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These practice activities are correlated to the state standards of learning for Geometry and are designed to prepare you to take Virginia’s high school assessment test. The practice tests reflect the type of wording likely to be encountered on the actual test.
Mathematics Standards of Learning

GEOMETRY

This course is designed for students who have successfully completed the standards for Algebra I. All students are expected to achieve the Geometry standards. The course includes, among other things, properties of geometric figures, trigonometric relationships, and reasoning to justify conclusions. Methods of justification will include paragraph proofs, two-column proofs, indirect proofs, coordinate proofs, algebraic methods, and verbal arguments. A gradual development of formal proof will be encouraged. Inductive and intuitive approaches to proof as well as deductive axiomatic methods should be used.

This set of standards includes emphasis on two- and three-dimensional reasoning skills, coordinate and transformational geometry, and the use of geometric models to solve problems. A variety of applications and some general problem-solving techniques, including algebraic skills, should be used to implement these standards. Calculators, computers, graphing utilities (graphing calculators or computer graphing simulators), dynamic geometry software, and other appropriate technology tools will be used to assist in teaching and learning. Any technology that will enhance student learning should be used.

Reasoning, Lines, and Transformations

G.1 The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include
   a) identifying the converse, inverse, and contrapositive of a conditional statement;
   b) translating a short verbal argument into symbolic form;
   c) using Venn diagrams to represent set relationships; and
   d) using deductive reasoning.

G.2 The student will use the relationships between angles formed by two lines cut by a transversal to
   a) determine whether two lines are parallel;
   b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and
   c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.

G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
   a) investigating and using formulas for finding distance, midpoint, and slope;
   b) applying slope to verify and determine whether lines are parallel or perpendicular;
   c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and
   d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

G.4 The student will construct and justify the constructions of
   a) a line segment congruent to a given line segment;
   b) the perpendicular bisector of a line segment;
   c) a perpendicular to a given line from a point not on the line;
   d) a perpendicular to a given line at a given point on the line;
e) the bisector of a given angle,
f) an angle congruent to a given angle; and
g) a line parallel to a given line through a point not on the given line.

**Triangles**

G.5 The student, given information concerning the lengths of sides and/or measures of angles in triangles, will
   a) order the sides by length, given the angle measures;
   b) order the angles by degree measure, given the side lengths;
   c) determine whether a triangle exists; and
   d) determine the range in which the length of the third side must lie.

These concepts will be considered in the context of real-world situations.

G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.

G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.

G.8 The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

**Polygons and Circles**

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

G.10 The student will solve real-world problems involving angles of polygons.

G.11 The student will use angles, arcs, chords, tangents, and secants to
   a) investigate, verify, and apply properties of circles;
   b) solve real-world problems involving properties of circles; and
   c) find arc lengths and areas of sectors in circles.

G.12 The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.

**Three-Dimensional Figures**

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

G.14 The student will use similar geometric objects in two- or three-dimensions to
   a) compare ratios between side lengths, perimeters, areas, and volumes;
   b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;
   c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and
   d) solve real-world problems about similar geometric objects.
Pre Test

1 Which Venn diagram represents all the following set of statements?

- Some animals are mammals.
- Some animals are reptiles.
- No animal is both a mammal and a reptile.
- Some mammals are marsupials.

A

```
Animals

Mammals

Marsupials

Reptiles
```

B

```
Animals

Mammals

Marsupials

Reptiles
```

C

```
Animals

Mammals

Reptiles

Marsupials
```

D

```
Animals

Mammals

Reptiles

Marsupials
```

GO ON
2 Which of the following is necessary to construct a perpendicular to a given line at a given point on the line?
   F Draw a line parallel to the given line.
   G Mark two other points on the given line.
   H Draw an arc around a point off the given line.
   J Mark two points away from the given line, on opposite sides.

3 Which additional fact proves that \( \triangle JQL \sim \triangle MNK \)?

\[
\begin{align*}
   &A \quad \frac{MN}{LQ} = \frac{MK}{LJ} \\
   &B \quad \frac{JL}{KM} = \frac{LQ}{NK} \\
   &C \quad \frac{JQ}{MN} = \frac{LQ}{NK} \\
   &D \quad \frac{JK}{LM} = \frac{JQ}{NK}
\end{align*}
\]

4 What is the measure of an exterior angle of a regular hexagon?
   F 15°
   G 30°
   H 60°
   J 120°
Pre Test  (continued)

5 What are the coordinates of $\triangle F'G'H'$ if $\triangle FGH$ is translated 3 units up and 1 unit to the left?

- $F'(-2, -4)$, $G'(-3, 0)$, $H'(-1, -1)$
- $F'(-1, -3)$, $G'(-4, 3)$, $H'(2, -2)$
- $F'(-3, -1)$, $G'(-4, 3)$, $H'(-2, 2)$
- $F'(1, -5)$, $G'(0, -1)$, $H'(2, -2)$

6 Line $t$ intersects lines $p$ and $q$.

Which statement must be true about $\angle 1$ and $\angle 2$ in order for line $p$ and line $q$ to be parallel?
- Their measures must be complementary.
- Their measures must be supplementary.
- Their measures must sum to $110^\circ$.
- Their measures must sum to $70^\circ$.

GO ON
Pre Test (continued)

7 What is the approximate volume of the paper water cup shown below? Use 3.14 for $\pi$.

![Image of a cone with dimensions 3 in. and 6 in.]

- $A \ 56.5 \text{ in.}^3$
- $B \ 108 \text{ in.}^3$
- $C \ 113.1 \text{ in.}^3$
- $D \ 226.2 \text{ in.}^3$

8 If you used a compass to draw the bisector of $\angle ABC$, through which point would it pass?

![Diagram of triangle ABC with points P, Q, R, and S]

- $F \ P$
- $G \ Q$
- $H \ R$
- $J \ S$

9 In $\triangle ABC$, if $m\angle A = 27^\circ$ and $m\angle B = 103^\circ$, which set of sides is in order from smallest to largest?

- $A \ BC, AB, CA$
- $B \ AB, CA, BC$
- $C \ BC, CA, AB$
- $D \ AB, BC, CA$
Use the proof to answer the question below.

Given: \( AB \parallel DC \) and \( AB \cong DC \).

Prove: \( \triangle ABC \cong \triangle CDA \)

1. \( AB \parallel DC \), \( AB \cong DC \)  
2. \( \angle BAC \cong \angle DCA \)  
3. \( \overline{AC} \cong \overline{AC} \)  
4. \( \triangle ABC \cong \triangle CDA \)

Which reason can be used to justify Statement 4?

F  SAS Similarity Theorem  
G  SSS Similarity Theorem  
H  SAS Congruence Postulate  
J  SSS Congruence Postulate
11 These three letters are symmetrical with respect to a vertical line, as shown.

A O M

Which letter could be added as a part of this group?

A S L

B E H

12 What is the last step in constructing an angle $\angle EDF$ congruent to a given angle $\angle A$?

F Draw segment $DF$.

G Draw a segment and label one end $D$.

H Draw two equal-radius arcs with centers and $A$ and $D$, and label points $B$, $C$, and $E$.

J Set the compass at distance $BC$ and then use it to draw point $F$.

13 Refer to the rectangle below. What is the area of the rectangle after all side lengths are doubled?

A 96 cm$^2$

B 192 cm$^2$

C 384 cm$^2$

D 576 cm$^2$
14 As modeled below, a 20-foot ladder leans against a tree. The ladder makes a 64° angle with the ground. Which of the following is closest to the distance up the tree the ladder reaches?

- **F** 8.8 ft
- **H** 22.2 ft
- **G** 18.0 ft
- **J** 41.0 ft

15 In the diagram, $\angle 2 \cong \angle 7$. Identify the postulate or theorem that justifies $u \parallel v$.

- **A** Corresponding Angles Postulate
- **B** Alternate Exterior Angles Theorem
- **C** Alternate Interior Angles Theorem
- **D** Consecutive Interior Angles Theorem

16 A triangle has one side of length 12 and another of length 19. Which of the following best describes the possible lengths of the third side?

- **F** $7 < x < 31$
- **G** $12 < x < 31$
- **H** $7 < x < 19$
- **J** $12 < x < 19$
17 In the figure, the railroad track represents a transversal to the lines that represent the sides of Pine Street. The sides of the street are parallel. Which statement can be justified by the Corresponding Angles Postulate?

A \( \angle 4 \equiv \angle 8 \)
B \( \angle 5 \equiv \angle 7 \)
C \( \angle 4 \equiv \angle 6 \)
D \( \angle 1 \equiv \angle 7 \)

18 A section of sidewalk needs to be poured in the shape of trapezoid \( WXYZ \) shown below, where \( XY \parallel WZ \). \( XY = 6 \) feet and \( WZ = 10 \) feet. A seam in the concrete is represented by \( MN \). How long is the seam?

F 3 ft  H 8 ft
G 6 ft  J 10 ft

19 Four students, DeShawn, Colleen, Joel and Mai, are standing in line. Joel is not behind Mai. Colleen is the last person in line. DeShawn is directly in front of Joel. Who is first in line?

A DeShawn  C Joel
B Colleen  D Mai
Pre Test  (continued)

20  In $\triangle DEF$, $DE = 14$, $EF = 18$, and $DF = 8$. Which inequality is true?
   
   F  $m\angle D > m\angle E > m\angle F$
   
   G  $m\angle D > m\angle F > m\angle E$
   
   H  $m\angle E > m\angle F > m\angle D$
   
   J  $m\angle F > m\angle D > m\angle E$

21  You have used your compass and straightedge to construct a line that is perpendicular to $AB$ and passes through point C. Through which other point does the perpendicular line pass?

   *C

   A  M
   
   B  N
   
   C  O
   
   D  P

22  What is the measure of $\angle ACB$?

   $A$ 40°
   
   B
   
   C

   F  10°
   
   G  20°
   
   H  30°
   
   J  60°
23 What is the last step in constructing a line segment $CD$ congruent to a given line segment $AB$?

A Place the compass at point $C$.
B Mark point $D$ on the new segment.
C Set your compass to the length of $AB$.
D Draw a segment longer than $AB$, and label one end $C$.

24 Line $q$ intersects lines $m$ and $n$.

For what value of $x$ are lines $m$ and $n$ parallel?

F 16  H 34
G 26  J 58

25 Which equation is an equation of a circle with radius $2\sqrt{3}$ and center at $(4, -3)$?

A $(x - 4)^2 + (y + 3)^2 = 12$
B $(x + 4)^2 + (y - 3)^2 = 36$
C $(x - 4)^2 + (y + 3)^2 = 36$
D $(x + 4)^2 + (y - 3)^2 = 12$

26 Nick jogs once around the triangular path shown. About how far does he jog?

F 522.4 m  H 860.6 m
G 980.5 m  J 1221.1 m
Pre Test  (continued)

27  Line $t$ intersects lines $a$ and $b$.

Which angle has to have the same measure as $\angle 5$ for lines $a$ and $b$ to be parallel?

A  $\angle 1$  C  $\angle 6$
B  $\angle 2$  D  $\angle 8$

28  If you construct a line that bisects $\overline{AB}$ using a compass and a straightedge, which other point lies on this line?

F  $M$  H  $P$
G  $N$  J  $Q$

29  Which of the following figures could represent a real triangle?

A

B

C

D
30 You are standing 8 feet from the edge of a circular swimming pool. The distance from you to a point of tangency is 16 feet. What is the diameter of the pool?

F 8 ft  
G 12 ft  
H 16 ft  
J 24 ft

31 Using slopes, how can you determine if a triangle is a right triangle?

A The slopes of the legs are equal.  
B The product of the slopes of the legs is $-1$.  
C The slope of the hypotenuse is equal to the slope of the long leg.  
D The slope of the hypotenuse is equal to the sum of the slopes of the legs.

32 Triangles $ABC$ and $DEF$ are similar. The area of $\triangle ABC$ is 42 cm$^2$. The area of $\triangle DEF$ is 672 cm$^2$. Which of the following equations is true?

F $DE = 2(AB)$  
G $DE = 4(AB)$  
H $DE = 8(AB)$  
J $DE = 16(AB)$

33 What is the inverse of the given statement?

GIVEN: If an animal is a mammal, then it is warm-blooded.

A If an animal is not a mammal, then it is not warm-blooded.  
B If an animal is warm-blooded, then it is a mammal.  
C If an animal is not warm-blooded, then it is not a mammal.  
D An animal is a mammal if and only if it is warm-blooded.
34 The pyramid below is a representation of a trellis for Marla’s flowering vine. The base is a regular hexagon. What is the surface area of the pyramid, including the base? Round your answer to the nearest hundredth.

\[
\begin{align*}
\text{3 ft} & \\
\text{8 ft} & \\
\end{align*}
\]

F 23.38 ft²  
G 72.00 ft²  
H 95.38 ft²  
J 167.38 ft²

35 The volumes of two paperweights, each in the shape of a hemisphere, are given. What is the ratio of the circumferences of their circular bases?

\[
\begin{align*}
V = 36\pi \text{ cm}^3 & \\
V = 121.5\pi \text{ cm}^3 & \\
\end{align*}
\]

A 2 : 3  
B 4 : 9  
C 8 : 27  
D 1 : 4

36 Let \( p \) be “it is raining,” let \( q \) be “it is thundering,” and let \( r \) be “we cannot swim.” What is \( \sim p \rightarrow q \)?

F If it is not raining, then it is thundering.  
G If it is not raining, then we cannot swim.  
H If it is thundering, then it is raining.  
J If it is thundering, then we cannot swim.
37. **KITE** is a kite. What is $m\angle K$?

- **A** $74^\circ$
- **B** $82^\circ$
- **C** $106^\circ$
- **D** $156^\circ$

38. Niki is using a straightedge and compass to complete the construction shown below.

Which of the following best describes the construction Nick is completing?

- **F** Equilateral triangle
- **G** Perpendicular bisector of a segment
- **H** Line parallel to a line through a point
- **J** Rectangle

39. Jessica cans tomatoes in two sizes of jars. The smaller jar has half the dimensions of the larger jar. If the larger jar has a volume of 430 cubic inches, what is the volume of the smaller jar?

- **A** $53\frac{3}{4}$ in.$^3$
- **B** $107\frac{1}{2}$ in.$^3$
- **C** 215 in.$^3$
- **D** 860 in.$^3$
Pre Test (continued)

40 If you know that $\angle TPS$ is $45^\circ$ from the construction shown below, what is $m\angle PQR$?

F $45^\circ$
G $55^\circ$
H $135^\circ$
J $225^\circ$

41 A circle has center $(5, 2)$ and goes through $(8, -2)$. Which of the following is the equation of the circle?

A $(x - 5)^2 + (y - 2)^2 = 49$
B $(x - 8)^2 + (y + 2)^2 = 25$
C $(x + 5)^2 + (y + 2)^2 = 36$
D $(x - 5)^2 + (y - 2)^2 = 25$

42 Identify the statement that has the same meaning as the statement below.

You can drive alone once you have your driver’s license.

F If you can drive alone, then you do have your driver’s license.
G If you can’t drive alone, then you don’t have your driver’s license.
H If you do have your driver’s license, then you can’t drive alone.
J If you don’t have your driver’s license, then you can’t drive alone.
43 Marcus wants to prove that there can be no more than one obtuse angle in a triangle. What assumption should he make to write a proof by contradiction?

- A \( \angle X \) is obtuse.
- B \( \angle Z \) is obtuse.
- C \( \angle X \) and \( \angle Z \) are obtuse.
- D \( \angle X \), \( \angle Y \), and \( \angle Z \) are obtuse.

44 Find the length of \( PQ \). Round your answer to the nearest tenth.

- F 8.1 cm
- G 8.7 cm
- H 9.1 cm
- J 10.2 cm

45 Find the midpoint of the segment with endpoints (9, 8) and (3, 5).

- A \( (3, \frac{3}{2}) \)
- B \( (12, 13) \)
- C \( (6, \frac{13}{2}) \)
- D \( (1, -2) \)
G.1a
The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include identifying the converse, inverse, and contrapositive of a conditional statement.

A **conditional statement** is a logical statement that has two parts, a **hypothesis** and a **conclusion**. When a conditional statement is written in **if-then form**, the “if” part contains the **hypothesis** and the “then” part contains the **conclusion**.

To write the **converse** of a conditional statement, exchange the **hypothesis** and **conclusion**.

To write the **inverse** of a conditional statement, negate both the hypothesis and the conclusion.

To write the **contrapositive**, first write the converse and then negate both the hypothesis and the conclusion.

A conditional statement and its contrapositive always have the same truth value (true or false), and the converse and the inverse always have the same truth value.

<table>
<thead>
<tr>
<th>Conditional Statement</th>
<th>If ( m \angle A = 99^\circ ), then ( \angle A ) is obtuse.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converse</td>
<td>If ( \angle A ) is obtuse, then ( m \angle A = 99^\circ ).</td>
</tr>
<tr>
<td>Inverse</td>
<td>If ( m \angle A = 99^\circ ), then ( \angle A ) is not obtuse.</td>
</tr>
<tr>
<td>Contrapositive</td>
<td>If ( \angle A ) is not obtuse, then ( m \angle A \neq 99^\circ ).</td>
</tr>
</tbody>
</table>

1. **Which statement is the converse of the following statement?**
   If two angles are complementary, then the sum of their angle measures is 90°.
   
   A. If two angles are not complementary, then the sum of their angle measures is not 90°.
   
   B. Two angles are complementary if and only if the sum of their angle measures is 90°.
   
   C. If the sum of the measures of two angles is not 90°, then the angles are not complementary.
   
   D. If the sum of the measures of two angles is 90°, then the angles are complementary.

2. **What is the inverse of the given statement?**
   GIVEN: If you do not enter the contest, you cannot win the contest.
   
   F. If you enter the contest, you can win the contest.
   
   G. If you cannot win the contest, do not enter the contest.
   
   H. If you enter the contest, you cannot win the contest.
   
   J. If you can win the contest, then enter the contest.
If two triangles are both equilateral, then they are similar.

Which of the following best describes the contrapositive of the assertion above?

A. If two triangles are not both equilateral, then they are not similar.
B. Two triangles are similar if and only if they are both equilateral.
C. If two triangles are not similar, then they are not both equilateral.
D. If two triangles are similar, then they are both equilateral.

You are told that a conditional statement is false. Which statement is also false?

F. inverse
G. contrapositive
H. converse
J. conclusion

“Switch the hypothesis and the conclusion.” This is a procedure for constructing which of the following?

A. The inverse
B. The converse
C. The contrapositive
D. None of the above

Given that the inverse of a statement is true, what other statement is true?

F. The original statement
G. The hypothesis
H. The converse
J. The contrapositive

If an argument containing a conditional statement among the premises is valid, then the argument remains valid when the conditional statement is replaced with which of the following?

A. Its negation
B. Its inverse
C. Its converse
D. Its contrapositive

If a conditional statement seems difficult to prove, one can instead try to prove which equivalent statement?

F. The negation
G. The inverse
H. The converse
J. The contrapositive
**G.1b**

The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include translating a short verbal argument into symbolic form.

**SYMBOLIC NOTATION** When a conditional statement is written in symbolic notation, an arrow (→) connects the hypothesis and conclusion. The arrow means “if…then….” So, if \( p \) represents “The ball is round” and \( q \) represents “The ball will roll,” then the conditional statement “If the ball is round, then it will roll” is written as \( p \rightarrow q \).

**TRUTH TABLES** The truth value of a statement is either true (T) or false (F). You can determine the conditions under which a conditional statement is true by using a truth table. The truth table at the right shows the truth values for hypothesis \( p \) and conclusion \( q \). The conditional \( p \rightarrow q \) is only false when a true hypothesis produces a false conclusion.

**NEGATION** The negation of a statement is the opposite of the original statement. To symbolize the negation of a statement \( p \), you write the symbol for negation (¬) before the letter. So, if \( p \) represents “The ball is red,” then “The ball is not red” is written as \( \neg p \). A statement and its negation always have opposite truth values: if \( p \) is true, then \( \neg p \) is false, and vice versa.

**ARGUMENTS** An argument is a set of premises followed by a conclusion. An argument is valid if the conclusion has to be true whenever all the premises are true. Otherwise the argument is invalid.

---

1. Let \( p \) be “it is raining,” let \( q \) be “it is thundering,” and let \( r \) be “we cannot swim.” What is \( \neg r \rightarrow \neg q \)?
   - A If it is thundering, then we cannot swim.
   - B If we can swim, then it is not thundering.
   - C If we cannot swim, then it is not thundering.
   - D If we can swim, then it is thundering.

2. Let \( p \) be “it is raining,” let \( q \) be “it is thundering,” and let \( r \) be “we cannot swim.” The statement \( \neg p \rightarrow \neg r \) could be
   - F The inverse of \( r \rightarrow p \)
   - G The inverse of \( \neg r \rightarrow \neg p \)
   - H The contrapositive of \( r \rightarrow p \)
   - J The converse of \( r \rightarrow p \)

3. Which of the following is guaranteed to make a conditional statement true?
   - A A true hypothesis
   - B A false hypothesis
   - C A false conclusion
   - D None of the above
4. Which of the following is guaranteed to make a conditional statement false?

F. A true hypothesis
G. A false hypothesis
H. A false conclusion
J. None of the above

5. Which of the following argument forms is invalid?

A. \( q \)
   \( p \rightarrow q \)
   Therefore, \( p \)

B. \( p \)
   \( p \rightarrow q \)
   Therefore, \( q \)

C. \( \sim q \)
   \( p \rightarrow q \)
   Therefore, \( \sim p \)

D. \( p \rightarrow q \)
   \( q \rightarrow r \)
   Therefore, \( p \rightarrow r \)

6. Which of the following argument forms is valid?

F. \( p \rightarrow q \)
   \( \sim p \)
   Therefore, \( \sim q \)

G. \( p \rightarrow q \)
   \( \sim q \)
   Therefore, \( \sim p \)

H. \( p \rightarrow q \)
   \( q \)
   Therefore, \( p \)

J. \( p \rightarrow q \)
   \( p \rightarrow r \)
   Therefore, \( q \rightarrow r \)

7. Let \( p \) be “the election was stolen,” let \( q \) be “the ballots were tampered with,” and let \( r \) be “officials lost control of the ballots.” Translate the following argument into symbolic form.

If officials did not lose control of the ballots, then ballots were not tampered with.

And if the ballots were not tampered with, then the election was not stolen.

Therefore, if the election was stolen, then officials lost control of the ballots.

A. \( \sim r \rightarrow \sim q \)
   \( \sim q \rightarrow \sim p \)
   Therefore, \( p \rightarrow r \)

B. \( \sim p \rightarrow \sim q \)
   \( \sim q \rightarrow \sim r \)
   Therefore, \( r \rightarrow p \)

C. \( \sim q \rightarrow r \)
   \( r \rightarrow \sim p \)
   Therefore, \( p \rightarrow q \)

D. \( r \rightarrow \sim p \)
   \( p \rightarrow \sim q \)
   Therefore, \( q \rightarrow \sim r \)
G.1c

The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include using Venn diagrams to represent set relationships.

A Venn diagram is used to represent relationships among different sets of objects. The diagram determines the truth or falsity of statements about the sets.

Here are some statements that are true based on the Venn diagram shown.

- All jets are airplanes.
- Some unpowered aircraft are airplanes.
- No jets are helicopters.

Here are some statements that are false based on the same diagram.

- Some helicopters are airplanes.
- No airplanes are jets.

One way to test the validity of an argument is to try drawing a Venn diagram that makes all the premises true and also makes the conclusion false. If you can do this, the argument is invalid. If the diagram is impossible, the argument is valid.

1. Which of the following statements is represented by the Venn diagram?

   - A. No pets are mammals.
   - B. All cats are mammals.
   - C. All cats are pets.
   - D. All mammals are cats.

2. Which of the following statements is not represented by the Venn diagram?

   - F. No boxy containers are crates.
   - G. All lockers are boxy containers.
   - H. Some crates are lockers.
   - J. Some boxy containers are lockers.
3. Which of the following Venn diagrams represents the statement “All jackets are outerwear”?

A. 

B. 

C. 

D. 

4. Some puppies are males.
   Some males are old dogs.
   Therefore, some puppies are old dogs.
   Which of the following Venn diagrams shows the above argument to be invalid?

F. 

G. 

H. 

J. 

GO ON
G.1d
The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include using deductive reasoning.

**Deductive reasoning** uses facts, definitions, accepted properties, and the laws of logic to form an argument. Here is an example.

Peter runs 4 miles on Massachusetts Avenue every morning.

This is Massachusetts Avenue.

Therefore, Peter runs here.

Words and symbols should be used consistently to avoid confusion. The above argument would be invalid if the two uses of the street “Massachusetts Avenue” referred to streets in two different cities.

Deductive reasoning tries to obtain a conclusion that *must* be true whenever all the premises are true. This is different from an **inductive reasoning**, in which a general conjecture is based on known specific cases but the conjecture could still be wrong. Guessing the next number in a sequence, such as 7, 14, 21, …, is an instance of inductive reasoning. The next number is probably 28, but it could be something else. There is no way to prove, deductively, that it is 28.

An **indirect proof**, or **proof by negation**, reaches a conclusion by assuming the opposite of the conclusion and showing that this leads to a contradiction.

1. **What is the definition of a deductive argument?**
   - **A** All of the premises are known with certainty.
   - **B** The conclusion is initially assumed to be false.
   - **C** The conclusion is supposed to follow by logical necessity.
   - **D** The conclusion is not already known to be true.

2. **What is the definition of a deductively valid argument?**
   - **F** It is impossible for any of the premises to be false.
   - **G** It is impossible for the conclusion to be false.
   - **H** It is impossible for the premises to be false and the conclusion true.
   - **J** It is impossible for the premises to be true and the conclusion false.
G.1d (continued)

3 Which statement follows logically from the following statements?
   If it is raining, then we will watch a movie.
   If we watch a movie, then we will eat popcorn.
   A If it is not raining, then we will not eat popcorn.
   B If we do not watch a movie, then we will not eat popcorn.
   C If we do not eat popcorn, then it is not raining.
   D If we eat popcorn, then we are watching a movie.

5 Which of the following is a part of writing proofs by negation?
   A Assume the given information is false.
   B Assume the statement you are trying to prove is false.
   C Assume both the given information and the statement you are trying to prove are false.
   D Find a contradiction between the given information and the statement you are trying to prove.

6 One limitation of deductive reasoning is that
   F It is too easy to reach a false conclusion by making a mistake.
   G There are strong limits on what one can logically deduce from given premises.
   H The criteria for a valid deductive argument are not well-defined.
   J Deductive arguments require more premises than other types of argument.

7 Which of the following is not permitted in constructing a deductive argument? Choose the best answer.
   A Using the same symbol to mean two different things in a symbolic translation.
   B Choosing one’s preferred form of argument (proof by negation, etc.).
   C Filling in whatever premises are needed to make the argument valid.
   D Choosing a conclusion one knows how to prove.

GO ON
G.2a

The student will use the relationships between angles formed by two lines cut by a transversal to determine whether two lines are parallel.

**Corresponding Angles Postulate**
If two parallel lines are cut by a transversal, then the pairs of corresponding angles are congruent.

The converse is also true. In the figure, \( \angle 1 \equiv \angle 5 \).

**Alternate Exterior Angles Theorem**
If two parallel lines are cut by a transversal, then the pairs of alternate exterior angles are congruent.

The converse is also true. In the figure, \( \angle 1 \equiv \angle 8 \).

**Alternate Interior Angles Theorem**
If two parallel lines are cut by a transversal, then the pairs of alternate interior angles are congruent.

The converse is also true. In the figure, \( \angle 4 \equiv \angle 5 \).

**Consecutive Interior Angles Theorem**
If two parallel lines are cut by a transversal, then the pairs of consecutive interior angles are supplementary. The converse is also true. In the figure, \( \angle 3 \) and \( \angle 5 \) are supplementary.

---

1. **Line c intersects both line a and line b.**
   What else must be true for line c to be considered the transversal of lines a and b?
   - A. Lines a and b must be parallel.
   - B. Lines a and b must intersect.
   - C. Line c must not intersect any other lines.
   - D. Nothing else is needed.

2. **Line t intersects lines p and q.**
   Which statement must be true about \( \angle 1 \) and \( \angle 2 \) in order for line p and line q to be parallel?
   - F. Their measures must be equal.
   - G. Their measures must be supplementary.
   - H. Their measures must sum to 105°.
   - J. Their measures must sum to 75°.
G.2a (continued)

Use the figure below for questions 3 and 4. Line \( t \) intersects lines \( a \) and \( b \).

3 Which angle has to have the same measure as \( \angle 2 \) for lines \( a \) and \( b \) to be parallel?
   - A \( \angle 1 \)
   - B \( \angle 3 \)
   - C \( \angle 7 \)
   - D \( \angle 8 \)

4 Which angle has to be supplementary to \( \angle 4 \) for lines \( a \) and \( b \) to be parallel?
   - F \( \angle 6 \)
   - G \( \angle 3 \)
   - H \( \angle 5 \)
   - J \( \angle 8 \)

5 Line \( t \) intersects lines \( p \) and \( q \).

Which statement must be true about \( \angle 1 \) and \( \angle 2 \) in order for line \( p \) and line \( q \) to be parallel?
   - A Their measures must sum to 62°.
   - B Their measures must sum to 118°.
   - C Their measures must be supplementary.
   - D Their measures must be equal.

6 If line \( m \) is rotated about its intersection with line \( p \), until line \( m \) is parallel to line \( n \), what is the resulting measure of \( \angle 1 \)?
   - F 34°
   - G 146°
   - H 90°
   - J 112°

Use the figure below for questions 7 and 8. Line \( t \) intersects lines \( a \) and \( b \).

7 Which angle has to have the same measure as \( \angle 5 \) for lines \( a \) and \( b \) to be parallel?
   - A \( \angle 3 \)
   - B \( \angle 1 \)
   - C \( \angle 8 \)
   - D \( \angle 2 \)

8 Which angle has to be supplementary to \( \angle 3 \) for lines \( a \) and \( b \) to be parallel?
   - F \( \angle 6 \)
   - G \( \angle 8 \)
   - H \( \angle 7 \)
   - J \( \angle 4 \)
G.2b

The student will use the relationships between angles formed by two lines cut by a transversal to verify the parallelism, using algebraic and coordinate methods as well as deductive proofs.

Finding the measures of angles formed by parallel lines and a transversal sometimes requires several steps of algebraic or geometric reasoning.

**EXAMPLE**

Angle 1 measures 57°. Find \( m \angle 3 \). Indicate how you would justify your steps if asked to give a two-column proof of your answer.

**Solution**

\[(m \angle 1 + 90°) + m \angle 2 = 180° \] by the Angle Addition Postulate and the Linear Pair Postulate.

Since \( m \angle 1 = 57° \) is given, it follows by the substitution and subtraction properties of equality that \( m \angle 2 = 33° \). By the Alternate Interior Angles Theorem, \( \angle 2 \cong \angle 3 \). Finally, from the definition of congruency it follows that \( m \angle 3 = 33° \).

1. Classify the pair \( \angle 1 \) and \( \angle 8 \).

A Corresponding angles
B Alternate interior angles
C Alternate exterior angles
D Consecutive interior angles

2. Use the diagram to answer the question below.

\( \angle PEA \cong \angle RFE \)

Prove that line \( PQ \) is parallel to line \( RS \).

What reason can be used to prove that lines \( PQ \) and \( RS \) are parallel?

F The distance between \( PQ \) and \( RS \) is the same.
G Corresponding angles are congruent.
H Supplementary angles are congruent.
J \( AB \) is a perpendicular transversal.
3 In the diagram, line \( s \) is parallel to line \( t \). What is the measure of \( \angle ACB \)?

\[ \text{A} \ 30^\circ \quad \text{C} \ 90^\circ \]
\[ \text{B} \ 60^\circ \quad \text{D} \ 150^\circ \]

4 Examine the diagram below, where lines \( m \) and \( n \) are parallel. Which is a valid conclusion and valid reasoning based on the diagram?

\[ \text{F} \ \angle 2 \text{ and } \angle 8 \text{ are congruent because corresponding and vertical angles are congruent.} \]
\[ \text{G} \ \text{The measures of } \angle 1 \text{ and } \angle 4 \text{ have a sum of } 180^\circ \text{ because same-side exterior angles are supplementary.} \]
\[ \text{H} \ \angle 5 \text{ and } \angle 3 \text{ are congruent because alternate interior angles are congruent.} \]
\[ \text{J} \ \angle 6 \text{ and } \angle 7 \text{ are congruent because same-side interior angles are congruent.} \]

5 Choose the reason the statement “If \( m \angle 3 = 115^\circ \), then \( m \angle 5 = 65^\circ \)” is true.

\[ \text{A} \ \text{Alternate Interior Angles Theorem} \]
\[ \text{B} \ \text{Alternate Exterior Angles Theorem} \]
\[ \text{C} \ \text{Consecutive Interior Angles Theorem} \]
\[ \text{D} \ \text{Vertical Angles Theorem} \]

6 Choose the reason the statement “If \( m \angle 1 = 65^\circ \), then \( m \angle 5 = 65^\circ \)” is true.

\[ \text{F} \ \text{Alternate Interior Angles Theorem} \]
\[ \text{G} \ \text{Alternate Exterior Angles Theorem} \]
\[ \text{H} \ \text{Consecutive Interior Angles Theorem} \]
\[ \text{J} \ \text{Corresponding Angles Postulate} \]

7 If \( m \angle 6 = 115^\circ \), then \( m \angle 3 = ? \)

\[ \text{A} \ 65^\circ \]
\[ \text{B} \ 115^\circ \]
\[ \text{C} \ 180^\circ \]
\[ \text{D} \ 90^\circ \]

Use the figure below for questions 5–7.

[Diagram showing angles 1, 2, 3, 4, 5, 6, 7, and 8 with lines \( \overline{AB} \) and \( \overline{CD} \) parallel.]

5 Choose the reason the statement “If \( m \angle 3 = 115^\circ \), then \( m \angle 5 = 65^\circ \)” is true.

\[ \text{A} \ \text{Alternate Interior Angles Theorem} \]
\[ \text{B} \ \text{Alternate Exterior Angles Theorem} \]
\[ \text{C} \ \text{Consecutive Interior Angles Theorem} \]
\[ \text{D} \ \text{Vertical Angles Theorem} \]

6 Choose the reason the statement “If \( m \angle 1 = 65^\circ \), then \( m \angle 5 = 65^\circ \)” is true.

\[ \text{F} \ \text{Alternate Interior Angles Theorem} \]
\[ \text{G} \ \text{Alternate Exterior Angles Theorem} \]
\[ \text{H} \ \text{Consecutive Interior Angles Theorem} \]
\[ \text{J} \ \text{Corresponding Angles Postulate} \]

7 If \( m \angle 6 = 115^\circ \), then \( m \angle 3 = ? \)

\[ \text{A} \ 65^\circ \]
\[ \text{B} \ 115^\circ \]
\[ \text{C} \ 180^\circ \]
\[ \text{D} \ 90^\circ \]
G.2c
The student will use the relationships between angles formed by two lines cut by a transversal to solve real-world problems involving angles formed when parallel lines are cut by a transversal.

Use the figure below for questions 1 and 2. The figure shows a top view of two walls and a string stretched between them that is perpendicular to one wall.

1  A contractor wants to ensure that the walls are parallel and checks that \( \angle 1 \) measures 90°. Which postulate or theorem does this rely on? Choose the best answer.
   A  Corresponding Angles Postulate
   B  Consecutive Interior Angles Theorem
   C  Alternate Interior Angles Theorem
   D  Alternate Exterior Angles Theorem

2  A contractor wants to ensure that the walls are parallel and checks that \( \angle 2 \) measures 90°. Which postulate or theorem does this rely on? Choose the best answer.
   F  Corresponding Angles Postulate
   G  Consecutive Interior Angles Theorem
   H  Alternate Interior Angles Theorem
   J  Alternate Exterior Angles Theorem
5 Which statement is justified by the Alternate Exterior Angles Theorem?
   A \( \angle 3 \cong \angle 5 \)
   B \( \angle 2 \cong \angle 8 \)
   C \( \angle 1 \) and \( \angle 8 \) are supplementary.
   D \( \angle 4 \) and \( \angle 5 \) are supplementary.

6 Which statement is justified by the Consecutive Interior Angles Theorem?
   F \( \angle 4 \cong \angle 6 \)
   G \( \angle 1 \cong \angle 7 \)
   H \( \angle 3 \) and \( \angle 6 \) are supplementary.
   J \( \angle 2 \) and \( \angle 7 \) are supplementary.

7 Which of the following statements is correct?
   A \( \angle 1 \) and \( \angle 6 \) are complementary.
   B \( \angle 1 \) and \( \angle 6 \) are supplementary.
   C \( \angle 1 \) and \( \angle 6 \) are congruent.
   D \( \angle 1 \) and \( \angle 6 \) are similar.

8 A wooden gate has \( z \)-shaped boards for support, as shown.

   Which of the following statements is true?
   F \( m\angle 1 + m\angle 2 = 180 \)
   G \( m\angle 1 + m\angle 2 = 90 \)
   H \( m\angle 2 - m\angle 1 = 2(m\angle 1) \)
   J \( m\angle 1 + m\angle 2 = 2(m\angle 2) \)
**G.3a**

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include investigating and using formulas for finding distance, midpoint, and slope.

**The Distance Formula**

If \(A(x_1, y_1)\) and \(B(x_2, y_2)\) are points in a coordinate plane, then the distance between \(A\) and \(B\) is \(AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}\).

**The Midpoint Formula**

The coordinates of the midpoint of a segment are the averages of the \(x\)-coordinates and of the \(y\)-coordinates of the endpoints. If \(A(x_1, y_1)\) and \(B(x_2, y_2)\) are points in a coordinate plane, then the midpoint \(M\) of \(\overline{AB}\) has coordinates \(\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)\).

**The Slope Formula**

The slope of a line is a ratio that compares the vertical change between two points to the horizontal change for the same two points. Slope also can be described as the ratio \(\frac{\text{rise}}{\text{run}}\) or the rate of change of \(y\) with respect to \(x\). To compute the slope from \((x_1, y_1)\) to \((x_2, y_2)\), use the slope formula \(m = \frac{y_2 - y_1}{x_2 - x_1}\).

1. On a map, two cities are located at \((2, 4)\) and \((-2, 2)\). What is the distance between the cities on the map?
   - A 2√3 units
   - B 2√5 units
   - C 12 units
   - D 20 units

2. The endpoints of \(\overline{MN}\) are \(M(-3, -9)\) and \(N(4, 8)\). What is the approximate length of \(\overline{MN}\)?
   - F 1.4 units
   - G 7.2 units
   - H 13 units
   - J 18.4 units

3. Find the coordinates of the other endpoint of a segment with endpoint \(X(-2, 3)\) and midpoint \(M(1, -2)\).
   - A \((4, -7)\)
   - B \((-4, 7)\)
   - C \((0, -1)\)
   - D \((-5, 8)\)

4. Carlos is walking in a straight line from the soccer field at point \(S(-2.23, 4.71)\) to his house at point \(H(4.2, 9.92)\). At what point will he be halfway home?
   - F \((0.985, 2.605)\)
   - G \((0.985, 7.315)\)
   - H \((3.215, 2.605)\)
   - J \((3.215, 7.315)\)
5. What rate of change is illustrated in the graph?

6. A passenger train is climbing a mountain that has a slope of 0.4 as it takes riders on a tour of a wildlife refuge. After traveling a vertical distance of 40 feet, how many feet has the train traveled horizontally?

7. Line segments $RS$ and $TU$ are congruent. Their coordinates are $R(0, 2), S(3, 6), T(6, 1), U(10, y)$. Find the value of $y$.

   A. 2
   B. 3
   C. 4
   D. 5

8. To the nearest hundredth of a unit, what is the length of the segment joining the midpoints of $LM$ and $LN$?

   F. 2.24
   G. 3.54
   H. 4.16
   J. 4.48
G.3b

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include applying slope to verify and determine whether lines are parallel or perpendicular.

To decide whether two lines are parallel, perpendicular, or neither, compare their slopes. If the lines are given by equations in slope-intercept form, \( y = m_1x + b_1 \) and \( y = m_2x + b_2 \), the slopes are the coefficients \( m_1 \) and \( m_2 \).

**Slopes of Parallel Lines**
In a coordinate plane, two nonvertical lines are parallel if and only if they have the same slope. Any two vertical lines are parallel.

**Slopes of Perpendicular Lines**
In a coordinate plane, two nonvertical lines are perpendicular if and only if the product of their slopes is \(-1\). Horizontal lines are perpendicular to vertical lines.
If the product of two numbers is \(-1\), then the numbers are called **negative reciprocals**.

1. Which lines are parallel?

   - **A** \( a \parallel c \)
   - **B** \( b \parallel c \)
   - **C** \( a \parallel b \)
   - **D** \( a \parallel b \parallel c \)

2. Grant wrote an equation of a line through the point \((4, 1)\) that is perpendicular to the one shown. What other point lies on his line?

   - **F** \((2, 7)\)
   - **G** \((3, 3)\)
   - **H** \((-1, 12)\)
   - **J** \((4, 5)\)
3 Which lines are perpendicular?
   Line 1: $2x + y = 4$
   Line 2: $y = x - 7$
   Line 3: $\frac{1}{2}x - y = -3$
   A Lines 1 and 2
   B Lines 1 and 3
   C Lines 2 and 3
   D None of the lines are perpendicular.

4 Which of the following statements are true about lines $w$, $n$, $p$, and $z$?
   $w$: $y = \frac{3}{2}x + 2$
   $n$: $y = \frac{2}{3}x + 6$
   $p$: $y = -\frac{3}{2}x - 3$
   $z$: $y = \frac{2}{3}x + 1$
   I. $w \perp p$  II. $n \parallel z$  III. $z \perp p$
   F I only
   G II only
   H III only
   J II and III

5 Which pair of lines are perpendicular?
   A Line 1: $(8, 12), (7, -5)$
      Line 2: $(-9, 3), (8, 2)$
   B Line 1: $(3, -4), (-1, 4)$
      Line 2: $(2, 7), (5, 1)$
   C Line 1: $(-3, 1), (-7, -2)$
      Line 2: $(2, -1), (8, 4)$
   D Line 1: $(-1, 3), (4, 1)$
      Line 2: $(-2, -1), (3, -3)$

6 If two different lines with equations $y = m_1x + b_1$ and $y = m_2x + b_2$ are parallel, which of the following must be true?
   F $b_1 = b_2$ and $m_1 \neq m_2$
   G $b_1 \neq b_2$ and $m_1 = m_2$
   H $b_1 \neq b_2$ and $m_1 \neq m_2$
   J $b_1 = b_2$ and $m_1 = m_2$

7 Which equation is an equation of the line parallel to $3x + 4y = 7$ that passes through the point $(2, -1)$?
   A $y = \frac{4}{3}x - \frac{11}{3}$
   B $y = -\frac{4}{3}x + \frac{5}{3}$
   C $y = \frac{3}{4}x - \frac{5}{2}$
   D $y = -\frac{3}{4}x + \frac{1}{2}$

8 Figure $ABCD$ is a parallelogram.
   Which statement would prove that parallelogram $ABCD$ is a rhombus?
   F $AB = CD$
   G $AC = BD$
   H $\text{slope } AB = \text{slope } CD$
   J $(\text{slope } AC)(\text{slope } BD) = -1$
G.3c
The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include investigating symmetry and determining whether a figure is symmetric with respect to a line or a point.

Line Symmetry
A figure is symmetric with respect to a line if the figure remains unchanged after being reflected across the line.

Point Symmetry
A figure has symmetry with respect to a point if the figure remains unchanged after being rotated a specified number of degrees about the point.

1  A quilt block is shown below. What type of transformation was performed to produce the image inside the block?

A  Translation
B  Reflection
C  Rotation
D  Dilation

2  In the figure below, which segment represents a 90° clockwise rotation of segment $AB$ about $P$?

F  $BC$
G  $EF$
H  $HG$
J  $CD$
3 Which type of symmetry does the figure possess?

A 180° clockwise rotation about the point \( \left( -\frac{3}{2}, 1 \right) \).
B 90° clockwise rotation about the point \( \left( -\frac{3}{2}, 1 \right) \).
C Reflection across a line through points \( Q \) and \( S \).
D Reflection across a line through points \( P \) and \( R \).

4 A regular pentagon has many symmetries. Two of them are ________ and ________ rotation symmetry.

F 72° clockwise; 144° counterclockwise
G 36° clockwise; 108° counterclockwise
H 90° clockwise; 270° counterclockwise
J 60° clockwise; 240° counterclockwise

5 The design below is made of congruent isosceles trapezoids

Each of the trapezoids has ________ symmetry, and the figure as a whole has ________ symmetry. Choose the best pair of answers to fill in the blanks.

A Reflection; reflection
B Reflection; rotation
C Rotation; reflection
D Rotation; rotation

6 Which of the following best describes the line of reflection symmetry in the figure below?

F Vertical line through the point \((-2, 3)\)
G Horizontal line through the point \((-2, 3)\)
H Diagonal line through point \( B \)
J Diagonal line through points \( A \) and \( C \)
**G.3d**

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

A **translation** moves every point of a figure the same distance in the same direction.

![Translation Diagram]

\[(x, y) \rightarrow (x + a, y + b)\]

A **reflection** uses a vertical, horizontal, or slanted line like a mirror to reflect an image.

![Reflection Diagram]

\[(x, y) \rightarrow (x, -y)\]

A **rotation** turns a figure about a fixed point, through a given angle.

![Rotation Diagram]

\[(x, y) \rightarrow (y, -x)\]

A **dilation** stretches or shrinks a figure to create a similar figure. The **scale factor**, \(k\), is the ratio of a side length of the image to the corresponding side length of the original figure.

![Dilation Diagram]

\[(x, y) \rightarrow (kx, ky)\]

1. Where is the image of \(M(-3, 5)\) after the translation \((x, y) \rightarrow (x - 1, y + 3)\)?
   - A \((-4, 8)\)
   - B \((-2, 2)\)
   - C \((-2, 8)\)
   - D \((8, -4)\)

2. The shortest distance between point \(W\) and a line of reflection is 64 inches. What will be the distance between \(W\) and its image \(W'\)?
   - F 8 in.
   - G 32 in.
   - H 64 in.
   - J 128 in.
3 Emily wants to transform \( \triangle JKL \) so that \( \triangle J'K'L' \) has the coordinates \( J'(-3, 5) \), \( K'(0, 4) \), and \( L'(-5, 1) \).

Which transformation should she perform?

A Translate \( \triangle JKL \) 4 units left and 3 units up.
B Rotate \( \triangle JKL \) counterclockwise 90°.
C Reflect \( \triangle JKL \) across the \( x \)-axis.
D Reflect \( \triangle JKL \) across the \( y \)-axis.

4 Lauren is working on a problem where she must rotate point \( J \) 90° clockwise about the origin. If the coordinates of \( J \) are \((2, -7)\), where should she plot the final image?

F \((2, 7)\)
G \((-2, 7)\)
H \((7, 2)\)
J \((-7, -2)\)

5 In quadrilateral \( RSTU \), the coordinates of \( R \) are \((3, -5)\). What are the coordinates of the image of \( R \) after a rotation of 180° counterclockwise?

A \( R'(-3, -5) \)
B \( R'(-5, -3) \)
C \( R'(5, 3) \)
D \( R'(-3, 5) \)

6 If quadrilateral \( EFGH \) was reflected over the \( x \)-axis to form \( E'F'G'H' \), what would be the coordinates of \( E' \)?

F \((5, -7)\)
H \((-5, 7)\)
G \((5, 7)\)
J \((-5, -7)\)

7 One vertex of a triangle is located at the point \( P(-2, 7) \). If a scale factor of 2.2 is used for a dilation of the triangle, where will the image point \( P' \) be located?

A \((-4.4, 15.4)\)
B \((-4.2, 4.8)\)
C \((0.2, 9.2)\)
D \((-0.9, 3.2)\)

8 \( \triangle ABC \) is to be reflected across the \( y \)-axis. What will be the coordinates of \( B' \)?
G.4a

The student will construct and justify the construction of a line segment congruent to a given line segment.

Here are the steps for constructing a line segment congruent to given line segment $\overline{AB}$.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use a straightedge to draw a segment longer than $\overline{AB}$. Label point $C$ on the new segment.</td>
<td>Set your compass to the length of $\overline{AB}$.</td>
<td>Place the compass at $C$. Mark point $D$ on the new segment. $\overline{CD} \cong \overline{AB}$</td>
</tr>
</tbody>
</table>

1. What is the basic idea for constructing a line segment congruent to a given line segment?
   - A Construct a parallelogram. Opposite sides are congruent.
   - B Measure the length of the given segment and mark off that length on another segment.
   - C The corresponding sides of congruent angles are congruent.
   - D Draw an arc around each end. The distance from each end of the segment to the point where the arcs intersect equals the length of the segment.

2. What is being done in the figure, as part of constructing a line segment congruent to a given line segment?
   - F The location of point $A$ is being determined.
   - G The location of point $B$ is being determined.
   - H The compass is being set to the length of segment $\overline{AB}$.
   - J Segment $\overline{AB}$ is being drawn.
3. In constructing a line segment congruent to a given line segment, what is the purpose of drawing an arc that intersects the second segment?

- A. To set the compass at the length of the original segment
- B. To mark the end of the second segment
- C. To establish the angle between the two segments
- D. To ensure that the two segments are parallel

4. The figure shows the construction of a line segment congruent to a given line segment. What is the distance from point C to point P?

- F. 2 cm
- G. 3 cm
- H. 5 cm
- J. 7 cm

5. In constructing a line segment \(\overline{CD}\) congruent to a given line segment \(\overline{AB}\), what is the purpose of placing the compass at C?

- A. Preparing to measure the distance from point C to point A
- B. Preparing to set the compass to the length of \(\overline{AB}\)
- C. Preparing to connect points C and D
- D. Preparing to mark point D

6. Some of the steps for constructing a line segment \(\overline{CD}\) congruent to a given line segment \(\overline{AB}\) are listed below. Which of these is the first step?

- F. Place the compass at point C.
- G. Mark point D on the new segment.
- H. Label one end of the new segment as point C.
- J. Draw a segment longer than \(\overline{AB}\).

7. For which of the following would it be useful to know how to construct a line segment congruent to a given line segment? Choose the best answer.

- A. To draw a perfect circle
- B. To draw a quadrilateral with two congruent sides
- C. To draw a trapezoid with two perfectly parallel sides
- D. To draw a perfect rectangle
G.4b

The student will construct and justify the construction of the perpendicular bisector of a line segment.

Here are the steps for constructing a perpendicular bisector of line segment $AB$.

**Step 1**
Place the compass at $A$. Use a compass setting that is greater than half the length of $AB$. Draw an arc.

**Step 2**
Keep the same compass setting. Place the compass at $B$. Draw an arc. It should intersect the other arc at two points.

**Step 3**
Use a straightedge to draw a segment through the two points of intersection. This segment bisects $AB$ at $M$, the midpoint of $AB$. It can also be proven that this segment is perpendicular to $AB$, so it is the perpendicular bisector of $AB$.

Use the figure below for questions 1–4.

1. If $AM = 6.2$, what is $AB$?
   - **A** 18.6
   - **B** 12.4
   - **C** 6.2
   - **D** 3.1

2. If $AD = 11.6$ and $CD = 2.2$, what is $AB$?
   - **F** 23.2
   - **G** 25.4
   - **H** 18.8
   - **J** 21.0

3. If $AC = 9.7$ and $CB = 12.1$, what is $CD$?
   - **A** 2.4
   - **C** 7.2
   - **B** 4.8
   - **D** 9.6

4. If $AC = 10.0$ and $MD = 2.3$, what is $CB$?
   - **F** 14.6
   - **H** 20.0
   - **G** 12.3
   - **J** 9.6
G.4b (continued)

5  What is the basic idea behind the procedure for constructing the perpendicular bisector of a line segment?
   A  Find two points each equidistant from the ends of the given segment. Draw a line through the two points.
   B  Draw an angle bisected by the given line segment. Measure the same distance down the leg of each angle and connect the two points found.
   C  Draw a line parallel to the given segment. Draw a perpendicular transversal through the line and the segment.
   D  Draw a segment congruent to the given segment, and extend both segments until they meet. Bisect the angle.

6  Given segments \( \overline{AB} \) and \( \overline{CD} \), how would you use a perpendicular bisector to draw an isosceles triangle with \( \overline{AB} \) as its base and an altitude congruent to \( \overline{CD} \)?
   F  Draw the perpendicular bisectors of \( \overline{AB} \) and \( \overline{CD} \). Use their intersection as the vertex of the isosceles triangle.
   G  Draw the perpendicular bisectors of \( \overline{AB} \) and \( \overline{CD} \), and then use the longer of the two as the altitude of the triangle.
   H  Draw the perpendicular bisector of \( \overline{CD} \), and then construct an angle bisected by this line. This is the vertex of the isosceles triangle.
   J  Draw the perpendicular bisector of \( \overline{AB} \). Copy the length of \( \overline{CD} \) onto the perpendicular bisector.

7  How does the construction of a perpendicular to a given line through a given point involve the construction of a perpendicular bisector? Choose the best answer.
   A  The point on the line closest to the given point is found. Then one draws a perpendicular bisector between that point and the given point.
   B  Two points on the line equidistant from the given point are found. Then one draws a perpendicular bisector for the segment between those two points.
   C  A line is drawn through the given point, parallel to the given line. Then a single line is drawn as the perpendicular bisector of both parallel lines.
   D  A line segment is drawn from the given point to another point on the other side. The original line is a perpendicular bisector of this new line segment.
G.4c
The student will construct and justify the construction of a perpendicular to a given line from a point not on the line.

Here are the steps for constructing a perpendicular to a given line \( m \) through a point \( P \) that is not on \( m \).

**Step 1**
Place the compass at \( P \). Draw two arcs intersecting \( m \). Label the intersection points \( A \) and \( B \).

**Step 2**
Open the compass to a setting greater than \( \frac{1}{2} AB \). Place the compass at \( A \), and draw an arc below line \( m \). Using the same compass setting, place the compass at \( B \) and draw an arc intersecting the previous arc. Label the point of intersection \( C \).

**Step 3**
Use a straightedge to draw \( \overrightarrow{CP} \). \( \overrightarrow{CP} \) is perpendicular to \( \overrightarrow{AB} \).

For questions 1–5, use the figure below. It shows the construction of a perpendicular to given line \( n \) through given point \( P \). All arcs were drawn with the same compass setting.

1. Suppose that distance \( PY \) is 6.2 cm. What is distance \( XZ \)?
   - A 12.4 cm
   - B 8.8 cm
   - C 6.2 cm
   - D Cannot be determined

2. Suppose that distance \( XZ \) is 4.9 cm. What is distance \( PZ \)?
   - F 9.8 cm
   - G 6.9 cm
   - H 4.9 cm
   - J Cannot be determined
Suppose that distance $PZ$ is 12 cm and distance $PY$ is 10 cm. What is distance $XY$?

A 16 cm  
B 12 cm  
C 11 cm  
D Cannot be determined

What is the first step in the construction?

F Draw line $n$.  
G From point $P$, draw two arcs that intersect line $n$.  
H Draw $PZ$.  
J Draw line segments $PX$ and $PY$.

What is the last step in the construction?

A Draw $PZ$.  
B From point $P$, draw two arcs that intersect line $n$.  
C Draw line segments $PX$ and $PY$.  
D Draw point $P$.

Which of the following is most closely related to the procedure for constructing a perpendicular to a given line from a point not on the line?

F Constructing the perpendicular bisector of a line segment  
G Constructing a line parallel to a given line through a given point not on the line  
H Constructing the bisector of a given angle  
J Constructing an angle congruent to a given angle

Which of the following would be most likely to involve constructing a perpendicular to a given line from a point not on the line?

A Constructing a rhombus for which one diagonal lies on the given line  
B Constructing an isosceles trapezoid for which the shorter base lies on the given line  
C Constructing an isosceles triangle for which the base lies on the given line  
D Constructing a right triangle for which the longer leg lies on the given line

The figure shows an attempt to construct a perpendicular to line $n$ from point $P$. Distances $PX$ and $PY$ are equal and distances $XZ$ and $YZ$ are equal, but $PX$ does not equal $XZ$.

What is wrong with this construction?

F Line $PZ$ will not be perpendicular to line $n$.  
G Line $PZ$ will not bisect segment $XY$.  
H The perpendicular will not pass exactly through point $P$.  
J Nothing is wrong. The construction will still work.
G.4d
The student will construct and justify the construction of a perpendicular to a given line at a given point on the line.

Here are the steps for constructing a perpendicular to a given line $m$ through a point $P$ that is not on $m$.

**Step 1**
Place the compass at $P$. Draw two arcs intersecting $m$. Label the intersection points $A$ and $B$.

**Step 2**
Open the compass to a setting greater than $AP$. Place the compass at $A$, and draw an arc above line $m$. Using the same compass setting, place the compass at $B$ and draw an arc intersecting the previous arc. Label the point of intersection $C$.

**Step 3**
Use a straightedge to draw $CP$. $CP$ is perpendicular to $AB$.

---

Use the figure below for Questions 1–5. The figure shows the construction of a perpendicular to given line $n$ through given point $P$.

1. Suppose that distance $XP$ is 7.3 cm. What is distance $YZ$?
   - A 16.3 cm
   - B 14.6 cm
   - C 7.3 cm
   - D Cannot be determined

2. Suppose that distance $XY$ is 24 cm and distance $YZ$ is 13 cm. What is distance $ZP$?
   - F 5 cm
   - G 10 cm
   - H 15 cm
   - J Cannot be determined

Go On
3. How hard would it be, using only the steps shown in the figure, to make distances $XP$ and $ZP$ equal?
   A. They are automatically equal.
   B. They could easily be made equal.
   C. They could be made equal with difficulty.
   D. There is no way to do this.

4. What is the basic idea behind the construction shown in the figure?
   F. Identify points $X$ and $Y$ equidistant from $P$, and then find the perpendicular bisector of segment $XY$.
   G. Identify a point an appropriate distance from $n$, and then construct an equilateral triangle.
   H. Construct two congruent angles with a common side.
   J. Create an intersection of two lines and apply the Vertical Angles Congruence Theorem twice.

5. Assuming the construction is done correctly, which of the following does not have to be true?
   A. Points $X$, $P$, and $Z$ define a right triangle.
   B. Distances $XY$ and $XZ$ are equal.
   C. Distances $XP$ and $PY$ are equal.
   D. Distances $XZ$ and $ZY$ are equal.

6. The figure below shows an attempt to construct a perpendicular to line $n$ through point $P$ by starting in the usual way but then finding point $W$ and drawing a line through $Z$ and $W$ instead of through $Z$ and $P$. What is needed for this method to work?

   Distances $XY$, $XZ$, $YZ$, $XW$, and $YW$ must all be equal.
   Distances $XZ$, $YZ$, $XW$, and $YW$ must all be equal to one another, although they need not be equal to $XY$.
   It is enough that distances $XW$ and $YW$ are equal to each other, just like $XZ$ and $YZ$.
   As described in the question, this method cannot work.
G.4e
The student will construct and justify the construction of the bisector of a given angle.

Here are the steps for constructing a bisector of a given angle, \(\angle A\).

### Step 1
Place the compass at \(A\). Draw an arc that intersects both sides of the angle. Label the intersections \(C\) and \(B\).

### Step 2
Place the compass at \(C\). Draw an arc. Then place the compass point at \(B\). Using the same radius, draw another arc.

### Step 3
Label the intersection \(G\). Use a straightedge to draw a ray through \(A\) and \(G\). \(\overline{AG}\) bisects \(\angle A\).

Use the figure below for questions 1–5. The figure shows the construction of the bisector of \(\angle CAB\).

1. **Which distances can you assume are equal?**
   - **A** \(AC\) and \(AG\)
   - **B** \(AC\) and \(AB\)
   - **C** \(AG\) and \(AB\)
   - **D** \(AC\) and \(BC\)

2. **Are there any restrictions on the radius of the two small arcs drawn in Step 2? Choose the best answer.**
   - **F** The radius cannot be too small.
   - **G** The radius cannot be too large.
   - **H** The radius must equal the length of segments \(AB\) and \(AC\).
   - **J** The radius must equal the length of segment \(BC\).

3. **If you know that distance \(AC = 3.6\) cm, what else do you know after the construction is completed?**
   - **A** \(CG = 3.6\) cm
   - **B** \(BG = 3.6\) cm
   - **C** \(CB = 3.6\) cm
   - **D** \(AB = 3.6\) cm
4. If you know that distance $BG = 1.7$ cm, what else do you know after the construction is completed?

- **F** $AC = 3.4$ cm
- **G** $AB = 3.4$ cm
- **H** $CG = 1.7$ cm
- **J** $BC = 1.7$ cm

5. If you know that $\angle CAB = 36^\circ$, what else do you know after the construction is completed?

- **A** $m\angle BAG = 18^\circ$
- **B** $m\angle BAG = 72^\circ$
- **C** $m\angle CAB = m\angle CAG \times m\angle BAG$
- **D** $m\angle CAB - m\angle CAG = 12^\circ$

Use the figure below for questions 6 and 7. It shows the construction of the bisector of $\angle CAB$.

6. Assuming the construction is done correctly, which of the following distance relationships does not have to be true?

- **F** $CG = BG$
- **G** $CG = CB$
- **H** $AB + BG > AG$
- **J** $AC + CG > AG$

7. How must the procedure for bisecting an angle be modified if the angle to be bisected is obtuse?

- **A** All arcs must be drawn counterclockwise instead of clockwise.
- **B** Point $G$ must be placed inside arc $\overline{BC}$.
- **C** Point $G$ must be placed outside the angle.
- **D** The procedure does not need to be modified at all.

8. What went wrong in the construction below?

- **F** Arc $\overline{BC}$ is not centered at $A$.
- **G** Distance $AG$ should not be longer than distances $AC$ and $AB$.
- **H** The two arcs through $G$ have different radii.
- **J** Nothing is wrong; the construction is done correctly.
**G.4f**

The student will construct and justify the construction of an angle congruent to a given angle.

Here are the steps for constructing an angle congruent to a given angle, $\angle A$.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw a segment. Label a point $D$ on the segment.</td>
<td>Draw an arc with center $A$. Using the same radius, draw an arc with center $D$.</td>
<td>Label $B$, $C$, and $E$. Draw an arc with radius $BC$ and center $E$. Label the intersection $F$.</td>
<td>Use a straightedge to draw $DF$. $\angle EDF \cong \angle BAC$.</td>
</tr>
</tbody>
</table>

1. **Which of the following steps is not part of the procedure for copying an angle?**
   - A. Measuring an angle with a protractor
   - B. Measuring along the side of an angle with a compass
   - C. Marking a point with a compass
   - D. Drawing a line segment with a straightedge

2. **What is the first step in constructing an angle, $\angle EDF$, congruent to a given angle $\angle CAB$?**
   - F. Draw two equal-radius arcs with centers at $A$ and $D$, and label points $B$, $C$, and $E$.
   - G. Draw segment $\overline{DF}$.
   - H. Draw a segment and label one end $D$.
   - J. Set the compass at distance $BC$ and then use it to draw point $F$.

3. **What went wrong with the following attempt to copy $\angle CAB$?**
   - A. The reference point for the compass should be $D$, not $E$.
   - B. Point $F$ should be drawn on the original angle, not the copy.
   - C. The compass being used to draw point $F$ is not set at distance $BC$.
   - D. Angle $CAB$ was drawn wider than it should be.
4. If \( \angle CAB \) is copied to make \( \angle FDE \), and distance \( FE \) is 5.2 cm, what is distance \( AC \)?
   - F 5.2 cm
   - G 10.4 cm
   - H 15.6 cm
   - J Cannot be determined

5. If \( \angle CAB \) is copied to make \( \angle FDE \), and distance \( CB \) is 12.2 cm, what is distance \( FE \)?
   - A 6.1 cm
   - B 18.3 cm
   - C 12.2 cm
   - D Cannot be determined

6. What went wrong with the following attempt to copy \( \angle CAB \)?
   - F This is not the correct stage of the process to draw point \( F \).
   - G Point \( F \) should be drawn to the right of point \( E \), not the left.
   - H Distance \( DE \) is set wrong.
   - J The reference point for the compass should be \( E \), not \( D \).

7. If \( \angle CAB \) is copied to make \( \angle FDE \), and distance \( AB \) is 11.7 cm, what other distance is also equal to 11.7 cm?
   - A \( CB \)
   - B \( FD \)
   - C \( FE \)
   - D No other distance equals 11.7 cm.

8. Milo says, “My way of copying an angle is to turn the angle into a triangle by adding the missing side. Then I copy the triangle, and finally I locate the angle that corresponds to the one I’m supposed to copy.” What is wrong with this method?
   - F Nothing is wrong; Milo’s method will work.
   - G There is no known procedure for copying a triangle.
   - H There is more than one way to add a missing side to turn an angle into a triangle.
   - J Not every angle can be turned into a triangle by adding a missing side.
G.4g

The student will construct and justify the construction of a line parallel to a given line through a point not on the given line.

Here are the steps for constructing a line parallel to a given line $m$ through a point $p$ that is not on $m$.

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw points $Q$ and $R$ on $m$. Draw $PQ$. Draw an arc with the compass point at $Q$ so it crosses $QP$ and $QR$.</td>
<td>Copy $\angle PQR$ on $QP$ with $P$ as the vertex.</td>
<td>Label the new angle $\angle TPS$. Use a straightedge to draw $PS$. $PS \parallel QR$</td>
</tr>
</tbody>
</table>

1. Which of the following is part of constructing a line parallel to a given line through a point not on the given line?
   - ACopying a line segment
   - BConstructing a perpendicular to a line
   - CBisecting an angle
   - DCopying an angle

Use the figure below for questions 2–5. The figure shows the construction of a line through point $P$ parallel to line $m$.

2. If $m \angle RQS = 50^\circ$, what is $m \angle TPU$?
   - F$50^\circ$
   - GH$80^\circ$
   - GI$65^\circ$
   - J$130^\circ$

3. If $PT = 1.4$ ft, what is $QS$?
   - A$0.7$ ft
   - C$2.1$ ft
   - B$1.4$ ft
   - D$2.8$ ft

4. If distance $TU$ equals $1.1$ ft, what other distance equals $1.1$ ft?
   - F$QS$
   - G$PT$
   - H$RS$
   - JNo other distance equals $1.1$ ft.

5. Which is the basis for the procedure used in the construction?
   - A Corresponding Angles Postulate
   - B Alternate Exterior Angles Theorem
   - C Alternate Interior Angles Theorem
   - D Consecutive Interior Angles Theorem
6  George is constructing a line parallel to line $PQ$ that passes through point $R$. Which of the following should be his first step?

F  

7  The figure shows point $S$ being drawn to meet certain conditions. What are the conditions?

A  $RS = JN$ and $RN = SJ$
B  $TS = MN$ and $SP = MQ$
C  $RS = JN$ and $TS = MN$
D  $RJ = SN$ and $SP = MQ$

8  What will happen if the compass is widened slightly just before point $S$ is marked?

F  Line $RS$ will intersect line $PR$ somewhere to the left of $J$.
G  Line $RS$ will intersect line $PR$ somewhere to the right of $J$.
H  Line $RS$ and $PR$ will still be parallel.
J  Cannot be determined
G.5a
The student, given information concerning the lengths of sides and/or measures of angles in triangles, will order the sides by length, given the angle measures. These concepts will be considered in the context of real-world situations.

In any triangle, the longest side is opposite the angle with the largest measure, and the shortest side is opposite the angle with the smallest measure. If any angles in a triangle have the same measure, then the sides opposite them have the same length.

EXAMPLE
List the sides of \( \triangle HIJ \) from longest to shortest.

Solution
Since \( \angle J \) has the largest measure, the side opposite it, \( HI \), is the longest side. \( \angle H \) has the smallest measure, so the side opposite it, \( IJ \), is the shortest side. From longest to shortest, the sides are \( HI, HJ, \) and \( IJ \).

1 Which is the shortest side of triangle \( ABC \)?
   \[ \begin{align*}
   A & \quad AB \\
   B & \quad BC \\
   C & \quad AC \\
   D & \quad \text{Cannot be determined}
   \end{align*} \]

2 In triangle \( XYZ \), \( m\angle X = 39^\circ \), \( m\angle Y = 82^\circ \), and \( m\angle Z = 59^\circ \). Which of the following lists the sides of \( \triangle XYZ \) from smallest to largest?
   \[ \begin{align*}
   F & \quad XY, XZ, YZ \\
   G & \quad YZ, XY, XZ \\
   H & \quad XZ, YZ, XY \\
   J & \quad XZ, XY, YZ
   \end{align*} \]

3 Triangle \( ABC \) is shown below. Which of the following inequalities is true?
   \[ \begin{align*}
   A & \quad AC > AB \\
   B & \quad BC > AB \\
   C & \quad AB > BC > AC \\
   D & \quad AB > AC > BC
   \end{align*} \]
4. Melanie is planting a triangular shaped garden. Her landscape designer told her to plant roses along the longest edge of the garden. Along which edge should Melanie plant roses?

5. A surveyor made the following diagram showing his measurements using three landmarks at points A, B, and C. The surveyor measured the lengths of the three sides as 119.0 meters, 141.0 meters, and 135.2 meters, but he forgot to write down which side each measurement belongs to. Which of the following is correct?

6. David is cutting out $\triangle HJK$ for a math poster. The measure of $\angle H = 58^\circ$ and the measure of $\angle K = 75^\circ$. David needs to place the triangle on the poster so that the shortest side is on the bottom. Which side should be on the bottom?

7. Which of the following inequalities is correct?
G.5b

The student, given information concerning the lengths of sides and/or measures of angles in triangles, will order the angles by degree measure, given the side lengths. These concepts will be considered in the context of real-world situations.

In any triangle, the largest angle is opposite the longest side, and the smallest angle is opposite the shortest side. If any sides in a triangle have the same length, then the angles opposite them are congruent.

EXAMPLE

List the angles of \( \triangle ABC \) from largest to smallest.

\[
\begin{align*}
A & \quad 12 \\
B & \quad 6 \\
C & \quad 9
\end{align*}
\]

Solution

\( \overline{AC} \) is the longest side, so \( \angle B \) is the largest angle. \( \overline{AB} \) is the shortest side, so \( \angle C \) is the smallest angle. From largest to smallest, the angles are \( \angle B \), \( \angle A \), and \( \angle C \).

1. Triangle \( \triangle ABC \) has \( AB = 13 \), \( BC = 9 \), and \( AC = 10 \). Which of the following inequalities is correct?

   A. \( m\angle A > m\angle B > m\angle C \)
   B. \( m\angle B > m\angle C > m\angle A \)
   C. \( m\angle C > m\angle B > m\angle A \)
   D. \( m\angle A > m\angle C > m\angle B \)

2. A farmer has three sections of fence that he is using to make an enclosure for a goat. Triangle \( \triangle DEF \) represents the enclosure. The farmer wants to put the goat’s water in the widest corner of the enclosure. Which angle represents this corner?

   F. \( \angle D \)  
   H. \( \angle F \)  
   G. \( \angle E \)  
   J. Cannot be determined
3. In which of the following triangles is \( \angle K \) the smallest angle?

- **A**
  ![Triangle A](image)

- **B**
  ![Triangle B](image)

- **C**
  ![Triangle C](image)

- **D**
  ![Triangle D](image)

4. As part of a large art mural, Michael is making a tessellation using tiles in the shape of \( \triangle RST \) shown below. On each tile, Michael needs to glue a pebble to the corner with the largest angle. Which angle represents this corner?

- **F** \( \angle R \)
- **G** \( \angle S \)
- **H** \( \angle T \)
- **J** Cannot be determined

5. Triangle \( \triangle GHI \) has a perimeter of 42 inches. \( GH = 15 \) inches and \( HI = 11 \) inches. Which of the following lists the angles of \( \triangle GHI \) from smallest to largest?

- **A** \( \angle I, \angle G, \angle H \)
- **B** \( \angle G, \angle I, \angle H \)
- **C** \( \angle I, \angle H, \angle G \)
- **D** \( \angle H, \angle G, \angle I \)

6. Triangle \( \triangle ABC \) has a perimeter of 100. \( AB = 2x + 7, BC = 3x - 1 \), and \( AC = 4x - 5 \). Which of the following inequalities is correct?

- **F** \( m\angle B > m\angle A > m\angle C \)
- **G** \( m\angle A < m\angle B < m\angle C \)
- **H** \( m\angle A > m\angle C > m\angle B \)
- **J** \( m\angle C > m\angle B > m\angle A \)
G.5c

The student, given information concerning the lengths of sides and/or measures of angles in triangles, will determine whether a triangle exists. These concepts will be considered in the context of real-world situations.

Not every group of three segments can be used to construct a triangle. The lengths of the sides of any triangle must meet certain requirements. Specifically, the sum of any two sides of a triangle must be greater than the length of the third side.

\[ AB + BC > AC, \ BC + AC > AB, \ \text{and} \ AC + AB > BC \]

**EXAMPLE**

Could a triangle have sides with lengths 2, 10, and 12?

**Solution**

Check to see if the sum of each possible combination of two sides is greater than the third side.

- \[ 10 + 12 > 2 \]
- \[ 12 + 2 > 10 \]
- \[ 2 + 10 \not> 12 \]

Since the last inequality is not true, such a triangle is not possible.

1. Which of the following sets of numbers could **not** represent the lengths of the sides of a triangle?
   - A 3, 9, 14
   - B 6, 8, 12
   - C 15, 20, 30
   - D 11, 11, 19

2. The lengths of two sides of the triangle are known.

   \[ 13 \quad 5 \]

   Which of the following could be the perimeter of the triangle?
   - F 22
   - G 26
   - H 28
   - J 36
3 Tong is making a triangular shaped frame out of three strips of wood. One of the strips is 10 centimeters long and a second is 15 centimeters long. What could be the length of the third strip?
   A 4 cm
   B 5 cm
   C 20 cm
   D 26 cm

4 A tile company is making a new size of triangular shaped tiles. What could be the dimensions of this new size?
   F 41 mm, 21 mm, 20 mm
   G 16 mm, 40 mm, 10 mm
   H 41 mm, 5 mm, 49 mm
   J 29 mm, 25 mm, 50 mm

5 Two sides of a triangle measure 14 and 9. Which of the following cannot be the perimeter of the triangle?
   A 28
   B 37
   C 42
   D 46

6 The figure shows the route Daniel took while riding his bicycle after school.

   Which of the following is not a possible measure for the third side of the triangle?
   F 4 mi
   G 5 mi
   H 6 mi
   J 7 mi

7 Which group of side lengths can be used to construct a triangle?
   A 3 yd, 4 ft, 5 yd
   B 3 yd, 5 ft, 8 ft
   C 11 in., 16 in., 27 in.
   D 2 ft, 11 in., 12 in.

8 The figure shows the outline of a flower garden.

   Which of the following is a possible measure for the third side of the garden?
   F 4 ft
   G 8 ft
   H 20 ft
   J 24 ft
G.5d
The student, given information concerning the lengths of sides and/or measures of angles in triangles, will determine the range in which the length of the third side must lie. These concepts will be considered in the context of real-world situations.

The length of any side of a triangle must be greater than the difference of the other two side lengths and less than the sum of the other two side lengths.

EXAMPLE
Two sides of a triangle have lengths 14 and 18. If \( x \) is the length of the third side, what inequality gives the range of possible values of \( x \)?

Solution
The difference of the two known side lengths is \( 18 - 14 = 4 \). The sum of the two known side lengths is \( 18 + 14 = 32 \), so the value of \( x \) must be between these values. The inequality is \( 4 < x < 32 \).

1. A triangle has one side of length 20 and another of length 10. Which of the following best describes the possible lengths of the third side?
   - A) \( 10 < x < 20 \)
   - B) \( 11 < x < 29 \)
   - C) \( 20 < x < 30 \)
   - D) \( 10 < x < 30 \)

2. The triangle below is isosceles.

   ![Isosceles Triangle]
   
   If \( t \) is a whole number, what is its largest possible value?
   - F) 35
   - G) 36
   - H) 37
   - J) 38

3. A new triangular walking track is being constructed. One side is 30 meters long and another side is 45 meters long. If \( P \) represents the perimeter of the track, which inequality gives the range of values for \( P \)?
   - A) \( 15 \text{ m} < P < 45 \text{ m} \)
   - B) \( 15 \text{ m} < P < 75 \text{ m} \)
   - C) \( 30 \text{ m} < P < 45 \text{ m} \)
   - D) \( 30 \text{ m} < P < 75 \text{ m} \)

4. Two sides of a triangle have sides 5 and 20. The length of the third side must be greater than ____ and less than ____.
   - F) 5, 20
   - G) 15, 25
   - H) 14, 26
   - J) 4, 21
5 Maxwell is cutting out a triangular piece of stained glass to make a window. One side of the triangle is 9 inches long. If the length of the second side must be between 4 and 14 inches, what is the length of the third side?

A 4 in.  
B 5 in.  
C 9 in.  
D 14 in.

6 A sign company is making a large triangle on a sign out of reflective tape. The triangle is shown below. If \( x \) is the total number of feet of tape needed to make the triangle, which of the following is true?

\[
\text{F } 4 < x < 28  
\text{G } 4 < x < 56  
\text{H } 12 < x < 16  
\text{J } 32 < x < 56
\]

7 One side of a triangle has a length of \( 5x - 2 \). A longer side has a length of \( 6x + 7 \). If \( t \) represents the length of the third side, which of the following is true?

A \( x + 5 < t < 11x + 5 \)  
B \( x + 9 < t < 11x + 5 \)  
C \( 5x - 2 < t < 6x + 7 \)  
D \( 5x + 7 < t < 6x - 2 \)

8 If \( P \) is the perimeter of quadrilateral \( ABCD \), which of the following is true?

\[
\text{F } 26 < P < 44  
\text{G } 26 < P < 58  
\text{H } 29 < P < 58  
\text{J } 35 < P < 67
\]
The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.

Triangles can be proven congruent using any of the following theorems and postulates:

<table>
<thead>
<tr>
<th>Triangle Congruence</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Side-Side-Side (SSS) Congruence Postulate</strong></td>
<td>![Diagram](SSS example)</td>
</tr>
<tr>
<td>If three sides of one triangle are congruent to three sides of a second triangle, then the two triangles are congruent. ( \triangle ABC \cong \triangle PQR )</td>
<td></td>
</tr>
<tr>
<td><strong>Side-Angle-Side (SAS) Congruence Postulate</strong></td>
<td>![Diagram](SAS example)</td>
</tr>
<tr>
<td>If two sides and the included angle of one triangle are congruent to two sides and the included angle of a second triangle, then the two triangles are congruent. ( \triangle DEF \cong \triangle STU )</td>
<td></td>
</tr>
<tr>
<td><strong>Angle-Side-Angle (ASA) Congruence Postulate</strong></td>
<td>![Diagram](ASA example)</td>
</tr>
<tr>
<td>If two angles and the included side of one triangle are congruent to two angles and the included side of a second triangle, then the two triangles are congruent. ( \triangle DEF \cong \triangle MNO )</td>
<td></td>
</tr>
<tr>
<td><strong>Hypotenuse-Leg (HL) Congruence Theorem</strong></td>
<td>![Diagram](HL example)</td>
</tr>
<tr>
<td>If the hypotenuse and a leg of a right triangle are congruent to the hypotenuse and a leg of a second right triangle, then the two triangles are congruent. ( \triangle JKL \cong \triangle XYZ )</td>
<td></td>
</tr>
<tr>
<td><strong>Angle-Angle-Side (AAS) Congruence Theorem</strong></td>
<td>![Diagram](AAS example)</td>
</tr>
<tr>
<td>If two angles and a non-included side of one triangle are congruent to two angles and a non-included side of a second triangle, then the two triangles are congruent. ( \triangle GHI \cong \triangle VWX )</td>
<td></td>
</tr>
</tbody>
</table>

1. In the figure below, \( \overline{PQ} \parallel \overline{SR} \).

Which additional information would be enough to prove \( \triangle PQS \cong \triangle RSQ \)?

- A \( \overline{PQ} \cong \overline{PS} \)
- B \( \overline{SR} \cong \overline{QR} \)
- C \( \overline{PQ} \cong \overline{SR} \)
- D \( \overline{PS} \cong \overline{QR} \)

2. In the figure below, \( \overline{HJ} \) bisects \( \angle KHI \) and \( \angle KJI \).

Which theorem or postulate can be used to prove \( \triangle HKJ \cong \triangle HIJ \)?

- F ASA
- G AAS
- H SAS
- J SSS

GO ON
G.6 (continued)

3 In the figure below, C is the midpoint of AD.

Which additional piece of information is needed to prove \( \triangle ABC \cong \triangle DEC \)?

A \( AC \cong CD \)
B \( AB \parallel DE \)
C \( \angle BCA \cong \angle ECD \)
D \( AB \cong DE \)

4 In the figure below, quadrilateral PQRS is a square and \( RT = RU \).

Which theorem or postulate can be used to prove \( \triangle RST \cong \triangle RQU \).

F SSS
G AAS
H SAS
J HL

5 Which postulate or theorem can be used to prove that \( \triangle ABC \cong \triangle BAD \)?

A SSS
B SAS
C ASA
D AAS

6 In the following diagram, if
\[
\sqrt{(e - g)^2 + (f - h)^2} = \sqrt{(a - g)^2 + (b - h)^2} \quad \text{and} \quad \sqrt{(c - e)^2 + (d - f)^2} = \sqrt{(c - a)^2 + (d - b)^2},
\]
what can be proven?

F \( \triangle XYZ \cong \triangle XZW \) by SAS
G \( \triangle XYZ \cong \triangle XZW \) by SSS
H \( \triangle XYZ \cong \triangle XZW \) by AAS
J \( \triangle XYZ \cong \triangle XZW \) by AA

GO ON
G.7

The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.

Triangles can be proven similar using any of the following theorems and postulates:

<table>
<thead>
<tr>
<th>Triangle Similarity</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Angle-Angle (AA) Similarity Postulate</strong></td>
<td><img src="triangle_similarity_1.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
| If two angles of one triangle are congruent to two angles of another triangle, then the two triangles are similar.  
\( \triangle JKL \sim \triangle PQR \) |
| **Side-Side-Side (SSS) Similarity Theorem** | ![Diagram](triangle_similarity_2.png) |
| If the corresponding side lengths of two triangles are proportional, then the triangles are similar.  
\[ \frac{AB}{JK} = \frac{BC}{KL} = \frac{AC}{JL} \]  
\( \triangle ABC \sim \triangle JKL \) |
| **Side-Angle-Side (SAS) Similarity Theorem** | ![Diagram](triangle_similarity_3.png) |
| If an angle of one triangle is congruent to an angle of a second triangle and the lengths of the sides including these angles are proportional, then the triangles are similar.  
\[ \frac{SU}{MO} = \frac{ST}{MN} \]  
\( \triangle STU \sim \triangle MNO \) |

1. In the figure below, \( \overline{WZ} \parallel \overline{XY} \).

Which theorem or postulate can be used to prove \( \triangle VWZ \sim \triangle VXY \)?

- **A** AAA  
- **B** AAS  
- **C** SAS  
- **D** SSS

2. In the figure below, \( \overline{SQ} \) is an altitude to \( \triangle PSR \).

Which theorem or postulate can be used to prove \( \triangle PRS \sim \triangle SRQ \)?

- **F** HL  
- **G** SSS  
- **H** SAS  
- **J** AA

**GO ON**
3  In the figure below, \( \angle P \equiv \angle X \).

Which of the following would be sufficient to prove the triangles are similar?

A  \( \frac{RP}{ZX} = \frac{RQ}{XY} \)

B  \( \frac{RP}{ZX} = \frac{PQ}{XY} \)

C  \( \frac{RQ}{ZX} = \frac{RP}{ZY} \)

D  \( \frac{RP}{ZX} = \frac{RQ}{ZY} \)

4  \( \triangle JKL \) and \( \triangle PQR \) are two triangles such that \( \angle K \equiv \angle Q \). Which of the following is sufficient to prove the triangles are similar?

F  \( \frac{JK}{PQ} = \frac{KL}{PR} \)

G  \( JK = PQ \)

H  \( \frac{JK}{PQ} = \frac{KL}{QR} \)

J  \( \angle J \) is right.

5  Which similarity statement and postulate or theorem correctly identifies the triangles’ relationship?

A  \( \triangle ABC \sim \triangle CDE \) by SSS Similarity Theorem

B  \( \triangle ABC \sim \triangle EDC \) by SAS Similarity Theorem

C  \( \triangle ABC \sim \triangle CDE \) by SAS Similarity Theorem

D  \( \triangle ABC \sim \triangle EDC \) by AA Similarity Theorem

6  Which of the following would be sufficient additional information to prove \( \triangle ABC \sim \triangle ADE \)?

F  \( \frac{c-0}{0-b} \cdot \frac{e-0}{0-d} = -1 \)

G  \( \sqrt{(d-0)^2 + (0-c)^2} = 2\sqrt{(b-0)^2 + (0-c)^2} \)

H  \( \frac{c-0}{0-b} = \frac{e-0}{0-d} \)

J  \( c + e = b + d \)
G.8
The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

**Pythagorean Theorem and its Converse**
For any triangle $ABC$, if it is a right triangle then $c^2 = a^2 + b^2$, and vice versa.

**Right Triangle Trigonometry**
A trigonometric ratio is a ratio of the lengths of two sides in a right triangle. Trigonometric ratios can be used to find the measure of a side or an acute angle in a right triangle.

\[
\sin A = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{a}{c} \quad \cos A = \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{b}{c} \quad \tan A = \frac{\text{opposite}}{\text{adjacent}} = \frac{a}{b}
\]

**Special Right Triangles**

1. A surveyor has measured the distances from a point $P$ to the east and west ends of a pond, as shown in the figure below. What is the distance across the pond from east to west?

2. Which set of lengths can represent the sides of a right triangle?
   - **F** 5, 12, 13
   - **G** 7, 8, 10
   - **H** 6, 6, 9
   - **J** 8, 12, 14
3. What is the value of \( y \) in the triangle below?

\[
\text{A} \quad 10 \\
\text{B} \quad 10\sqrt{2} \\
\text{C} \quad 5\sqrt{3} \\
\text{D} \quad \frac{5\sqrt{3}}{3}
\]

4. A waterski jump has the measurements shown in the figure below. What ratio could be used to find the measure of \( \angle C \), the angle of inclination for the ramp?

\[
\begin{align*}
\text{F} & \quad \cos C = \frac{5.5}{20.5} \\
\text{G} & \quad \cos C = \frac{5.5}{21.2} \\
\text{H} & \quad \sin C = \frac{5.5}{20.5} \\
\text{J} & \quad \sin C = \frac{5.5}{21.2}
\end{align*}
\]

5. To the nearest tenth of a foot, what is the height of the telephone pole in the diagram?

\[
\begin{align*}
\text{A} & \quad 24.0 \text{ ft} \\
\text{B} & \quad 30.6 \text{ ft} \\
\text{C} & \quad 39.8 \text{ ft} \\
\text{D} & \quad 53.0 \text{ ft}
\end{align*}
\]

6. About how far is the lighthouse from the boat?

\[
\begin{align*}
\text{F} & \quad 6.6 \text{ yd} \\
\text{G} & \quad 11 \text{ yd} \\
\text{H} & \quad 72.7 \text{ yd} \\
\text{J} & \quad 90.4 \text{ yd}
\end{align*}
\]

7. Triangle \( DEF \) is a right triangle.

What is the length of \( DF \)?

\[
\begin{align*}
\text{A} & \quad 20\sqrt{3} \text{ in.} \\
\text{B} & \quad 40 \text{ in.} \\
\text{C} & \quad 10\sqrt{2} \text{ in.} \\
\text{D} & \quad 20\sqrt{2} \text{ in.}
\end{align*}
\]
8. What is the perimeter of quadrilateral \( RSTU \) shown below?

\[ \text{UR} = 12 \text{ cm}, \quad \text{ST} = 5 \text{ cm}, \quad \text{TS} = 3 \text{ cm} \]

\[ \text{RF} = 20 \text{ cm}, \quad \text{FH} = 32 \text{ cm} \]

\[ \text{GF} = 30 \text{ cm}, \quad \text{JH} = 37 \text{ cm} \]

9. Wires are used to stabilize a telephone pole that is 50 feet high. A wire from the top of the pole to the ground is 63 feet long. To the nearest tenth of a foot, how far from the bottom of the pole is the wire anchored in the ground?

\[ \text{Wire length} = 63 \text{ ft}, \quad \text{Pole height} = 50 \text{ ft} \]

\[ \text{A} \quad 13.0 \text{ ft} \]

\[ \text{B} \quad 38.3 \text{ ft} \]

\[ \text{C} \quad 40.2 \text{ ft} \]

\[ \text{D} \quad 80.4 \text{ ft} \]

10. The figure shows a ramp leading up to a loading dock that forms a $15^\circ$ angle with the ground. The loading dock height is 4 feet. What is the approximate distance from point \( A \) to point \( B \) to the nearest hundredth foot?

\[ \text{Dock height} = 4 \text{ ft}, \quad \text{Angle} = 15^\circ \]

\[ \text{F} \quad 4.14 \text{ ft} \]

\[ \text{G} \quad 14.93 \text{ ft} \]

\[ \text{H} \quad 15.45 \text{ ft} \]

11. Triangle \( JKL \) is an equilateral triangle.

\[ \text{Side length} = 18 \text{ m}, \quad \text{Height} = 18 \text{ m} \]

What is the length of \( KM \)?

\[ \text{A} \quad 3\sqrt{3} \text{ m} \]

\[ \text{B} \quad 6\sqrt{3} \text{ m} \]

\[ \text{C} \quad 9\sqrt{3} \text{ m} \]

\[ \text{D} \quad 18\sqrt{3} \text{ m} \]

12. Cory is building a rectangular frame. In order to check that the frame has right angles at its corners, he is measuring the diagonals of the rectangle. To the nearest tenth, what should be the length of the diagonals?

\[ \text{Frame dimensions} = 2 \text{ m}, \quad 4 \text{ m} \]

\[ \text{F} \quad 3.5 \text{ m} \]

\[ \text{G} \quad 4.5 \text{ m} \]

\[ \text{H} \quad 5.3 \text{ m} \]

\[ \text{J} \quad 6.0 \text{ m} \]
13 What is the value of $h$ in the figure below?

\[ \text{A} \quad \frac{\sqrt{3}}{2} \]
\[ \text{B} \quad \frac{3}{2} \]
\[ \text{C} \quad \frac{3\sqrt{2}}{2} \]
\[ \text{D} \quad 3\sqrt{2} \]

14 What is the perimeter of the triangle?

\[ \begin{array}{c}
\text{A} \quad 3 + 3\sqrt{3} \\
\text{B} \quad 9 + \sqrt{3} \\
\text{C} \quad 3 + 3\sqrt{2} \\
\text{D} \quad 9 + 3\sqrt{2} \\
\end{array} \]

15 In the figure below, a cable supports a radio tower. The tower is 385 feet tall. What is the approximate distance from the anchor point of the cable to the base of the tower?

\[ \begin{array}{c}
\text{A} \quad 93.1 \text{ ft} \\
\text{B} \quad 96.0 \text{ ft} \\
\text{C} \quad 373.6 \text{ ft} \\
\text{D} \quad 396.8 \text{ ft} \\
\end{array} \]

16 Which set can represent the side lengths of a right triangle?

\[ \begin{array}{c}
\text{F} \quad 5, 11, 12 \\
\text{G} \quad 2, 4, 2\sqrt{5} \\
\text{H} \quad 6, 7, 2\sqrt{21} \\
\text{J} \quad 5, 7, 5\sqrt{3} \\
\end{array} \]
G.9

The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

**Rectangles, rhombuses, and squares** are all special types of parallelograms.

<table>
<thead>
<tr>
<th>Property</th>
<th>Rectangle</th>
<th>Rhombus</th>
<th>Square</th>
<th>Parallelogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposite sides are parallel and congruent.</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Diagonals are perpendicular.</td>
<td></td>
<td>×</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagonals are congruent.</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opposite angles are congruent.</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>All sides are congruent.</td>
<td></td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Diagonals bisect each other.</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>All angles are right angles.</td>
<td>×</td>
<td></td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>All sides are congruent.</td>
<td></td>
<td></td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

A **trapezoid** is a quadrilateral with exactly one pair of opposite parallel sides.

- The midsegment of a trapezoid is parallel to each base, and its length is one half the sum of the lengths of the bases.
- If a trapezoid is isosceles, then each pair of base angles is congruent.
- If a trapezoid has a pair of congruent base angles, then it is an isosceles trapezoid.
- A trapezoid is isosceles if and only if its diagonals are congruent.

A **kite** is a quadrilateral with two distinct pairs of adjacent congruent sides.

- Its diagonals are perpendicular.
- Exactly one pair of opposite angles is congruent.

1. **Quadrilateral PQRS** is a trapezoid.

   ![Diagram of a trapezoid]

   **What is PQ?**
   
   - A 8
   - B 10
   - C 13
   - D 16

2. **Quadrilateral WXYZ** is a parallelogram. If its diagonals are congruent, which statement must be true?

   - F Quadrilateral WXYZ is a kite.
   - G Quadrilateral WXYZ is a rhombus.
   - H Quadrilateral WXYZ is a rectangle.
   - J Quadrilateral WXYZ is an isosceles trapezoid.

**GO ON**
3 Quadrilateral \(ABCD\) has vertices at \(A(0, 0), B(2, 5), C(5, 2)\) and \(D(3, -3)\). What is the most specific name for \(ABCD\)?

A Trapezoid
B Kite
C Rhombus
D Parallelogram

4 Molly cuts quadrilateral \(PQRS\) into four triangles by cutting along the diagonals. If this produces four congruent triangles, what type of quadrilateral could \(PQRS\) be?

F Trapezoid
G Kite
H Rhombus
J Rectangle

5 Mrs. Wahlen is out sailing. As shown in the figure below, she started at point \(A\), sailed to point \(B\), and then went on to point \(C\). She is about to begin her return to point \(A\) sailing through a fourth point along the way. She wants the path of her trip to form a rhombus. Which ordered pair represents the location of the fourth vertex of the rhombus?

![Diagram of Mrs. Wahlen’s sailing route]

A \((-5, 1)\)
B \((1, 1)\)
C \((0, 1)\)
D \((3, 1)\)

6 The diagram shows parallelogram \(FGHJ\). Which statement would prove that parallelogram \(FGHJ\) is a rectangle?

![Diagram of parallelogram]

F \(FH = JG\)
G \(FG = JH\)
H \(\frac{\text{slope } FH}{\text{slope } JG} = 1\)
J \(\frac{\text{slope } FH}{\text{slope } JG} = -1\)
G.10
The student will solve real-world problems involving angles of polygons.

Polygon Interior Angles Theorem
The sum of the measures of the interior angles of a convex n-gon is \((n - 2) \cdot 180^\circ\).
\[
m\angle 1 + m\angle 2 + \ldots + m\angle n = (n - 2) \cdot 180^\circ
\]

Interior Angles of a Quadrilateral
The sum of the measures of the interior angles of a quadrilateral is 360°.

Polygon Exterior Angles Theorem
The sum of the measures of the exterior angles of a convex polygon, one angle at each vertex, is 360°.
\[
m\angle 1 + m\angle 2 + \ldots + m\angle n = (n - 2) \cdot 360^\circ
\]

EXAMPLE
The trampoline shown is shaped like a regular dodecagon. Find (a) the measure of each interior angle and (b) the measure of each exterior angle.

Solution
a. Use the Polygon Interior Angles Theorem to find the sum of the measures of the interior angles.
\[
(n - 2) \cdot 180^\circ = (12 - 2) \cdot 180^\circ = 1800^\circ
\]
Then find the measure of one interior angle. A regular dodecagon has 12 congruent interior angles. Divide 1800° by 12: 1800° \(\div 12 = 150^\circ\).
The measure of each interior angle in the dodecagon is 150°.

b. By the Polygon Exterior Angles Theorem, the sum of the measures of the exterior angles, one angle at each vertex, is 360°. Divide 360° by 12 to find the measure of one of the 12 congruent exterior angles: 360° \(\div 12 = 30^\circ\).
The measure of each exterior angle in the dodecagon is 30°.

1. Quadrilateral JKLM is a kite.

If \(\angle KJM\) is a right angle, what is the measure of \(\angle JML\)?

A 33°  B 48°  C 56°  D 66°

2. What is the measure of an exterior angle of a regular pentagon?

F 36°  G 45°  H 72°  J 90°
3. Which expression gives the measure for an interior angle of a regular polygon with \( n \) sides?

A. \( \frac{360}{n} \) \\
B. \( \frac{180}{n} \) \\
C. \( \frac{180(n-2)}{n} \) \\
D. \( \frac{360(n-2)}{n} \)

4. Glenn needs to choose a tile shape that tessellates so that he can tile a floor with a single shape of tile. Which of the following shapes should Glenn not select?

F. Scalene triangle \\
G. Equilateral triangle \\
H. Regular hexagon \\
J. Regular octagon

5. The coin shown is in the shape of a regular 11-gon. What is the sum of the measures of the interior angles?

A. 1100° \\
B. 1620° \\
C. 1980° \\
D. 3240°

6. What is the measure of the smallest interior angle in the quadrilateral?

7. Veronica is installing carpet in a room shaped like the polygon shown below. She needs to know all of the interior angle measures in the room so that she can cut the carpet. What is \( x \) in the figure below?

8. Polygon \( ABCDEFGH \) is a regular octagon. Suppose sides \( AB \) and \( CD \) are extended to meet at point \( P \). What is \( m\angle BPC \)?
G.11a
The student will use angles, arcs, chords, tangents, and secants to investigate, verify, and apply properties of circles.

Tangents
In a plane, a line is tangent to a circle if and only if the line is perpendicular to a radius of the circle at its endpoint on the circle.

Line $m$ is tangent to circle $Q$ if and only if $m \perp \overline{QP}$.

Inscribed Angles
The measure of an inscribed angle is one half the measure of its intercepted arc.

<table>
<thead>
<tr>
<th>Angles and Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>If two chords intersect inside a circle, then the measure of each angle is one half the sum of the measures of the arcs intercepted by the angle and its vertical angle.</td>
</tr>
<tr>
<td>$m\angle 1 = \frac{1}{2}(m\overline{DC} + m\overline{AB})$</td>
</tr>
<tr>
<td>$m\angle 2 = \frac{1}{2}(m\overline{AD} + m\overline{BC})$</td>
</tr>
</tbody>
</table>

If a tangent and a secant, two tangents, or two secants intersect outside a circle, then the measure of the angle formed is one half the difference of the measures of the intercepted arcs.

If two chords intersect in the interior of a circle, then the product of the lengths of the segments of one chord is equal to the product of the lengths of the segments of the other chord.

$EA \cdot EB = EC \cdot ED$

If two secant segments share the same endpoint outside a circle, then the product of the lengths of one secant segment and its external segment equals the product of the lengths of the other secant segment and its external segment.

If a secant segment and a tangent share an endpoint outside a circle, then the product of the lengths of the secant segment and its external segment equals the square of the length of the tangent segment.
1 In the figure below, \(m\angle AD = 130^\circ\) and \(m\angle BC = 22^\circ\). What is the measure of \(\angle AED\)?

![](image1.png)

- **A** 44°
- **B** 54°
- **C** 65°
- **D** 76°

2 \(\overline{WY}\) is a diameter of circle \(X\), and \(\overline{YZ}\) is tangent to the circle at \(Y\). What is \(m\angle WZ\)?

![](image2.png)

- **F** 32°
- **H** 116°
- **G** 58°
- **J** 148°

3 In circle \(P\) below, \(GH = JK = 13\). \(PR = 4c - 5\).

![](image3.png)

What is \(PQ\)?

- **A** 7
- **B** 5
- **C** 3
- **D** 2

4 In the figure below, secant \(\overline{PQ}\) intersects the circle at \(R\) and secant \(\overline{SQ}\) intersects the circle at \(T\).

![](image4.png)

What is the value of \(z\)?

- **F** about 15.67
- **H** 21
- **G** about 18.67
- **J** 24

5 In the figure below, secant \(\overline{HK}\) intersects the circle at \(J\) and \(\overline{GH}\) is tangent to the circle at \(G\). If \(KJ = 16\) and \(JH = 4\), what is \(GH\)?

![](image5.png)

- **A** \(2\sqrt{5}\)
- **B** 8
- **C** \(4\sqrt{5}\)
- **D** 12

6 What is the value of \(a\)?

![](image6.png)

- **F** 66
- **H** 140
- **G** 74
- **J** 280
G.11b
The student will use angles, arcs, chords, tangents, and secants to solve real-world problems involving properties of circles.

EXAMPLE 1
The rays in the diagram show the directions that two spotlights will be aimed over a circular stage during a performance. What is $m\angle 1$?

Solution
The rays form two secants that intersect outside of the circle, so the angle measure is half of the difference of the measures of the two intercepted arcs. $m\angle 1 = \frac{86^\circ - 22^\circ}{2} = 32^\circ$.

EXAMPLE 2
As part of a project for his graphic design class, Trent made the design shown at the right. What is the value of $x$?

Solution
The diagram shows a secant and tangent that share an endpoint outside the circle, so the product of the length of the secant and its external segment is equal to the square of the length of the tangent segment.

$x^2 = 11 \cdot 4$
$x \approx 6.63$

1. The design below is part of a company logo. What is $m\angle SKR$?

   ![Diagram of a logo with angles](image1.png)

   - A $40^\circ$
   - B $60^\circ$
   - C $80^\circ$
   - D $90^\circ$

2. A circular cake is cut into four sections as shown in the diagram below. If $m\angle SP = 135^\circ$ and $m\angle STR = 70^\circ$, what is $m\angle QR$?

   ![Diagram of a circular cake](image2.png)

   - F $55^\circ$
   - H $110^\circ$
   - G $85^\circ$
   - J $122.5^\circ$
3 A drop leaf table is made by cutting and hinging two parallel, congruent chords in a circular tabletop. If the length of the chords is 37 inches and the distance between the two cords is 26 inches, what is the radius of the original tabletop?

A 22.6 in.  
B 26 in.  
C 28.3 in.  
D 31.5 in.

4 Caitlyn is making a circular stained glass window out of four pieces of glass as shown below. What is the value of \( x \)?

F 3 cm  
G 4 cm  
H 5 cm  
J 6 cm

5 Two children are sitting at points \( A \) and \( E \) at the edge of the circular sandbox shown below. Their mother is standing at point \( C \). What is the value of \( y \)?

A 4.2 ft  
B 5 ft  
C 9 ft  
D 9.8 ft

6 A satellite orbiting Earth takes a picture that shows Earth from point \( Q \) to point \( R \) in the diagram below. What is the angle of the camera lens, represented by \( \angle QPR \)?

F 30°  
G 45°  
H 60°  
J 75°
G.11c
The student will use angles, arcs, chords, tangents, and secants to find arc lengths and area of sectors in circles.

You can use a proportion to find the length of an arc of a circle or the area of a sector of a circle. An arc is the part of the circle between two points on a circle. A sector is the part of the circle bounded by two radii and the arc of the circle between those two radii.

To find the length of an arc:
\[
\text{length of arc} = \frac{\text{degree measure of arc}}{360} \times \text{circumference of circle}
\]

To find the area of a sector of a circle:
\[
\text{area of sector} = \frac{\text{measure of central angle}}{360} \times \text{area of circle}
\]

**EXAMPLE**
What is the length of arc \( MN \)?

**Solution**
Since the radius of the circle is 7 meters, the circumference is \( 14\pi \) meters. The central angle has a measure of 80°, so the degree measure of the arc is also 80°.

\[
\frac{\ell}{14\pi} = \frac{80}{360}
\]

Three terms of the arc length proportion are known.

\[
360\ell = 80(14\pi)
\]

Cross products property

\[
\ell = \frac{1120\pi}{360}
\]

Solve for \( \ell \).

\[
\ell = 9.8
\]

Use a calculator.

The length of arc \( MN \) is about 9.8 meters.

---

1. The center of the circle is \( R \).

2. The radius of the circle shown below is 11 centimeters. What is the area of the shaded sector?

   - \( A \) 61 ft
   - \( B \) 115 ft
   - \( C \) 122 ft
   - \( D \) 335 ft
G.11c  (continued)

3 The area of sector $APB$ is $13.5 \text{ cm}^2$. What is the length of $AB$? Round to the nearest tenth.

\[ \text{Area of sector } APB = \frac{1}{2} \times \text{radius} \times \text{central angle} \]

\[ \frac{1}{2} \times 5 \times \theta = 13.5 \]

\[ \theta = \frac{13.5 \times 2}{5} \]

\[ \theta = 5.4 \}

A 5.4 cm  
B 7.9 cm  
C 8.6 cm  
D 10.8 cm

4 Miranda is writing her name using all capital letters, with the bottom of the letters along arc $KL$ shown in the figure below. If she wants the letters to be evenly spaced along the arc, what arc length should she devote to each letter? Round your answer to the nearest tenth.

\[ \text{Arc length} = \frac{\text{central angle}}{360} \times \text{circumference} \]

\[ \text{Arc length} = \frac{140}{360} \times 2 \]

\[ \text{Arc length} = 0.1 \text{ in.} \]

F 0.1 in.  
G 1.2 in.  
H 3.1 in.  
J 4.9 in.

5 Maria is planting a garden in the shaded area of the circle shown below. The area of her garden is $68.1 \text{ ft}^2$. She wants to place garden edging along the curved edge of her garden. How much edging will she need? Round your answer to the nearest tenth.

\[ \text{Circumference} = 2 \pi \text{radius} \]

\[ \text{Circumference} = 2 \pi \times 8 \]

\[ \text{Circumference} = 16 \pi \]

\[ \text{Circumference} = 50.24 \text{ ft} \]

A 15.2 ft  
B 16.5 ft  
C 17.0 ft  
D 18.3 ft

6 A circular pizza has a diameter of 14 inches and is cut into 8 equal slices. To the nearest tenth of a square inch, which answer represents the area of one slice?

\[ \text{Area of sector} = \frac{\text{central angle}}{360} \times \pi \text{radius}^2 \]

\[ \text{Area of one slice} = \frac{110}{360} \times \pi \times 7^2 \]

\[ \text{Area of one slice} = 22.0 \text{ in.}^2 \]

F 615.8 in.\(^2\)  
H 22.0 in.\(^2\)  
G 44.0 in.\(^2\)  
J 19.2 in.\(^2\)

7 In the figure below, $AC$ is a diameter of circle $X$, and $GJ$ is a diameter of circle $Y$. Which statement is true?

\[ \text{Statement of congruence} \]

A $\overline{GH} \cong \overline{BCD}$  
B $\overline{AB} \cong \overline{GK}$  
C $\overline{AB} \cong \overline{BCD}$  
D $\overline{GK} \cong \overline{KJH}$
The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.

**Standard Equation of a Circle**

The standard equation of a circle with center \((h, k)\) and radius \(r\) is:

\[(x - h)^2 + (y - k)^2 = r^2\]

**EXAMPLE 1**

Write the standard equation of a circle with center \((0, -9)\) and radius 4.2.

**Solution**

\[(x - h)^2 + (y - k)^2 = r^2 \quad \text{Standard equation of a circle} \]
\[(x - 0)^2 + (y - (-9))^2 = 4.2^2 \quad \text{Substitute.} \]
\[x^2 + (y + 9)^2 = 17.64 \quad \text{Simplify.} \]

**EXAMPLE 2**

Write the standard equation of a circle with center \((3, 1)\) that goes through \((6, 5)\).

**Solution**

\((3, 1)\) and \((6, 5)\) are endpoints of a radius of the circle. Use the distance formula to compute the length of the radius.

\[d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad \text{Distance Formula} \]
\[d = \sqrt{(6 - 3)^2 + (5 - 1)^2} \quad \text{Substitute.} \]
\[d = 5 \quad \text{Simplify.} \]

The radius of the circle is 5. Substituting this value and the coordinates of the center of the circle into the standard equation of a circle gives \((x - 3)^2 + (y - 1)^2 = 25\).

1. An equation of a circle is \((x - 1)^2 + (y + 4)^2 = 8\). What are the center and radius of the circle?
   - **A** Center \((1, -4)\); radius 4
   - **B** Center \((-1, 4)\); radius 4
   - **C** Center \((1, -4)\); radius \(2\sqrt{2}\)
   - **D** Center \((-1, 4)\); radius \(2\sqrt{2}\)

2. Which is an equation of a circle with radius 3 and center at \((4, -1)\)?
   - **F** \((x - 4)^2 + (y + 1)^2 = 9\)
   - **G** \((x + 4)^2 + (y - 1)^2 = 9\)
   - **H** \((x - 1)^2 + (y + 4)^2 = 9\)
   - **J** \((x + 1)^2 + (y - 4)^2 = 9\)
3 A circle is centered at \((-2, 3)\) and contains point \((5, 9)\). Which is an equation of the circle?
   
   **A** \((x + 2)^2 + (y - 3)^2 = 13\)
   
   **B** \((x - 5)^2 + (y - 9)^2 = 85\)
   
   **C** \((x + 2)^2 + (y - 3)^2 = 85\)
   
   **D** \((x - 2)^2 + (y - 3)^2 = 45\)

4 An equation of a circle is \((x - 4)^2 + (y + 5)^2 = 36\). What are the center and diameter of the circle?
   
   **F** Center \((4, -5)\); diameter 6
   
   **G** Center \((4, -5)\); diameter 12
   
   **H** Center \((-4, 5)\); diameter 6
   
   **J** Center \((-4, 5)\); diameter 12

5 Which is an equation of a circle with diameter 8 and center at \((1, 2)\)?
   
   **A** \((x + 1)^2 + (y + 2)^2 = 64\)
   
   **B** \((x + 1)^2 + (y + 2)^2 = 16\)
   
   **C** \((x - 1)^2 + (y - 2)^2 = 64\)
   
   **D** \((x - 1)^2 + (y - 2)^2 = 16\)

6 The endpoints of a diameter of a circle are \((11, 13)\) and \((8, 17)\). Which is an equation of the circle?
   
   **F** \((x - 8)^2 + (y - 17)^2 = 5\)
   
   **G** \((x - 11)^2 + (y - 13)^2 = 25\)
   
   **H** \((x - 9.5)^2 + (y - 15)^2 = 25\)
   
   **J** \((x - 9.5)^2 + (y - 15)^2 = 6.25\)

7 An equation of a circle is \((x - 3)^2 + (y + 5)^2 = 50\). What is the radius of the circle?
   
   **A** \(5\sqrt{2}\)
   
   **B** \(10\sqrt{2}\)
   
   **C** 25
   
   **D** 50

8 A circle is centered at \((1, -6)\) and has a radius of 10. Which of the following is a point on the circle?
   
   **F** \((-11, 0)\)
   
   **G** \((-5, 2)\)
   
   **H** \((3, 5)\)
   
   **J** \((11, -6)\)
G.13
The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

You can use general formulas to find the surface area and volume of solids. In the formulas, \( B \) = area of the base, \( L \) = lateral area, \( h \) = height, \( \ell \) = slant height, \( r \) = radius, and \( P \) = perimeter of the base.

<table>
<thead>
<tr>
<th>Solid</th>
<th>Surface Area</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prisms and Cylinders</td>
<td>( S = 2B + L )</td>
<td>( V = Bh )</td>
</tr>
<tr>
<td>Pyramids and Cones</td>
<td>( S = B + \frac{1}{2}P\ell )</td>
<td>( V = \frac{1}{3}Bh )</td>
</tr>
<tr>
<td>Spheres</td>
<td>( S = 4\pi r^2 )</td>
<td>( V = \frac{4}{3}\pi r^3 )</td>
</tr>
</tbody>
</table>

**EXAMPLE**
What is the surface area of the cone?

**Solution**
To compute the surface area, we need the slant height. Using the Pythagorean Theorem, \( \ell = \sqrt{15^2 + 20^2} \), so \( \ell = 25 \).

The area of the base is \( B = \pi(15)^2 = 225\pi \), and the perimeter of the base is \( P = 2\pi(15) = 30\pi \).

\[
S = B + \frac{1}{2}P\ell \quad \text{Formula for Surface Area}
\]
\[
S = 225\pi + \frac{1}{2}(30\pi)(25) \quad \text{Substitute.}
\]
\[
S \approx 1884\text{yd}^2 \quad \text{Simplify.}
\]

1. What is the volume of the sphere in cubic meters? Use 3.14 for \( \pi \). Round your answer to the nearest whole number.

\[4\text{m}\]

A 33 m\(^3\)  
B 50 m\(^3\)  
C 201 m\(^3\)  
D 268 m\(^3\)

2. A regular octagonal pyramid has a height of 11 centimeters and a base with side length 3 centimeters. What is the volume of the pyramid?

\[20\text{ yd} \quad 15\text{ yd}\]

F 159.3 cm\(^3\)  
G 172.5 cm\(^3\)  
H 285.8 cm\(^3\)  
J 478.0 cm\(^3\)
3 Find the volume of the pyramid. Round to the nearest tenth.

\[ \frac{1}{3} \times \text{base area} \times \text{height} \]

\[ \frac{1}{3} \times 5 \times 5 \times 9 = 75 \text{ cm}^3 \]

A 141.4 cm\(^3\)  
B 33.3 cm\(^3\)  
C 47.1 cm\(^3\)  
D 37.5 cm\(^3\)

4 What is the volume of this solid?

\[ V = \text{length} \times \text{width} \times \text{height} \]

\[ 1 \times 2 \times 3 = 6 \text{ yd}^3 \]

F 14 yd\(^3\)  
H 169 yd\(^3\)  
G 51 yd\(^3\)  
J 270 yd\(^3\)

5 Find the surface area of the regular right prism.

\[ \text{Surface Area} = 2 \times (\text{base area}) + \text{perimeter} \times \text{height} \]

\[ 2 \times (8 \times 4) + (24 + 24 + 16 + 16) \times 7.5 = 330 \text{ in}^2 \]

A 105 in\(^2\)  
B 160 in\(^2\)  
C 187 in\(^2\)  
D 215 in\(^2\)

6 José wants to calculate the volume of air in a building, shown below, so that he can decide on the size of a new furnace. What is the volume of the building?

\[ \text{Volume} = \text{length} \times \text{width} \times \text{height} \]

\[ 12 \times 40 \times 30 = 14,400 \text{ ft}^3 \]

F 8280 ft\(^3\)  
H 72,000 ft\(^3\)  
G 82,800 ft\(^3\)  
J 93,600 ft\(^3\)

7 What is the surface area of a sphere with a radius of 20 centimeters?

\[ \text{Surface Area} = 4\pi r^2 \]

\[ 4\pi \times 20^2 = 1600\pi \approx 5024 \text{ cm}^2 \]

A 5024 cm\(^2\)  
B 6400 cm\(^2\)  
C 20,096 cm\(^2\)  
D 33,493 cm\(^2\)

8 The diagram represents a sculpture in an art museum. What is the surface area of the sculpture? Round your answer to the nearest tenth. Use 3.14 for \(\pi\).

\[ \text{Surface Area} = \pi r^2 + 2\pi rh \]

\[ \pi \times 7.5^2 + 2\pi \times 7.5 \times 7.5 \approx 113.7 \text{ ft}^2 \]

F 113.7 ft\(^2\)  
H 241.7 ft\(^2\)  
G 127.9 ft\(^2\)  
J 301.8 ft\(^2\)
G.14a
The student will use similar geometric objects in two- or three-dimensions to compare ratios between side lengths, perimeters, areas, and volumes.

<table>
<thead>
<tr>
<th>Theorem</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perimeters of Similar Polygons</strong></td>
</tr>
<tr>
<td>If two polygons are similar, then the ratio of their perimeters is equal to the ratios of their corresponding side lengths.</td>
</tr>
<tr>
<td><strong>Areas of Similar Polygons</strong></td>
</tr>
<tr>
<td>If two polygons are similar with the lengths of corresponding sides in the ratio of $a:b$, then the ratio of their areas is $a^2:b^2$.</td>
</tr>
<tr>
<td><strong>Surface Areas of Similar Solids</strong></td>
</tr>
<tr>
<td>If two similar solids have a scale factor of $a:b$, then corresponding areas have a ratio of $a^2:b^2$.</td>
</tr>
<tr>
<td><strong>Volumes of Similar Solids</strong></td>
</tr>
<tr>
<td>If two similar solids have a scale factor of $a:b$, then corresponding volumes have a ratio of $a^3:b^3$.</td>
</tr>
</tbody>
</table>

**EXAMPLE**

The pyramid shown is a scale model for a pyramid with a base side length of 12 feet. What is the ratio of the surface areas of the pyramids?

**Solution**

The scale factor is $3:12$ or $1:4$, so the surface areas have a ratio of $1^2:4^2$ or $1:16$.

1. The triangles shown below are similar. What is the ratio of the perimeter of the larger right triangle to the perimeter of the smaller right triangle?

   - A 36 : 5
   - B 9 : 1
   - C 3 : 1
   - D 36 : 3

2. The perimeters of two squares are in a ratio of 5 to 11. What is the ratio between the areas of the two squares?

   - F 15 to 33
   - G 2 to 3
   - H 5 to 11
   - J 25 to 121
3. The lateral areas of two similar cylindrical juice containers are shown. What is the ratio of their volumes?

\[ L = 121\pi \quad \text{and} \quad L = 169\pi \]

A. 11 : 13
B. 33 : 39
C. 121 : 169
D. 1311 : 2197

4. An architect is designing a building in the shape of a triangular prism. If the ratio of the height of her scale model to the height of the actual building is 1 : 98, what is the ratio of the volume of the scale model to the volume of the building?

F. 1 : 196
G. 1 : 294
H. 1 : 9604
J. 1 : 941,192

5. Alana has one large toy box and one small toy box. Both of the toy boxes are in the shape of a cube. What is the scale factor of the surface areas of the toy boxes?

14 in. 28 in.

A. 1 : 2
B. 2 : 3
C. 1 : 4
D. 1 : 8

6. ABC Moving Company makes shipping crates in two sizes that are similar rectangular prisms. If the ratio of volumes of the crates is 5 : 21, approximately what is the ratio of side lengths of the crates?

F. 1.7 : 2.8
G. 1.7 : 7
H. 2.2 : 4.6
J. 2.5 : 10.5

7. The surface area of Sphere A is 27 m². The surface area of Sphere B is 48 m². What is the ratio of the diameter of Sphere A to the diameter of Sphere B, expressed as a decimal? Round your answer to the nearest hundredth.

A. 0.83
B. 0.56
C. 0.55
D. 0.75

8. Sam is making a scale model of an Egyptian pyramid. The ratio of the surface area of his model to the surface area of the pyramid is 1 : 100. What is the ratio of the volume of the model to the volume of the pyramid?

F. 1 : 10
G. 1 : 200
H. 1 : 500
J. 1 : 1000
G.14b

The student will use similar geometric objects in two- or three-dimensions to determine how changes in one or more dimensions of an object affect area and/or volume of the object.

EXAMPLE

The dimensions of two similar triangular prisms have a ratio of 2 : 5. If the volume of the smaller prism is 580 cm³, what is the volume of the larger prism?

Solution

If the dimensions of two similar objects have a ratio of \(a : b\), then their volumes have a ratio of \(a^3 : b^3\). Therefore, the volumes of the triangular prisms have a ratio of \(2^3 : 5^3\), or \(8 : 125\).

Let \(x\) represent the volume of the larger prism, then set up and solve a proportion using this ratio to find \(x\).

\[
\frac{8}{125} = \frac{580}{x}
\]

Set up a proportion.

\[
8x = 125(580)
\]

Use the cross products property.

\[
x = \frac{125(580)}{8}
\]

Solve for \(x\).

\[
x = 9062.5
\]

Simplify.

The volume of the larger prism is 9062.5 cm³.

1. Two triangles are similar with a scale factor of 4. How many times greater is the area of the larger triangle compared to the area of the smaller triangle?
   
   A. 2
   B. 4
   C. 8
   D. 16

2. Two similar cones are shown below. The volume of the larger cone is 3600 cubic centimeters. What is the volume of the smaller cone?

   F. 450 cm³
   G. 900 cm³
   H. 1250 cm³
   J. 1800 cm³
3. The dimensions of a sphere are increased by a scale factor of 4. The surface area of the original sphere is about 314 cm². What is the surface area of the larger sphere?

A. 1256 cm²  
B. 2512 cm²  
C. 3768 cm²  
D. 5024 cm²

4. Mr. Gonzalez needs to increase the space he rents at a boat yard. He currently rents a rectangular storage space of 6000 cubic feet. If he increases the dimensions of the storage space 1.5 times, what will be the volume of the new storage space?

F. 9000 ft³  
G. 13,500 ft³  
H. 20,250 ft³  
J. 27,000 ft³

5. A large gazebo is shaped like a regular octagon. Its sides are 12 feet and it has an area of about 696 square feet. Find the area of a similar gazebo that has a side of length 8 feet. Round to the nearest tenth.

A. 130.5 ft²  
B. 309.3 ft²  
C. 116 ft²  
D. 1566 ft²

6. The height of a hemispherical dome is 20 feet. A similar dome is \(2\frac{1}{2}\) times as high. How many times greater is the volume of the second dome than the first?

F. 6\(\frac{1}{4}\)  
G. 8  
H. 15\(\frac{5}{8}\)  
J. 20.83

7. A swimming pool in the shape of a rectangular prism has a volume of 960 cubic feet. A similar pool next door has dimensions twice as large. What is the volume of the larger pool?

A. 1920 ft³  
B. 3840 ft³  
C. 7680 ft³  
D. 9600 ft³

8. Two spheres are similar with a scale factor of 1 : 3. The volume of the smaller sphere is 34 cubic inches. What is the volume of the larger sphere?

F. 68 in.³  
G. 102 in.³  
H. 306 in.³  
J. 918 in.³
G.14c
The student will use similar geometric objects in two- or three-dimensions to determine how changes in area and/or volume of an object affect one or more dimensions of the object.

EXAMPLE
The two pentagons shown are similar. The area of $ABCDE$ is 27 cm$^2$, and the area of $RSTUV$ is 48 cm$^2$. If $ED = 5$ cm, what is $VU$?

Solution
The ratio of the dimensions of two similar objects is the square root of the ratio of their areas. The areas of the pentagons have a ratio of 27 : 48, which can be simplified to $9 : 16$. Therefore, the dimensions have a ratio of $\sqrt{9} : \sqrt{16}$, or $3 : 4$.

Set up and solve a proportion using this ratio to find $VU$.

\[
\frac{3}{4} = \frac{5}{VU} \quad \text{Set up a proportion.}
\]

\[
3 \cdot VU = 4(5) \quad \text{Use the cross products property.}
\]

\[
VU = \frac{20}{3} \quad \text{Solve.}
\]

\[
VU \approx 6.67 \text{ cm}
\]

1. Two similar cones are shown below. The ratio of their surface areas is 1:25. If the radius of the smaller cone is 4 cm, what is the radius of the larger cone?

A 10 cm  
B 20 cm  
C 25 cm  
D 100 cm

2. A toy store sells two sizes of balls. If the volumes of the balls are 1728 cm$^3$ and 46656 cm$^3$, how many times larger is the diameter of the second ball than the diameter of the first ball?

F 3  
H 9  
G 3.3  
J 27

3. The areas of two similar polygons are 144 cm$^2$ and 28 cm$^2$. If one of the sides of the first polygon is 3 cm long, exactly how long is the corresponding side of the second polygon?

A $\frac{7}{6}$  
B $\frac{7}{12}$  
C $\frac{\sqrt{7}}{2}$  
D $\frac{\sqrt{7}}{3}$

GO ON
G.14c (continued)

4 In the floor plan for a new house, the area of a closet is 6 square inches. If the area of the actual closet is 9.375 square feet, what is the scale of the floor plan? (1 square foot = 144 square inches)

\[ \text{F} \quad 1 \text{ in.} = 6.1 \text{ in.} \\
\text{G} \quad 1 \text{ in.} = 12 \text{ in.} \\
\text{H} \quad 1 \text{ in.} = 15 \text{ in.} \\
\text{J} \quad 1 \text{ in.} = 225 \text{ in.} \]

5 Carter applies a dilation to a drawing of a cube twice using the same scale factor both times. The volume changes from 8 cubic units to 216 cubic units to 5832 cubic units. What is the scale factor of the dilation he applied?

\[ \text{A} \quad 3 \quad \text{B} \quad 9 \quad \text{C} \quad 27 \quad \text{D} \quad 54 \]

6 The two cylinders shown are similar. The smaller cylinder has a radius of 2 ft and has a surface area of \( 28\pi \text{ ft}^2 \). The larger cylinder has a surface area of \( 252\pi \text{ ft}^2 \). What is the height of the larger cylinder?

\[ SA = 2\pi r^2 + 2\pi rh \]

\[ \text{F} \quad 10 \text{ ft} \\
\text{G} \quad 15 \text{ ft} \\
\text{H} \quad 18 \text{ ft} \\
\text{J} \quad 22 \text{ ft} \]

7 A scale model of the ramp shown below has a volume of 0.34375 \( \text{ft}^3 \). What is the height of the scale model ramp?

\[ \text{A} \quad 0.5 \text{ ft} \\
\text{B} \quad \frac{\sqrt{6}}{12} \text{ ft} \\
\text{C} \quad 1 \text{ ft} \\
\text{D} \quad 3 \text{ ft} \]

8 A rectangle has a width of 8 centimeters and an area of 160 centimeters. A similar rectangle has an area of 250 centimeters. What are the dimensions of the larger rectangle?

\[ \text{F} \quad 8 \text{ cm by } 31.25 \text{ cm} \\
\text{G} \quad 10 \text{ cm by } 25 \text{ cm} \\
\text{H} \quad 12.5 \text{ cm by } 20 \text{ cm} \\
\text{J} \quad 15 \text{ cm by } 16\frac{2}{3} \text{ cm} \]
G.14d
The student will use similar geometric objects in two- or three-dimensions to solve real-world problems about similar geometric objects.

EXAMPLE
A certain brand of laundry detergent is sold in two sizes of boxes that are similar rectangular prisms. The volume of the larger box is eight times the volume of the smaller box. If the surface area of the smaller box is 228 in.\(^2\), what is the surface area of the larger box?

Solution
The ratio of the dimensions of two similar objects is the cube root of the ratio of their volumes. Since the ratio of the volumes of the two boxes is 1 : 8, the ratio of their dimensions is \(\sqrt[3]{1} : \sqrt[3]{8}\) or 1 : 2. The ratio of surface areas of similar objects is the square of the ratio of their dimensions, so the ratio of surface areas is \(1^2 : 2^2\), or 1 : 4.

Set up and solve a proportion to find the surface area of the larger box. Using \(x\) to represent the surface area of the larger box:

\[
\frac{1}{4} = \frac{228}{x}
\]

Set up a proportion.

\[1x = 4(228)\]
Use the cross products property.

\[x = 912\text{ in.}^2\]
Solve.

1. Vince has a box that he is using as a model for building a cedar chest. The dimensions of the box are shown. If he triples each dimension to obtain the dimensions of the cedar chest, how many times greater is the volume of the cedar chest than the volume of the box?

A 81 times greater
B 27 times greater
C 9 times greater
D 3 times greater

2. A square-shaped office has a side length of 90 feet. The owners want to double the dimensions of the space. If the area of the existing space is 8100 square feet, what will be the area of the new office space?

F 48,600 ft\(^2\)
G 32,400 ft\(^2\)
H 24,300 ft\(^2\)
J 16,200 ft\(^2\)
3 A photograph has the dimensions shown below. Which set of dimensions could describe a copy of the photograph produced by a photocopy machine?

A photograph has the dimensions 25 cm by 35 cm.

- A 30 cm by 40 cm
- B 80 cm by 112 cm
- C 64 cm by 84 cm
- D 102.2 cm by 140 cm

4 The area of Nebraska is 76,878 square miles. On a map, the area covered by Nebraska is 23 square inches. What is the approximate scale of the map?

- F 1 in. = 12 mi
- G 1 in. = 58 mi
- H 1 in. = 145 mi
- J 1 in. = 3342 mi

5 A large rectangular tabletop is 64 inches long by 36 inches wide. A smaller tabletop is similar to the large tabletop. The area of the smaller tabletop is 1296 square inches. Find the width of the smaller tabletop.

- A 20.25 in.
- B 27 in.
- C 36 in.
- D 48 in.

6 A stop sign is made from an octagon that is 75 centimeters wide. The letters in the word “STOP” are 25 centimeters tall. A toy set has a scale model of a stop sign. If the letters on the toy stop sign are 1.8 centimeters tall, what is the width of the octagon?

- F 3.1 cm
- H 7.7 cm
- G 5.4 cm
- J 13.9 cm

7 The scale factor of a small ice cream cone to a large ice cream cone is 2 : 3. The volume of the small cone is 24 cubic centimeters. What is the volume of the large cone?

- A 36 cm³
- B 54 cm³
- C 72 cm³
- D 81 cm³

8 A soup company makes two different sizes of soup cans. The cans are similar cylinders. The radius of the small can is 2.5 inches, and the height of the small can is 6 inches. If the volume of the large can is 482.3 cubic inches, what is the radius of the large can? Round your answer to the nearest tenth.

- F 4.0 in.
- G 4.2 in.
- H 5.1 in.
- J 5.7 in.
Post Test

1. A student has sticks of lengths 5 cm and 9 cm. She wants to use a third stick to form a triangle. What are the possible lengths of the third side?
   - A. Greater than 3 cm and less than 14 cm
   - B. Greater than 4 cm and less than 14 cm
   - C. Greater than 5 cm and less than 9 cm
   - D. Greater than 4 cm and less than 10 cm

2. Shawn wants to draw a tessellation using just a single shape. Which regular polygon will always tessellate the plane when used by itself?
   - F. Hexagon
   - H. Pentagon
   - G. Octagon
   - J. Nonagon

3. Mila has been asked to construct a line segment congruent to a given line segment. How can she use a ruler in the process?
   - A. As a straightedge
   - B. As a compass
   - C. To measure the length of the given segment
   - D. To measure the distance between the two segments

4. Henry said, “If the measure of an angle is $b$ degrees, then the angle is a straight angle.” For what value of $b$ is Henry’s argument valid?
   - F. 45°
   - G. 90°
   - H. 180°
   - J. 360°

5. Two triangles are similar. The height of the smaller triangle is 4 units and the height of the larger triangle is 6 units. If the area of the smaller triangle is 24 square units, what is the area of the larger triangle?
   - A. 36 square units
   - B. 48 square units
   - C. 54 square units
   - D. 108 square units
6 In the figure below, $ED \perp DF$, $HG \perp GF$, and $F$ is the midpoint of $DG$.

Which theorem or postulate can be used to prove $\triangle DEF \cong \triangle GHF$?

F ASA
G SSS
H SAS
J HL

7 Kevin is using a straightedge and compass to complete the construction shown below.

Which best describes the construction Kevin is completing?

A Square
B Equilateral triangle
C Perpendicular to a line
D Angle bisector
Post Test  (continued)

8  What value of \( x \) will make the polygon a parallelogram?

\[ (4x)^\circ \quad (2x)^\circ \]

\[ \begin{array}{cccc}
F & 30 \\
G & 60 \\
H & 120 \\
J & 180 \\
\end{array} \]

9  Let \( p \) be “it is raining,” let \( q \) be “it is thundering,” and let \( r \) be “we cannot swim.”
What is \( p \rightarrow \neg q \)?

\[ \begin{array}{cccc}
A & \text{If it is thundering, then it is raining.} \\
B & \text{If it is raining, then it is not thundering.} \\
C & \text{If it is not thundering, then it is not raining.} \\
D & \text{If it is not thundering, then it is raining.} \\
\end{array} \]

10  Emma is using a straightedge and compass to complete the construction shown below. Which
of the following best describes the construction Emma is completing?

\[ \begin{array}{cccc}
F & \text{Copying an angle} \\
G & \text{Bisecting a line segment} \\
H & \text{Constructing a line parallel to a given line} \\
J & \text{Constructing a line perpendicular to a given line} \\
\end{array} \]

11  What is the surface area of the triangular prism shown? (slant height \( = 14.87 \) feet)

\[ \begin{array}{cccc}
A & 814.8 \text{ ft}^2 \\
B & 1254.8 \text{ ft}^2 \\
C & 1064.54 \text{ ft}^2 \\
D & 1200 \text{ ft}^2 \\
\end{array} \]
12 Use the diagram determine which statement is true.

\[ \angle H < \angle J < \angle I \]

**F** \( m\angle H < m\angle J < m\angle I \)

**G** \( HI < HJ < JI \)

**H** \( JI < HJ < HI \)

**J** \( HJ > HI \)

13 Let \( p \) be “it is raining,” let \( q \) be “it is thundering,” and let \( r \) be “we can swim.” Translate the statement “if it is raining, we cannot swim” into symbolic form. Choose the best answer.

**A** \( q \rightarrow r \)

**B** \( r \rightarrow \neg p \)

**C** \( \neg r \rightarrow \neg q \)

**D** \( p \rightarrow \neg r \)

14 What is the midpoint of \( \overline{KL} \)?

**F** \( \left( \frac{1}{2}, \frac{5}{2} \right) \)

**G** \( \left( -1, -\frac{5}{2} \right) \)

**H** \( \left( 3, -\frac{1}{2} \right) \)

**J** \( (6, -1) \)
15. The bottom end of a loading ramp is 15 feet from the side of a loading dock. The length of the ramp is 17 feet. What is the height of the dock?

![right triangle with side lengths 15 ft, 17 ft, and h ft]

A. 10 ft  
B. 9 ft  
C. 8 ft  
D. 6 ft

16. A wooden gate has z-shaped boards for support, as shown. Which theorem allows you to conclude that $\angle 1 \cong \angle 2$?

![z-shaped boards with angles 1 and 2]

F. Alternate Interior Angles Theorem  
G. Consecutive Interior Angles Theorem  
H. Alternate Exterior Angles Theorem  
J. Perpendicular Transversal Theorem
17 Greta is painting a circular tabletop. As part of her design, she needs to paint two lines across the table, as represented in the diagram below by chords $AB$ and $CD$. The values of $AE$, $BE$, and $DE$ (in inches) are shown in the diagram. What is $CE$?

![Circular Tabletop Diagram]

- A 3 in.
- B 6 in.
- C 8 in.
- D 9 in.

18 In the diagram below, parallel lines $p$ and $q$ are cut by transversal $t$. Which statement about angles 1 and 2 must be true?

![Parallel Lines Diagram]

- F $\angle 1$ is the supplement of $\angle 2$.
- G $\angle 1 \equiv \angle 2$
- H $\angle 1$ is the complement of $\angle 2$.
- J $\angle 1$ and $\angle 2$ are right angles.
Post Test  (continued)

19  The ratio of the diameters of two spheres is \(\frac{3}{2}\).
What is the ratio of the surface area of the larger sphere to the surface area of the smaller sphere?

A  \(\frac{8}{27}\)  C  \(\frac{9}{4}\)
B  \(\frac{4}{9}\)  D  \(\frac{27}{8}\)

20  Which of the following statements is *not* represented by the diagram?

F  Some mammals are common pets.
G  Some common pets are mammals.
H  Some mammals are marsupials.
J  Some common pets are marsupials.

21  Which of the following sets of numbers could *not* represent the lengths of the sides of a triangle?

A  3, 4, 6  C  5, 5, 8
B  2, 4, 7  D  4, 7, 10

22  Which statement is the contrapositive of the following statement?
If the sides of a triangle are congruent, then the angles of the triangle are congruent.

F  If the sides of a triangle are congruent, then the angles of the triangle are not congruent.
G  If the angles of a triangle are congruent, then the sides of the triangle are congruent.
H  If the sides of a triangle are not congruent, then the angles of the triangle are not congruent.
J  If the angles of a triangle are not congruent, then the sides of the triangle are not congruent.
23. The top of the grain silo shown below is a hemisphere. What is the approximate volume of the silo? Use 3.14 for $\pi$.

![Diagram of a silo with a hemisphere top]

- 16 ft
- 30 ft

A. 1910 ft³
B. 2111 ft³
C. 2312 ft³
D. 7101 ft³

24. Which additional piece of information proves that $\triangle ABC$ and $\triangle PQR$ are similar?

- $\angle B \cong \angle Q$
- $\angle A \cong \angle P$
- $\angle C \cong \angle R$
- $\angle R \cong \angle B$

25. Jason is using a straightedge and compass to complete the construction shown below.

![Diagram of a construction with a compass and straightedge]

Which best describes the construction Jason is completing?

- A. Bisecting an angle
- B. Bisecting a segment
- C. Copying an angle
- D. Copying a segment
26 What scale factor could be used to transform \(\triangle JKL\) into \(\triangle RST\)?

Options:
- F 12
- H 3
- G 4
- J \(\frac{1}{4}\)

27 What are \(m\angle EGD\) and \(m\angle EDG\) in the inscribed figure?

Options:
- A 30° and 50°
- B 60° and 50°
- C 30° and 70°
- D 60° and 70°
The Chicago Cereal Company is developing a new cardboard box to use for its oatmeal. The old box is a cylinder 6 inches tall with a radius of 1.5 inches. The new box is also a cylindrical container with a required volume of 339.12 cubic inches. What changes in dimensions are necessary to address the required volume?

- **F** Increase the height to 10 inches
- **G** Increase the radius to 2 inches
- **H** Increase the height to 9 inches and radius to 2.25 inches
- **J** Increase the height to 12 inches and radius to 3 inches

Point $P$ is inside $\triangle ABC$ and is equidistant from points $A$ and $B$. On which of the following segments must $P$ be located?

- **A** $\overline{AB}$
- **B** The perpendicular bisector of $\overline{AB}$
- **C** The midsegment opposite $\overline{AB}$
- **D** The perpendicular bisector of $\overline{AB}$

Rectangle $PQRS$ is shown below.

If this rectangle is reflected across the $y$-axis, what will be the coordinates of the vertices for the image $P'Q'R'S'$?

- **F** $P'(1, -4), Q'(-4, 4), R'(4, -2), S'(1, -2)$
- **G** $P'(1, 4), Q'(4, 4), R'(4, 2), S'(1, 2)$
- **H** $P'(-4, -1), Q'(-4, -4), R'(-2, -4), S'(-2, -1)$
- **J** $P'(4, 1), Q'(4, 4), R'(2, 4), S'(2, 1)$
Post Test (continued)

31  In \( \triangle WXY, XY > YW > WX \), which set of angles is in order from largest to smallest?
   
   \[ \begin{array}{ll}
   A & m \angle X, m \angle Y, m \angle W \\
   B & m \angle Y, m \angle W, m \angle X \\
   C & m \angle W, m \angle X, m \angle Y \\
   D & m \angle Y, m \angle X, m \angle W \\
   \end{array} \]

32  Which of the following figures does not possess symmetry with respect to a point?

   \[ \begin{array}{ll}
   F & S \\
   G & I \\
   H & L \\
   J & H \\
   \end{array} \]

33  To make a cone, Avery cuts a circle from a sheet of paper and then removes a sector of the circle, as seen in the figure below.

   ![Diagram of a circle with a sector cut out](image)

   To the nearest tenth of an inch, which answer represents the remaining portion of the original circumference of the circle after the sector is removed?

   \[ \begin{array}{ll}
   A & 26.2 \text{ in.} \\
   B & 28.8 \text{ in.} \\
   C & 57.6 \text{ in.} \\
   D & 314.2 \text{ in.} \\
   \end{array} \]
Post Test (continued)

34 Which of the following is not used in deductive reasoning to form a logical argument?
   F Definitions  H Accepted properties
   G Facts  J Specific examples

35 Navid is using a straightedge and compass to complete the construction shown below.
Which of the following best describes the construction Navid is completing?

A Bisecting an angle
B Copying a line segment
C Constructing a line parallel to a given line
D Constructing a line perpendicular to a given line

36 An equation of a circle is $(x - 3)^2 + (y + 4)^2 = 48$. What is the center of the circle?
   F $(-3, 4)$  H $(3, -4)$
   G $(4, -3)$  J $(-4, 3)$

37 In $\triangle PQR$, $\angle R$ is a right angle. If point $P$ has coordinates $(0, 0)$ and point $Q$ has coordinates $(a, b)$, which of the following are possible coordinates for point $R$?
   Choose the best answer.
   A $\left(\frac{a}{2}, \frac{b}{2}\right)$
   B $(a, a)$
   C $(0, b)$
   D $(b, b)$

38 The base of the adult pool at the community center is a circle with a diameter of 40 feet. The base of the baby pool is also a circle. The area of the baby pool is $\frac{1}{4}$ the area of the base of the adult pool. What is the diameter of the base of the baby pool?
   F 8 feet  H 20 feet
   G 10 feet  J 30 feet
39 What is the converse of the given statement?
Given: If the sum of the interior angles of a polygon is 180°, then the polygon is a triangle.
A If the sum of the interior angles of a polygon is not 180°, then the polygon is not a triangle.
B If a polygon is not a triangle, then the sum of the interior angles of the polygon is not 180°.
C If the sum of the interior angles of a polygon is 180°, then the polygon is not a triangle.
D If a polygon is a triangle, then the sum of the interior angles of the polygon is 180°.

40 You want to create a triangular garden between a walkway and a driveway, as shown in the diagram. Find x to the nearest tenth of a foot.

\[ \text{Diagram with triangle} \]

F 9.9 ft
G 16.7 ft
H 19.3 ft
J 21.3 ft

41 What is the last step in constructing a perpendicular to a given line at a given point P on the line?
A Draw a line through points P and C.
B Draw two arcs, one around A and one around B.
C Mark two other points, A and B, on the given line.
D Mark point S where the arcs around A and B intersect.
42 Savannah has planted a circular flower garden around a corner of her deck as shown. To the nearest tenth, what is the area of her garden?

\[ \text{Area} = \frac{120^\circ \times 4^2}{2} = 24 \times 4 = 96 \text{ yd}^2 \]

F 4.2 yd\(^2\)  
G 8.4 yd\(^2\)  
H 16.8 yd\(^2\)  
J 33.5 yd\(^2\)

43 The endpoints of a diameter of a circle are (3, 4) and (9, -4). Which is an equation of the circle?

A \((x + 6)^2 + y^2 = 25\)  
B \((x - 3)^2 + y^2 = 25\)  
C \((x - 6)^2 + y^2 = 10\)  
D \((x - 6)^2 + y^2 = 25\)

44 If lines \(s\) and \(t\) are parallel, what must be the value of \(x\)?

\[ (5x - 10)^\circ + 75^\circ = 180^\circ \]

F 23  
G 19  
H 17  
J 5
45 The lengths of two sides of the triangle are known.

Which of the following could be the perimeter of the triangle?

A 19
B 24
C 31
D 38
Pre Test

1. A B C D
2. F G H J
3. A B C D
4. F G H J
5. A B C D
6. F G H J
7. A B C D
8. F G H J
9. A B C D
10. F G H J
11. A B C D
12. F G H J
13. A B C D
14. F G H J
15. A B C D

Fill in the correct answer

16. F G H J
17. A B C D
18. F G H J
19. A B C D
20. F G H J
21. A B C D
22. F G H J
23. A B C D
24. F G H J
25. A B C D
26. F G H J
27. A B C D
28. F G H J
29. A B C D
30. F G H J
31. A B C D
32. F G H J
33. A B C D
34. F G H J
35. A B C D
36. F G H J
37. A B C D
38. F G H J
39. A B C D
40. F G H J
41. A B C D
42. F G H J
43. A B C D
44. F G H J
45. A B C D
## Post Test

1. A B C D
2. F G H J
3. A B C D
4. F G H J
5. A B C D
6. F G H J
7. A B C D
8. F G H J
9. A B C D
10. F G H J
11. A B C D
12. F G H J
13. A B C D
14. F G H J
15. A B C D

## Fill in the correct answer

16. F G H J
17. A B C D
18. F G H J
19. A B C D
20. F G H J
21. A B C D
22. F G H J
23. A B C D
24. F G H J
25. A B C D
26. F G H J
27. A B C D
28. F G H J
29. A B C D
30. F G H J
31. A B C D
32. F G H J
33. A B C D
34. F G H J
35. A B C D
36. F G H J
37. A B C D
38. F G H J
39. A B C D
40. F G H J
41. A B C D
42. F G H J
43. A B C D
44. F G H J
45. A B C D