Sounds Good To Me

ABOUT THIS LESSON

In this lesson, students will explore patterns and how it relates to graphing on a coordinate grid. Students will also be informally introduced to translations, or slides, which is a transformation through the use of patterns. The students will have experiences with sounds made by various objects to help build their schema as well as opportunities to manipulate objects and recognize the affect that has on sounds created. Students will explore sound as it travels through different mediums.

LEVEL

Grade 4 Math and Science

MODULE

Transformations

MODALITY

NMSI emphasizes using multiple representations to connect various approaches to a situation in order to increase student understanding. The lesson provides multiple strategies and models for using those representations indicated by the darkened points of the star to introduce, explore, and reinforce mathematical concepts and to enhance conceptual understanding.

P – Physical
V – Verbal
A – Analytical
N – Numerical
G – Graphical

OBJECTIVES

Students will

- Graph points on a number line
- Graph ordered pairs in the first quadrant
- Draw parallel lines using patterns
- Write a “rule”, verbally and symbolically, based on a pattern
- Investigate sound waves
- Predict visual representations for types of sound waves
- Read sound waves
- Create a model of a sound wave

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COMMON CORE STATE STANDARDS FOR MATHEMATICAL CONTENT

This lesson addresses the following Common Core State Standards for Mathematical Content. The lesson requires that students recall and apply each of these standards rather than providing the initial introduction to the specific skill.

Targeted Standards

4.OA.5 Generate a number of shape of pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

4.G.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

COMMON CORE STATE STANDARDS FOR MATHEMATICAL PRACTICE

These standards describe a variety of instructional practices based on processes and proficiencies that are critical for mathematics instruction. NMSI incorporates these important processes and proficiencies to help students develop knowledge and understanding and to assist them in making important connections across grade levels. This lesson allows teachers to address the following Common Core State Standards for Mathematical Practice.

MP.4 Model with mathematics

Students use water in cups and rubber bands with cardboard to investigate various sound waves.

MP.6 Attend to precision

Students plot ordered pairs correctly. Students write ordered pairs based on patterns and verbal instructions

MP.7 Look for and make use of structure

Students use patterns to create parallel lines and make connections between the ordered pairs and the type of line.

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NEXT GENERATION SCIENCE STANDARDS

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.

ASSESSMENTS

The following types of formative assessments are embedded in this lesson:

- Evaluate the correct identification of patterns
- Correct plotting of points and drawing line segments
- Apply patterns to the appearance of line segments
- Correlation of patterns and the “rules” that create the pattern
- Use correct vocabulary

MATERIALS AND RESOURCES

- Set of *x* and *y* cards for each pair of students
- Set of matching cards for each pair of students
- Manila folders
- Number lines, one labeled *x* and the other labeled *y* or masking tape to mark the scale on the horizontal and vertical axis. Index cards can be used to label the numbers on the scale.
- Masking tape
- Plastic rulers
- Colored pencils
- Scissors
- Plastic cups
- Water
- Various Objects (will be dropped to produce sound)

  Examples: bag of rice, tin can, ruler, baseball, etc.
- Glass cups
- Metal spoons
- Metal coat hanger
- various strings (cotton, fishing line, dental floss, thin metal wire, thread, etc.)

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TEACHING SUGGESTIONS

Sounds Good to Me is an informal introduction to translations, or slides, which is a transformation. Through the use of patterns with ordered pairs, students create parallel lines based on given coordinates. The resulting lines are a translation of the original line. This lesson is also designed to show how patterns relate to sound waves, which is a real world application. Students plot ordered pairs, apply a rule to the ordered pairs, and determine the patterns in sound waves based on a visual model. As a culminating activity, students construct their own sound generating instrument and apply this model to sound waves. In middle grade physical science, the lesson Catch the Wave further reinforces these concepts.

In Activity 1, students develop a basic understanding about coordinate grids and coordinates that represent specific points. Even though this is not a 4th grade standard, through the use of number lines and a physical activity, students are introduced to this concept.

The initial part of this activity is completed with the entire class. Later students will work in groups and pairs as they build their knowledge of the coordinate plane.

In Part 1, students will create two number lines, one vertical and the other horizontal, on the floor. If your classroom has tile floors or carpets squares, use these to mark the scale and create a "grid." Label each number line with *x* for the horizontal line and *y* for the vertical line. Depending on the level of your students, you might want to take time to talk about the coordinate plane and provide some practice before using the *x* and *y* cards. Discuss questions 1 and 2 prior to graphing ordered pairs. Question 3 is designed as a formative assessment once the physical activity has concluded.

A physical representation of plotting ordered pairs is a great way to introduce or reinforce this concept. Ask for two volunteers to be the *x* and *y* coordinates. Have the students stand at the appropriate number on the number lines based on the cards they draw from the *x* and *y* deck. For example, if one student has 3 and the other student has 4, have the students walk to their number on the number lines. Ask the students to walk along their respective lines, horizontal or vertical, until they meet. Discuss that this point has an *x* value of 3 and a *y* value of 4. Continue with this process until the students can plot ordered pairs. Emphasize the importance of the order of the coordinates and how the *x* and *y* coordinates are not interchangeable through specific examples. Use 4 students so that the class can visually see the difference. Practice this concept using the *x* and *y* cards either physically or have pairs of students plot the ordered pairs on grid paper.

As a class activity in Part 2, students try to locate your "hiding spot". This is very similar to the "Battleship" game. Select an ordered pair from the deck. This represents your "hiding spot." Place the cards back in the deck. Have each group draw the *x* and y cards from the deck and plot the ordered pair either on the floor or on a grid at the board. Make sure the students place their cards back in the deck. You may want to shuffle the cards after each draw. Students record each ordered pair on their table to keep track of the previous moves. If no one discovers your location after 15 moves, provide a hint so that teams can guess the spot.

In Part 3, students create their own "hiding spot" on a piece of grid paper. Each student selects an ordered pair and marks this on their grid. Using a folder to hide their graph, the students face each other. They take turns drawing from their decks to find the where the other is hiding. Make sure they record the ordered pairs and

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return the cards to the deck. The first person to locate the spot wins. If the students have not located their "hiding spot" within 15 moves, have them give a hint to their partner.

Activity 2 allows students to build upon their understanding and use coordinate grids to plot coordinates generated by the class. The approach to this activity is more formal and includes specific vocabulary. They will read and interpret already plotted coordinate points. Students should work on this activity in small groups of 3 – 5 in order to best facilitate discussion. This is a good opportunity for you to determine any misconceptions that students have about plotting points after the explicit directions in Activity 1. Many students reverse the coordinates, so they have been purposefully asked to do so in this activity in order to elicit a discussion about the importance of properly plotting the points. For example, the location of point (11, 3) would be far different from the location of point (3, 11).

Part 1 begins with students collecting data using the length of their hands. The data is plotted on the provided grid. Inches and centimeters should be rounded to the nearest whole number.

Since these points are considered to be discrete data, the students cannot connect the dots. Instead they are going to observe that if they could connect the points, a straight line segment would be the shape. Have students use their rulers to "line" up the points to help them draw this conclusion. Since the ordered pairs may not line up perfectly with the ruler, the "trend" should be obvious. This is a great opportunity to talk about "variation" in data. Questions 6 and 7 reinforces the importance of correctly plotting ordered pairs. This part of the lesson is foreshadowing "trend lines" which is taught in middle school.

In Part 2, students are asked to recognize patterns in already plotted points and create patterns of their own. This activity works best in pairs. For assessment purposes, the teacher may elect to give each student their own set of questions to answer in conjunction with the activity. Discuss that sometimes there are patterns within patterns. For example, if the pattern is "add 2," then the first coordinate is an odd number, the second coordinate will also be an odd number as well. When looking at the ordered pairs, there is a difference of 2 between the *x*-coordinates and a difference of 3 between the y-coordinates. This process foreshadows rate of change.

Ask the students for examples of other patterns within patterns. If a student is having difficulty recognizing these patterns, the teacher may want to assist a student's understanding by supplying examples of patterns that are not coupled with the coordinate grid. This will also isolate the student's misconceptions, and allow the teacher to see whether or not the student is having difficulty with patterns themselves or creating the coordinate grid. Teachers might also decide to scaffold a student's understanding of pattern making by supplying manipulative objects and visual aids. Students who are struggling to see the patterns within patterns can do so more easily on pre-labeled items such as chess or checker boards whereas the red squares represent even numbers and the black squares represents odds. Additionally, number lines are a familiar tool that can be used to help better see patterns, so that they can transition into seeing the patterns on a coordinate grid.

As students use patterns, they identify the types of line segments they plot based on specific instructions. For example, when the students are asked to add 3 to each *x* coordinate, they have created a parallel line. To reinforce this

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concept, they have to draw a parallel line and then write the coordinates along with other instructions.

In Part 3, students continue to use patterns to graph ordered pairs. Provide the students with a coordinate grid and colored pencils. Based on the given ordered pairs, students use written instructions to plot the points and then answer questions. As an option, provide different ordered pairs to each group. Post their graphs and have a "gallery" walk to discuss the similarities and differences between each grid.

Students write the "rule" based on the pattern for the coordinates. They begin by identifying the relationship between the *x* and *y* coordinates and then they write the pattern using symbols.

In Part 4, students match the table, verbal description of the pattern, the symbolic representation of the pattern, and the graph. Multiple representations of ordered pairs is a very important part of graphing.

In Activity 3, the students are asked to transfer their knowledge of coordinate grids and patterns into an investigation on sound. In Part 2, the students are introduced to the real-world application of coordinate grids as they are used in oscilloscope-produced images. The students will be introduced to patterns that are not linear, and therefore do not follow rules that are as simple as those they worked with earlier. The students will need to explain these more complex relationships in their own words.

Students will also be required to make predictions as to the visual representations and the types of sound that would be produced based on in-class reading on the sound wave.

In Activity 4, student will explore sound as it travels through different mediums. First, the students will explore the difference in sound as a spoon clink travels through air versus a string. Then, they will use the same experimental setup but with a coat hanger instead of a spoon. Finally, students will select another variable, string type or string length, to investigate on their own. Provide the students with a variety of string types such as cotton string, dental floss, fishing line, thread, and even thin metal wires.

Sound waves travel through a variety of mediums to reach our ears. Once they reach our ears they move the eardrum which in turn moves the three tiny bones in our inner ear which ultimately results in signals being send to our auditory nerve that our brain interprets as sound. If the sound waves and their energy travel through a solid, such as string they can easily transmit their energy through the molecules in the string, send the energy in your fingers and get transmitted to your ears without losing a lot of energy. The more energy the sound wave contains the more it will cause your eardrum to move and the more those tiny bones in your ear will dance and your brain sense a very loud sound.

Unlike the string, which is a solid with tightly packed together molecules, the air contains gas molecules that are spaced quite far apart. In order for the sound waves and their energy to reach your ears it must "hop" from gas molecule to gas molecule. All of this "hopping" between molecules expends a lot of energy and by the time the sound wave reaches your ear drum it has left a lot of its energy behind in the air molecules. As a result of all of this hopping around the sound wave has less energy and produces a quieter sound.

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Sounds Good to Me

Activity 1: Location, Location, Location...

PART 1: PLOTTING ORDERED PAIRS

1. What do you notice about the lines?

   Possible reasonable answers could include that it looks like a grid, it is made up of squares, all the spaces are the same, or that the lines intersect at perpendicular angles. There appear to be two number lines, one going left to right and the other up and down.

2. Do the lines remind you of anything that you have seen before? Explain your answer.

   Possible answers could include that is reminds the student of graph paper, tiles on the floor, base-ten blocks, or anything that is made up of uniform squares.

3. Now that you have observed how to plot points, write a sentence to describe how to plot x = 5 and y = 3.

   Possible answer is "You move 5 spaces along the horizontal number line and then move up 3 spaces."

ANSWER KEY

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PART 2: HIDE AND GO SEEK

Record all of the points that have been drawn in the table.

Number of Draws	X	Y
Example	5	7
1	4	9
2	1	7
3	8	5
4	7	8
5	9	3
6	4	9
7	6	6
8	6	8
9	4	3
10	2	7
11	7	3
12	6	5
13	7	6
14	6	3
15	5	9

ANSWER KEY

Where is the teacher hiding?

If the students have not guessed the location after fifteen moves, give them a hint such as the x-coordinate is 5, and the y-coordinate is less than 9 but greater than 6.

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PART 3: NOW IT'S MY TURN TO HIDE

Example: You select $x = 2$ and $y = 4$. Make a dot to mark the spot and record in the table.

Record all coordinates that you select from the deck of cards in the table.

Number of Draws	X	Y
Example	2	4
1	4	9
2	1	7
3	8	5
4	7	8
5	9	3
6	4	9
7	6	6
8	6	8
9	4	3
10	2	7
11	7	3
12	6	5
13	7	6
14	6	3
15	5	9

Where is your partner hiding?

Have the partner provide a hint if the student has not located the spot in 15 moves.

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Activity 2: Plotting Points

PART 1: UNDERSTANDING COORDINATE GRIDS

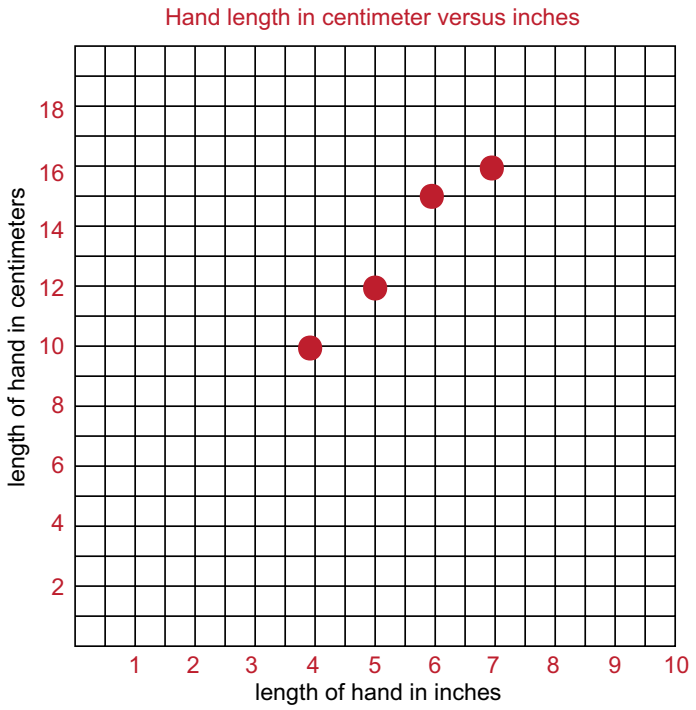
1. Using the diagram below, measure the length of the hand of each person in your group using inches and then centimeters. Round to the nearest inch and centimeter. Record the results in the table.

Length of hand in inches	Length of hand in centimeters
5	12
6	15
4	10
5	12
7	16

2. Re-write the measurements below as coordinate points, where inches are the *x*-coordinates and the centimeters are the *y*-coordinates. For example, if the length of the hand measures 5 inches and 12 centimeters, the coordinates would be (5, 12).

   (5, 12) (6, 15) (4, 10) (5, 12) (7, 16)

3. Plot the points on the graph.



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4. Use your ruler to help describe the appearance of the ordered pairs.

   Answers will vary, but the students should observe that the data forms a mostly straight line even though some points may not be exactly on the line.

5. Why do you think the ordered pairs form that shape?

   The students should draw a connection between the "trend" appearance of the points and the variation in the lengths of their hands.

6. How do you think the points on the grid would have looked like if we had reversed the coordinates (length of the hand in centimeters as the *x*-coordinate and the length of the hand in inches as the *y*-coordinate).

   Answers will vary, but students should give a reason for their prediction.

7. Reverse the coordinates and graph the points. What happened to the appearance of the ordered pairs?

   Answers will vary. The students should note that the location of the points are different, and as a result, orientation of the "trend" is different. We would like the students to observe that this "trend" is not as steep as the original line.

8. How do the points on the grid from question 7 compare to your prediction in question 6?

   Answers will vary but should reference both their prediction and result. For example, "we predicted that the graph might be a line going down, but it turned out to be a line going up just not as steep."

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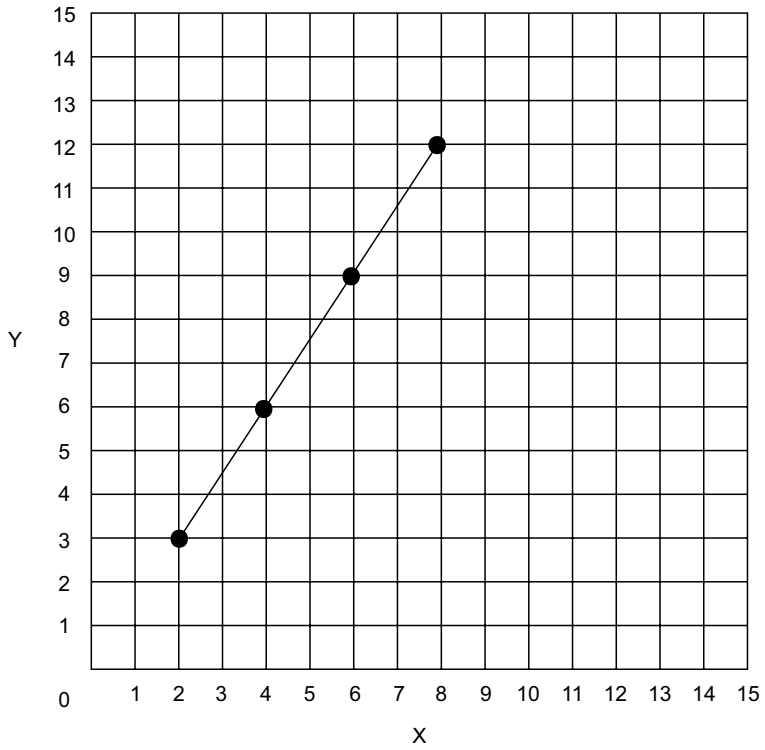
PART 2: PATTERNS WITH ORDERED PAIRS

1. Complete the chart below with the *x* and *y* coordinates of the plotted points in the given graph.



x-coordinate	*y*-coordinate
2	3
4	6
6	9
8	12

2. Add 3 units to each of the *x*-coordinates. Use a different color to plot the new ordered pairs and connect them with a line segment.

x-coordinate + 3	*y*-coordinate
5	3
7	6
9	9
11	12

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3. What type of line segment did you draw compared to the original line segment? Justify your answer.

   The line segment is parallel to the original line. This is because the lines will never intersect.

4. Draw a line segment that is parallel to the original line segment and record the coordinates in the table.

x-coordinate	*y*-coordinate
4	6
6	6
8	9
10	12

5. How do the coordinate points of your line segment compare to the original points?

   The x-coordinate is two more than the original coordinates.

6. Do you think you would always create parallel line segments if you add any number to the *x*-coordinate of the original ordered pairs?

   Yes; the lines would always be parallel because we are sliding the original line to the right by the same number of units for each x-coordinate.

7. Reverse the coordinates for the original line segment and record the ordered pairs in the table.

x-coordinate	*y*-coordinate
3	2
6	4
9	6
12	8

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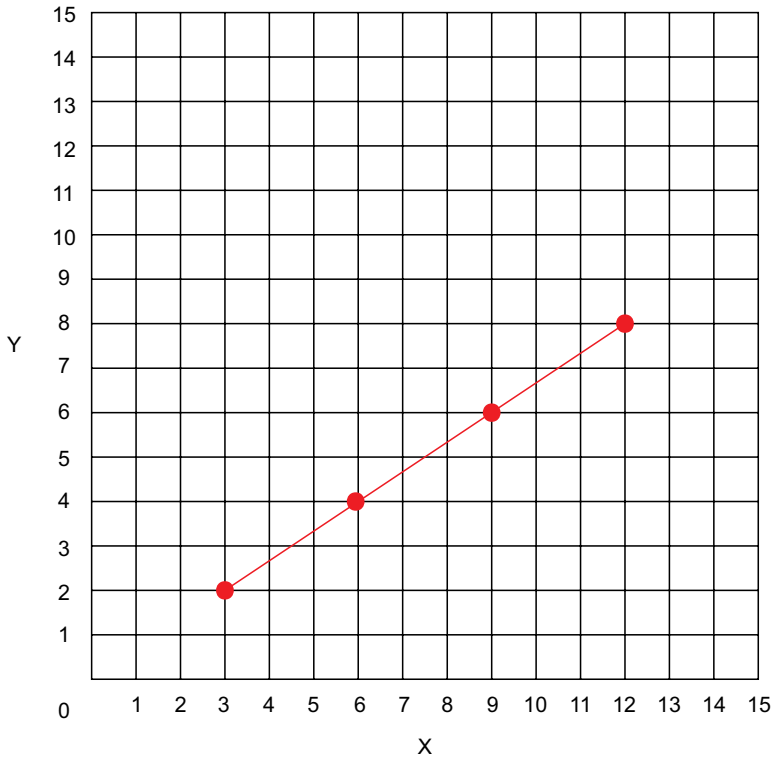
8. Use another color to plot and connect these points to form a line segment.



9. What type of line segment did you draw compared to the original line segment? Justify your answer.

The students should note that the location of the points are different, and as a result, orientation of the line is different. It is still a line, but it doesn't have as steep a slope.

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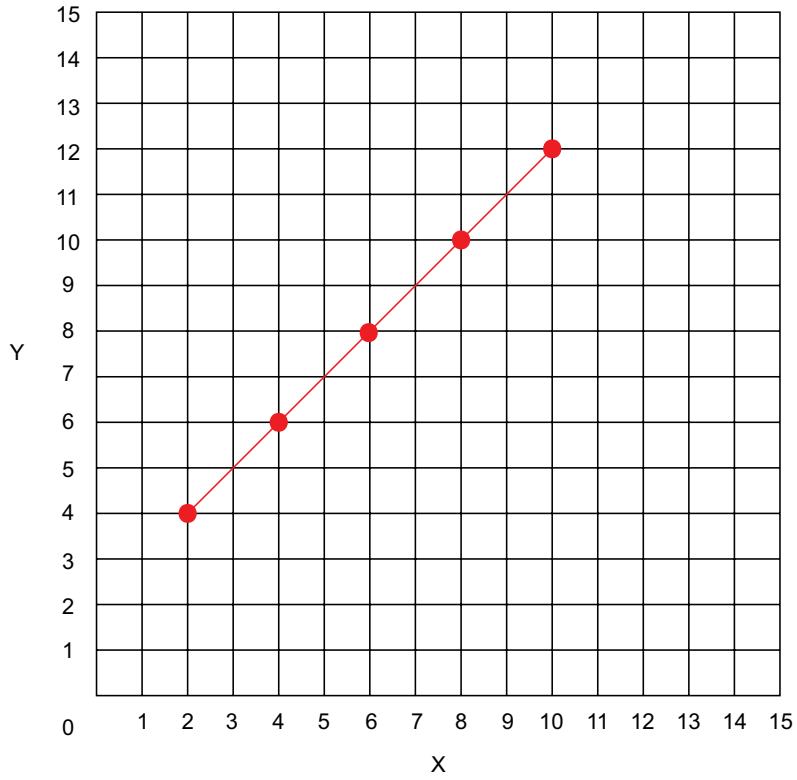
PART 3: PLAYING WITH PATTERNS

Your group will receive a coordinate grid and colored pencils.

1. Using the coordinates below, plot and connect the following points on your coordinate grid in red.

x-coordinate	*y*-coordinate
2	4
4	6
6	8
8	10
10	12



2. Look at the first *x*-coordinate and the first y-coordinate in the table. Do the points follow a pattern? If so, what is the pattern?

   Yes, the points follow a pattern. The y-coordinate is larger than the x-coordinate by 2 units.

3. What would be the *y*-coordinate if $x = 3$?

   $y = 5$

4. What would be the *y*-coordinate if $x = 7$?

   $y = 9$

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5. Write a numerical sentence to describe how you determine the *y*-coordinate given the *x*-coordinate.

   y-coordinate = *x*-coordinate + 2

   $y = x + 2$

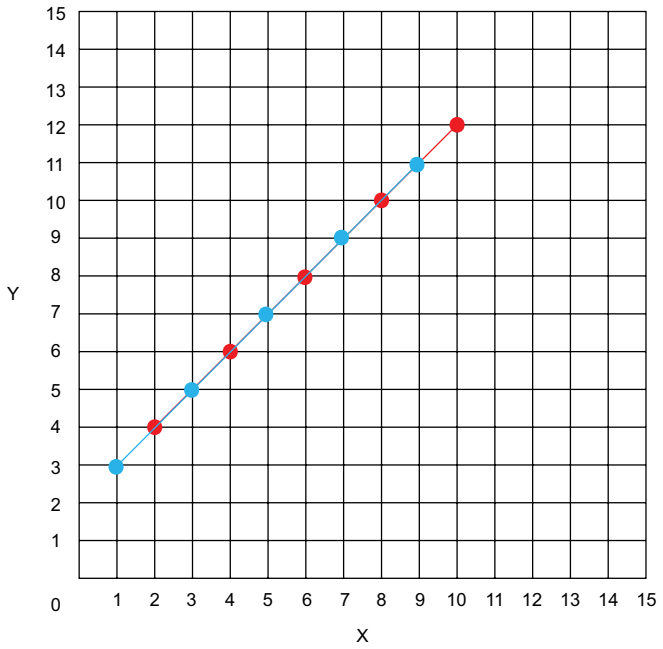
6. If the points followed the same pattern, what would the *y*-coordinate be if the first *x*-coordinate is 1 instead of 2?

   $y = 3$

7. Complete the chart below using the pattern from step 1. Write the numerical sentence from question 5 in the blank for the pattern.

Pattern:	$y = x + 2$
***x*-coordinate**	***y*-coordinate**
1	3
3	5
5	7
7	9
9	11

8. Graph the points on the grid using the blue pencil.



9. What portion of the lines, the original and the blue line, overlap?

   All but the short line segment from (2, 0) to (1, 3) overlaps

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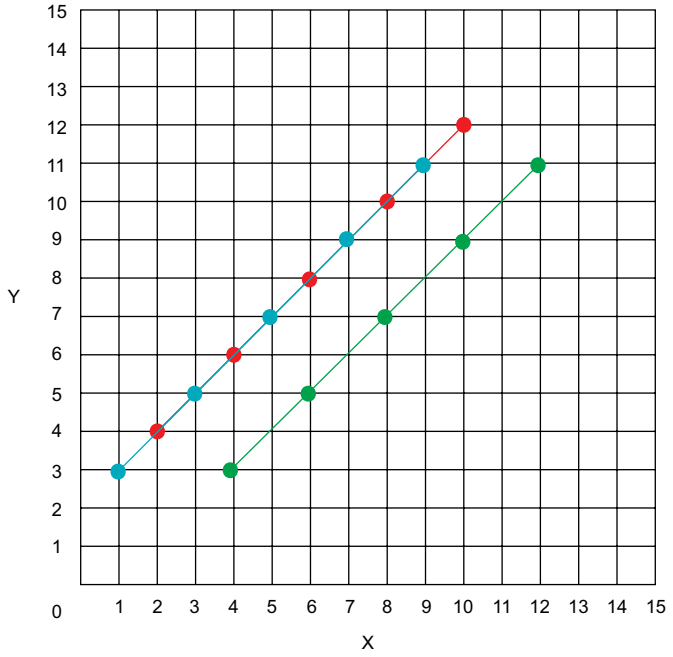
10. Using your green colored pencil, draw a line segment on your coordinate grid that is parallel to the segments on the grid. Mark at least three points of this line with your colored pencil.



11. Complete the table with the points of your new line segment.

x-coordinate	*y*-coordinate
4	3
6	5
8	7
10	9
12	11

12. What type of line segment did you create? How many units and in what direction is the green line compared to the original line?

    Parallel line; The green line moved 3 units to the right of the original line.

13. Is there a pattern to the coordinates you created? If so, what is the pattern?

    Parallel line; The green line moved 3 units to the right of the original line.

14. Use a number sentence to describe the pattern in your table.

    $y = x - 1$

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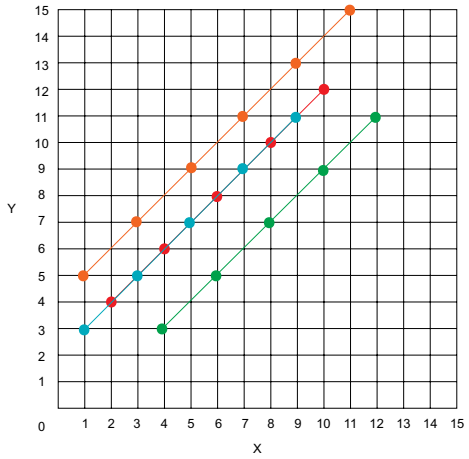
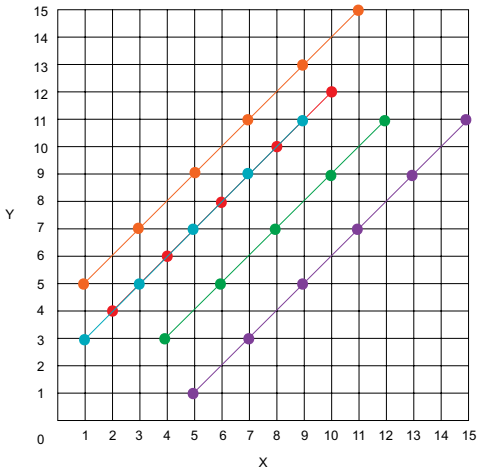
15. Create a new pattern for the coordinates that has not been used before. Give the pattern to another student and have them write the ordered pairs based on this pattern.

Pattern: $y = x + 4$	
x-coordinate	*y*-coordinate
1	5
3	7
5	9
7	11
9	13

16. Draw the line on your coordinate grid using the orange pencil.



17. Reverse the coordinates (switch the *x* and *y* coordinates) and draw the line on your coordinate grid using the purple pencil.



18. How does the purple line look as compared to the orange line?

The lines are parallel.

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PART 4: THE MATCHING GAME

In pairs, match the patterns, in words and symbols, with the table of coordinates and the graph of the line segment. Record your answers in the table using the letters on the cards to identify your match.

Graph	Table	Pattern	Verbal Description of Pattern
A	G	U	Q
B	H	V	S
C	I	W	R
D	J	X	T

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Activity 3: Seeing Sound

PART 1: SOUNDS ALL AROUND

1. How close were your guesses to the actual objects that were dropped?

   Answers will vary, but students should reflect on wether they got the majority correct, objects were similar, etc.

2. Were some objects easier to infer correctly than others? If so, why?

   Answers will vary, but students should connect that more familiar objects or perhaps objects that make a more distinct or intense sound were easier to identify.

3. If you were going to do this activity again, what other objects do you think would be good to include? Why do you think that?

   Answers will vary, but students should justify their reasoning. They may argue that unfamiliar objects should be used to challenge the players or motivate them to think creatively, or they may argue that familiar objects should be used to help players guess the object.

4. Were the sounds different each time your teacher dropped the spoon? Why do you think so?

   The sounds should vary intensity or volume.

5. What do you think caused the difference in the sound?

   Answers will vary, but students might suggest that the type of material the object was made of was important.

6. Describe what happened when you hit the different glasses.

   The sounds should vary intensity or volume.

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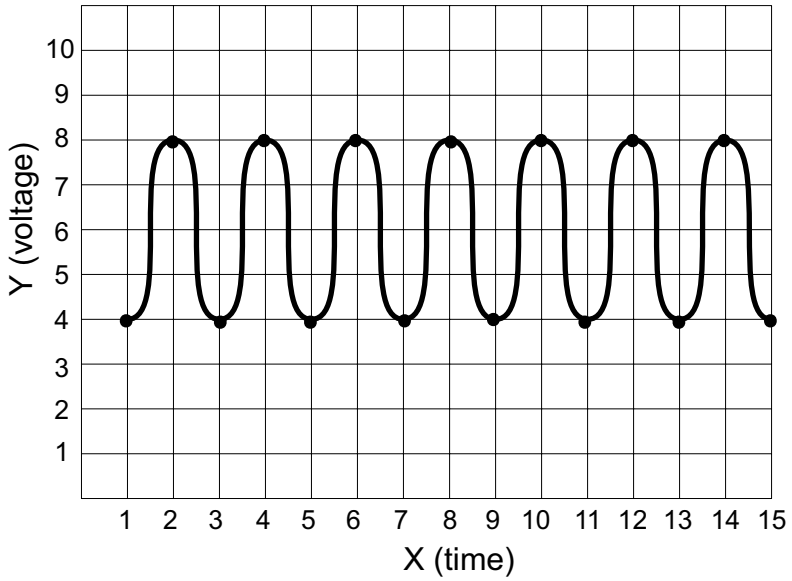
PART 2: UNDERSTAND SOUND WAVES

Luis' Flute: Image 1



The image an oscilloscope creates is like a coordinate grid. Luis is playing his flute into an oscilloscope and creates the image above. Using the oscilloscope image from Luis' flute, fill in the missing coordinate points on the chart below.

x coordinate	*y* coordinate
1	4
2	8
3	4
4	8
5	4
6	8
7	4
8	8
9	4
10	8
11	4
12	8
13	4
14	8
15	4

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7. Is there a pattern to the coordinates? If so, describe the pattern.

   Yes, as *x* increases by 1 the *y* values go back and forth between 4 and 8. Or, if the *x* coordinate is even, the *y* coordinate is 8, if the *x* coordinate is odd, the *y* coordinate is 4.

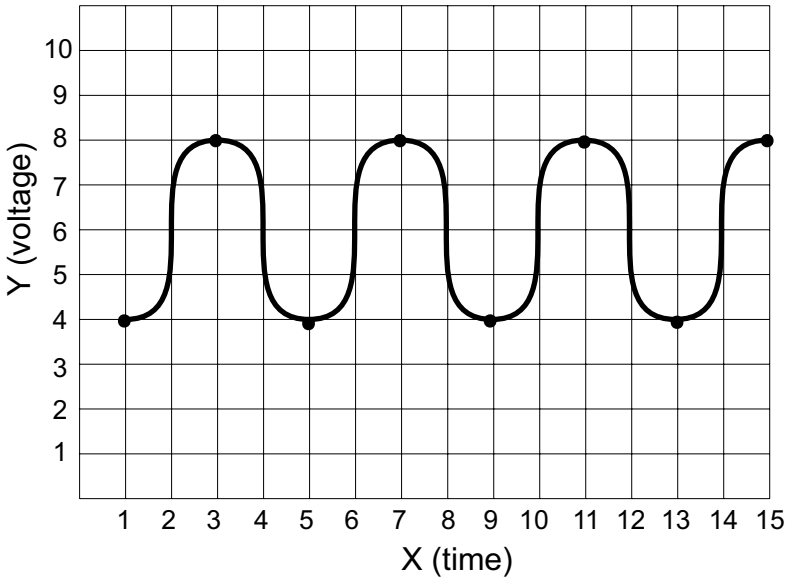
8. What is the wavelength? Show the work that leads to your answer.

   For this wave, the wavelength would be 2. You can subtract two x coordinates with the same *y* coordinate because the wavelength is the distance between crests.

9. What is the amplitude of the wave? Explain your answer.

   The amplitude of the wave is 2 because 8 is the crest and 4 is the trough. 6 is in the middle of those two numbers. 8 is 2 more than 6 and 4 is 2 less than 6.

Luis' Flute: Image 2



10. Is Luis' flute producing a louder or softer sound than before? Explain.

    It is producing the same volume of sound because the amplitude is the same.

11. Describe how the frequency has changed now that Luis' fingers are in a different position.

    There are fewer crests so there is a lower frequency. This would make a lower-pitched sound.

12. Is there a pattern for the points plotted on the second oscilloscope image? If so, what is it?

    Yes, as *x* increases by 2 the *y* values go back and forth between 4 and 8.

ANSWER KEY

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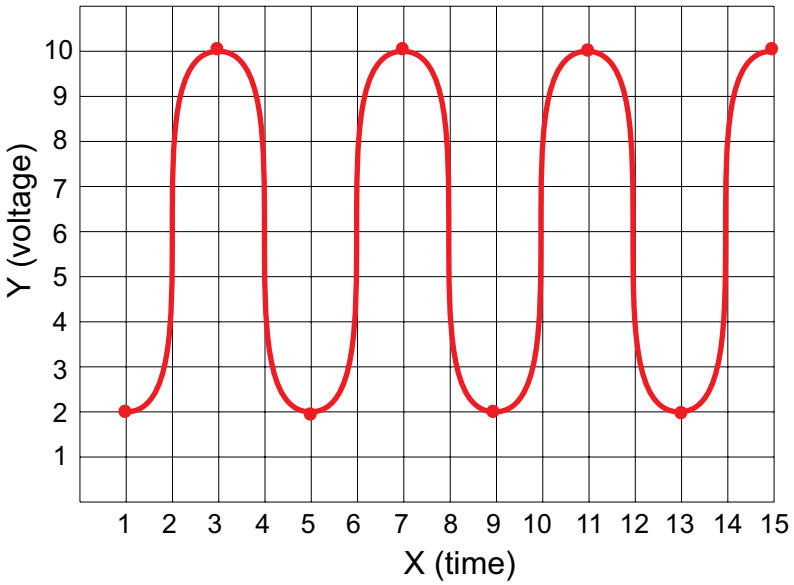
13. Luis keeps his fingers in the same position, but this time he blows through the flute much harder. Predict how that would change the image on the oscilloscope. If you would like, you can make a labeled diagram as part of your explanation.

The amplitude of the wave changes, but not the frequency.



ANSWER KEY

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Activity 4: Singing Strings

QUESTIONS

1. Why do you think the sound of the spoon or coat hanger hitting the table is different when you fingers are in your ears as compared to when they are out of your ears? Remember the sound is travelling in a wave and needs a medium to travel through.

   Answers will vary but students might recognize that the sound is travelling through a different medium -- air or string.

2. During the experiments where did the energy come from that produced the sound wave?

   The energy comes from the clinking of the objects together.

3. Describe the path the sound wave and its energy travelled during Experiment 1 when you did not have your fingers with the string wrapped around them in your ears and you banged the spoon against the table.

   Energy was transferred from my body to the spoon as I clinked it on the desk. Then, the energy was transferred to the air in the form of sound waves. Eventually the energy was transferred to my eardrum which caused my brain to register the sound.

4. Describe the path that the sound wave and its energy travelled during Experiment 2 when you had your fingers with the string wrapped around them in your ears and you banged the spoon against the table.

   Energy was transferred from my body to the spoon as I clinked it on the desk. Then, the energy was transferred to the string in the form of sound waves. Eventually the energy was transferred to my eardrum which caused my brain to register the sound.

5. In which Experiment, 1 or 2, did the banging spoon create a louder sound?

   Experiment 2

6. In which Experiment, 1 or 2, did the sound waves and their energy travel through a solid to reach your ears? What was the solid?

   Experiment 2; string

7. In which Experiment, 1 or 2, did the sound waves and their energy have to travel through the air to reach your ears?

   Experiment 1

8. How do the sounds from the coat hanger compare to those of the spoon? same? different? louder? different pitch?

   Answers will vary, but students might suggest that one had a “higher” sound than the other.

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9. Describe some additional experiments you could conduct that would be similar to what you have done here. If you have the materials at home to try them, come back and report to your class what you found.

   Answers will vary, but students may wonder what different objects they could connect to the strings. They may have more questions about the string length and some make connects to the “cans on a string” telephone that they’ve seen in movies. Encourage students to try all kinds of explorations with sound and report back to the class.

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Sounds Good to Me

Activity 1: Location, Location, Location…

Have you ever wondered how a GPS system can locate your position or give you driving directions to your favorite restaurant? Locating a specific point is based on longitude and latitude. This grid system uses coordinates to describe the exact location of a specific address.

PART 1: PLOTTING ORDERED PAIRS

Your teacher has created two lines on the floor. Discuss your observations with your group.

1. What do you notice about the lines?

2. Do the lines remind you of anything that you have seen before? Explain your answer.

3. Now that you have observed how to plot points, write a sentence to describe how to plot $x = 5$ and $y = 3$.

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PART 2: HIDE AND GO SEEK

- Each group will take turns trying to locate where your teacher is hiding.
- For each turn, your group will draw a card from the X deck and a card from the Y deck.
- Plot the point on the grid located on the board. Your teacher will tell you if you found the hiding spot
- Return the cards to the deck and shuffle.
- Use the table to record all previous moves.
- If you draw the same coordinates, redraw the X and Y cards.
- The first team to discover the hiding place wins.

Record all of the points that have been drawn in the table.

Number of Draws	X	Y
Example	5	7
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Where is the teacher hiding?

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PART 3: NOW IT'S MY TURN TO HIDE

You and a partner are going to recreate the game, this time playing on graph paper instead of the grid on the floor. You will each have a piece of graph paper, a folder, and your X and Y decks of cards.

- Sit facing each other.
- Place folders standing upright so you cannot see your partner's paper and he or she cannot see your paper.
- Draw an X and a Y card. On your grid paper mark this as your hiding spot using a pen. Your partner does the same. Do not show each other your hiding spots.
- Take turns drawing from your deck of coordinates, calling out the coordinates to your partner so they can confirm or deny if you have found their hiding spot.
- Using a pencil, mark a point on your provided grid for each ordered pair you select until you find your partner's hiding spot.
- Record the ordered pairs you select in the table. This way you have a list of the coordinates you have drawn. If you draw the same coordinates as one in your list, draw again.
- The first person to find the other person's hiding spot wins.
- If you run out of cards before you find the spot, shuffle your cards and try again.

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Example: You select $x = 2$ and $y = 4$. Make a dot to mark the spot and record in the table.

Record all coordinates that you select from the deck of cards in the table.

Number of Draws	X	Y
Example	2	4
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Where is your partner hiding?

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Activity 2: Plotting Points

Now that you have practiced plotting ordered pairs, we are going to use the skills by collecting data.

PART 1: UNDERSTANDING COORDINATE GRIDS

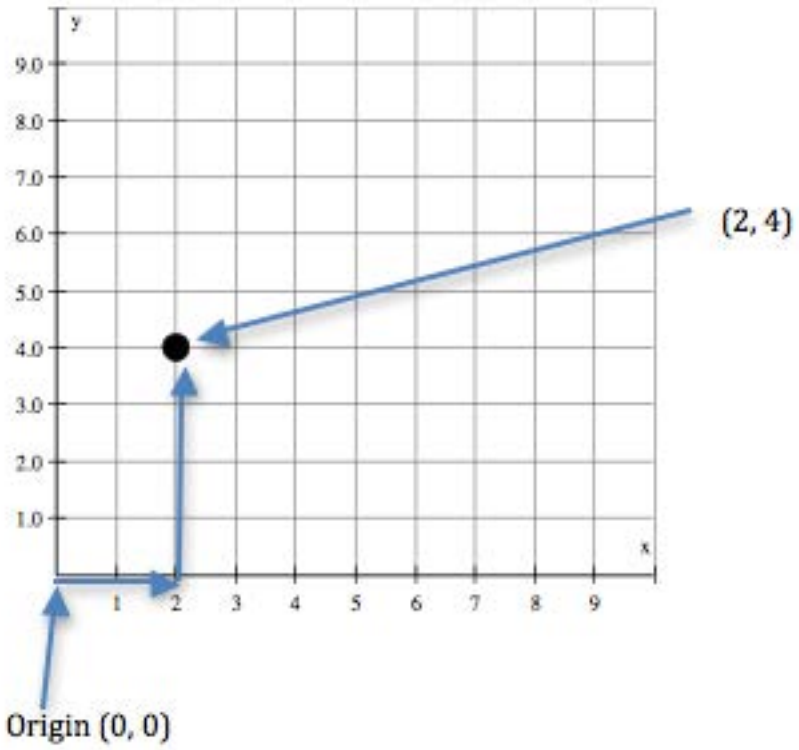
Coordinate grids have an *x* and a *y*-axis that extend from a point of origin where they meet. The *x*-axis is horizontal, and the *y*-axis is vertical.

To find a location on your coordinate grid, you need to know the *x* and *y* coordinates. These are written as a pair in parenthesis with the *x* coordinate written before the y coordinate – just like *x* is before *y* in the alphabet.

For example, in the coordinate pair (2, 4), 2 is the *x*-coordinate and 4 is the *y*-coordinate.

To find this point on the coordinate grid, you would start at the point of origin and count two spaces to the right of the point of origin and four spaces above the location of the *x*-coordinate. The point of origin where the *x* and *y*-axis meet always has the same coordinate: (0,0).

The dot on the grid is the location of (2, 4).



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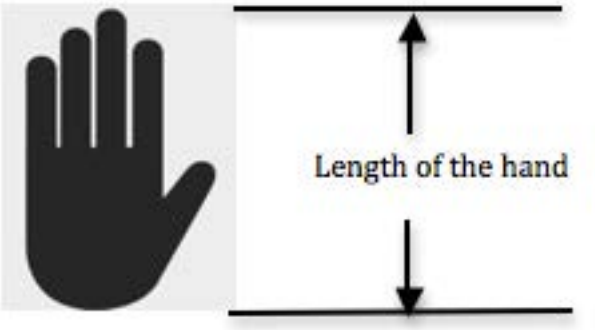
1. Using the diagram below, measure the length of the hand of each person in your group using inches and then centimeters. Round to the nearest inch and centimeter. Record the results in the table.



Length of hand in inches	Length of hand in centimeters

2. Re-write the measurements below as coordinate points, where inches are the *x*-coordinates and the centimeters are the *y*-coordinates. For example, if the length of the hand measures 5 inches and 12 centimeters, the coordinates would be (5, 12).

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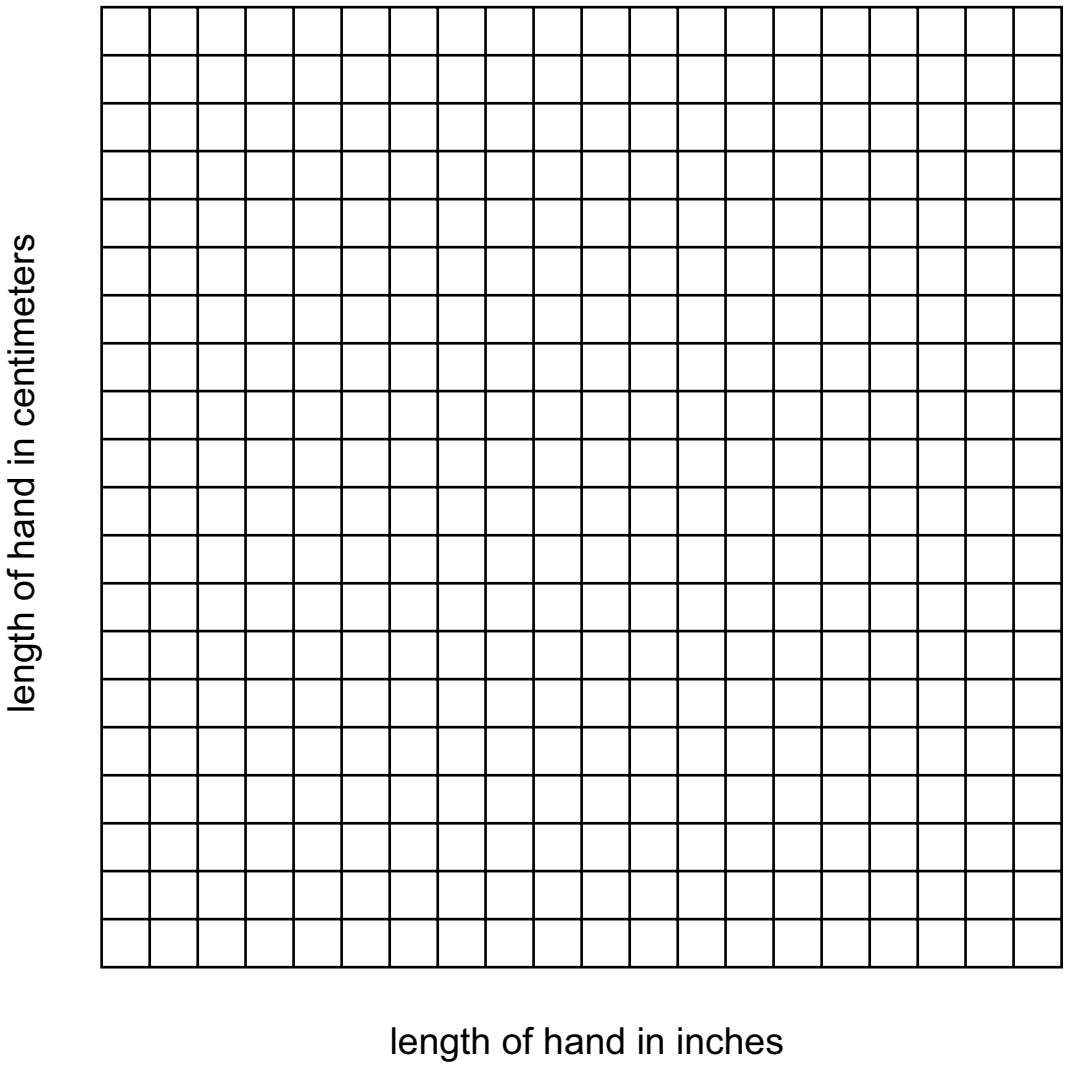
3. Plot the points on the graph.



4. Use your ruler to help describe the appearance of the ordered pairs.

5. Why do you think the ordered pairs form that shape?

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6. How do you think the points on the grid would have looked like if we had reversed the coordinates (length of the hand in centimeters as the *x*-coordinate and the length of the hand in inches as the *y*-coordinate).

7. Reverse the coordinates and graph the points and graph the points using a different color pencil or pen. What happened to the appearance of the ordered pairs?

8. How do the points on the grid from question 7 compare to your prediction in question 6?

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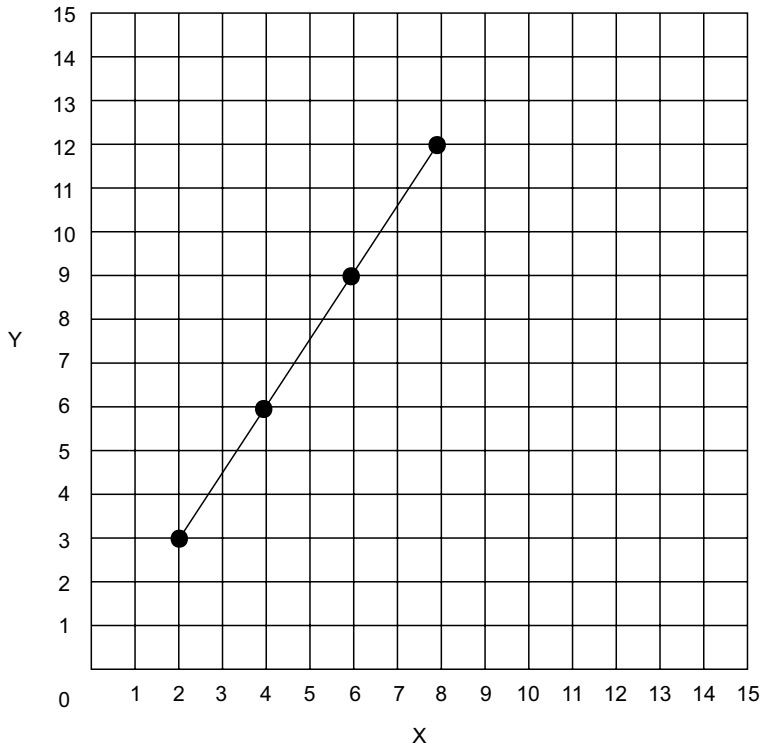
PART 2: PATTERNS WITH ORDERED PAIRS

1. Complete the chart below with the *x* and *y* coordinates of the plotted points in the given graph.



x-coordinate	*y*-coordinate

2. Add 3 units to each of the *x*-coordinates. Use a different color to plot the new ordered pairs and connect them with a line segment.

x-coordinate + 3	*y*-coordinate

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3. What type of line segment did you draw compared to the original line segment? Justify your answer.

4. Draw a line segment that is parallel to the original line segment and record the coordinates in the table.

x-coordinate	*y*-coordinate

5. How do the coordinate points of your line segment compare to the original points?

6. Do you think you would always create parallel line segments if you add any number to the *x*-coordinate of the original ordered pairs?

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7. Reverse the coordinates for the original line segment and record the ordered pairs in the table.

x-coordinate	*y*-coordinate

8. Use another color to plot and connect these points to form a line segment.

9. What type of line segment did you draw compared to the original line segment? Justify your answer.

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PART 3: PLAYING WITH PATTERNS

Your group will receive a coordinate grid and colored pencils.

1. Using the coordinates below, plot and connect the following points on your coordinate grid in red.

x-coordinate	*y*-coordinate
2	4
4	6
6	8
8	10
10	12

2. Look at the first *x*-coordinate and the first y-coordinate in the table. Do the points follow a pattern? If so, what is the pattern?

3. What would be the *y*-coordinate if $x = 3$?

4. What would be the *y*-coordinate if $x = 7$?

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5. Write a numerical sentence to describe how you determine the *y*-coordinate given the *x*-coordinate.

   y-coordinate = *x*-coordinate + _____

   $y = x +$ _____

6. If the points followed the same pattern, what would the *y*-coordinate be if the first *x*-coordinate is 1 instead of 2?

7. Complete the chart below using the pattern from step 1. Write the numerical sentence from question 5 in the blank for the pattern.

Pattern:_____	
***x*-coordinate**	***y*-coordinate**
1	
3	
5	
7	
9	

8. Graph the points on the grid using the blue pencil.

9. What portion of the lines, the original and the blue line, overlap?

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10. Using your green colored pencil, draw a line segment on your coordinate grid that is parallel to the segments on the grid. Mark at least three points of this line with your colored pencil.

11. Complete the table with the points of your new line segment.

x-coordinate	*y*-coordinate

12. What type of line segment did you create? How many units and in what direction is the green line compared to the original line?

13. Is there a pattern to the coordinates you created? If so, what is the pattern?

14. Use a number sentence to describe the pattern in your table.

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15. Create a new pattern for the coordinates that has not been used before. Give the pattern to another student and have them write the ordered pairs based on this pattern.

Pattern:_____	
x-coordinate	*y*-coordinate

16. Draw the line on your coordinate grid using the orange pencil.

17. Reverse the coordinates (switch the *x* and *y* coordinates) and draw the line on your coordinate grid using the purple pencil.

18. How does the purple line look as compared to the orange line?

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PART 4: THE MATCHING GAME

In pairs, match the patterns, in words and symbols, with the table of coordinates and the graph of the line segment. Record your answers in the table using the letters on the cards to identify your match.

Graph	Table	Pattern	Verbal Description of Pattern

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Activity 3: Seeing Sound

PART 1: SOUNDS ALL AROUND

Your teacher is going to drop some objects from the other side of the room. With your eyes closed, make an guess about what the objects might be.

	Guess	Actual Object
Example	Bean Bag	Bag of Rice
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

1. How close were your guesses to the actual objects that were dropped?

2. Were some objects easier to infer correctly than others? If so, why?

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3. If you were going to do this activity again, what other objects do you think would be good to include? Why do you think that?

Now your teacher is going to drop a spoon from the other side of the room five times. With your eyes closed, think about the sounds the spoon makes as it hits the floor.

4. Were the sounds different each time your teacher dropped the spoon? Why do you think so?

5. What do you think caused the difference in the sound?

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You are now going to investigate with some materials in a small group. Your group will need four identical glasses, water, and a ruler.

- Pour water into the first jar until it is almost full.
- Measure the height of the water from the base of the jar to the top of the water.
- Write that measurement here: _____.
- Divide that number in half and write that measurement here: _____. Holding your ruler up to the second glass, pour that amount of water into the second glass.
- Now, divide the amount of water in the second glass in half and write that measurement here: _____. Holding your ruler up to the third glass, pour that amount of water into the third glass.
- Leave the last glass empty.
- Now, tap the mouth of the glasses one at a time with your spoon.

6. Describe what happened when you hit the different glasses.

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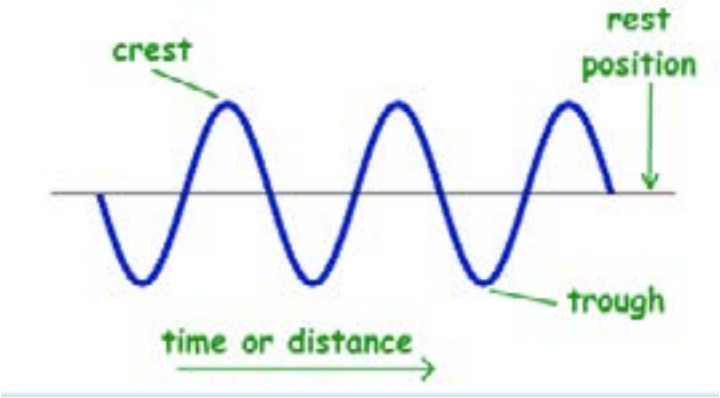
PART 2: UNDERSTAND SOUND WAVES

When most people think of sound they think of hearing. Today, however, we are going to work with sound you can see.

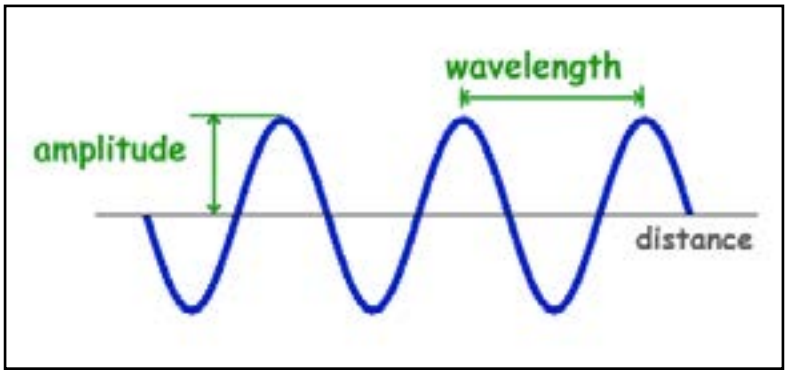
- Take a plastic ruler and hang it about six inches over the edge of your desk.
- Pluck the ruler as you would a guitar string.
- Observe what happens.
- Change the length of ruler that hangs over the edge and pluck it again.
- How does the sound change?

When you pluck the plastic ruler, it creates vibrations. Vibrations create sound. When the ruler vibrates, it causes the air molecules around it to vibrate, too. Then those air molecules cause other nearby objects to vibrate, too. When energy is transferred like this from the source of the sound, it creates sound waves.



When scientists are talking about sound waves, they use certain vocabulary to describe the wave.

Each unique sound produces a sound wave with a unique shape. The distance from the resting position to the top of the crest or the bottom of the trough is called the amplitude. Louder, more intense sounds will have higher amplitude. Softer, less intense sounds will have smaller amplitude.



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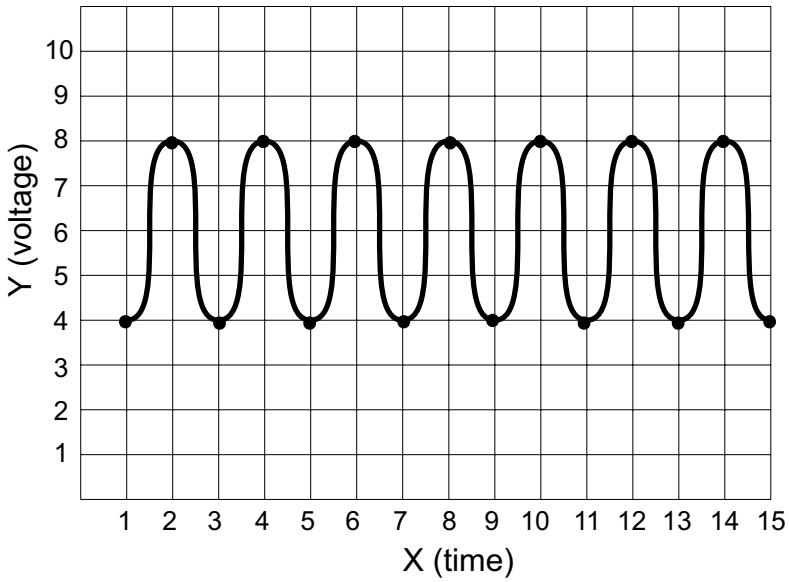
The distance from crest to crest is called the wavelength. The wavelength of a sound wave will depend on what kind of sound is being made. Sometimes scientists will represent this length using the Greek letter lambda. λ is the symbol for lambda. The number of wavelengths that pass through a point at a certain amount of time is called the frequency.

Though sound waves are invisible in reality, scientists can use an oscilloscope to create images of sound waves like this:

Let's look at some of the images from an oscilloscope.

Luis' Flute: Image 1



The image an oscilloscope creates is like a coordinate grid. Luis is playing his flute into an oscilloscope and creates the image above.

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1. Using the oscilloscope image from Luis' flute, fill in the missing coordinate points on the chart below.

x **coordinate**	*y* **coordinate**
1	4
2	8
3	
4	8
	4
6	8
7	
8	8
	4
10	8
11	
12	8
	4
14	8
15	

2. Is there a pattern to the coordinates? If so, describe the pattern.

3. What is the wavelength? Show the work that leads to your answer.

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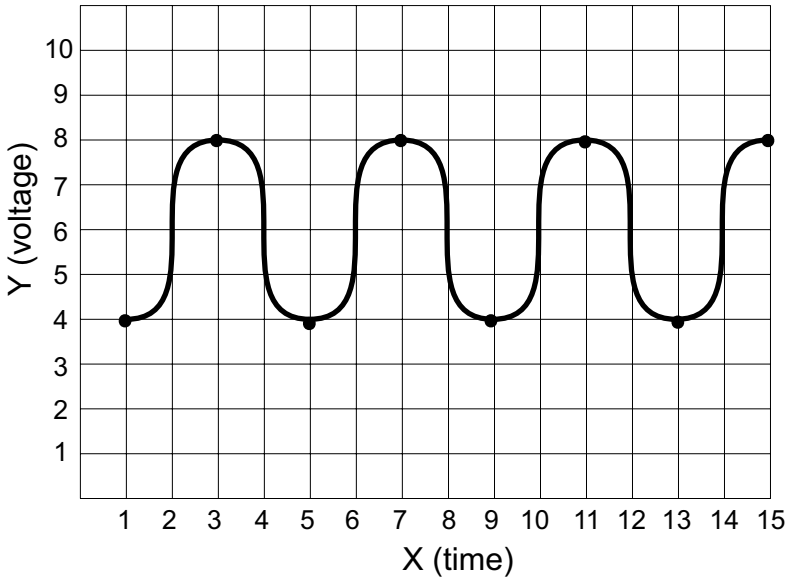
4. What is the amplitude of the wave? Explain your answer.

Luis changes the position of his fingers on the flute, and creates a new sound. The image on the oscilloscope now looks like this:

Luis' Flute: Image 2



5. Is Luis' flute producing a louder or softer sound than before? Explain.

6. Describe how the frequency has changed now that Luis' fingers are in a different position.

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7. Is there a pattern for the points plotted on the second oscilloscope image? If so, what is it?

8. Luis keeps his fingers in the same position, but this time he blows through the flute much harder. Predict how that would change the image on the oscilloscope. If you would like, you can make a labeled diagram as part of your explanation.

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Activity 4: Singing Strings

Have you ever been to the lake or the ocean and watched the waves move across the surface of the water and crash upon the shore? How are the waves formed? For the most part, the waves are formed from the energy contained in the wind. The wind's energy can blow a hat off your head, turn the blades on a wind turbine, and create a wave in a body of water. From ripples across a puddle to storm surges during a hurricane, the energy from the wind moves into the water and produces a movement that we call waves.

Waves in water are not the only type of waves that exist. Have you ever heard a clap of thunder or the roar of a plane travelling far above your head? In each of these cases the energy released by the lightening bolt or the plane transfers to the air and causes sound waves. Those waves of energy travel to your ears and move the delicate bones found in your inner ear. The movement of these bones is what your brain registers as sound to tell you there is lightening or a plane nearby.

Of course, lightning bolts and planes aren't the only things that produce sound waves. What are some other causes of sound waves?

Let's explore how sound waves are generated and how they travel.

EXPERIMENT 1

1. Tie the middle of the string around the metal spoon handle so that you create two segments of string about 18 inches each.
2. Holding one piece of string in each hand, swing the metal spoon into the table or desk and listen to the sound it makes.

EXPERIMENT 2

1. Wrap the end of one string to the index finger of your left hand. Wrap the other end of the string around the index finger of your right hand.
2. Standing next to a table or desk put an index finger, with the string wrapped around them, into each of your ears.
3. Bend over and swing the spoon into the table. Describe what you hear.

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EXPERIMENT 3

1. Use scissors to cut the string into two equal pieces, about 18 inches each. Tie one piece of string around one end of the coat hanger and the other piece of string around the other end of the coat hanger.
2. Just like you did in experiment 1, clink the coat hanger against the table or desk with and without your fingers in your ears. How do the sounds differ?

EXPERIMENT 4

Now it's your turn to design an experiment. Decide with your partner whether you want to test the effect of the length of the strings or the type of strings to see how it affects the sound produced. Let the questions below guide you as you set up your experiment.

1. What variable are you testing -- string length or string type?
   a. If string length, what 3 lengths will you test?
   b. If string type, what 3 string types will you test?

2. In order to be a fair test, you can only change one variable at a time. So, based on the variable you chose to test, what conditions are you NOT changing about your experimental set up? The are called your experimental constants.

3. Now that you have decided what variable you will test, write the question that you will be trying to answer. This is called your experimental question.

   How does changing _____

   affect _____?

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4. Before you try to answer your question, write a hypothesis statement about what you think might happen.

   If we change _____(fill in with your variable),

   then we think _____(fill in with what will happen)

5. Now, conduct your experiment and write your observations:

6. Finally, write a conclusion statement that answers your experimental question.

QUESTIONS

1. Why do you think the sound of the spoon or coat hanger hitting the table is different when you fingers are in your ears as compared to when they are out of your ears? Remember the sound is travelling in a wave and needs a medium like air or string to travel through.

2. During the experiments where did the energy come from that produced the sound wave?

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3. Describe the path the sound wave and its energy travelled during Experiment 1 when you did not have your fingers with the string wrapped around them in your ears and you banged the spoon against the table:

4. Describe the path that the sound wave and its energy travelled during Experiment 2 when you had your fingers with the string wrapped around them in your ears and you banged the spoon against the table:

5. In which Experiment, 1 or 2, did the banging spoon create a louder sound?

6. In which Experiment, 1 or 2, did the sound waves and their energy travel through a solid to reach your ears? What was the solid?

7. In which Experiment, 1 or 2, did the sound waves and their energy have to travel through the air to reach your ears?

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8. How do the sounds from the coat hanger compare to those of the spoon? same? different? louder? different pitch?

9. Describe some additional experiments you could conduct that would be similar to what you have done here. If you have the materials at home to try them, come back and report to your class what you found.

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X 1 X	X 2 X	X 3 X
X 4 X	X 5 X	X 6 X
X 7 X	X 8 X	X 9 X

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Y 1 Y	Y 2 Y	Y 3 Y
Y 4 Y	Y 5 Y	Y 6 Y
Y 7 Y	Y 8 Y	Y 9 Y

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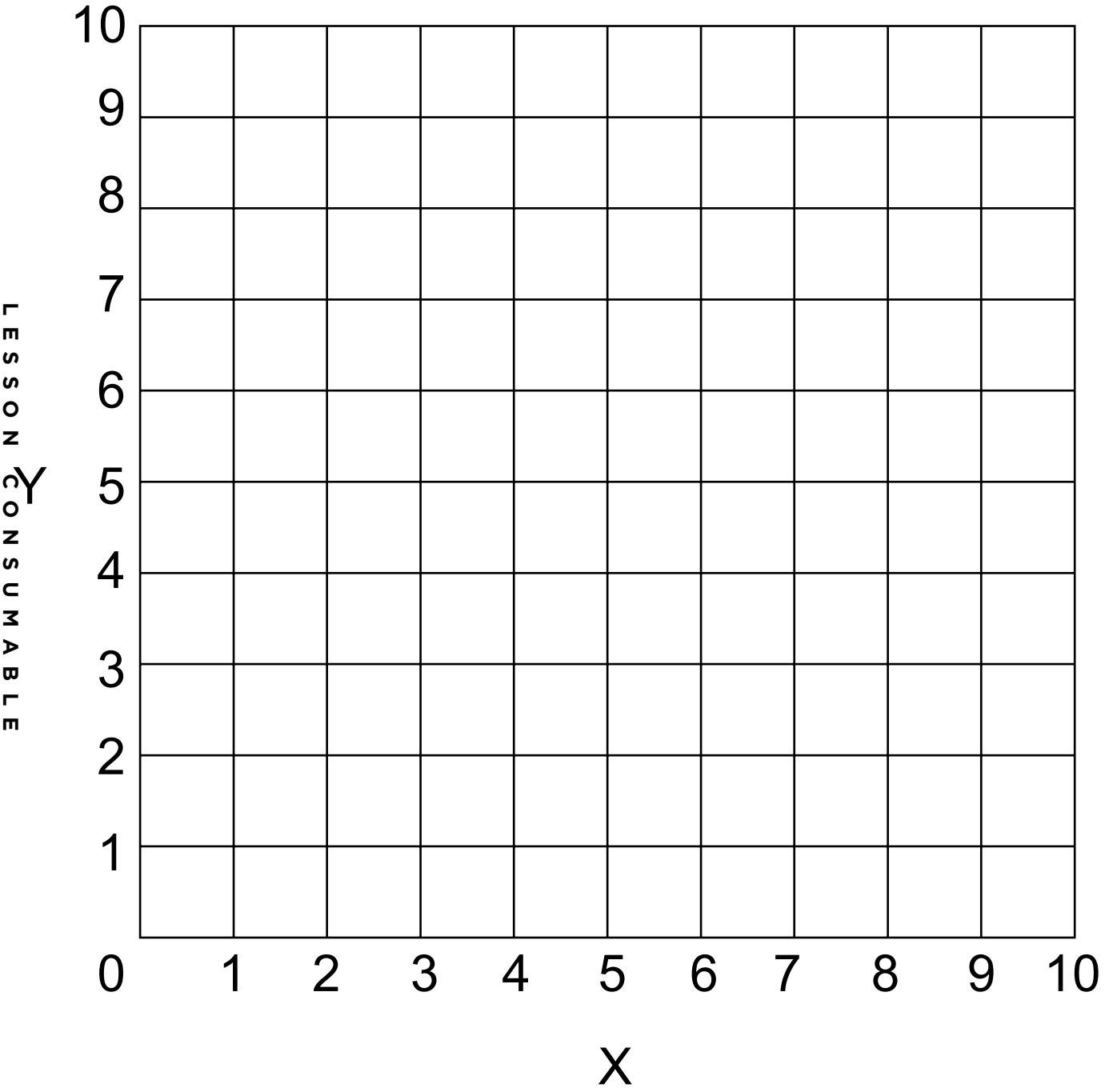

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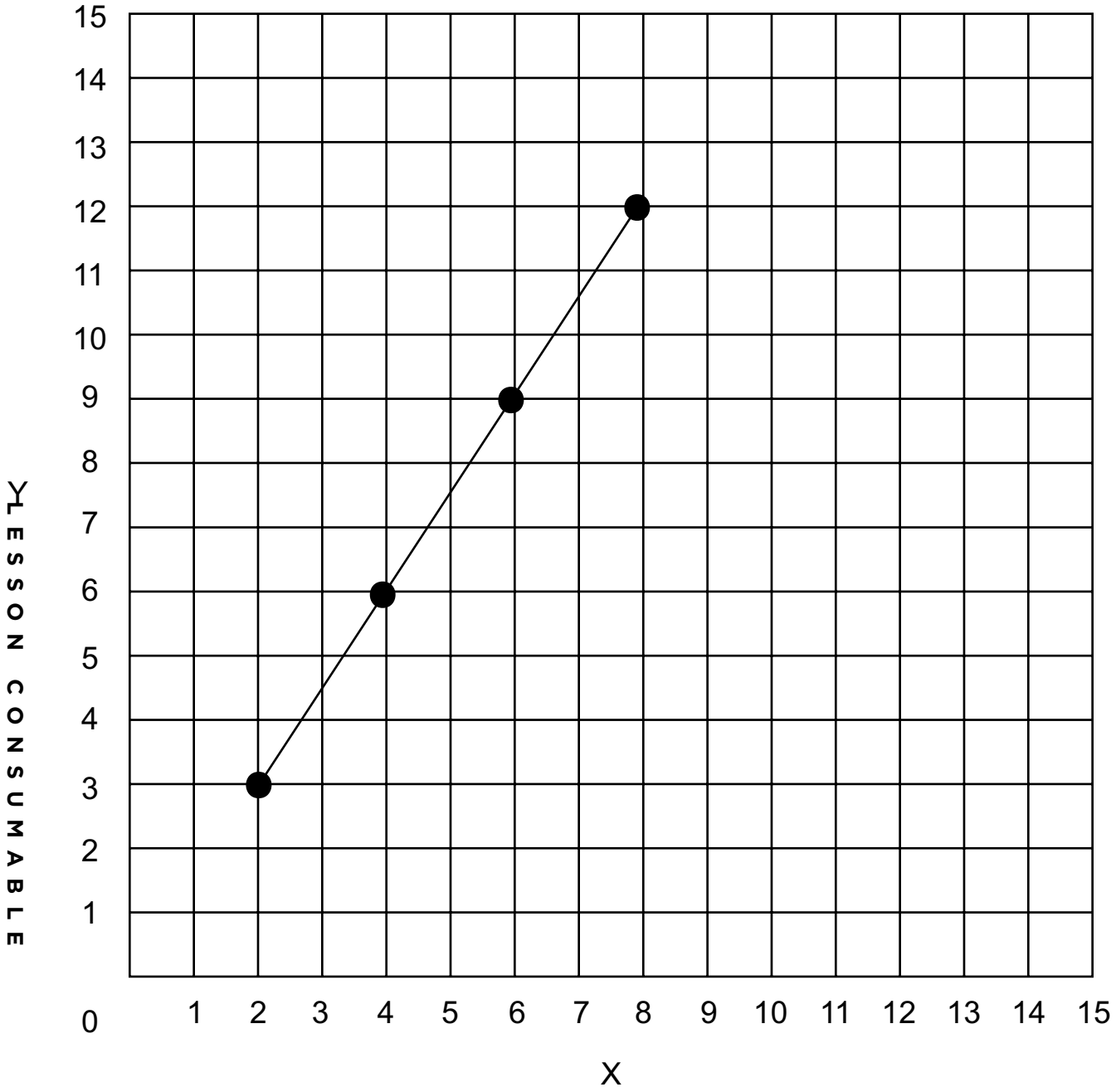

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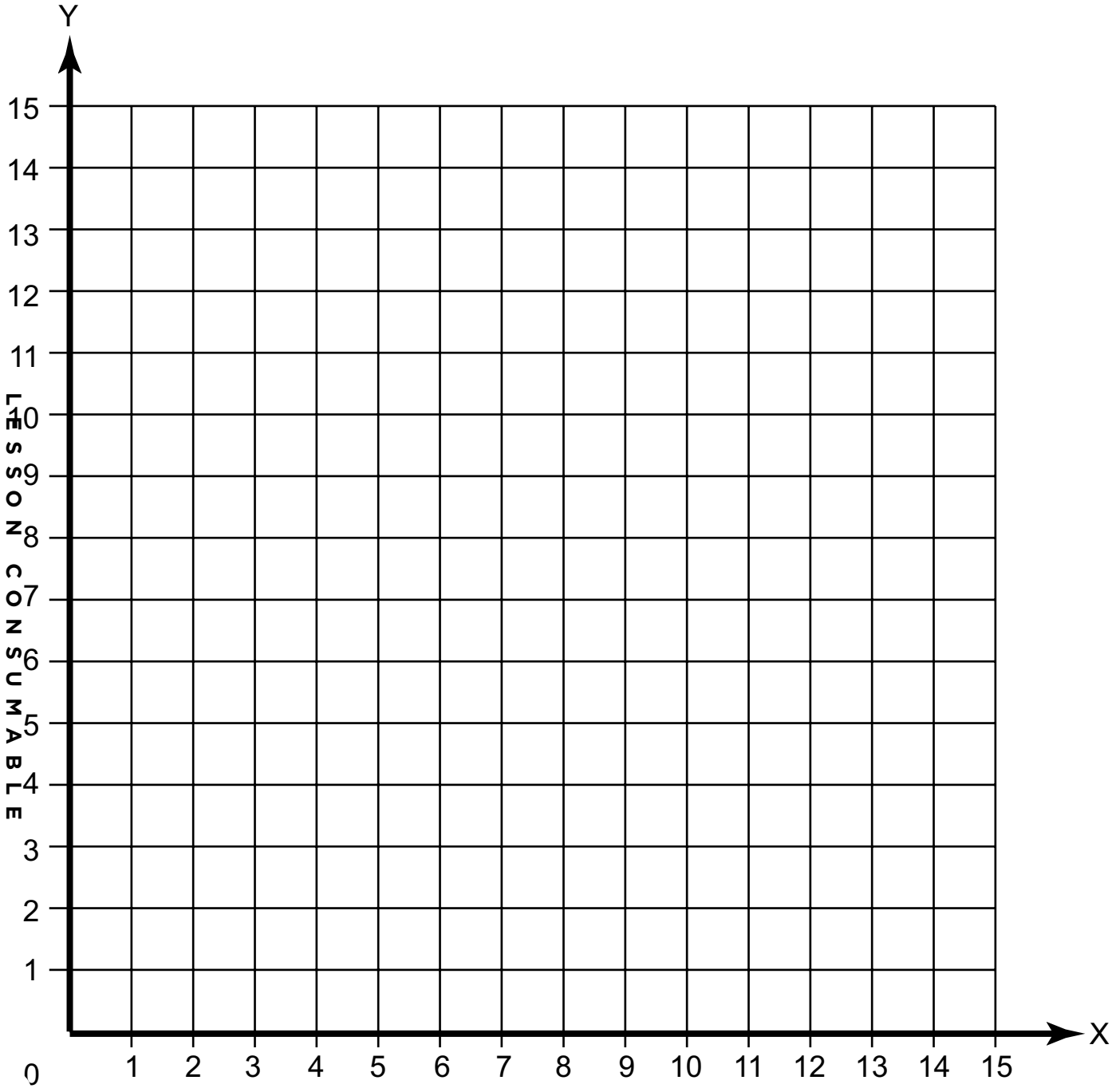

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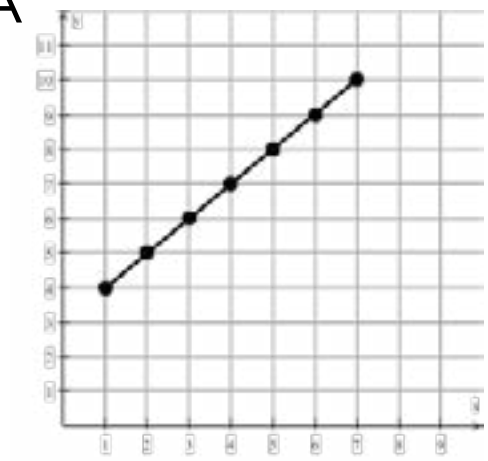
A



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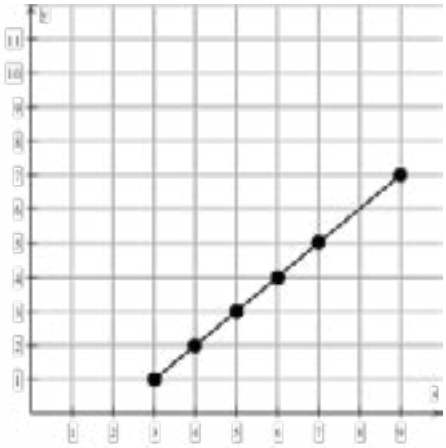

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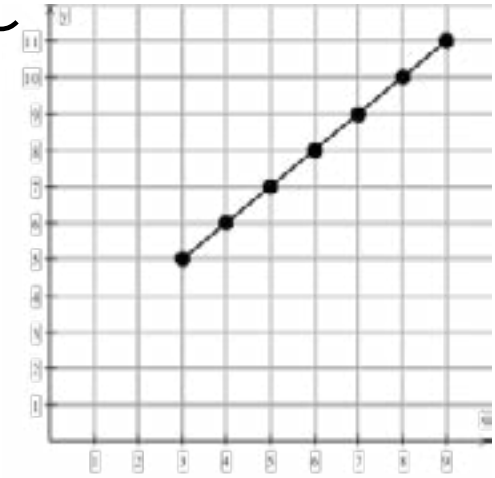

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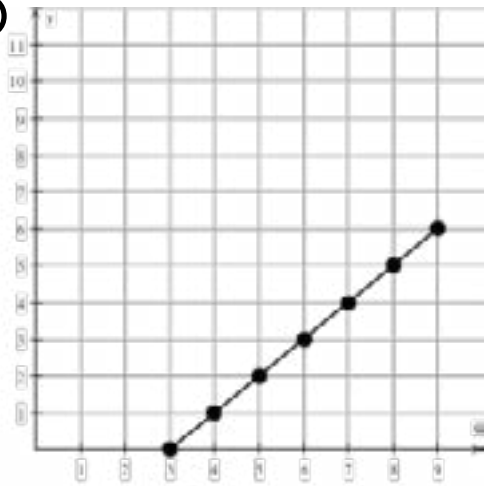

G

X	Y1
1	4
2	5
3	6
4	7
5	8
6	9
7	10

H

X	Y1
3	1
4	2
5	3
6	4
7	5
8	6
9	7

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I

X	Y1
3	5
4	6
5	7
6	8
7	9
8	10
9	11

J

X	Y1
3	0
4	1
5	2
6	3
7	4
8	5
9	6

Q

The y-coordinate is 3 more than the x-coordinate.

R

The y-coordinate is 2 more than the x-coordinate.

S

The y-coordinate is 2 less than the x-coordinate.

T

The y-coordinate is 3 less than the x-coordinate.

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U $y = x + 3$	V $y = x - 2$
W $y = x + 2$	X $y = x - 3$

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