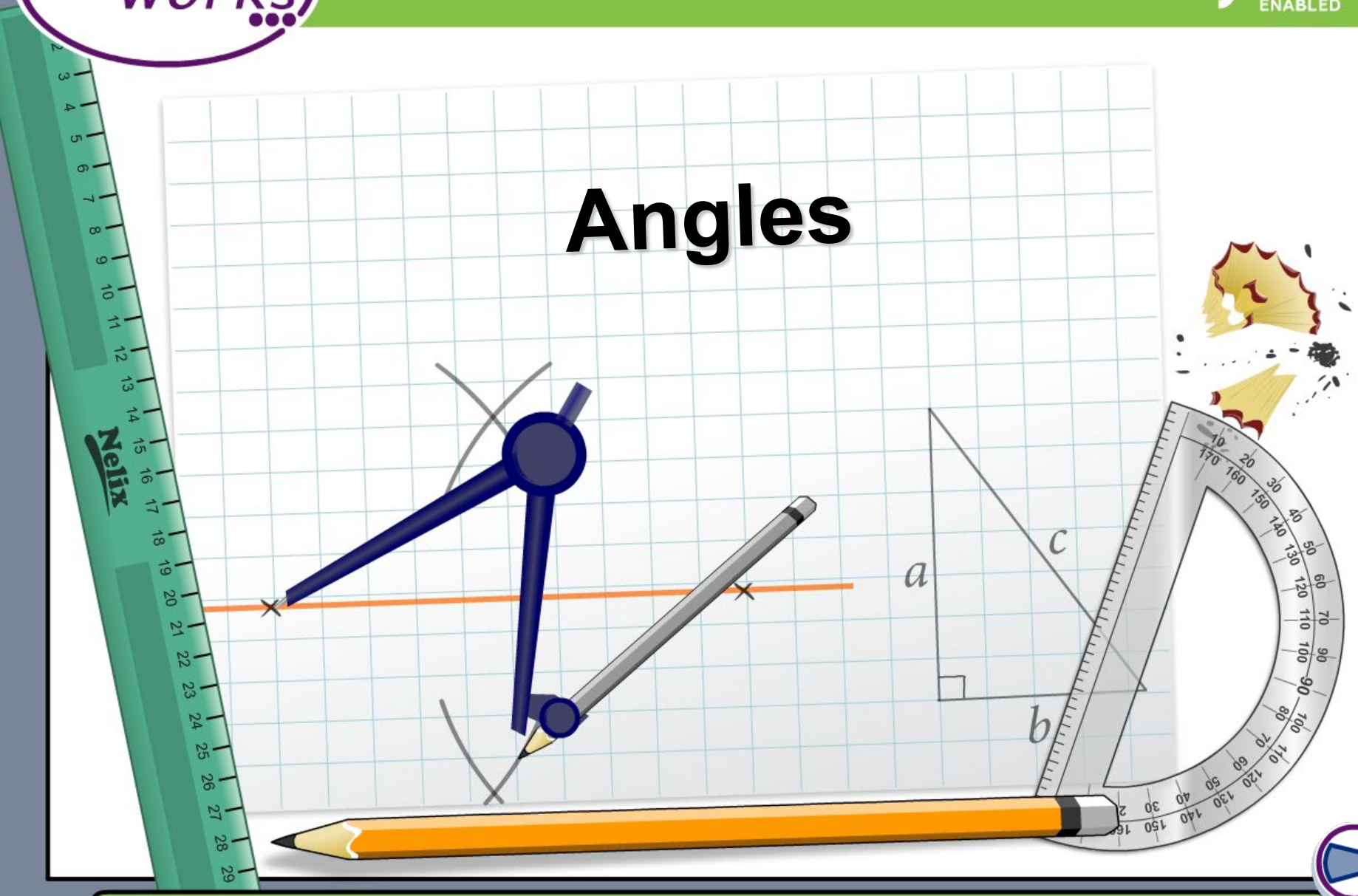
Angles



Information

Common core icons

This icon indicates a slide where the Standards for Mathematical Practice are being developed. Details of these are given in the Notes field.

Slides containing examples of mathematical modeling are marked with this stamp.

This icon indicates an opportunity for discussion or group work.

The **Standards for Mathematical Practice** outlined in the Common Core State Standards for Mathematics describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

These are:

1) Make sense of problems and persevere in solving them.

2) Reason abstractly and quantitatively.

3) Construct viable arguments and critique the reasoning of others.

4) Model with mathematics.

5) Use appropriate tools strategically.

6) Attend to precision.

7) Look for and make use of structure.

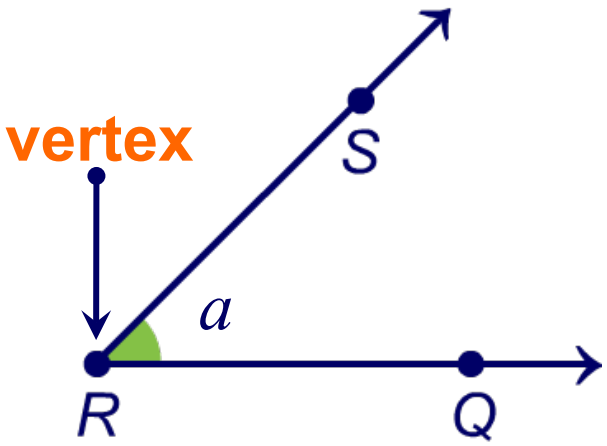
8) Look for and express regularity in repeated reasoning.

This icon indicates that the slide contains activities created in Flash. These activities are not editable.

This icon indicates teacher's notes in the Notes field.

Angles

A **angle** is formed by two rays with the same endpoint. This endpoint is called the **vertex** of the angle.



Angles can be labeled several ways using the angle symbol and:

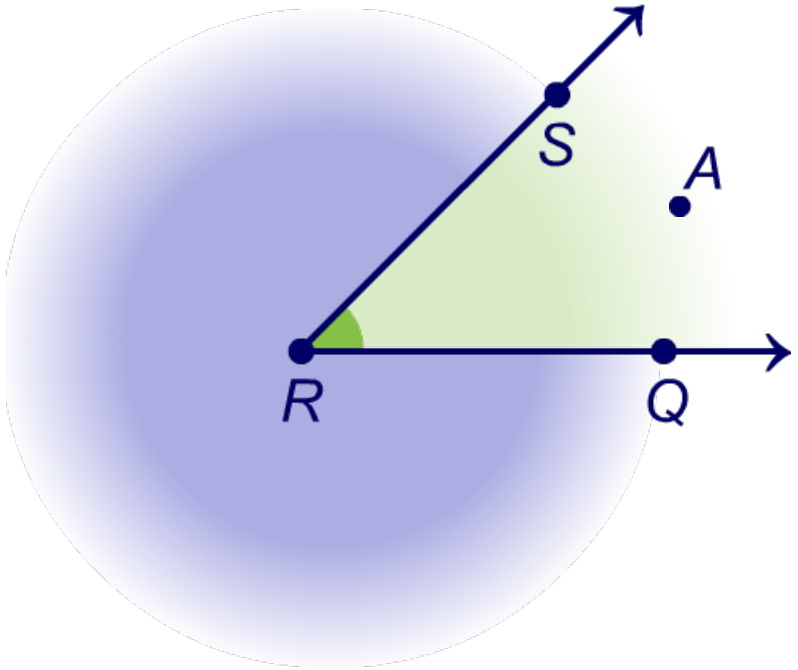
- the vertex and one point on each of the rays, where the vertex is always the second point listed: $\angle QRS$ or $\angle SRQ$
- a letter or number that names the angle: $\angle a$
- the vertex alone, if there are no other angles: $\angle R$

Interior and exterior of an angle

All angles have both an interior and an exterior.

The **interior** of an angle consists of all points in between the rays.

The **exterior** of an angle consists of all points outside the angle.



Is point A in the interior or exterior of angle $\angle SRQ$?

Point A is located in the interior of the angle because it is in between the rays of the angle.

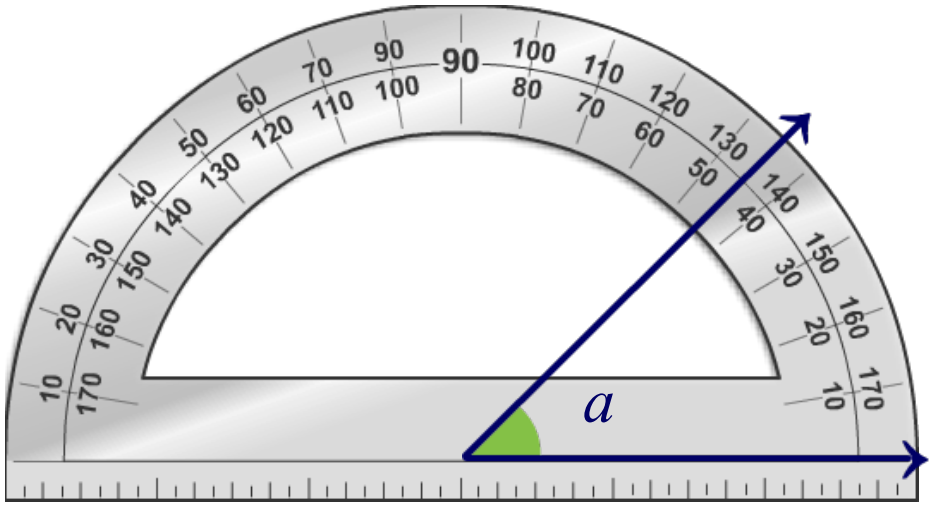
Measuring angles

Angles have a **measure** that describes the relationship between the two rays.

The measure of $\angle a$ is denoted $m\angle a$.

An angle is measured in degrees using a protractor:

$$m\angle a = 45^{\circ}$$



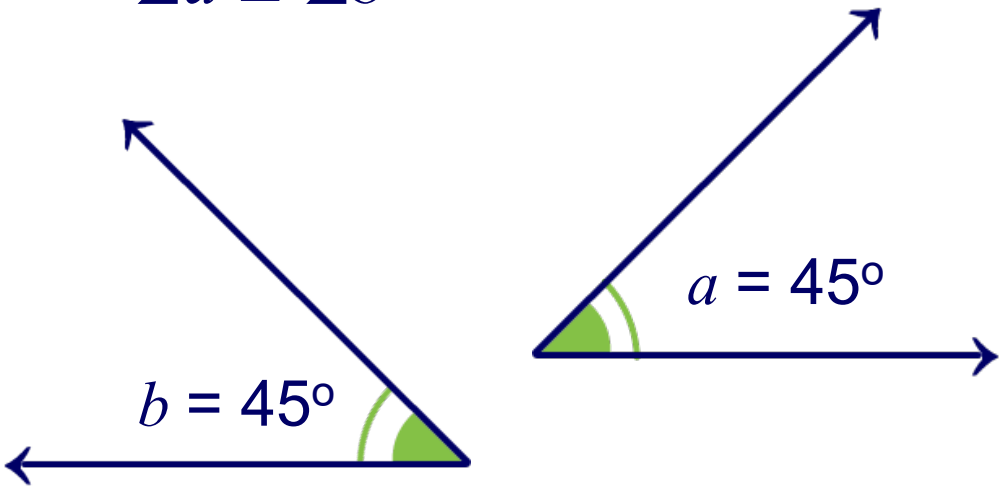
Congruent angles

Angles are **congruent** if they have the same measure.

$$m\angle a = m\angle b = 45^\circ$$

Congruent angles are denoted using the symbol ≅.

$$\angle a \cong \angle b$$



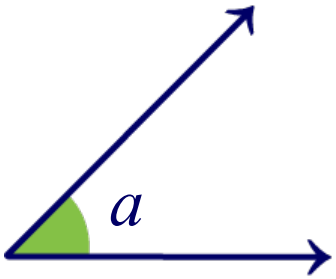
Congruent angles are noted with matching tick marks.

Classifying angles

Can you give the range of measure in degrees for each type of angle?

acute angle

$0° < m\angle a < 90°$

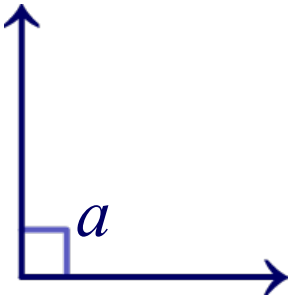


straight angle

$m\angle a = 180°$

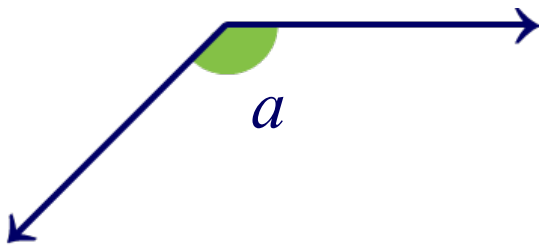
right angle

$m\angle a = 90°$



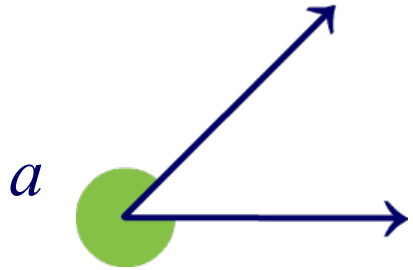
obtuse angle

$90° < m\angle a < 180°$



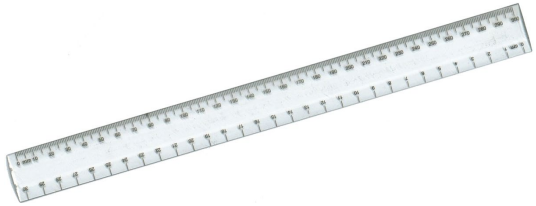
reflex angle

$180° < m\angle a < 360°$

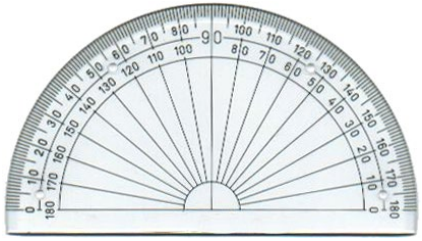


Equipment needed for constructions

Which equipment do you need for constructing angles?



ruler



protractor

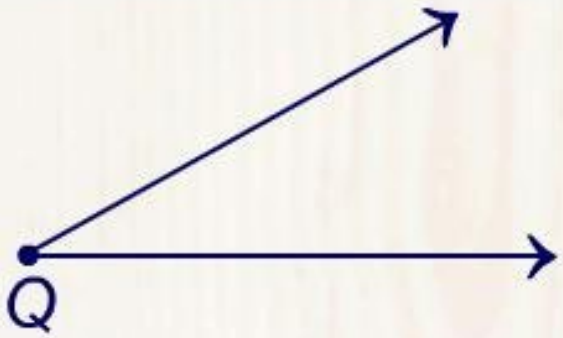
compass

sharp pencil

Constructing an angle

How can you make a copy of $\angle Q$ using only a ruler and a compass?

Press **play** to learn more.



Angle addition postulate

The *angle addition postulate* states that if S is in the interior of $\angle QRT$, then $m\angle QRS + m\angle SRT = m\angle QRT$

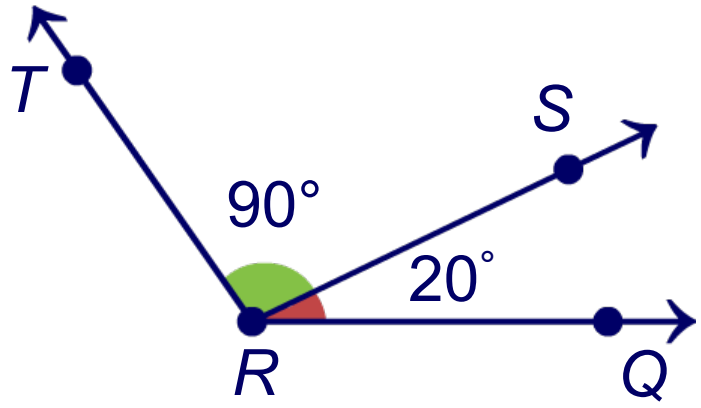
Find $m\angle QRS$ when $m\angle QRT = 115°$ and $m\angle SRT = 95°$.

substitute values into angle addition postulate:

$$115° = 95° + m\angle QRS$$

subtract 95°:

$$m\angle QRS = \mathbf{20°}$$



Angle bisector

The **angle bisector** is the ray that **bisects** an angle by dividing it into two congruent angles.

$$\angle TRM \cong \angle MRQ$$

If m$\angle QRT$ = 115°, what is the measure of $\angle QRM$ and $\angle QRT$?

divide 115° by two:

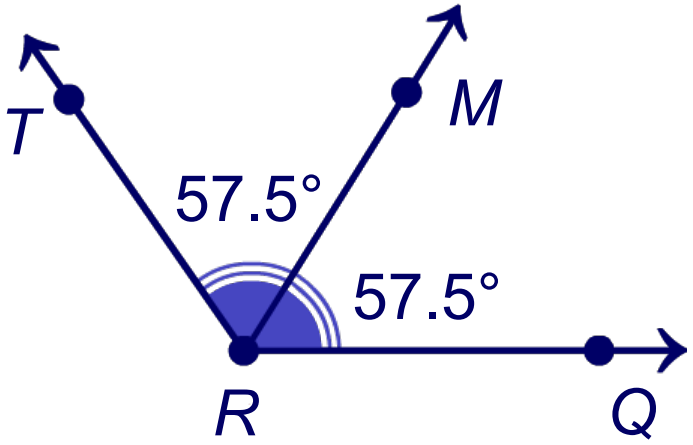
$$115° \div 2 = 57.5°$$

$\overline{RM}$ bisects the angle:

$$m\angle QRM = m\angle QRT$$

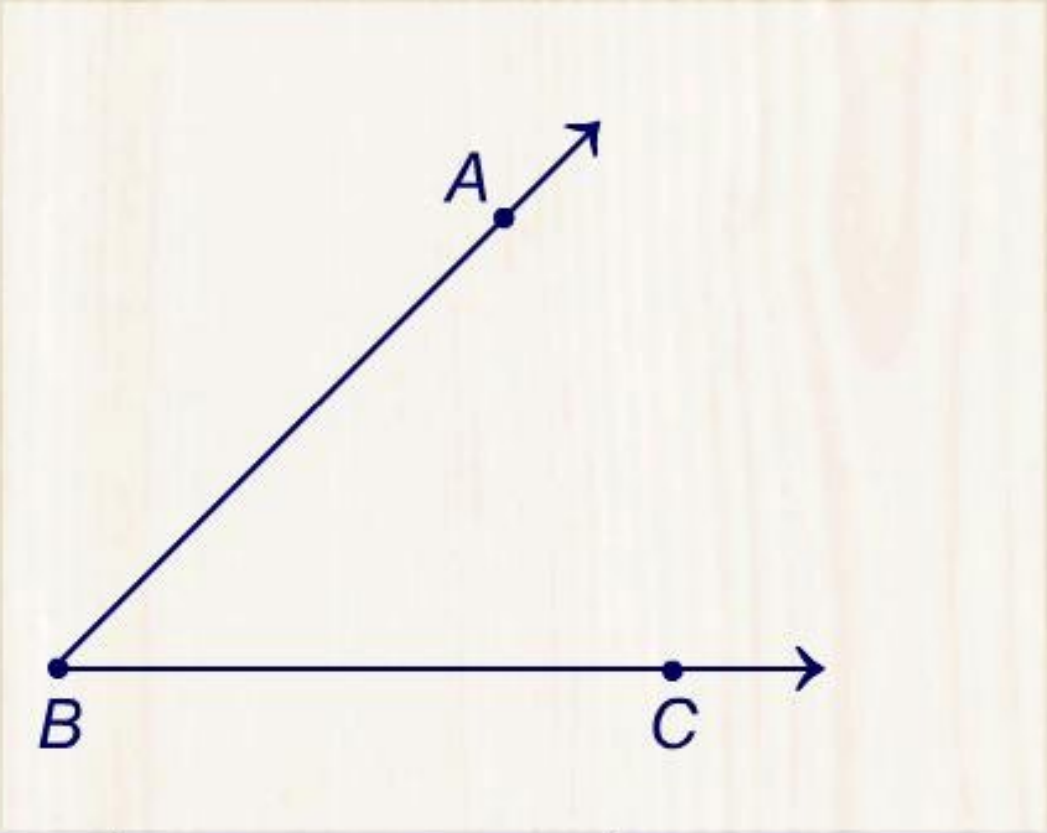
$$m\angle QRM = 57.5°$$

$$m\angle QRT = 57.5°$$



Constructing the bisector of an angle

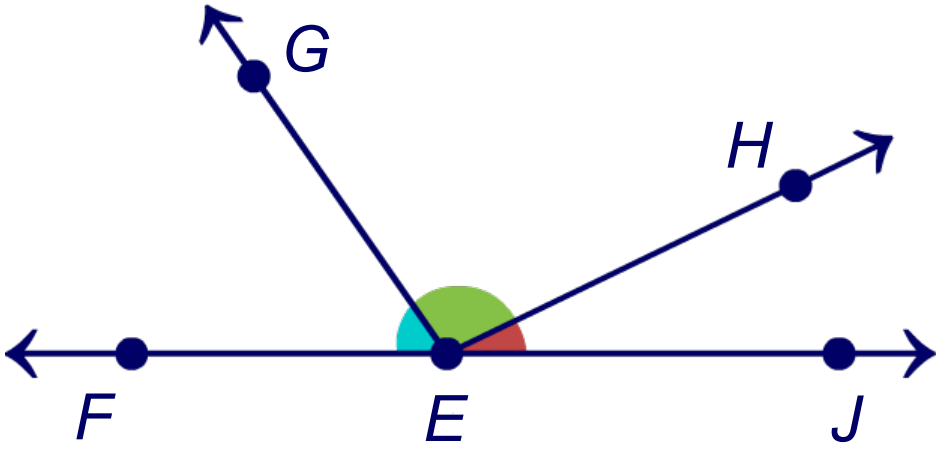
Press **play** to see how to construct the bisector of an angle $\angle ABC$ using a ruler and a compass.



Adjacent angles

Adjacent angles are two angles that share exactly one side and a vertex.

How many adjacent pairs are in the figure below? Identify the common ray and vertex of each pair.



$\angle FEG$ and $\angle GEH$, $\overline{EG}$

$\angle FEG$ and $\angle GEJ$, $\overline{EG}$

$\angle GEH$ and $\angle HEJ$, $\overline{HE}$

$\angle FEH$ and $\angle HEJ$, $\overline{HE}$

All the pairs share the same vertex at point E.

Linear pairs

Two adjacent angles on a line are called a **linear pair**.

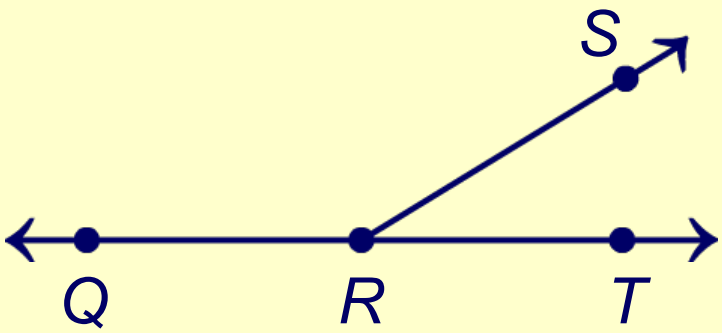
The measures of linear pairs of angles add up to 180°.

Prove the theorem above.

straight angle: $m\angle QRT = 180°$

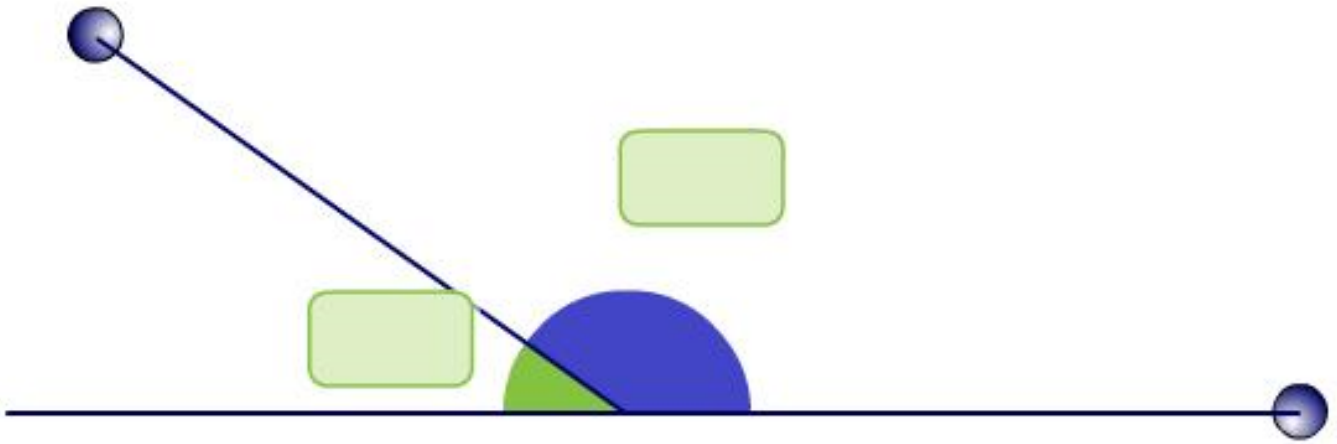
angle addition postulate: S is in the interior of $\angle QRT$

therefore: $m\angle QRS + m\angle SRT = m\angle QRT = \mathbf{180°}$ ✓



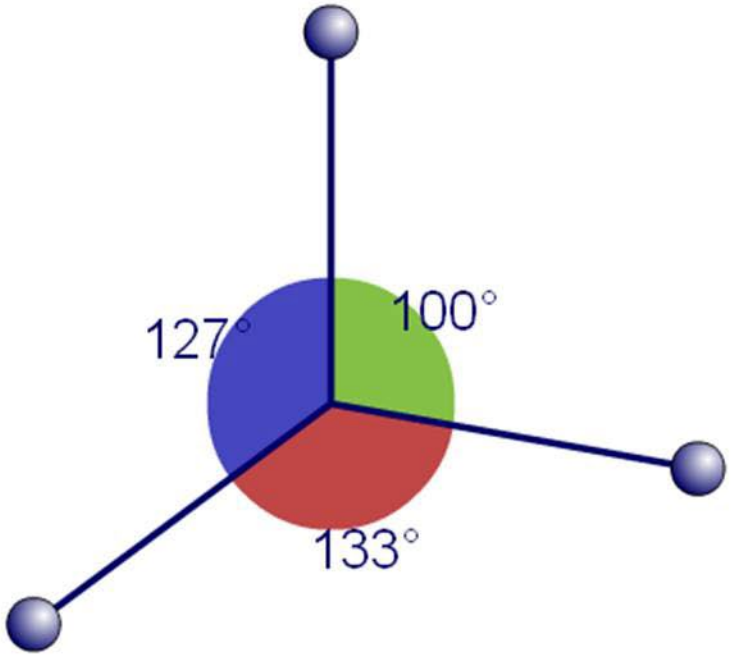
Angles on a line segment

Drag the left circle to change the angles.
Drag the right circle to add a third angle.



Angles around a point

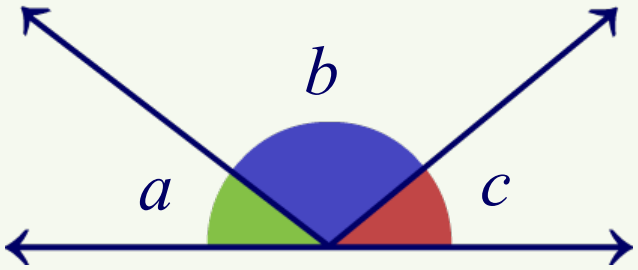
Drag the points to change the angles.
Calculate the missing ones and click to reveal the answers.



Angles on a line and around a point

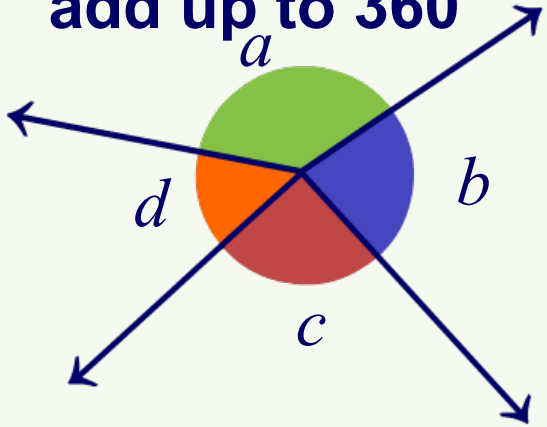
Using similar logic that proved linear pairs of angles add up to 180°, can you prove the following two theorems?

angles along a line add up to 180°



$m\angle a + m\angle b + m\angle c = 180°$

angles around a point add up to 360°

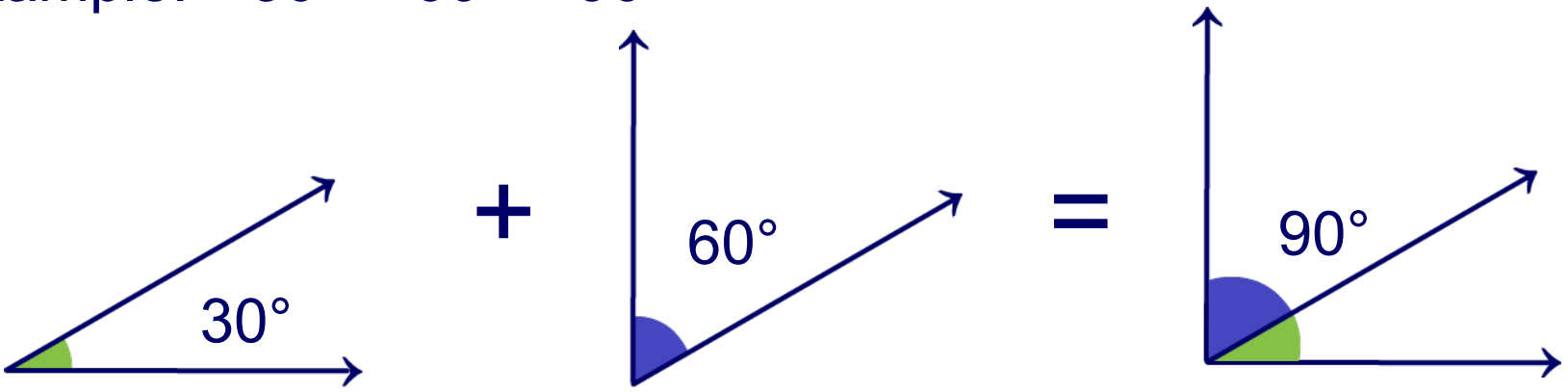


$m\angle a + m\angle b + m\angle c + m\angle d = 360°$

Complementary angles

The measures of two **complementary angles** add up to 90°.
Angles do not have to be adjacent to be complementary.

example: 30° + 60° = 90°



Can you give the measures of the missing complementary angles?

42° + **48°** = 90°

63° + **27°** = 90°

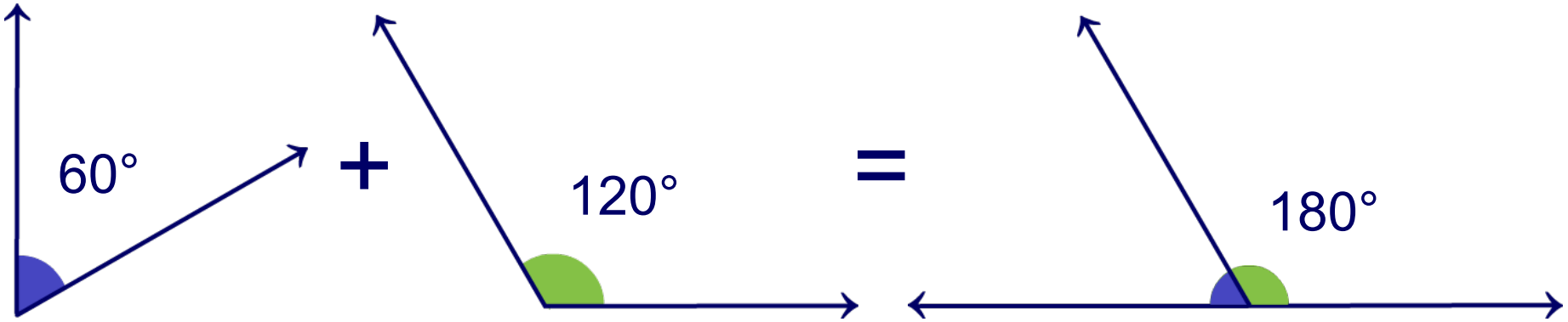
15° + **75°** = 90°

79° + **11°** = 90°

Supplementary angles

The measures of two **supplementary angles** add up to 180°.
Angles do not have to be adjacent to be supplementary.

example: 60° + 120° = 180°



Are the following angles complementary or supplementary? Give the missing measure.

22° + **68°** = 90°
complementary

87° + 93° = 180°
supplementary

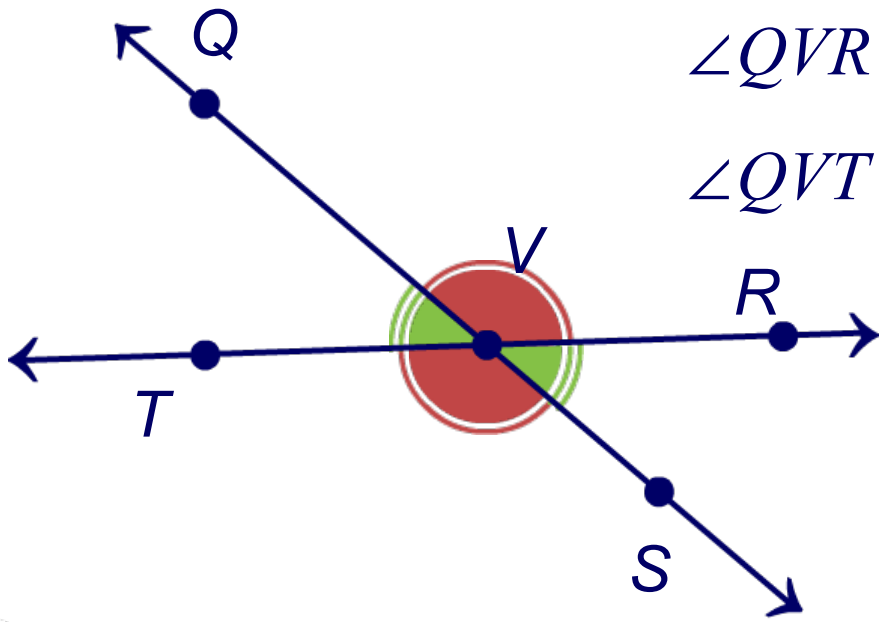
79° + 101° = **180°**
supplementary

11° + 79° = **90°**
complementary

Vertical angles

Vertical angles are nonadjacent pairs created by two intersecting lines.

Name the vertical angles in the figure below. What conjectures can you make about the measures of these pairs of angles?



$\angle QVR$ and $\angle TVS$ are vertical angles.

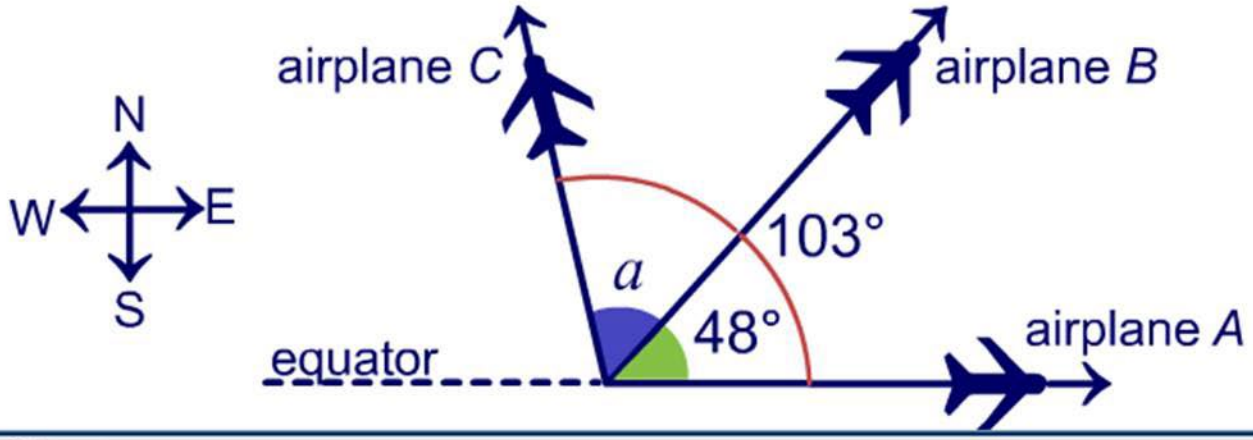
$\angle QVT$ and $\angle RVS$ are vertical angles.

Vertical angle pairs are congruent.

Angles quiz

Question: 1/6

Three planes leave an airport on the equator. Airplane A flies east, airplane B flies at a 48° angle to the equator and airplane C flies at a 103° angle to the equator. What is the measure of angle a, the angle between the paths of airplanes B and C?



A) 90°

B) 55°

C) 42°