Geometry: Lines & Angles

Chapter 4

The Wright Brothers

Wilbur and Orville Wright were interested in mechanical things even as children. They built their own toys and fixed their friends' bicycles. They loved to experiment with new inventions. Wilbur thought up the ideas, and Orville figured out how to design and make them.

Both boys were extremely interested in the idea of flight. They studied the subject in great detail, reading the writings of George Cayley and Samuel Langley. In 1899 they began designing their own model gliders, and by 1903 they had come up with a design they believed would actually be able to fly.

The Wrights' airplane, named the *Flyer*, had two 40-foot wings and was powered by a 12-horse-power engine. It had two propellers driven by bicycle chains, and it had a rudder to control the direction of its flight.

The Wrights traveled to Kitty Hawk, North Carolina, to test the *Flyer*. Sunday, December 13, was a beautiful day for flying, but the brothers refused to test their machine on the Lord's Day. Instead they spent the day reading and resting.

The next day, the brothers laid a wooden rail track on the side of a hill. Wilbur climbed aboard the plane and it shot off down the track. Before reaching the bottom of the hill, it lifted into the air. But Wilbur turned the nose of the aircraft up suddenly. The *Flyer* slowed and then fell to the ground.

Controlling the angle at which an airplane's wings meet the air (the angle of attack) is critical to maintaining lift. God established the principles that determine this angle. Exceeding it stalled the plane and brought failure.

The Wrights did not give up, however. Three days later, on December 17, 1903, Orville attempted to fly the plane. The wind was stronger this time, so they laid the track on level ground. They started the engine, and the *Flyer* moved down the track. Just as it lifted into the air, a friend snapped the famous picture shown above. Orville carefully controlled the angle of attack so that the plane stayed level. It flew 120 feet in 12 seconds. Mankind's attempt to conquer flight had taken a giant step forward.

Chapter 4

Geometry: Lines & Angles

Chapter Objectives

- Identify and name points, lines, line segments, planes, rays, and angles
- Measure and draw angles
- Identify right, acute, obtuse, and straight angles
- Identify, name, and draw a radius, diameter, chord, and central angle in a circle
- Plot points on a coordinate graph
- Find an unknown measure of an angle in a triangle
- Evaluate the secular belief that the order and consistency we observe in nature can be explained by chance BWS

Materials

Teacher Resources

- 14 *Engineering Design Process*
- 20 *Coordinate Graph*
- 21 *Angles*
- 22 *Graph Paper*
- 23 *More Angles*
- 24 *Measuring Angles*
- 25 *Triangles*
- 26 *Circle & Center Point*
- 27 *Central Angles*

Other Teaching Aids

- 5 different-colored strands of uniformly sized beads
- Graph paper
- Rulers
- Markers
- Protractors
- Building blocks
- Colored pencils
- Picture of regularly spaced stepping stones across a stream
- Books on paper airplane design (optional)
- Variety of sturdy paper for constructing paper airplanes
- Tape measure
- Masking tape

Assessments

- Chapter 4 Test

Chapter Information

In this chapter students will extend their knowledge of geometry as they identify and measure right, acute, obtuse, and straight angles. They will also plot points on a coordinate graph and draw a radius, diameter, chord, and central angle in a circle. Students will use reasoning and related equations to find the measure of an unknown angle.

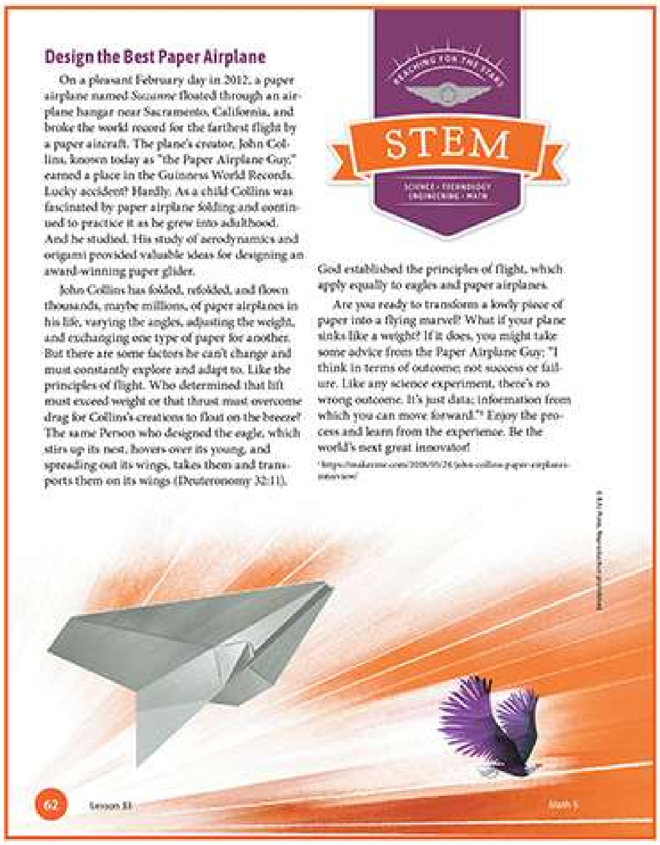
STEM Lessons

In this chapter's STEM lessons, students will collaborate in the Engineering Design Process to design the best possible paper airplane, solving a problem and learning a biblical worldview truth along the way. In order to teach them effectively, preview the STEM lessons (which appear toward the end of this chapter in the Teacher Edition) and prepare any necessary materials in advance. Additional ideas for exploring this chapter's STEM theme are provided at the end of Lesson 40.

Mastery of Basic Facts

Facts are practiced through Fact Fun Activities and Fact Reviews (TeacherToolsOnline.com). You may also use technology or standard flashcards to review math facts with the students. Make fact practice, both oral and written, part of your daily math routine to help the students with mastery.

Visit AfterSchoolHelp.com for math practice resources, or visit TeacherToolsOnline.com for additional resources to enhance the lessons.



Design the Best Paper Airplane

On a pleasant February day in 2012, a paper airplane named *Suzanne* floated through an airplane hangar near Sacramento, California, and broke the world record for the farthest flight by a paper aircraft. The plane's creator, John Collins, known today as "the Paper Airplane Guy," earned a place in the Guinness World Records. Lucky accident? Hardly. As a child Collins was fascinated by paper airplane folding and continued to practice it as he grew into adulthood. And he studied. His study of aerodynamics and origami provided valuable ideas for designing an award-winning paper glider.

John Collins has folded, refolded, and flown thousands, maybe millions, of paper airplanes in his life, varying the angles, adjusting the weight, and exchanging one type of paper for another. But there are some factors he can't change and must constantly explore and adapt to. Like the principles of flight. Who determined that lift must exceed weight or that thrust must overcome drag for Collins's creations to float on the breeze? The same Person who designed the eagle, which stirs up its nest, hovers over its young, and spreading out its wings, takes them and transports them on its wings (Deuteronomy 32:11). God established the principles of flight, which apply equally to eagles and paper airplanes.

Are you ready to transform a lowly piece of paper into a flying marvel? What if your plane sinks like a weight? If it does, you might take some advice from the Paper Airplane Guy: "I think in terms of outcome, not success or failure. Like any science experiment, there's no wrong outcome. It's just data; information from which you can move forward."[1] Enjoy the process and learn from the experience. Be the world's next great innovator!

[1] https://makezine.com/2016/05/24/john-collins-paper-airplanes-interview/

Lesson 32

Worktext pages 61, 63–64
Activities pages 53–54

Objectives

- Explain that math is useful to us because our minds are patterned after the orderly mind of God BWS
- Identify and name points, lines, line segments, and planes
- Write ordered pairs to identify points on a coordinate graph
- Plot points on a coordinate graph
- Use points on a coordinate graph to construct a line

Teacher Resources

- 20 *Coordinate Graph*

Other Teaching Aids

- 5 different-colored strands of uniformly sized beads
- Graph paper
- Ruler
- Markers: black, red

Practice and Review

Multiply a 2-, 3-, or 4-digit factor by a 2-digit factor

► Direct the students to solve the following multiplication problems. Then select students to demonstrate solving each problem.

24 × 17 = 408

456 × 23 = 10,488

8,903 × 46 = 409,538

Practice math facts

► Review division facts in this chapter using one of the Fact Review pages or a Fact Fun Activity (TeacherToolsOnline.com).

Teach for Understanding

Lesson Focus
In this lesson you will identify and name points, lines, line segments, and planes. You will also write ordered pairs to identify points on a coordinate graph.

Explain that math is useful to us because our minds are patterned after the orderly mind of God

► Direct attention to Worktext page 61. Read the page aloud and discuss it with the students.

What caused the *Flyer* to slow and fall to the ground? Wilbur turned the nose of the aircraft up suddenly.

What term describes the angle at which an airplane's wings meet the air? the angle of attack

► Read aloud Genesis 1:20.

What flying creature does this verse tell us was created by God? birds

When God created the world, what did He establish that enables birds to fly? the principles of flight; the angle of attack

Points, Lines & Planes Name ____________

Read: point *A*	**Read:** line *BC* or line *CB*	**Read:** line segment *DE* or line segment *ED*	**Read:** plane *d*
	Symbol: $\overleftrightarrow{BC}$ or $\overleftrightarrow{CB}$	**Symbol:** $\overline{DE}$ or $\overline{ED}$	
A **point** is a location in space.	A **line** is a straight path of points that goes on endlessly in both directions.	A **line segment** is a part of a line. It has 2 endpoints.	A **plane** is a flat surface that goes on endlessly in all directions.

Use a ruler to draw the figure. Use the symbol to name the figure.

1. Line

$\overleftrightarrow{FG}$ or $\overleftrightarrow{GF}$

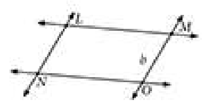
2. Line segment

$\overline{HI}$ or $\overline{IH}$

3. Line

$\overleftrightarrow{JK}$ or $\overleftrightarrow{KJ}$

Use plane *b* to find the answer. Write the answer using symbols. *Accept all correct names.*



4. Name the 4 line segments. $\overline{NL}$, $\overline{LM}$, $\overline{MO}$, $\overline{ON}$
5. Name the 4 points on this plane. L, M, N, O
6. Name the 4 lines. $\overleftrightarrow{NL}$, $\overleftrightarrow{LM}$, $\overleftrightarrow{MO}$, $\overleftrightarrow{ON}$

Complete the sentence.

7. A line segment has two endpoints.
8. A plane goes on endlessly in all directions.
9. A line goes on endlessly in both directions.
10. A piece of string is an example of a line segment.
11. The head of a pin is an example of a point.

What did the Wright brothers need to understand before they could solve the problem of how to fly? They needed to understand how the principles of flight work and how the angle of attack affects lift.

Do you think the angle of attack always affects lift in the same way? Why or why not? Yes; answers may vary.

What is the reason for this consistency? Our orderly God created an orderly, predictable world.

Explain that because God created the world to operate on dependable principles, it is possible for us to study and apply math.

► Read aloud Proverbs 2:6.

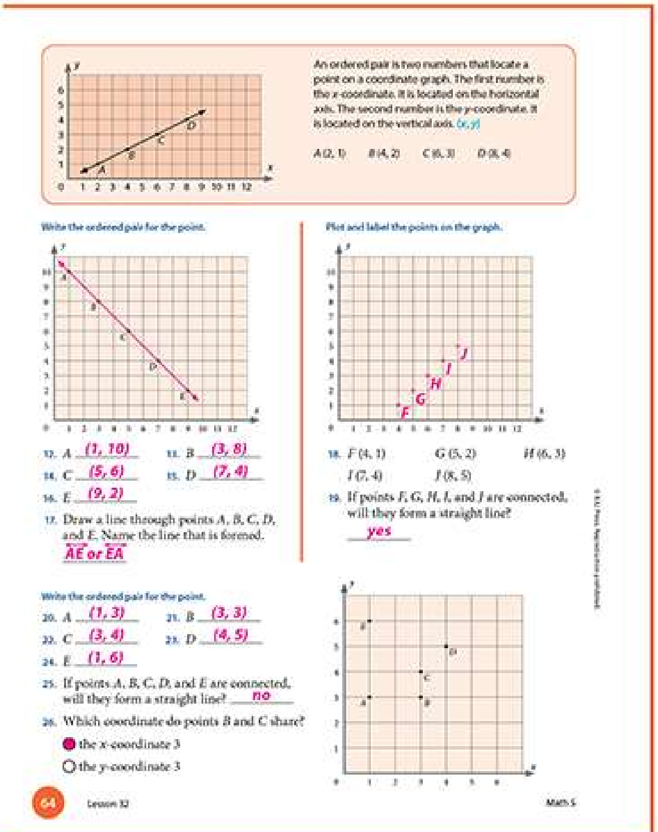
Why are people like Orville and Wilbur Wright able to make amazing discoveries? God has created us with understanding to learn about His creation and gives us wisdom to apply that knowledge.

Explain that because we are made in God's image, we seek order just like He does. This is why we are able to recognize patterns as we use math.

Identify and name points, lines, line segments, and planes

► Direct attention to point *A* at the top of Worktext page 63. Explain that a point marks a location in space and that an uppercase letter is used to name a point.

What is the name of this point? point *A*



An ordered pair is two numbers that locate a point on a coordinate graph. The first number is the x-coordinate. It is located on the horizontal axis. The second number is the y-coordinate. It is located on the vertical axis. (x, y)

A (2, 1) B (4, 2) C (6, 3) D (8, 4)

Write the ordered pair for the point.

12. A (1, 10) 13. B (3, 8)
14. C (5, 6) 15. D (7, 4)
16. E (9, 2)
17. Draw a line through points A, B, C, D, and E. Name the line that is formed. $\overleftrightarrow{AE}$ or $\overleftrightarrow{EA}$

Plot and label the points on the graph.

18. F (4, 1) G (5, 2) H (6, 3) I (7, 4) J (8, 5)
19. If points F, G, H, I, and J are connected, will they form a straight line? yes

Write the ordered pair for the point.

20. A (1, 3) 21. B (3, 3)
22. C (3, 4) 23. D (4, 5)
24. E (1, 6)
25. If points A, B, C, D, and E are connected, will they form a straight line? no
26. Which coordinate do points B and C share?
● the x-coordinate 3
○ the y-coordinate 3

64 Lesson 32 Math 5

You may choose to explain that the point shown on the page is merely a representation of a point. It cannot be a point itself, since a point does not have length, width, or thickness. A point is merely a location in space.

As you examine the definitions at the top of Worktext page 63, you may choose to discuss the abstract nature of these geometric figures, pointing out that while these figures can be described, they are abstract ideas that exist in the mind; they have no concrete form.

- Direct attention to line *BC* on the page.

  How would you describe this line? It is straight; there is an arrow at each end, and points *B* and *C* are on the line.

  Why does the line have an arrow at each end? The arrows show that a line goes on without end in opposite directions.

- Display 1 strand of beads in a straight line. Explain that, like the beads, a line is made of many points that lie side by side, forming a straight path; a line can be named using any 2 of its points.
- Direct attention to and discuss the written symbols used to name the line on the page.

  What names can be given to this line? line *BC* or line *CB*

  Point out that unlike the beads, points and lines are flat; they do not have depth or thickness.

- Direct attention to the line segment in the third column. Explain that a line segment is a section of a line between 2 points called endpoints.

  Why do you think these points are called endpoints? They name the points at each of the 2 ends of the line segment.

  Select students to name the line segment. line segment *DE* or line segment *ED*

  Lead a discussion about the written symbols used to name the line segment.

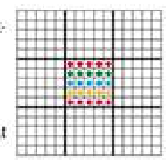
- Discuss the idea that every line segment is a small part of a line that continues in opposite directions.

  Conclude that since a line segment is a part of a line, a line can be named by the same 2 points used to name the line segment it contains. Point out that the line containing a line segment can be named even when the line itself is not pictured.

- Direct each student's attention to his desktop.

  How can you describe the surface of your desktop? It is a flat surface.

  Explain that in geometry a flat surface is called a plane. Write "plane" for display.



- Display the 5 strands of beads extended adjacent to one another. Point out that each solid-color row represents a line segment, and each multicolored (perpendicular) row represents a different line segment, forming an array.
- Explain that a plane is a flat surface made up of points, and that it extends endlessly in all directions. The displayed array can be thought of as part of a plane.
- Insert 1 sheet of graph paper under the 5 strands of beads. Explain that the graph paper can be used to show more of the plane extending beyond the array.

  Direct attention to the plane pictured at the top right of Worktext page 63.

  Why do you think a 2-dimensional shape was chosen to represent a plane? because a plane is a flat surface

  Why do you think arrows are included in the depiction of the plane? A plane goes on endlessly in all directions.

  If you taped additional sheets of graph paper to this sheet, would they show a different plane? No; they would be only more of the same plane, which extends in every direction. They would show only more of the same plane.

  Could you ever add enough paper to show the entire plane? No; a plane extends endlessly in all directions.

- Explain that there is no symbol to name a plane, just as there is no symbol to name a point; an uppercase letter is used to name a point, and a lowercase letter is used to name a plane.

  What is the name of the plane shown at the top of the Worktext page? plane *d*

  Write "plane *d*" for display.

- Discuss the similarities between a point and a speck of dust, a plane and a wall, and a line (or line segment) and the edge where two walls meet.

Write ordered pairs to identify points on a coordinate graph; plot points on a coordinate graph; use points on a coordinate graph to construct a line

- Write "(x, y)" for display. Remind the students that the x-coordinate comes first in an ordered pair.
- Display the *Coordinate Graph* page. Choose a student to use a black marker to plot point A at coordinates (3, 3) by starting at 0, moving along the x-axis until he comes to the number 3, and then moving up the y-axis until he comes to the number 3.

  Invite another student to plot point B at (6, 6) in a similar way. Then use a ruler and the red marker to draw a line segment connecting the points.

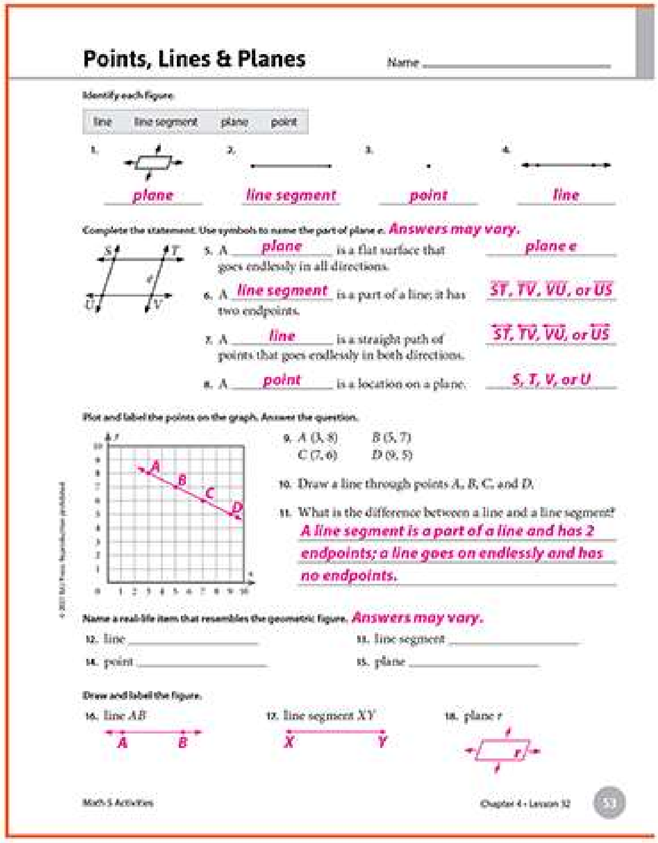
  What other coordinates mark points on line segment AB? (4, 4) and (5, 5); these points are included in the straight path of points that make up line segment AB.

  Choose students to plot points at (4, 4) and (5, 5).

  Do you think the point located at ordered pair (7, 7) is part of line AB? Yes; when line segment AB is extended in both directions to show line AB, the point at (7, 7) is included in that path.

  Invite a student to extend line segment AB in both directions to show line AB.

  What other ordered pairs represent points on line AB? (0, 0), (1, 1), (2, 2), (8, 8), (9, 9), (10, 10), etc.



Points, Lines & Planes

Name ____________

Identify each figure.

line | line segment | plane | point

1. plane
2. line segment
3. point
4. line

Complete the statement. Use symbols to name the part of plane e. Answers may vary.

5. A plane is a flat surface that goes endlessly in all directions. plane e
6. A line segment is a part of a line; it has two endpoints. $\overline{ST}$, $\overline{TV}$, $\overline{VU}$, or $\overline{US}$
7. A line is a straight path of points that goes endlessly in both directions. $\overleftrightarrow{ST}$, $\overleftrightarrow{TV}$, $\overleftrightarrow{VU}$, or $\overleftrightarrow{US}$
8. A point is a location on a plane. S, T, V, or U

Plot and label the points on the graph. Answer the question.

9. A (3, 8) B (5, 7) C (7, 6) D (9, 5)
10. Draw a line through points A, B, C, and D.
11. What is the difference between a line and a line segment? A line segment is a part of a line and has 2 endpoints; a line goes on endlessly and has no endpoints.

Name a real-life item that resembles the geometric figure. Answers may vary.

12. line ____________
13. line segment ____________
14. point ____________
15. plane ____________

Draw and label the figure.

16. line AB
17. line segment XY
18. plane r

Math 5 Activities

Chapter 4 • Lesson 32

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Worktext pages 63–64

- Review the terms *point*, *line*, *line segment*, and *plane*; choose students to draw the following figures for display.

  plane e

  line segment CD

  point G

  line RS
- Read and guide completion of page 63.
- Read and explain the directions for page 64. Assist the students as they complete the page independently.

Activities pages 53–54

- Review finding multiples of a number on page 54.

Daily Review

- Students should complete Chapter 4, section *a*.

Circle prime or composite.

1. 38 prime **composite**
2. 57 prime **composite**
3. 61 **prime** composite
4. 32 prime **composite**
5. 29 **prime** composite
6. 39 prime **composite**

Solve. Label your answers.

Greenfield Basketball Card Collector's Club has 24 members. Each member has at least one full collection album. Each album holds 20 pages with 12 cards per page.

7. How many cards does each album hold?

   20 × 12 = 240 cards

8. If each club member has 1 full album, how many pages of cards does the club have in total?

   20 × 24 = 480 pages

9. What is the smallest number of cards the club owns? *Equations may vary.*

   20 × 12 × 24 = 5,760 cards

Circle all multiples of the number.

10.	4	**(8)**	10	**(12)**	14	**(16)**	18	**(20)**	22	**(24)**
11.	5	**(10)**	12	**(15)**	18	**(20)**	**(25)**	**(35)**	38	**(40)**
12.	9	10	**(18)**	**(27)**	35	40	**(45)**	50	**(54)**	60

Solve. Label your answers.

13. Rachel's class has 20 students. Each student has 11 textbooks. How many textbooks does her class have?

    20 × 11 = 220 textbooks

14. Mrs. Carruthers teaches Spanish to 8 elementary grades. Each grade has 4 classrooms. Each classroom has 23 students. Use the Distributive Property to find out how many students she teaches.

    8 × (*4* × *23*) =
    8 × (*4* × 20) + (*4* × 3) =
    8 × (*80* + *12*) =
    8 × *92* =
    736 students

Solve.

15. 18 ÷ 6 = *3*
16. $6\overline{)72}$ = *12*
17. *48* ÷ 6 = 8
18. *30* ÷ 5 = 6
19. 6 × 0 × 6 = *0*
20. 54 ÷ 6 = *9*
21. $\frac{12}{6}$ = *2*
22. 6 × 6 × 6 = *216*
23. (2 × 3) • 6 = *36*

54 Chapter 4 • Lesson 32 Math 5 Activities

Differentiated Instruction

Use the following to provide extra help for any student who experiences difficulty with the concepts taught in Chapter 4.

Use a protractor to measure angles

- Keep a classroom supply of smaller protractors available for students who have difficulty using a large protractor to measure angles in the textbook. Another alternative is to allow the students to place an index card along the ray to extend it so that they can clearly see the intersection of the ray with the scale on the protractor.

Lesson 39 Worktext pages 62, 77

Objectives
- Identify the problem that needs to be solved
- Research paper airplane design
- Choose a paper airplane design
- Follow a pattern to make a paper airplane
- Predict how the airplane will perform

Teacher Resources
- 14 *Engineering Design Process*

Other Teaching Aids
- Books on paper airplane design (optional)
- Variety of sturdy papers for constructing paper airplanes

Teach for Understanding

Lesson Focus
In this lesson you will construct a paper airplane to achieve the best possible performance.

Identify the problem that needs to be solved

- Display the *Engineering Design Process* page. Review as needed.
- Read aloud Worktext page 62. Lead a discussion to emphasize the effort it took for John Collins to achieve his goal. Remind the students that Mr. Collins's understanding of flight principles helped him design his record-setting paper airplane.

> You may choose to connect the last paragraph of Worktext page 62 with the scientific method as presented in BJU Press's SCIENCE 5.

Review the flight principles described on Teacher Edition page 83 and how they affect the flight of an airplane.

- Explain that the students will work in groups to design the best possible paper airplane with the provided materials.

How would you determine that your airplane was the best in a specific category? by testing it against other airplanes to prove that it flies the fastest, highest, longest, or farthest

Which was John Collins's goal? fashioning a paper airplane that would fly the farthest of any on record

Explain that the students will focus on designing a paper airplane that flies the farthest possible.

> Visit TeacherToolsOnline.com for resources to enhance the lesson.

Design the Best Paper Airplane

On a pleasant February day in 2012, a paper airplane named *Suzanne* floated through an airplane hangar near Sacramento, California, and broke the world record for the farthest flight by a paper aircraft. The plane's creator, John Collins, known today as "the Paper Airplane Guy," earned a place in the Guinness World Records. Lucky accident? Hardly. As a child Collins was fascinated by paper airplane folding and continued to practice it as he grew into adulthood. And he studied. His study of aerodynamics and origami provided valuable ideas for designing an award-winning paper glider.

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[1] https://makezine.com/2018/05/24/john-collins-paper-airplanes-interview/

62 Lesson 33 Math 5

Ask

What is the problem that needs to be solved? how to make a paper airplane that will fly the farthest distance possible

- Direct the students to answer problem 1 on Worktext page 77.

Research paper airplane design

Imagine

What is the next question you should ask? How could I solve this problem?

- Discuss the students' ideas for developing the best possible paper airplane design. Lead them to conclude that research or trial and error could help them strategize; emphasize the importance of research.
- Arrange the students into groups for research and collaboration and allow each group to choose a group name. Display resources that the students may consult. Worktext page 82 could also be used as a resource.
- Direct the students to record their ideas in problem 2 on the Worktext page or on their own paper if more room is needed.

STEM
ACTIVITY

Name ____________________

1. What problem do you want to solve?

how to make a paper airplane that will fly the farthest distance possible

Answers will vary for problems 2–11.

2. How could you solve this problem? Use your own paper for recording ideas or drawings if needed.

3. Which design and material will you use? Use your own paper for recording ideas or drawings if needed.

4. Why did you choose this design and material?

5. Construct your airplane, then sketch a picture of it. Measure the plane's dimensions and at least 4 of its angles and label them on your sketch.

6. What changes did you make to improve your airplane?

7. How far do you predict your airplane will fly? ____________________

Math 5 Lesson 39 77

Choose a paper airplane design

Plan

- ► Display the paper choices for constructing the airplanes. Instruct the students to work within their groups to decide on a paper airplane design and the paper that might make their plane fly the farthest.
- ► Direct the groups to work together to finalize their design and to then record their design plan and the reasons for their choices in problems 3–4 on the Worktext page.

Follow a pattern to make a paper airplane

Create

- ► Direct the students to construct their airplanes, following the pattern they chose.
- ► When each group's plane has been completed, instruct them to complete problem 5 on the Worktext page. Instruct the students to make careful measurements so they will have an accurate record of their airplane's dimensions and angles.

REACHING FOR THE STARS
STEM
SCIENCE • TECHNOLOGY
ENGINEERING • MATH

Improve

- ► Instruct the students to test their airplanes informally within their groups. They should not test their planes against the other groups' planes at this point.

  Did your plane fly as well as you wanted it to? Answers will vary.
- ► Encourage the groups to make any desired modifications to improve their airplanes. Emphasize the importance of recording any changes they make so they can reference them for future improvements.

  Instruct the students to record their changes in problem 6 on the Worktext page.

Predict how the airplane will perform

- ► Remind the students that their airplanes will be tested for distance in the next lesson.
- ► Instruct the students to record their predictions in problem 7 on the Worktext page.
- ► Direct each group to label their Worktext pages and airplanes with their group name. Collect and store the Worktext pages and planes for the next lesson.