

Student Name

Mathematics Stage 4

ANGLE RELATIONSHIPS

Book 2 Identify geometrical properties of
angles at a point

Version: 260207
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OVERVIEW

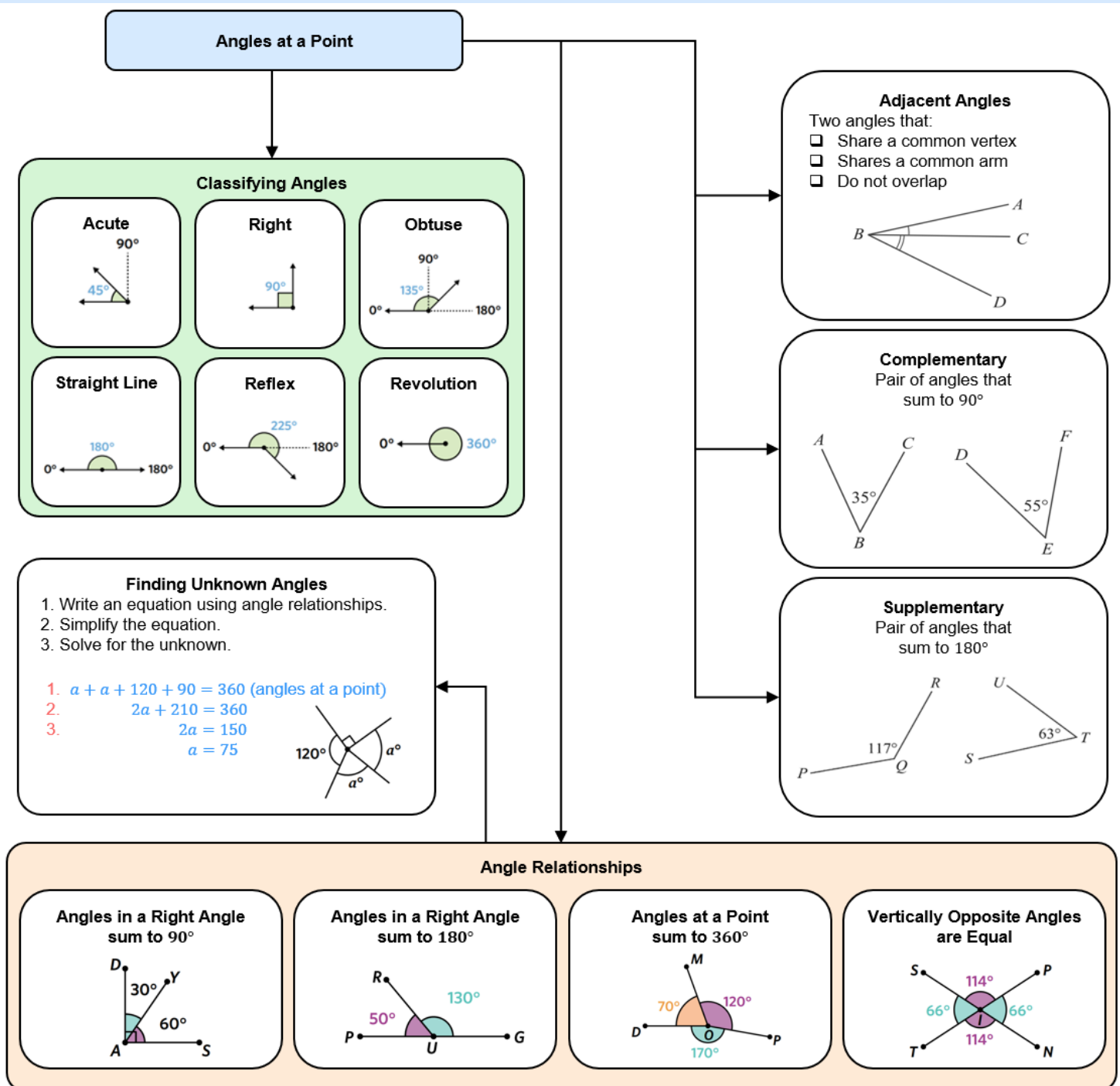
SYLLABUS CONTENT

MA4-ANG-C-01 applies angle relationships to solve problems, including those related to transversals on sets of parallel lines

Identify geometrical properties of angles at a point

- Identify right angles, straight angles, angles of complete revolution and vertically opposite angles
- Apply the terms complementary and supplementary to a pair of angles adding to 90° and 180° , respectively
- Apply the term adjacent angles to a pair of angles with a common arm and common vertex

SUMMARY



PRIOR KNOWLEDGE CHECK

1 Work out the following:

a $360 - 140$

b $360 - (80 + 60)$

c $360 - 149$

2 Find the value of x .

a $60 + x = 90$

b $x + 25 = 90$

c $90 = x + 86$

d $66 + x = 90$

e $23 + x = 90$

f $90 = x + 38$

g $162 + x = 180$

h $180 = x + 177$

i $x + 161 = 180$

j $94 + x = 180$

k $180 = 68 + x$

l $x + 154 = 180$

3 Solve these equations.

a $a + 150 = 360$

b $f + 180 = 360$

c $222 + e = 360$

d $136 + 90 + b = 360$

e $4x = 360$

f $6x = 360$

4 Solve these equations.

a $2x + 140 = 360$

b $2x + 50 + 60 = 360$

c $2x + 90 + 110 = 360$

d $x + x + 120 = 360$

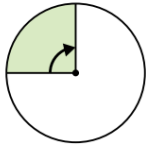
e $3x + 60 = 360$

f $2x + x + 30 = 360$

MEASURING ANGLES

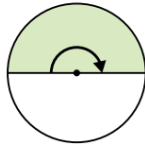
- An **angle** is a measure of turn from one arm to another.

Angles as Measure of Turn: <https://www.geogebra.org/m/e9zbuqwk>



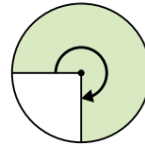
One quarter of a turn.

$$\frac{1}{4} \times 360^\circ = 90^\circ$$



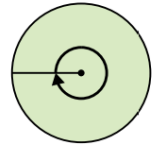
One half of a turn.

$$\frac{1}{2} \times 360^\circ = 180^\circ$$



Three quarters of a turn.

$$\frac{3}{4} \times 360^\circ = 270^\circ$$

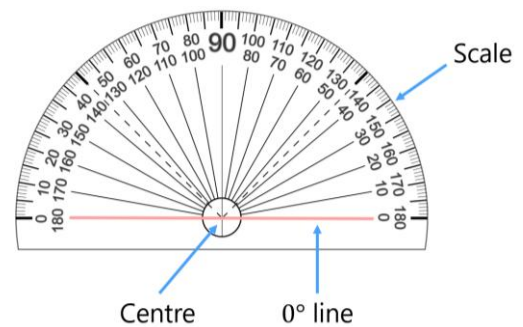


One full turn.

$$1 \times 360^\circ = 360^\circ$$

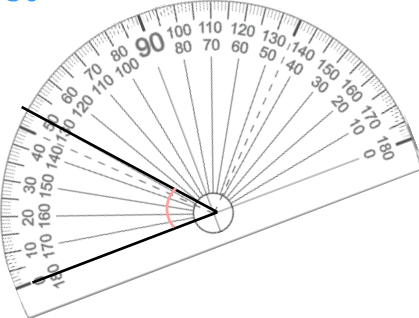
- Measuring angles with a **protractor**.

- Align the protractor's centre with the angle's vertex.
- Match one arm to the 0° line.
- Read where the other arm crosses the scale.

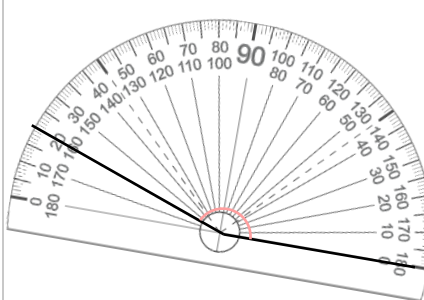


Example Measure angles using a protractor.

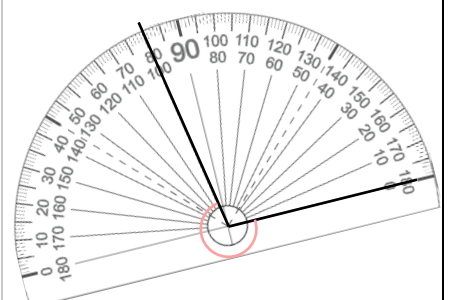
50°



150°



$360 - 110^\circ = 250^\circ$



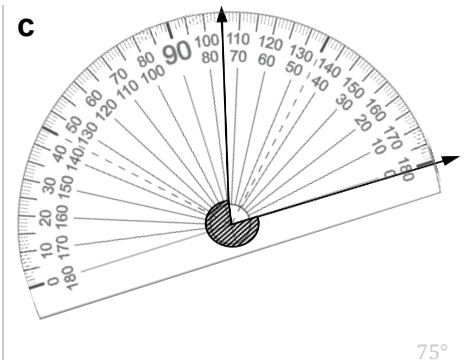
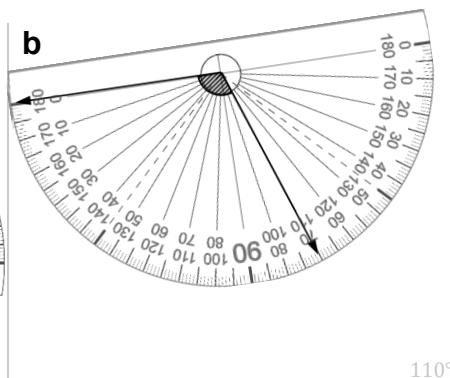
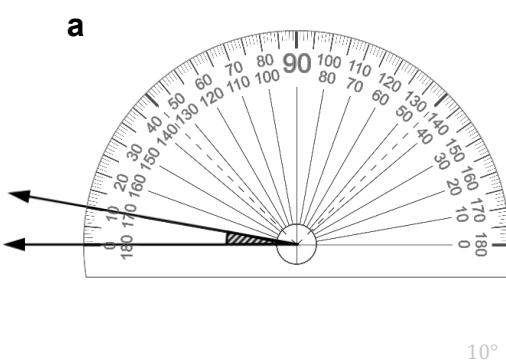
How do we know whether to read the inside number or outside number of a protractor?

We always start measuring from

How do we measure an angle greater than 180°?

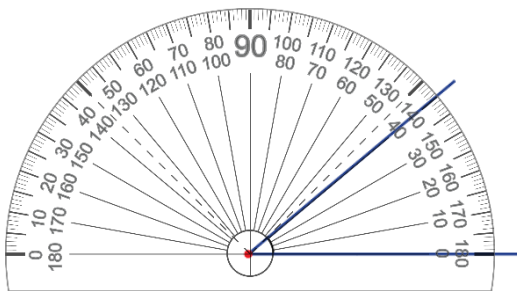
We measure the part of the angle that is less than 180°, then subtract the result from

Measure these angles.



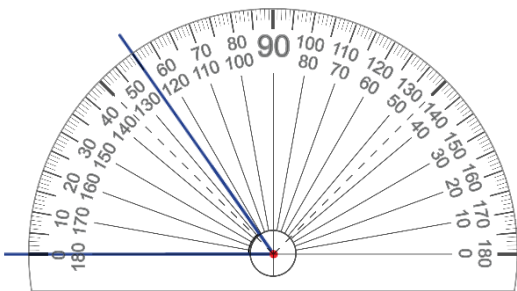
1 Measure these angles.

a



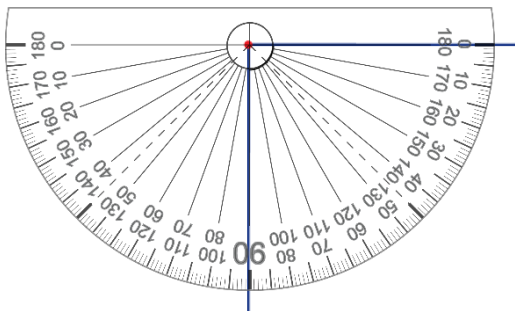
40°

b



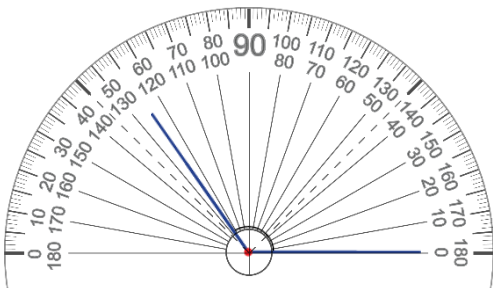
55°

c



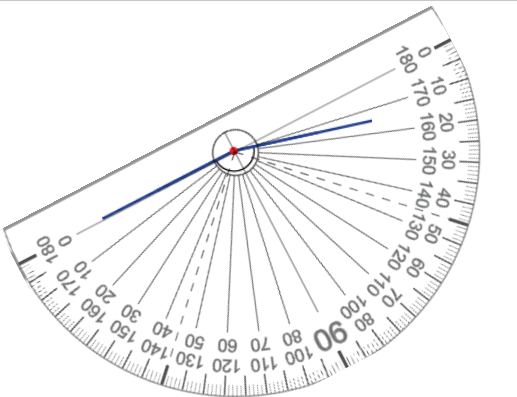
90°

d



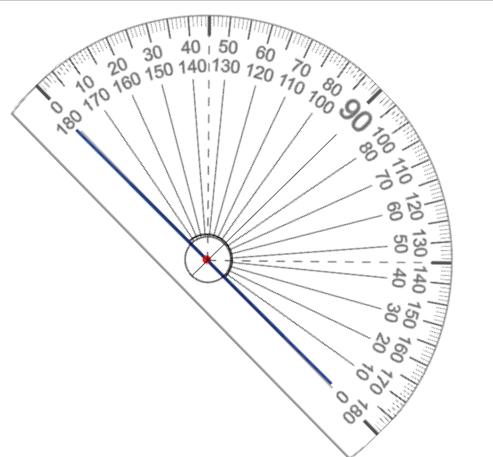
125°

e



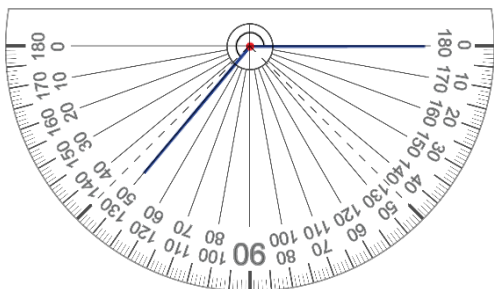
165°

f



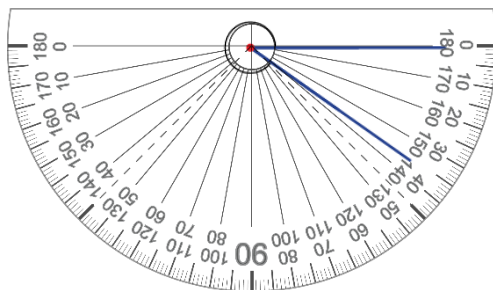
180°

g



130°

h



35°

- 2 Benji thinks that the angle between the hands of a clock at 6:30 pm is 0°. Explain why Benji is wrong and find the correct angle.



The hour hand is not at 6 when it is 6:30.

The two hands are $\frac{1}{24}$ th of a revolution apart, so $\frac{360}{24} = 15^\circ$

Find a time when the angle between the hands of the clock is

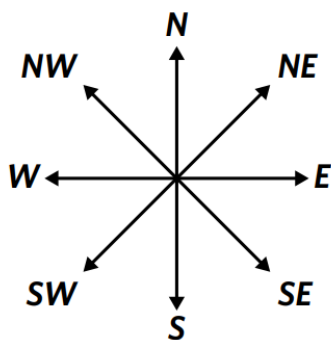
- a 0°
- b 180°
- c 90°

12:00

6:00

9:00 and 3:00

- 3 Arthur is navigating using a compass. Which direction is he facing when:



- a He starts at north and turns clockwise 90°
- b He then turns clockwise another 45°
- c He turns anticlockwise 135°
- d He turns anticlockwise 270°

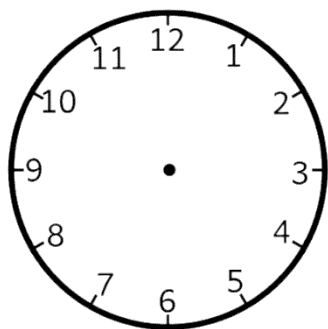
E

SE

N

E

- 4 A clock face is shown. Determine the angle the minute hand turns in:



- a 1 hour
- b 45 minutes
- c 20 minutes
- d 1 minute

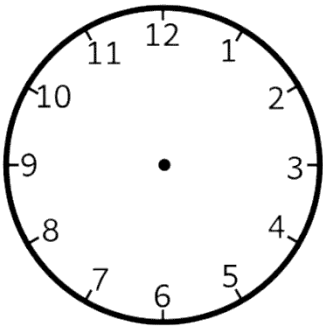
360°

270°

120°

6°

5 Determine the angle between the minute hand and hour hand at:



a 6:00 pm

180°

b 11:00 pm

30°

c 4:00 am

120°

d 3:30 pm

75°

6 How many degrees does the hour hand of a clock turn in:

a 12 hours?

360°

b 24 hours?

720°

c 6 hours?

180°

d 1 hour?

30°

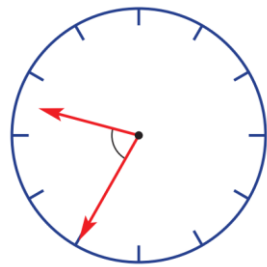
e 30 minutes?

15°

f 1 minute?

0.5°

7 The angle between the two hands of a clock at 9:35 a.m. is 77.5°
Explain why. (hint: how much does the hour hand move in 5 minutes?)



Minute hand is at position $(180 + 30) = 210^\circ$
Hour hand is at position $(270 + 35 \times 0.5) = 287.5^\circ$
The difference between the two hands is 77.5°

8 Determine the angle between the hour hand and minute hand of a clock at

a 10:10 am

115°

b 4:45 am

127.5°

c 7:15 am

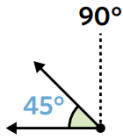
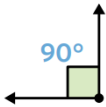
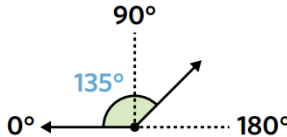
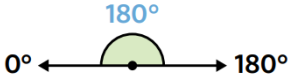
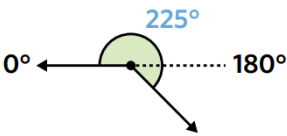
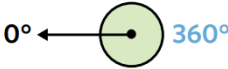
127.5°

d 2:35 p.m

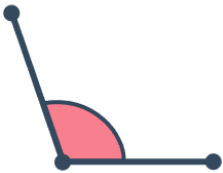
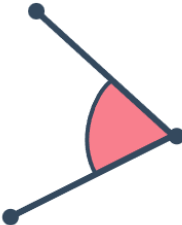
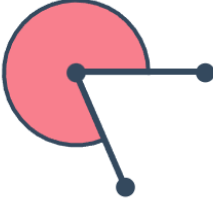
132.5°

CLASSIFYING ANGLES

Types of Angles: <https://www.geogebra.org/m/jx4defks>

Acute angle $0^\circ < \theta < 90^\circ$ 	Right angle $\theta = 90^\circ$ 	Obtuse angle $90^\circ < \theta < 180^\circ$ 
Straight line $\theta = 180^\circ$ 	Reflex angle $180^\circ < \theta < 360^\circ$ 	Full turn, or revolution $\theta = 360^\circ$ 

Example Classify angles.

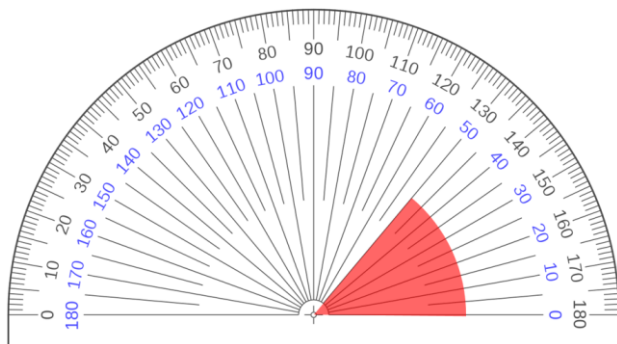
a 	b 	c 	d 
e 	f 	g 	h 

Key ideas

1. The unit used to measure angles is
2. A full turn is degrees.
3. Acute angles are between and
4. A right angle is exactly
5. Obtuse angles are between and
6. A straight line is exactly
7. Reflex angles are between and

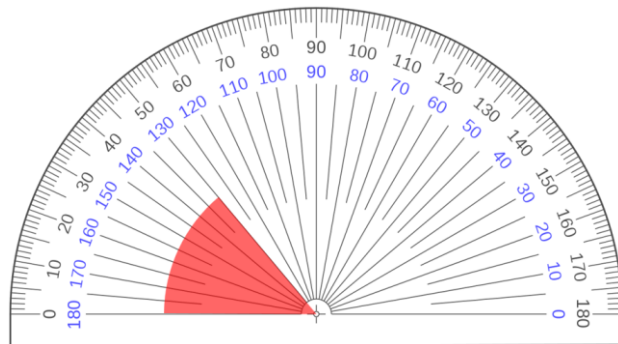
1 Measure and classify these angles.

a Size: Classification:



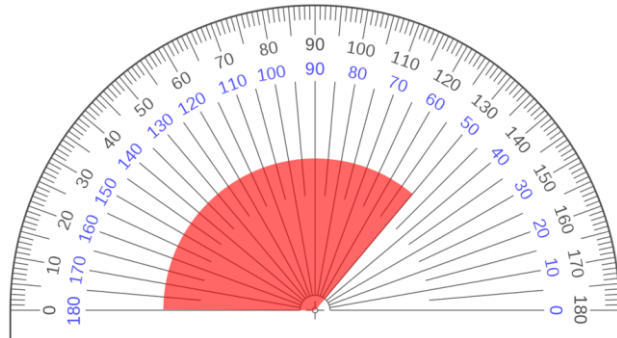
50° acute

b Size: Classification:



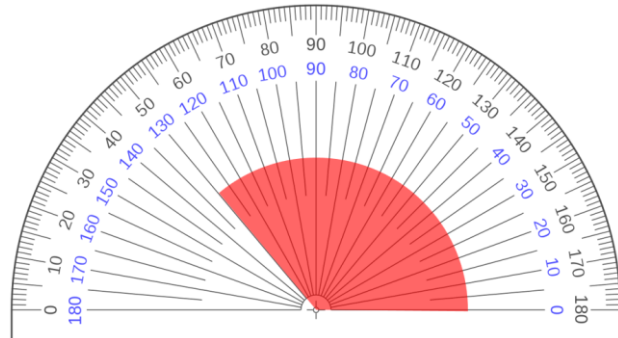
50° acute

c Size: Classification:



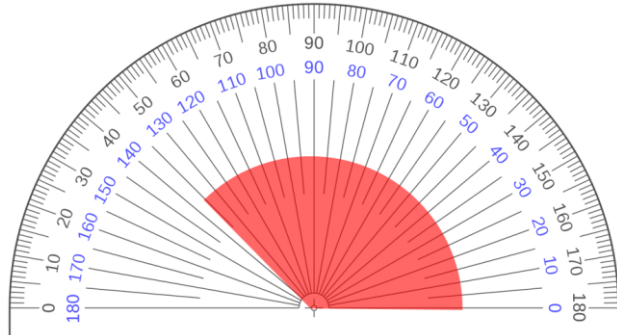
130° obtuse

d Size: Classification:



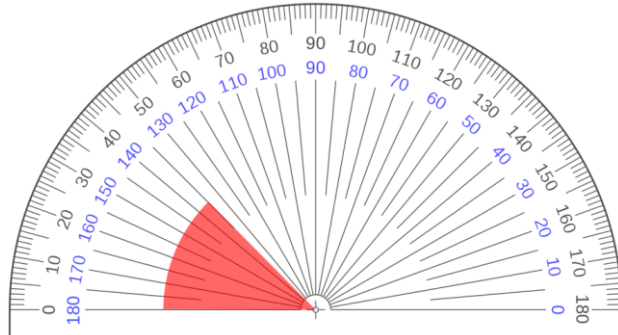
130° obtuse

e Size: Classification:



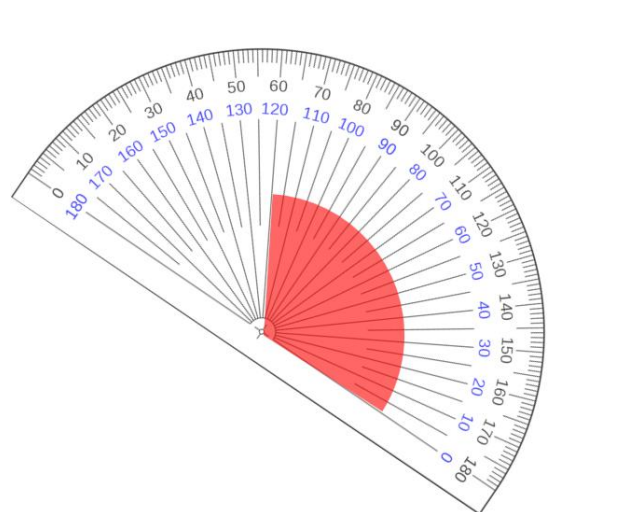
135° obtuse

f Size: Classification:



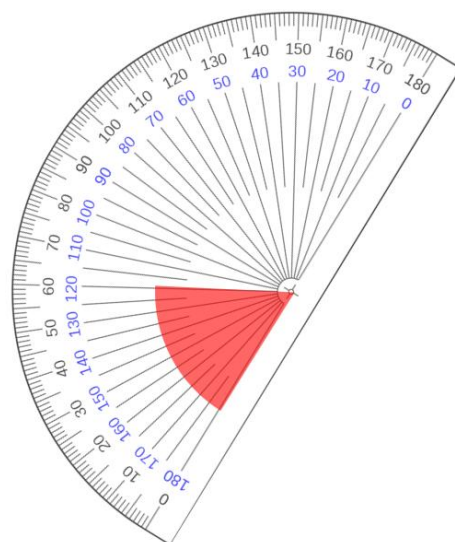
45° acute

g Size: Classification:



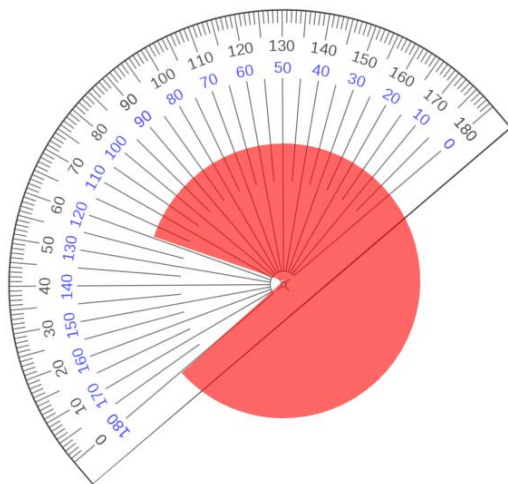
120° obtuse

h Size: Classification:



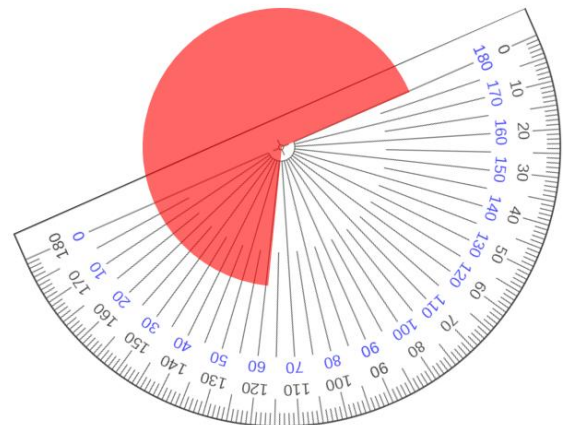
60° acute

i Size: Classification:



300° reflex

j Size: Classification:



240° reflex

2 Decide whether each of these angles is acute, obtuse, or reflex.

a



Acute Obtuse Reflex

acute

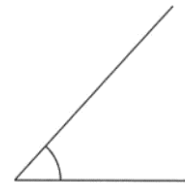
b



Acute Obtuse Reflex

obtuse

c



Acute Obtuse Reflex

acute

d



Acute Obtuse Reflex

acute

e



Acute Obtuse Reflex

obtuse

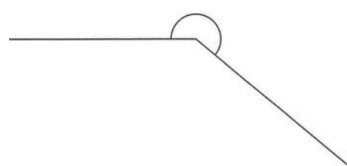
f



Acute Obtuse Reflex

obtuse

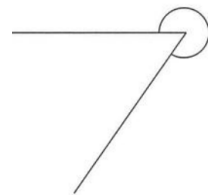
g



Acute Obtuse Reflex

reflex

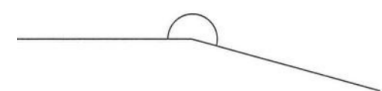
h



Acute Obtuse Reflex

reflex

i



Acute Obtuse Reflex

reflex

3 Classify these angles.

a 58°

acute

b 175°

obtuse

c 90°

right angle

d 195°

reflex

e 360°

revolution

f 149°

obtuse

g 242°

reflex

h 180°

straight line

i 15°

acute

j 136°

obtuse

k 305°

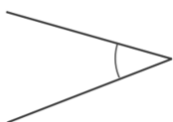
reflex

l 224°

reflex

9 Classify these angles.

a



acute

b



obtuse

c



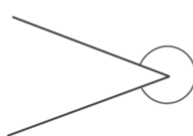
straight line

d



right angle

e



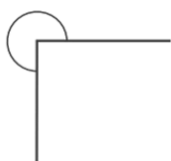
reflex

f



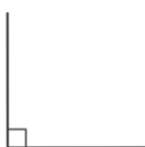
obtuse

g



reflex

h



right angle

i



reflex

j



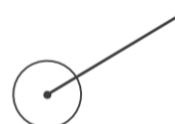
reflex

k



straight line

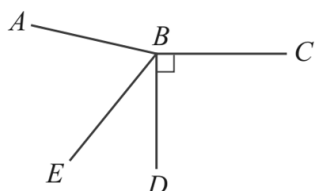
l



revolution

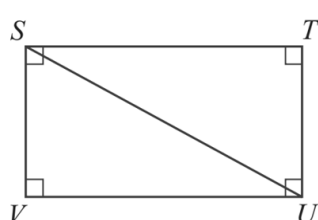
10 Classify the angles shown in these diagrams.

a



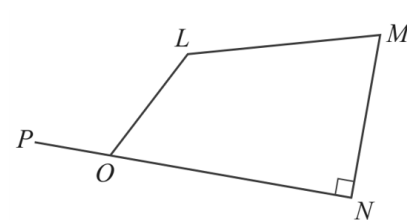
$\angle ABC$ reflex
 $\angle CBD$ right angle
 $\angle EBD$ acute
 $\angle ABE$ acute

b



$\angle SVU$ right angle
 $\angle STU$ right angle
 $\angle VSU$ acute
 $\angle TUS$ acute

c

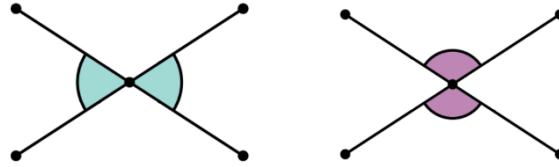


$\angle OLM$ obtuse
 $\angle PON$ straight line
 $\angle LOP$ obtuse
 $\angle ONM$ right angle

VERTICALLY OPPOSITE ANGLES

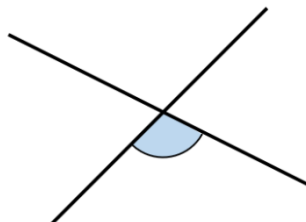
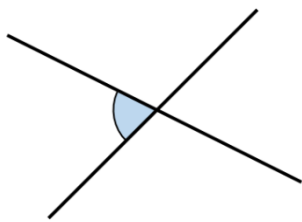
Vertically Opposite Angles

If two lines intersect, then the angles opposite each other at the vertex are called vertically opposite.

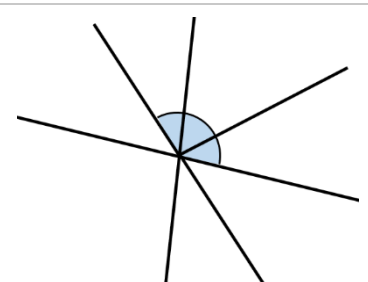
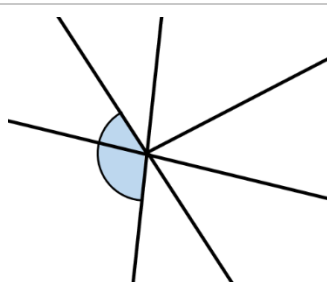
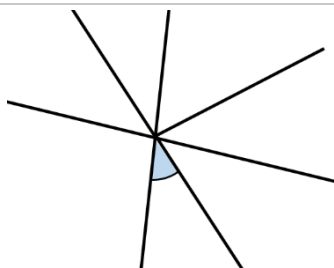
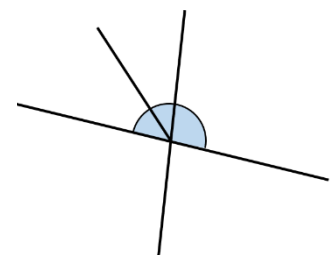
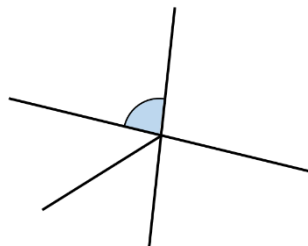
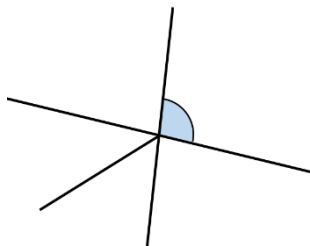
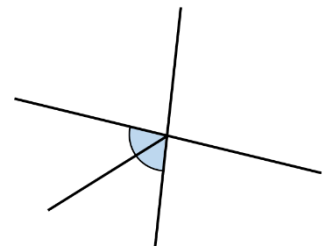
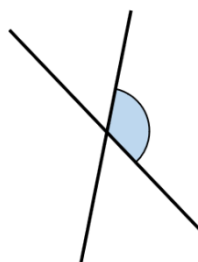
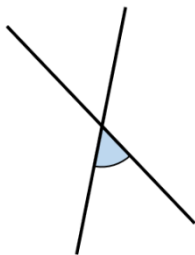
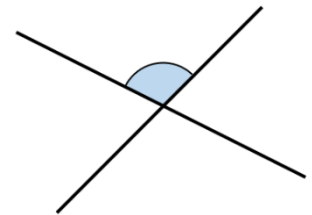


Example Identify vertically opposite angles.

Identify the vertically opposite angle to the given angle in these diagrams.



s



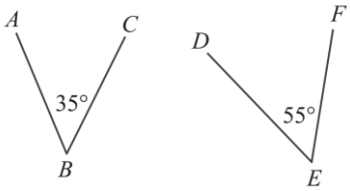
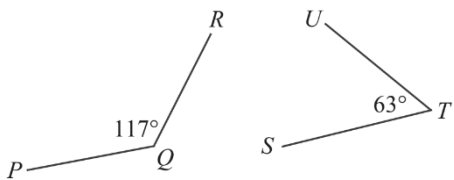
1 Identify the vertically opposite angle to $\angle FGH$ in these diagrams.

a $\angle BGA$	b $\angle OGP$	c $\angle RGT$
d $\angle PGQ$	e $\angle SGI$	f $\angle YGW$

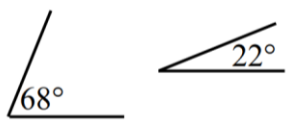
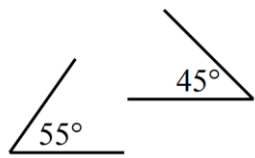
2 Label the angle and the angle vertically opposite to it.

a $\angle FGS$ $\angle HGI$	b $\angle SGB$ $\angle AGH$	c $\angle AGI$ $\angle FGB$
d $\angle FGB$ $\angle AGW$	e $\angle YGF$ $\angle BGA$	f $\angle AGW$ $\angle FGB$

COMPLEMENTARY AND SUPPLEMENTARY ANGLES

Complementary angles	Supplementary angles
If two angles sum to 90°, they are complementary  $\angle ABC + \angle DEF = 90^\circ$	If two angles sum to 180°, they are supplementary  $\angle PQR + \angle SUT = 180^\circ$

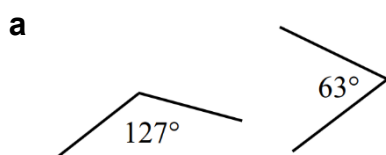
Example Determine whether two angles are complementary, supplementary, neither.

 + = ☐ Complementary ☐ Supplementary ☐ Neither complementary	 + = ☐ Complementary ☐ Supplementary ☐ Neither neither	 + = ☐ Complementary ☐ Supplementary ☐ Neither supplementary
--	--	--

Key ideas

1. Complementary angles sum to°
2. Supplementary angles sum to°

1 Decide whether these angles are complementary, supplementary, or neither.



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

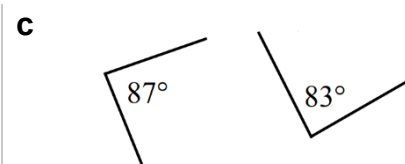
neither



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

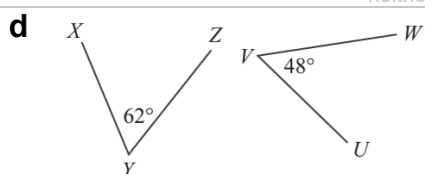
complementary



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

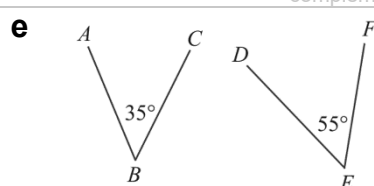
neither



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

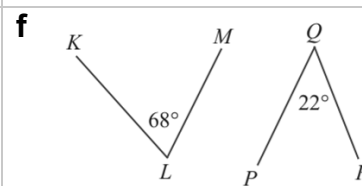
neither



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

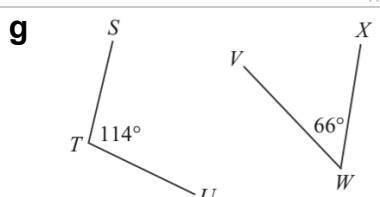
complementary



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

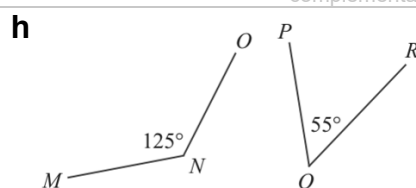
complementary



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

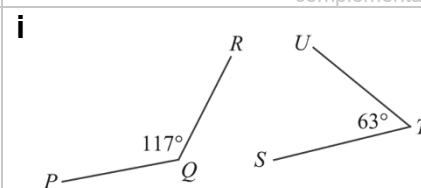
supplementary



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

supplementary



..... + =

- ☐ Complementary
☐ Supplementary
☐ Neither

supplementary

2 When two angles add up to 90° , we call each angle the “complement” of the other. Find the complement of these angles by subtracting it from 90° .

a 30°

60°

b 45°

45°

c 73°

17°

d 21°

69°

e 9°

81°

f 57°

33°

3 When two angles add up to 180° , we call each angle the “supplement” of the other. Find the supplement of these angles by subtracting it from 180° .

a 110°

70°

b 45°

135°

c 162°

18°

d 16°

164°

e 123°

57°

f 27°

153°

4 Complete the table.

Angle	Complement	Supplement
25°	65°	155°
65°	25°	115°
13°	77°	167°
79°	11°	101°
57°	33°	123°
3°	87°	177°
41°	49°	139°

5 Work out the:

a complement of 40°	b supplement of 60°	c complement of 41°
50°	120°	49°
d supplement of 100°	e supplement of 15°	f supplement of 48°
80°	165°	132°
g complement of 72°	h complement of 5°	i supplement of 90°
18°	85°	90°

6 If a pair of complementary angles are placed adjacent to each other, what type of angle is formed?

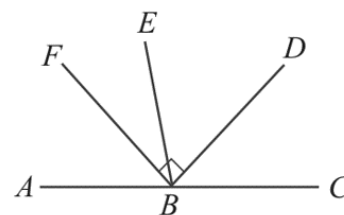
Right-angle

7 If a pair of supplementary angles are placed adjacent to each other, what type of angle is formed?

Straight line

8 State whether these pairs of angles are complementary, supplementary, or neither.

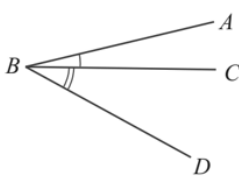
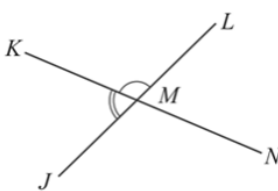
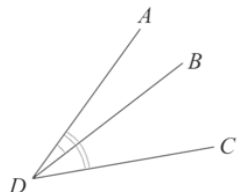
a $\angle FBE$ and $\angle DBE$	b $\angle ABE$ and $\angle CBE$
complementary	supplementary
c $\angle FBE$ and $\angle DBC$	d $\angle FBC$ and $\angle FBA$
neither	supplementary
e $\angle FBA$ and $\angle DBC$	f $\angle FBA$ and $\angle EBD$
neither	neither



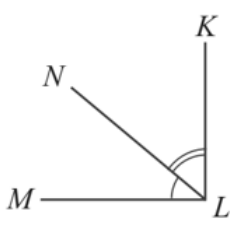
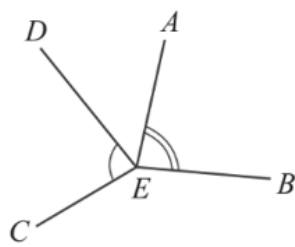
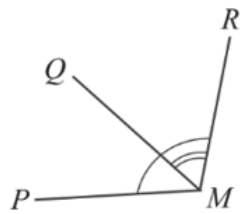
ADJACENT ANGLES

- **Adjacent** means “next to”.
- If two angles share a **common vertex**, a **common arm**, and **do not overlap**, then they are adjacent angles.

Example Identify adjacent angles.

Decide whether the angles are adjacent.			
a 	b 	c 	d 
☒ Common vertex ☒ Common arm ☒ Angles next to each other ☒ Adjacent	☒ Common vertex ☒ Common arm ☒ Angles next to each other ☒ Adjacent	☒ Common vertex ☒ Common arm ☒ Angles next to each other ☒ Adjacent	☒ Common vertex ☒ Common arm ☒ Angles next to each other ☒ Adjacent

Complete these statements to determine whether the marked angles are adjacent.

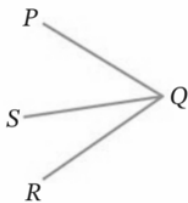
a 	b 	c 
☐ Common vertex ☐ Common arm ☐ Angles next to each other ☐ Adjacent	☐ Common vertex ☐ Common arm ☐ Angles next to each other ☐ Adjacent	☐ Common vertex ☐ Common arm ☐ Angles next to each other ☐ Adjacent
adjacent	not adjacent	not adjacent

Key ideas

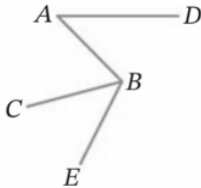
1. Adjacent angles are to each other. They have a common and

1 On the diagram, identify the angle adjacent to:

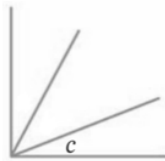
a $\angle RQS$



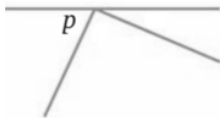
b $\angle ABC$



c Angle marked c

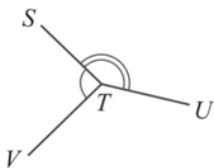


d Angle marked p



2 Decide whether the marked angles in each diagram are adjacent.

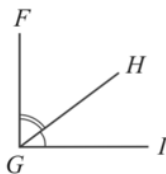
a



- ☐ Common vertex
- ☐ Common arm
- ☐ Angles next to each other
- ☐ Adjacent

adjacent

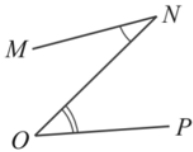
b



- ☐ Common vertex
- ☐ Common arm
- ☐ Angles next to each other
- ☐ Adjacent

adjacent

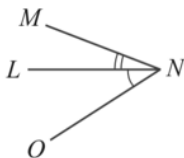
c



- ☐ Common vertex
- ☐ Common arm
- ☐ Angles next to each other
- ☐ Adjacent

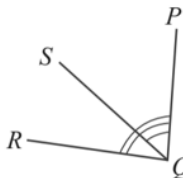
not adjacent

d



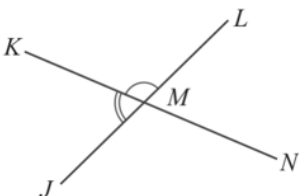
adjacent

e



Not adjacent

f



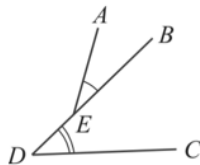
adjacent

g



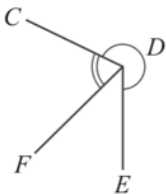
adjacent

h



Not adjacent

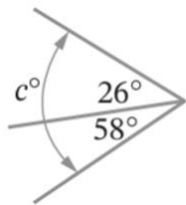
i



adjacent

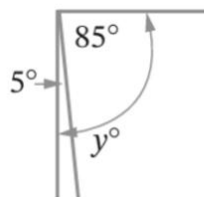
3 Find the value of the variable in each diagram.

a



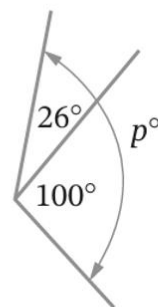
84°

b



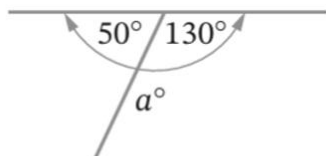
90°

c



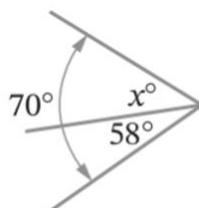
126°

d



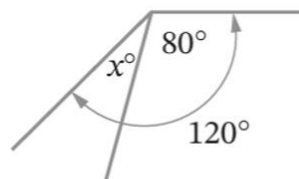
180°

e



12°

f



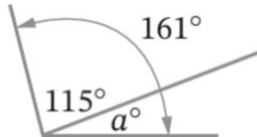
40°

g



15°

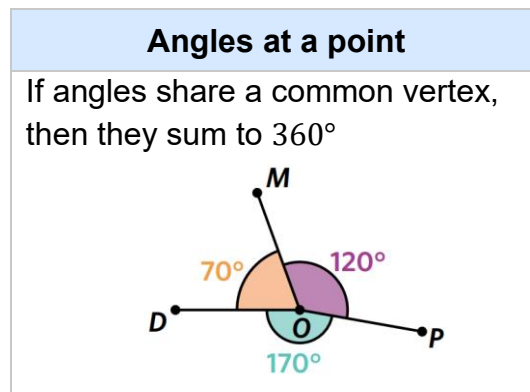
h



46°

ANGLES AT A POINT

🌟 Angles at a Point: <https://www.geogebra.org/m/rx9zhepc>



- To find unknown angles involving angles at a point:
 - Write an equation using angle relationships.
 - Simplify the equation, if needed.
 - Solve for the unknown using inverse operations.

Example Solve problems involving angles at a point.

Calculate the value of m $m + 70 + 65 = 360$ (angles at a point) $m + 135 = 360$ $m = 225$	How do we know that all the angles add to 360°? Angles that share a vertex always sum to 360°
Calculate the value of a $a + a + 120 + 90 = 360$ (angles at a point) $2a + 210 = 360$ $2a = 150$ $a = 75$	Describe how we solve $2a + 210 = 360$ First, we 210 from 360, Then, we the result by

Calculate the value of the pronumeral.

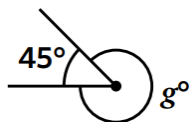
a $u + 98 + 62 = 360$ $u + \dots = 360$ $u = \dots$	b $5y = 360$ $y = \dots$
c $3a + 120 = \dots$ $3a = \dots$ $a = \dots$	d $w = 80^\circ$

Key ideas

- Angles at a point add up to

1 Calculate the value of the unknown angle.

a



$$45 + g = 360$$

$$g = \dots\dots\dots$$

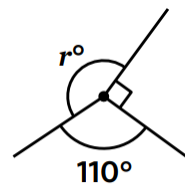
315°

b



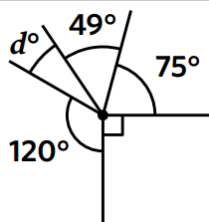
330°

c



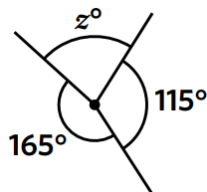
160°

d



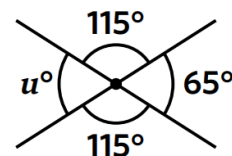
26°

e



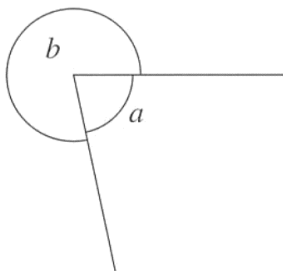
80°

f



65°

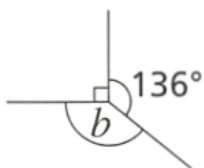
2 Seb measures these angles and writes $a = 82^\circ$ and $b = 284^\circ$. Explain how you know that Seb must have measured incorrectly.



$$a + b \text{ must sum to } 360. 284 + 82 = 366.$$

3 Calculate the value of the pronumeral.

a



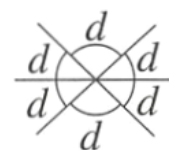
134°

b



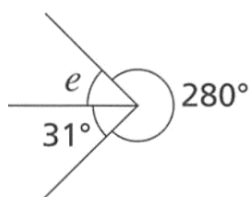
90°

c



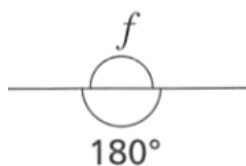
60°

d



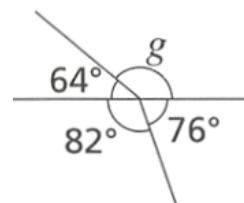
49°

e



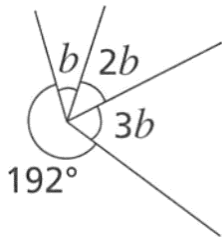
180°

f



138°

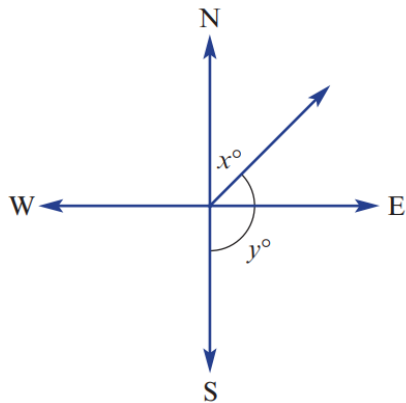
- 4 Determine the value of b .



28°

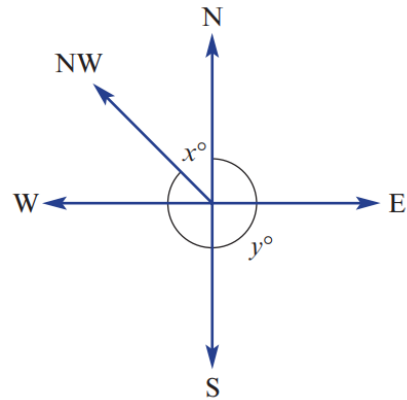
- 5 Find the values of x and y .

a



$$x = 45^\circ, y = 135^\circ$$

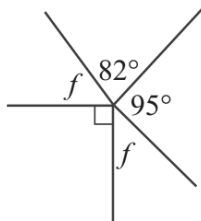
b



$$x = 45^\circ, y = 315^\circ$$

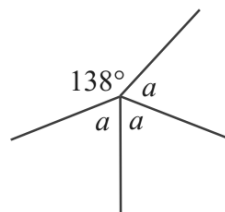
- 6 Calculate the value of the pronumeral.

a



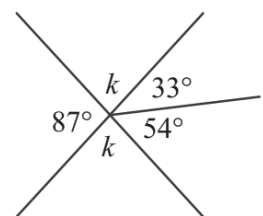
$$46.5^\circ$$

b



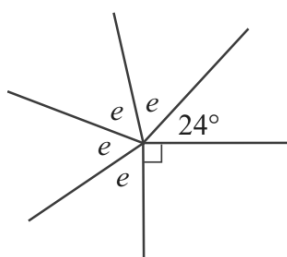
$$74^\circ$$

c



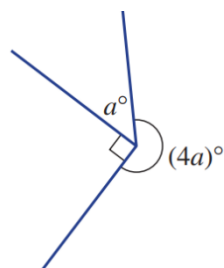
$$93^\circ$$

d



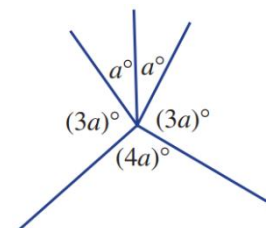
$$61.5^\circ$$

e



$$54^\circ$$

f

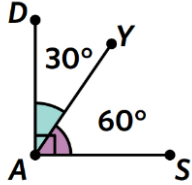
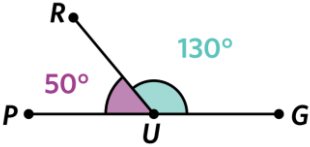


$$30^\circ$$

ANGLES IN A RIGHT-ANGLE AND STRAIGHT LINE

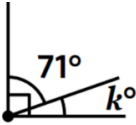
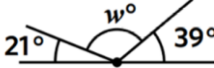
 <https://www.geogebra.org/m/htq7jgyq>

<https://www.geogebra.org/m/bfdfrbqg>

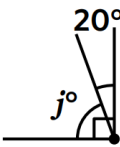
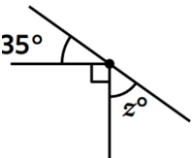
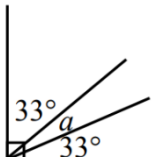
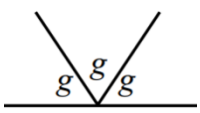
Angles in a right-angle	Angles on a straight line
If angles are within a right angle, then they add up to 90 degrees.	If angles are on a straight-line, then they add up to 180 degrees.
	

- To find unknown angles involving angles in a right-angle and straight line:
 - Write an equation using angle relationships.
 - Simplify the equation, if needed.
 - Solve for the unknown using inverse operations.

Example Solve problems involving supplementary/complementary angles.

Calculate the value of k 1. $k + 71 = 90$ (angles in a right-angle) 3. $k = 19$		How do we know the angles add up to 90° Adjacent angles on a are
Calculate the value of w 1. $w + 21 + 39 = 180$ (angles on a straight-line) 2. $w + 60 = 180$ 3. $w = 120$		How do we know the angles add up to 180° ? Adjacent angles on a are

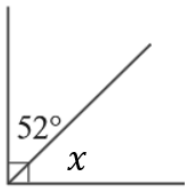
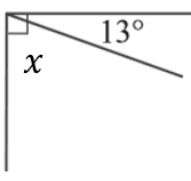
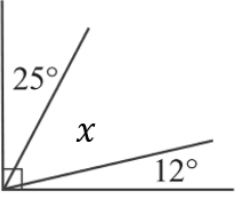
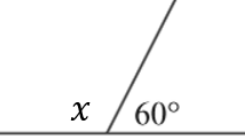
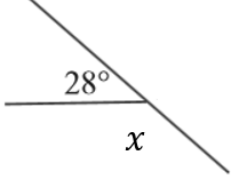
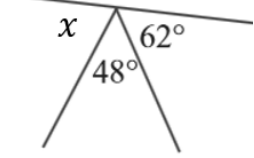
Calculate the value of the pronumerals.

a  $j + 20 = 90$ $j = \dots\dots\dots$	b  $z + 90 + 35 = 180$ $z + \dots\dots\dots = 180$ $z = \dots\dots\dots$
$j = 70^\circ$	$z = 55^\circ$
c  $a = 24^\circ$	d  $g = 60^\circ$

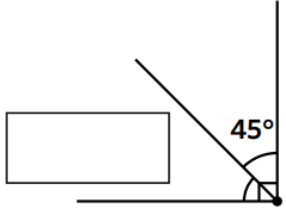
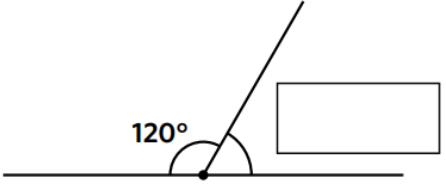
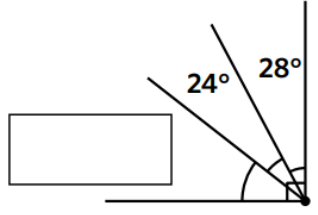
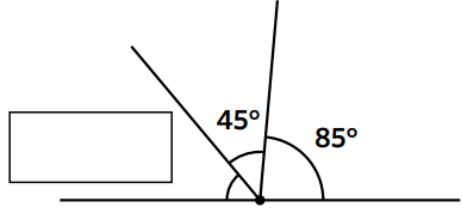
Key ideas

- Angles in a right-angle sum to
- Angles on a straight-line sum to

1 Find the value of each pronumeral.

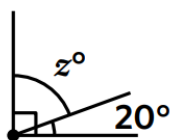
a  $x + 52 = 90$ $x = \dots\dots$ 38°	b  $x + \dots\dots = \dots\dots$ $x = \dots\dots$ 77°	c  $x + \dots\dots + \dots\dots = \dots\dots$ $x + \dots\dots = \dots\dots$ $x = \dots\dots$ 53°
d  $x + 60 = 180$ $x = \dots\dots$ 120°	e  $x + \dots\dots = \dots\dots$ $x = \dots\dots$ 152°	f  $x + \dots\dots + \dots\dots = \dots\dots$ $x + \dots\dots = \dots\dots$ $x = \dots\dots$ 70°

2 Circle whether the angles are supplementary or complementary, then determine the missing angle measurements.

a  complementary supplementary The angle sum is: 90° 180° 45°, complementary, 90°	b  complementary supplementary The angle sum is: 90° 180° 60°, supplementary, 180°
c  complementary supplementary The angle sum is: 90° 180° 38°, complementary, 90°	d  complementary supplementary The angle sum is: 90° 180° 50°, supplementary, 180°

3 Calculate the value of the unknown angle.

a

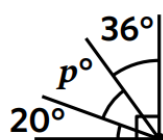


$$z + 20 = 90$$

$$z = \dots\dots\dots$$

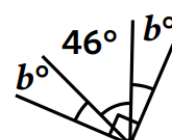
70°

b



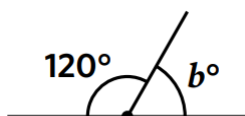
34°

c



22°

d

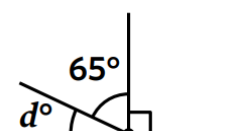


$$b + 120 = 180$$

$$b = \dots\dots\dots$$

60°

e



25°

f

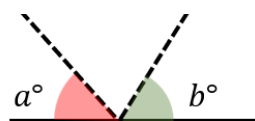


52°

4 Decide whether each statement is true or false.

a

$$a + b = 180$$



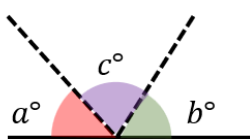
True

False

false

b

$$a + b + c = 180$$



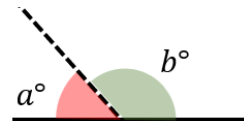
True

False

true

c

$$a + b = 180$$



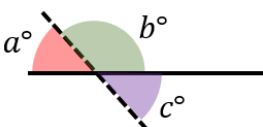
True

False

true

d

$$a + b + c = 180$$



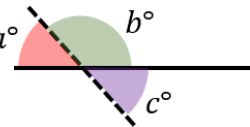
True

False

false

e

$$b + c = 180$$



True

False

true

f

$$a + b = 180$$



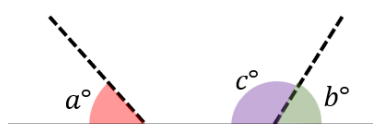
True

False

false

g

$$a + b + c = 180$$



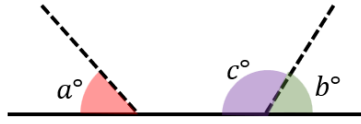
True

False

false

h

$$b + c = 180$$



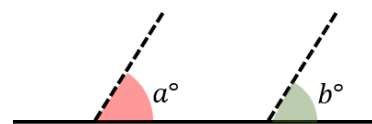
True

False

true

i

$$a + b = 180$$



True

False

false

5 Marta thinks that $x = 180^\circ - 41^\circ = 139^\circ$ because angles on a straight line add up to 180° . Explain why she is incorrect.

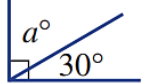


41° and x do not share a common vertex; they are not adjacent.

6 Calculate the value of the letter a in each diagram, giving reasons.

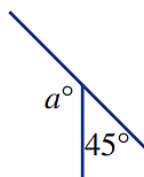
a $a + 30 = 90$ (angles in a right angle)

$a = \dots\dots$



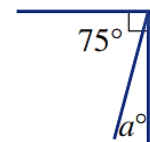
60°

b



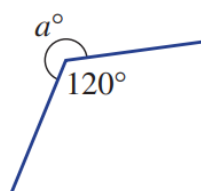
$a + 45 = 180$ (angles on a straight line)
 $a = 135$

c



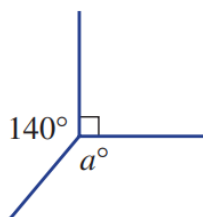
$a + 75 = 90$ (angles in a right angle)
 $a = 15$

d



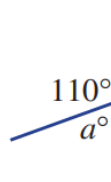
$a + 120 = 180$ (angles on a straight line)
 $a = 60$

e



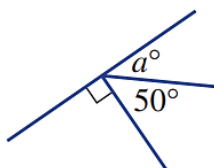
$a + 90 + 140 = 360$
 $a + 230 = 360$
 $a = 130$

f



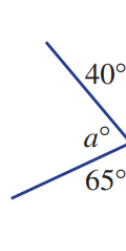
$a + 110 = 180$
 $a = 70$

g



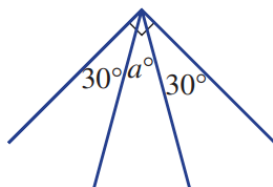
$a + 50 + 90 = 180$
 $a + 140 = 180$
 $a = 40$

h



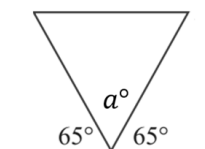
$a + 40 + 65 = 180$
 $a + 105 = 180$
 $a = 75$

i



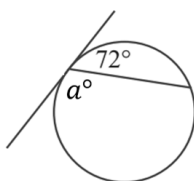
$a + 30 + 30 = 90$
 $a + 60 = 90$
 $a = 30$

j



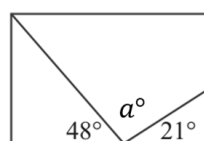
$a + 65 + 65 = 180$
 $a + 130 = 180$
 $a = 50$

k



$a + 72 = 180$
 $a = 108$

l

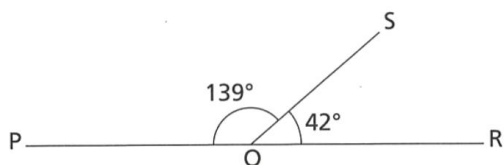


$a + 48 + 21 = 180$
 $a + 69 = 180$
 $a = 111$

- 7 Felix has a gaming chair that has a backrest that can lean all the way back until it is flat. If the angle between the chair and the backrest is 119° , how much more will it have to turn to lay flat?

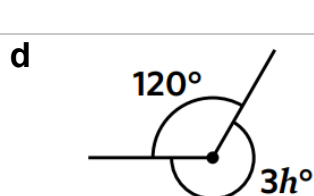
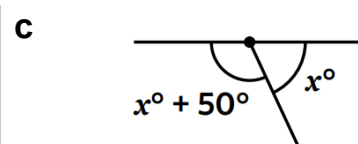
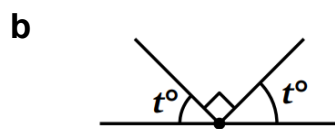
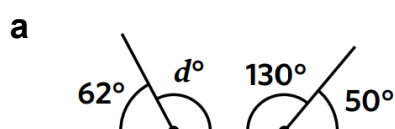
61°

- 8 Explain why PQR is not a straight line.

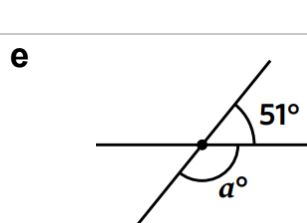


$139 + 42 = 181^\circ$, a straight line must sum to 180

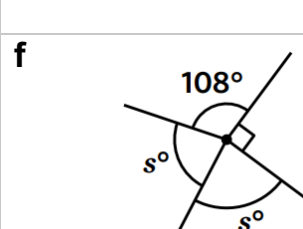
- 9 Calculate the unknown angles.



118°

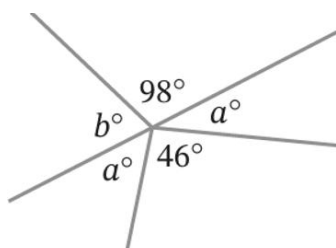


45°



65°

- 10 Find the value of a and b .



$b = 82^\circ, a = 67^\circ$

11 Determine the size of the missing angles using complementary angles.

a

$a = 70, b = 20$

b

$c = 25, d = 25$

c

$e = 33, f = 33$

d

$a = 50, b = 40$

e

$c = 55, d = 35$

f

$e = 63, f = 63$

g

$a = 50$

h

$b = 70$

i

$c = 65$

j

$a = 20$

k

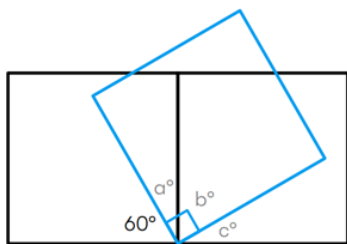
$a = 30$

l

$b = 60$

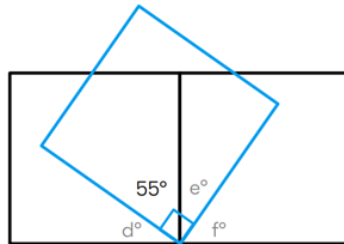
12 Determine the size of the missing angles using supplementary angles.

a



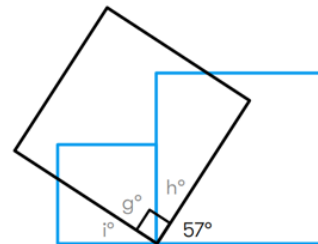
$$a = 30, b = 60, c = 30$$

b



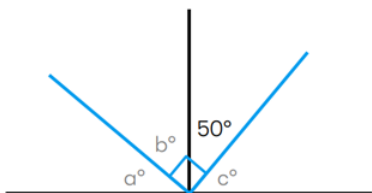
$$d = 35, e = 35, f = 55$$

c



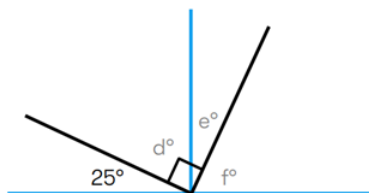
$$g = 57, h = 33, i = 33$$

d



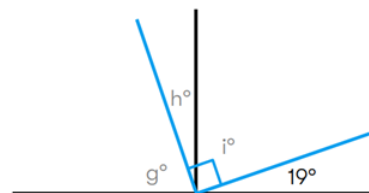
$$a = 50, b = 40, c = 40$$

e



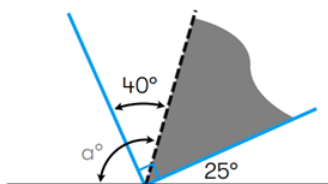
$$d = 65, e = 25, f = 65$$

f



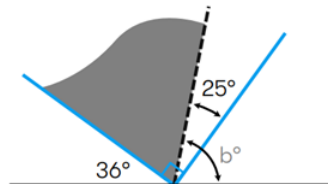
$$g = 71, h = 19, i = 71$$

g



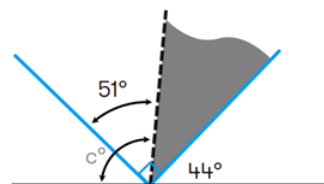
$$a = 105$$

h



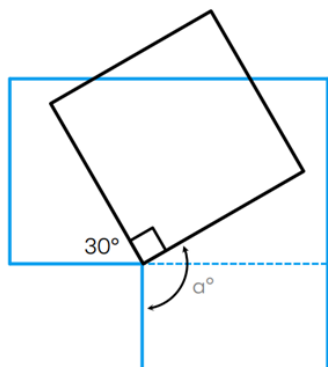
$$b = 79$$

i



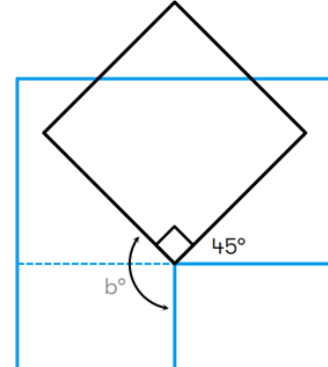
$$c = 97$$

j



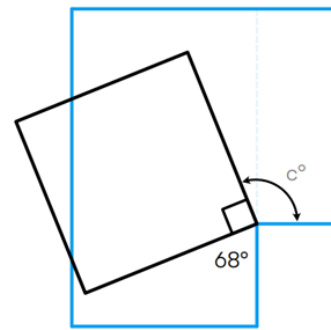
$$a = 150$$

k



$$b = 135$$

l



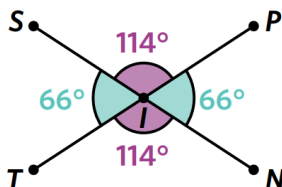
$$c = 112$$

VERTICALLY OPPOSITE ANGLES

🌟 Vertically Opposite Angles: <https://www.geogebra.org/m/wwkdqdbz>

Vertically Opposite Angles

If angles are vertically opposite, then they are equal



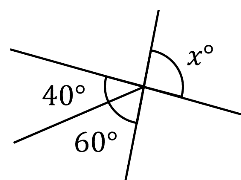
Example Solve problems involving vertically opposite angles.

Calculate the value of a



$$a = 37 \text{ (vertically opposite)}$$

Calculate the value of x

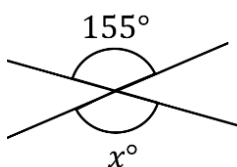


$$40 + 60 = x \text{ (vertically opposite)}$$

$$100 = x$$

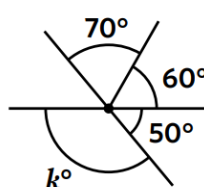
Calculate the value of the pronumerals.

a



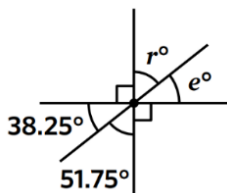
$$x = 155^\circ$$

b



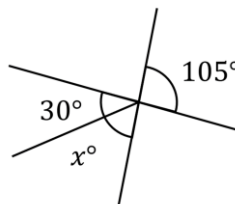
$$k = 130^\circ$$

c



$$r = 51.75^\circ, e = 38.25^\circ$$

d



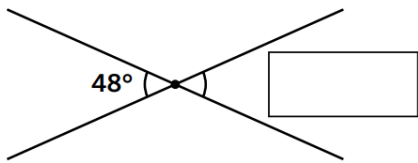
$$x = 75^\circ$$

Key ideas

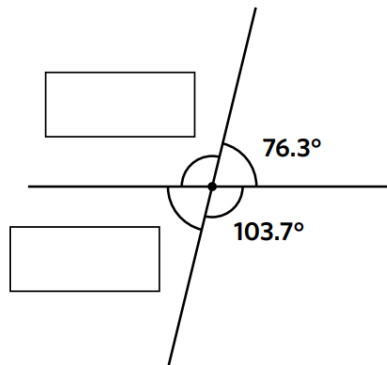
1. Vertically opposite angles are

1 Calculate the value of the unknown angles.

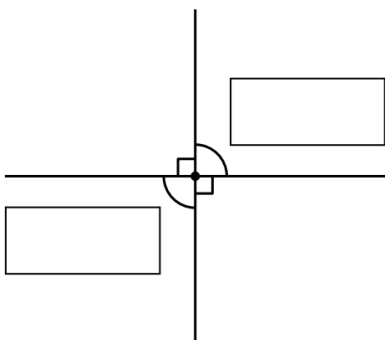
a



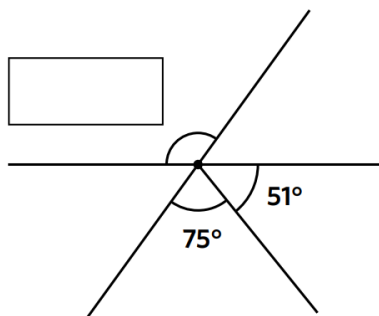
b



c



d



48°

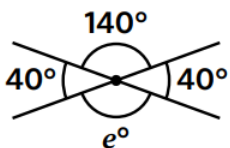
103.7°, 76.3°

90°, 90°

126°

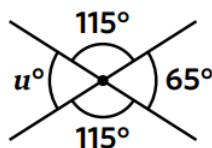
2 Determine the value of each unknown angle.

a



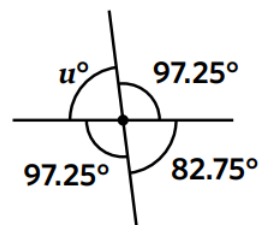
140°

b



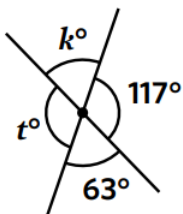
65°

c



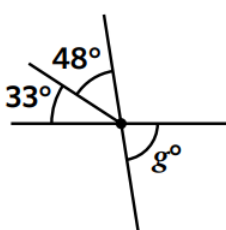
82.75°

d



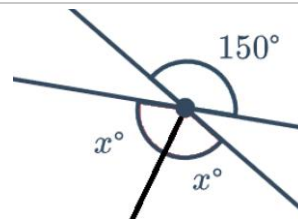
$t = 117^\circ$
 $k = 63^\circ$

e



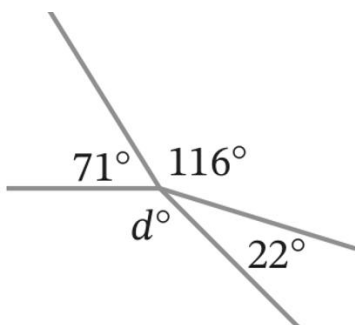
81°

f



75°

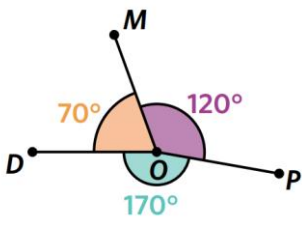
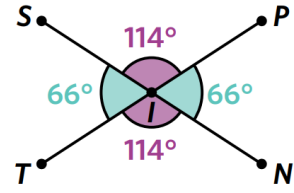
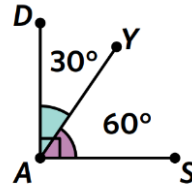
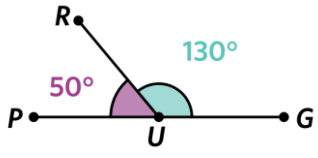
3 Jimmy says $d = 116^\circ$ because it is vertically opposite to 116° . Explain why he is incorrect and find the correct value of d .



d is not vertically opposite because it is not formed by the same straight lines that form 116°

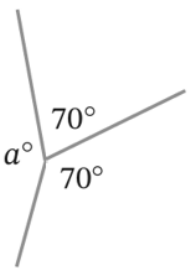
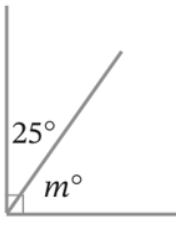
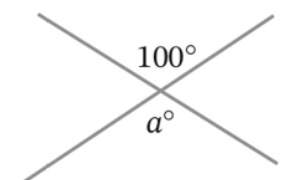
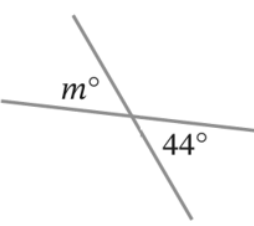
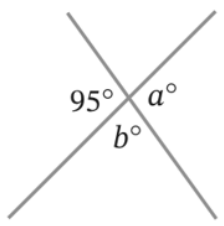
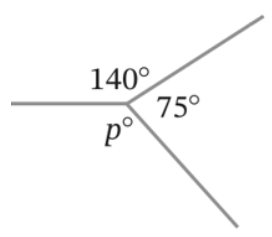
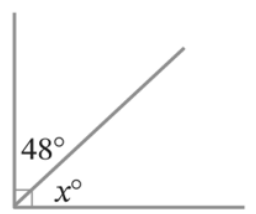
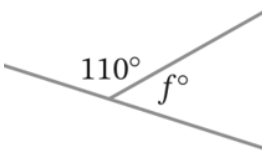
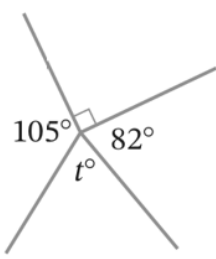
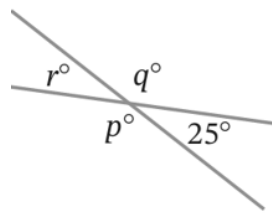
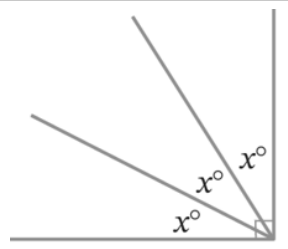
We can find d using angles at a point; $360 - 22 - 116 - 71 = 151$

MIXED PRACTICE

Angles at a point	Vertically Opposite Angles
If angles share a common vertex, then they sum to 360° 	If angles are vertically opposite, then they are equal 
Angles in a right-angle	Angles on a straight line
If angles are within a right angle, then they add up to 90 degrees. 	If angles are on a straight-line, then they add up to 180 degrees. 

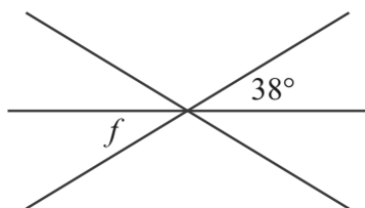
FOUNDATION

1 Calculate the value of the unknown angles. You do not need to show reasoning.

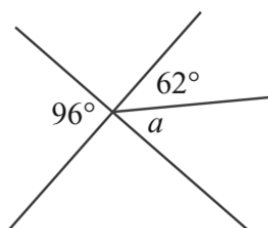
a  220°	b  65°	c  325°	d  100°
e  44°	f  $a = 95^\circ, b = 85^\circ$	g  145°	h  42°
i  70°	j  83°	k  $r = 25^\circ, p = q = 155^\circ$	l  30°

- 2 Combine your knowledge of angle relationships to calculate the value of each angle. You do not need to give reasoning.

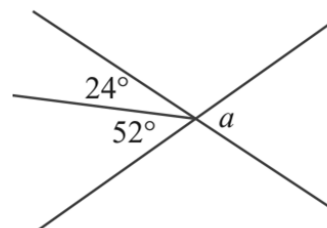
a

 38°

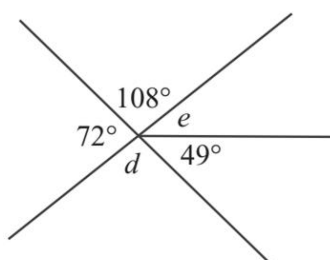
b

 34°

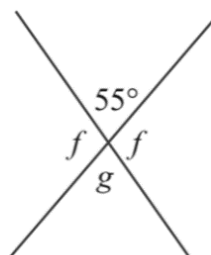
c

 76°

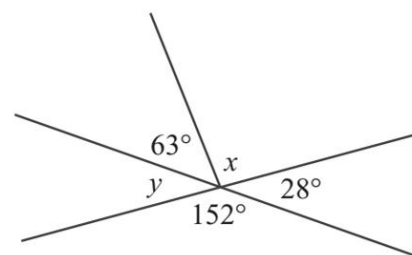
d

 $d = 108^\circ, e = 23^\circ$

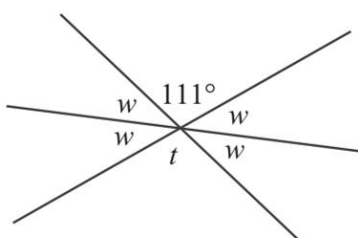
e

 $g = 55^\circ, f = 125^\circ$

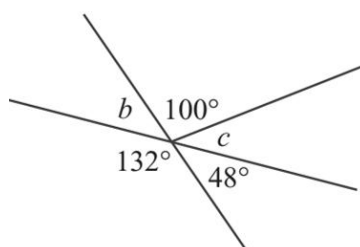
f

 $x = 89^\circ, y = 28^\circ$

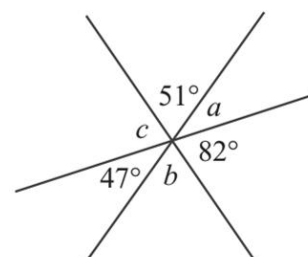
g

 $t = 111^\circ, w = 34.5^\circ$

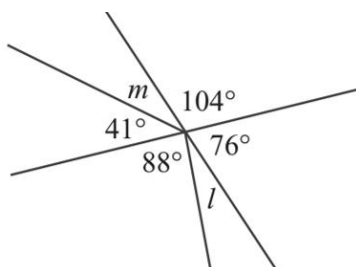
h

 $b = 48^\circ, c = 32^\circ$

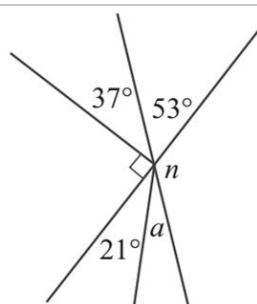
i

 $a = 47^\circ, b = 51^\circ, c = 82^\circ$

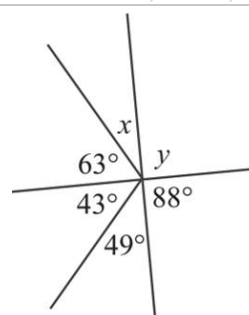
j

 $l = 16^\circ, m = 35^\circ$

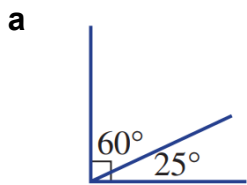
k

 $a = 32^\circ, n = 127^\circ$

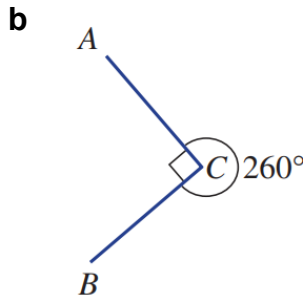
l

 $x = 25^\circ, y = 92^\circ$

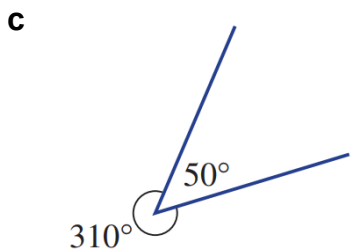
3 Decide whether these diagrams have the correct information or not. Justify your answer.



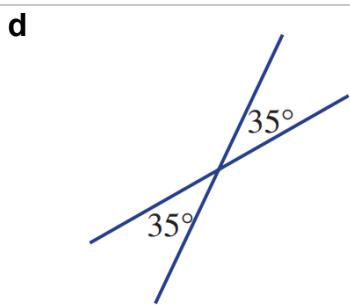
$60 + 25 = 85^\circ$
No, as angles in a right angle must sum to 90° .



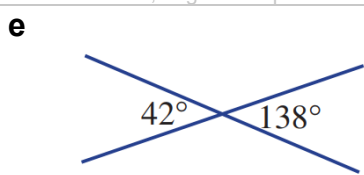
No, angles at a point sum to 360°



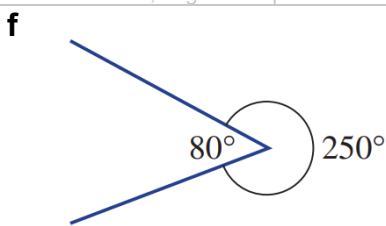
Yes, angles at a point sum to 360°



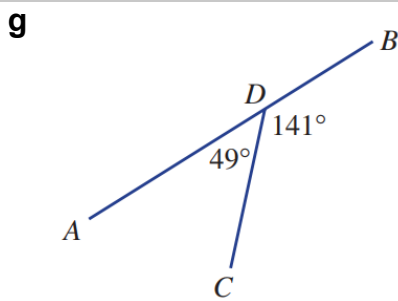
Yes, vertically opposite angles are equal.



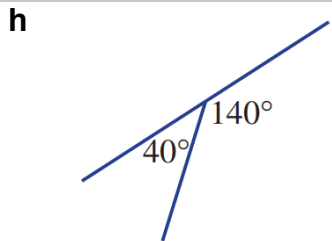
No, vertically opposite angles are equal.



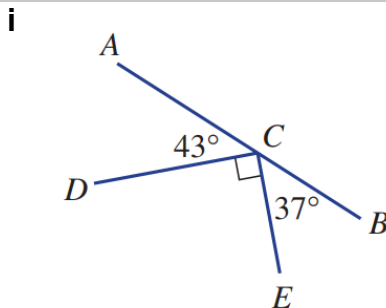
No, angles at a point sum to 360°



No, angles on a straight line sum to 180°

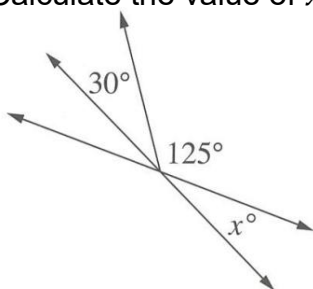


Yes, angles on a straight line sum to 180°



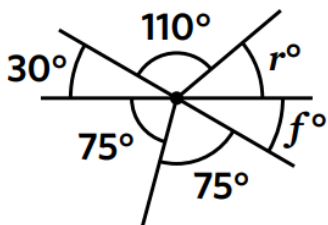
No, angles on a straight line sum to 180°

- 4 Calculate the value of x .



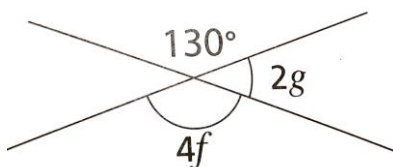
$$x = 25^\circ$$

- 5 Calculate the value of r and f



$$r = 40^\circ, f = 30^\circ$$

- 6 Which has the larger value, f or g ? Explain your reasoning.



$$f = 32,5, g = 25, \therefore f > g$$

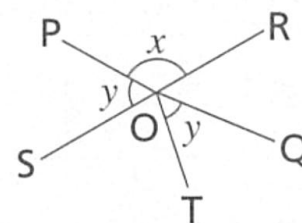
- 7 Write expressions in terms of x and/or y for

a $\angle ROQ$

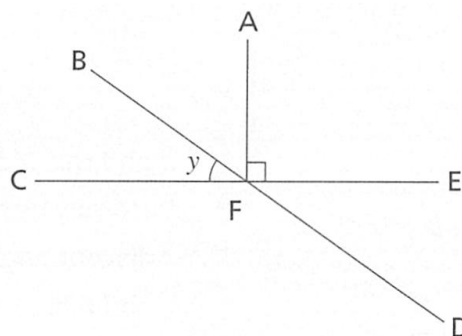
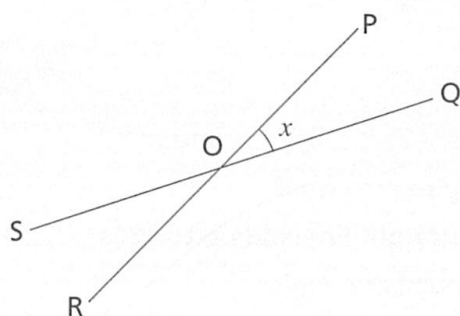
b $\angle SOT$

$$\angle ROQ = y$$

$$\angle SOT = x - y$$



- 8 Consider the two diagrams.



Write an expression for:

a $\angle ROS$

b $\angle POS$

c $\angle ROQ$

d $\angle DFC$

e $\angle EFD$

f $\angle AFB$

$$x$$

$$180 - x$$

$$180 - x$$

$$180 - y$$

$$y$$

$$90 - y$$

CHECK YOUR UNDERSTANDING

Measuring angles

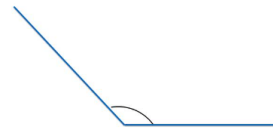
1 How many degrees are there in half of a turn?

- a 180° b 90° c 50° d 30°

2 How many degrees are there in three-quarters of a turn?

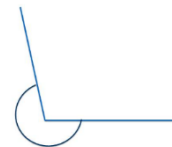
- a 75° b 90° c 180° d 270°

3 What is the best estimate for the size of this angle?



- a 60° b 90° c 120° d 160°

4 What is the best estimate for the size of this angle?



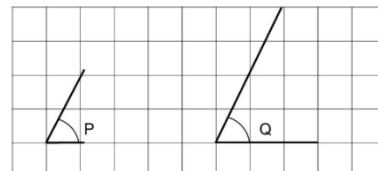
- a 45° b 100° c 200° d 260°

5 What is the best estimate for the size of this angle?



- a 180° b 165° c 195° d 265°

6 Which of these statements is correct?



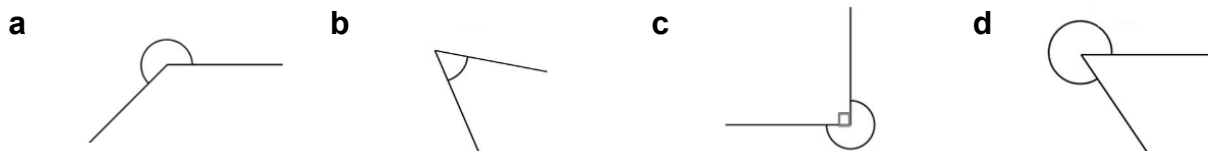
- a $\angle P$ is larger than $\angle Q$ b $\angle Q$ is larger than $\angle P$ c $\angle Q$ is the same size as $\angle P$ d Impossible to tell without measuring

7 What is the name for this angle?



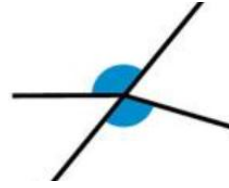
- a Acute b Obtuse c Reflex d Right angle

8 Which angle could measure 250° ?



Vertically opposite angles

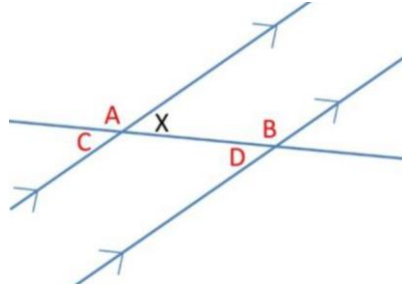
- 1 Tom says these are vertically opposite Katie says these are vertically opposite.



Who is correct?

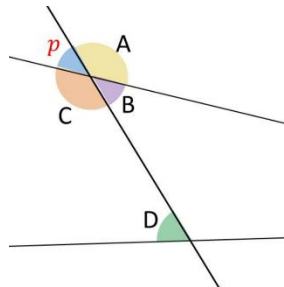
- a Only Tom b Only Katie c Both d Neither

- 2 Which angle is vertically opposite to angle X ?



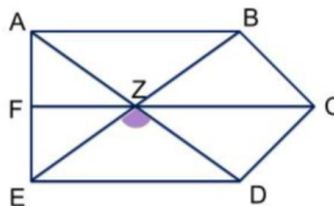
- a b c d

- 3 Which angle is vertically opposite to angle p ?



- a b c d

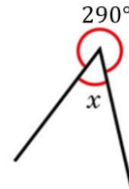
- 4 Which angle is vertically opposite to angle $\angle EZD$?



- a $\angle AZB$ b $\angle BZC$ c $\angle BAZ$ d No vertically opposite angle

Angles at a point

1 What is the size of angle x ?



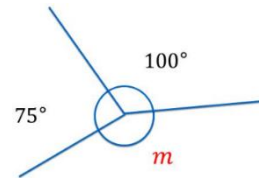
a 290°

b 70°

c 50°

d 45°

2 What is the size of angle m ?



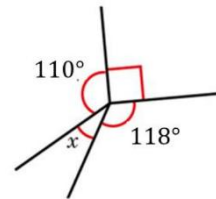
a 100°

b 185°

c 75°

d 175°

3 What is the size of angle x ?



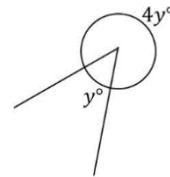
a 42°

b 132°

c 48°

d 52°

4 What is the size of angle y ?



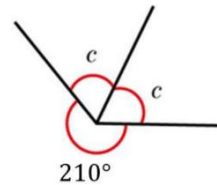
a 90°

b 72°

c 60°

d Not enough information

5 What is the size of angle c ?



a 150°

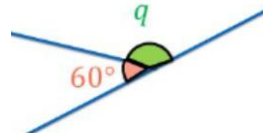
b 80°

c 105°

d 75°

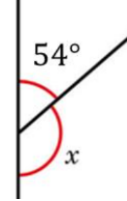
Angles on a straight line and right angle

- 1 Which of these equations can we write from this diagram?



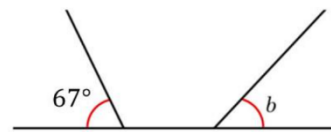
a $q + 60 = 180$ **b** $q + 60 = 90$ **c** $q + 60 = 360$ **d** $q - 60 = 180$

- 2 What is the size of angle x ?



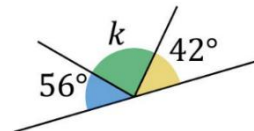
a 54° **b** 126° **c** 136° **d** 130°

- 3 What is the size of angle b ?



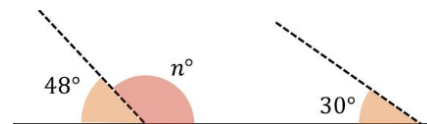
a 67° **b** 113° **c** 123° **d** Not enough information

- 4 What is the size of angle k ?



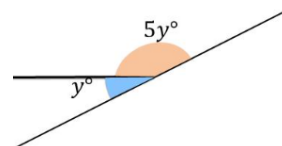
a 82° **b** 90° **c** 138° **d** Not enough information

- 5 What is the size of angle n ?



a 132° **b** 142° **c** 102° **d** 312°

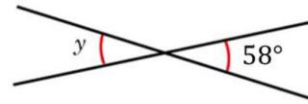
- 6 What is the size of angle y ?



a 45° **b** 36° **c** 30° **d** Not enough information

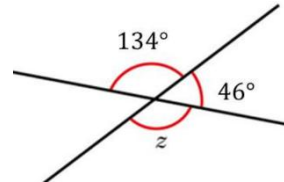
Vertically opposite angles

1 What is the size of angle y ?



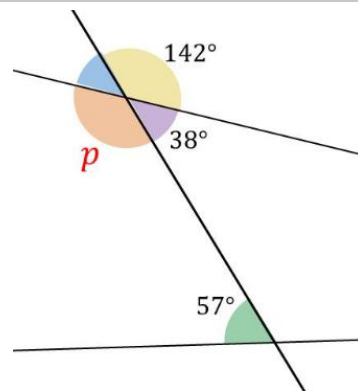
- a 58° b 122° c 132° d Not enough information

2 What is the size of angle z ?



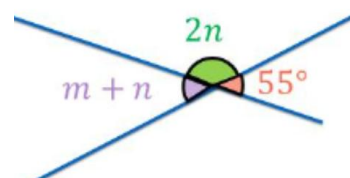
- a 134° b 88° c 46° d Not enough information

3 What is the size of angle p ?



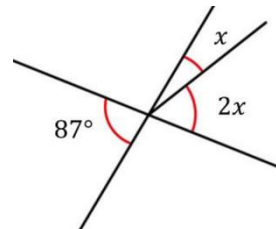
- a 142° b 38° c 57° d Not enough information

4 Tom says the diagram shows $2n + 55 = 180$
Katie says the diagram shows $m + n = 55$
Who is correct?



- a Only Tom b Only Katie c Both d Neither

5 What is the size of angle x ?



- a 87° b 43.5° c 29° d Not enough information