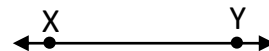


## **GEOMETRY: TRIANGLES**

### **Lesson 1   Angles**

#### **1. BASIC GEOMETRY SHAPES: POINTS AND LINES**

A **line** has arrows on both ends, which shows that it continues forever in both directions.



A line is named by the points that are labeled on it. Points X and Y are on the line above, and it is named line XY. The symbol  $\overleftrightarrow{XY}$  stands for line XY.

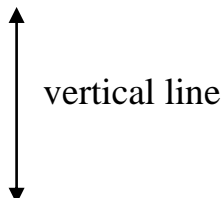
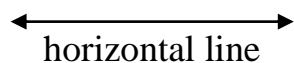
A **ray** begins at a specific point, called an endpoint, and continues forever in the other direction. The ray to the right is called ray FG, and the symbol  $\overrightarrow{FG}$  stands for ray FG.



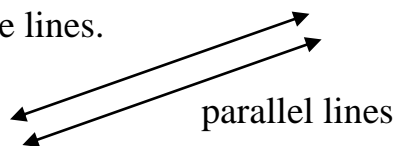
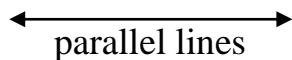
A **line segment** has two specific endpoints. The line segment to the right is called line segment AB, and the symbol  $\overline{AB}$  stands for line segment AB.



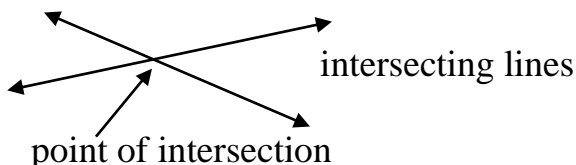
A **horizontal line** runs across, and a **vertical line** runs up and down.



**Parallel lines** run in the same direction, and never cross. The distance between two parallel lines is the same at any point on the lines.

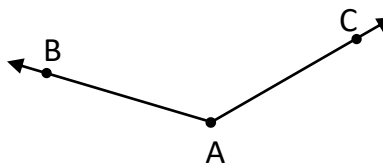
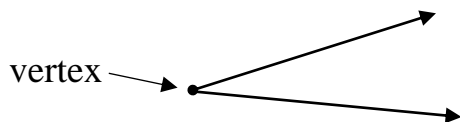


**Intersecting lines** are lines that cross each other, and they meet at a point of intersection.



## 2. ANGLE BASICS

Two rays extending from the same endpoint form an angle. The point from which they extend is called the **vertex**, and the symbol for an angle is  $\angle$ .

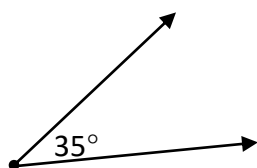


Angles are named by the points that are labeled on the rays. The angle above right can be named “angle A” using just the vertex point. The symbol for this is  $\angle A$ .

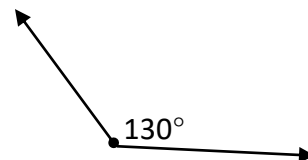
It can also be named “angle BAC” or “angle CAB” using all three labeled points. The symbols for this are  $\angle BAC$  and  $\angle CAB$ .

**IMPORTANT:** When using a 3-letter name for an angle, the vertex point must always be in the middle of the 3-letter name. The angle above **cannot** be named  $\angle ABC$  or  $\angle BCA$ , because vertex angle A must be the middle letter in the 3-letter name.

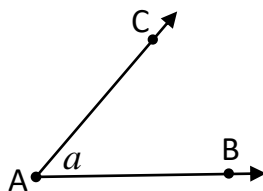
Angles are measured in **degrees**, which measure the size of the opening between the two rays that form the angle. The symbol for degrees is  $^\circ$ , and the degree measurement is usually written inside the angle next to the vertex.



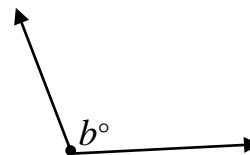
The  $35^\circ$  angle on the left is smaller than the  $130^\circ$  angle on the right because the  $35^\circ$  angle has a smaller opening between the two rays.



As shown below, if the degree measurement of an angle is unknown, it can be represented by a variable, which is a letter that stands for an unknown number.



When doing Geometry problems you may see the variable written with or without the degree symbol. Either way, the variable inside the vertex stands for the degree measurement of the angle.

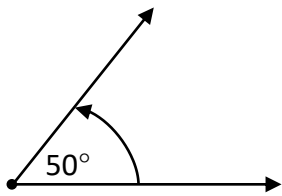


In the diagram above left, the capital letters A B and C stand for points on the rays that form the angle.

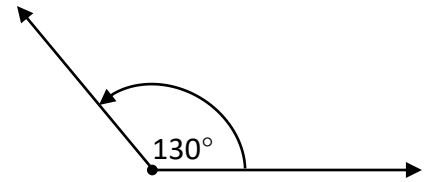
The small letter  $a$  inside the angle stands for the degree measurement of the angle.

Points on rays and lines are usually shown as capital letters, and degree measurements are usually shown as small letters.

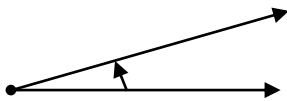
### 3. ANGLE SIZE



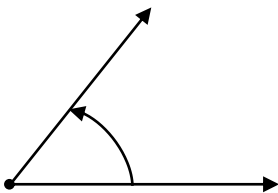
The  $50^\circ$  angle on the left is smaller than the  $130^\circ$  angle on the right because the  $50^\circ$  angle has a smaller opening between the two rays.



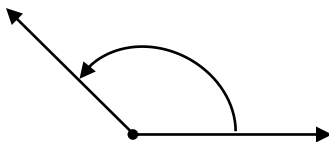
Think of the bottom ray of the angle as staying in place, and the top ray as rotating away from it. The farther the top rotates away, the bigger the size of the angle.



Small angle.

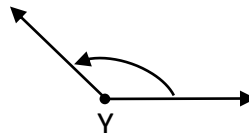
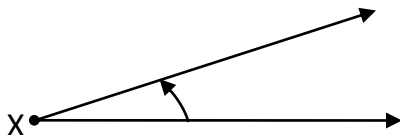


More rotation. Bigger opening. Bigger angle.



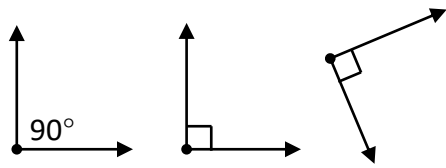
Even more rotation. Bigger opening. Bigger angle.

The length of the rays is not related to the size of the angle. Remember, the rays go on forever, so can be drawn at any length with arrows on the ends. Look at the two angles below.



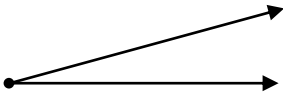
The rays of  $\angle X$  are drawn longer than the rays of  $\angle Y$ . However,  $\angle Y$  is larger than  $\angle X$ . This is because  $\angle Y$  has more degrees of opening between the rays. You can see that the top ray has rotated further away from the bottom ray in  $\angle Y$  than it has in  $\angle X$ .

## 4. TYPES OF ANGLES



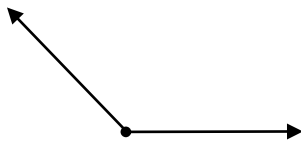
### Right Angle

Measures exactly  $90^\circ$ . A small square box at the vertex is the symbol for a right angle.



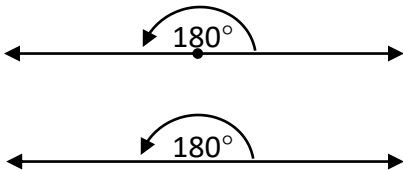
### Acute Angle

Measures less than  $90^\circ$ .



### Obtuse Angle

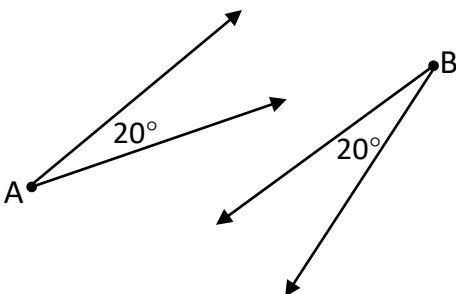
Measures more than  $90^\circ$  and less than  $180^\circ$ .



### Straight Angle

Measures exactly  $180^\circ$ .

This is often drawn as a straight line, without showing the vertex point.



### Congruent Angles

have equal measures.  $\angle A$  and  $\angle B$  are congruent because they both measure  $20^\circ$ . Angles do not have to be turned in the same direction to be congruent. The symbol  $\cong$  means “is congruent to.”  
 $\angle A \cong \angle B$

**Practice One**    *Answers – p. 21*

1. Choose one of the following labels for each diagram below and write it on the blank line next to the diagram.

Ray

Line Segment

Intersecting Lines

Parallel Lines

Vertical Line

Horizontal Line



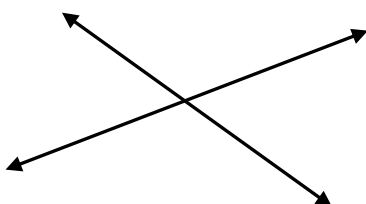
\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_

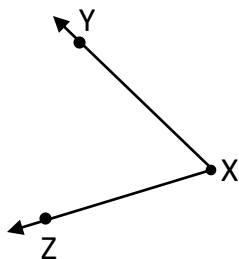


\_\_\_\_\_



\_\_\_\_\_

2. Which of the choices correctly names the angle below? Write Yes on the line next to the correct names, and write No if the name is not correct.



$\angle X$  \_\_\_\_\_

$\angle ZXY$  \_\_\_\_\_

$\angle Y$  \_\_\_\_\_

$\angle XYZ$  \_\_\_\_\_

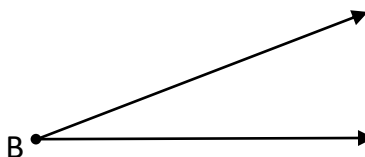
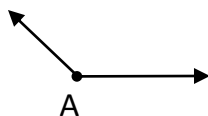
$\angle Z$  \_\_\_\_\_

$\angle YZX$  \_\_\_\_\_

$\angle XZY$  \_\_\_\_\_

$\angle YXZ$  \_\_\_\_\_

3. Which of the angles below is larger,  $\angle A$  or  $\angle B$ ? \_\_\_\_\_



4.  $\angle X$  is an acute angle. Which of the degree measurements below could possibly be the measure of  $\angle X$ ? Write Yes or No on the line next to each measurement.

$45^\circ$  \_\_\_\_\_

$35^\circ$  \_\_\_\_\_

$90^\circ$  \_\_\_\_\_

$89^\circ$  \_\_\_\_\_

$12^\circ$  \_\_\_\_\_

$150^\circ$  \_\_\_\_\_

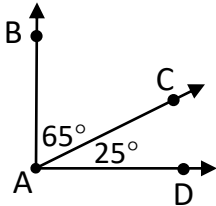
5. What type of angle is pictured below? \_\_\_\_\_

How many degrees does it measure? \_\_\_\_\_



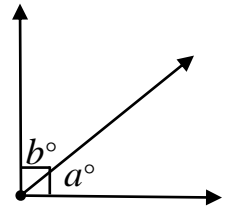
## 5. COMPLEMENTARY ANGLES

**Complementary Angles** are two angles that together measure  $90^\circ$ . You can think of this as two angles that form a right angle when put together.



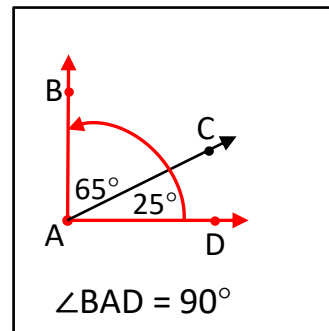
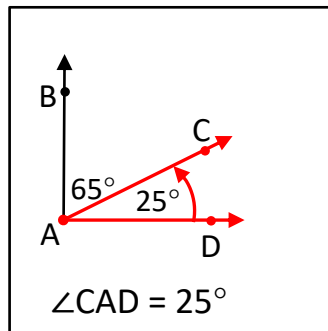
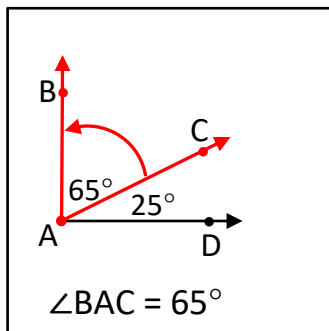
In the diagram on the left, the two complementary angles are  $\angle BAC$  and  $\angle CAD$ . They are complementary because together they measure  $90^\circ$ .

In the diagram on the right, the two complementary angles are  $a$  and  $b$ . Their degree measurements are not given, but the box at their shared vertex shows that the angle they form together is a  $90^\circ$  right angle.

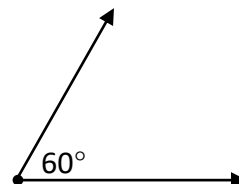
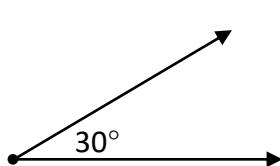


Each diagram above shows a pair of **adjacent angles**, which means the two angles are next to each other, and have the same vertex and share a side. In the diagram above left, the two angles share the vertex point A, and the ray AC.

In both the diagrams above, in addition to the two adjacent complementary angles, there is also the  $90^\circ$  angle that they form. Make sure you can see all three of these angles separately. The three angles for the diagram above left are shown in red below.



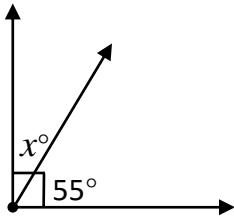
The two angles below are also complementary because together they measure  $90^\circ$ . Angles do not have to be adjacent to be complementary.



### Example 1

What is the value of  $x$  in the diagram below?

- A.  $90^\circ$       B.  $45^\circ$       C.  $35^\circ$       D.  $55^\circ$       E.  $25^\circ$



The  $55^\circ$  angle and the  $x^\circ$  angle together measure  $90^\circ$  because together they form a right angle. We know this because the box symbol means it is a right angle. To get  $x$ , subtract  $90 - 55 = 35$ .

**Answer: C.  $35^\circ$**

### Example 2

$\angle X$  and  $\angle Y$  are complementary angles. If  $\angle X$  measures  $14^\circ$ , what is the measurement of  $\angle Y$ ?

- A.  $14^\circ$       B.  $28^\circ$       C.  $90^\circ$       D.  $76^\circ$       E.  $41^\circ$

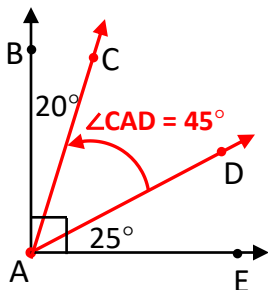
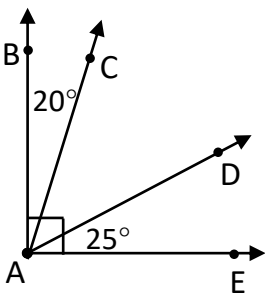
Since the problem tells you that the two angles are complementary, you know that together they add up to  $90^\circ$ . To get the measurement of  $\angle Y$ , subtract  $90 - 14 = 76$ .

**Answer: D.  $76^\circ$**

### Example 3

What is the measure of  $\angle CAD$  in the diagram below?

- A.  $70^\circ$       B.  $45^\circ$       C.  $90^\circ$       D.  $64^\circ$       E.  $41^\circ$



The diagram shows 3 adjacent angles:  $\angle BAC = 20^\circ$   
 $\angle CAD = ?$   
 $\angle DAE = 25^\circ$

The 3 angles are adjacent and together form right angle  $\angle BAE$ , so together they add up to  $90^\circ$ .

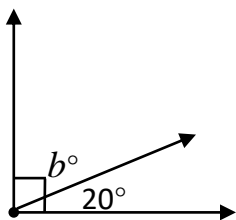
To get  $\angle CAD$  subtract  $90 - 20 - 25 = 45$ . **Answer: B.  $45^\circ$**



**Practice Two**    *Answers – p. 23*

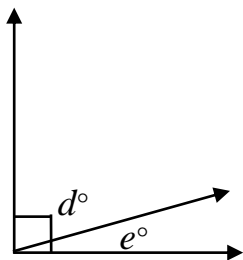
1. What is the value of  $b$  in the diagram below?

- A.  $90^\circ$       B.  $20^\circ$       C.  $70^\circ$       D.  $110^\circ$       E.  $25^\circ$



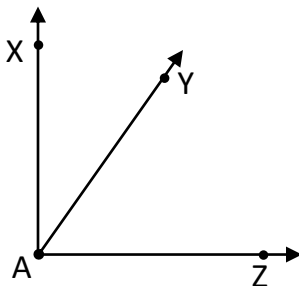
2. In the diagram below, what is the value of  $e$  if  $d = 74^\circ$ ?

- A.  $60^\circ$       B.  $90^\circ$       C.  $15^\circ$       D.  $45^\circ$       E.  $16^\circ$



3. If  $\angle XAZ$  is a right angle, and  $\angle YAZ$  measures  $51^\circ$ . What is the measure of  $\angle XAY$ ?

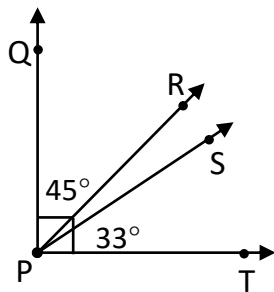
- A.  $110^\circ$       B.  $90^\circ$       C.  $39^\circ$       D.  $160^\circ$       E.  $75^\circ$



4. If two angles are complementary angles, and one of the angles measures  $71^\circ$ , what is the measurement of the other angle?

- A.  $20^\circ$       B.  $70^\circ$       C.  $90^\circ$       D.  $19^\circ$       E.  $21^\circ$

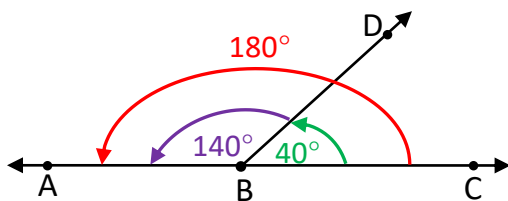
5. What is the measure of  $\angle RPS$  in the diagram below?
- A.  $45^\circ$       B.  $12^\circ$       C.  $90^\circ$       D.  $33^\circ$       E.  $78^\circ$



## 6. SUPPLEMENTARY ANGLES

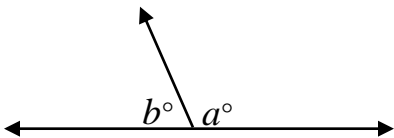
**Supplementary Angles** are two angles that together measure  $180^\circ$ . You can think of this as two angles that form a straight angle when put together.

In the diagram below,  $\angle CBD$  and  $\angle DBA$  lie along line AC. They are supplementary because together they form a straight angle,  $\angle CBA$ , which we know measures  $180^\circ$ .

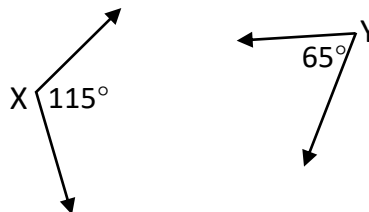


$\angle CBD = 40^\circ$ $\angle DBA = 140^\circ$ $\angle CBA = 180^\circ$
---

Angles  $a$  and  $b$  below are supplementary angles. Even though their degree measurements are not given, together they form a straight angle, which we know measures  $180^\circ$ .



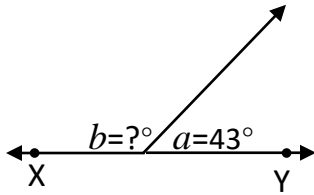
$\angle X$  and  $\angle Y$  below are supplementary angles because together they measure  $180^\circ$ . Angles do not have to be adjacent to be supplementary.



### Example 1

In the diagram below  $\overleftrightarrow{XY}$  is a straight line. What is the value of  $b$ ?

- A.  $47^\circ$       B.  $90^\circ$       C.  $180^\circ$       D.  $137^\circ$       E.  $43^\circ$

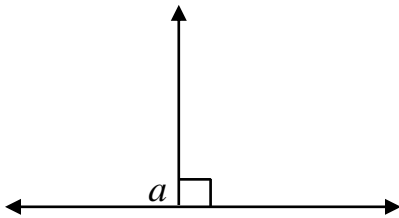


Angles  $a$  and  $b$  are supplementary angles because together they form a straight angle, which measures  $180^\circ$ .  
To get the measure of  $b$ , subtract the measure of  $a$  from  $180^\circ$ .  
 $180 - 43 = 137$     **Answer: D.  $137^\circ$**

### Example 2

What is the value of  $a$  in the diagram below?

- A.  $180^\circ$       B.  $90^\circ$       C.  $95^\circ$       D.  $45^\circ$       E.  $85^\circ$



The angle next to  $a$  is a  $90^\circ$  right angle. Together, both angles form a  $180^\circ$  straight angle.

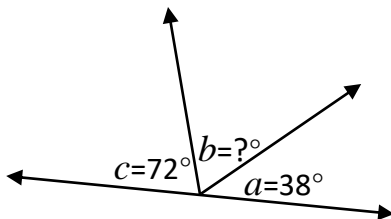
To get the measure of  $a$ , subtract  $180 - 90 = 90$ .

**Answer: B.  $90^\circ$**

### Example 3

In the diagram below angles  $a$ ,  $b$ , and  $c$  lie along a straight line. What is the value of  $b$ ?

- A.  $180^\circ$       B.  $90^\circ$       C.  $108^\circ$       D.  $142^\circ$       E.  $70^\circ$



The diagram shows 3 adjacent angles:  $a = 38^\circ$

$b = ?^\circ$

$c = 72^\circ$

The 3 angles are adjacent and together form a straight angle, so together they add up to  $180^\circ$ .

To get the value of  $b$  subtract  $180 - 38 - 72 = 70$ .

**Answer: E.  $70^\circ$**

**Example 4**

$\angle X$  and  $\angle Y$  are supplementary angles. If  $\angle X$  measures  $29^\circ$ , what is the measurement of  $\angle Y$ ?

- A.  $151^\circ$       B.  $61^\circ$       C.  $90^\circ$       D.  $29^\circ$       E.  $58^\circ$

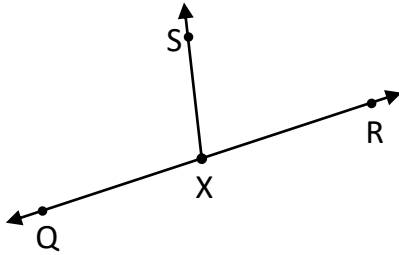
Since the problem tells you that the two angles are supplementary, you know that together they add up to  $180^\circ$ . To get the measurement of  $\angle Y$ , subtract  $180 - 29 = 151$ .

**Answer: A.  $151^\circ$**

**Practice Three**    *Answers – p. 24*

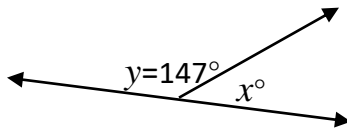
1. In the diagram below  $\overleftrightarrow{QR}$  is a straight line. If  $\angle QXS$  measures  $100^\circ$ , what is the measure of  $\angle RXS$ ?

- A.  $28^\circ$       B.  $62^\circ$       C.  $90^\circ$       D.  $80^\circ$       E.  $180^\circ$



2. In the diagram below,  $x$  and  $y$  lie along a straight line. What is the value of  $x$ ?

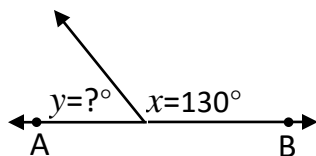
- A.  $33^\circ$       B.  $180^\circ$       C.  $90^\circ$       D.  $43^\circ$       E.  $30^\circ$



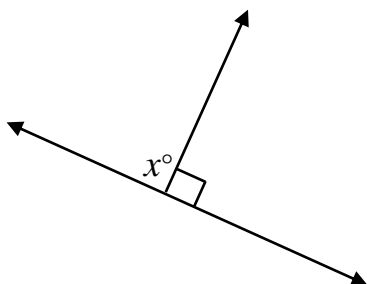
3. If two angles are supplementary and one of the angles measures  $171^\circ$ , what is the measurement of the other angle?

- A.  $9^\circ$       B.  $90^\circ$       C.  $180^\circ$       D.  $10^\circ$       E.  $8^\circ$

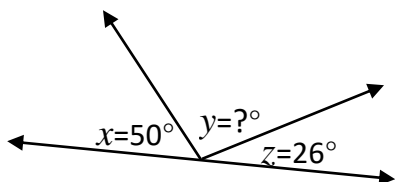
4. In the diagram below  $\overleftrightarrow{AB}$  is a straight line. What is the value of  $y$ ?
- A.  $40^\circ$       B.  $50^\circ$       C.  $180^\circ$       D.  $90^\circ$       E.  $60^\circ$



5. What is the value of  $x$  in the diagram below?
- A.  $180^\circ$       B.  $45^\circ$       C.  $95^\circ$       D.  $90^\circ$       E.  $85^\circ$



6. Angles  $x$ ,  $y$ , and  $z$  lie along a straight line in the diagram below. What is the value of  $y$ ?
- A.  $180^\circ$       B.  $130^\circ$       C.  $90^\circ$       D.  $154^\circ$       E.  $104^\circ$



## 7. OPPOSITE ANGLES

When two lines intersect, two pairs of **Opposite Angles**, also called **Vertical Angles** are formed. The two angles that are across from each other form each pair of opposite angles.

Look at the diagram below in Example 1.

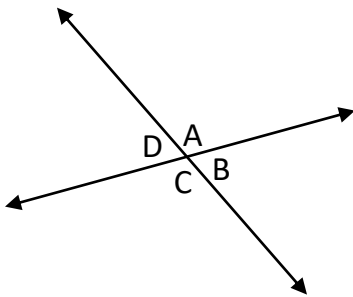
$\angle A$  and  $\angle C$  are across from each other and form one pair of opposite angles.

$\angle B$  and  $\angle D$  are across from each other form the other pair of opposite angles.

**Angles that are opposite from each other have equal measures.**

### Example 1

In the diagram of two intersecting lines below, the measure of  $\angle A = 120^\circ$ . What are the measures of  $\angle B$ ,  $\angle C$ , and  $\angle D$ ?



Angles that are opposite from each other are equal.

$$\angle A = \angle C$$

$$\angle B = \angle D$$

Angles that are next to each other form a straight angle, so together =  $180^\circ$ .

$$\angle A + \angle B = 180^\circ$$

$$\angle B + \angle C = 180^\circ$$

$$\angle C + \angle D = 180^\circ$$

$$\angle D + \angle A = 180^\circ$$

**$\angle C = 120^\circ$**   $\angle C$  is opposite from  $\angle A$ , so  $\angle C = \angle A$ . The problem tells us  $\angle A = 120^\circ$ , so  $\angle C$  is also equal to  $120^\circ$ .

**$\angle B = 60^\circ$**   $\angle B$  and  $\angle A$  together make up a straight angle which =  $180^\circ$ . To find  $\angle B$ , subtract the measure of  $\angle A$  from  $180^\circ$ .  $180^\circ - 120^\circ = 60^\circ$

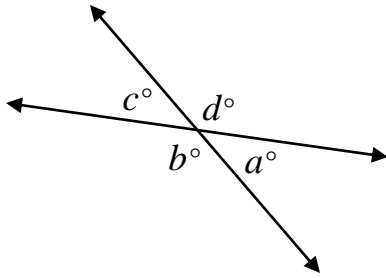
**$\angle D = 60^\circ$**   $\angle D$  is opposite from  $\angle B$ , so  $\angle D = \angle B$ .

Notice that to get the measure of the four angles formed by two intersecting lines, you only need the measure of one angle. Then, use the properties of vertical angles and supplementary angles to get the measurements of the other three angles.

**Example 2**

In the diagram of two intersecting lines below, what is the value of  $c + d$ ?

- A.  $180^\circ$       B.  $90^\circ$       C.  $100^\circ$       D.  $220^\circ$       E.  $45^\circ$



No angle measurements are given, so you can't calculate the value of  $c + d$ . But, you can see that  $c$  and  $d$  together make up a straight angle which  $= 180^\circ$ . So, the value of  $c + d = 180^\circ$ .

**Answer: A.  $180^\circ$**

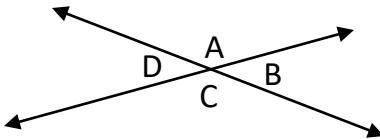
**Practice Four**

Answers – p. 26

1. In the diagram of two intersecting lines below, the measure of  $\angle B = 35^\circ$ .

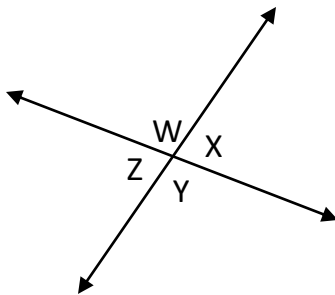
What is the measure of  $\angle D$ ?

- A.  $55^\circ$       B.  $70^\circ$       C.  $35^\circ$       D.  $180^\circ$       E.  $145^\circ$

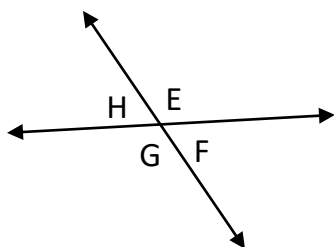


2. In the diagram below of two intersecting lines, what is the measure of  $\angle W$  if  $\angle X = 73^\circ$ ?

- A.  $107^\circ$       B.  $73^\circ$       C.  $17^\circ$       D.  $180^\circ$       E.  $90^\circ$



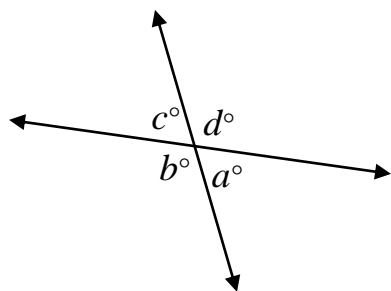
Questions 3 and 4 refer to the pair of intersecting lines in the diagram below.



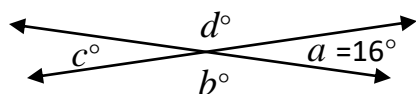
3.  $\angle H$  measures  $58^\circ$ . What is the measurement of  $\angle F$ ?  
 A.  $32^\circ$       B.  $122^\circ$       C.  $90^\circ$       D.  $180^\circ$       E.  $58^\circ$

4.  $\angle H$  measures  $58^\circ$ . What is the measurement of  $\angle E$ ?  
 A.  $70^\circ$       B.  $20^\circ$       C.  $180^\circ$       D.  $122^\circ$       E.  $105^\circ$

5. In the diagram of two intersecting lines below, what is the value of  $b + c$ ?  
 A.  $120^\circ$       B.  $60^\circ$       C.  $180^\circ$       D.  $90^\circ$       E.  $45^\circ$

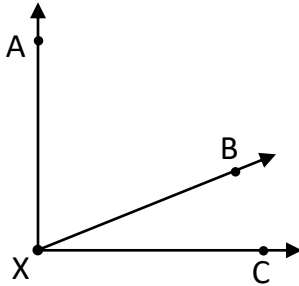


6. In the diagram of two intersecting lines below, what is the value of  $b + d$ ?  
 A.  $164^\circ$       B.  $328^\circ$       C.  $32^\circ$       D.  $180^\circ$       E.  $300^\circ$

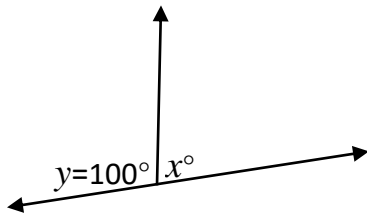




1.  $\angle AXC$  is a right angle, and  $\angle BXC$  measures  $20^\circ$ . What is the measure of  $\angle AXB$ ?
- A.  $110^\circ$       B.  $90^\circ$       C.  $70^\circ$       D.  $160^\circ$       E.  $75^\circ$

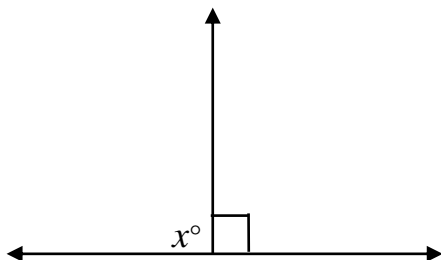


2. In the diagram below,  $x$  and  $y$  lie along a straight line. What is the value of  $x$ ?
- A.  $80^\circ$       B.  $180^\circ$       C.  $90^\circ$       D.  $100^\circ$       E.  $85^\circ$

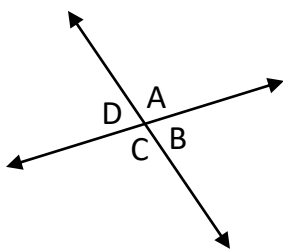


3.  $\angle A$  and  $\angle B$  are a pair of supplementary angles that are congruent. How many degrees does  $\angle A$  measure?
- A.  $180^\circ$       B.  $90^\circ$       C.  $60^\circ$       D.  $45^\circ$       E.  $25^\circ$

4. What is the value of  $x$  in the diagram below?
- A.  $30^\circ$       B.  $60^\circ$       C.  $90^\circ$       D.  $180^\circ$       E.  $300^\circ$



Questions 5 and 6 refer to the pair of intersecting lines in the diagram below.



5.  $\angle D$  measures  $70^\circ$ . What is the measurement of  $\angle B$ ?

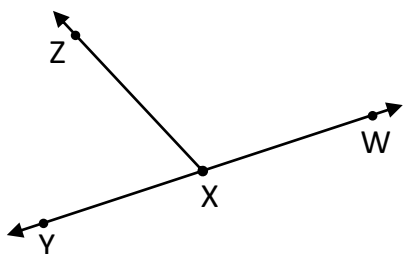
- A.  $20^\circ$       B.  $110^\circ$       C.  $140^\circ$       D.  $180^\circ$       E.  $70^\circ$

6.  $\angle D$  measures  $70^\circ$ . What is the measurement of  $\angle C$ ?

- A.  $70^\circ$       B.  $20^\circ$       C.  $110^\circ$       D.  $180^\circ$       E.  $105^\circ$

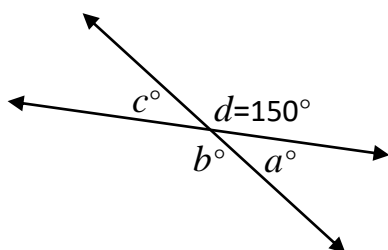
7. In the diagram below  $\overleftrightarrow{WY}$  is a straight line. If  $\angle YXZ$  measures  $62^\circ$ , what is the measure of  $\angle WXZ$ ?

- A.  $28^\circ$       B.  $62^\circ$       C.  $90^\circ$       D.  $118^\circ$       E.  $180^\circ$

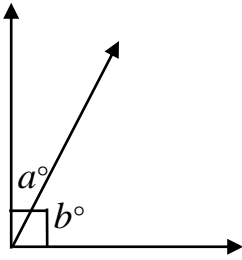


8. In the diagram below of two intersecting lines, what is the value of  $a + c$ ?

- A.  $30^\circ$       B.  $60^\circ$       C.  $90^\circ$       D.  $180^\circ$       E.  $300^\circ$



9. In the diagram below, what is the value of  $a$  if  $b = 60^\circ$ ?
- A.  $60^\circ$       B.  $90^\circ$       C.  $180^\circ$       D.  $45^\circ$       E.  $30^\circ$

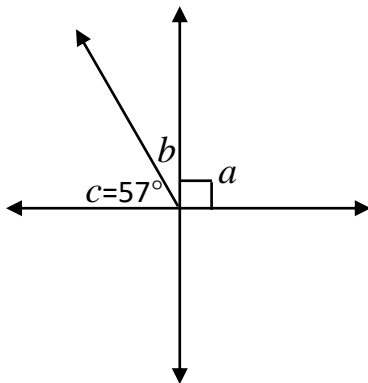


10.  $\angle X$  and  $\angle Y$  are supplementary angles. If  $\angle X$  measures  $142^\circ$ , what is the measurement of  $\angle Y$ ?

A.  $180^\circ$       B.  $28^\circ$       C.  $38^\circ$       D.  $76^\circ$       E.  $241^\circ$

11. What is the measure of  $b$  in the diagram below?

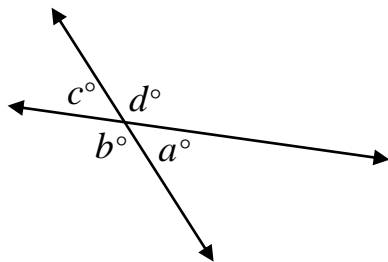
A.  $123^\circ$       B.  $90^\circ$       C.  $57^\circ$       D.  $33^\circ$       E.  $180^\circ$



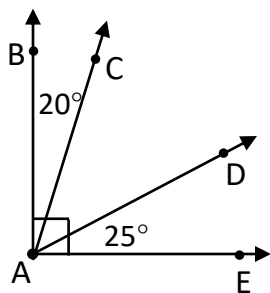
12.  $\angle A$  and  $\angle B$  are a pair of complementary angles that are congruent. How many degrees does  $\angle A$  measure?

A.  $90^\circ$       B.  $180^\circ$       C.  $45^\circ$       D.  $50^\circ$       E.  $54^\circ$

13. In the diagram of two intersecting lines below, what is the value of  $a + b + c + d$ ?
- A.  $360^\circ$       B.  $60^\circ$       C.  $90^\circ$       D.  $180^\circ$       E.  $300^\circ$



14. What is the measure of  $\angle BAD$  in the diagram below?
- A.  $70^\circ$       B.  $45^\circ$       C.  $90^\circ$       D.  $65^\circ$       E.  $41^\circ$



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## ANSWER KEY Lesson 1 Angles

### **Practice One**

1. Choose one of the following labels for each diagram below and write it on the blank line next to the diagram.

Ray

Line Segment

Intersecting Lines

Parallel Lines

Vertical Line

Horizontal Line



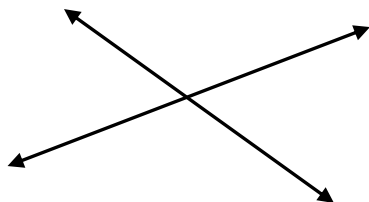
Horizontal Line



Vertical Line



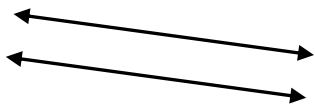
Line Segment



Intersecting Lines



Ray

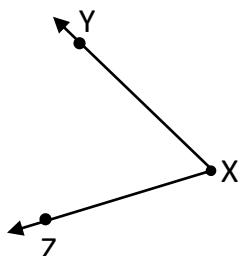


Parallel Lines

2. Which of the choices correctly names the angle below? Write Yes on the line next to the correct names, and write No if the name is not correct.

The angle can be named by the vertex point alone:  $\angle X$ .

The angle can also be named by all 3 points, but only if the vertex point is in the middle:  $\angle ZXY$ ,  $\angle YXZ$ .



$\angle X$  Yes

$\angle ZXY$  Yes

$\angle Y$  No

$\angle XYZ$  No

$\angle Z$  No

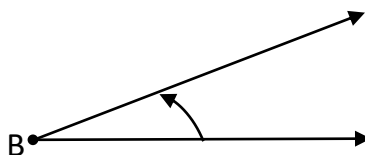
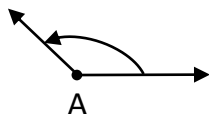
$\angle YZX$  No

$\angle XZY$  No

$\angle YXZ$  Yes

3. Which of the angles below is larger,  $\angle A$  or  $\angle B$ ?  $\angle A$

$\angle A$  is larger because it has a larger opening between the rays.



4.  $\angle X$  is an acute angle. Which of the degree measurements below could possibly be the measure of  $\angle X$ ? Write Yes or No on the line next to each measurement.

An acute angle must measure less than  $90^\circ$ .

$45^\circ$  Yes

$35^\circ$  Yes

$90^\circ$  No

$89^\circ$  Yes

$12^\circ$  Yes

$150^\circ$  No

5. What type of angle is pictured below? Right Angle

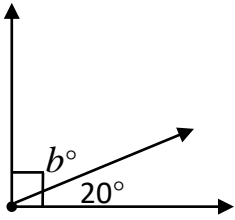
How many degrees does it measure?  $90^\circ$



### Practice Two

1. What is the value of  $b$  in the diagram below?

- A.  $90^\circ$       B.  $20^\circ$       **C.  $70^\circ$**       D.  $110^\circ$       E.  $25^\circ$

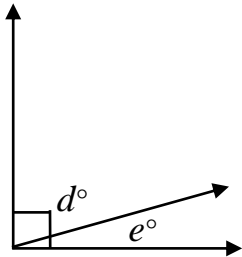


The  $20^\circ$  angle and the  $b^\circ$  angle together measure  $90^\circ$  because together they form a right angle. We know this because the box symbol means it is a right angle. To get  $b$ , subtract  $90 - 20 = 70$ .

**Answer: C.  $70^\circ$**

2. In the diagram below, what is the value of  $e$  if  $d = 74^\circ$ ?

- A.  $60^\circ$       B.  $90^\circ$       C.  $15^\circ$       D.  $45^\circ$       **E.  $16^\circ$**



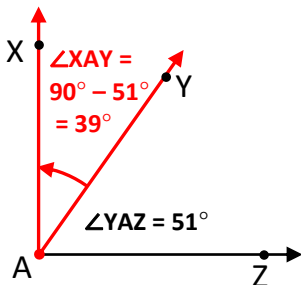
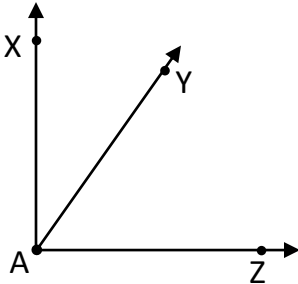
The box at the vertex tells us that together angles  $d$  and  $e$  form a right angle, so together the two angles measure  $90^\circ$ .

To get  $e$ , subtract  $90 - 74 = 16$ .

**Answer: E.  $16^\circ$**

3. If  $\angle XAZ$  is a right angle, and  $\angle YAZ$  measures  $51^\circ$ . What is the measure of  $\angle XAY$ ?

- A.  $110^\circ$       B.  $90^\circ$       **C.  $39^\circ$**       D.  $160^\circ$       E.  $75^\circ$



$\angle XAY$  and  $\angle YAZ$  are adjacent angles that form a right angle, so together they measure  $90^\circ$ . To get the measure of  $\angle XAY$ , subtract  $90 - 51 = 39$ .

**Answer: C.  $39^\circ$**

4. If two angles are complementary angles, and one of the angles measures  $71^\circ$ , what is the measurement of the other angle?

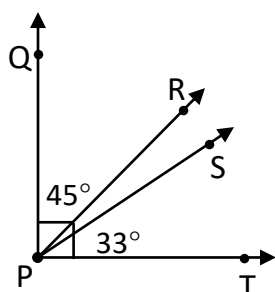
- A.  $20^\circ$       B.  $70^\circ$       C.  $90^\circ$       **D.  $19^\circ$**       E.  $21^\circ$

Since the problem tells you that the two angles are complementary, you know that together they add up to  $90^\circ$ . To get the measurement of the unknown angle, subtract  $90 - 71 = 19$ .

**Answer: D.  $19^\circ$**

5. What is the measure of  $\angle RPS$  in the diagram below?

- A.  $45^\circ$       **B.  $12^\circ$**       C.  $90^\circ$       D.  $33^\circ$       E.  $78^\circ$



The diagram shows 3 adjacent angles:  $\angle QPR = 45^\circ$

$\angle RPS = ?$

$\angle SPT = 33^\circ$

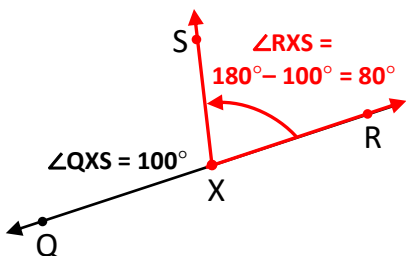
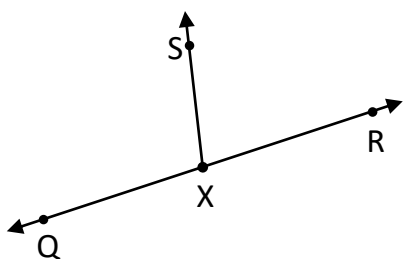
The 3 angles are adjacent and together form right angle  $\angle QPT$ , so together they add up to  $90^\circ$ .

To get  $\angle RPS$  subtract  $90 - 45 - 33 = 12$ . **Answer: B.  $12^\circ$**

### Practice Three

1. In the diagram below  $\overleftrightarrow{QR}$  is a straight line. If  $\angle QXS$  measures  $100^\circ$ , what is the measure of  $\angle RXS$ ?

- A.  $28^\circ$       B.  $62^\circ$       C.  $90^\circ$       **D.  $80^\circ$**       E.  $180^\circ$



$\angle QXS$  and  $\angle RXS$  together form a straight angle which measures  $180^\circ$ .

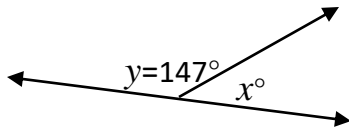
To get the value of  $\angle RXS$ , subtract  $100^\circ$  from  $180^\circ$ .

$180 - 100 = 80$  **Answer: D.  $80^\circ$**



2. In the diagram below,  $x$  and  $y$  lie along a straight line. What is the value of  $x$ ?

- A.  $33^\circ$       B.  $180^\circ$       C.  $90^\circ$       D.  $43^\circ$       E.  $30^\circ$



Angles  $x$  and  $y$  together form a straight angle which measures  $180^\circ$ .

To get the value of  $x$ , subtract  $y$  from  $180^\circ$ .

$$180 - 147 = 33 \quad \text{Answer: A. } 33^\circ$$

3. If two angles are supplementary and one of the angles measures  $171^\circ$ , what is the measurement of the other angle?

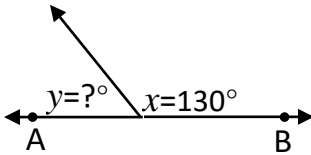
- A.  $9^\circ$       B.  $90^\circ$       C.  $180^\circ$       D.  $10^\circ$       E.  $8^\circ$

Since the problem tells you that the two angles are supplementary, you know that together they add up to  $180^\circ$ . To get the measurement of the unknown angle subtract  $180 - 171 = 9$ .

**Answer: A.  $9^\circ$**

4. In the diagram below  $\overleftrightarrow{AB}$  is a straight line. What is the value of  $y$ ?

- A.  $40^\circ$       **B.  $50^\circ$**       C.  $180^\circ$       D.  $90^\circ$       E.  $60^\circ$



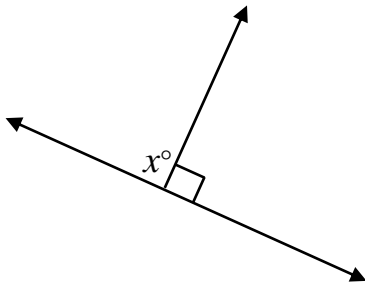
Angles  $x$  and  $y$  are supplementary angles because together they form a straight angle, which measures  $180^\circ$ .

To get the measure of  $y$ , subtract the measure of  $x$  from  $180^\circ$ .

$$180 - 130 = 50 \quad \text{Answer: B. } 50^\circ$$

5. What is the value of  $x$  in the diagram below?

- A.  $180^\circ$       B.  $45^\circ$       C.  $95^\circ$       **D.  $90^\circ$**       E.  $85^\circ$



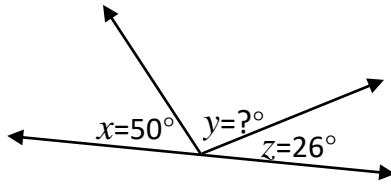
The angle next to  $x$  is a  $90^\circ$  right angle. Together, both angles form a  $180^\circ$  straight angle.

To get the measure of  $x$ , subtract  $180 - 90 = 90$ .

**Answer: D.  $90^\circ$**

6. Angles  $x$ ,  $y$ , and  $z$  lie along a straight line in the diagram below. What is the value of  $y$ ?

- A.  $180^\circ$       B.  $130^\circ$       C.  $90^\circ$       D.  $154^\circ$       **E.  $104^\circ$**



The diagram shows 3 adjacent angles:  $x = 50^\circ$

$$y = ?^\circ$$

$$z = 26^\circ$$

The 3 angles are adjacent and together form a straight angle, so together they add up to  $180^\circ$ .

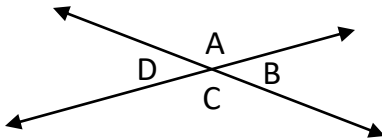
To get the value of  $y$  subtract  $180 - 50 - 26 = 104$ .

**Answer: E.  $104^\circ$**

#### Practice Four

1. In the diagram of two intersecting lines below, the measure of  $\angle B = 35^\circ$ . What is the measure of  $\angle D$ ?

- A.  $55^\circ$       B.  $70^\circ$       **C.  $35^\circ$**       D.  $180^\circ$       E.  $145^\circ$

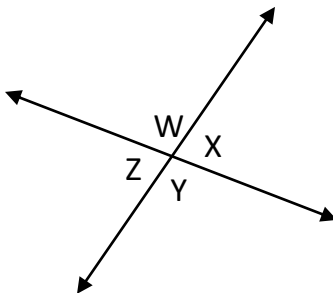


$\angle B = \angle D$  because they are opposite angles, so  $\angle D = 35^\circ$ .

**Answer: C.  $35^\circ$**

2. In the diagram below of two intersecting lines, what is the measure of  $\angle W$  if  $\angle X = 73^\circ$ ?

- A.  $107^\circ$**       B.  $73^\circ$       C.  $17^\circ$       D.  $180^\circ$       E.  $90^\circ$



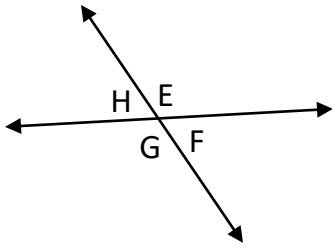
$\angle W$  and  $\angle X$  lie next to each other along a straight line, so together =  $180^\circ$ .

Subtract the measure of  $\angle X$  from 180 to get the measure of  $\angle W$ .

$$180 - 73 = 107$$

**Answer: A.  $107^\circ$**

Questions 3 and 4 refer to the pair of intersecting lines in the diagram below.



3.  $\angle H$  measures  $58^\circ$ . What is the measurement of  $\angle F$ ?

- A.  $32^\circ$       B.  $122^\circ$       C.  $90^\circ$       D.  $180^\circ$       **E.  $58^\circ$**

$\angle H$  and  $\angle F$  are opposite angles, so  $\angle H = \angle F$ .

**Answer: E.  $58^\circ$**

4.  $\angle H$  measures  $58^\circ$ . What is the measurement of  $\angle E$ ?

- A.  $70^\circ$       B.  $20^\circ$       C.  $180^\circ$       **D.  $122^\circ$**       E.  $105^\circ$

$\angle H$  and  $\angle E$  together form a straight angle, which measures  $180^\circ$ .

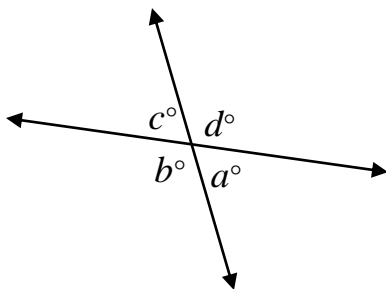
To get the measurement of  $\angle E$ , subtract the measure of  $\angle H$  from  $180^\circ$ .

$$180 - 58 = 122$$

**Answer: D.  $122^\circ$**

5. In the diagram of two intersecting lines below, what is the value of  $b + c$ ?

- A.  $120^\circ$       B.  $60^\circ$       **C.  $180^\circ$**       D.  $90^\circ$       E.  $45^\circ$

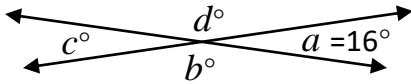


No angle measurements are given, so you can't calculate the value of  $b + c$ . But, you can see that  $b$  and  $c$  together make up a straight angle which  $= 180^\circ$ . So, the value of  $b + c = 180^\circ$ .

**Answer: C.  $180^\circ$**

6. In the diagram of two intersecting lines below, what is the value of  $b + d$ ?

- A.  $164^\circ$       **B.  $328^\circ$**       C.  $32^\circ$       D.  $180^\circ$       E.  $300^\circ$



**First**, get the measure of  $d$ .

$a + d$  are supplementary, so together  $= 180^\circ$ .

To get  $d$ , subtract  $180 - 16 = 164$ .

$$d = 164^\circ$$

**Next**, get the measure of  $b$ .

$b$  and  $d$  are opposite angles, so they are equal.

$$b = 164^\circ$$

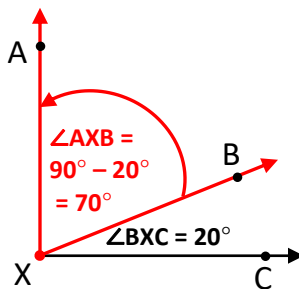
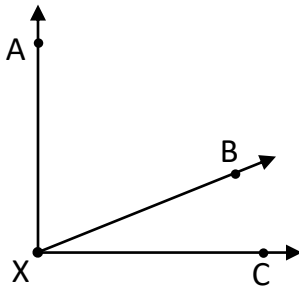
$$b + d = 164^\circ + 164^\circ = 328^\circ$$

**Answer: B.  $328^\circ$**

### Practice Five – Mixed Practice

1.  $\angle AXC$  is a right angle, and  $\angle BXC$  measures  $20^\circ$ . What is the measure of  $\angle AXB$ ?

- A.  $110^\circ$       B.  $90^\circ$       **C.  $70^\circ$**       D.  $160^\circ$       E.  $75^\circ$

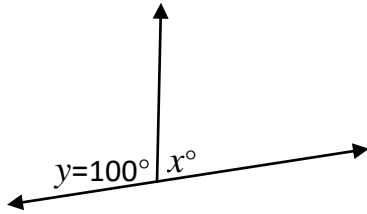


$\angle BXC$  and  $\angle AXB$  are adjacent angles that form a right angle, so together they measure  $90^\circ$ . To get the measure of  $\angle AXB$ , subtract  $90 - 20 = 70$ .

**Answer: C.  $70^\circ$**

2. In the diagram below,  $x$  and  $y$  lie along a straight line. What is the value of  $x$ ?

- A.  $80^\circ$       B.  $180^\circ$       C.  $90^\circ$       D.  $100^\circ$       E.  $85^\circ$



Angles  $x$  and  $y$  together form a straight angle which measures  $180^\circ$ .

To get the value of  $x$ , subtract  $y$  from  $180^\circ$ .

$$180 - 100 = 80 \quad \textbf{Answer: A. } 80^\circ$$

3.  $\angle A$  and  $\angle B$  are a pair of supplementary angles that are congruent. How many degrees does  $\angle A$  measure?

- A.  $180^\circ$       **B.  $90^\circ$**       C.  $60^\circ$       D.  $45^\circ$       E.  $25^\circ$

Since the problem tells you that the two angles are supplementary, you know that  $\angle A + \angle B = 180^\circ$ .

You also know that  $\angle A$  and  $\angle B$  are congruent, which means they are equal and must have the same degree measure.

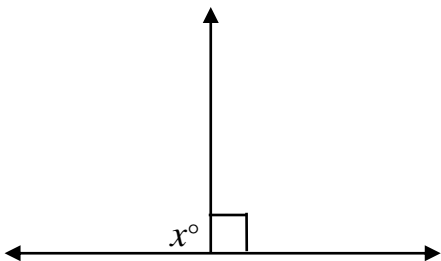
Divide total degrees into two equal parts to get the measure of each angle.

$$180 \div 2 = 90$$

**Answer: B.  $90^\circ$**

4. What is the value of  $x$  in the diagram below?

- A.  $30^\circ$       B.  $60^\circ$       **C.  $90^\circ$**       D.  $180^\circ$       E.  $300^\circ$



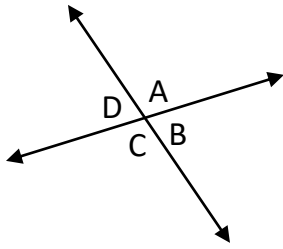
$x$  and the  $90^\circ$  right angle are supplementary, so together =  $180^\circ$ .

To get  $x$ , subtract the right angle from  $180$ .

$$180 - 90 = 90$$

**Answer: C.  $90^\circ$**

Questions 5 and 6 refer to the pair of intersecting lines in the diagram below.



5.  $\angle D$  measures  $70^\circ$ . What is the measurement of  $\angle B$ ?

- A.  $20^\circ$       B.  $110^\circ$       C.  $140^\circ$       D.  $180^\circ$       **E.  $70^\circ$**

$\angle D$  and  $\angle B$  are opposite angles, so  $\angle D = \angle B$ .

**Answer: E.  $70^\circ$**

6.  $\angle D$  measures  $70^\circ$ . What is the measurement of  $\angle C$ ?

- A.  $70^\circ$       B.  $20^\circ$       **C.  $110^\circ$**       D.  $180^\circ$       E.  $105^\circ$

$\angle D$  and  $\angle C$  together form a straight angle, which measures  $180^\circ$ .

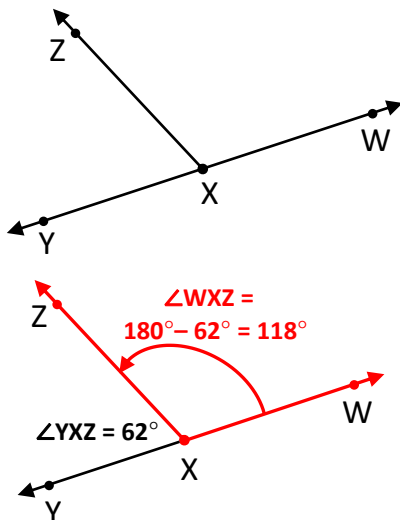
To get the measurement of  $\angle C$ , subtract the measure of  $\angle D$  from  $180^\circ$ .

$$180 - 70 = 110$$

**Answer: C.  $110^\circ$**

7. In the diagram below  $\overleftrightarrow{WY}$  is a straight line. If  $\angle YXZ$  measures  $62^\circ$ , what is the measure of  $\angle WXZ$ ?

- A.  $28^\circ$       B.  $62^\circ$       C.  $90^\circ$       **D.  $118^\circ$**       E.  $180^\circ$



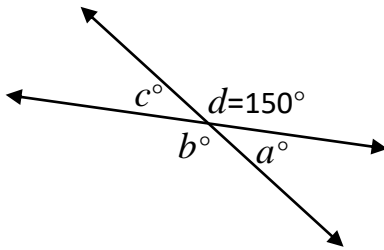
$\angle YXZ$  and  $\angle WXZ$  together form a straight angle which measures  $180^\circ$ .

To get the value of  $\angle WXZ$ , subtract  $62^\circ$  from  $180^\circ$ .

$$180 - 62 = 118 \quad \textbf{Answer: D.  $118^\circ$ }$$

8. In the diagram below of two intersecting lines, what is the value of  $a + c$ ?

- A.  $30^\circ$       **B.  $60^\circ$**       C.  $90^\circ$       D.  $180^\circ$       E.  $300^\circ$



**First**, get the measure of  $c$ .

$c + d$  are supplementary, so together =  $180^\circ$ .

To get  $c$ , subtract  $180 - 150 = 30$ .

$$c = 30^\circ$$

**Next**, get the measure of  $a$ .

$a$  and  $c$  are opposite angles, so they are equal.

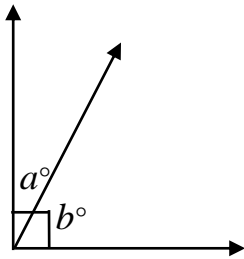
$$a = 30^\circ$$

$$a + c = 30^\circ + 30^\circ = 60^\circ$$

**Answer: B.  $60^\circ$**

9. In the diagram below, what is the value of  $a$  if  $b = 60^\circ$ ?

- A.  $60^\circ$       B.  $90^\circ$       C.  $180^\circ$       D.  $45^\circ$       **E.  $30^\circ$**



The box at the vertex tells us that together angles  $a$  and  $b$  form a right angle, so together the two angles measure  $90^\circ$ .

To get  $a$ , subtract  $90 - 60 = 30$ .

**Answer: E.  $30^\circ$**

10.  $\angle X$  and  $\angle Y$  are supplementary angles. If  $\angle X$  measures  $142^\circ$ , what is the measurement of  $\angle Y$ ?

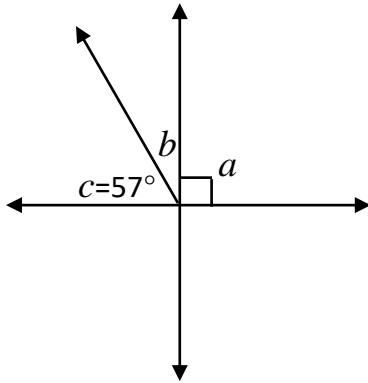
- A.  $180^\circ$       B.  $28^\circ$       **C.  $38^\circ$**       D.  $76^\circ$       E.  $241^\circ$

Since the problem tells you that the two angles are supplementary, you know that together they add up to  $180^\circ$ . To get the measurement of  $\angle Y$ , subtract  $180 - 142 = 38$ .

**Answer: C.  $38^\circ$**

11. What is the measure of  $b$  in the diagram below?

- A.  $123^\circ$       B.  $90^\circ$       C.  $57^\circ$       **D.  $33^\circ$**       E.  $180^\circ$



The diagram shows 3 adjacent angles:  $a = 90^\circ$

$$b = ?^\circ$$

$$c = 57^\circ$$

The 3 angles are adjacent and together form a straight angle, so together they add up to  $180^\circ$ .

To get the value of  $b$  subtract  $180 - 90 - 57 = 33$ .

**Answer: D.  $33^\circ$**

**OR**

Notice that  $b$  and  $c$  together =  $90^\circ$ .

To get the value of  $b$ , subtract  $90 - 57 = 33$ .

12.  $\angle A$  and  $\angle B$  are a pair of complementary angles that are congruent. How many degrees does  $\angle A$  measure?

- A.  $90^\circ$       B.  $180^\circ$       **C.  $45^\circ$**       D.  $50^\circ$       E.  $54^\circ$

Since the problem tells you that the two angles are complementary, you know that  $\angle A + \angle B = 90^\circ$ .

You also know that  $\angle A$  and  $\angle B$  are congruent, which means they are equal and must have the same degree measure.

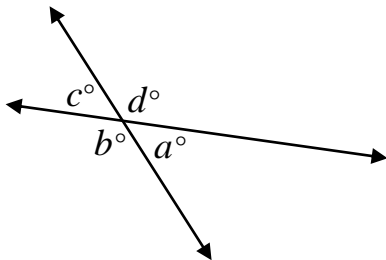
Divide total degrees into two equal parts to get the measure of each angle.

$$90 \div 2 = 45$$

**Answer: C.  $45^\circ$**

13. In the diagram of two intersecting lines below, what is the value of  $a + b + c + d$ ?

- A.  $360^\circ$**       B.  $60^\circ$       C.  $90^\circ$       D.  $180^\circ$       E.  $300^\circ$



$c + d$  are supplementary, so together =  $180^\circ$ .

$a + b$  are supplementary, so together =  $180^\circ$ .

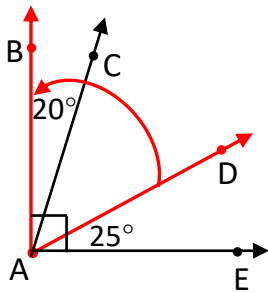
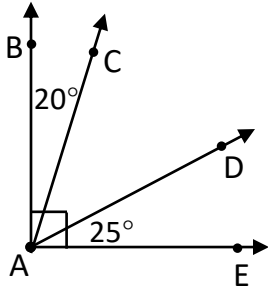
$$a + b + c + d = 180^\circ + 180^\circ = 360^\circ$$

**Answer: A.  $360^\circ$**



14. What is the measure of  $\angle BAD$  in the diagram below?

- A.  $70^\circ$       B.  $45^\circ$       C.  $90^\circ$       **D.  $65^\circ$**       E.  $41^\circ$



The question asks for  $\angle BAD$ , shown in red.

$\angle BAD + \angle DAE$  together equal  $90^\circ$ .

To get  $\angle BAD$ , subtract  $90 - 25 = 65$ .

**Answer: D.  $65^\circ$**

**Careful**

It is easy to look at this problem too quickly and assume that the question is asking for the value of the middle angle,  $\angle CAD$ .