify a prism or pyramid you would need to look at the shape and number of bases. Model how to find the vertices, faces and edges of a solid. Using the overhead display a copy of a **net worksheet (Student Resource Sheets 1-9),** explain how to use a net in order to create a polyhedron.

Student Application – Divide the class into groups of four or five (depending on the size of your class). Distribute one set of **net worksheets (Student Resource Sheets 1-9)** to each group of students. (Each person should construct at least one solid figure.) First, have students make predictions, then record on the worksheet which solid each net will create.

Embedded Assessment – Informally assess the students using geometry vocabulary, identifying solid figures creating nets. Collect the completed solid figures to be used in Lesson two.

Reteaching/Extension-

- Have students discuss whether or not their predictions were right. Tell students to explain their response.
- Review vocabulary as needed and, if time allows, groups can complete additional nets.
- Using their coloring tools, have students color the vertices black, edges blue and bases yellow.

Lesson 2

Preassessment – Have the students review the material from Lesson 1 by showing a polyhedron and have them explain the new vocabulary terms (edges, vertices, and faces) for the various solid figures that you display.

Launch – Pass out the **BCR (Student Resource Sheet 10)** that requires the students to explain the differences between a pyramid and a prism. Allow five to seven minutes for completion. Reviews the BCR by having the students share their responses. You can collect the **BCR** and score it or score as a class. (Use the **Rubric** to help you score (Teacher Resource Sheets 2 and 3.)

Teacher Facilitation – Return the polyhedrons that the students made in the previous lesson. Pass out the **Faces, Vertices, and Edges chart (Student Resource Sheet 11)** and complete the first example as a class. Allow the students to discover the relationships between the edges, bases and vertices of solid figures. (n= the number of sides of the base; Prisms: faces= n + 2; vertices= n x 2 (2n) edges= n x 3 (3n); Pyramids: faces= n+ 1; vertices= n + 1 edges = n x 2 (2n).

Student Application – Allow the students to work with a partner to fill in the rest of the chart. They can use their polyhedrons or any other examples of the solid figures. After the students have completed the chart, have a discussion about the patterns that they see between the shape of the base and the number of edges, faces, and vertices. The students should be able to apply the rule to determine the number of faces, vertices, and edges to a polyhedron without seeing the figure. Answers can be found on Teacher Resource Sheet 4.

Embedded Assessment –**Exit Card**: Have the students fill in the exit card which requires them to tell the number edges, faces and vertices of a decagonal prism without seeing the solid figure. It can also be an index card (Student Resource Sheet 12). Collect the exit card to determine the students who can recognize the relationship between the type of figure and the number of vertices, faces, and edges. Answers can be found on Teacher Resource Sheet 5.

Reteaching/Extension –

- For those who have understood the lesson, have them work with a child who needs help so they can assist the child.
- Have them create more riddles to describe a polyhedron.

Lesson 3

Preassessment-Students should have had experience measuring and classifying angles prior to this lesson. Focus on the vocabulary: acute angles, obtuse angles and right angles. Distribute an envelope to each cooperative group of 3 to 5 students containing the **letters P R O T R A C T O R (Student Resource Sheet 13)**. Allow the class 2 to 3 minutes to unscramble the letters to form "PROCTRACTOR". Ask what are protractors used for? (Measuring angles.) At this point, you can informally assess prior knowledge regarding angles.

Launch – Distribute protractors and **angle worksheet (Student Resource Sheet 14)**. Display on overhead the **angle answers worksheet (Teacher Resource Sheet 6)**. Have students measure the angles and label as obtuse, acute or right. Students can check or call for help if there is a discrepancy. Once students have shown mastery of angle measure and naming, ask students to name the objective from the previous math lesson. (Discover how to identify solids by edges, vertices and number of bases.) Today we will continue to explore solids using angle measure.

Teacher Facilitation –Distribute a copy of the **Polygon Shape worksheet (Student Resource Sheet 15)**. (Preferably on card stock or heavy paper since students will be tracing some of the shapes to make their own net.) Distribute **Measurement of Angles worksheet** (Student Resource Sheet 16) to each student. Have the students cut out the shapes, measure each angle within the shape and record data on the worksheet. What did you discover about the relationship between shapes and their angles? (The number of the sides affects the measure of the interior angles.) Answers may be found on Teacher Resource Sheet 7.

Student Application- Have students share their discoveries. Ask them to now choose shapes to create a net of their own. Distribute a blank piece of paper to each child. Have another student name the solid their net will form and write it on the net.

Embedded Assessment-There are many worksheets, opportunity for discussion, informal assessment regarding students' use of a protractor, help students who might need assistance using a protractor or labeling angles. The constructed net is a culminating activity that will assess students' proficiency regarding nets and solid figures.

Reteaching/Extension-

- Allow students the opportunity to find and share solids they encounter in their world. They can bring objects from home or cut out pictures from magazines or newspapers.

Summative Assessment:

Students will complete an assessment activity sheet that is modeled after the MSA (Maryland State Assessment) (Student Resource Sheet 17). They will complete an Extended Constructed Response (ECR) and selected response in order to display a level of understanding (Student Resource Sheet 18). Answers can be found on Teacher Resource Sheets 8, 9, and 10.

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Vocabulary Terms

- **Acute Angle**- An angle measuring greater than 0º and less than 90°.
- **Base**- A special face of a solid figure.
- **Edges**- Line segments where two faces of a solid figure meet.
- **Face**- a side of a solid figure.
- **Lateral Face**- sides of the polyhedron that are not bases.
- **Net**- a two dimensional shape, that can be folded into a three dimensional figure.
- **Obtuse Angle**- An angle measuring greater than 90 º and less than 180°.
- **Polygon**- A closed plane figure formed from line segments that meet at endpoints.
- **Polyhedron**- A three-dimensional figure in which all surfaces is polygons.
- **Prism**- A three-dimensional figure that has two congruent and parallel bases that are polygons. The rest of the faces are rectangles.
- **Protractor**- A tool for measuring angles.
- **Pyramid**- A polyhedron whose base is a polygon and other faces are triangles that share a common vertex.
- **Right Angle**- An angle measuring exactly 90°.
- **Vertex**- a point where three or more faces intersect.

Name _____

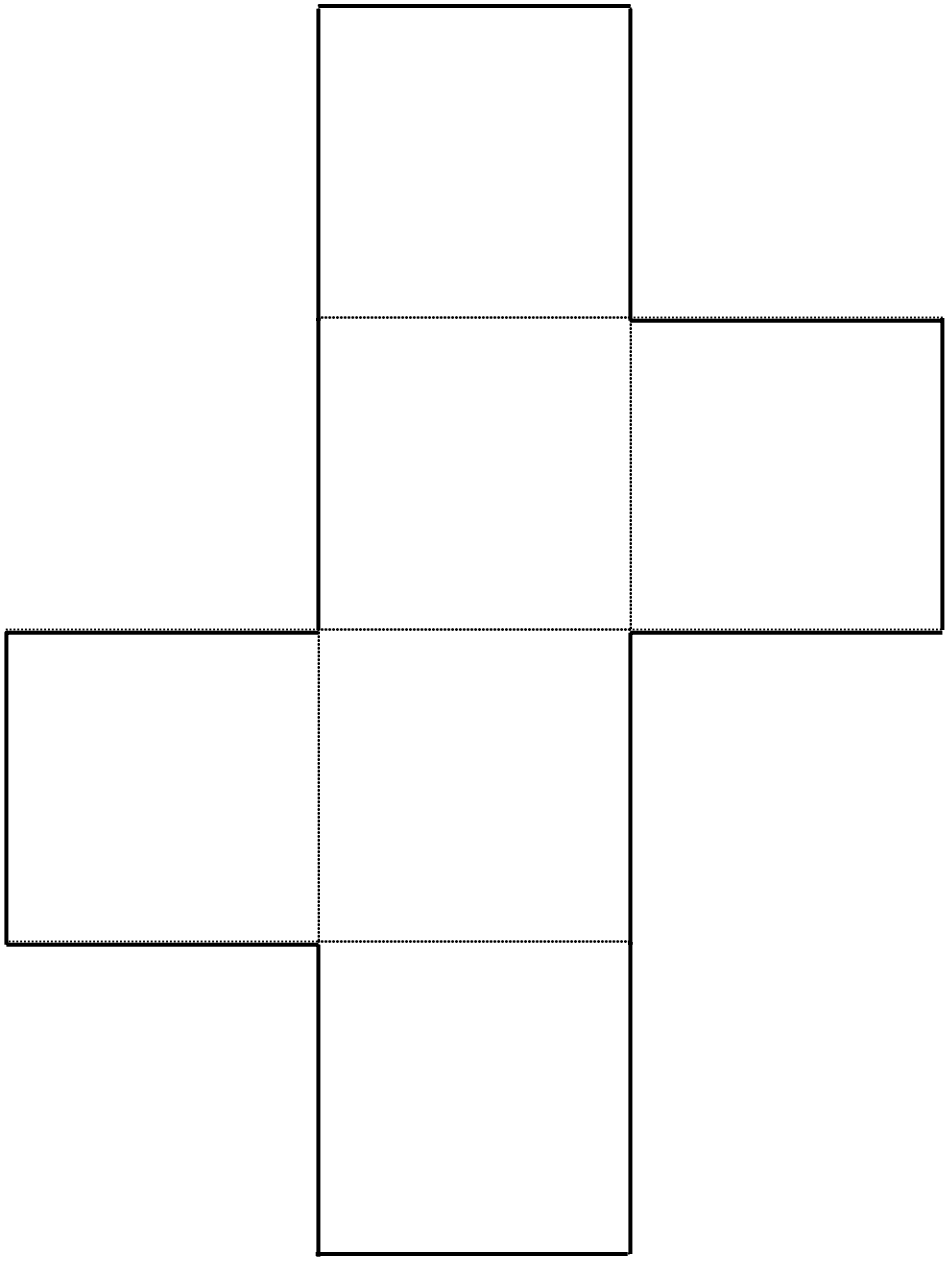
1. Prediction: Which solid will this net create? Explain your answer.

_____

_____

_____

2. Cut out the net along the heavy solid lines.
3. Fold the net along the light lines.



Name _____

1. Prediction: Which solid will this net create? Explain your answer.

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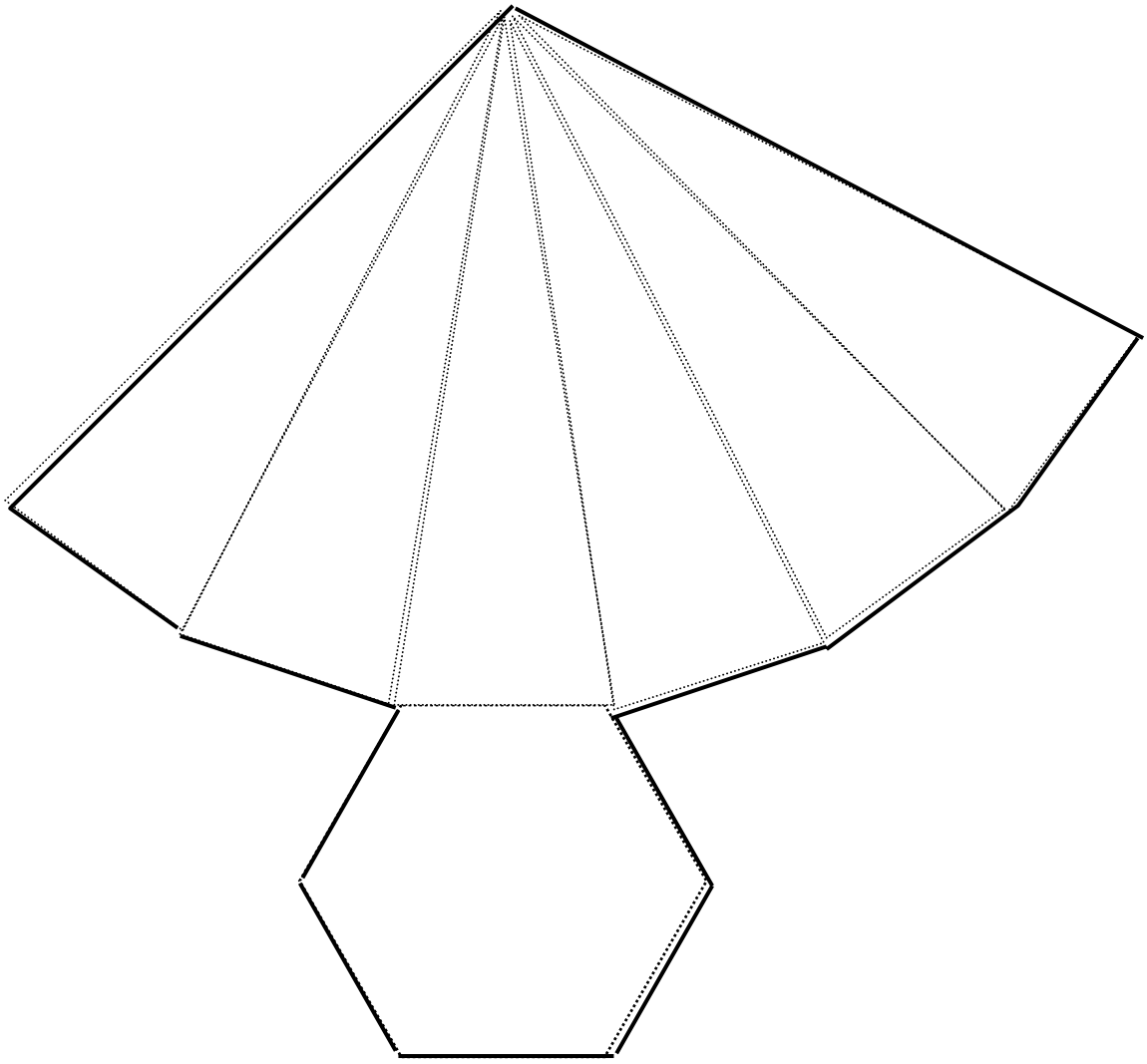
3. Fold the net along the light lines.



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1. Prediction: Which solid will this net create? Explain your answer.

_____

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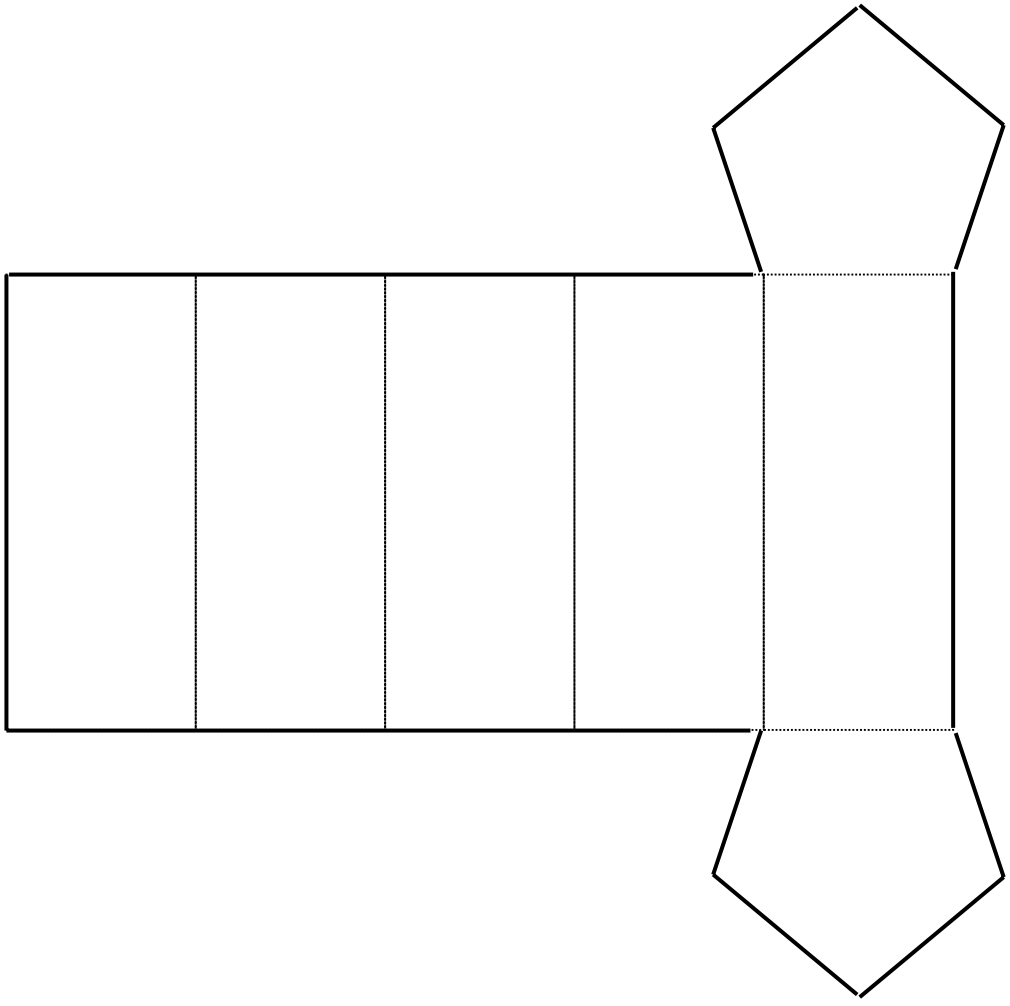

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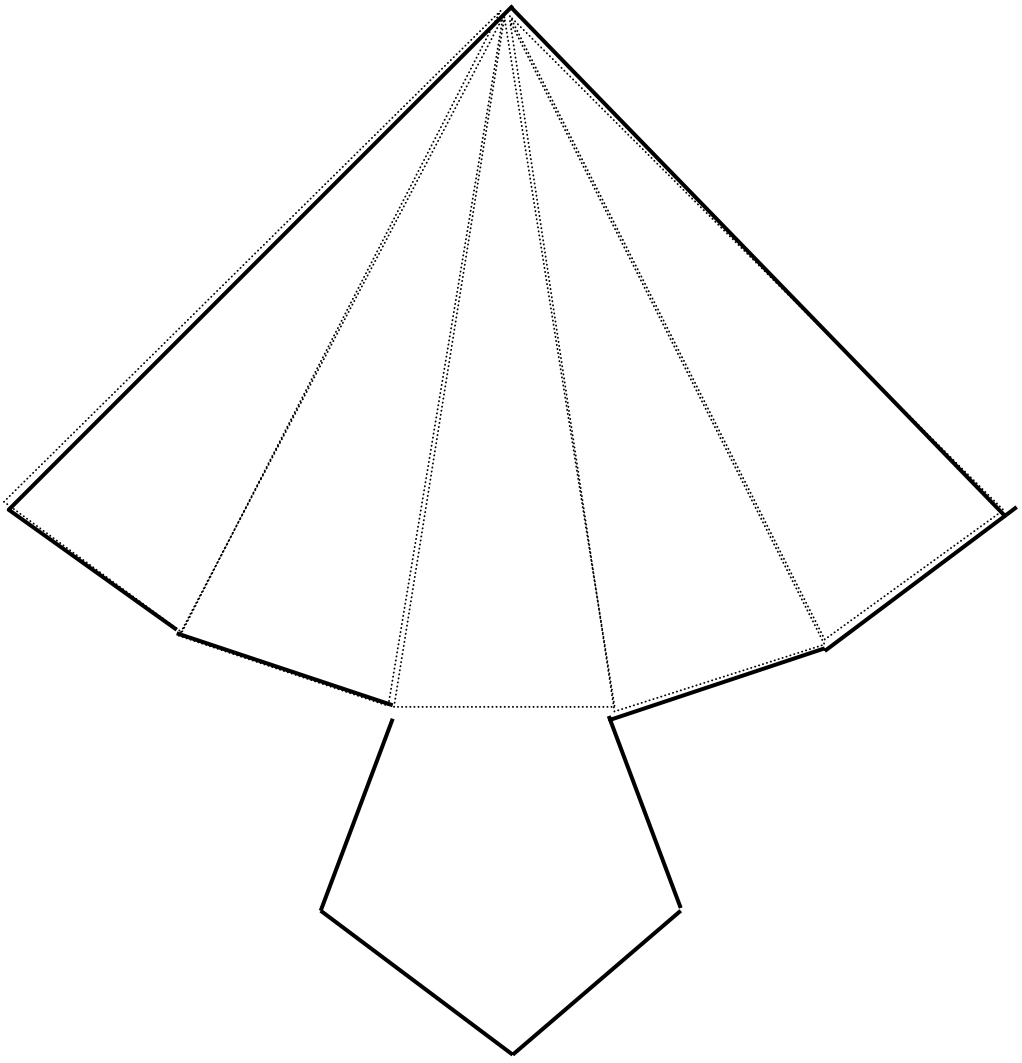

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_____

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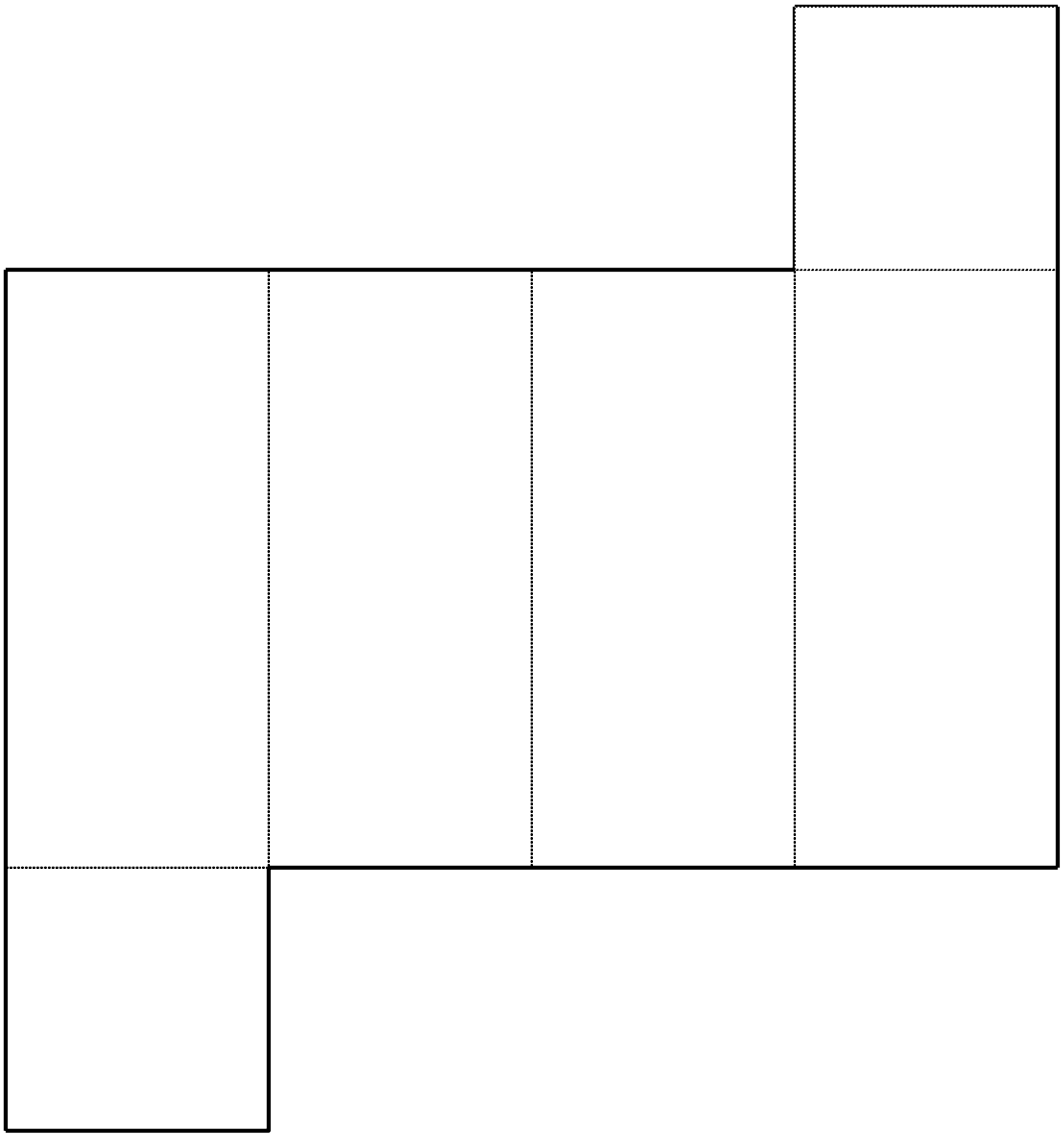
2. Cut out the net along the heavy solid lines.
3. Fold the net along the light lines.



Name _____

1. Prediction: Which solid will this net create? Explain your answer.

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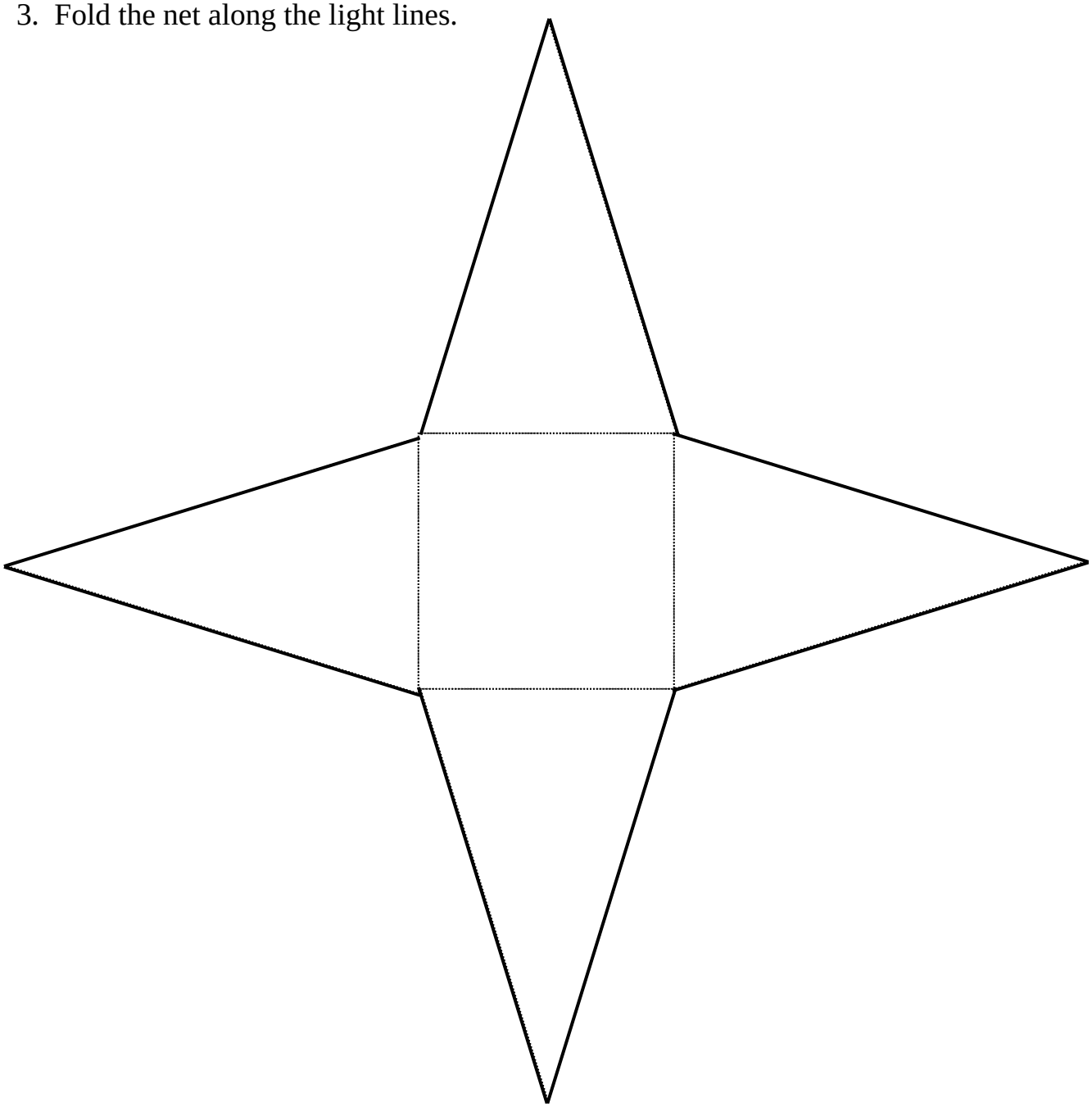
2. Cut out the net along the heavy solid lines.
3. Fold the net along the light lines.



Name _____

1. Prediction: Which solid will this net create? Explain your answer.

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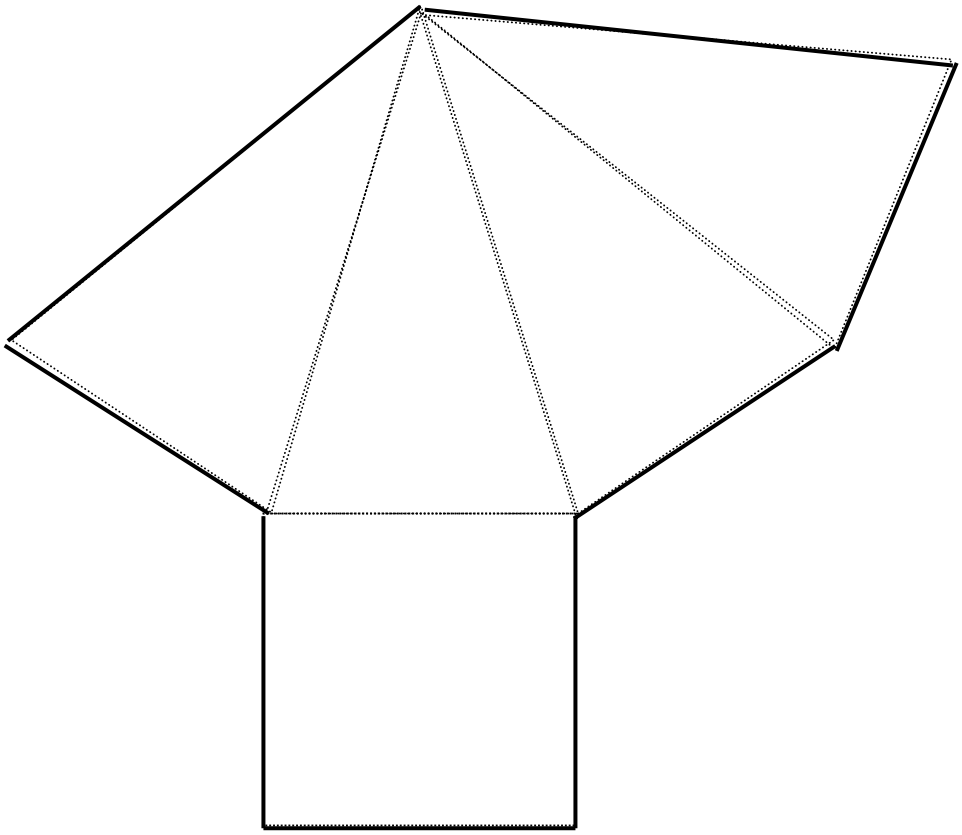
3. Fold the net along the light lines.



Name _____

1. Prediction: Which solid will this net create? Explain your answer.

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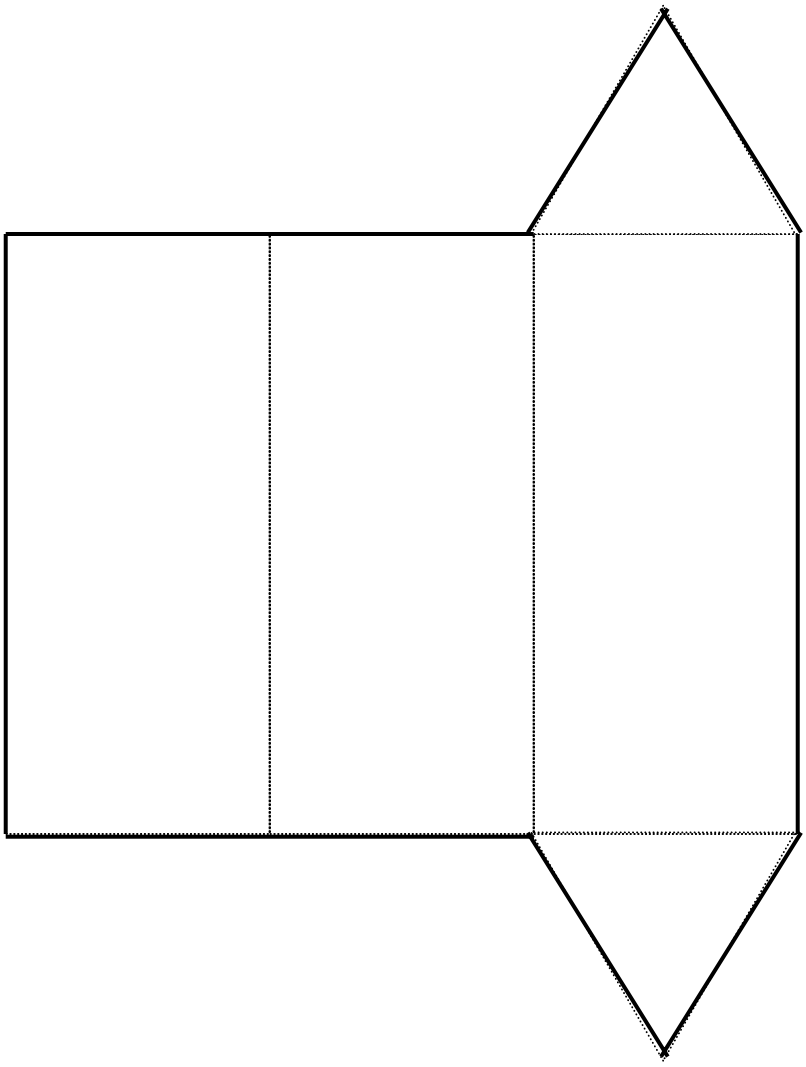

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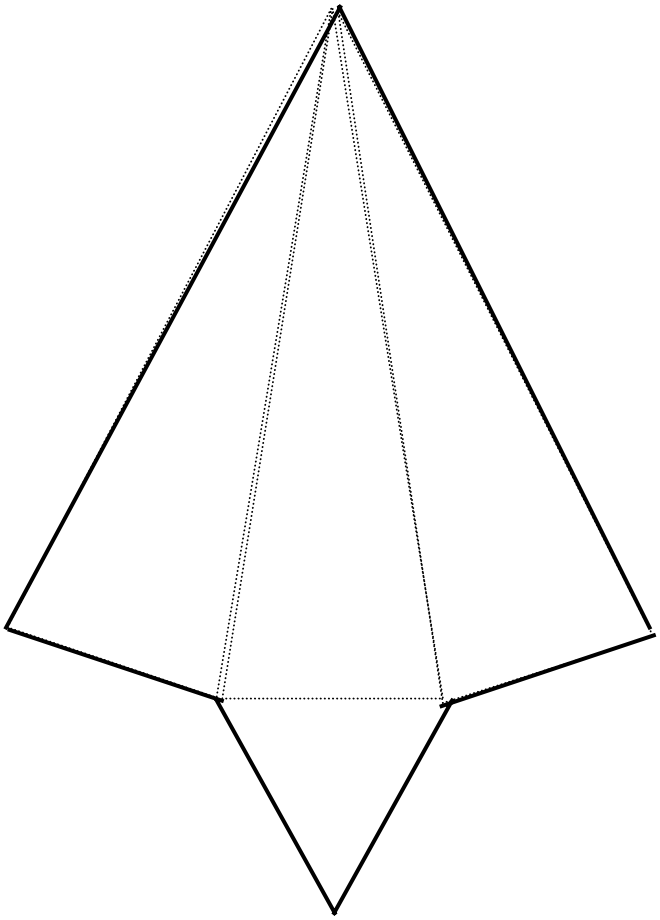


Brief Constructed Response

Look at the following solids. Tawana says they are both prisms. Jeanann says only Figure A is a prism.

Figure A

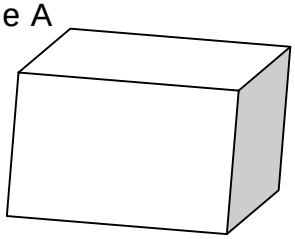
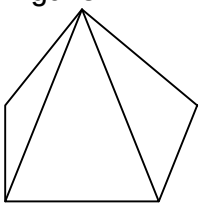


Figure B



Part A

Which student is correct?

_____

Part B

Use what you know about solids to explain why your answer is correct. Use numbers and/or words in your explanation.

Teacher Resource Sheet 2

Brief Constructed Response

Look at the following solids. Tawana says they are both prisms. Jeanann says only Figure A is a prism.

Figure A

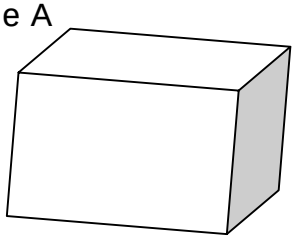
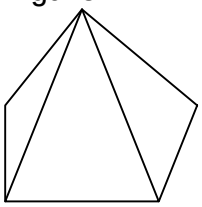


Figure B



Part A

Which student is correct?

___Jeanann is correct. Only Figure A is a prism._____

Part B

Use what you know about solids to explain why your answer is correct. Use numbers and/or words in your explanation.

Answers will vary. Answer cues are: prism has two congruent bases, rectangular faces.

Figure B is a pyramid with only one base and contains triangular faces and a common vertex.

MSA Mathematics BCR Rubric
Grades 3 through 8

2 The response demonstrates a complete understanding and analysis of a problem.

- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem are clear, developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear.
- Supportive information and/or numbers are provided as appropriate. [3]

The response demonstrates a minimal understanding and analysis of a problem.

- Partial application of a strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is partially developed, logically flawed, or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or flawed.
- Supportive information and/or numbers may or may not be provided as appropriate. [3]

0 The response is completely incorrect, irrelevant to the problem, or missing. [4]

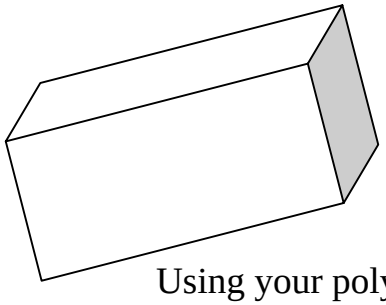
Notes:

[1] **Explanation** refers to students' ability to communicate **how** they arrived at the solution for an item using the language of mathematics.

[2] **Justification** refers to students' ability to support the reasoning used to solve a problem, or to demonstrate **why** the solution is correct using mathematical concepts and principles.

[3] Students need to complete rubric criteria for ***explanation, justification, connections*** and/or ***extensions*** as cued for in a given problem.

[4] Merely an exact copy or paraphrase of the problem will receive a score of "0".



Faces, Vertices, and Edges

Using your polyhedron figures fill in the rest of the chart.

Name	Shape of the base	Shape of the lateral faces	# of faces	# of vertices	# of edges
triangular prism			5		
	rectangle	rectangle	6		12
	pentagonal	rectangle		10	
	square		6	8	
	hexagon	triangle			12
	square	triangle	5		
pentagonal pyramid				6	

See if you can see a pattern for the number of faces, edges, and vertices if you know the name of the polyhedron. (Hint: The name tells you the shape of the base and the faces.)

Bonus: Create a riddle on the back giving clues to a specific polyhedron.

Faces, Vertices, and Edges

Using your polyhedron figures fill in the rest of the chart.

Name	Shape of the base	Shape of the lateral faces	# of faces	# of vertices	# of edges
triangular prism	(triangle)	(rectangles)	5	(6)	(9)
(rectangular prism)	rectangle	rectangle	6	(8)	12
(pentagonal prism)	pentagonal	rectangle	(7)	10	(15)
(cube)	square	(square)	6	8	(12)
(hexagonal pyramid)	hexagon	triangle	(7)	(7)	12
(square pyramid)	square	triangle	5	(5)	(8)
pentagonal pyramid	(pentagon)	(triangle)	(6)	6	(10)

See if you can see a pattern for the number of faces, edges, and vertices if you know the name of the polyhedron. (Hint: The name tells you the shape of the base and the faces.)

Bonus: Create a riddle on the back giving clues to a specific polyhedron.

Exit Card

If you have a decagonal prism, how many faces, vertices and edges would there be? (Hint: a decagon is a ten-sided figure.)

faces: _____
vertices: _____
edges: _____

Use the space to explain how you determined the answers.

Exit Card

If you have a decagonal prism, how many faces, vertices and edges would there be? (Hint: a decagon is a ten-sided figure.)

faces: _____
vertices: _____
edges: _____

Use the space to explain how you determined the answers

Exit Card

If you have a decagonal prism, how many faces, vertices and edges would there be? (Hint: a decagon is a ten-sided figure.)

faces: __12____
vertices: __20____
edges: __30____

Use the space to explain how you determined the answers.

Answers will vary.

Should include:
-Using the expressions n + 2; n x 2; n x 3
-An explanation of the expressions
-Drawing of the figure

Directions: Cut the following letters out and place them in a plain envelope.

P R O T R A

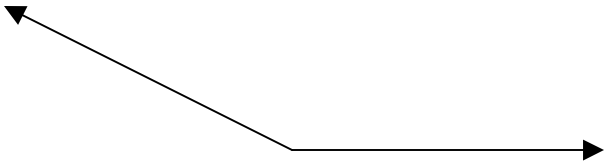
C T O R

Name_____

Angle Worksheet

Measure each angle with a protractor. Label angles as acute, right or obtuse.

1.



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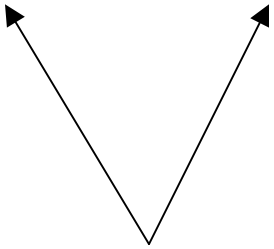
2.



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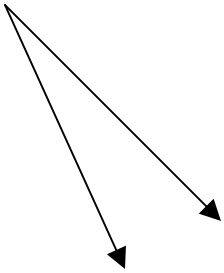
3.



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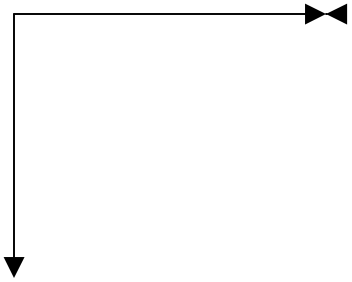
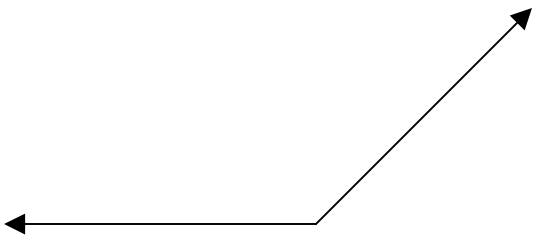
4.



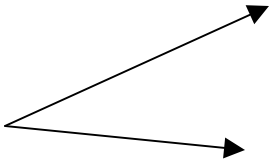
_____

5.



_____

6.



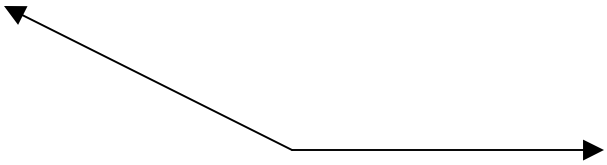
_____

Name_____

Angle Worksheet

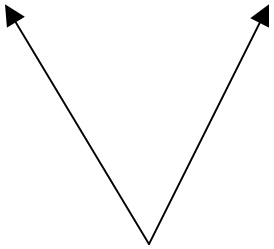
Measure each angle with a protractor. Label angles as acute, right or obtuse.

1.



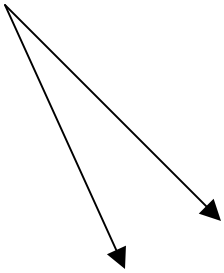
obtuse, 153°

2.



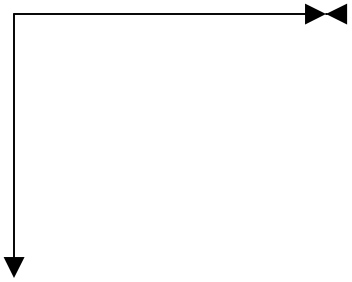
acute, 60°

3.



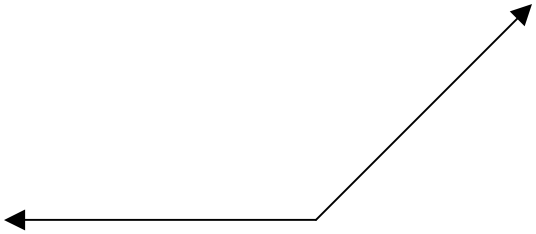
acute, 22°

4.



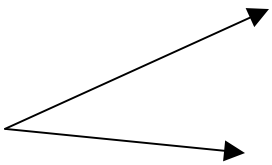
right, 90°

5.



obtuse, 135°

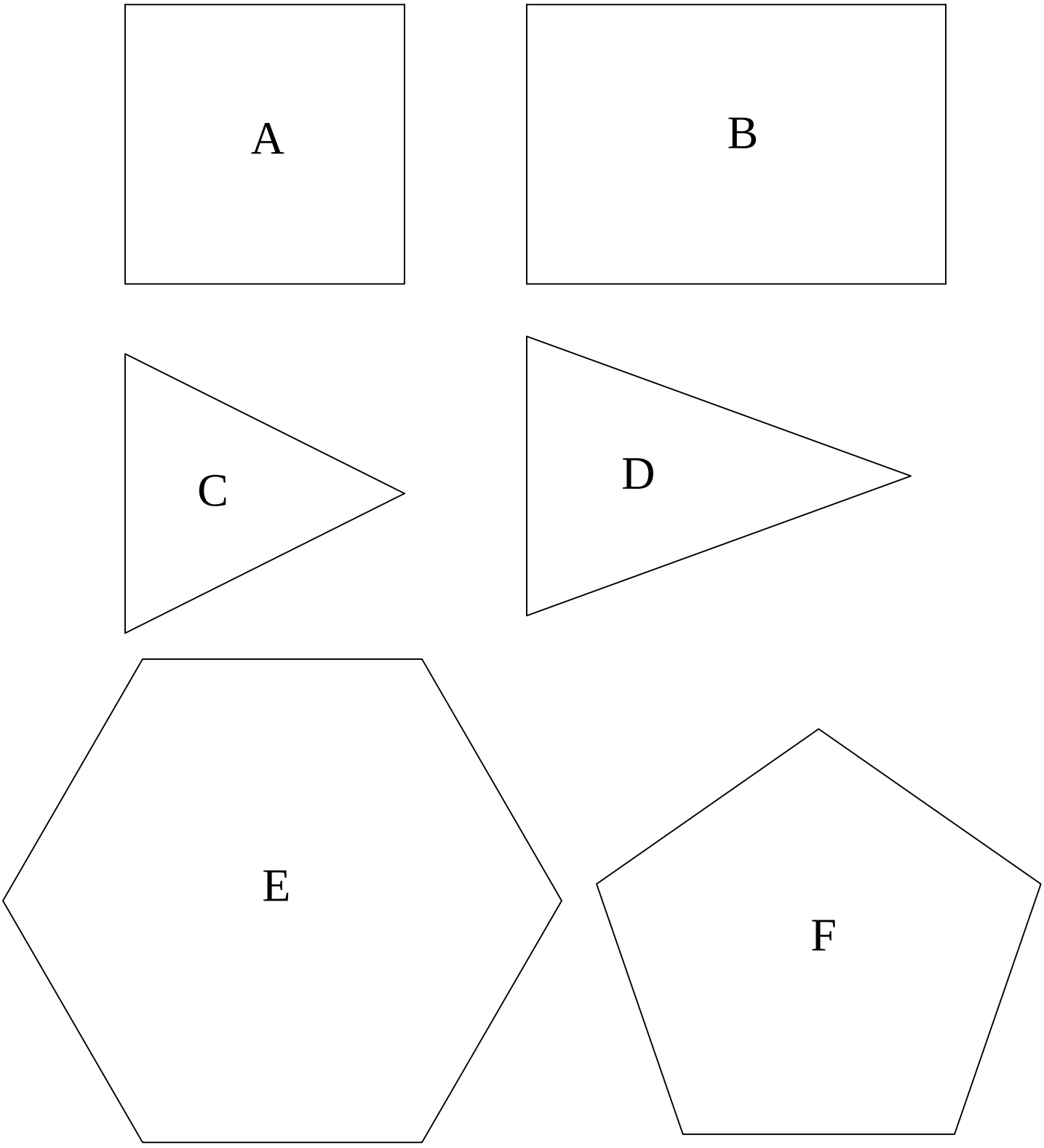
6.

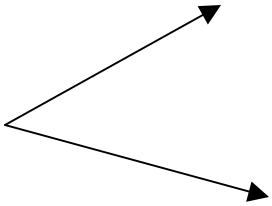


acute, 31°

Polygon Shapes

Write the following shapes on the chart and determine the type of angles. Then measure the interior angles of the shapes and record the measurements on the chart. You will need to extend the rays of the shapes.



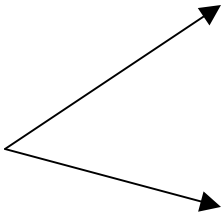


Measurement of Angles

Measure the interior angles of the polygons and then record your answers on the following chart. Don't forget to extend your rays and use the degree sign.

Name of Shape	# of angles	Type of angles	Measure of angles	Sum of interior angles
A				
B				
C				
D				
E				
F				

After you have your chart filled in, use a piece of loose-leaf paper to create a net by tracing the necessary shapes. Then have a partner try to determine the polyhedron without cutting it out. Check your net by cutting it and making your polyhedron.



Measurement of Angles

Measure the interior angles of the polygons and then record your answers on the following chart. Don't forget to extend your rays and use the degree sign.

Name of Shape	# of angles	Type of angles	Measure of angles	Sum of interior angles
rectangle	4	right	90º	360º
small triangle	3	acute	60º	180º
pentagon	5	obtuse	110º	550º
hexagon	6	obtuse	120º	720º
large triangle	3	acute	60º	180º
square	4	right	90º	360º

After you have your chart filled in, use a piece of loose-leaf paper to create a net by tracing the necessary shapes. Then have a partner try to determine the polyhedron without cutting it out. Check your net by cutting it and making your polyhedron.

Summative Assessment

Selected Response
Directions: Fill in the circle of the correct answer.

1. A tool that measures angles is a _____.

   (A) ruler (B) compass (C) protractor (D) calculator

2. A(n) _____ is a line segment that connects two faces.

   (A) vertex (B) base (C) polygon (D) edge

3. The shapes that make up a triangular prism are _____.

   (A) triangles and rectangles (B) triangles and hexagons

   (C) squares and circles (D) only triangles

4. A square pyramid has _____ vertices.

   (A) 2 (B) 4 (C) 5 (D) 8

5. Which solid is <u>not</u> a polyhedron?

   (A) cube (B) cylinder

   (C) pentagonal prism (D) hexagonal pyramid

MSA Extended Constructed Response

Part A
I am a polyhedron created with pentagons and rectangles. I have 7 faces, 10 vertices and 15 edges. What solid am I?

Part B

- *Use what you know about polyhedrons to explain how you know your answer is correct. Use words, numbers and /or symbols in your explanation.*
- *Suppose the riddle in Part A was changed to a solid figure containing only a hexagon and triangles. Identify the new solid figure. How does this change the number of faces, vertices and edges?*

_____

_____

_____

_____

_____

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_____

_____

_____

Select Response Answer Key 1-C, 2-D, 3-A, 4-C, 5-B

MSA Extended Constructed Response Answer Key

Part A
I am a polyhedron created with pentagons and rectangles. I have 7 faces, 10 vertices and 15 edges. What solid am I?

Answer: A pentagonal prism.

Part B

- *Use what you know about polyhedrons to explain how you know your answer is correct. Use words, numbers and /or symbols in your explanation.*
- *Suppose the riddle in Part A was changed to a solid figure containing only a hexagon and triangles. Identify the new solid figure. How does this change the number of faces, vertices and edges?*

Answers will vary.
Answer cues are: more than one base defines a prism, shape of base determines the name (pentagonal prism), bases are connected by rectangles, 2 x number of sides of base (2 x 5) = # of vertices, etc.

The second figure created is a hexagonal pyramid. Exactly one base and triangular faces defines a pyramid. A hexagonal pyramid has 7 faces, 7 vertices and 12 edges.

MSA Mathematics ECR Rubric
Grades 5 through 8

3 The response demonstrates a comprehensive understanding and analysis of a problem.

- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is clear, fully developed, and logical.
- Connections and/or extensions made within mathematics or outside of mathematics are clear and stated explicitly.
- Supportive information and/or numbers are provided as appropriate. [3]

2 The response demonstrates a general understanding and analysis of a problem.

- Application of a reasonable strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem is feasible, but may be only partially developed.
- Connections and/or extensions made within mathematics or outside of mathematics are partial or overly general, or may be implied.
- Supportive information and/or numbers are provided as appropriate. [3]

1 The response demonstrates a minimal understanding and analysis of a problem.

- Partial application of a strategy in the context of the problem is indicated.
- Explanation[1] of and/or justification[2] for the mathematical process(es) used to solve a problem are logically flawed or missing.
- Connections and/or extensions made within mathematics or outside of mathematics are flawed or missing.
- Supportive information and/or numbers may or may not be provided as appropriate. [3]

0 The response is completely incorrect, irrelevant to the problem, or missing. [4]

Notes:

[1] **Explanation** refers to students' ability to communicate **how** they arrived at the solution for an item using the language of mathematics.

[2] **Justification** refers to students' ability to support the reasoning used to solve a problem, or to demonstrate **why** the solution is correct using mathematical concepts and principles.

[3] Students need to complete rubric criteria for ***explanation, justification, connections*** and/or ***extensions*** as cued for in a given problem.

[4] Merely an exact copy or paraphrase of the problem will receive a score of "0".

MSA Brief Constructed Response "Kid Speak" Mathematics Rubric
Grades 1 through 8

Score	
2	**My answer shows I completely understood the problem and how to solve it:** • **I used a very good, complete strategy to correctly solve the problem.** • **I used my best math vocabulary to clearly explain what I did to solve the problem. My explanation was complete, well organized and logical.** • **I applied what I know about math to correctly solve the problem.** • **I used numbers, words, symbols or pictures (or a combination of them) to show how I solved the problem.**
1	**My answer shows I understood most of the problem and how to solve it:** • **I used a strategy to find a solution that was partly correct.** • **I used some math vocabulary and most of my reasons were correct to explain how I solved the problem. My explanation needed to be more complete, well organized or logical.** • **I partly applied what I know about math to solve the problem.** • **I tried to use numbers, words, symbols or pictures (or a combination of them) to show how I got my answer, but these may not have been completely correct.**
0	**My answer shows I didn't understand the problem and how to solve it:** • **I wasn't able to use a good strategy to solve the problem.** • **My strategy wasn't related to what was asked.** • **I didn't apply what I know about math to solve the problem.** • **I left the answer blank.**

MSA Extended Constructed Response "Kid Speak"
Mathematics Rubric
Grades 4 through 8

Score	
3	**My answer shows I completely understood the problem and how I solved it:** • **I used a very good, complete strategy to correctly solve the problem.** • **I used my best math vocabulary to clearly explain what I did to solve the problem. My organized and logical.** • **I applied what I know about math to correctly solve the problem.** • **I used numbers, words, symbols or pictures (or a combination of them) to show how I s**
2	**My answer shows I understood most of the problem and how I solved it:** • **I used a good strategy to solve the problem.** • **I used math vocabulary and my explanation was mostly complete, well organized and lo** • **I was able to apply some of what I know about math to solve the problem.** • **I tried to use some numbers, words, symbols or pictures (or a combination of them) to s**
1	**My answer shows I knew only a little about the problem and how I solved it:** • **I used only part of a good strategy to solve the problem.** • **I needed to use better math vocabulary and my explanation needed to be more complet** • **I needed to apply more about what I know about math to solve the problem.** • **I tried to use some numbers, words, symbols or pictures (or a combination of them) to s may not have been correct in what I used.**
0	**My answer shows I didn't understand the problem and how I solved it:** • **I didn't use a good strategy to solve the problem.** • **My strategy wasn't related to what was asked.** • **I didn't apply what I know about math to solve the problem.** • **I left the answer blank.**