Teacher Guide

WESTERN**RESERVE**
PUBLIC MEDIA

http://www.WesternReservePublicMedia.org/phi

Contents

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Funding

This series was funded by the Ohio Legislature through the eTech Ohio Commission.

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Made possible with funding from eTech Ohio

Phi 1.61803: Art in Math and Science

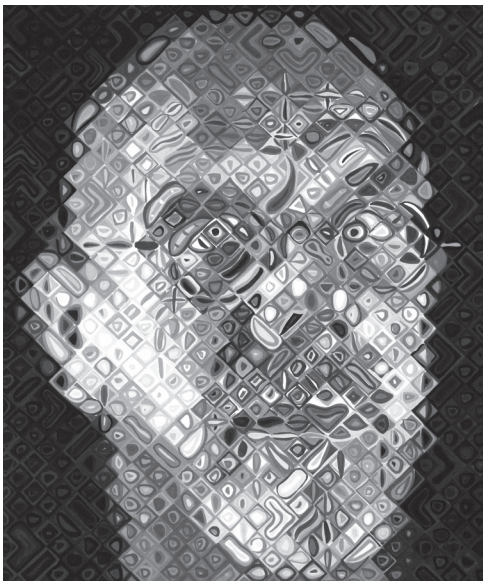
Three lessons included in this guide relate the mathematical concept of phi to the beauty of art. The lessons include formative and summative assessments, teacher resource pages, student handouts, a professional development video and more. A companion music video that resembles "Schoolhouse Rock" studies artwork that was exhibited at the Akron Art Museum to help students understand the concept.

Phi (Φ) is a Greek symbol that stands for 1.61803. This number is derived from the golden ratio and has been studied for many years – from Pythagoras and Euclid to the astronomer Kepler to the present-day physicist Roger Penrose. Phi appears in the proportions of human and animal bodies, in plants, in DNA, in the solar system, in art and architecture, in music, in population growth, in the stock market and in theology. It is believed that the golden ratio is considered the divine proportion and illustrates the concept of beauty. *Source:* ***http://www.goldennumber.net/neophite.htm***.

Let's look at one way the golden ratio can be derived. During the 12th century, Leonardo Fibonacci discovered a simple numerical series that is the foundation for phi. If you start with zero and one, each new number in the series is simply the sum of the two numbers before it. The series looks like this:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 ...

The ratio of each successive pair of numbers in the series approximates phi (1.61803...) because five divided by three is 1.666... and eight divided by five is 1.60. After the 40th division, the number is accurate to 15 decimal places. *Source:* ***http://www.goldennumber.net/fibonser.htm.***



Chuck Close, *Self-Portrait Woodcut*, 2007, 47-color hand-printed woodcut created in the Ukiyo-e tradition with 39 blocks on Shiramine paper 30 x 25 in. (image); 37 x 30 in. (sheet), Private Collection, Photo courtesy Pace Editions, Inc. © Chuck Close, courtesy Pace Editions, Inc.

Chuck Close

Ratio, Proportion and Percent

Chances are good that when your students think of beauty and objects that are most pleasing to the eye, they aren't thinking of ratio, proportion or percent. But this unit, which is inspired by the work of artist Chuck Close, might change that.

Comfort with these mathematical concepts gives any person a better way of seeing the world around him. With mathematical eyes and a solid knowledge of ratio, students will grow up to be better consumers. For that reason, understanding ratio, proportion and percentage is a valuable concept to teach.

The unit begins with several PowerPoint presentations that introduce the concepts of ratio, unit rate and proportion to your classes. These presentations are supported with various activities and handouts that ask students to solve puzzles using their new knowledge. Your classes move on to the Fibonacci sequence and the golden ratio. They apply these concepts to Chuck Close's artwork as it was displayed at the Akron Art Museum. The final project asks students to use the same process on a picture of themselves or someone they know.

Standards Addressed

Grade 5 , Mathematics — Number, Number Sense and Operations Standard

05-07 Benchmark

D. Use models and pictures to relate concepts of ratio, proportion and percent.

Y2003.CMA.S01.G05-07.BD.L05.I01 / Number and Number Systems

01. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole.

James Gobel, *I'll Be Your Friend, I'll Be Your Love, I'll Be Everything You Need*, 2009, felt, yarn, acrylic and rhinestones on canvas, 72 x 56 in., Courtesy of Kravets/Wehby, New York

Pattern ID

Interior Angles of Triangles and Quadrilaterals

Our diverse buildings, diamond jewelry, traffic patterns, modern art, classical furniture, Broadway stage designs and simple tools of daily living are all constructed of angles. Understanding angles increases both artistic appreciation and comprehension of function.

This unit begins with a PowerPoint lesson that leads students through the basics of angles and the use of protractors. They test their knowledge using puzzles and apply that specific learning to quadrilaterals.

The final project for this unit requires students to build their own octahedrons. Directions for the project are specific and give your students a chance to use their new knowledge of angles. Students make the finished octahedron into a fun predicting toy similar to the classic Magic Eight Ball toy.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark

D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Mark Mothersbaugh, co-founder of the band Devo.

Mark Mothersbaugh

Sound Energy

Controlling sound is important to health, mood, entertainment and especially communication. Mark Mothersbaugh, an original member of the rock band Devo and an Ohio native whose work has been featured at the Akron Art Museum, was the inspiration for this unit. Both he and the museum are interested in the art of sound. A beginning understanding of the basics about the transmission, reflection and absorption of sound waves would be useful to anyone. This unit is designed to support and focus your lessons.

The unit begins by asking students to explore sound in various ways to solidify understanding that it is caused by vibration. Students are then introduced to the families of sound found in a modern orchestra. They also get to know Mark Mothersbaugh through an interview in which he discusses sound and what it has meant to him. Your classes finalize their learning with a project that requires them to design and build their own instrument. They must be able to use it to explain and demonstrate both volume and pitch.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

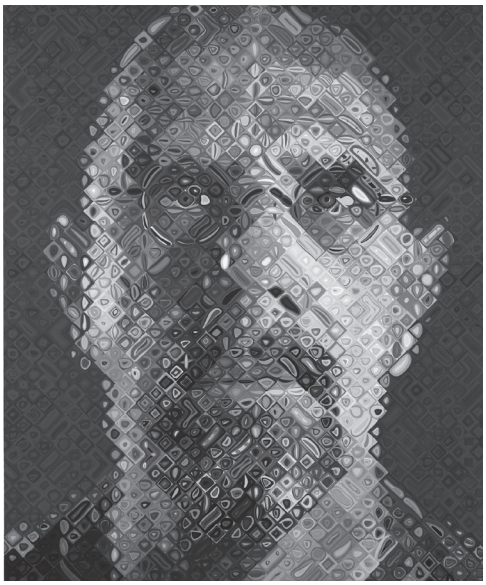
06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Y2003.CSC.S03.G03-05.BF.L05.I07 / Nature of Energy

07. Describe that changing the rate of vibration can vary the pitch of a sound.

Ratio, Proportion and Percent

http://www.WesternReservePBS.org/phi



Chuck Close, *Self-Portrait Screenprint*, 2007, screenprint in 203 colors, 74 1/2 x 57 3/4 in. (image and sheet), Private Collection, Photo courtesy Pace Editions, Inc. © Chuck Close, courtesy Pace Editions, Inc.

Ratio, Proportion and Percent Overview

In this unit, students complete hands-on activities and puzzles related to the difficult concepts of ratio, proportion and percent. The unit starts with a formative assessment and includes two instructional PowerPoint presentations and puzzles.

The second section deals with the different formats for ratios and the concept of unit rate. After viewing a PowerPoint presentation about proportion, students do a puzzle and then use proportion to double and triple a recipe.

They then use the Fibonacci sequence and the artwork of Chuck Close to find the value used in the golden ratio. They use measurement to determine if a face is mathematically perfect. As a project, they use a digital camera to either photograph themselves, a teacher or a friend to determine if the face measurements match the golden ratio.

These activities are followed by a summative assessment. Also included are resources pages, a vocabulary page and a resource page showing fraction bars.

The videos are brief but have two sections. The first part is a music video that reviews vocabulary and concepts. The last part is an introduction to the projects the students will be doing.

Standards Addressed

Grade 5 , Mathematics — Number, Number Sense and Operations Standard

05-07 Benchmark

D. Use models and pictures to relate concepts of ratio, proportion and percent.

Y2003.CMA.S01.G05-07.BD.L05.I01 / Number and Number Systems

01. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole.

Ratio, Proportion and Percent

Ratio is the comparison of two numbers by division. If a team won three games and lost two games, the ratio of wins to losses could be written in three ways (usually written in lowest terms):

$\frac{\text{3 wins}}{\text{2 losses}}$ $\frac{3}{2}$ 3:2 (read "three to two") 3 to 2

Proportion is a statement of equality for two ratios. For example:

$\frac{3}{6} = \frac{1}{2}$ This could also be written 3:6::1:2, which means three is to six as one is to two.

These very important concepts can help you to solve problems. For example, you spent $25 in two months on your favorite game. If you spend at the same rate, how much can you expect to spend in a year?

$$\frac{\text{Months}}{\text{Amount spent}} \quad \frac{\text{2 months}}{\$25} = \frac{\text{12 months (in a year)}}{x}$$

$2x = 12 \times 25$ or $\frac{2x}{2} = \frac{300}{2}$

$x = \$150$ for the year

A **percent** is the ratio of a number to 100. For example, 8 percent means eight out of 100.

To find a percent of a number, you divide the part by the whole. For example, on your school's bowling team, two-fifths of the team is girls. What percent of the team members are girls? To solve, divide two by five. You will need to move the decimal point two places to change it to a percent.

$2/5 = .4 = 40\%$

If you move the decimal point two places (past the hundredth place), you will see that 40 percent of the members are girls.

The team has 15 members. How many are girls? This could be solved in two ways.

a. Multiply 15 times 40 percent. Change 40 percent to the decimal .40 by moving the decimal point two places. Then multiply 15 by .4 to get the answer of six girls.

b. Use a proportion to solve the problem.

$$\frac{\text{Number of girls}}{\text{Total on the team}} \quad \frac{x \text{ girls}}{15} = \frac{\text{40 (percent of girls)}}{\text{100 (percent on the team)}}$$ $x = 6$ girls

Ratio, Proportion and Percent Vocabulary

Fibonacci sequence: Each number is the sum of the two previous numbers beginning with 0, 1, 1, 2, 3, 5, 8...

Golden ratio: Derived from the Fibonacci sequence and equals 1.618033989. Objects that have this ratio are said to be pleasing to the eye.

Percent: Another way of saying hundredth, or divided by 100. It is usually denoted by the symbol %.

Proportion: An equation that states that two ratios are equal.

Ratio: The ratio of one number to another number is the quotient when the first number is divided by the second number (not zero).

Solution of a sentence: Any value of a variable that turns an open mathematical sentence into a true statement.

Unit price: The price of one unit of a given item.

Variable: A symbol used to represent one or more numbers.

Name_____

Formative Assessment

What is the ratio in lowest terms?

1. Circles to lines _____

2. Circles to all shapes _____

3. Lines to boxes_____

Write the ratio.

Your team played 15 games and you won 10. What is the ratio in lowest terms of ...

4. wins to losses? _____

5. losses to total? _____

Write the unit rate in lowest terms.

6. It took you two hours to walk four miles (miles per hour). _____

7. You earned $55 in five hours (dollars per hour). _____

Find the missing number in these proportions. Please show your work.

8. $\frac{10}{4} = \frac{5}{n}$ n = _____

9. $\frac{5}{4} = \frac{n}{12}$ n = _____

Write these in words.

10. 6:7 _____

11. $\frac{4}{5}$ = _____

Bonus:

A recipe calls for ¾ cup of sugar for some cookies you are making. You want to triple the recipe. How much sugar would you add? (show work)

Answers to Formative Assessment

1. 5 to 3 or 5:3 or $\frac{\text{5 circles}}{\text{3 lines}}$

2. 5 to 12 or 5:12 or $\frac{\text{5 circles}}{\text{12 shapes}}$

3. 3 to 4 or 3:4 or $\frac{\text{3 lines}}{\text{4 boxes}}$

4. $\frac{10}{5} = \frac{2}{1}$ or 2:1 or 2 wins to 1

5. $\frac{5}{15} = \frac{1}{3}$ or 1 to 3 or 1 win to 3 games

6. $\frac{\text{4 miles}}{\text{2 hours}} = \frac{\text{2 miles}}{\text{1 hour}}$ or 2 miles per hour

7. $\frac{\text{55 dollars}}{\text{5 hours}} = \frac{\text{11 dollars}}{\text{1 hour}}$ or $11 per hour

8. $\frac{10}{4} = \frac{5}{n}$ so $\frac{10/2}{4/2} = \frac{5}{n}$ so n = 2

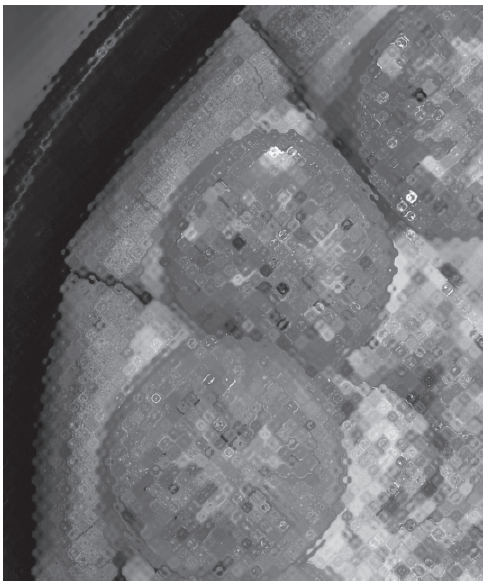
9. $\frac{5}{4} = \frac{n}{12}$ so $\frac{5 \times 3}{4 \times 3} = \frac{15}{12}$ so n = 15

10. Six to seven, 6 to 7 or 6 out of 7

11. Four to five, 4 to 5 or 4 out of 5

Bonus:

¾ x 3 or ¾ + ¾ + ¾ = 9/4 or 2¼ cups of sugar needed.



Understanding Ratios

Overview

Students will learn what a ratio is and how it can be written through the use of PowerPoint activities and student handouts.

Standards Addressed

Grade 5, Mathematics — Number, Number Sense and Operations Standard

05-07 Benchmark

D. Use models and pictures to relate concepts of ratio, proportion and percent.

Y2003.CMA.S01.G05-07.BD.L05.I01 / Number and Number Systems

01. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole.

Procedure

1. Begin with a class discussion. Ask students, "If you eat half of the pizza, how much pizza is left?" They'll answer "one half." Write ½ on the board. Describe the math involved with their answer: four pieces are eaten out of eight pieces in the whole pizza, so 4/8 equals ½. Show that four is the amount of pizza eaten and eight is the total amount. The comparison is part (pizza remaining) to whole (entire pizza).

2. Now ask the students to compare the number of boys in the class to the number of girls. An example might be eight boys and 10 girls in the class. This can be written 8/10 or 4/5. Ask if this represents the part of the class to the whole class, which, of course, it does not. It represents a part-to-part ratio. Ask what the number of boys compared to the whole class would look like (8/18 or 4/9).

3. Explain that both of these concepts – part-to-whole and part-to-part – can be called ratios. Explain that a ratio is usually written as the quotient of two numbers but can also be written as 4:9, which verbally is "four to nine."

4. Ask the class if the numbers' order is important: Is the ratio four to nine the same as nine to four? Show that if the ratios were written as fractions, 4/9 and 9/4, they would have different values *(4/9 = .44 and 9/4 = 2.25)*.

5. View the PowerPoint presentation Understanding Ratios with the class and distribute the related handout.

6. Once the students understand basic ratios, discuss that when one divides using part-to-whole, the result is the percent of the whole. For example, if half of a pizza is eaten, two is divided into one and the result is .5 or 50 percent.

7. Ask the class what ratio shows that a car went 50 miles per hour *(50 to 1)*. When the denominator is a one, this is called a unit rate. Then ask what typing 50 words per minute means *(50 words in one minute)*.

8. Review the PowerPoint presentation More About Ratios with the students.

9. Distribute the student handout More About Ratios. Allow students to work with a partner.

Answer Keys

Understanding Ratios

T	H	E	-	S	T	U	D	E	N	T	-	S	A	I	D	-	H	E	-	W	O	U	L	D	-	S	T	U	D	Y
5/7	2/5	7/3	1/5	7/5	5/7	5/3	3/4	7/3	2/1	5/7	1/5	7/5	1/3	2/3	3/4	1/5	2/5	7/3	1/5	5/6	3/5	5/3	4/3	3/4	1/5	7/5	5/7	5/3	3/4	20/1

W	H	E	N	-	H	E	-	G	O	T	-	R	O	U	N	D	-	T	U	I	T
5/6	2/5	7/3	2/1	1/5	2/5	7/3	1/5	13/6	3/5	5/7	1/5	7/12	3/5	5/3	2/1	3/4	1/5	5/7	5/3	2/3	5/7

More About Ratios

H	E	-	A	L	R	E	A	D	Y	-	K	N	E	W	-	H	O	W
2/3	5/3	2/5	3/2	60/1	10/1	5/3	3/2	1/10	45/1	2/5	10/3	7/3	5/3	50/1	2/5	2/3	7/10	50/1

M	A	N	Y	-	P	O	C	K	E	T	S	-	H	E	-	H	A	D
5/9	3/2	7/3	45/1	2/5	5/2	7/10	9/20	1/3	5/3	30/1	3/7	2/5	2/3	5/3	2/5	2/3	3/2	1/10

Evaluation

Student will receive a percent correct on each student handout.

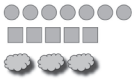
Understanding Ratios PowerPoint Presentation

Understanding Ratios

Number a paper from one to 15 and find these ratios.

Slide 1

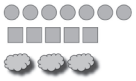
Write the ratios.



1. Circles to squares
2. Circles to clouds
3. Clouds to circles
4. Circles to all figures
5. Clouds to all figures
6. All figures to squares
7. Squares to all figures

Slide 2

Answers



1. Circles to squares **7 to 5** 7/5 part-to-part
2. Circles to clouds **7 to 3** 7/3 part-to-part
3. Clouds to circles **3 to 7** 3/7 part-to-part
4. Circles to all figures **7 to 15** 7/15 part-to-whole
5. Clouds to all figures **3 to 15** (1 to 5 or 1/5) part-to-whole
6. All figures to squares **15 to 5** (3 to 1 or 3/1) whole-to-part
7. Squares to all figures **5 to 15** (1 to 3 or 1/3) part-to-whole

Slide 3

Write the ratios.

The class has 30 students. Fourteen are girls.

8. Girls to boys
9. Boys to girls
10. Girls to all students
11. Boys to all students

Slide 4

Answers

The class has 30 students. Fourteen are girls.

8. Girls to boys 14:16 = 7 to 8 or 7/8
9. Boys to girls 16:14 = 8 to 7 or 8/7
10. Girls to all students 14:30 = 7 to 15 or 7/15
11. Boys to all students 16:30 = 8 to 15 or 8/15

Slide 5

Write the ratios.

12. Length to width

13. Width to length

Slide 6

Answers

12. Length to width 12 to 3 = 4 to 1 or 4/1

13. Width to length 3 to 12 = 1 to 4 or 1/4

Slide 7

Write the ratios.

Your dog is 24 inches long and 18 inches high.

14. Height to length

15. Length to height

Slide 8

Answers

Your dog is 24 inches long and 18 inches high.

14. Height to length 18:24 = 3 to 4 or 3/4

15. Length to height 24 to 18 = 4 to 3 or 4/3

Slide 9

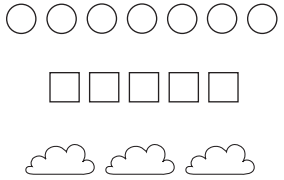
Name_____

Understanding Ratios

Why did the teacher give one of her students a button like this one? **TUIT**

Answer the questions below, then put the letter that is by the number into the box with the same number. Please show work.

Show the ratio as a fraction in lowest terms.



S Circles to squares _____

T Squares to circles _____

– Clouds to all shapes _____

U Squares to clouds _____

A Squares to all shapes _____

E Circles to clouds _____

Write each ratio below as a fraction in lowest terms.

R 7 to 12

H 10:25

N 50:25

Y 20 teachers to 1 student

G 26 to 12

O 6 to 10

I 6 out 9

D 75 out of 100

W 5 to 6

L 16 boys to 12 girls

5/7	2/5	7/3	1/5	7/5	5/7	5/3	3/4	7/3	2/1	5/7	1/5	7/5	1/3	2/3	3/4	1/5	2/5	7/3	1/5	5/6	3/5	5/3	4/3	3/4	1/5	7/5	5/7	5/3	3/4	20/1

5/6	2/5	7/3	2/1	1/5	2/5	7/3	1/5	13/6	3/5	5/7	1/5	7/12	3/5	5/3	2/1	3/4	1/5	5/7	5/3	2/3	5/7

More About Ratios PowerPoint Presentation

More About Ratios

Number a paper from one to eight and find these ratios.

Slide 1

Write the ratio in simplest form.

1. 5 to 13

Slide 2

Answer

1. $\frac{5}{13}$ (cannot be reduced)

Slide 3

Write the ratio in simplest form.

2. Six out of 15

Slide 4

Answer

2. Six out of 15 = $\frac{6}{15} = \frac{6/3}{15/3} = \frac{2}{5}$

Slide 5

Write the ratio in simplest form.

3. 20:12

Slide 6

Answer

3. $20:12 = \frac{20}{12} = \frac{20/4}{12/4} = \frac{5}{3}$

Slide 7

Write the ratio in simplest form.

4. The ratio of wins to losses for a team with 14 wins and eight losses.

Slide 8

Answer

4. The ratio of wins to losses for a team with 14 wins and eight losses.

$\frac{14}{8} = \frac{14/2}{8/2} = \frac{7 \text{ wins}}{4 \text{ losses}}$

Slide 9

Write the ratio in simplest form.

5. You are painting a room and want to mix red and blue to make purple. The ratio should be 15 oz. red to 20 oz. blue.

Slide 10

Answer

5. You are painting a room and want to mix red and blue to make purple. The ratio should be 15 oz. red to 20 oz. blue.

$\frac{15}{20} = \frac{15/5}{20/5} = \frac{3 \text{ oz. red}}{4 \text{ oz. blue}}$

Slide 11

Write the Unit Rate*

**The denominator must be 1.*

6. A car traveled 300 miles on 10 gallons of gas. What is the unit rate (miles per gallon)?

Slide 12

Answer

6. A car traveled 300 miles on 10 gallons of gas. What is the unit rate (miles per gallon)?

$\frac{300}{10} = \frac{300/10}{10/10} = \frac{30 \text{ miles}}{1 \text{ gallon of gas}}$

(30 miles per gallon)

Slide 13

Write the unit rate.*

**The denominator must be 1.*

7. JoJo earned $50 in five hours cutting grass. What is the unit rate?

Slide 14

Answer

7. JoJo earned $50 in five hours cutting grass. What is the unit rate?

$\frac{50}{5} = \frac{50/5}{1} = \frac{10 \text{ dollars}}{1 \text{ hour}}$

($10 per hour)

Slide 15

Write the Unit Rate

**The denominator must be 1.*

8. On vacation, Mike hiked 30 miles in six hours. What is the unit rate?

Slide 16

Answer

8. On vacation, Mike hiked 30 miles in six hours. What is the unit rate?

$\frac{30}{6} = \frac{30/6}{6/6} = \frac{5 \text{ miles}}{1 \text{ hour}}$

(five miles per hour)

Slide 17

Name_____

More About Ratios

Why didn't George want a pocket calculator?

Answer the questions then put the letter that is by the number into the box with the same number. Please show work

Write each ratio as a fraction in lowest terms.

A class has 25 students and 15 of them are girls.				M 5 to 9	K 3:9
H	boys to girls	A	girls to boys	P 15:6	D 28 to 280
–	boys to class	E	class to girls	C 45 out of 100	

A team played 40 games and won 28.	Write the unit rate in lowest terms.
N wins to losses	L a car traveled 180 miles in three hours
O wins to total games	Y Zoe types 90 words in two minutes
S losses to wins	T Zack drove 120 miles using four gallons of gasoline
K total games to losses	R Zima eared $80 in eight hours
	W Zeke ran 100 meters in two minutes

2/3	5/3	2/5	3/2	60/1	10/1	5/3	3/2	1/10	45/1	2/5	10/3	7/3	5/3	50/1	2/5	2/3	7/10	50/1

5/9	3/2	7/3	45/1	2/5	5/2	7/10	9/20	1/3	5/3	30/1	3/7	2/5	2/3	5/3	2/5	2/3	3/2	1/10

student handout

Understanding Proportion

Overview

Students will learn about proportion and how it can be written.

Standards Addressed

Grade 5, Mathematics — Number, Number Sense and Operations Standard

05-07 Benchmark

D. Use models and pictures to relate concepts of ratio, proportion and percent.

Y2003.CMA.S01.G05-07.BD.L05.I01 / Number and Number Systems

01. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole.

Procedure

1. Review the concept of ratio by asking these questions:

    a. What is the ratio of boys to girls in this class? Girls to boys? Girls to whole class?

    b. What is the ratio of students with blue eyes to those who do not have blue eyes? Blue eyes to total? Other eye colors to total?

2. Introduce proportion as an equation that shows that two ratios are equal. Start with some examples:

    a. 1 in = 1.54 cm. How many cm would there be in 12 in?
    The proportion would look like this: $\frac{1}{2.54} = \frac{12}{x}$ (unknown)

    b. it could also be written 1:2.54 = 12:x or 1:2.54::12:x
    (This is read "one is to 2.54 as 12 is to x.")

3. Ask the class how they would solve this problem. The correct answer is to multiply 12 by 2.54. Have them do this and then check on a ruler to see if they are correct.

4. Show a proportion that the students can easily see, such as ⅔ =⅘.
Show how the means and extremes are equal.

    a. $\frac{2}{3} = \frac{4}{6}$ 2 x 6 = 3 x 6 or 12 = 12

5. Review the PowerPoint presentation on Understanding Proportion.

6. Have the students complete the Understanding Proportion handout.

Handout Answer Key

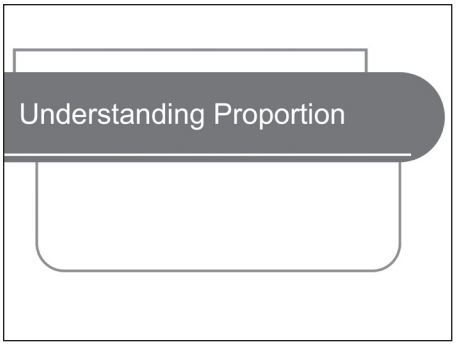
G	I	V	E	-	H	I	M	-	A	-	H	A	N	D
8	12	14	15	2	5	12	20	2	10	2	5	10	1	6

One batch of cookies	Proportions for two batches	Proportions for three batches
¾ cups white sugar	1½ cups white sugar	2¼ cups white sugar
½ cup milk	1 cup milk	2 cups milk
½ cup butter	1 cup butter	1½ cups butter
4 tablespoons unsweetened cocoa powder	8 tablespoons unsweetened cocoa powder	12 tablespoons unsweetened cocoa powder
½ cup crunchy peanut butter	1 cup crunchy peanut butter	1½ cups crunchy peanut butter
3 cups quick-cooking oats	6 cups quick-cooking oats	9 cups quick-cooking oats
1 teaspoon vanilla extract	2 teaspoons vanilla extract	3 teaspoons vanilla extract

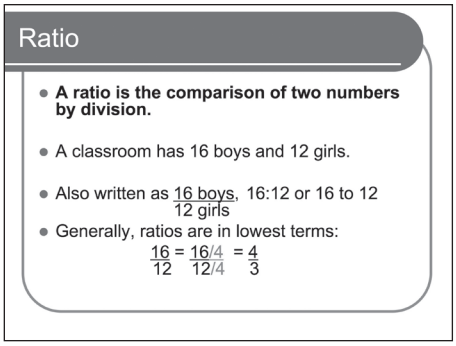
Evaluation

Category	4	3	2	1
Explanation	A complete response with a detailed explanation.	Good solid response with clear explanation.	Explanation is unclear.	Explanation misses key points.
Mechanics	No math errors.	No major math errors or serious flaws in reasoning.	May be some serious math errors or flaws in reasoning.	Major math errors or serious flaws in reasoning.
Demonstrated Knowledge	Response shows complete understanding of the questions, mathematical ideas and processes.	Response shows substantial understanding of the problem, ideas and processes.	Response shows some understanding of the problem.	Response shows a complete lack of understanding for the problem.

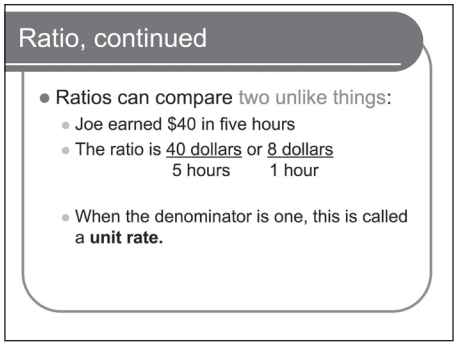
Understanding Proportion PowerPoint Presentation



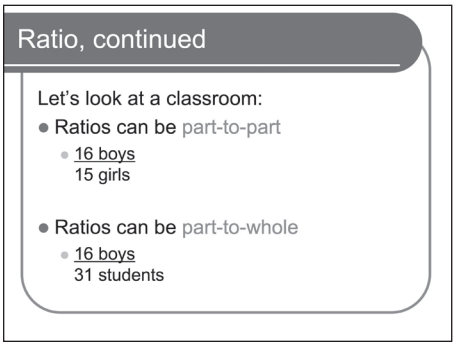
Slide 1



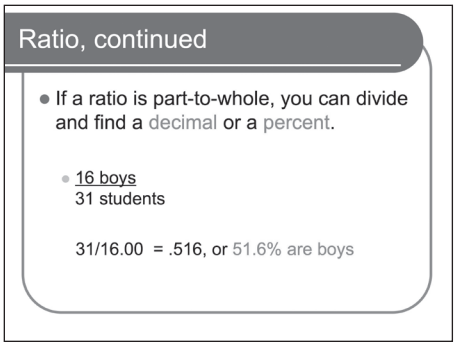
Slide 2



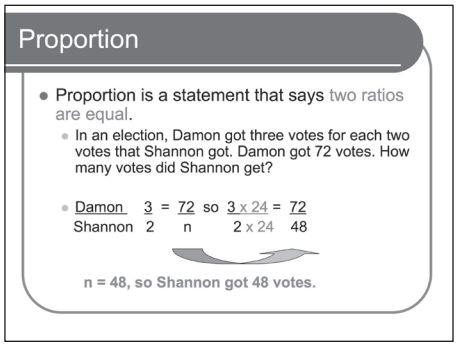
Slide 3



Slide 4



Slide 5



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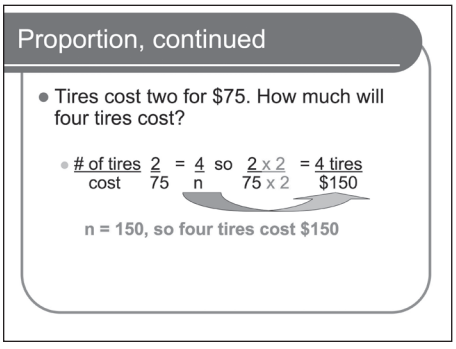

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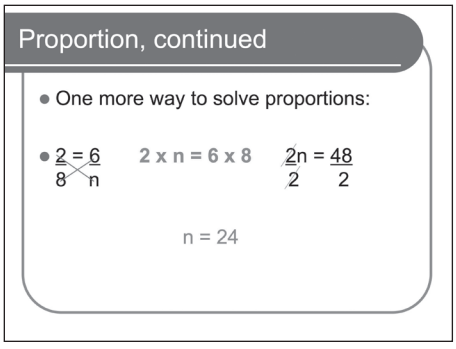
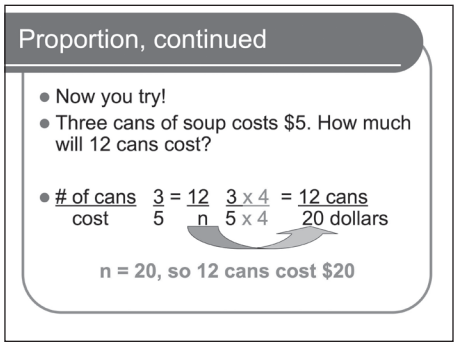


Slide 8



Slide 9

Name_____

Understanding Proportion

What should you do for a starving cannibal?

(Warning! This is a "groaner.") Please show work!

A $\frac{1}{2} = \frac{5}{n}$

- $\frac{10}{4} = \frac{5}{n}$

I $\frac{3}{4} = \frac{9}{n}$

G $\frac{16}{n} = \frac{8}{4}$

H $\frac{n}{2} = \frac{50}{20}$

N $\frac{n}{5} = \frac{4}{20}$

V $\frac{7}{10} = \frac{n}{20}$

D $\frac{12}{8} = \frac{n}{4}$

E $\frac{5}{n} = \frac{30}{90}$

M $\frac{5}{3} = \frac{n}{12}$

8	12	14	15	2	5	12	20	2	10	2	5	10	1	6

Names _____

Using Ratios and Proportion

A **ratio** is the relationship between two quantities. It is expressed as a **quotient** of one divided by the other. **Unit rates** are a relationship of quantities where the denominator is always 1. A **proportion** is an equation that states that two ratios are equal.

Example: In your school the ratio between students and teachers is 20 to 1. This means that there are 20 students for each teacher or 20 times as many students as there are teachers. So if there are 60 students, there would be 3 teachers. That **proportion** would look like this 20/1 = 60/3 or 20:1 = 60:3 or 20:1::60:3.

We can put ratios to work.

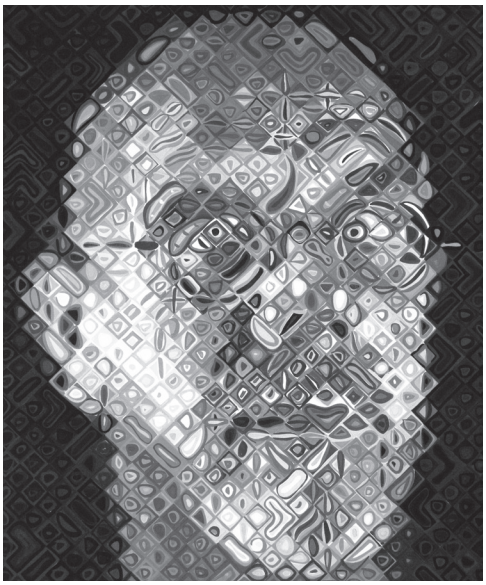
One Batch of Cookies	**Proportions for Two Batches**	**Proportions for Three Batches**
3/4 cups white sugar	$\frac{3/4}{1} = \frac{\quad}{2}$	
1/2 cup milk	$\frac{1/2}{1} = \frac{\quad}{2}$	
1/2 cup butter		
4 tablespoons unsweetened cocoa powder	$\frac{4}{1} = \frac{\quad}{2}$	
1/2 cup crunchy peanut butter		
3 cups quick-cooking oats		
1 teaspoon vanilla extract		

Explain how you solved these problems.

Fraction Bars

1											
1/2						1/2					
1/3				1/3				1/3			
1/4			1/4			1/4			1/4		
1/5		1/5			1/5			1/5			1/5
1/6		1/6			1/6			1/6			1/6
1/8		1/8		1/8		1/8		1/8		1/8	
1/10		1/10		1/10		1/10		1/10		1/10	
1/12		1/12		1/12		1/12		1/12		1/12	

Golden Ratio



Chuck Close, *Self-Portrait Woodcut*, 2007, 47-color hand printed woodcut created in the Ukiyo-e tradition with 39 blocks on Shiramine paper 30 x 25 in. (image); 37 x 30 in. (sheet), Private Collection, Photo courtesy Pace Editions, Inc. © Chuck Close, courtesy Pace Editions, Inc.

Overview

Students will first look at portraits by Chuck Close that were exhibited at the Akron Art Museum. They will then find out what the Fibonacci sequence is and its relationship to the golden ratio.

Standards Addressed

Grade 5, Mathematics — Number, Number Sense and Operations Standard

05-07 Benchmark

D. Use models and pictures to relate concepts of ratio, proportion and percent.

Y2003.CMA.S01.G05-07.BD.L05.I01 / Number and Number Systems

01. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole.

Materials

- Digital camera
- Rulers or tape measures
- Calculator

Procedure

1. Introduce the artwork of Chuck Close and the idea of portraiture. You can distribute the Chuck Close handout to the class or just review it with them.

2. Talk about the Fibonacci sequence and its relation to the golden ratio (also known as phi, Φ or ~1.6).

3. If you prefer, you can affix tape measures to the wall and have the students use these measuring stations.

4. Distribute the student handout Is He a Greek Classic? Explain that the picture on the top left of the handout shows how to measure the sections of the face. Students first need to measure each part of the face and record the measurement in centimeters to the tenth place. They then do the division and find out if the face would be considered "classically Greek." Go over the answers with the class. Discuss why there are small differences among the measurements.

5. The last project is to have students photograph someone else's face. This could be a classmate, family member, teacher or someone else who they know.

6. The students attach the picture to the Try It With Your Picture student handout and then determine if the face matches the golden ratio of 1.61803 using the same method that was used in the prior part of the lesson.

7. Differentiated version: Some students may have difficulties with the first version. If this is the case, you could use the student handout Vitruvius Man, in which students use a single measure to find the ratio.
8. You could collate the data and have the class make a graph that compare boys' ratio to girls' ratio.

Evaluation for Project

Process	**Below Average**	**Satisfactory**	**Excellent**
1. Has clear vision of final product	1, 2, 3	4, 5, 6	*7*, 8, 9
2. Properly organized to complete project	1, 2, 3	4, 5, 6	*7*, 8, 9
3. Managed time wisely	1, 2, 3	4, 5, 6	*7*, 8, 9
4. Acquired needed knowledge base	1, 2, 3	4, 5, 6	*7*, 8, 9
5. Communicated efforts with teacher	1, 2, 3	4, 5, 6	*7*, 8, 9

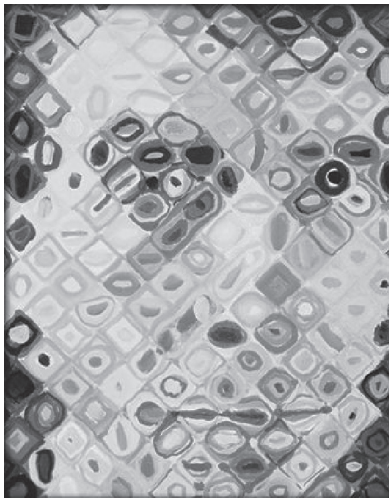
Product (Project)	**Below Average**	**Satisfactory**	**Excellent**
1. Format	1, 2, 3	4, 5, 6	*7*, 8, 9
2. Mechanics of speaking/writing	1, 2, 3	4, 5, 6	*7*, 8, 9
3. Organization and structure	1, 2, 3	4, 5, 6	*7*, 8, 9

Adapted from teach-nology

Chuck Close

The most beloved artwork in the Akron Art Museum's collection is "Linda," a 9-foot-tall, unflinchingly realistic painting of a woman's face. Its creator, Chuck Close (born 1940), happens to be one of the most important American artists of our time.

"Linda"

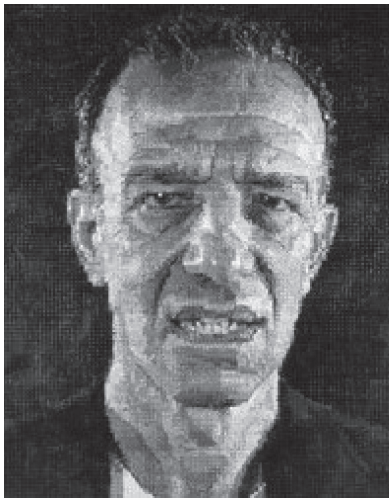


Close-up of a similar painting

If you look closely at the paintings by Chuck Close, you'd see a very different picture. Up close, you see small, individual pieces that only look like the face when you are far away from the picture. Some of those pieces might look like the close-up of the painting shown on the right above.

Does this look like a face? In his work, the farther away you get from the painting, the more it looks like a real face.

Here is another example of his work. Do you find this picture attractive to you? Is it mathematically perfect?



"Alex"

Images courtesy of Chuck Close and the Akron Art Museum.

The **golden ratio**, or **phi**, describes how objects that follow the ratio of 1.666 for length to width of rectangles are considered perfect. It is believed that this was first discovered in Greece around 500 B.C. in relation to sculpture. Leonardo da Vinci used the golden ratio in many of his artworks, including "The Last Supper" and "Mona Lisa." The golden ratio is represented by the symbol Φ.

Are you curious about what this magic ratio is? Let's look at the origin.

What are the next three numbers in this pattern?

0 1 1 2 3 5 8 13 ___ ___ ___

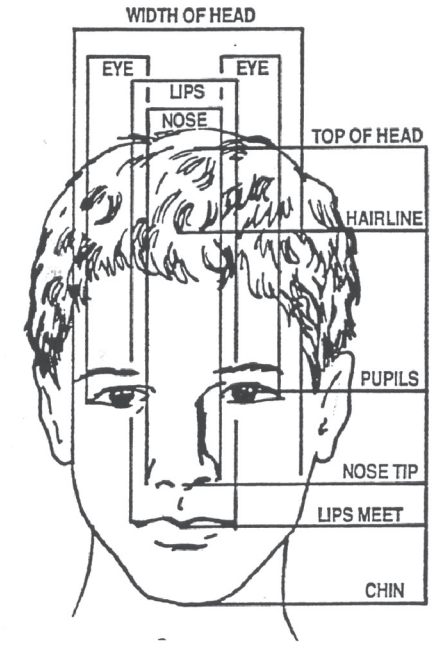
The answer is that each number is the sum of the two previous numbers. For example, two is the sum of 1 + 1. Three is the sum of 2 + 1. The numbers go on infinitely. This is called the **Fibonacci sequence**. It has a special significance. If you divide the former number by the latter number, you get approximately 1.6. For example 3/2 = 1.6..., 5/3 = 1.6, 8/5 = 1.5, 13/8 = 1.625, etc. The pattern is consistent throughout the series (after the first three numbers).

The golden ratio is 1.618033989. For our purposes, we will truncate this number to 1.6. Reliable evidence has shown that objects that meet the requirements of the golden ratio are attractive and pleasing to the human eye.

To see if this works, go to the Math Behind Beauty website – **http://www.intmath.com/numbers/mathofbeauty.php** – where there are pictures of current celebrities. There is an interactive section at the bottom of the page that allows you to determine if they have "perfect" faces because they match the golden ratio.

Names _____

Is He a Greek Classic?



Picture is from work Zephyr Press, Mark Wahl

LeBron James

On the left is a drawing that shows how you measure the face. The measurements are used to determine if the face matches the golden ratio.

If it does, you would say that the face is "classically Greek" because Greek statues embody this ratio.

Measure the picture of sports icon LeBron James below.

Measure using cm (to tenths)

a = top of head to chin = _____cm

b = top of head to pupil = _____cm

c = pupil to nose tip = _____cm

d = pupil to lips = _____cm

e = width of nose = _____cm

f = outside distance between eyes = _____cm

g = width of head = _____cm

h = hairline to pupil = _____cm

i = nose tip to chin = _____cm

j = lips to chin = _____cm

k = length of lips = _____cm

l = nose tip to lips = _____cm

Complete the calculations below. How often is the quotient 1.6 or close to 1.6?

1. $\frac{a}{g}$ = _____ = _____

2. $\frac{b}{d}$ = _____ = _____

3. $\frac{i}{i}$ = _____ = _____

4. $\frac{i}{c}$ = _____ = _____

5. $\frac{e}{l}$ = _____ = _____

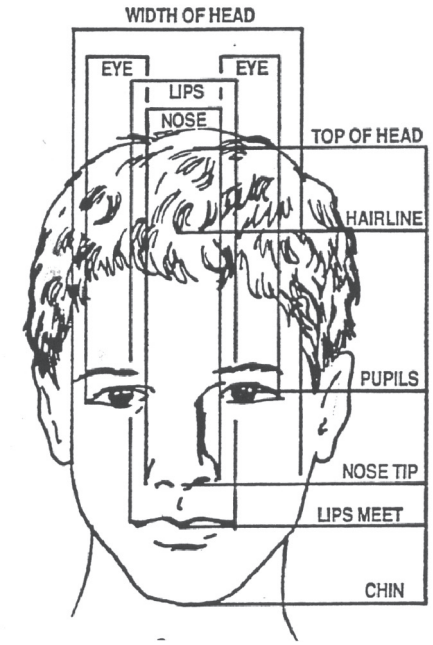
6. $\frac{f}{h}$ = _____ = _____

7. $\frac{k}{e}$ = _____ = _____

Please write at least two sentences telling if you think this face is mathematically perfect, and why or why not.

Names _____

Try It With Your Picture



Picture is from work Zephyr Press, Mark Wahl

Place the picture here.

On the left is a drawing that shows how you measure the face. The measurements are used to determine if the face matches the golden ratio.

If it does, you would say that the face is "classically Greek" because Greek statues show all of these golden ratios.

Using a digital camera, take a close-up picture of someone's face. It could be your classmate, a teacher, a family member or a friend.

Measure using cm (to tenths)

a = top of head to chin = _____cm

b = top of head to pupil = _____cm

c = pupil to nose tip = _____cm

d = pupil to lips = _____cm

e = width of nose = _____cm

f = outside distance between eyes = _____cm

g = width of head = _____cm

h = hairline to pupil = _____cm

i = nose tip to chin = _____cm

j = lips to chin = _____cm

k = length of lips = _____cm

l = nose tip to lips = _____cm

Complete the calculations below. How often is the quotient 1.6 or close to 1.6?

1. $\frac{a}{g}$ = _____ = _____

2. $\frac{b}{d}$ = _____ = _____

3. $\frac{i}{j}$ = _____ = _____

4. $\frac{i}{c}$ = _____ = _____

5. $\frac{e}{l}$ = _____ = _____

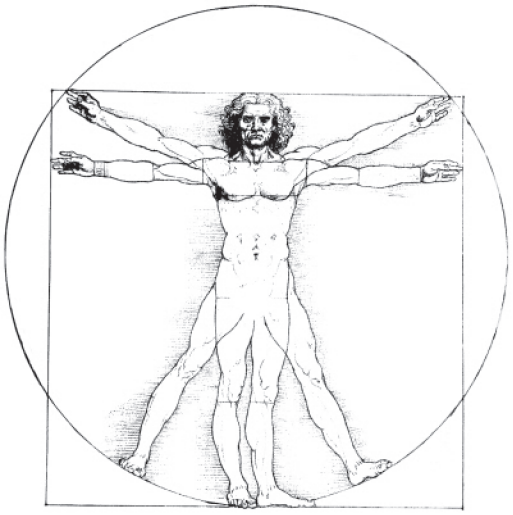
6. $\frac{f}{h}$ = _____ = _____

7. $\frac{k}{e}$ = _____ = _____

Please write at least two sentences telling if you think this face is mathematically perfect, and why or why not.

Name(s)_____

Vitruvian Man



The picture at the left shows Vitruvian Man. It is a drawing created by Leonardo da Vinci. It is based on the work of a Roman engineer called Vitruvius. Notice that the man has two sets of arms and two sets of legs. Also notice that one set of arms and one set of legs touch both the circumference of the circle and the square.

Vitruvius concluded that the length of the arm span is equal to the height of the man.

He believed that the ratio of arm span divided by height should equal one.

Let's see if this works for you.

1. Working with a partner, use a tape measure or meter stick to measure your height in centimeters from the top of your head to the bottom of your feet. Record the measurement in the box below.

2. Hold your arms out and measure your arm span in centimeters from the tip of your fingers on one hand to the tip of your fingers on the other hand.

Partner 1 _____			Partner 2 _____		
Height	Arm Span	$\frac{\text{Height}}{\text{Arm Span}}$	Height	Arm Span	$\frac{\text{Height}}{\text{Arm Span}}$

Is your arm span equal to your height?_____

If so, the ratio is one. If not, what is your ratio? _____

How close is it to one (divide the height by the arm span)?_____

Do you think this is more true for boys or for girls? _____

How could you find out?_____

Name_____

Summative Assessment

What is the ratio in lowest terms of the following?

1. Circles to squares _____

2. All shapes to squares _____

3. Boxes to lines _____

Write the ratio.

Your team played 20 games and you won 15. What is the ratio in lowest terms of the following?

4. Wins to losses _____

5. Losses to total _____

Write the unit rate in lowest terms.

6. While shopping, you spent $50 in two hours (dollars per hour). _____

7. Your car went 90 miles on three gallons of gas (miles per gallon). _____

Find the missing number in these proportions. Please show your work.

8. $\frac{20}{5} = \frac{4}{n}$ n = _____

9. $\frac{8}{2} = \frac{n}{12}$ n = _____

Write these in words.

10. 9:5_____

11. $\frac{7}{5}$ _____

BONUS:

A recipe calls for ⅔ cup of sugar for some cookies that you are making. You want to triple the recipe. How much sugar would you add? Please show your work.

Summative Assessment Answers

1. 5 to 4 or 5:4 or $\frac{5 \text{ circles}}{4 \text{ squares}}$

2. 12 to 4 or 15:4 or $\frac{12}{4} = \frac{3 \text{ shapes}}{1 \text{ square}}$

3. 4 to 3 or 4:3 or $\frac{4 \text{ boxes}}{3 \text{ lines}}$

4. $\frac{15}{5} = \frac{3}{1}$ or 3:1 or 3 wins to 1 loss

5. $\frac{5}{20} = \frac{1}{4}$ or 1 to 4 or 1 win to 4 games

6. $\frac{50 \text{ dollars}}{2 \text{ hours}} = \frac{25 \text{ dollars}}{1 \text{ hour}}$ or $25 per hour

7. $\frac{90 \text{ miles}}{3 \text{ hours}} = \frac{30 \text{ miles}}{1 \text{ hour}}$ or 30 miles per hour

8. $\frac{20}{4} = \frac{5}{n}$ so $\frac{20/4}{4/4} = \frac{5}{n}$ so n = 1

9. $\frac{8}{2} = \frac{n}{12}$ so $\frac{8 \times 6}{2 \times 6} = \frac{48}{12}$ so n = 48

10. Nine to five or 9 to 5

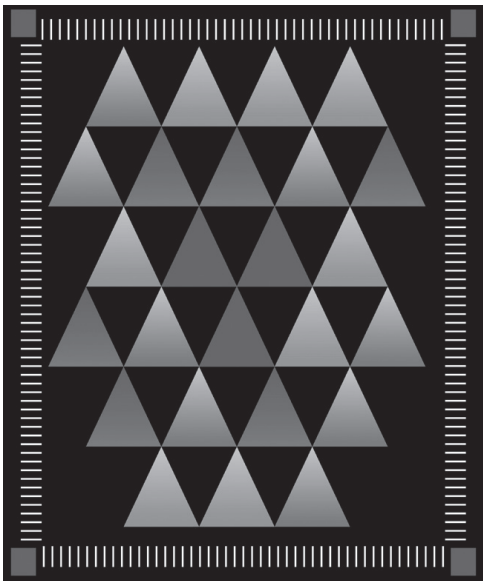
11. Seven to five or 7 to 5

Bonus

⅔ x 3 or ⅔ + ⅔ + ⅔ = ⅔ or 2 cups of sugar needed.

Interior Angles

http://www.WesternReservePBS.org/phi



Interior Angles Overview

Students begin the lesson with a formative assessment about angles. A PowerPoint presentation reviews the identification and naming of angles and triangles.

In the first project, students identify the names of angles and polygons. They then practice measuring angles and quadrilaterals.

For a final project, the students make an octahedron. They use a protractor to create equilateral triangles and put them together after labeling each face with terms to answer any and all questions. This polyhedron then becomes a predicting tool.

There is an extension lesson where students find the measure of the interior angles of a pentagon, hexagram and octagon, and then try to find a formula or rule that allows them to find the interior angle of any polygon without measuring.

The summative assessment measures the lesson's indicator. Resource pages are available on interior angles, protractors and vocabulary.

The videos are brief but have two sections. The first is a music video that reviews vocabulary and concepts. The second is an introduction to the projects the students will be doing.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark

D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

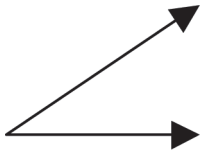
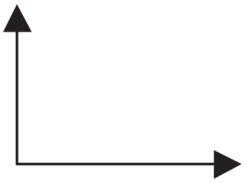
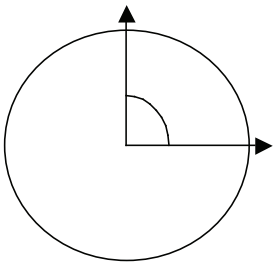
05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Angles

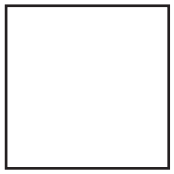
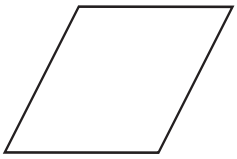
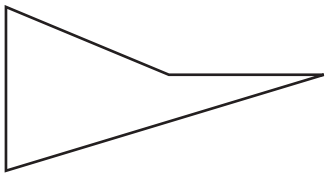
The ultimate goal of this unit is to understand that the interior angles of a triangle measure 180 degrees and the interior angles of a quadrilateral measure 360 degrees. To achieve this end, students must have some prerequisite skills.

Definitions:

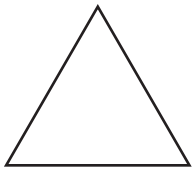
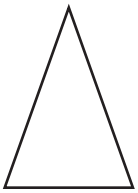
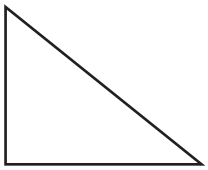
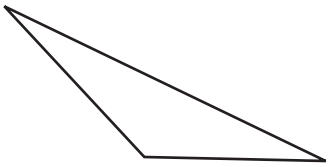
Angle: A shape formed by two rays sharing a common endpoint; contains two rays and a vertex.

	**Acute angle:** An angle whose measure is greater than 0 degrees and less than 90 degrees.
	**Right angle:** An angle that measures 90 degrees.
	**Obtuse angle:** One angle measures greater than 90 degrees and less than 180 degrees.
	**Straight angle:** A line that goes infinitely in both directions and measures 180 degrees.
	**Central angle:** An angle whose vertex is on the circle and whose sides are chords of the circle.

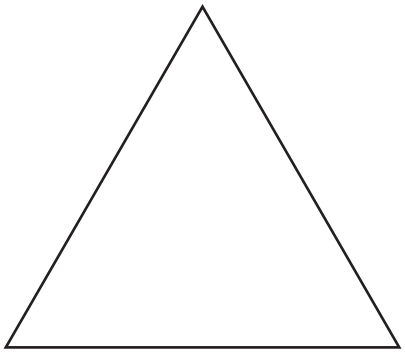
Quadrilateral: A polygon with four sides.

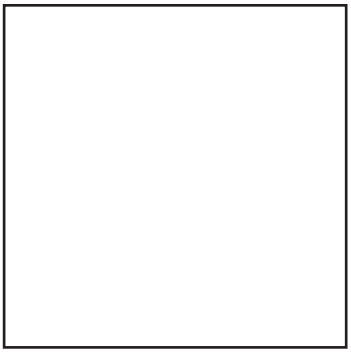
	**Square:** A quadrilateral with four equal sides and four right angles.
	**Rectangle:** A quadrilateral with two pairs of equal sides and four right angles.
	**Parallelogram:** A quadrilateral with opposite sides that are parallel and of equal length and opposite angles that are equal.
	**Rhombus:** A parallelogram with four equal sides and opposite angles that are equal.
	**Trapezoid:** A quadrilateral with one pair of parallel sides.
	**Irregular shapes:** A quadrilateral with no equal sides and no equal angles.

Triangle: A polygon with three sides and three angles.

	**Equilateral triangle:** A triangle with three congruent (or equal) sides.
	**Isosceles triangle:** A triangle with at least two congruent sides.
	**Right triangle:** Has only one right angle.
	**Scalene triangle:** A triangle that has no congruent sides.

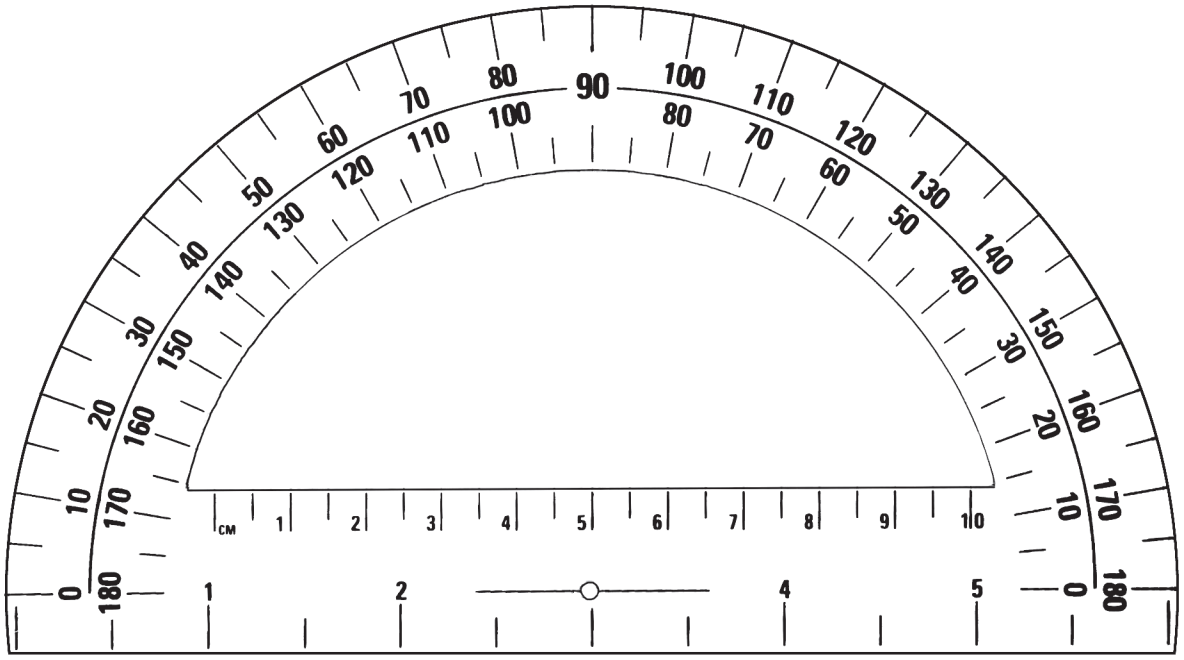
Interior (or internal) angle: The inner of the two angles formed where two sides of a polygon come together. A simple polygon has exactly one internal angle per vertex.





The sum of the interior angles of any triangle is 180 degrees.
The sum of the interior angles of any quadrilateral is 360 degrees.

Protractor: A tool that measures the number of degrees in an angle.



Polyhedron or platonic solid: A three-dimensional geometric figure whose sides are polygons.

1. Is a square a rectangle? Why or why not?

2. Is a square a rhombus? Why or why not?

3. Is a square a parallelogram? Why or why not?

4. Is a square a quadrilateral? Why or why not?

5. Is a square a trapezoid? Why or why not?

Angles Vocabulary

Angle: A shape formed by two rays sharing a common endpoint; contains two rays and a vertex.

Congruent: Equal.

Equiangular: In a given shape, all angles have the same measure.

Equilateral: In a given shape, all sides have the same length.

Intersecting lines: Two lines that cross at exactly one point.

Parallel lines: Lines in the same plane that do not cross; the distance between lines is constant.

Perpendicular lines: Lines that intersect at one point, forming 90 degrees.

Polygon: A closed plane shape having three or more sides.

Polyhedron (or Platonic solid): A three-dimensional geometric figure whose sides are polygons.

Proportion: An equation showing that two ratios are equal.

Protractor: Measures the number of degrees in an angle.

Quadrilateral: A polygon with four sides.

Ray: A line that has a starting point but no endpoint.

Regular shapes: Polygons with equal sides and equal angles.

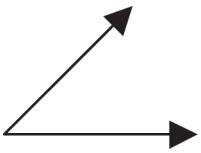
Triangle: A polygon with three sides and three angles.

Vertex: A point where surfaces meet.

Name_____

Formative Assessment

Name these angles.

1. 

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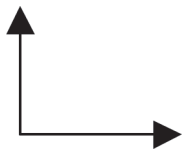
2. 

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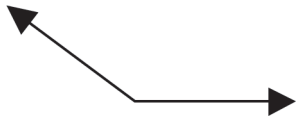
3. 

_____

4. 

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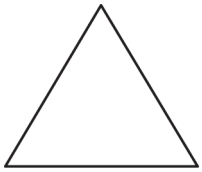
Name these triangles.

5. 

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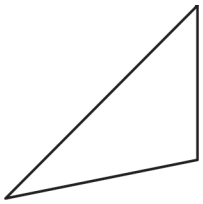
6. 

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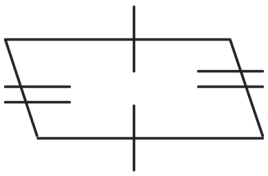
7. 

_____

Name these quadrilaterals.

8. 

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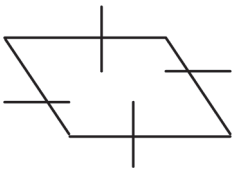
9. 

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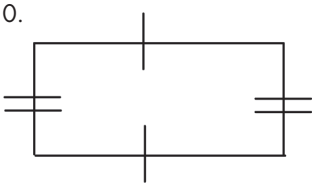
10. 

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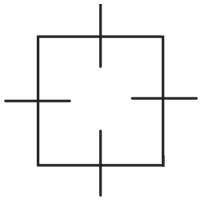
11. 

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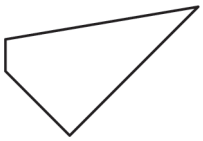
12. 

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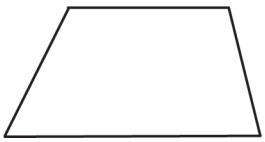
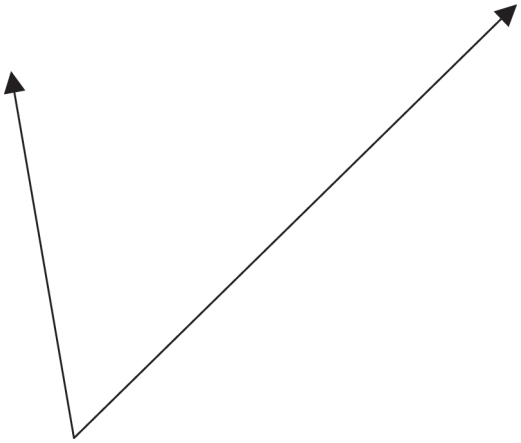
13. 

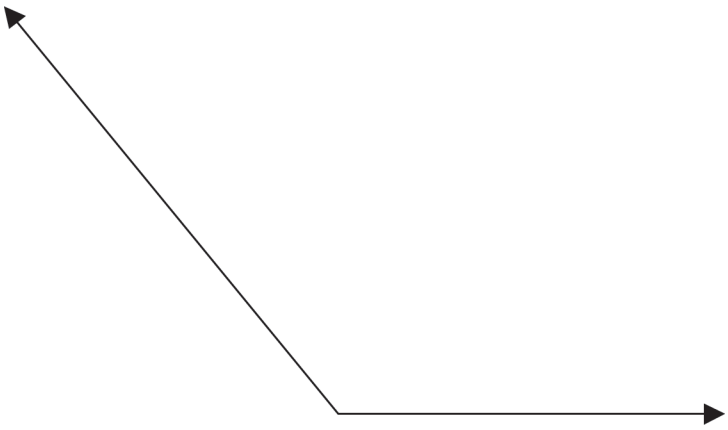
_____

Measure these angles.

14.



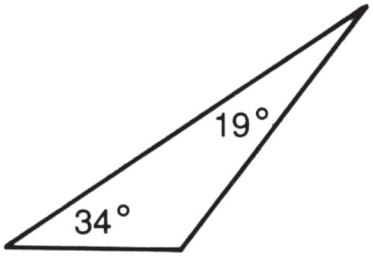
15.



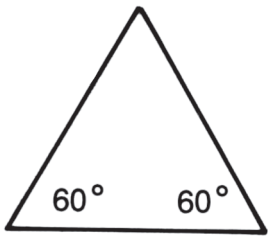
16. How many degrees is the total measure of interior angles of a triangle?

What is the measure of the missing angle?

17.



18.



19. How many sides are there in a quadrilateral? _____

20. How many degrees is the total measure of the interior angles of a quadrilateral? _____

BONUS:

True or false:

1. _____ A square is a rectangle.
2. _____ A square is a parallelogram.
3. _____ A rectangle is a parallelogram.
4. _____ A trapezoid has two sets of parallel sides.

BONUS:

Construct an equilateral triangle.

Angles Answers

1. Yes. All angles are 90 degrees and opposite sides are equal.
2. No. A square has angles that equal 90 degrees and a rhombus has opposite angles that do not equal 90 degrees.
3. Yes. Both a parallelogram and a square have opposite angles that are equal and opposite sides are parallel.
4. Yes. A square has four sides.
5. No. A trapezoid only has one set of parallel sides and a square has both opposite sides parallel.

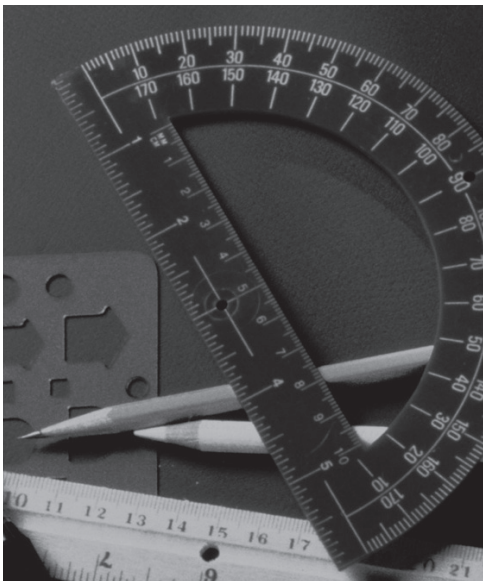
Formative Assessment Answers

Only questions 16, 17, 18, 19 and 20 deal directly with the standard. The other questions are given so that you have an idea of how much work needs to be done for students to understand the concept. The summative assessment deals only with the concepts in the five questions related to the standard.

1. Acute angle
2. Right angle
3. Straight angle
4. Obtuse angle
5. Equilateral triangle
6. Scalene triangle (could also be obtuse triangle)
7. Isosceles triangle
8. Parallelogram
9. Rhombus (also parallelogram)
10. Rectangle (also parallelogram)
11. Square
12. Irregular
13. Trapezoid
14. 55°
15. 130°
16. 180°
17. 127°
18. 60°
19. Four sides
20. 360°

BONUS

1. True
2. True
3. True
4. False



Angles, Triangles and Quadrilaterals

Overview

Students will learn to use a protractor to measure an angle, review the types of angles and triangles and learn that the interior measure of triangles is always 180 degrees.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark

D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Materials

- Protractors
- Heavy paper (if Interior Angles of Triangles handout is used)

Procedure

Part 1 — Triangles

1. Give the formative assessment.

2. Use the PowerPoint presentation Angles and Triangles. Ask the students to have a piece of paper out so that they can answer the questions in the presentation as they go along. This presentation is a review of types of angles and triangles and their characteristics.

3. The last slide reviews the use of a protractor. Point out to the students that the foot of the protractor always goes on the vertex. Review that there are two measuring scales on the arc of the protractor and they need to be very careful to use the correct one. Also review the idea that the zero line is what they would place on one side of the angle.

4. Distribute the student handout Using a Protractor. Have the students work with a partner to complete this handout.

Answers for Using a Protractor handout

1. 25°
2. 60°
3. 20°
4. 35°
5. 90°
6. 20°
7. 65°
8. 120°
9. 90°
10. Acute angle
11. Straight angle
12. Obtuse angle

Interior Angle of Triangles

1. Introduce the concept of the interior angles of a triangle. Review how to use the protractor to find the measure of the angle.

2. There are two possible routes that you can take at this point: either have students work with a partner on the Triangles student handout or have them do the more hands-on activity Interior Angles of Triangles.

3. For the interior angles activity, follow the directions for cutting apart the Interior Angles Cutout sheet. Heavy paper works best for this project. Put the pieces in an envelope for each group.

4. Allow the students to work with a partner or in a group of three and distribute the Interior Angles of Triangles student handout.

5. Have the students measure the interior angles, put each triangle together, record the scores and find the sum of the angles.

6. Students can then put the whole rectangle together.

Answers for Triangles handout: When going over the answers, remind students that the angles in an equilateral triangle are all 60 degrees. Also discuss that in an isosceles triangle such as #10, two of the angles will be equal.

1. 180°, right triangle
2. 180°, scalene triangle
3. 180°, scalene triangle
4. 180°
5. 56°
6. 58°
7. 127°
8. 60°
9. 25°
10. 45°

Answers for Interior Angles of Triangles

m/1 = 90°	m/4 = 20°	m/7 = 45°
m/2 = 45°	m/5 = 45°	m/8 = 65°
m/3 = 45°	m/6 = 115°	m/9 = 70°

Part 2 — Quadrilaterals

1. Follow the same procedure with quadrilaterals.

2. Ask students what they know about quadrilaterals. This should be review material. If this is not the case, discuss it again.

3. View the PowerPoint presentation Quadrilaterals.

4. Distribute the Quadrilaterals student handout.

5. Review the concept of interior angles.

6. Review using a protractor to measure an angle. Explain that the foot of the protractor is always on the vertex of the angle. Students need to know the difference between acute and obtuse angles to understand which of the two different measures on the arc of the protractor to use.

7. Ask the students if they think the sum of the measure of the interior angles of quadrilaterals is more or less than the sum of the interior angles of triangles.

8. If more work is needed or if the students need a more hands-on approach, use the handout Interior Angles of Quadrilaterals.

    a. Prior to doing the project, cut the angles apart along the heavy lines and then again along the thinner lines and put them in an envelope.

    b. Have students work with partners or in groups of three. Give each group an envelope containing the quadrilateral pieces.

    c. Instruct them to add the angles in each column and record the sums.

    d. They should then assemble the pieces in each column to form either a triangle or a quadrilateral and put them all together to make a rectangle.

Answers for Interior Angles of Quadrilaterals

m/1 = 90°	m/5 = 90°	m/9 = 90°	m/13= 90°
m/2 = 90°	m/6 = 90°	m/10 = 90°	m/14 = 120°
m/3 = 90°	m/7 = 150°	m/11 = 90°	m/15 = 60°
m/4 = 90°	m/8 = 30°	m/12 = 90°	m/16 = 90°

Answers to Quadrilaterals Handout

S	H	E		R	A	N		A	W	A	Y		F	R	O	M		T	H	E		B	A	L	L
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Evaluation

This rubric can be use for either of the interior angle student handouts.

CATEGORY	4	3	2	1
Mathematical Errors	90-100 percent of the steps and solutions have no mathematical errors.	Almost all (85-89 percent) of the steps and solutions have no mathematical errors.	Most (75-84 percent) of the steps and solutions have no mathematical errors.	More than 75 percent of the steps and solutions have mathematical errors.
Working With Others	Student was an engaged partner, listening to suggestions of others and working cooperatively throughout lesson.	Student was an engaged partner but had trouble listening to others and/or working cooperatively.	Student cooperated with others, but needed prompting to stay on task.	Student did not work effectively with others.
Completion	All problems are completed.	All but one of the problems are completed.	All but two of the problems are completed.	Several of the problems are not completed.
Strategy Procedures	Typically, uses an efficient and effective strategy to solve the problem(s).	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.

Assessment

Summative assessment should be given at this point.

Angles and Triangles PowerPoint Presentation

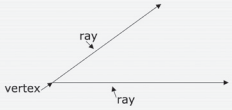
Angles and Triangles

Slide 1

Angles

- A shape formed by two rays sharing a common endpoint; contains two rays and a vertex

vertex—point common to two rays of a triangle or two sides of a polygon



ray—has one endpoint and goes infinitely in one direction

Slide 2

Types of Angles

- **Acute angle:** An angle whose measure is greater than zero degrees and less than 90 degrees

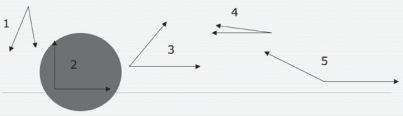
Which angles are **not** acute?

Slide 3

Types of Angles

- **Right angle:** Angle that measures 90 degrees

Which angle is a right angle?

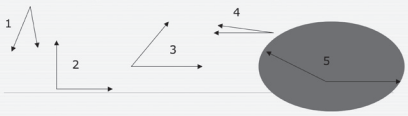


Slide 4

Types of Angles

- **Obtuse angle:** One angle measures greater than 90 degrees and less than 180 degrees

Which angle is an obtuse angle?



Slide 5

Straight Angle

- **Straight angle:** A line that goes infinitely in both directions and measures 180 degrees

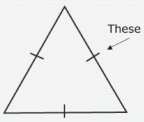
Which is **not** a straight angle?

This is a ray. It only goes in one direction.

Slide 6

Types of Triangles

- **Equilateral triangle:** A triangle with three congruent (equal) sides and three equal angles

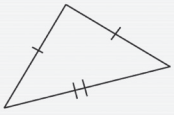


These marks indicate equality.

Slide 7

Types of Triangles

- **Isosceles triangle:** A triangle with at least two congruent (equal) sides



Slide 8

Types of Triangles

- **Right triangle:** Has only one right angle (90 degrees)

This box indicates a right angle or a 90-degree angle.

Slide 9

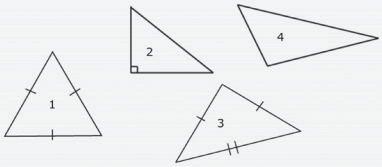
Types of Triangles

- **Scalene triangle:** A triangle that has no congruent (equal) sides

Slide 10

Types of Triangles

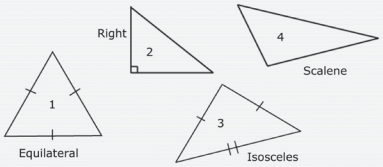
- Name each type of triangle



Slide 11

Types of Triangles

- Name each type of triangle



Slide 12

Interior Angles

- **Interior angles:** An **interior angle** (or **internal angle**) is an angle formed by two sides of a simple polygon that share an endpoint
- Interior angles of a triangle always equal 180 degrees.

Slide 13

Measuring Angles

- You measure angles with a **protractor.**

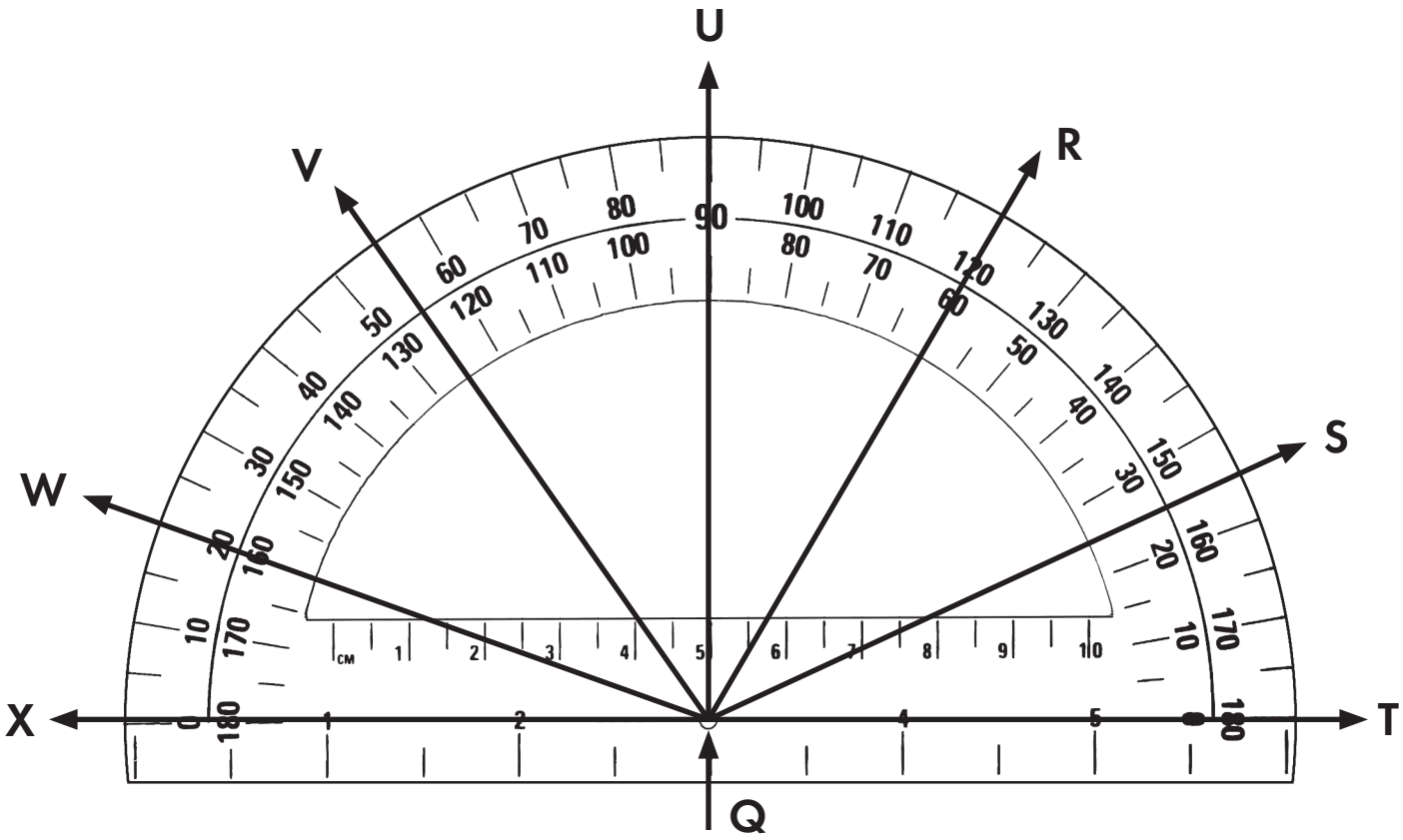
Notice there are two scales. Be careful which 0 you start at.

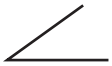
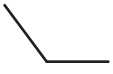
Slide 14

Names _____

Using a Protractor

Find the measure of the angle listed.
In the angle XQU, Q is the **vertex** of the angle.

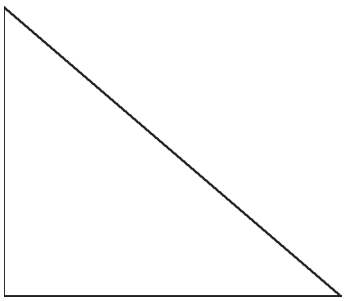


1. m/TQS = _____
2. m/TQR = _____
3. m/XQW = _____
4. m/SQR = _____
5. m/XQU = _____
6. m/WQX = _____
7. m/VQR = _____
8. m/XQR = _____
9. A right angle has a measure of _____ degrees.
10.  This is what type of angle? _____
11. This is what type of angle? _____
12.  This is what type of angle? _____

Names _____

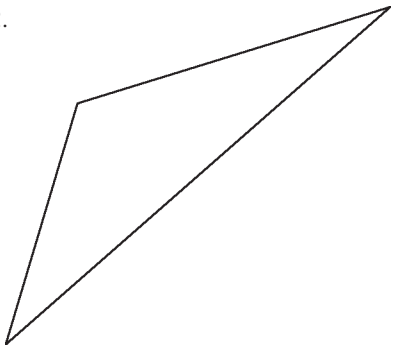
Triangles

Write the measure of the interior angles of each triangle and the type of triangle below.

1. 

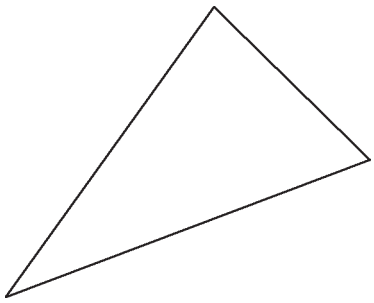
Total degrees _____

Type of triangle _____

2. 

Total degrees _____

Type of triangle _____

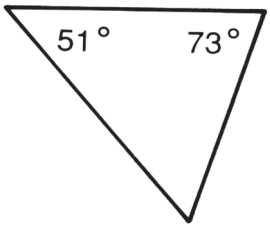
3. 

Total degrees _____

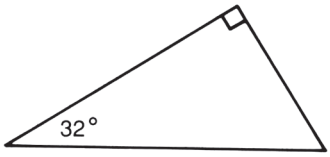
Type of triangle _____

4. Added together the interior angles of all triangles is _____ degrees.

Find the measure of the missing angle below.

5. 

_____

6. 

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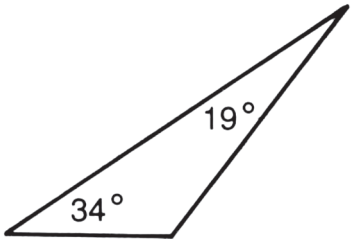
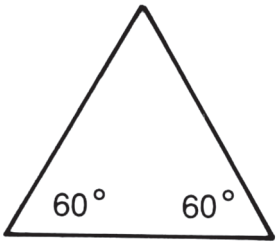
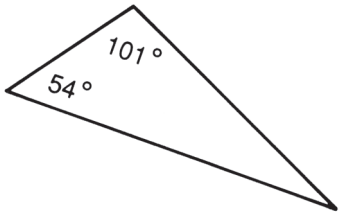
7. 

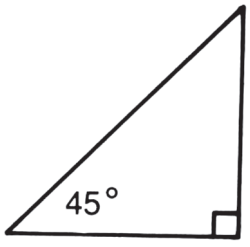
_____

8. 

_____

9. 

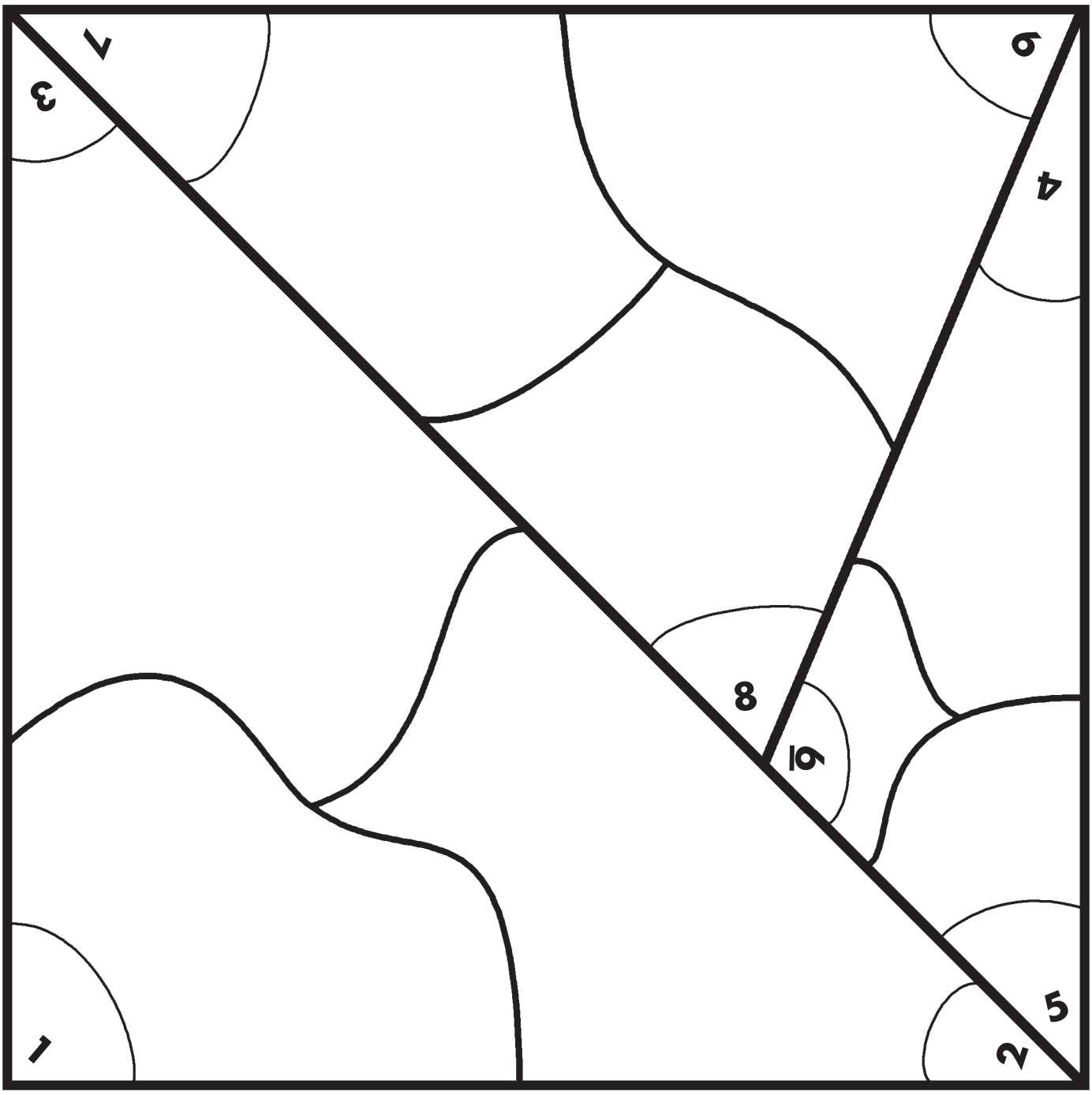
_____

10. 

_____

Interior Angles Cutout

Cut out the rectangle. Then cut along the solid and wiggly lines and put the pieces in an envelope for each group. (Heavy paper works best.)



Name(s) _____

Interior Angles of Triangles

1. You will find nine angles in your envelope. Measure each angle to the nearest degree and record your measurements in Table 1.
2. Add the angles in each column and record the sum.
3. Assemble the pieces in each column to form triangles.
4. Place the five triangles together to form a rectangle.

Table 1

A	B	C
m/ 1 =	m/ 4 =	m/ 7 =
m/ 2 =	m/ 5 =	m/ 8 =
m/ 3 =	m/ 6 =	m/ 9 =
Total =	Total =	Total =

Use your protractor to create an equilateral triangle below. Measure each angle and record it on the triangle that you made.

Quadrilaterals PowerPoint Presentation

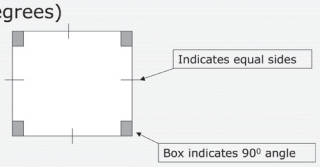
Quadrilaterals

Polygons with four sides

Slide 1

Types of Quadrilaterals

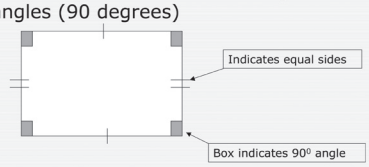
- **Square:** Quadrilateral with four equal sides and four right angles (90 degrees)



Slide 2

Types of Quadrilaterals

- **Rectangle:** Quadrilateral with two pairs of equal sides and four right angles (90 degrees)



Slide 3

Types of Quadrilaterals

- **Parallelogram:** Quadrilateral with opposite sides that are parallel and of equal length and opposite angles are equal

Slide 4

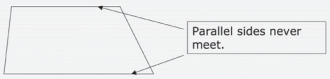
Types of Quadrilaterals

- **Rhombus:** Parallelogram with four equal sides and opposite angles equal

Slide 5

Types of Quadrilaterals

- **Trapezoid:** Quadrilateral with one pair of parallel sides



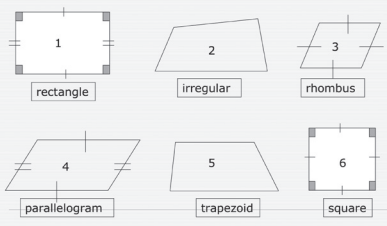
Slide 6

Types of Quadrilaterals

- **Irregular shapes:** Quadrilateral with no equal sides and no equal angles

Slide 7

Name the Quadrilaterals



Slide 8

Interior Angles

- **Interior angles:** An **interior angle** (or **internal angle**) is an angle formed by two sides of a simple polygon that share an endpoint
- Interior angles of a quadrilateral **always** equal 360 degrees

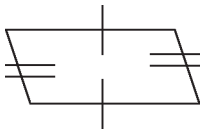
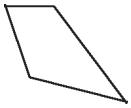
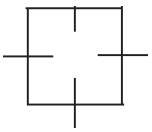
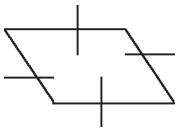
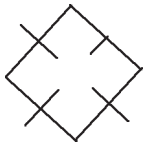
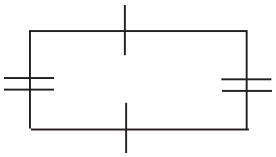
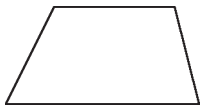
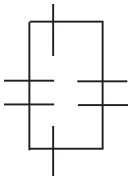
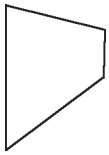
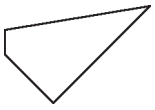
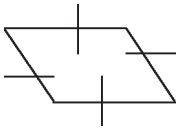
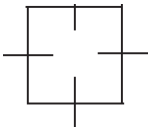
Slide 9

Name_____

Quadrilaterals

Why was Cinderella kicked off the baseball team?

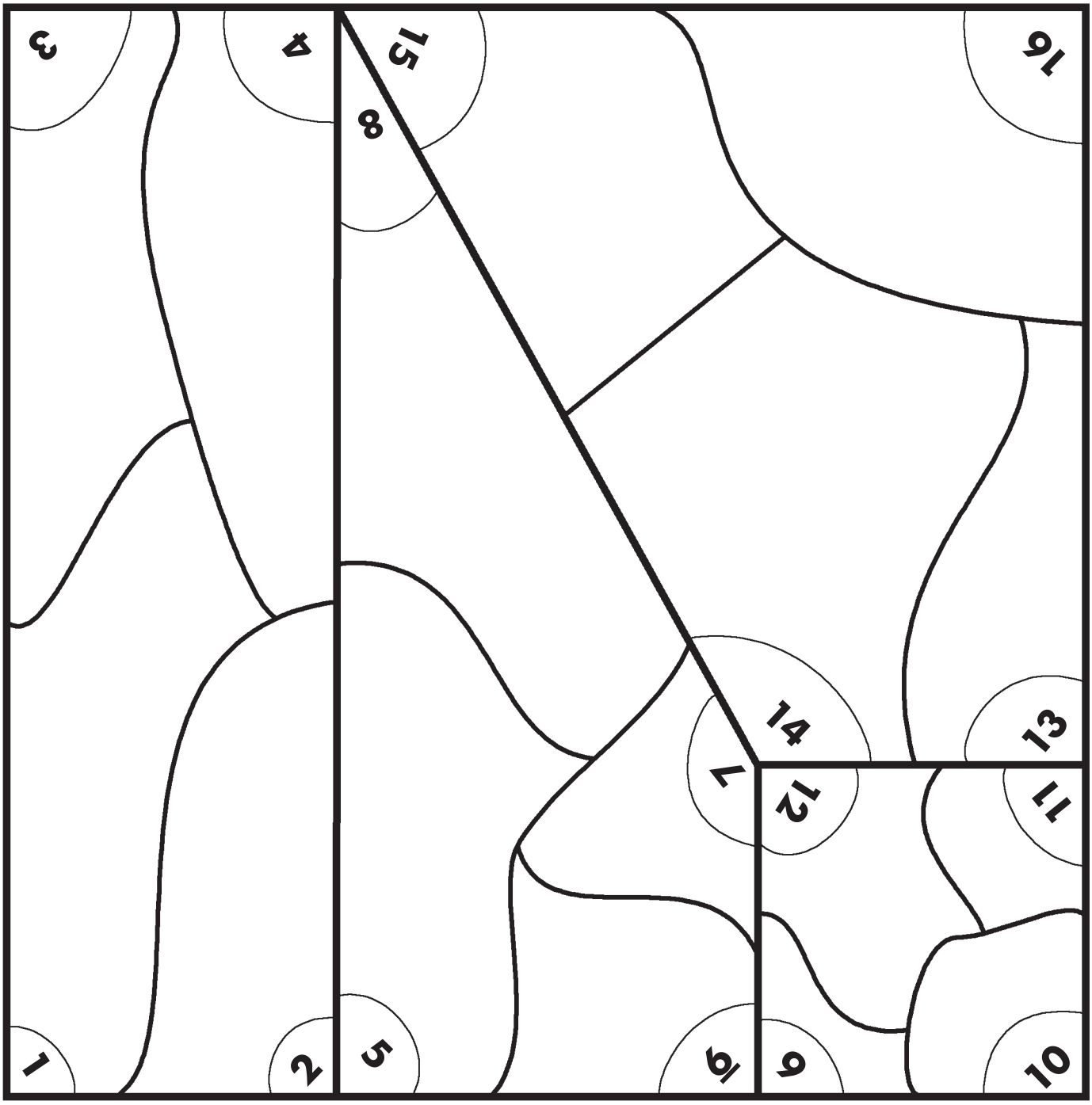
Circle the names that match the picture and then write the letter in the box with the matching number.

 Parallelogram – 15-R Rectangle – 4-T Rhombus –16-L	 Quadrilateral – 9-A Parallelogram –15-M Rhombus – 22-R	 Parallelogram – 19-T Rectangle – 10-W Square – 3-E
 Parallelogram – 26-L Rectangle – 20-L Rhombus – 24-A	 Rectangle – 25-L Rhombus – 23-B Square – 17-M	 Parallelogram – 14-F Rectangle – 2-H Square – 27-X
 Quadrilateral – 21-E Parallelogram – 13-V Trapezoid – 6-A	 Trapezoid – 26-K Square – 8-M Rectangle – 7-N	 Parallelogram – 18-R Rhombus – 13-C Trapezoid – 1-S
 Quadrilateral – 11-A Trapezoid – 17-U Irregular – 20-H	 Quadrilateral – 12-Y Rhombus – 16-O Square – 25-J	 Square – 5-R Trapezoid – 13-S Irregular – 24-T

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Interior Angles of Quadrilaterals Cutout

Cut out the rectangle. Then cut along the solid and wavy lines and put the pieces in an envelope for each group.



Name(s)_____

Interior Angles of Quadrilaterals

1. You will find 16 angles in your envelope. Measure each angle to the nearest degree and record your measurements in Table 1.
2. Add the angles in each column and record the sum.
3. Assemble the pieces in each column to form quadrilaterals.
4. Place the four quadrilaterals together to form a rectangle.

Table 1

A	B	C	D
m/ 1 =	m/ 5 =	m/ 9 =	m/ 13 =
m/ 2 =	m/ 6 =	m/ 10 =	m/ 14 =
m/ 3 =	m/ 7 =	m/ 11 =	m/ 15 =
m/ 4 =	m/ 8 =	m/ 12 =	m/ 16 =
Total =	Total =	Total =	Total =

Use your protractor to create an equilateral triangle below. Measure each angle and record it on the triangle you made.

Interior Angles

James Gobel, *I'll Be Your Friend, I'll Be Your Love, I'll Be Everything You Need*, 2009, felt, yarn, acrylic and rhinestones on canvas, 72 x 56 in., Courtesy of Kravets/Wehby, New York

Overview

Students will study the work of three artists who had exhibits at the Akron Art Museum: Mickalene Thomas, James Gobel and Julian Stanczak. All three have used triangles and quadrilaterals as part of their artwork. The students will create their own artwork that must include an equilateral triangle and an equilateral quadrilateral in the picture.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark *D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.*

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Materials

- Chalk
- Colored pencils
- Crayons
- Art paper
- Other materials as needed (colored paper, paint, etc.)

Procedure

1. Based on the knowledge gained in the previous lessons, the students should know that the interior angle of a triangle is 180° and the interior angle of any quadrilateral is 360°. If they don't know this, remind them that this is the case.

2. Tell the students that they are going to create a piece of art that must contain at least one equilateral triangle and one equilateral quadrilateral (which is either a square or a rhombus). Tell them that often artists use these shapes as they are creating their own art.

3. Show the class examples of the art of Mickalene Thomas (**http://mickalenethomas.com/gallery.html**), James Gobel (**http://www.marxzav.com/artist.php?artistID=26**) and Julian Stanczak (**http://www.marxzav.com/artist.php?artistID=26**).

4. As you show the pictures, ask the students how the shapes were used.

5. Distribute the student handout Interior Angles and Art. Show that each picture on the handout has used the shape in a different manner.

6. On page two of the handout, go over the specific instructions with the class. Give students a time limit for completing the project.

Evaluation

This unique rubric is an adaptation of one written by Woody Duncan. The URL is **http://www.princetonol.com/groups/iad/lessons/middle/rubric2.htm**. You can select which sentences apply to the students' work. There are several other art rubrics at this site.

(90 to 100 points)

- Wow! It is amazing! You showed initiative and originality.
- You met all criteria.
- You did something extra special.
- You went beyond all expectations.
- You broke the rules in a creative way.
- Your craftsmanship is exceptional!
- Excellent solution to the problem!
- You outdid the teacher on this one!

(80 to 89 points)

- It is good! It is all I ask for. You were a self-starter.
- You met almost all of the criteria.
- You did everything I requested – you followed all directions the first time.
- You met all expectations, but did not push the boundaries.
- You did a very good job. Good use of design principles.
- You showed a mastery of skills and craftsmanship.

(70 to 79 points)

- Well, OK ... it is not up to snuff.
- You met some of the criteria.
- You did just enough to get by.
- You did minimum requirements necessary for a C – nothing more.
- You might have thrown it together. You didn't care much for this project?
- Poor craftsmanship – lacks skill. Design principles are off.
- You did not try very hard.

(60 to 69 points)

- Oops! It is not finished.
- You did not meet the lesson objectives.
- You did not follow directions; you did not try very hard.
- You forgot to finish it, or you hurried through.
- Your work lacks understanding of design principles.
- Low effort – below expectations for skills. Poor craftsmanship.
- You didn't finish – Shall I leave your grade unfinished too?

(0 to 59 points)

- Zero! It is missing.
- Did you forget to put your name on it?
- Were you absent?
- Did you lose it or throw it away?
- I saw you working on it – but cannot find it now?
- No effort – no participation. Poor work.
- No project – no grade.

Name_____

Interior Angles and Art

The Akron Art Museum recently had an art show titled Pattern ID. In this show, some of the artists actually used triangles and quadrilaterals as part of their work. Below are three painting. Look at them closely:

In this picture, artist Mickalene Thomas used quadrilaterals and triangles as part of the floor. This is an examples of how shapes can be used in the background of a picture.

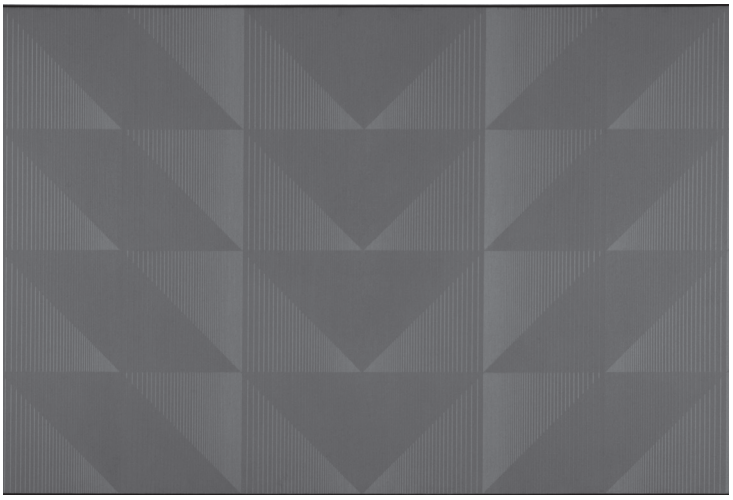
She titled her picture "Girlfriends and Lovers."

Photo courtesy of Mickalene Thomas and Rhona Hoffman Gallery.

In this picture, artist James Gobel used quadrilaterals as part of the clothing. This is another way that shapes can be used when creating art.

The title of the picture is "The Fitting #1."

Photo courtesy of Kravets/Wehby, New York.



In this picture artist, Julian Stanczak simply used the shape as the focus of the picture. He did exciting and unusual things to make the shape be appealing to us.

This picture is titled "Dual Glare."

Collection of the Akron Art Museum, Museum Acquisition Fund.

Your Task:

Your job is to create a piece of art that contains at least one equilateral triangle and at least one equilateral quadrilateral (in other words, a square or a rhombus). The artists' works in this handout show how they used shapes in their artwork. Now see what you can come up with. Be sure to measure the angles to make your shape. You may use any medium available to you.

Remember:

- A triangle has an interior angles measure of 180 degrees so if it is equilateral, each angle has a measure of _____ .
- A square has an interior angles measure of 360 degrees so if it is a square, each measure will have a measure of _____ .
- A rhombus also has an interior angles measure of 360 degrees. In this case, the opposite angles have to have equal measures. The sides must, however, all be equal.

You have one week to complete this project. You will have _____ class period(s) to work on it. If you have not completed it in that time, you will need to complete it at home.

Project — Making a Prediction

Overview

Students have spent a lot of time learning that the interior angles of a triangle equal 180 degrees and the interior angles of a quadrilateral equal 360 degrees. They will now use this information to create a cube using a pattern and to make an eight-sided polyhedron using a triangle.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark

D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Materials

- Protractors
- Scissors
- Tape
- Crayons, markers or colored pencils
- Paper (heavy-duty paper is preferable)

Procedure

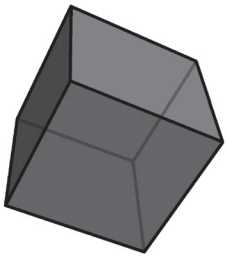
1. Do a general review of the measure of interior angles of a triangle and rectangle.
2. Allow the students to work with a partner or in groups of three.
3. Their first task is to make a cube. They can use a pattern (or they can measure it themselves) and, using the supplies given, create a cube. They will hand the cube in when they are finished.
4. Now students make an octahedron. This works best with paper that is heavier than regular paper. They must create an equilateral triangle using a protractor and then copy it seven more times so that they have eight triangles.
5. They will then write their predictive words on the shapes and connect them together to look like the picture on the student handout. They can use their octahedron to answer fun questions.
6. If you add string to the top, the octahedrons can be hung around the room.

Evaluation

The students need to accurately measure the interior angles of a triangle using a protractor and then connect the pieces to make an octahedron. If this is completed, it demonstrates their ability to use a protractor and create an equilateral triangle using the interior angle measures.

Making a Prediction

Did your eyes glaze over when the teacher told you that you would be making a polyhedron? Did you even know what a polyhedron was? Well, a **polyhedron** is a three-dimensional geometric figure whose sides are polygons. They are also known as **platonic solids.** Below is an example of a polyhedron.

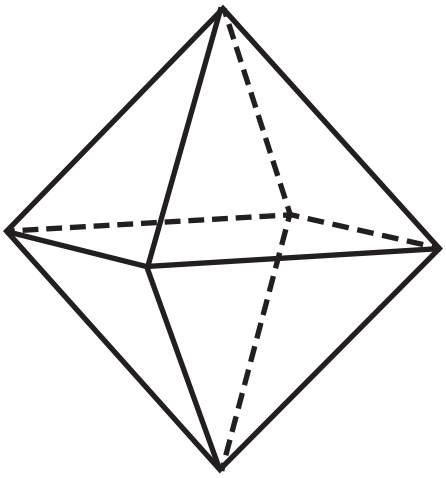


This is a **cube**. It has six regular sides. In other words, all the sides are equal and all of the angles are equal. An example of a cube is a die.

Part 1

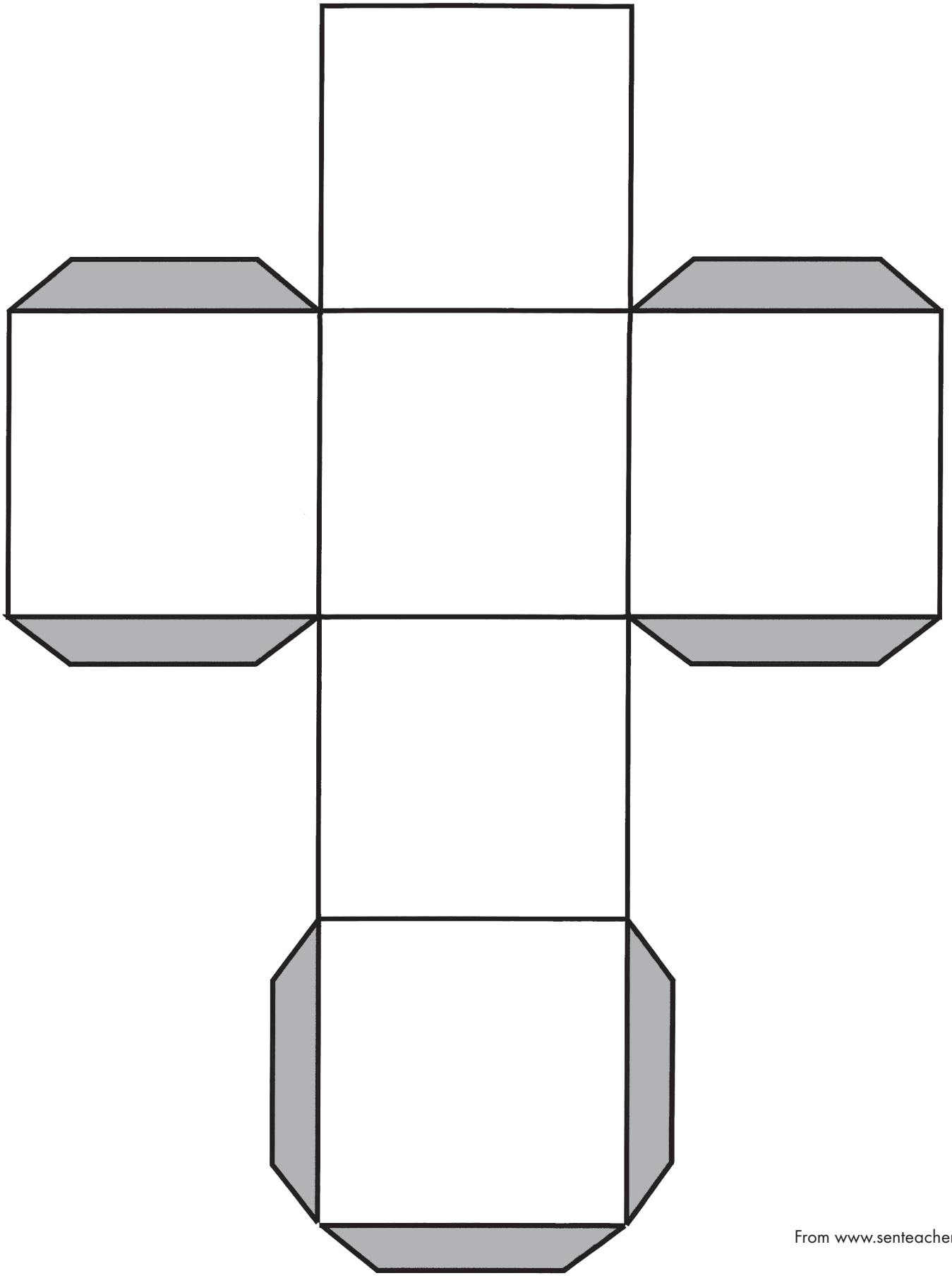
1. Pick a partner with whom you would like to work.
2. One of the partners should come to the front and select a cube pattern, a protractor, scissors, tape, crayons and markers or colored pencils.
3. On the each of the cube sides, draw a square, a rhombus, a rectangle, a trapezoid and an irregular quadrilateral. On the sixth side, put your names.
4. Now fold along the lines and tape the cube together.
5. Turn it in to the teacher.

Part 2



1. Now you are going to create a prediction tool (octahedron) like the one pictured here.
2. Notice that there are four equilateral triangles on the top and four on the bottom.
3. One of the partners should come to the front and get supplies.
4. Make one equilateral triangle. If the interior measure of a triangle is 180 degrees and there are three angles in a triangle, how many degrees should each angle be?
5. Once one triangle is created, copy it seven times so that you have a total of eight triangles.
6. To make this a prediction tool, you need to label the sides with the answers to questions you might ask. Some possible answers include "yes," "no," "try later," "maybe," "are you out of your mind?," etc. Make sure your names are on the shape.
7. Now you need to connect the triangles. Do you remember how there were pieces of the shape that were not part of the cube in Part 1? You may want to make those parts or you can fasten the sides together with tape.
8. Be sure one triangle has your name and your partner's name on it.
9. Now ask each other fun questions and find the answers using your prediction tool.

Cube Template



How Many Degrees?

Overview

Students will find the interior measure of a polygon, a hexagon and an octagon. They will record the measure and try to come up with a way to determine what the measure is of a 50-sided polygon. This lesson is for enrichment.

Standards Addressed

Grade 5, Mathematics — Geometry

05-07 Benchmark *D. Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.*

Y2003.CMA.S03.G05-07.BD.L05.I05 / Characteristics and Properties

05. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals.

Materials

- Pens or pencils
- Protractors (optional)

Procedure

1. Have students work with a partner. Distribute the student handout How Many Degrees?

2. Ask the students how they could find the measure of the interior angles of any polygon. They'll probably say by using a protractor.

3. Tell them that they already know the measure of the angles of a triangle (180 degrees) and of a quadrilateral (360 degrees). Ask them to think about how they might find the measure of interior angles another way. If no one suggests making triangles after they've read the directions, give the student this hint and help those who need it.

4. After they've completed the first side of the handout, have students fill in what they have found on the table on the back side.

5. Ask them if they'd like to make a 50-sided polygon and find the measure of the interior angle by drawing triangles. Ask them to find a better way. Someone should suggest to subtract two sides and multiply by 180 degrees. The formula should be: If n = the number of sides, then (n-2) x 180°, which gives you the measure of the interior angle of any polygon.

Answers to *How Many Degrees?*

1. 180°
2. 360°
3. 540°
4. 720°
5. 1080°

Name of Shape	Number of Sides	Number of Triangles in Polygon	Measure of Interior Angle
Triangle	3	1	180°
Quadrilateral	4	2	360°
Polygon	5	3	540°
Hexagon	6	4	720°
Octagon	8	6	1,080°

The students should realize that if you subtract two from the number of sides and multiply that number by 180 degrees, you will get the measure of the interior angles in the polygon.

6. 50 - 2 = 48
   48 x 180° = 8,640° in a 50-sided polygon

   So the formula would be, "If n = the number of sides, then (n-2) x 180° = the measure of the interior angles of a polygon."

Evaluation

Because this is an enrichment activity, evaluation can be very broad:

- If students are able to figure out the formula, they would get full credit or 100 points (or however many you want to give them).
- If they filled out the page correctly and figured out how to calculate the measure of the interior angles of a 50-sided polygon, but not the formula, they could get 90 points.
- If they filled the paper out correctly but didn't figure out problem number six, they could get 75 points.
- If they had difficulty filling out questions 1-5 but had the idea of using triangles to determine the measure, they could receive 50 points.

Name(s)_____

How Many Degrees?

Your task:

Find out how many degrees there are in the interior angles of an octagon.

See if you can figure out an easy way to figure out the measure of the interior angle of any polygon.

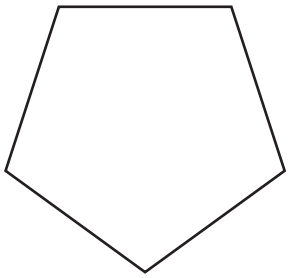
1. How many degrees are in the interior angles of a triangle? _____

2. How many degrees are in the interior angles of a quadrilateral? _____

Let's figure out how many degrees are in the interior of the pentagon (five-sided) figure below. You could use a protractor and measure each angle and add it together.

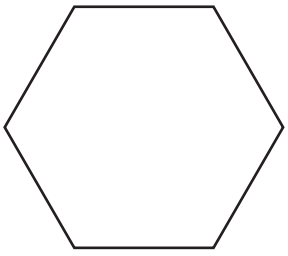
OR

You could try dividing the pentagon into triangles. The line must go from one vertex to another vertex. You know the measure of the interior angle of one triangle.



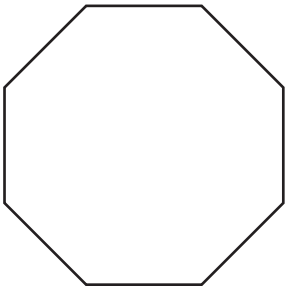
3. What is the measure of the interior angles of this pentagon? _____

Now find the measure of the interior angles of this hexagon (six-sided).



4. What is the measure of the interior angles of this hexagon?_____

Now find the measure of the interior angles of this octagon (eight-sided).



5. What is the measure of the interior angles of this octagon? _____

Fill in the information you have found.

Name of Shape	Number of Sides	Number of Triangles in Polygon	Measure of Interior Angles
Triangle			
Quadrilateral			
Pentagon			
Hexagon			
Octagon			

Look closely at the data above. Try to come up with a formula that would allow you to find the measure of the interior angle of a polygon that has 50 sides (without drawing triangles in it). How about 100 sides? Show work below.

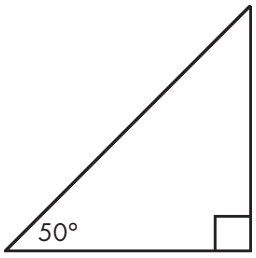
6. What is the measure of the interior angle or a polygon with 50 sides?

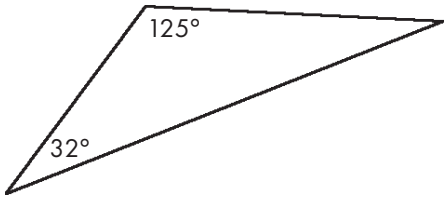
Name_____

Summative Assessment

1. What is the measure of the interior angles of a triangle? _____

Give the measure of the missing angle.

2. 

3. 

4. Create an equilateral triangle below.

5. Make a rhombus below. Show the measures of each angle.

6. How many sides are in a quadrilateral? _____

7. What is the sum of the interior angles of a quadrilateral? _____

True or False (If false, explain why.)

8. _____ A shape with three or more sides is called a polygon.

9. _____ A trapezoid must have two sets of parallel lines.

10. _____ A shape whose angles are 50 degrees, 20 degrees and 90 degrees is a triangle.

Summative Assessment Answers

1. 180°
2. 40°
3. 23°
4. Students should have three 60-degree angles.
5. Students should have equal sides and opposite angles equal.
6. Four
7. 360°
8. True
9. False – must have one set of parallel sides.
10. False – interior angles do not equal 180 degrees.

Sound Energy

http://www.WesternReservePBS.org/phi

Sound Energy Overview

This unit features the music and art of Mark Mothersbaugh. The first lesson provides a hands-on activity that allows students to discover that sound is produced by vibrations. In the second lesson, the students explore sound characteristics and use these explorations to define the content vocabulary.

Lesson three introduces students to the basic families of musical instruments. The final combines all the concepts that were covered. Students will create an instrument that will demonstrate changes in pitch and volume. They will watch an interview with Mark Mothersbaugh and listen to examples of the music that he has created.

There are resource pages that give an overview of sound and a vocabulary list. Also provided are a PowerPoint presentation about sound energy and directions for making a pitch machine.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I05 / Nature of Energy

05. Explore and summarize observations of the transmission, bending (refraction) and reflection of light.

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Y2003.CSC.S03.G03-05.BF.L05.I07 / Nature of Energy

07. Describe that changing the rate of vibration can vary the pitch of a sound.

Sound Energy

What is sound?

Sound is a form of energy made by vibrations. When an object vibrates, it causes the air particles around it to move. These particles bump into the particles that are close to them, which in turn causes those particles to move and bump into more particles. This creates sound waves that keep going until they run out of energy.

Try this: Put your index and middle finger on your neck. Say the word "aah" as loud as you can. Then try it as soft as you can. You not only hear a sound, but you feel a movement inside your throat. When you say "aah," your vocal cords vibrate. That means they move quickly back and forth. As your vocal cords vibrate, they produce sound. *Source:* ***http://www.fi.edu/fellows/fellow2/apr99/soundsci.html***

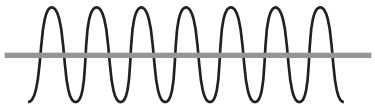
Think about throwing a stone in a pool of water. You see rings of waves around where the stone hits the water. This is true for sound waves also. They spread out all around. The sound can be either noise or music. If the wave is irregular, noise is created. If it is regular, repeating waves, music can be the result.

Sound vibrations are able to travel through all forms of matter: gases, liquids and solids. These are called the **medium**. Sound cannot travel through a vacuum.

Sound is transmitted through gases, plasma and liquids as **longitudinal waves**, also called **compression waves** (mechanical longitudinal waves or pressure waves). When the vibrations are fast, you hear a high note. Whey they are slow, a low note is created. A longitudinal wave is moving in the same direction in which the particles of the medium vibrate.

Pitch is how high or low a sound seems. Birds have high-pitched tones and a lion's roar is low-pitched.

Low-Frequency Sound Waves



High-Frequency Sound Waves

How do musical instruments create sound?

There are four types of musical instruments: **wind, brass, string** and **percussion**. In wind instruments (such as the flute or trumpet), vibrating air makes the sound. The air particles move back and forth creating sound waves. In instruments such as a clarinet, a vibrating reed (a thin piece of wood in the mouthpiece) starts the wave. The player gets different pitches by pressing the keys to open or close the holes. This makes the tube longer or shorter. Longer air passages create lower pitches.

String instruments are played by pressing down on the string and making longer or shorter strings. This causes the strings to vibrate at different frequencies and make different sounds. Shorter strings make higher sounds. Strings also produce different sounds, depending on how thick the strings are.

Percussion instruments such as drums and cymbals vibrate when they are hit, causing sound. Brass instruments make music by the user buzzing his or her lips while blowing.

Did you know?

- Sound travels four times faster through water than through the air. Whales in the ocean "sing" to each other. The sound of their song can travel a distance of 800 km.
- There's no sound in space. Sound needs a medium to travel through.
- Sound travels through air at 1,120 feet per second or 340 meters per second.
- Geologists use their knowledge of how sound travels through rocks to help them find oil fields.
- When a sound wave hits soft material, much of the sound is absorbed. This material is called an insulator because it absorbs much of the energy of sound waves.
- Hard materials can reflect sound so that the sound travels back in the opposite direction. This is called an echo.
- One of the loudest sounds produced by our own invention is the noise of a space rocket blasting from the launch pad.
- When artists are in a recording studio, they don't want any extra noise. The walls, ceilings and floors are covered with sound-absorbing substances, such as wavy-surfaced tiles and thick carpets.

Sound Energy Vocabulary

Absorption: A process in which sound energy is reduced when sound waves pass through a medium or strike a surface – also known as acoustic absorption.

Characteristics of Waves:

- **Amplitude of a transverse wave:** The vertical distance between the line of origin and the crest of the wave. The higher the amplitude, the more energy sent to the medium.
- **Compression in a longitudinal wave:** The area where the medium is pushed together. Compressions in a longitudinal wave compare to the crests of a transverse wave.
- **Crest:** The highest point of the wave above the line of origin.
- **Frequency:** The number of wavelengths that pass a point in a given amount of time. The unit for the frequency is the **hertz (Hz)**.
- **Hertz (Hz):** The number of wavelengths that pass a point in a given amount of time (such as a second). The more waves that pass through the medium in the same amount of time, the more energy that is released.
- **Line of origin:** The original position of the medium before a transverse wave moves through it.
- **Period:** Time it takes for a wave to repeat itself.
- **Rarefaction in a longitudinal wave:** The area where the medium spreads apart. Rarefaction in a longitudinal wave compare to the troughs of a transverse wave.
- **Trough of a transverse wave:** The lowest point of the wave beneath the line of origin.
- **Wavelength of a transverse wave:** The distance between two neighboring crests or between two troughs.

Medium: Matter that is made up of molecules and takes up space. Some waves move through a medium that includes solids, liquids and gases.

Pitch: The property of a sound, especially a musical tone, that is determined by the frequency of the waves producing it; highness or lowness of sound.

Reflection: The throwing back by a body or surface of light, heat or sound without absorbing it.

Transmission: Passage of a sound wave through a medium or series of media.

Types of Waves: A disturbance that transfers energy through matter or through space or a disturbance in the medium.

- **Longitudinal wave:** A wave such as a sound wave that is moving in the same direction in which the particles of the medium vibrate. Mechanical longitudinal waves have been also referred to as **compressional waves** or **pressure waves**.
- **Transverse wave:** A wave that makes the medium through which it travels vibrate in a direction at right angles to the direction of its travel.

Vibration: Periodic back-and-forth motion of the particles of an elastic body or medium.

Name_____

Formative Assessment

1. The volume of a sound is determined by its:
   A. frequency
   B. amplitude
   C. vibration
   D. loudness

2. The pitch of a sound is determined by its:
   A. frequency
   B. amplitude
   C. vibration
   D. loudness

3. Sound waves are produced by _____ .

4. If you want to increase the volume of an instrument, you can:
   A. strike or pluck it harder
   B. blow harder
   C. none of the above
   D. all of the above

5. Complete the table below with as much information as you can.

Instrument Families		
Name of Family	**How the Instruments in This Family Produce Sound**	**Two (or More) Examples**
Woodwind		
String		
Percussion		
Brass		

6. Tonia was studying with Corey this weekend for Monday's science test. She said that volume and pitch are the same thing. Corey respectfully disagreed. Who do you think is correct, and why?

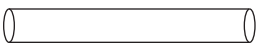
Diagram the following:

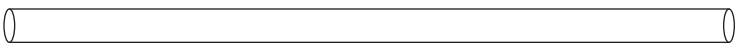
7. A wave with a high pitch

8. A wave with a loud volume

9. Two waves with the same pitch but different volume

10. Look at the diagrams of the straws below. Which do you think would produce a lower pitch? Why do you think this?

A. 

B. 

Formative Assessment Answers

1. B

2. A

3. Vibrations

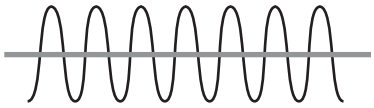
4. D

5.

Instrument Families		
Name of Family	**How the Instruments in This Family Produce Sound**	**Two (or more!) Examples**
Woodwind	Blowing on the top of the instrument or on a reed(s)	Flute, clarinet
String	Plucking or strumming strings	Violin, cello
Percussion	Striking, shaking or scraping	Drum, xylophone
Brass	Buzzing lips while blowing	Trombone, trumpet

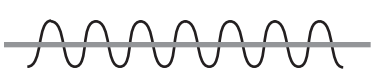
6. Corey is correct: volume and pitch are not synonymous. Volume is the loudness of a sound, determined by amplitude. Pitch is how high or low a sound is, determined by frequency.

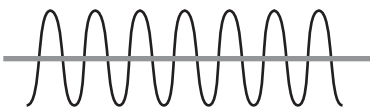
7. Wavelengths should be close together; height doesn't matter.



8. Waves should be large; wavelength doesn't matter.

9. Wavelengths should be about the same distance, but heights should be different.





10. B would produce a lower sound because the waves have a longer distance to travel.

Sound Energy PowerPoint Presentation

Sound Energy

Slide 1

What is sound?

- Sound is
  - **A form of energy made by vibrations.**
  - When an object vibrates it causes the air particles around it to move.
  - These particles bump into particles close to them and this continues until they run out of energy.

Slide 2

Try this:

- Put your finger on your neck and say "aah" as loud as you can.
- Now say it as soft as you can.
- You can not only hear the sound, but you can feel the vibration inside your throat.

Slide 3

How does sound travel?

- Sound travels through all forms of matter—**gases, liquids and solid**.
- These are called the **medium**.
- Sound **cannot** travel through a **vacuum.**

Slide 4

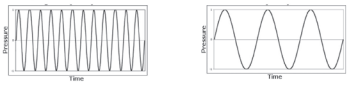
What is pitch?

- Pitch is how high or how low a sound is.
- This is a **high pitched** sound.
- This is a **low pitched** sound.

Slide 5

How does sound travel?

- Sound passes through the medium as **longitudinal waves.**
- When the vibrations are fast you hear a **high pitch**. When they're slow, you hear a **low pitch.**



High Pitch Low Pitch

Slide 6

How else can we change sound?

- We can make it louder or softer by changing the **amplitude** of the height of the wave.
- The higher the amplitude, the louder the sound. The lower the amplitude the softer the sound.

Slide 7

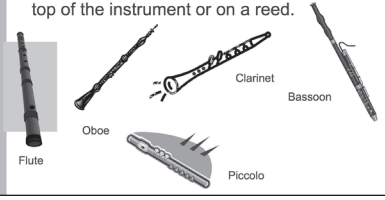
How do musical instruments create sound?

- It depends on the type of instrument. There are four types.
  - Woodwind
  - String
  - Percussion
  - Brass

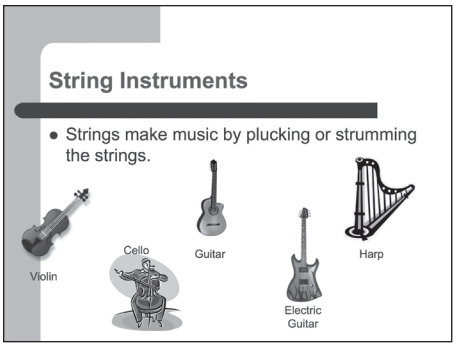
Slide 8

Woodwinds Instruments

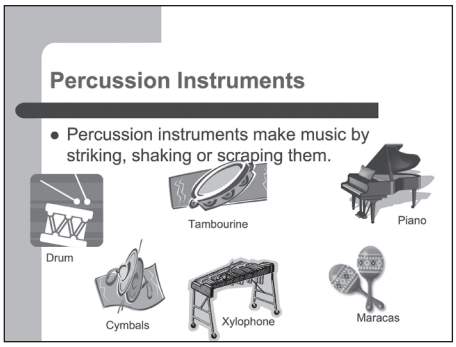
- Woodwinds make music by blowing on the top of the instrument or on a reed.



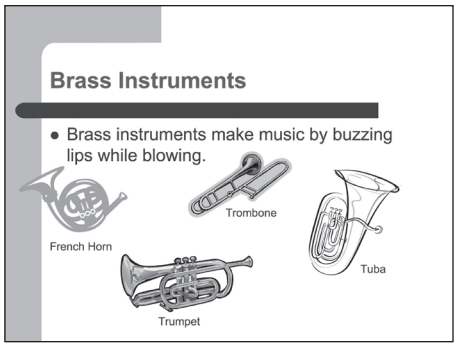
Slide 9



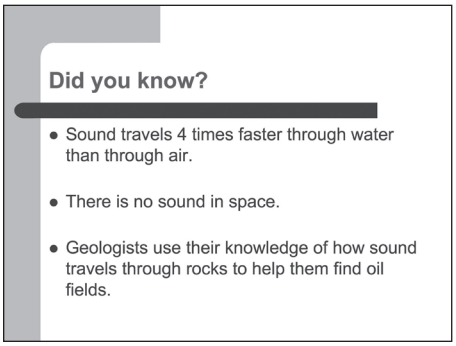
Slide 10



Slide 11



Slide 12



Slide 13

Good Vibrations

Overview

Students will use everyday materials to discover that sound is produced by vibrations.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Materials

- Rubber bands
- Bottles
- Paint stirrers
- String
- Popsicle sticks
- Rulers
- Straws

Procedure

1. Have students listen to a silent room for one minute and record all of the sounds they hear. Share and discuss. Ask students to think about how these sounds are produced.

2. Introduce sound stations. Distribute materials around the room. The stations should contain the materials listed above.

3. Pass out recording sheet (or instruct students to record their observations in science notebooks) and instruct students that they will be making sounds with the materials and recording their observations; that is, how they produced the sounds and what sounds they heard.

4. Have students work in pairs to complete the project. Circulate and assist as needed.

5. Share observations and have students draw conclusions from their explorations. How is sound produced?

Evaluation

- Observations during stations.
- Responses on recording sheet or in science journal.
- Rubric can be used to evaluate sound station project.

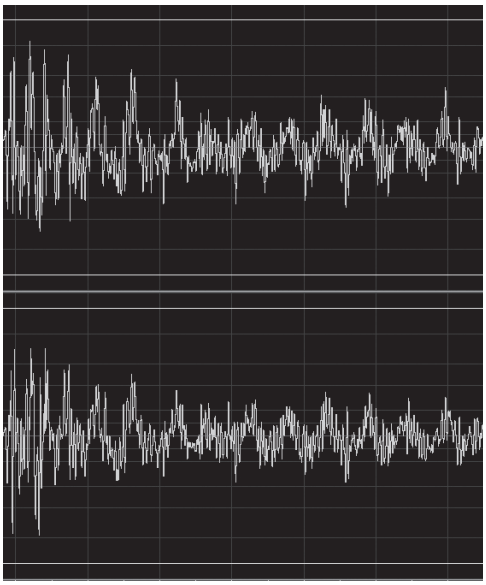
CATEGORY	4	3	2	1
Focus on the Task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod and remind to keep this person on task.	Rarely focuses on the task and what needs to be done. Lets others do the work.
Working With Others	Almost always listens to, shares with and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with and supports the efforts of others. Often is not a good team player.
Quality of Work	Provides work of the highest quality.	Provides high-quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/ redone by others to ensure quality.

Sound Stations

Name(s): _____ Date: _____

Material	Sound Produced	How You Produced the Sound
rubber band		
bottle		
paint stirrer		
string		
popsicle stick		
ruler		
straw		

Your Conclusion: **How is sound produced?**



Measuring Sound

Overview

Students will explore sound characteristics and use these explorations to define content vocabulary. They will do experiments that help them understand pitch, volume, frequency, amplitude and wavelength.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Y2003.CSC.S03.G03-05.BF.L05.I07 / Nature of Energy

07. Describe that changing the rate of vibration can vary the pitch of a sound.

Materials

- Krumhorn or flute
- Slinky (metal works best)
- Straws (straight, not bendable)

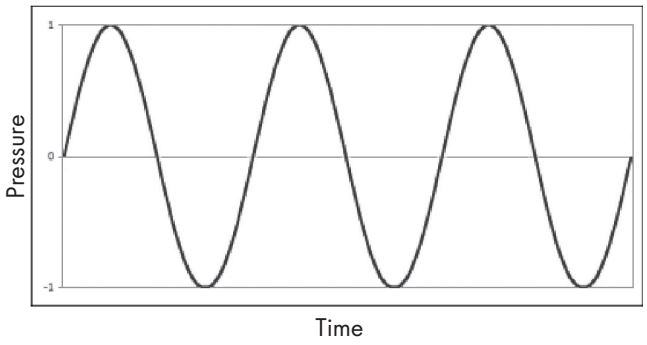
Procedure

1. Introduce the following vocabulary: pitch, volume, frequency, amplitude and wavelength. Tell students that they will be defining these terms based on their explorations in this lesson.

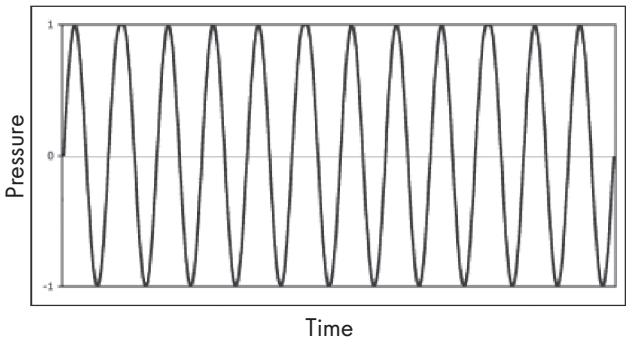
2. Play the krumhorn with no extension. Have the students share their observations. Add extensions, one at a time, and share observations. (You could also demonstrate with a flute.)

3. Introduce the term "pitch." Guide students in defining pitch as how high or how low a sound is. Discuss how you changed the pitch with the krumhorn *(the longer the sound wave had to travel, the lower the pitch)*. Represent with a diagram:

Low-Frequency Sound Waves



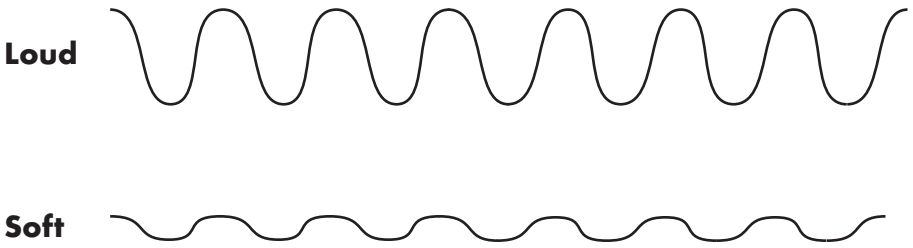
High-Frequency Sound Waves



4. Ask the students the following questions:

   a. How else can we change sounds? Have students demonstrate (lead discussion to volume – loudness or softness). Simulate how sound waves travel when volume increases or decreases with the slinky (slowly move up and down to simulate a low volume; gradually increase speed to simulate increasing volume).

   b. Ask students how we changed the volume (*made the wave bigger by adding more energy*). Discuss the definitions of volume and amplitude. Represent with a diagram:



5. Introduce the Measuring Sound Recording Sheet activity. Students will use four straws to create seven different straw lengths. They will measure each length in centimeters and record these lengths, and then predict and record the order of the straws from lowest to highest pitch. The students will then blow across each straw and record their observations.

6. Share results and discuss conclusions.

Evaluation

- Observations during discussions.
- Responses on recording sheet.

Rubric could be used to evaluate the Measuring Sound activity.

CATEGORY	4	3	2	1
Focus on the Task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod and remind to keep this person on task.	Rarely focuses on the task and what needs to be done. Lets others do the work.
Working With Others	Almost always listens to, shares with and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares with and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with and supports the efforts of others. Often is not a good team player.
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.

Name: _____

Measuring Sound

Challenge: Using four straws, create a pan flute with seven different straw lengths. Record what your flute looks like and the straw lengths (in centimeters) below:

Diagram	Straw Length (in cm)

Predict what your flute will sound like! Order the straws from the highest pitch to the lowest.

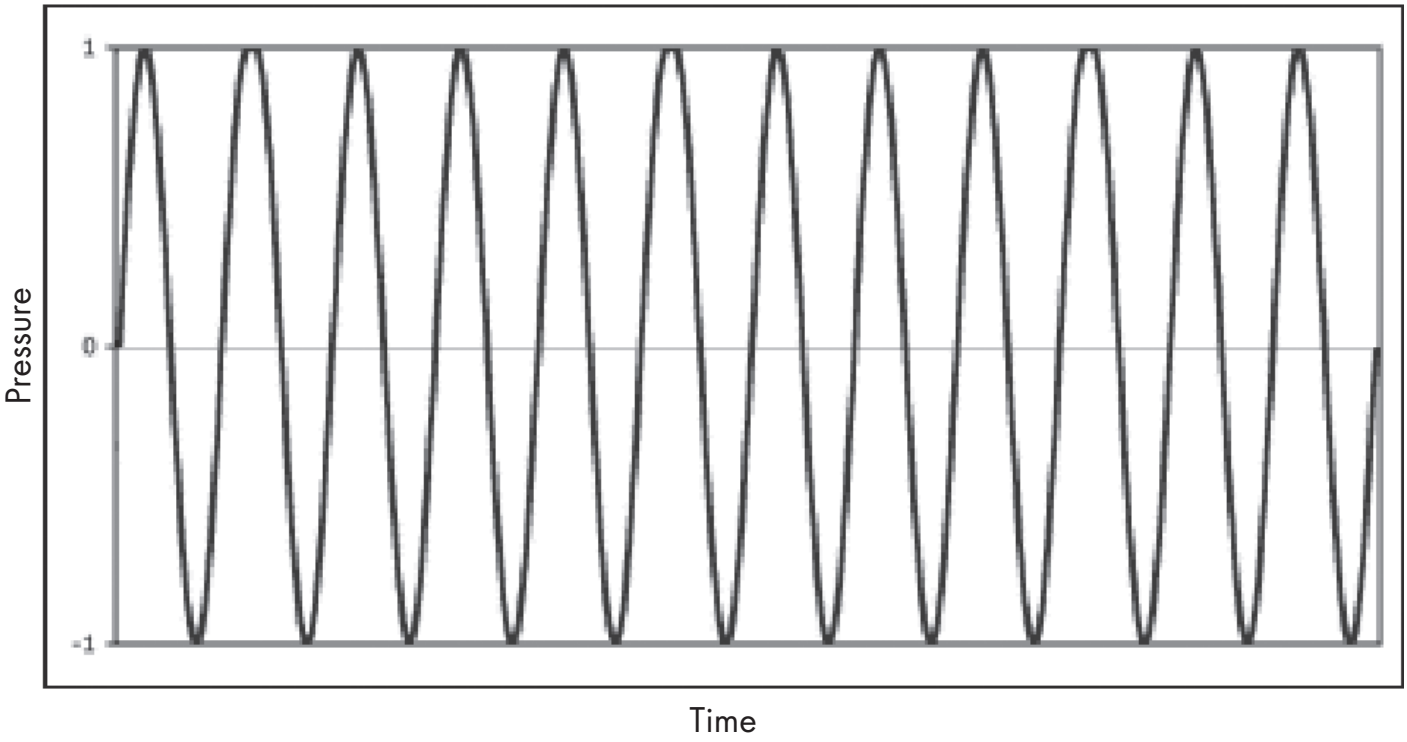
Highest ◄——————————————————————————► Lowest

Blow across the tops of your straws and listen to the sounds. Record your observations (think about pitch!).

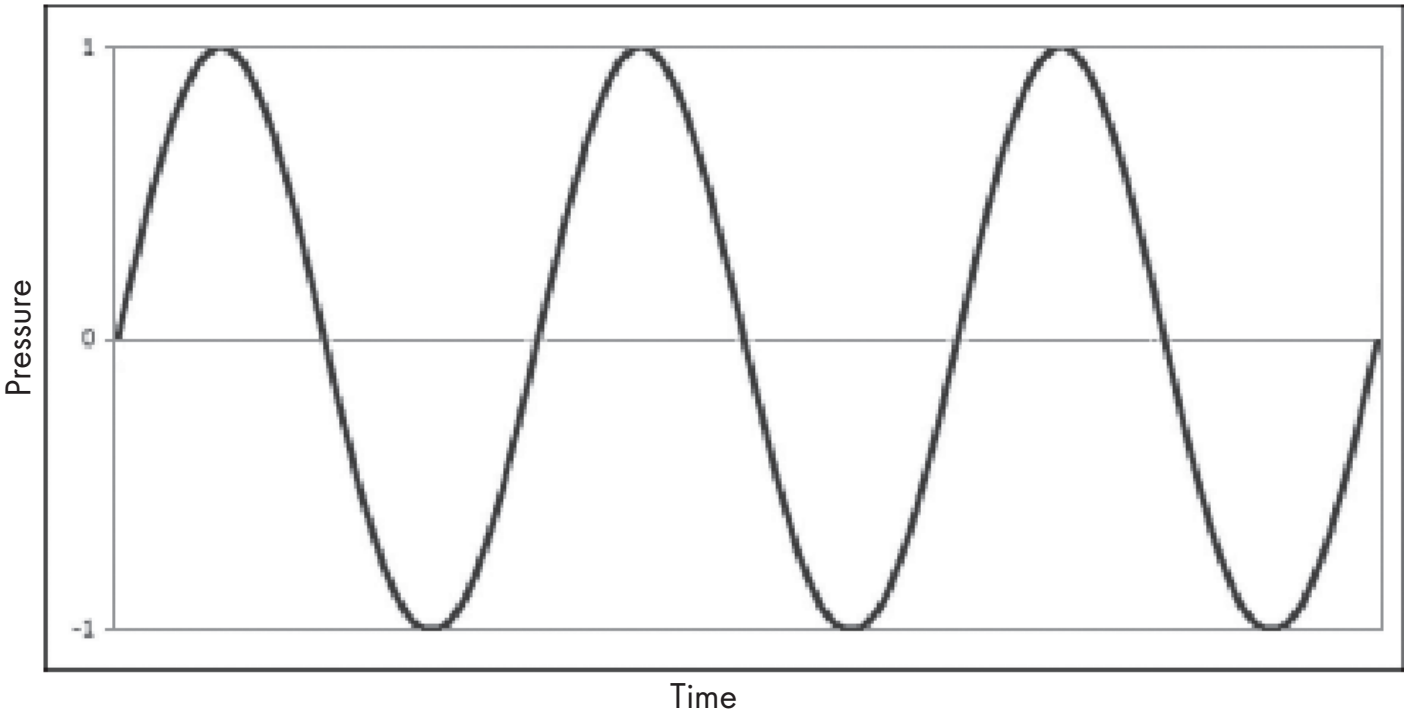
Compare your predictions to the results of your observations. What can you conclude about changing the pitch of a sound?

Sound Waves

High-Frequency Sound Waves

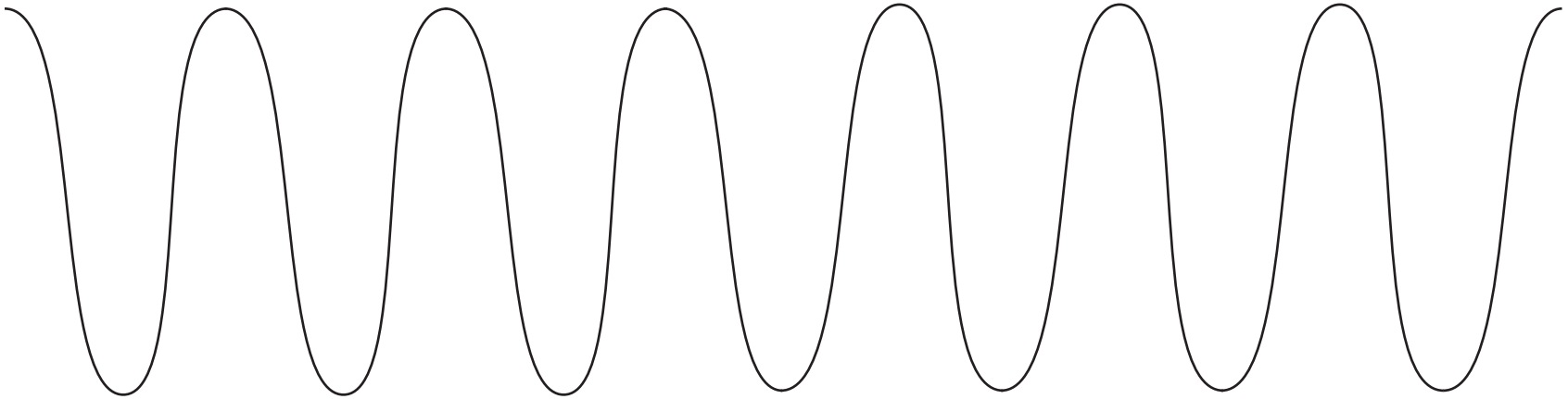


Low-Frequency Sound Waves



Volume

Loud



Soft

Instrument Families

Overview

Students will study instrument families and learn about different kinds of instruments.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Y2003.CSC.S03.G03-05.BF.L05.I07 / Nature of Energy

07. Describe that changing the rate of vibration can vary the pitch of a sound.

Materials

- Envelopes
- Styrofoam cups
- Push pins
- Rules
- Rubber bands

Procedure

1. Before class begins, cut apart the instrument cards and put them in an envelope labeled "Instruments." Also put the name of each family group in the envelope.

2. Pose the following quick-write question to students: What are the instrument families? How is sound produced with each? Share responses.

3. Introduce the following websites. If a computer lab is available, allow students to explore individually or in pairs.
   - **Dallas Symphony Orchestra** Listen to the instruments http://www.dsokids.com/listen/instrumentlist.aspx
   - **San Francisco Symphony: Instruments of the Orchestra** http://www.sfskids.org/templates/instorchframe.asp?pageid=3

4. Distribute instrument cards.

5. Have students sort themselves according to instrument family and then work together to develop a short presentation describing one of the instrument families, how sound is produced in this family and examples of instruments in this family.

6. Present and discuss.

7. Optional: Have students work with a partner to build a pitch instrument, as described in the Making a Pitch Instrument handout.

Evaluation

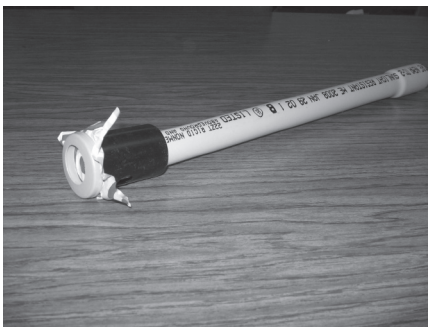
- Observations during discussions.

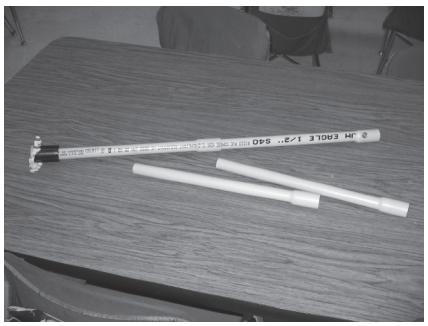
Rubric for presentation:

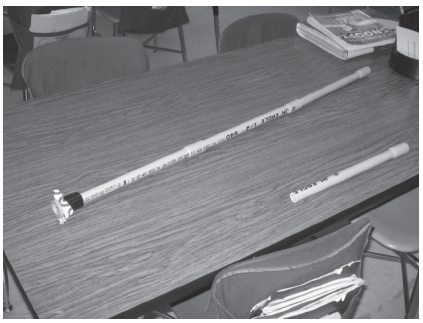
Criteria	4	3	2	1
Organization	Student presents information in logical, interesting sequence that audience can follow.	Student presents information in logical sequence that audience can follow.	Audience has difficulty following presentation because student jumps around.	Audience cannot understand presentation because there is no sequence of information.
Content Knowledge	Student demonstrates full knowledge (more than required) with explanations and elaboration.	Student is at ease with content, but fails to elaborate.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student does not have grasp of information; student cannot answer questions about subject.
Visuals	Student used visuals to reinforce screen text and presentation.	Visuals related to text and presentation.	Student occasional used visuals that rarely support text and presentation.	Student used no visuals.

The Krumhorn

A true krumhorn is a double-reed musical instrument and sometimes is included among the many "voices" of a pipe organ. Our krumhorn's sound is produced by a plastic membrane vibrating against one end of the krumhorn's body. Note that the Bernoulli effect (fast air is weak air) explains the vibrations of the plastic membrane. When you blow into the 3/8" hole, fast-moving air flowing under the membrane results in reduced pressure there, so the membrane closes down onto the end of the pipe. With the air flow now cut off, the pressure under the membrane builds back up, lifting the membrane and restoring the flow of air. The whole process rapidly repeats, so the membrane vibrates at a frequency determined by the length of the pipe. The body is a length of one-half inch PVC electrical conduit pipe. Sound waves in the pipe body result from the membrane's vibrations and include a rich mixture of harmonics (which are integer multiples of the lowest or fundamental frequency). The pitch we hear depends on the fundamental and is lower for longer pipes and higher for shorter pipes.







Making a Krumhorn

What You Need

- A round plastic film can with a 3/8-inch hole drilled in its side (about in the middle of the can's length) and a 13/16-inch hole drilled in the end. (A flat spade bit works well for the larger hole. The 13/16-inch hole fits tightly onto the pipe used for the body.)
- The film can's lid, with a 7/8-inch hole. The size of this hole is not critical, but it helps if you can get your finger into it (as you can see in the diagram).
- About a 2-inch square of plastic membrane. Pieces cut from plastic shopping bags work fine for this.
- A length of 1/2-inch PVC pipe electrical conduit. This plastic pipe has a 1/2-inch **inside** diameter and about a 3/4-inch **outside** diameter. The pipe costs about $2.50 for 10 feet at a hardware store. Plastic water pipe also works and is cheaper.
- Other pipe fittings as desired: elbows and various lengths of pipe.

Assembly

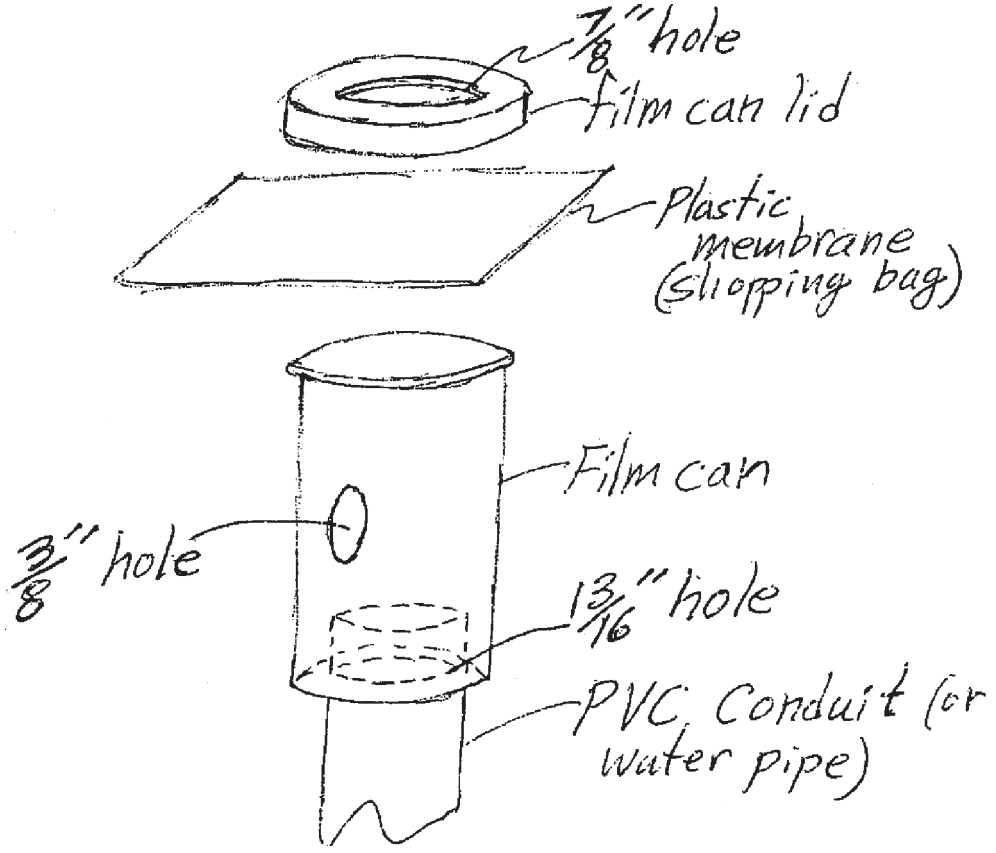
1. Place the membrane over the open end of the film can. Snap on the can's lid to draw the membrane tightly.

2. Carefully insert the PVC pipe resonator tube into the hole in the film can, but only a little way into the can.

3. **Now comes the tricky part!** Carefully slide the pipe farther into the can until the pipe's end barely and gently touches the membrane. (You can feel with your finger or look through the hole in the lid.) The tube must be uniformly touching across the entire width of the tube. This may take some care to accomplish.

4. Blow into the ⅜-inch slide hole in the can and listen!

5. If no sound occurs, first you need to be sure the membrane still remains flat and tight and hasn't been stretched by an overly exuberant poking of the pipe. If the membrane has been distorted, back off the pipe, remove the can lid and repeat Step 1. Then you may need to fine tune the position of the pipe's end relative to the membrane. You can often do this while you are blowing in the side hole. The rewarding sound assures that this fine tuning has been successful.



Variations

1. Use slip-on fittings, elbows, etc., to change the length of the horn and/or its shape. Does the pitch depend upon the shape or only on the total length? It's fun to see "How low can you go?" How long can a pipe be to still produce an audible pitch? Try 10 feet: You can almost count the low rumble of vibrations. How short can the pipe be? Even a three-inch piece works.

2. Try drilling finger holes in a two- to three-foot piece of pipe for a body. Holes as small as ⅛ inch work, but ¼ inch works better. Producing an actual playable scale would be a real challenge.

3. With a microphone feeding into an oscilloscope, note how the rich krumhorn sound waves appear very different from the pure-tone sounds from a tuning for. That's because of all of those harmonics.

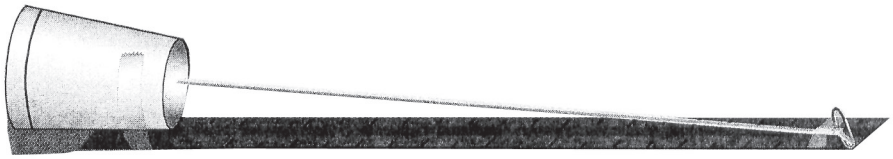
Stan Christensen, Kent State University

Making a Pitch Instrument

Pitch is the highness or the lowness of a sound. Do this activity to see what determines the pitch.

Directions:

1. Use a push pin to poke a hole in the bottom of a cup.
2. Tie a large knot in the rubber band and push the rubber band through the hole, making sure the knot is inside the cup.
3. Tape the cup to one end of the ruler so that the bottom of the cup is at the 2 cm line.
4. Place a paper clip on the end of the rubber band that is not in the cup. Place that paper clip on the end of the ruler opposite the paper clip. Make sure the rubber band is pulled tight.
5. Tape the end of the rubber band with the paper clip to the end of the ruler.
6. Hold the cup up to your ear. Pluck the rubber band once. Press the rubber band down onto the ruler near the end opposite the cup. Pluck the rubber band again.
7. Press the rubber band down as you move your finger closer and closer to the cup. Pluck the rubber band each time you move your hand and notice what happens to the pitch.



Based on your observations, answer the following questions:

1. How does changing the length of the vibrating part of the rubber band change the pitch of the sound?

2. How do you think the sound will change if, instead of pressing the rubber band down closer and closer to the cup, you press the rubber band down farther away from the cup?

3. How is this similar to the way a guitar player can change the pitch of a string on a guitar?

Woodwinds

Flute

Oboe

Clarinet

Bassoon

Piccolo

Strings

Violin

Cello

Guitar

Electric Guitar

Harp

Brass

French Horn

Trumpet

Trombone

Tuba

Percussion

Drum

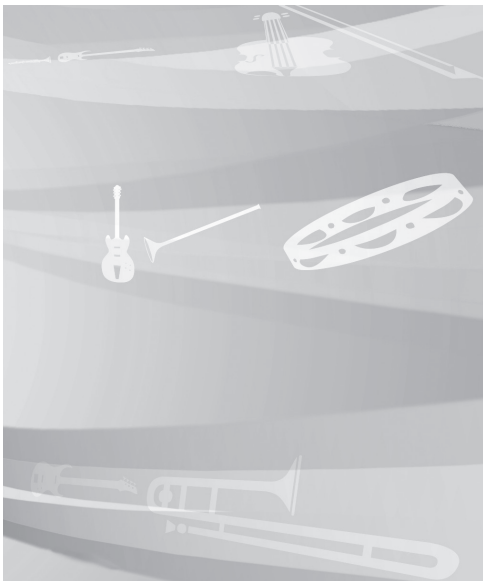
Cymbals

Tambourine

Piano

Xylophone

Maracas



Final Project — Putting It All Together!

Overview

Students will create instruments that demonstrate changes in pitch and volume. Video and audio clips by Mark Mothersbaugh will help students understand the science of pitch and volume. Mothersbaugh has created music for many movies and was a founding member of Devo. He grew up in Peninsula, Ohio, and went to Woodridge Local Schools.

Standards Addressed

Grade 5, Science — Physical Science

3-5 Benchmark *F. Describe the properties of light and sound energy.*

Y2003.CSC.S03.G03-05.BF.L05.I06 / Nature of Energy

06. Describe and summarize observations of the transmission, reflection and absorption of sound.

Y2003.CSC.S03.G03-05.BF.L05.I07 / Nature of Energy

07. Describe that changing the rate of vibration can vary the pitch of a sound.

Materials

- Mark Mothersbaugh's video and sound clips
- Miscellaneous materials (rubber bands, string, boxes, craft sticks, rice, straws, etc.)

Procedure

1. Prior to beginning this project, students should take home the "It Sounds Like Science ..." letter to their parents to explain the project.
2. Introduce Mark Mothersbaugh through video and sound clips. Clips are available at http://westernreservepublicmedia.org/phi.
3. Discuss the project requirements sheet.
4. Have students plan and sketch their instrument designs, then gather materials and begin creating their instruments.
5. Have students present instruments to the class according to project requirements.

Evaluation

- Observations during discussions.
- Completed instrument.

Name_____

Instrument Project Requirements	My Score
Your instrument showed how sound is produced. (10 points)	
Your instrument demonstrated different pitches. (10 points)	
Your instrument demonstrated different volumes. (10 points)	
You explained to which family your instruments belongs and why. (10 points)	
You presented your instrument professionally. (10 points)	
TOTAL POINTS	

Name_____

Instrument Project Requirements	My Score
Your instrument showed how sound is produced. (10 points)	
Your instrument demonstrated different pitches. (10 points)	
Your instrument demonstrated different volumes. (10 points)	
You explained to which family your instruments belongs and wh (10 points)	
You presented your instrument professionally. (10 points)	
TOTAL POINTS	

It Sounds Like Science ...

Dear Families,

As you know, we've been studying sound in science for the past few weeks. As one of our final projects, each student will be creating an instrument to share with the class. These projects will be constructed in school on Wednesday and Thursday. I will have materials available, but your child is welcome to bring in anything he or she would like to use from home, with your permission, of course! These instruments will be required to demonstrate what we've learned about sound, including how sound is produced, pitch, volume and to which musical family the instrument would belong. **Please do not go out and buy materials!** The instruments are to be made from ordinary household items. Please discuss your child's plan for the instrument and have him or her bring any materials from home in to school **tomorrow**. Thanks for your help and support!

It Sounds Like Science ...

Dear Families,

As you know, we've been studying sound in science for the past few weeks. As one of our final projects, each student will be creating an instrument to share with the class. These projects will be constructed in school on Wednesday and Thursday. I will have materials available, but your child is welcome to bring in anything he or she would like to use from home, with your permission, of course! These instruments will be required to demonstrate what we've learned about sound, including how sound is produced, pitch, volume and to which musical family the instrument would belong. **Please do not go out and buy materials!** The instruments are to be made from ordinary household items. Please discuss your child's plan for the instrument and have him or her bring any materials from home in to school **tomorrow**. Thanks for your help and support!

Name_____

Summative Assessment

1. What does the frequency of a sound wave tell you?
   A. volume
   B. amplitude
   C. vibration
   D. pitch

2. What does the amplitude of a sound wave tell you?
   A. volume
   B. pitch
   C. vibration
   D. frequency

3. Sound waves are produced by _____ .

4. If you want to decrease the volume of an instrument you can:
   A. strike or pluck it harder
   B. blow softer
   C. none of the above
   D. all of the above

5. Complete the table below with as much information as you can.

Instrument Families		
Name of Family	**How the Instruments in This Family Produce Sound**	**Two (or More) Examples**

6. Owen was studying with Ben this weekend for Monday's science test. He said that volume and pitch are not the same thing. Ben respectfully disagreed. Who do you think is correct, and why?

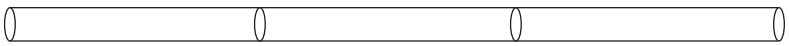
Diagram the following:

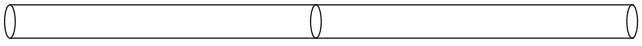
7. A wave with a low pitch.

8. A wave with a soft volume.

9. Two waves with the same volume but different pitch.

10. Mitch went to the hardware store over the weekend and bought the materials to construct a krumhorn. He put it together on Sunday and now wants to challenge his friend Ty to a sound contest! He thinks his krumhorn will make a lower pitch than Ty's krumhorn. Look at the diagrams below and tell who you think won the contest and why.

Ty 

Mitch 

Summative Assessment Answers

1. D

2. A

3. vibrations

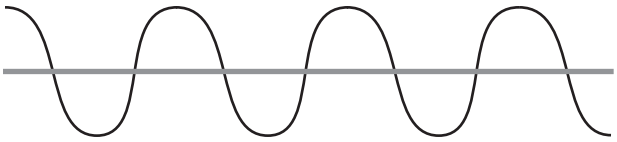
4. B

5.

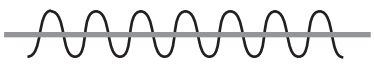
Instrument Families		
Name of Family	**How the Instruments in This Family Produce Sound**	**Two (or More) Examples**
Woodwind	Blowing on the top of the instrument or on a reed(s)	Flute, clarinet
String	Plucking or strumming strings	Violin, cello
Percussion	Striking, shaking or scraping	Drum, xylophone
Brass	Buzzing lips while blowing	Trombone, trumpet

6. Owen is correct; volume and pitch are not synonymous. Volume is the loudness of a sound, determined by amplitude. Pitch is the how high or low a sound is, determined by frequency.

7. Wavelengths should be far apart; height doesn't matter.



8. Waves should be shorter; wavelength doesn't matter.



9. Wave heights should be about the same but wavelengths should be different.

10. Ty's horn would produce a lower sound because the waves have a longer distance to travel.

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