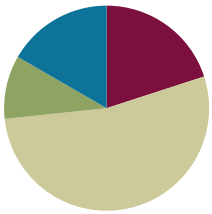
Lesson 3

Objective: Identify, define, and draw perpendicular lines.

Suggested Lesson Structure

Fluency Practice	(12 minutes)
Application Problem	(6 minutes)
Concept Development	(32 minutes)
Student Debrief	(10 minutes)
Total Time	**(60 minutes)**



Fluency Practice (12 minutes)

- Multiply Mentally **4.NBT.4** (3 minutes)
- Identify Two-Dimensional Figures **4.G.1** (4 minutes)
- Physiometry **4.G.1** (5 minutes)

Multiply Mentally (3 minutes)

Materials: (S) Personal white boards

Note: This drill will review G4–M3–Lessons 34–38's Concept Development.

T: (Write 34 × 2.) Say the multiplication sentence.
S: 34 × 2 = 68.
T: (Write 34 × 2 = 68. Below, write 34 × 20 =____.) Say the multiplication sentence.
S: 34 × 20 = 680.
T: (Write 34 × 20 = 680. Below, write 34 × 22 =____.) On your boards, solve 34 × 22.
S: 748.

Repeat the process with the following possible sequence: 23 × 2, 23 × 30, and 23 × 32.

Identify Two-Dimensional Figures (4 minutes)

Materials: (S) Personal white boards

Note: This fluency reviews terms learned in G4–M4–Lessons 1–2.

NOTES ON MULTIPLE MEANS OF REPRESENTATION:

The Identify Two-Dimensional Figures fluency activity gives English language learners and others a valuable opportunity to speak and review meanings and representations of recently introduced geometry terms. If necessary, allow extra time for students to respond.

T: (Project a line AB. Trace line AB.) Write the symbol for what I'm pointing to.
S: $\overleftrightarrow{AB}$.
T: (Point to point A.) Say the term.
S: Point A.
T: (Point to point B.) Say the term.
S: Point B.
T: On your boards, draw $\overleftrightarrow{CD}$.
S: (Draw a line with points C and D on the line.)

Continue with the following possible suggestions: $\overline{EF}$, $\angle GIH$, and $\overrightarrow{JK}$.

T: (Project a right angle LNM.) Name the angle.
S: $\angle LNM$.
T: What type of angle is it?
S: Right angle.
T: (Project an acute angle OQP.) Name the angle.
S: $\angle OQP$.
T: Is it greater than or less than a right angle?
S: Less than.
T: What's the term for an angle that's less than a right angle?
S: Acute angle.
T: (Project an obtuse angle RTS.) Name the angle.
S: $\angle RTS$.
T: Is it greater than or less than an acute angle?
S: Greater than.
T: Is it greater than or less than a right angle?
S: Greater than.
T: What's the term for an angle greater than a right angle?
S: Obtuse angle.

Physiometry (5 minutes)

Materials: (S) Personal white boards

Note: Kinesthetic memory is strong memory. This fluency reviews terms from G4–M4–Lessons 1–2.

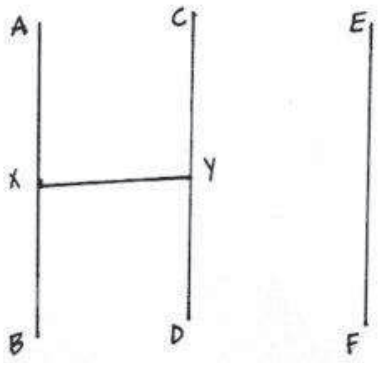
T: Stand up.
S: (Stand up.)
T: Model a line segment.
S: (Extend arms straight so that they are parallel with the floor. Clench both hands into fists.)
T: Model a line.

S: (Extend arms straight so that they are parallel with the floor. Open both hands and point at side walls.)
T: Model a point.
S: (Clench one hand in a fist and extend arm forward.)
T: Model a ray.
S: (Extend arms straight so that they are parallel with the floor. Clench one hand in a fist and leave the point with a finger on the other hand.)
T: Model a ray pointing the other direction.
S: (Clench open hand and open clenched hand. Point with a finger on the open hand.)
T: (Stretch one arm up, directly at the ceiling. Stretch the other arm directly toward a wall, parallel to the floor.) What type of angle do you think I'm modeling with my arms?
S: Right angle.
T: Model a right angle with your arms.
S: (Stretch one arm up, directly at the ceiling. Stretch another arm directly towards a wall, parallel to the floor.)
T: (Stretch the arm pointing towards a wall directly up towards the ceiling. Move the arm pointing towards the ceiling so that it points directly towards the opposite wall.) Model another right angle.
S: (Stretch the arm pointing towards a wall directly up towards the ceiling. Move the arm pointing towards the ceiling so that it points directly towards the opposite wall.)
T: Model an acute angle.
S: (Model an acute angle with arms.)
T: Model an obtuse angle.
S: (Model an obtuse angle with arms.)

Next move between figures with the following possible suggestions: right angle, ray, line segment, acute angle, line, obtuse angle, point, and right angle.

Application Problem (6 minutes)

1. Use a straight edge to draw and label $\overline{AB}$, $\overline{CD}$, and $\overline{EF}$ as modeled on the board.
2. Estimate to draw point X halfway up $\overline{AB}$.
3. Estimate point Y halfway up $\overline{CD}$.
4. Draw horizontal line segment XY. What word did you write?
5. Erase segment XY. Draw segment CF. What word did you draw?



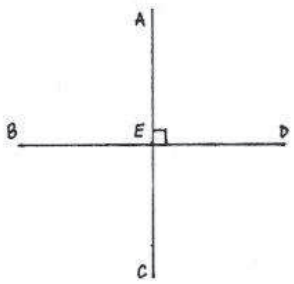
Note: This Application Problem reviews G4–M4–Lessons 1's introduction to and application of points and line segments. This Application Problem also bridges to today's

lesson in which students discover types of lines or line segments present in letters of the English alphabet.

Concept Development (32 minutes)

Materials: (T) Straightedge (S) Straightedge, right angle template, personal white board, square grid paper, Problem Set

Problem 1: Define perpendicular lines.



T: (Draw perpendicular lines using the right angle template and a straightedge.) What do you see?

S: A right angle! → Two line segments and four right angles. → A cross. → The lowercase letter *t*. → A plus sign.

T: (Label central point E and endpoints A, B, C, and D.) $\overline{AE}$ and $\overline{ED}$ make right angles. (Mark a right angle.) With your partner list two more segments that form a right angle.

S: $\overline{AE}$ and $\overline{BE}$. → $\overline{EB}$ and $\overline{EC}$. → $\overline{EC}$ and $\overline{ED}$. → $\overline{AC}$ and $\overline{BD}$.

T: Can you find examples in the room?

S: Yes! In my square grid paper! → In the heating grate! → I see them in the floor tiles.

T: (Point to perpendicular lines.) These lines are **perpendicular**. They intersect to make right angles. (Draw an X.) Are these lines perpendicular? Share your thoughts with your partner.

S: Those lines cross. But they don't make right angles. They're not perpendicular.

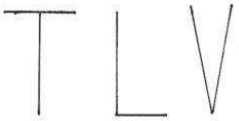
T: No, they are not perpendicular. They are **intersecting** lines. (Point to an acute angle). What type of angle?

S: Acute.

MP.6

T: (Point to an obtuse angle). What type of angle?

S: Obtuse.



T: (Draw the letters *T, L,* and *V*.) Discuss with your partner whether or not the segments in these letters are perpendicular.

S: The lines of *T* and *L* meet to make a right angle. → *T* and *L* are perpendicular. → Letter *V* doesn't have a right angle. So, those lines are not perpendicular.

Use the right angle template to verify student responses.

T: List three more letters of the alphabet with perpendicular lines.

S: H, F, E.

Problem 2: Identify perpendicular lines by measuring right angles with a right angle template.

T: Hold up your right angle template and trace the right angle with your finger. (Model.) Let's use this right angle to find perpendicular lines in our room. On your desk, which objects have perpendicular lines?

S: My personal board, my rectangular eraser, my ruler, and my math journal all have perpendicular lines. → My name tag, my iPad screen, and the edges of my desk have perpendicular lines.

T: On our classroom wall, which objects have perpendicular lines?

S: Our rules poster, the calendar, the white board, the door, and the windows have perpendicular lines.

T: Take a look at Figure B on your Problem Set. Place your right angle edge on the lines of the shape. Do they match up? Does this pentagon have perpendicular lines?

S: No. The lines form obtuse angles. The lines cross, but they do not make right angles. They are not perpendicular lines.

Problem 3: Recognize and write symbols for perpendicular segments.

T: Take a look at Problem 4(a) on the Problem Set. Trace your finger across $\overline{AC}$. (Write $\overline{AC}$.) Tell your partner the name of two segments that are perpendicular to segment $\overline{AC}$.

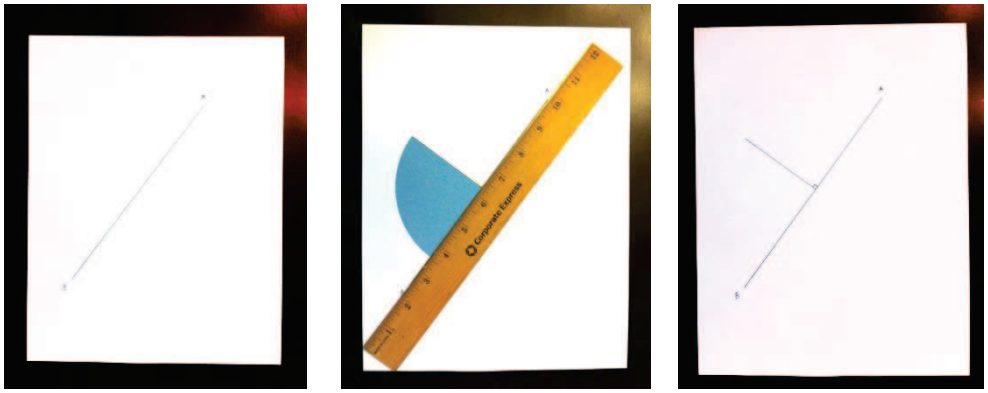
S: $\overline{AC}$ is perpendicular to $\overline{AB}$. $\overline{CD}$ is also perpendicular to $\overline{AC}$.

T: (Write $\overline{AC} \perp \overline{AB}$ and point.) $\overline{AC}$ is perpendicular to $\overline{AB}$. Use symbols to write $\overline{CD}$ is perpendicular to $\overline{AC}$.

S: $\overline{CD} \perp \overline{AC}$.

Problem 4: Draw perpendicular line segments.

T: A line can be drawn in any direction. (Draw.) Here is a diagonal $\overline{AB}$. I can use my right angle template to draw a line perpendicular to $\overline{AB}$. (Model.)



T: What do you notice about the angles?

S: I notice there are two right angles. You marked one right angle with a small square.

T: On your blank paper, use your pencil and ruler to draw $\overline{CD}$. Now, use your right angle template to draw a line perpendicular to $\overline{CD}$. Check for perpendicularity with your right angle edge.

S: It's easier to draw a line perpendicular to a horizontal line. → When you drew the diagonal line, I thought it would be hard to draw a perpendicular line. So, I turned the paper to make the diagonal line, horizontal to me.

T: When you're drawing or using the right angle template to identify perpendicular lines, you can turn the paper for ease, if you want to. What's another helpful tip?

S: Steady the ruler and hold the right angle template still while you're drawing.

NOTES ON LINES IN THE REAL WORLD:

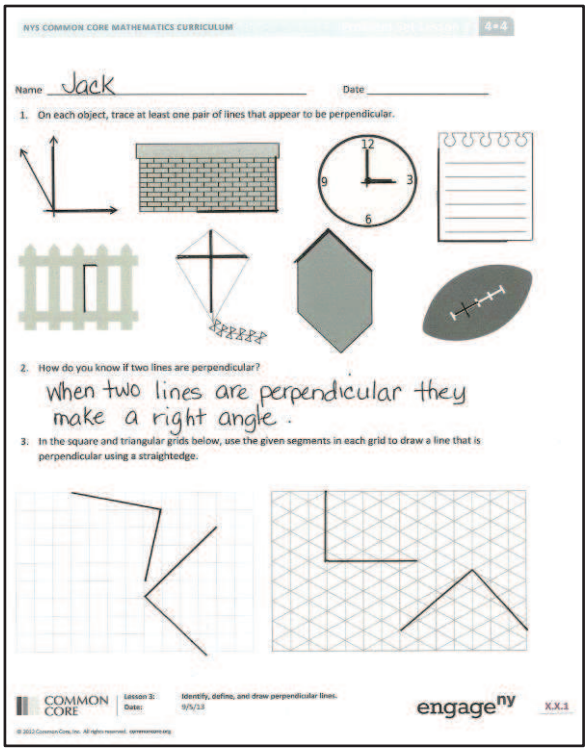
Challenge students to search for upright and diagonal perpendicular lines in their natural and manmade environments. This activity may best be prepared beforehand with photographs of examples. Prompt observation, analysis, and discovery with the following questions:

Are perpendicular lines found in nature? Intersecting lines?

How are upright perpendicular lines used by man? Diagonal perpendicular lines? Intersecting lines?

Problem Set (10 minutes)

Students should do their personal best to complete the Problem Set within the allotted 10 minutes. For some classes, it may be appropriate to modify the assignment by specifying which problems they work on first. Some problems do not specify a method for solving. Students solve these problems using the RDW approach used for Application Problems.


NYS COMMON CORE MATHEMATICS CURRICULUM 4•4

Name Jack Date

1. On each object, trace at least one pair of lines that appear to be perpendicular.

2. How do you know if two lines are perpendicular?

When two lines are perpendicular they make a right angle.

3. In the square and triangular grids below, use the given segments in each grid to draw a line that is perpendicular using a straightedge.

COMMON CORE Lesson 3: Date: Identify, define, and draw perpendicular lines. 9/5/13 engage^ny X.X.1

Student Debrief (10 minutes)

Lesson Objective: Identify, define, and draw perpendicular lines.

The Student Debrief is intended to invite reflection and active processing of the total lesson experience.

Invite students to review their solutions for the Problem Set. They should check work by comparing answers with a partner before going over answers as a class. Look for misconceptions or misunderstandings that can be addressed in the Debrief. Guide students in a conversation to debrief the Problem Set and process the lesson.

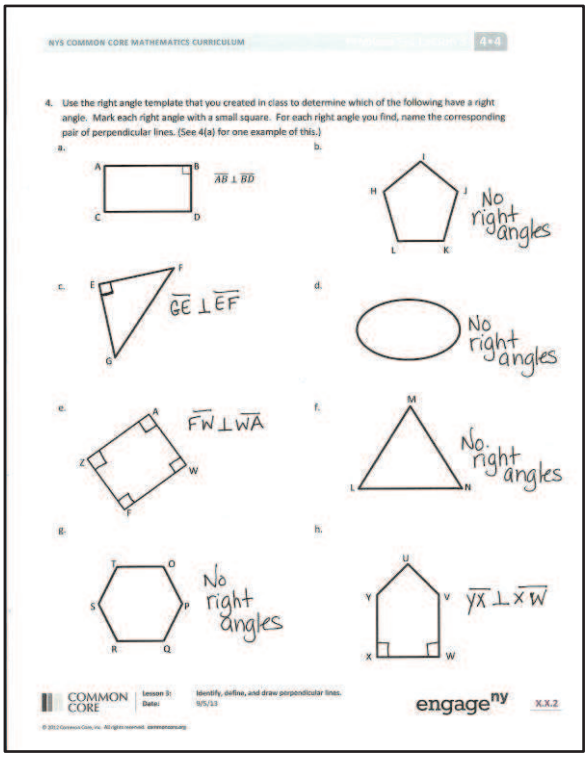
You may choose to use any combination of the questions below to lead the discussion.

- How did your knowledge of right angles prepare you to identify **perpendicular lines** in the figures for Problem 1?

- How can you tell if two lines are perpendicular (Problem 2)?
- In Problem 3, what was your strategy for drawing the segments perpendicular to the given segments? In what ways did the grids help you? How were the grids challenging?
- Look at the grid lines in Problem 3. Are the grid lines perpendicular or intersecting? Or both?
- In Problem 4, which figures had no perpendicular lines? Explain.
- In Problem 5, I only located eight right angles (on the interior of the figure). How many more right angles are there? What did this problem show you about locating angles on figures?
- How are perpendicular lines related to right angles? Acute angles? Obtuse angles?
- How might you use your understanding of perpendicular lines to solve a problem in real life? How might you use perpendicular lines when building something, for example?
- As you search for lines in your environment, notice if you find perpendicular or **intersecting lines** in nature. Analyze upright perpendicular lines, diagonal perpendicular lines, and intersecting lines as used by human beings.

Exit Ticket (3 minutes)

After the Student Debrief, instruct students to complete the Exit Ticket. A review of their work will help you assess the students' understanding of the concepts that were presented in the lesson today and plan more effectively for future lessons. You may read the questions aloud to the students.


NYS COMMON CORE MATHEMATICS CURRICULUM 4•4

4. Use the right angle template that you created in class to determine which of the following have a right angle. Mark each right angle with a small square. For each right angle you find, name the corresponding pair of perpendicular lines. (See 4(a) for one example of this.)

a. $\overline{AB} \perp \overline{BD}$

b. No right angles

c. $\overline{GE} \perp \overline{EF}$

d. No right angles

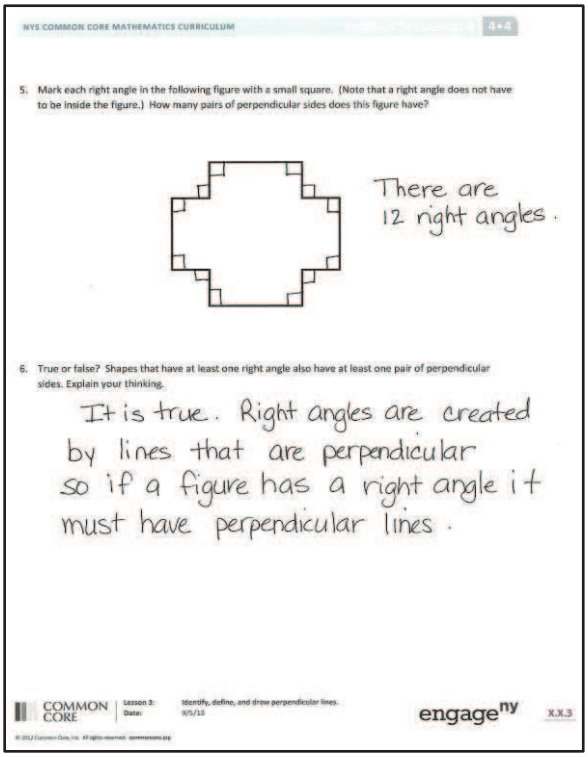
e. $\overline{FW} \perp \overline{WA}$

f. No right angles

g. No right angles

h. $\overline{YX} \perp \overline{XW}$

COMMON CORE | Lesson 3: Identify, define, and draw perpendicular lines. Date: 9/5/13 | engage^ny | X.X.2


NYS COMMON CORE MATHEMATICS CURRICULUM 4•4

5. Mark each right angle in the following figure with a small square. (Note that a right angle does not have to be inside the figure.) How many pairs of perpendicular sides does this figure have?

There are 12 right angles.

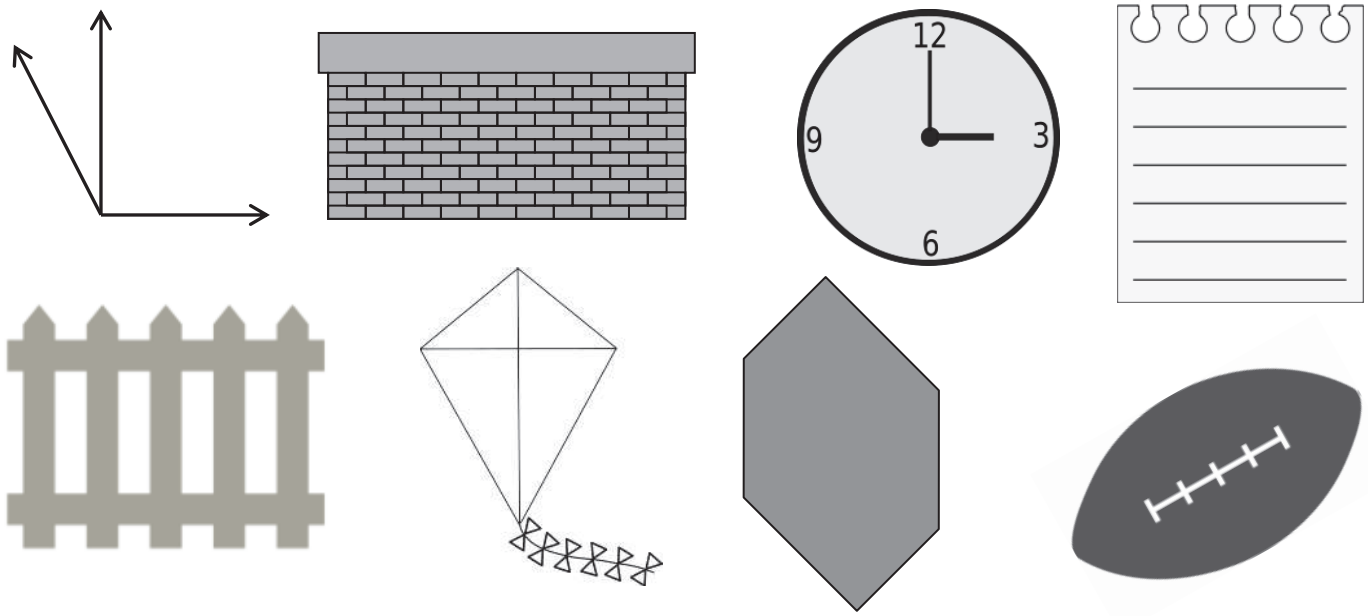
6. True or false? Shapes that have at least one right angle also have at least one pair of perpendicular sides. Explain your thinking.

It is true. Right angles are created by lines that are perpendicular so if a figure has a right angle it must have perpendicular lines.

COMMON CORE | Lesson 3: Identify, define, and draw perpendicular lines. Date: 9/5/13 | engage^ny | X.X.3

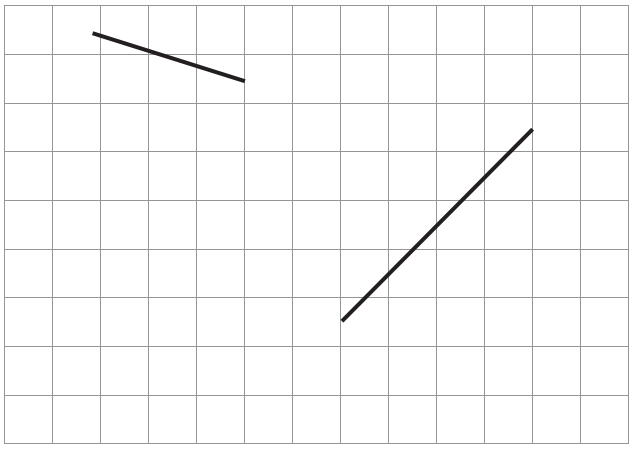
Name _____ Date _____

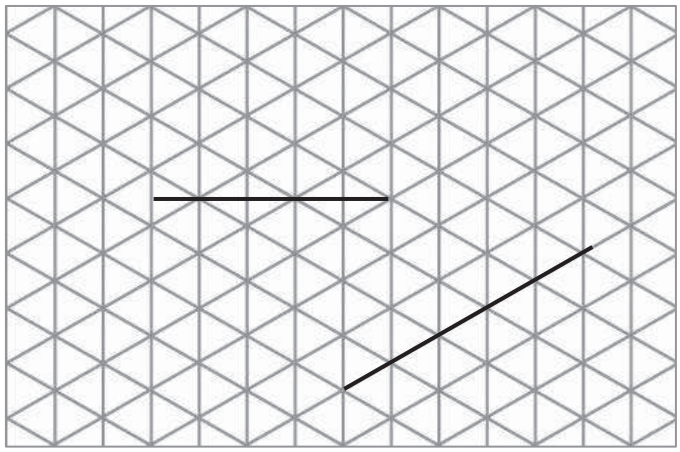
1. On each object, trace at least one pair of lines that appear to be perpendicular.



2. How do you know if two lines are perpendicular?

3. In the square and triangular grids below, use the given segments in each grid to draw a line that is perpendicular using a straightedge.



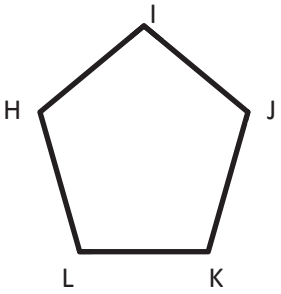


4. Use the right angle template that you created in class to determine which of the following have a right angle. Mark each right angle with a small square. For each right angle you find, name the corresponding pair of perpendicular lines. (See 4(a) for one example of this.)

a.

$\overline{AB} \perp \overline{BD}$

b.



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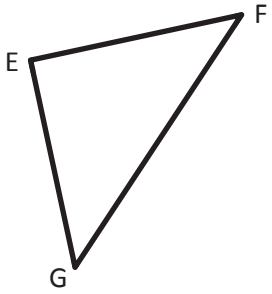

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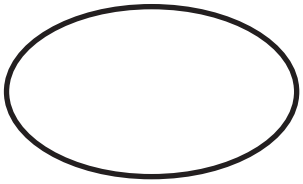

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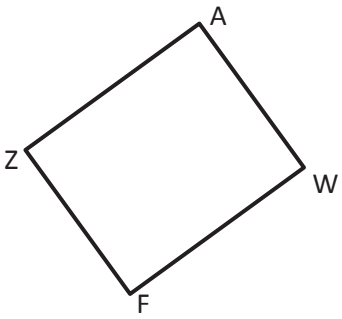

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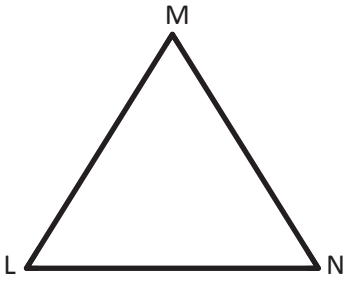

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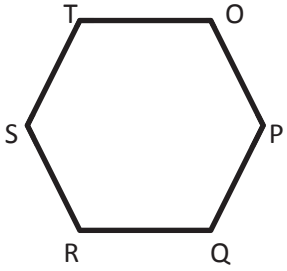

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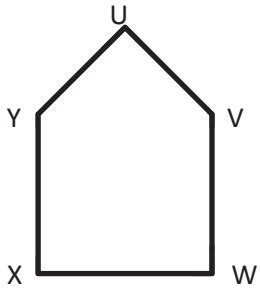
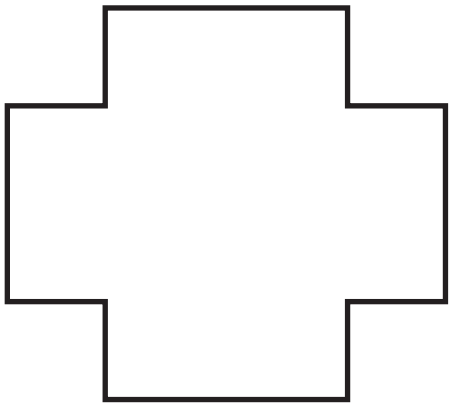


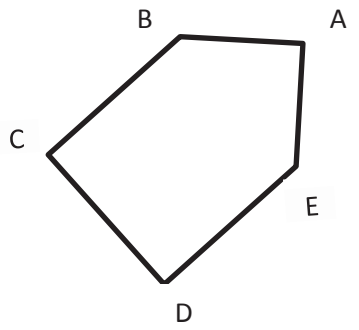
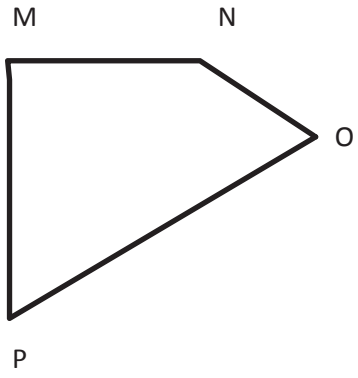
5. Mark each right angle in the following figure with a small square. (Note that a right angle does not have to be inside the figure.) How many pairs of perpendicular sides does this figure have?



6. True or false? Shapes that have at least one right angle also have at least one pair of perpendicular sides. Explain your thinking.

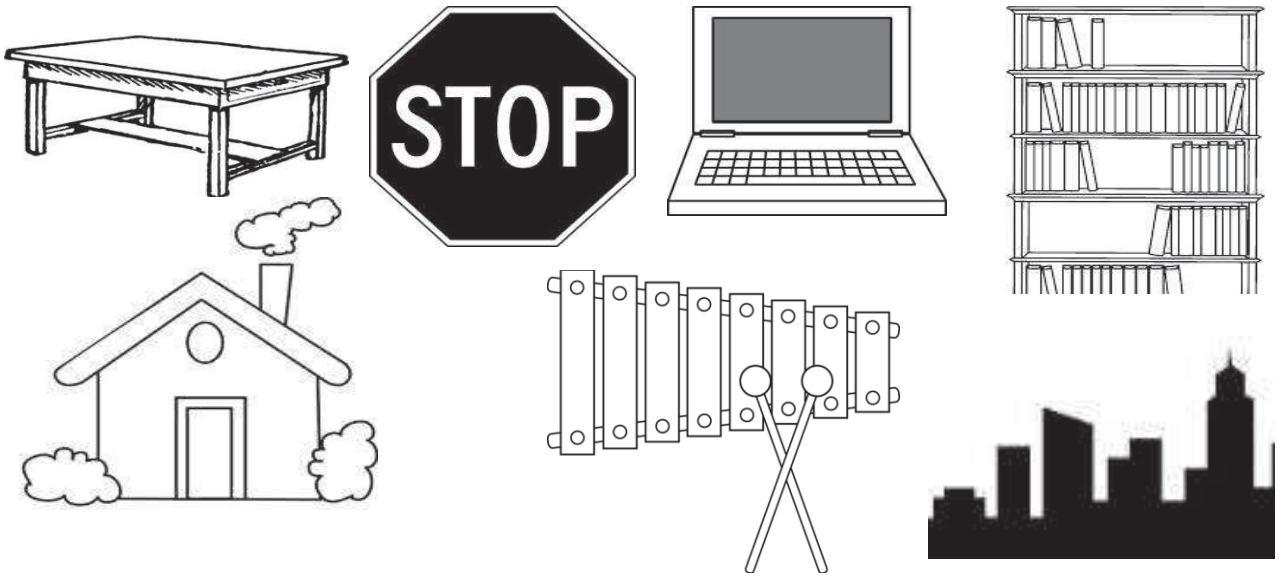
Name _____ Date _____

Find all of the pairs of perpendicular lines in each figure. Mark with the right angle symbol then name them. Use your right angle template as a guide.

	$\overline{BC} \perp$ _____
	$\overline{MN} \perp$ _____

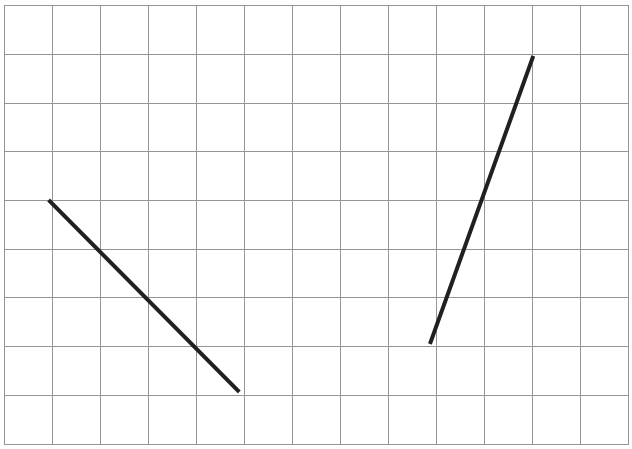
Name _____ Date _____

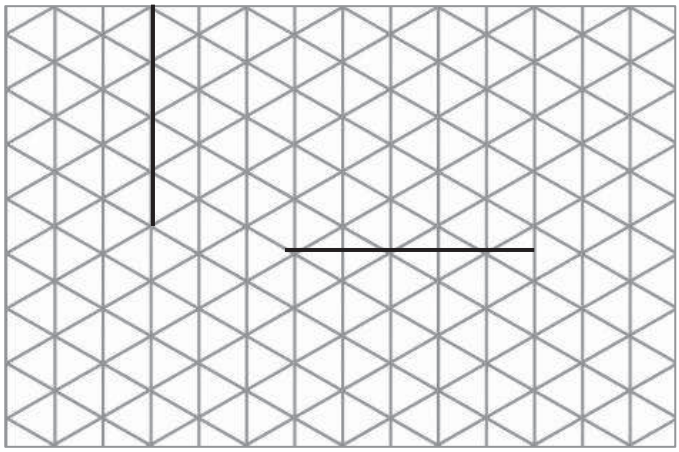
1. On each object, trace at least one pair of lines that appear to be perpendicular.



2. How do you know if two lines are perpendicular?

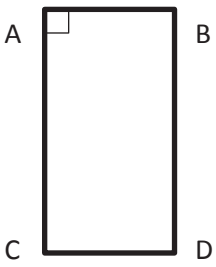
3. In the square and triangular grids below, use the given segments in each grid to draw a line that is perpendicular using a straightedge.





4. Use the right angle template that you created in class to determine which of the following have a right angle. Mark each right angle with a small square. For each right angle you find, name the corresponding pair of perpendicular lines. (See 4(a) for one example of this.)

a.



$\overline{AB} \perp \overline{BD}$

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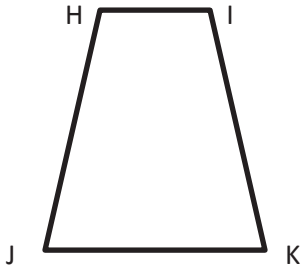

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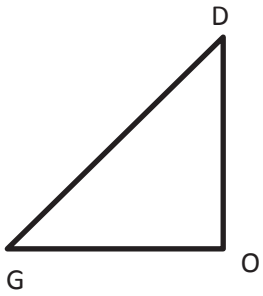

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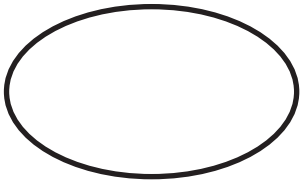

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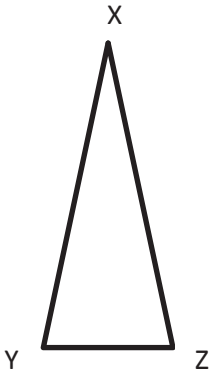

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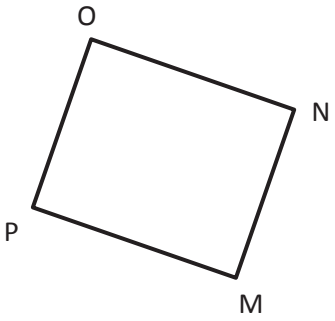

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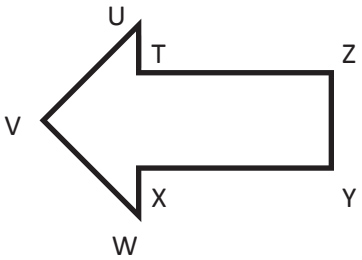
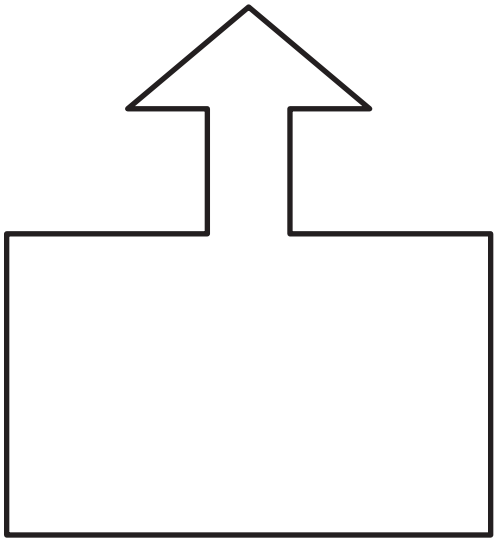
h.



5. Use your right angle template as a guide and mark each right angle in the following figure with a small square. (Note that a right angle does not have to be inside the figure.) How many pairs of perpendicular sides does this figure have?



6. True or false? Shapes that have no right angles also have no perpendicular segments. Draw some figures to help explain your thinking.