

BENCHMARK 1*(Chapters 1 and 2)***A. Line Segments** (pp. 1–5)

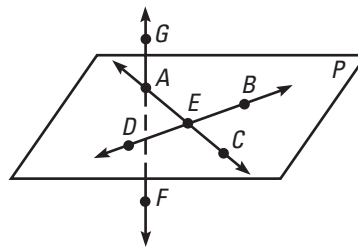
In geometry, the words point, line and plane are undefined terms. They do not have formal definitions but there is agreement about what they mean. Terms that can be described using these words, such as line segment and ray, are called defined terms. The formal definitions allow us to calculate the length and midpoint of a line segment.

1. Name Points, Lines, Segments, and Rays**Vocabulary**

The **line segment** \overline{AB} consists of all points on the line \overleftrightarrow{AB} that are between A and B .

The **ray** \overrightarrow{AB} consists of the endpoint A and all points on the line \overleftrightarrow{AB} which lie on the same side of A as B .

EXAMPLE Use the diagram to name points, lines, and line segments.



\overrightarrow{AB} is in plane P even though it is not drawn in.

- Name two line segments in line \overleftrightarrow{AC} .
- Name three points in P which are not collinear.
- Name a ray which is not in plane P .
- Name a point which is on line \overleftrightarrow{GF} and ray \overrightarrow{CE} .

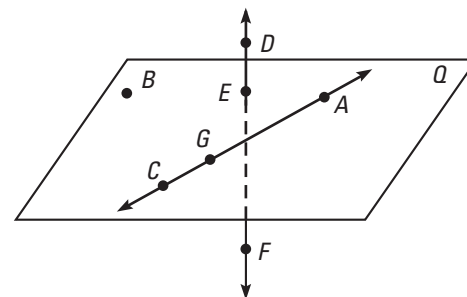
Solution:

- | | |
|--|---------------------------------|
| a. \overline{AC} and \overline{EA} , for example | b. A, E, B is one possibility |
| c. \overrightarrow{AG} or \overrightarrow{AF} | d. A |

PRACTICE

Use the diagram.

- Give another name to plane Q .
- Give three different names for \overleftrightarrow{DF} .
- Name three points which are collinear.
- Are \overline{DE} and \overline{ED} the same line segment?
- Are \overrightarrow{GC} and \overrightarrow{CG} the same ray?
- Name two pairs of opposite rays.

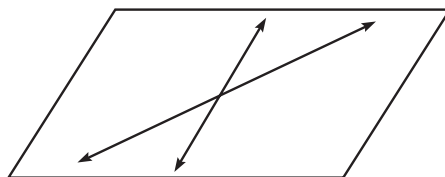
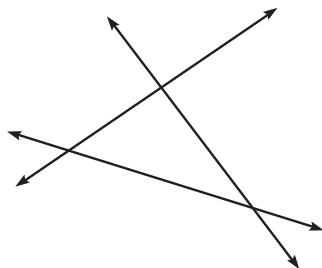
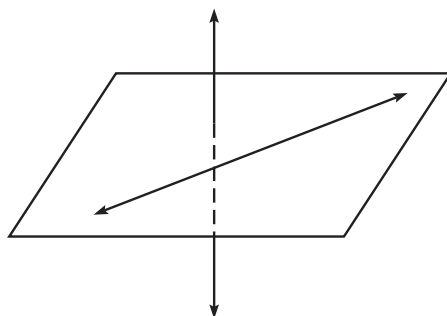


BENCHMARK 1*(Chapters 1 and 2)***2. Sketch Intersections****Vocabulary**

The **intersection** of two or more geometric figures is the set of points the figures have in common.

EXAMPLE

- Sketch two intersecting lines and the plane that they determine.
- Sketch three lines such that each pair intersects in a point which is not on the line which remains.
- Sketch a pair of lines which do not intersect and which are not contained in the same plane.

Solution:**a.****b.****c.**

A dashed line in a diagram indicates the line is out of view.

PRACTICE

- Draw two rays whose intersection is a point.
- Draw two rays whose intersection is a line segment.

BENCHMARK 1*(Chapters 1 and 2)*

9. Draw two rays whose intersection is a ray.
10. Draw two lines which do not intersect and which are contained in the same plane.
11. Draw two lines which do not intersect but which are contained in planes that do intersect.
12. Is it possible for three planes to intersect in just a single point? Explain.

3. Find Lengths of Line Segments**Vocabulary**

The line segments \overline{AB} and \overline{CD} are **congruent** if they have the same length; that is, if $AB = CD$. We write $\overline{AB} \cong \overline{CD}$ to denote congruence.

EXAMPLE

$J(2, 2)$, $K(2, -3)$, $L(-1, 3)$, and $M(4, 3)$ are plotted in the coordinate plane below.

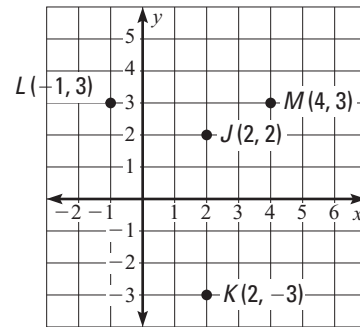
- a. Is \overline{JK} congruent to \overline{LM} ?
- b. Is \overline{LJ} congruent to \overline{JM} ?
- c. Is \overline{JM} congruent to \overline{KM} ?

 $\overline{AB} \neq AB$

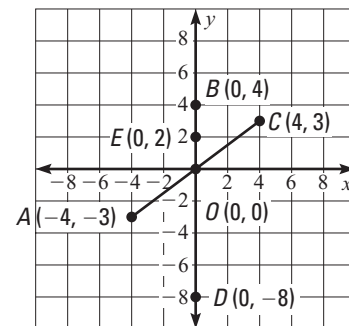
The left hand side is a set of points while the right hand side is a number.

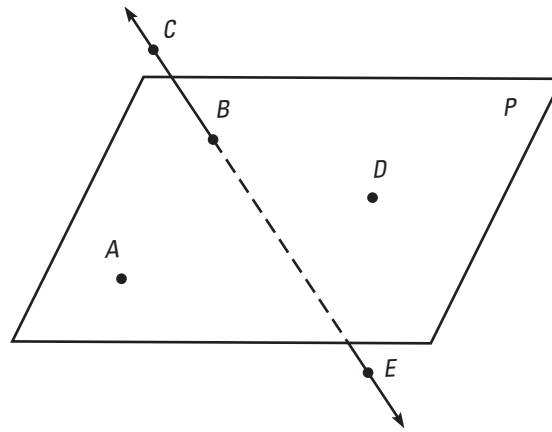
Solution:

- a. Yes, we can see that each segment has length 5.
- b. We measure and see that, no, \overline{LJ} and \overline{JM} do not have the same length.
- c. We measure and see that, no, \overline{JM} and \overline{KM} do not have the same length.

**PRACTICE****Use the diagram.**

13. Name a segment which is half as long as \overline{AC} .
14. Could $DA = 4$?
15. Which segment is congruent to \overline{DE} ?
16. Which segment has length $2(EO)$?
17. Name two pairs of congruent line segments.
18. Is it true that $AO + OC = AC$?



BENCHMARK 1*(Chapters 1 and 2)***Quiz****Use the diagram.**

1. Give another name for plane P .
2. What is the intersection of \overleftrightarrow{BC} with the plane P ?
3. Name a point not on line \overleftrightarrow{AB} .
4. What is the intersection of \overleftrightarrow{CE} with \overleftrightarrow{BC} ?

The endpoints of three line segments are $A(1, 5)$, $B(3, -1)$, and $C(7, 3)$.

5. Find the midpoint of \overline{BC} .
6. Find the exact length of \overline{AC} .
7. Find the exact length of \overline{AB} .
8. Is $\overline{AB} \cong \overline{AC}$?

Answer Key

Benchmark 1

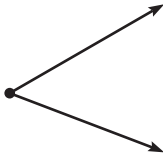
A. Line Segments

1–11. Answers will vary. Samples are given.

1. \overline{BAC} 2. $\overleftrightarrow{DE}, \overleftrightarrow{FE}, \overleftrightarrow{ED}$ 3. A, G, C 4. Yes

5. No 6. \overleftrightarrow{ED} and \overleftrightarrow{EF} , \overleftrightarrow{GA} and \overleftrightarrow{GC}

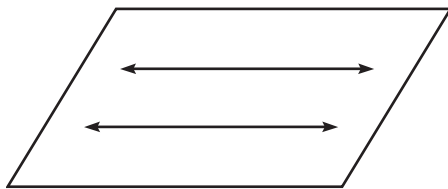
7.



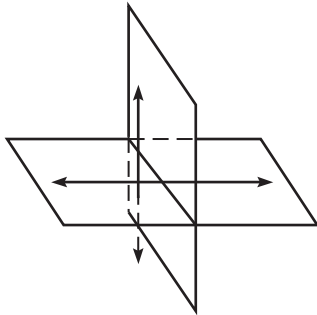
8.

9.

10.



11.



12. Yes; think of the corner of a room where two walls and the ceiling meet.

13. \overline{AO} or \overline{OC} 14. No 15. \overline{AC} 16. \overline{OB}

17. $\overline{AO} \cong \overline{OC}$ and $\overline{EO} \cong \overline{EB}$ 18. Yes

19. $(\frac{5}{2}, \frac{5}{2})$ 20. $(\frac{3}{2}, -\frac{3}{2})$ 21. (2.35, 0.95)

22. $(-\frac{1}{5}, \frac{5}{3})$ 23. (3, 2) 24. (-4, -8) 25. 1.4

26. 7.6 27. 14.3 28. 1.7 29. 8 30. $2|a|$

Quiz

1. \overline{ABD} 2. B 3. $C, D,$ or E 4. \overline{BC}

5. (5, 1) 6. $2\sqrt{10}$ 7. $2\sqrt{10}$ 8. Yes

BENCHMARK 1*(Chapters 1 and 2)***B. Angles** (pp. 6–10)

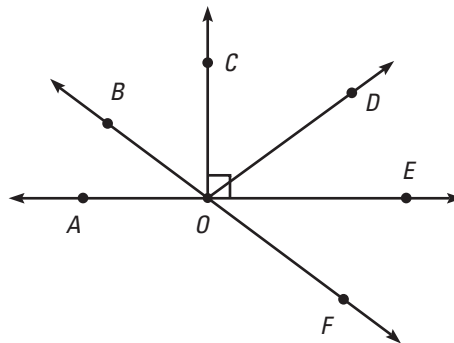
An angle can be acute, obtuse, or right. In the examples which follow, we describe how to name, measure, and classify angles.

1. Name, Measure, and Classify Angles**Vocabulary**

An **angle** consists of two different rays with the same endpoint. The rays are the **sides** of the angle. The endpoint is called the **vertex** of the angle.

EXAMPLE Use the diagram to name and classify angles.

Angles can be measured in degrees or radians. We are using degrees here.



- Name two acute angles.
- Name three obtuse angles.
- Name four right angles (use your protractor to be sure).
- Give another name for $\angle BOC$.

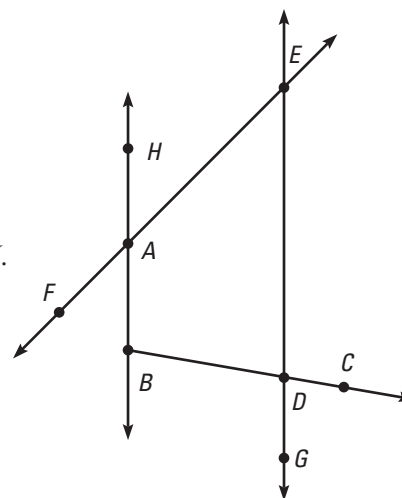
Solution:

- $\angle BOC$ and $\angle EOF$, for example
- $\angle AOD$, $\angle BOE$, and $\angle COF$ are all obtuse angles
- $\angle AOC$ and $\angle COE$ are right angles
- $\angle COB$

PRACTICE

Use the diagram.

- Give two different names for $\angle ABC$.
- Name two straight angles.
- Use a protractor to measure $\angle CDG$ and $\angle FAH$.
- Do there appear to be any right angles?
- How many obtuse angles are shown in the diagram?
- How many acute angles are shown in the diagram?

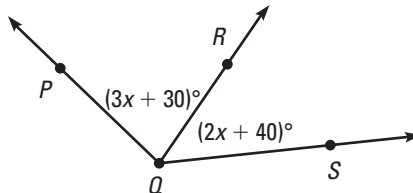


BENCHMARK 1*(Chapters 1 and 2)***2. Find Angle Measures****Vocabulary**

The **bisector of an angle** is a ray that divides the angle into two angles which have the same measure.

EXAMPLE Use the diagram to find angle measures.

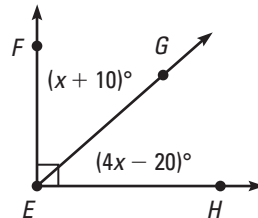
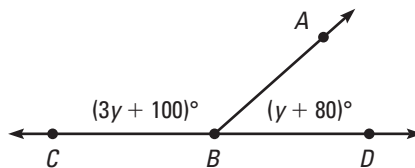
Every angle has exactly one bisector.



- If $m\angle PQS = 85^\circ$, what is $m\angle PQR$ and $m\angle RQS$?
- What is the value of x if \overrightarrow{QR} bisects $\angle PQS$?

Solution:

- We must have that $(3x + 30) + (2x + 40) = 85$ so that $x = 3$. This means that $m\angle PQR = [3(3) + 30]^\circ = 39^\circ$ and $m\angle RQS = [2(3) + 40]^\circ = 46^\circ$.
- We must have that $3x + 30 = 2x + 40$ so that $x = 10$.

PRACTICE**Use the diagram.**

- Is $\angle FEG$ acute?
- Find the value of x .
- Does \overrightarrow{EG} bisect $\angle FEH$?
- Could $\angle CBA$ and $\angle ABD$ both be obtuse?
- Find the value of y .
- Does \overrightarrow{BA} bisect $\angle CBD$?

BENCHMARK 1*(Chapters 1 and 2)***3. Identify Congruent Angles****Vocabulary**

$\angle A$ is **congruent** to $\angle B$ if $m\angle A = m\angle B$. We write $\angle A \cong \angle B$ to denote congruence of angles.

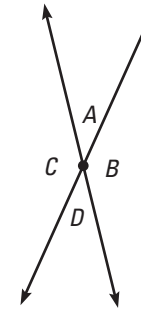
EXAMPLE

The diagram shows two lines intersecting in a point.

$\angle A \neq m\angle A$.

The left hand side is a set of points, the right hand side is a number.

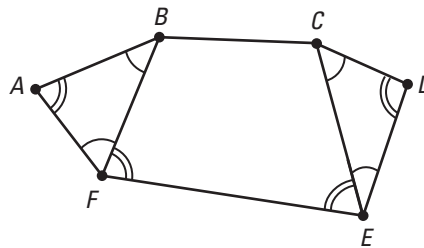
- Show that $\angle A \cong \angle D$.
- Show that $\angle C \cong \angle B$.
- If you know that $\angle B \cong \angle D$, what can you say about the measure of $\angle A$?

**Solution:**

- Since $m\angle A + m\angle C = 180^\circ$ and $m\angle D + m\angle C = 180^\circ$, we must have that $m\angle A = m\angle D$ so that $\angle A \cong \angle D$.
- Since $m\angle A + m\angle C = 180^\circ$ and $m\angle A + m\angle B = 180^\circ$, we must have that $m\angle C = m\angle B$ so that $\angle C \cong \angle B$.
- If $\angle B \cong \angle D$, then $m\angle B = m\angle D$. Thus, $m\angle B = 90^\circ$, since $m\angle B + m\angle D = 180^\circ$. Since $m\angle A + m\angle B = 180^\circ$, we must have that $m\angle A = 90^\circ$ as well.

PRACTICE

Use the diagram.



- Name two angles congruent to $\angle A$.
- Name two angles congruent to $\angle ECD$.
- Name an angle which is congruent to $\angle AFE$.
- If $m\angle AFB = 50^\circ$, what is the measure of $\angle DCE$?
- Suppose that $m\angle ABC = 150^\circ$ and $m\angle DCB = 150^\circ$. What can we say about $\angle FBC$ and $\angle ECB$?
- If $m\angle CEF = (2x + 50)^\circ$ and $m\angle FAB = (4x + 20)^\circ$, what is the value of x ?

BENCHMARK 1*(Chapters 1 and 2)***4. Find Measures of a Complement and a Supplement****Vocabulary**

Two angles are **complementary angles** if the sum of their measures is 90° . Two angles are **supplementary angles** if the sum of their measures is 180° . Two angles are **adjacent angles** if they have a common vertex and side but no common interior points.

EXAMPLE

A complement "completes" a right angle.

- a. Given that $\angle A$ is a complement of $\angle B$ and that $m\angle A = 57^\circ$, what is $m\angle B$?
- b. Given that $\angle C$ is a supplement of $\angle D$ and that $m\angle C = 105^\circ$, what is $m\angle D$?

Solution:

- a. Since $m\angle A + m\angle B = 90^\circ$, we have that $57^\circ + m\angle B = 90^\circ$ so that $m\angle B = 33^\circ$.
- b. Since $m\angle C + m\angle D = 180^\circ$, we have that $105^\circ + m\angle D = 180^\circ$ so that $m\angle D = 75^\circ$.

PRACTICE

Given that $\angle E$ and $\angle F$ are complementary and that $\angle G$ and $\angle H$ are supplementary, find $m\angle F$ and $m\angle H$ in each case.

19. $m\angle E = 30^\circ, m\angle G = 30^\circ$
20. $m\angle E = 42^\circ, m\angle G = 120^\circ$
21. $m\angle E = 18.5^\circ, m\angle G = 125.2^\circ$
22. $m\angle E = 45^\circ, m\angle G = 90^\circ$
23. $m\angle E = 60^\circ, m\angle G = 45^\circ$
24. $m\angle E = 89^\circ, m\angle G = 60^\circ$

5. Find Angle Measures in a Linear Pair**Vocabulary**

Two angles form a **linear pair** if they are adjacent and their non-common sides are opposite rays. The angles in a linear pair are supplementary. Two angles are **vertical angles** if their sides form two pairs of opposite rays.

EXAMPLE

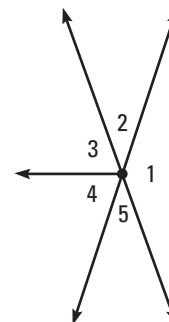
One angle in a linear pair "supplements" the other to form a line.

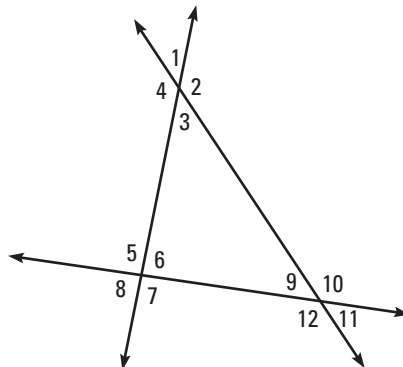
Identify all of the linear pairs and all of the vertical angles labeled in the figure below.

Solution:

To find linear pairs, look for adjacent angles whose noncommon sides are opposite rays: $\angle 1$ and $\angle 2$ are a linear pair.

To find vertical angles, look for angles formed by intersecting lines: $\angle 2$ and $\angle 5$ are vertical angles.

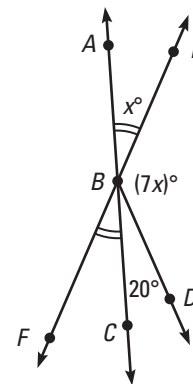


BENCHMARK 1*(Chapters 1 and 2)***PRACTICE** Refer to the figure below.

25. Name a vertical pair containing $\angle 4$.
26. Which two angles each form a linear pair with $\angle 1$?
27. Name a vertical pair containing $\angle 8$.
28. Which two angles each form a linear pair with $\angle 12$?

QuizLines \overleftrightarrow{AC} and \overleftrightarrow{FE} intersect in point B in the diagram.

1. Name a pair of obtuse vertical angles.
2. Identify a linear pair.
3. Give another name for $\angle FBC$.
4. Find the value of x .
5. What is $m\angle DBE$?
6. Name a pair of supplementary angles which are not a linear pair.
7. One angle in the diagram is bisected by a ray. Name that angle and that ray.
8. Name a pair of congruent angles.



Answer Key

Benchmark 1

B. Angles

1-3. Answers may vary. Samples are given.

1. $\angle HBD, \angle CBH$ 2. $\angle HAB, \angle FAE$ 3. $80^\circ, 135^\circ$

4. No 5. 7 6. 7 7. Yes 8. 20

9. No 10. No 11. 0 12. No

13-15. Answers may vary. Samples are given.

13. $\angle BFE, \angle CDE$ 14. $\angle DEC, \angle ABF$

15. $\angle DEF$ 16. 50° 17. They are congruent.

18. 15 19. $m\angle F = 60^\circ, m\angle H = 150^\circ$

20. $m\angle F = 48^\circ, m\angle H = 60^\circ$

21. $m\angle F = 71.5^\circ, m\angle H = 54.8^\circ$

22. $m\angle F = 45^\circ, m\angle H = 90^\circ$ 23. $m\angle F = 30^\circ, m\angle H = 135^\circ$

24. $m\angle F = 1^\circ, m\angle H = 120^\circ$

25. $\angle 4$ and $\angle 2$ 26. $\angle 4$ and $\angle 2$ 27. $\angle 6$ and $\angle 8$

28. $\angle 9$ and $\angle 11$

Quiz

1. $\angle ABF, \angle EBC$ 2. $\angle CBD, \angle DBA$

3. $\angle CBF$ 4. 20 5. 140° 6. $\angle ABD, \angle FBC$

7. $\angle FBD, \overrightarrow{BC}$ 8. $\angle ABE \cong \angle FBC$

BENCHMARK 1*(Chapters 1 and 2)***C. Polygons** (pp. 11–14)

While a circle is not a polygon, it can be thought of as a regular n -gon where n is infinite.

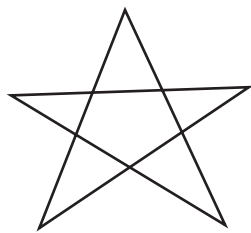
A **polygon** is a closed plane figure which is formed by three or more line segments, called sides. Each side intersects exactly two other sides, one at each endpoint, so that no two sides with a common endpoint are collinear.

1. Identify Polygons**Vocabulary**

A polygon is **convex** if no line that contains a side of the polygon also contains a point in the interior of the polygon. A polygon which is not convex is called **concave** or **nonconvex**.

EXAMPLE Tell whether each figure is a polygon and, if it is a polygon, tell whether it is convex or concave.

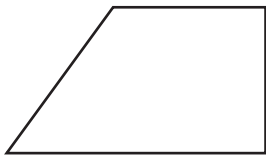
a.



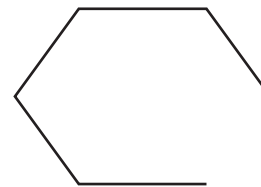
b.



c.



d.

**Solution:**

- a. Some of the line segments intersect more than two other segments, so it is not a polygon.
- b. The figure is a concave polygon.
- c. The figure is a convex polygon.
- d. The figure has sides which intersect only one other side, so it is not a polygon.

PRACTICE

Draw a polygon that fits the description.

1. Three-sided and convex
2. Four-sided and convex
3. Four-sided and concave
4. Five-sided and convex
5. Five-sided and concave
6. Eight-sided and convex

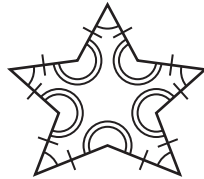
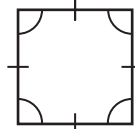
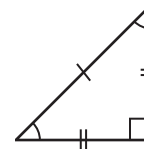
BENCHMARK 1*(Chapters 1 and 2)***2. Classify Polygons****Vocabulary**

An **equilateral polygon** has all its sides congruent to each other. An **equiangular polygon** has all its interior angles equal to each other. A **regular polygon** is both equilateral and equiangular.

EXAMPLE

A square is a regular quadrilateral.

Classify the polygon by the number of sides. Tell whether the polygon is equilateral, equiangular, or regular.

a.**b.****c.****Solution:**

- The polygon has 10 sides. It is equilateral, but not equiangular since not all of its interior angles are equal to each other. So this decagon is not regular.
- This equilateral polygon has 4 sides all of equal length and all its interior angles are equal. It is a regular quadrilateral.
- This 3 sided polygon, a triangle, is not regular because it is neither equilateral nor equiangular.

PRACTICE

Draw a polygon that fits the description.

- An equiangular quadrilateral which is not equilateral.
- An equilateral quadrilateral which is not regular.
- A regular heptagon.
- A concave equilateral nonagon.
- A concave heptagon which is not regular.
- A convex equiangular pentagon.

3. Find Perimeter and Area**Vocabulary**

Perimeter is the distance around a figure, **circumference** is the distance around a circle, and **area** is the amount of surface covered by a figure.

EXAMPLE

Find the perimeter and area of a triangle.

Solution:**Perimeter**

$$P = a + b + c$$

$$= 3 + 4 + 5$$

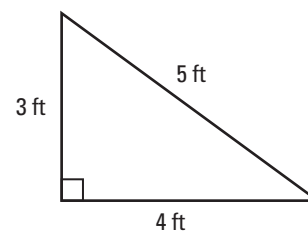
$$= 12$$

Area

$$A = \frac{1}{2}bh$$

$$= \frac{1}{2}(4)(3)$$

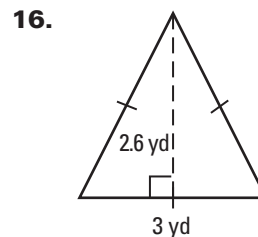
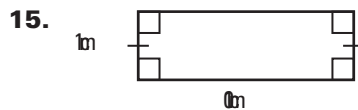
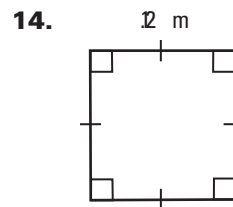
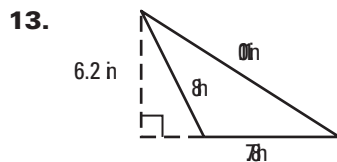
$$= 6$$



The perimeter is 12 feet and the area is 6 square feet.

BENCHMARK 1*(Chapters 1 and 2)***PRACTICE** Find the perimeter and area of each figure. Round to the nearest tenth.

We will see formulas which give the area of more complicated polygons later.

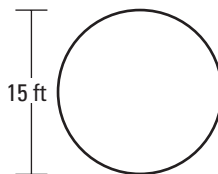
**4. Find Circumference and Area of a Circle.****Vocabulary**

Pi, or π , is the ratio of a circle's circumference to its diameter.

EXAMPLE

Remember how π is defined. It is *not* actually 3.14.

You are ordering a circular tablecloth for your grandmother's oak table. Find the approximate circumference and area of the tablecloth shown.

**Solution:**

First find the radius. The diameter is 15 feet, so the radius is $\frac{1}{2}(15) = 7.5$ feet. Then find the circumference and area.

Use 3.14 to approximate the value of π .

$$C = 2\pi r \approx 2(3.14)(7.5) = 47.1 \text{ and } A = \pi r^2 \approx 3.14(7.5)^2 = 176.6$$

Thus, the circumference is about 47.1 feet and the area is about 176.6 square feet.

PRACTICE

Find the circumference and area of a circle with the given radius. Round to the nearest tenth.

17. $r = 15$ cm

18. $r = 12$ miles

19. $r = 125$ m

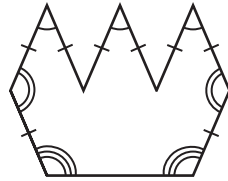
20. $r = 21.8$ in.

21. $r = 3$ yd

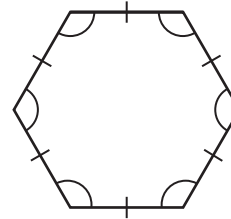
22. $r = 30$ ft

BENCHMARK 1*(Chapters 1 and 2)***Quiz****Classify the polygon shown. Be as descriptive as you can.**

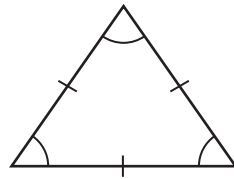
1.



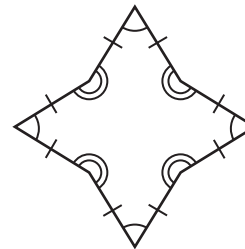
2.



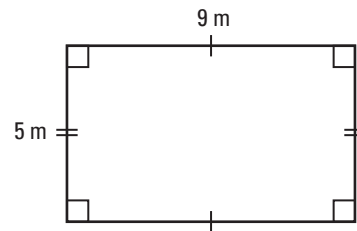
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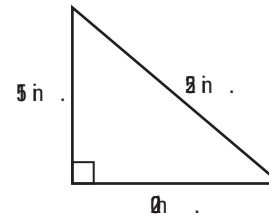
4.

**Find the perimeter and area of the polygon.**

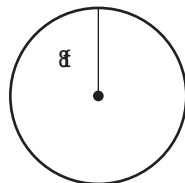
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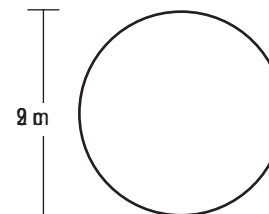
6.

**Find the circumference and area of the circles. Round to the nearest tenth.**

7.



8.

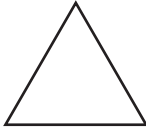


Answer Key

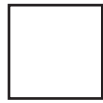
Benchmark 1

C. Polygons

1.



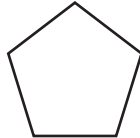
2.



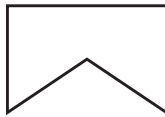
3.



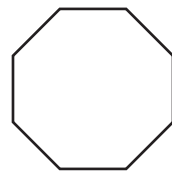
4.



5.



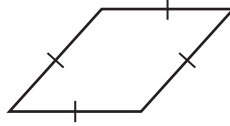
6.



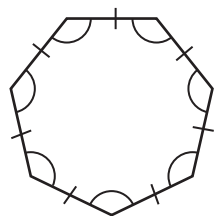
7.



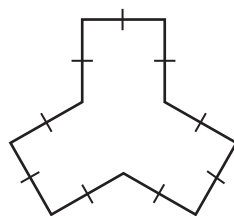
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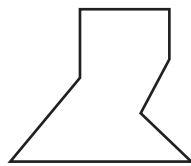
9.



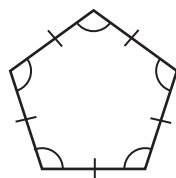
10.



11.



12.



13. $P = 25.9$ in., $A = 24.2$ in.² 14. $P = 4.8$ m, $A = 1.4$ m²

15. $P = 22$ cm, $A = 10$ cm² 16. $P = 9$ yd, $A = 3.9$ yd²

17. $C = 94.2$ cm, $A = 706.5$ cm² 18. $C = 75.4$ mi, $A = 452.2$ mi²

19. $C = 785$ m, $A = 49,062.5$ m² 20. $C = 136.9$ in., $A = 1492.3$ in.²

21. $C = 18.8$ yd, $A = 28.3$ yd² 22. $C = 188.4$ ft, $A = 2826$ ft²

Quiz

1. a concave nonagon 2. convex, equiangular, equilateral, regular hexagon

3. a convex, equiangular, equilateral, regular triangle 4. a concave, equilateral octagon

5. $P = 28$ m, $A = 45$ m² 6. $P = 60$ in., $A = 150$ in.² 7. $C = 50.2$ ft, $A = 201.0$ ft²

8. $C = 91.1$ cm, $A = 660.2$ cm²

BENCHMARK 2*(Chapters 3 and 4)***B. Equations of Lines** (pp. 32–34)

When two lines intersect in the coordinate plane, the steeper line has the slope with the greater absolute value. Lines with positive slope slant up to the right, while lines with negative slope slant up to the left. Horizontal lines have slope zero and vertical lines are of undefined slope.

1. Find Slopes of Lines**Vocabulary**

The **slope** of the line passing through the points (x_1, y_1) and (x_2, y_2) is given by the

$$\text{formula } m = \frac{y_2 - y_1}{x_2 - x_1}.$$

EXAMPLE

Find the slope of line a and line d .

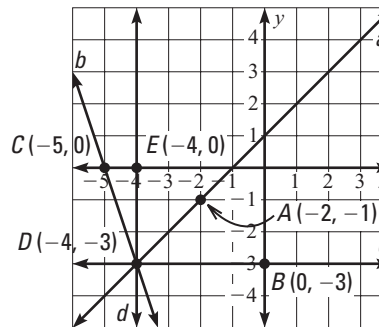
Slope is the ratio of the “rise” to the “run.”

Solution:

$$\text{Slope of line } a: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - (-3)}{-2 - (-4)} = \frac{2}{2} = 1.$$

$$\text{Slope of line } d: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - (-3)}{-4 - (-4)} = \frac{3}{0},$$

which is undefined.

**PRACTICE**

Use the graph above to find the slope of the given line.

- Line b
- Line c
- \overleftrightarrow{AB}
- \overleftrightarrow{AC}
- The x -axis
- The y -axis

2. Classify Lines**Vocabulary**

Two non-vertical lines in the coordinate plane are **parallel** if and only if they have the same slope. Two non-vertical lines in the coordinate plane are **perpendicular** if and only if the product of their slopes is -1 .

EXAMPLE

Find the slope of each line. Which lines are parallel? Which lines are perpendicular?

All vertical lines are perpendicular to all horizontal lines.

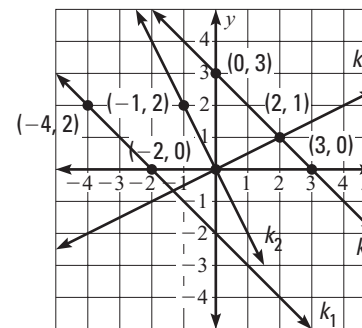
Solution:

Find the slope of line k_1 through

$$(-2, 0) \text{ and } (-4, 2): m_1 = \frac{2 - 0}{-4 - (-2)} = \frac{2}{-2} = -1.$$

Find the slope of line k_2 through

$$(-1, 2) \text{ and } (0, 0): m_2 = \frac{0 - 2}{0 - (-1)} = \frac{-2}{1} = -2.$$



BENCHMARK 2*(Chapters 3 and 4)*

Find the slope of line k_3 through (3, 0) and (0, 3): $m_3 = \frac{0 - 3}{3 - 0} = \frac{-3}{3} = -1$.

Find the slope of line k_4 through (2, 1) and (0, 0): $m_4 = \frac{0 - 1}{0 - 2} = \frac{-1}{-2} = \frac{1}{2}$.

Since $m_1 = m_3$, and these are the only slopes that are equal to each other, k_1 and k_3 is the only pair of parallel lines. Since $m_2 \cdot m_4 = -1$, and these are the only slopes with product -1 , $k_2 \perp k_4$ and this is the only pair of perpendicular lines.

PRACTICE

Tell whether the lines through the given points are parallel, perpendicular, or neither. Justify your answer.

7. Line 1: (-4, -5), (2, -1) Line 2: (2, -5), (-2, 1)

8. Line 1: (3, 7), (-1, 4) Line 2: (8, 5), (14, 10)

9. Line 1: (-6, 6), (-2, 10) Line 2: (-8, 9), (-4, 5)

3. Write Equations of Parallel and Perpendicular Lines**Vocabulary**

The **slope-intercept form** of a linear equation is $y = mx + b$, where m is the slope and b is the y -intercept.

EXAMPLE

Write an equation of the line passing through the point (2, 2) that is:

a. parallel to the line $y = 2x + 1$

b. perpendicular to the line $y = 2x + 1$

Horizontal lines have equations of the form $y = k$.
Vertical lines have equations of the form $x = k$.

Solution:

a. The slope m of a line parallel to $y = 2x + 1$ is the same as the slope of this line, so $m = 2$. We find the y -intercept, b , using $m = 2$ and the point (2, 2):

$$y = mx + b$$

$$2 = 2(2) + b$$

$$-2 = b$$

An equation for the line is $y = 2x - 2$.

b. The slope m of a line perpendicular to $y = 2x + 1$ is the negative reciprocal of the slope of this line, so $m = -\frac{1}{2}$. We find the y -intercept, b , using $m = -\frac{1}{2}$ and the point (2, 2):

$$y = mx + b$$

$$2 = -\frac{1}{2}(2) + b$$

$$3 = b$$

An equation for the line is $y = -\frac{1}{2}x + 3$.

PRACTICE

10. Verify that the lines found in the example above are actually parallel and perpendicular to the given line by graphing all three on the same set of axes.

11. Write an equation for the line that passes through (5, -2) and (2, 1).

12. Write an equation for the line which passes through the point (0, 0) and which is a) parallel to $y = 2x + 8$ and b) perpendicular to $y = -3x - 7$.

BENCHMARK 2*(Chapters 3 and 4)***4. Graph a Line****Vocabulary**

The **standard form** of a linear equation is $Ax + By = C$, where A and B are not both zero.

EXAMPLE Graph $2x + 4y = 8$.**Solution:**

Two points determine a line.

The equation is in standard form, so use intercepts.

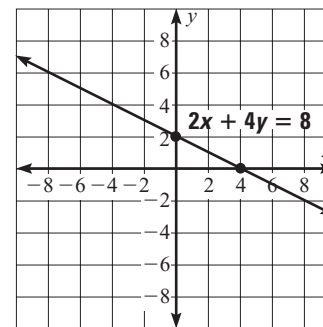
To find the x -intercept, let $y = 0$. To find the y -intercept, let $x = 0$.

$$2x + 4y = 8 \qquad 2x + 4y = 8$$

$$2x + 4(0) = 8 \qquad 2(0) + 4y = 8$$

$$x = 4 \qquad y = 2$$

Graph the points $(4, 0)$ and $(0, 2)$ and draw a line through them.

**PRACTICE****Graph the equation.**

13. $2x + 3y = 12$

14. $-5x + 2y = 10$

15. $8x - 3y = -12$

Quiz

Refer to the points $A(0, 0)$, $B(2, 2)$, $C(4, 0)$, and $D(2, -1)$.

- Find an equation for \overleftrightarrow{AB} .
- Find an equation for \overleftrightarrow{BC} .
- Is $\overleftrightarrow{AB} \perp \overleftrightarrow{BC}$?
- Find an equation of the line through D which is perpendicular to \overleftrightarrow{BC} .
- Find an equation of the line through D which is parallel to \overleftrightarrow{BC} .
- Find the x - and y -intercepts of \overleftrightarrow{CD} .
- Is $\overleftrightarrow{CD} \parallel \overleftrightarrow{AB}$?

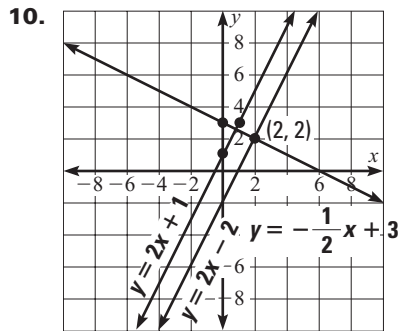
Answer Key

Benchmark 2

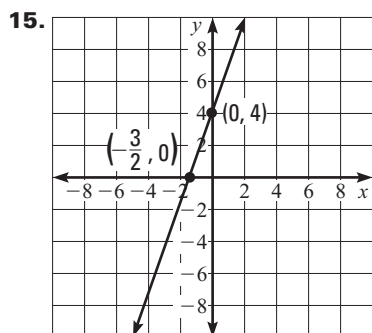
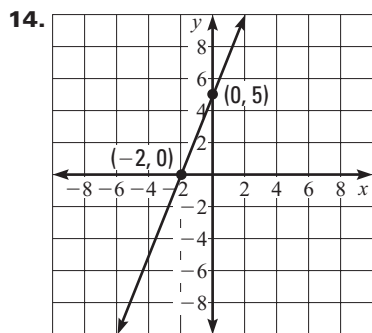
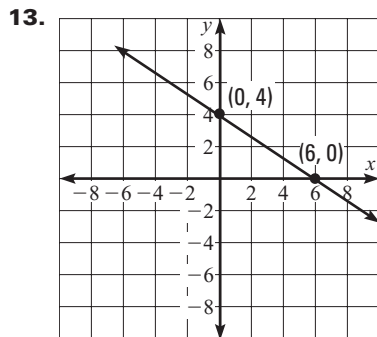
B. Equations of Lines

1. -3 2. 0 3. -1 4. $-\frac{1}{3}$ 5. 0 6. undefined

7. perpendicular 8. neither 9. perpendicular



11. $y = -x + 3$ 12a. $y = 2x$ 12b. $y = \frac{1}{3}x$



Answer Key

Quiz

1. $y = x$ **2.** $y = -x + 4$ **3.** Yes

4. $y = x - 3$ **5.** $y = -x + 1$

6. $(4, 0)$ and $(0, -2)$ **7.** No