Teach Yourself Trigonometry

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Part 3 : Radian Measure

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Before you begin:

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Before you begin:

Understand that learning happens best when the learner puts in **real effort**.

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That's you!

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Understand that learning happens best when the learner puts in **real effort**.
Be willing to **work hard** to understand the concepts as you progress.

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Understand that learning happens best when the learner puts in **real effort**.
Be willing to **work hard** to understand the concepts as you progress.
Finally, do not rush through this.

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Understand that learning happens best when the learner puts in **real effort**. Be willing to **work hard** to understand the concepts as you progress. Finally, do not rush through this. In this case, it means **doing the activities** along with the lessons.

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Understand that learning happens best when the learner puts in **real effort**. Be willing to **work hard** to understand the concepts as you progress. Finally, do not rush through this. In this case, it means **doing the activities** along with the lessons. Do your best to understand each concept **before** moving on to the next slide. Good Luck.

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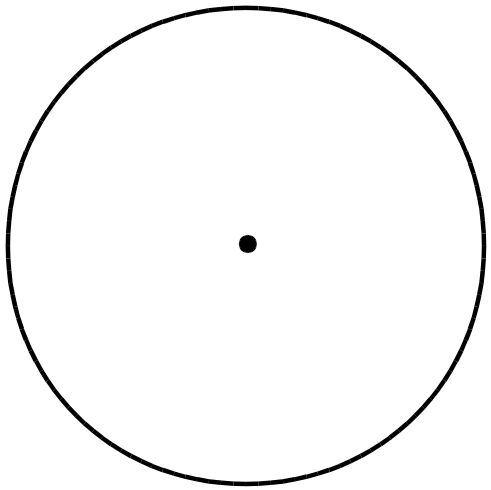

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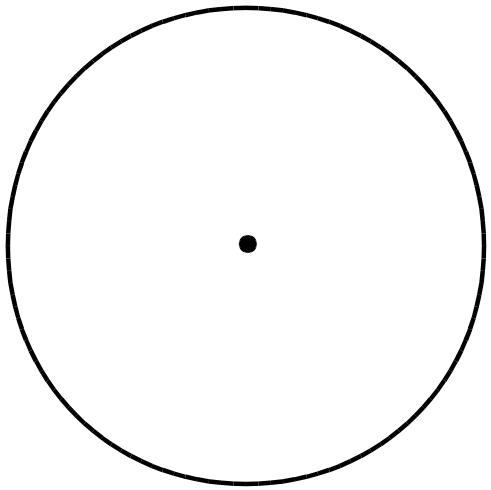

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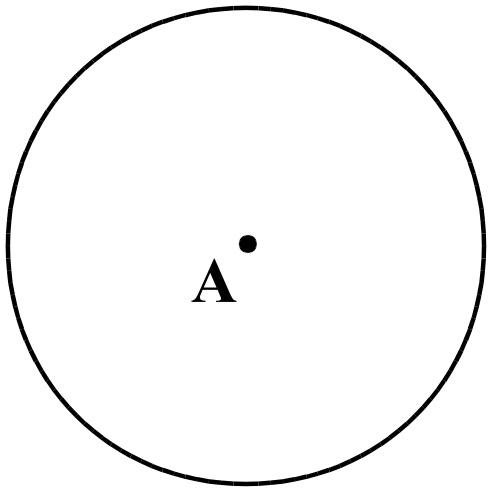

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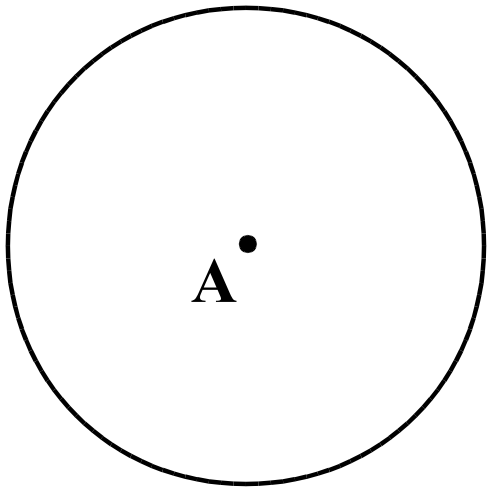

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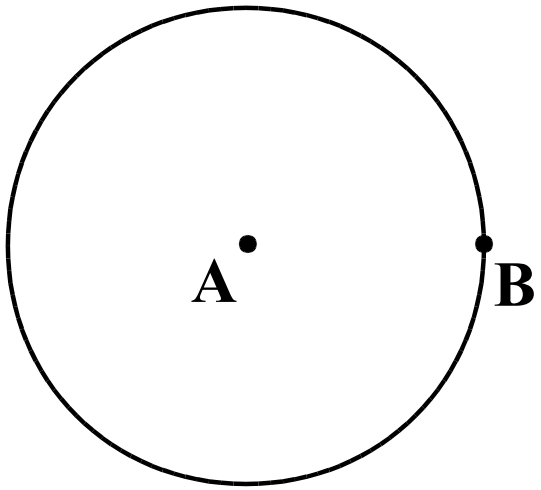

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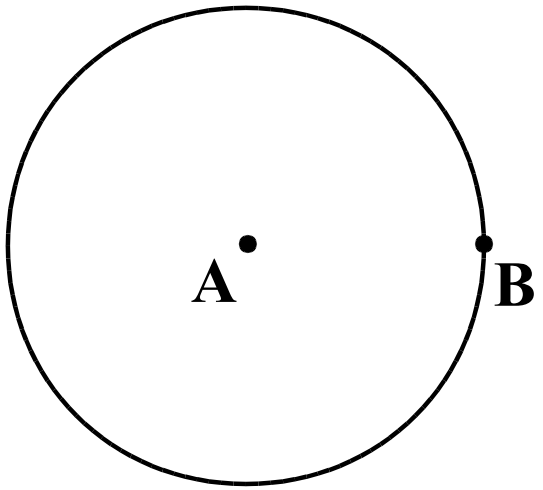

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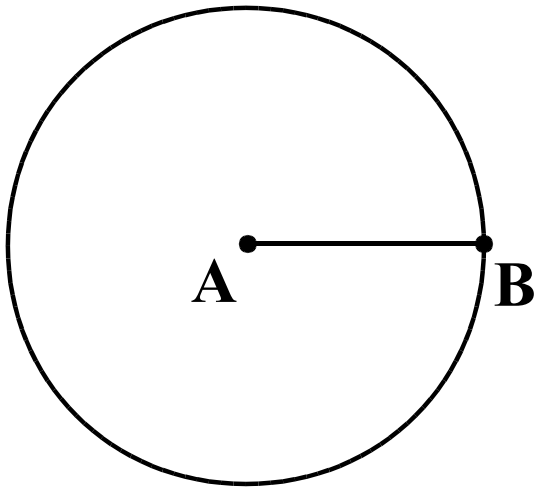

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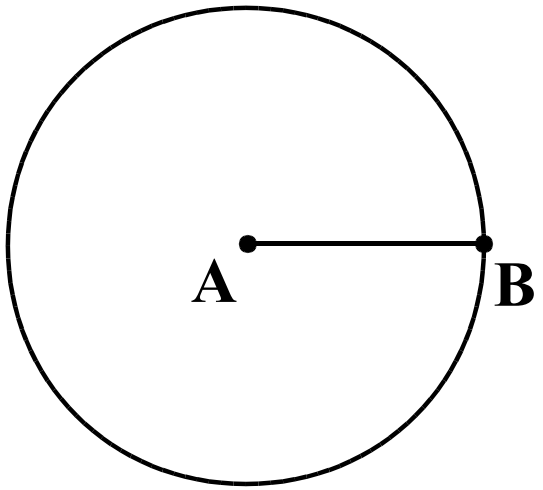

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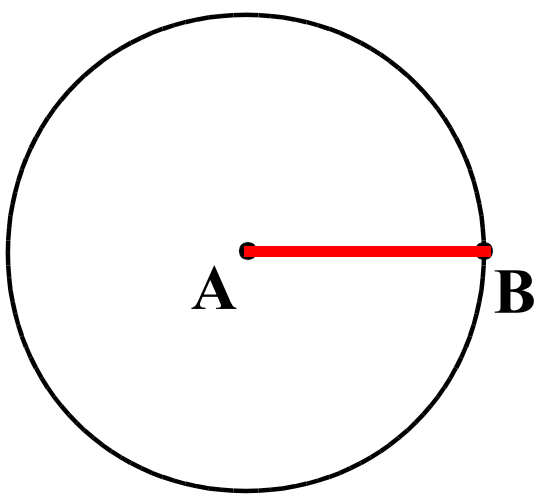

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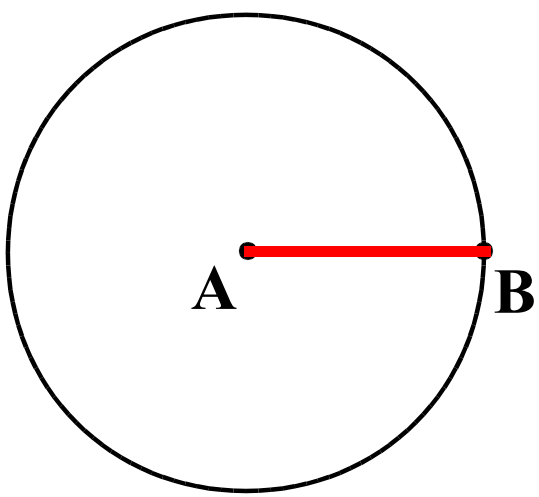

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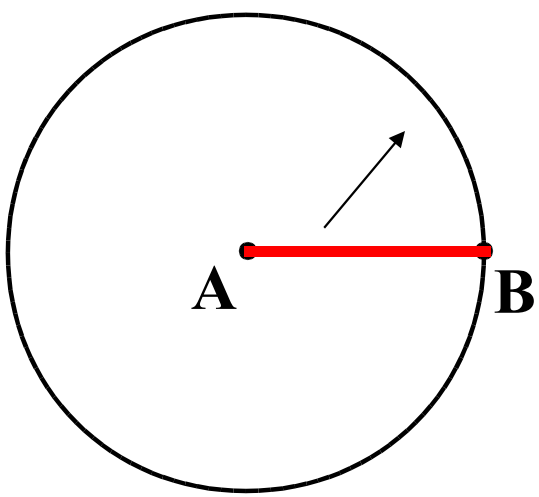

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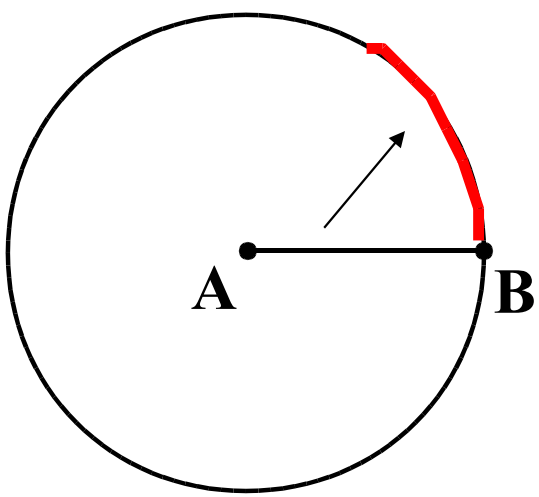

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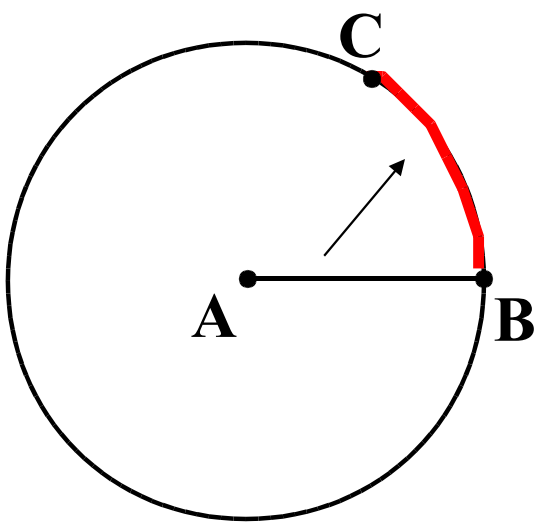

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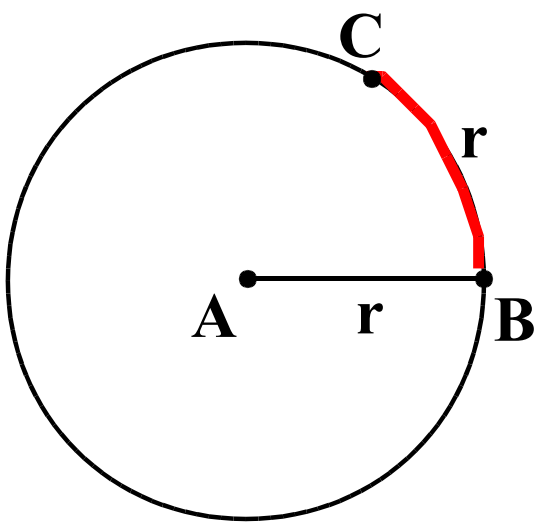

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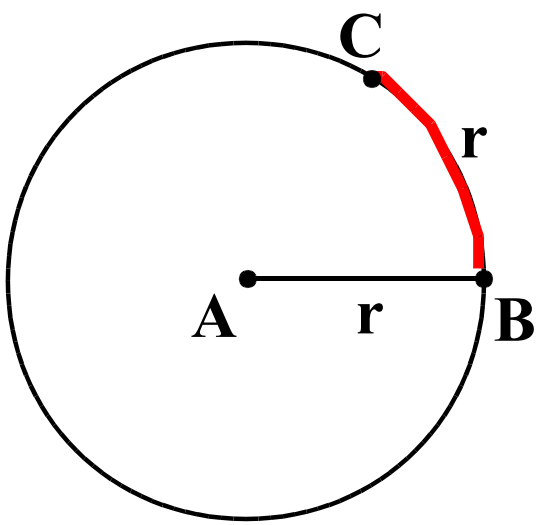

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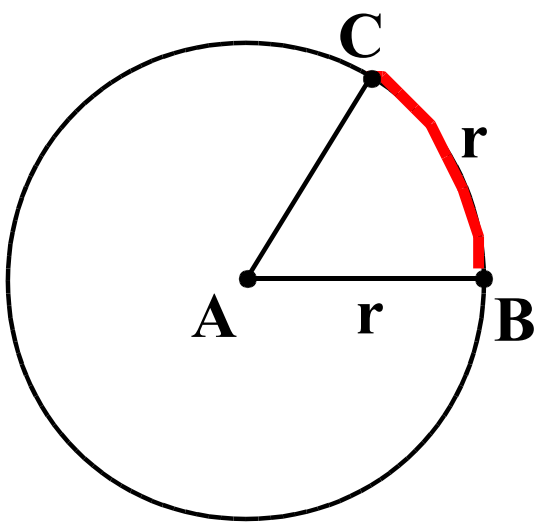

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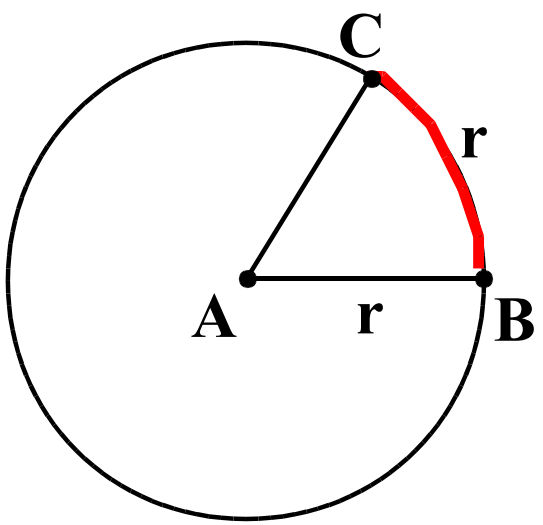
Angle CAB is a central angle of circle A.



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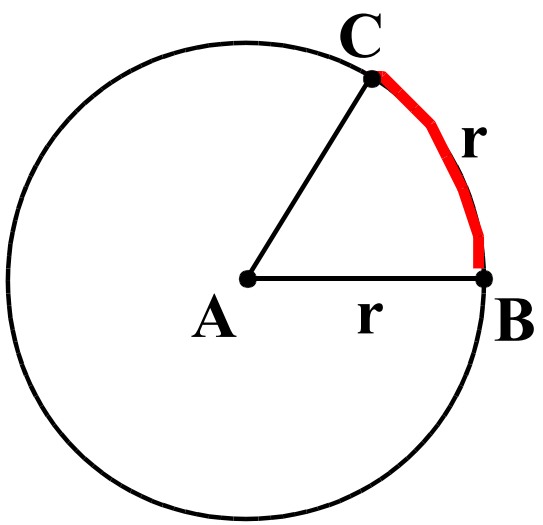
Angle CAB is a central angle of circle A.

Angle CAB 'intercepts' arc BC of the circle.



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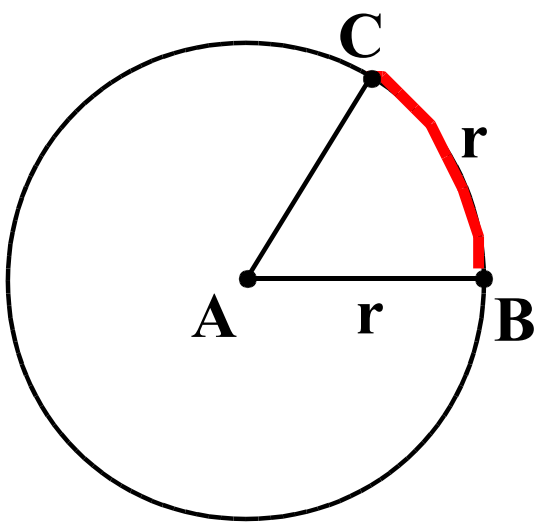

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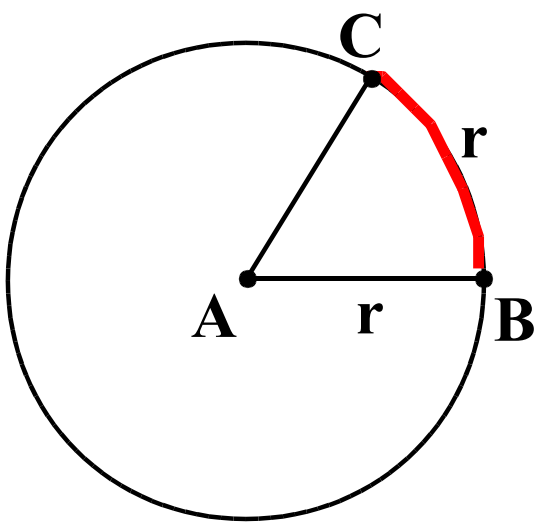

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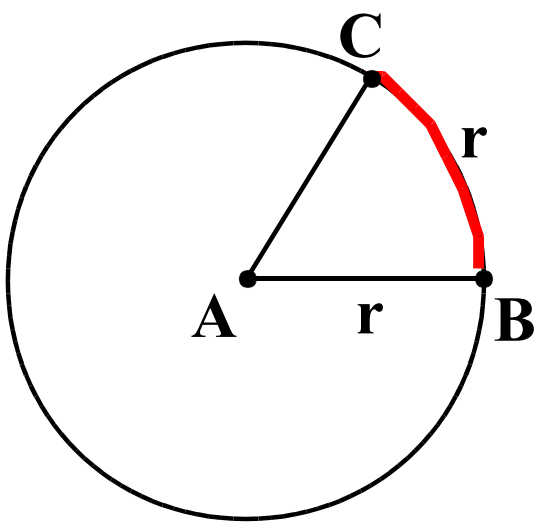

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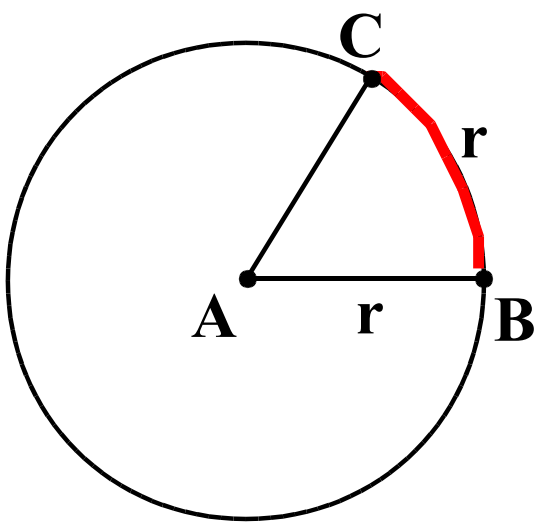

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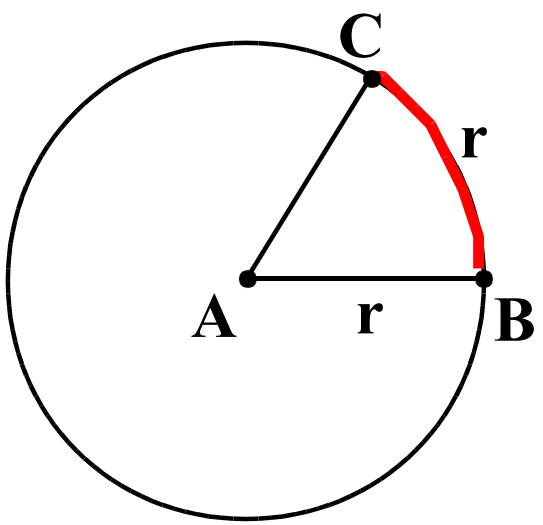

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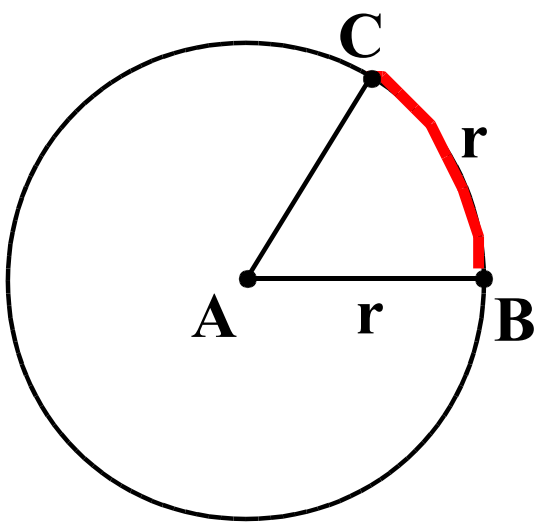

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The radian measure of angle CAB =

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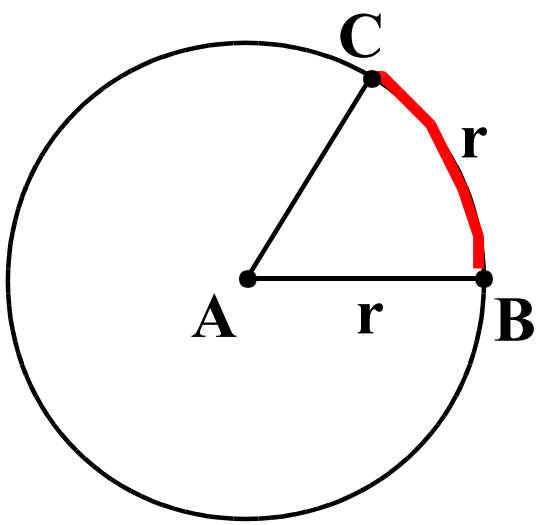

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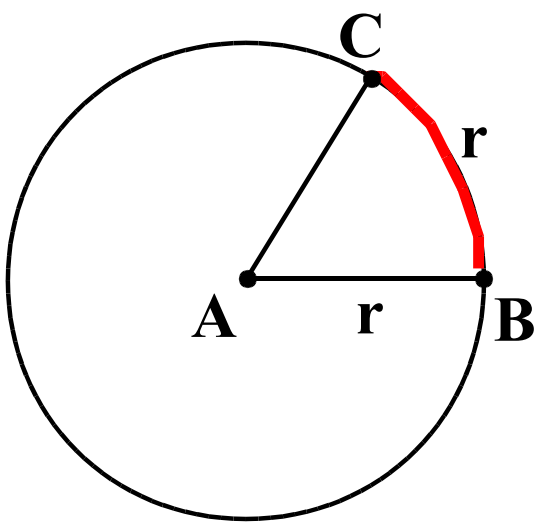

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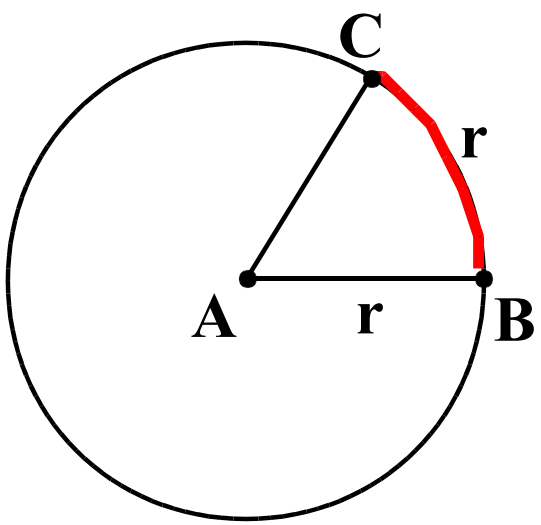

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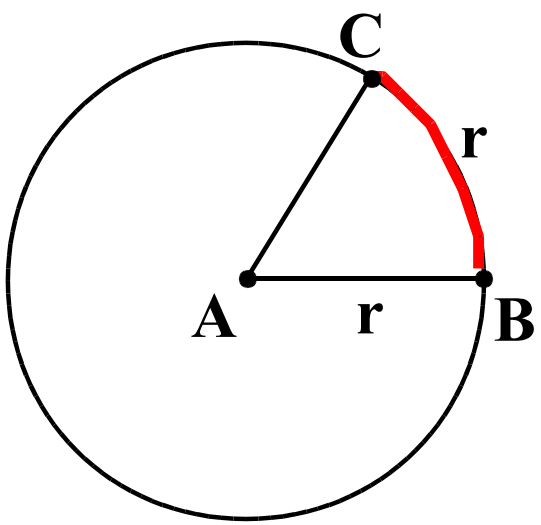

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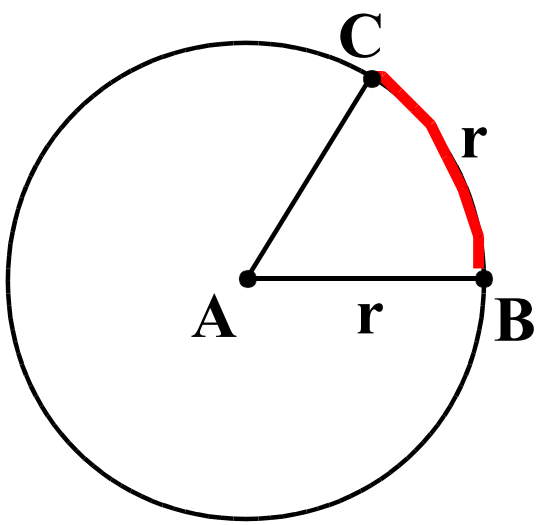

Angle CAB is a central angle of circle A.

Angle CAB 'intercepts' arc BC of the circle.

By definition, the radian measure of an angle is equal to the length of the intercepted arc divided by the radius of the circle.

What is the radian measure of angle CAB?

The radian measure of angle CAB = $\frac{\mathbf{r}}{}$

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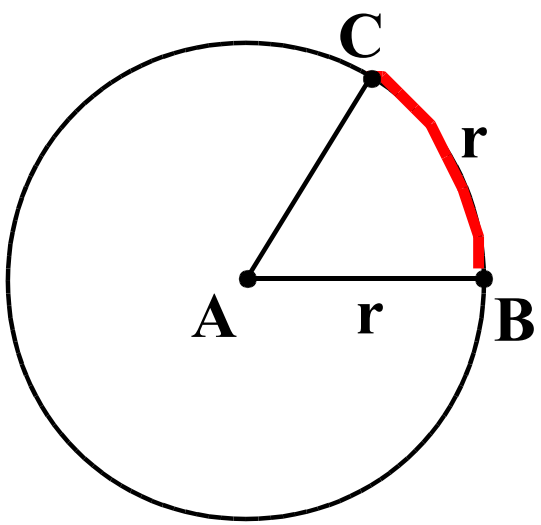

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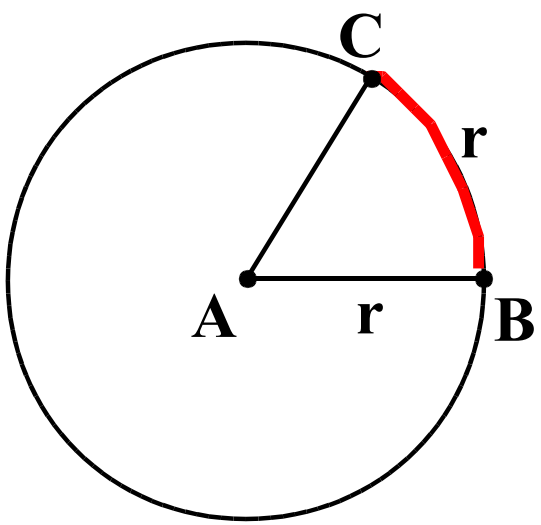

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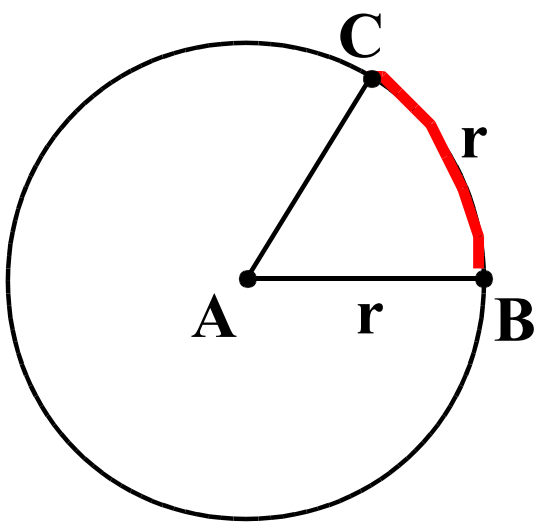

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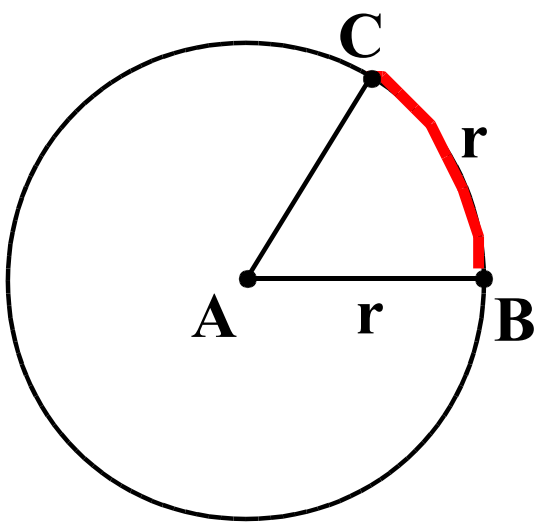

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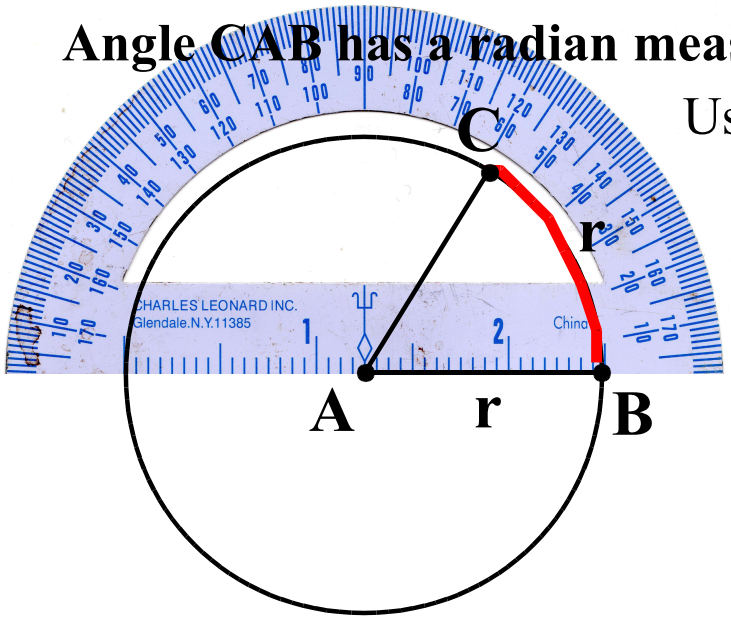

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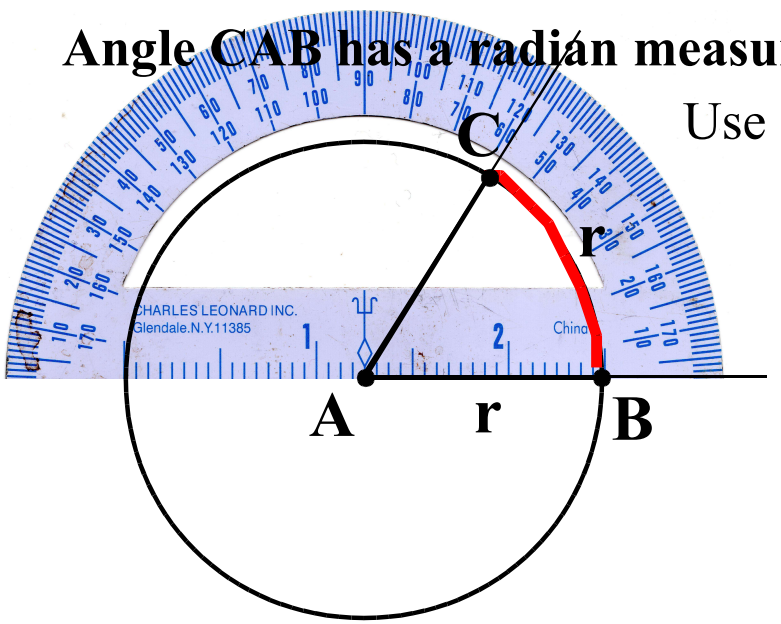

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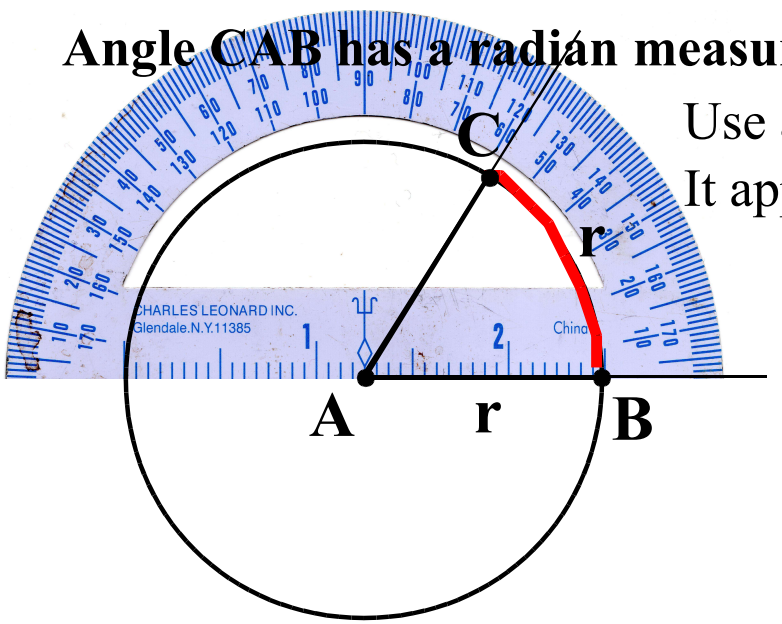

Use a protractor to measure angle CAB in degrees. It appears to be a little less than 60 degrees.

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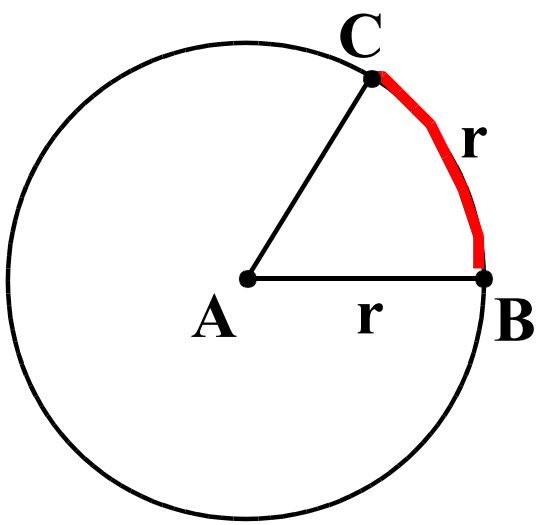

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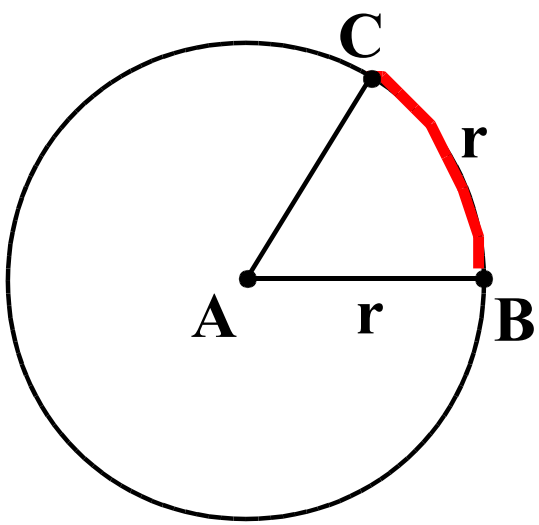

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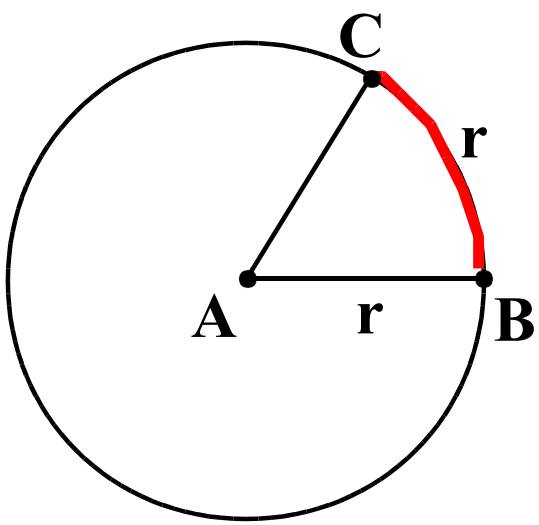

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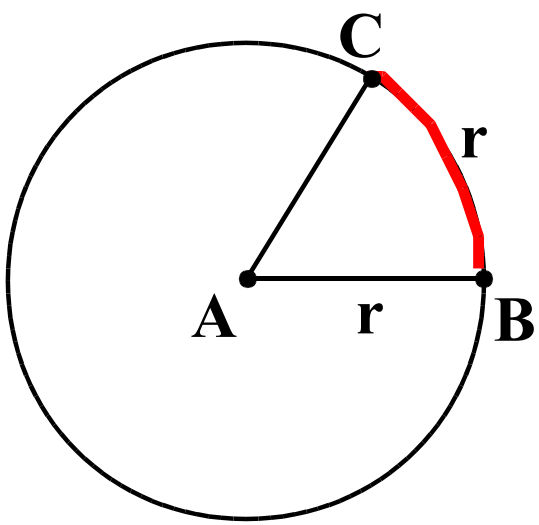

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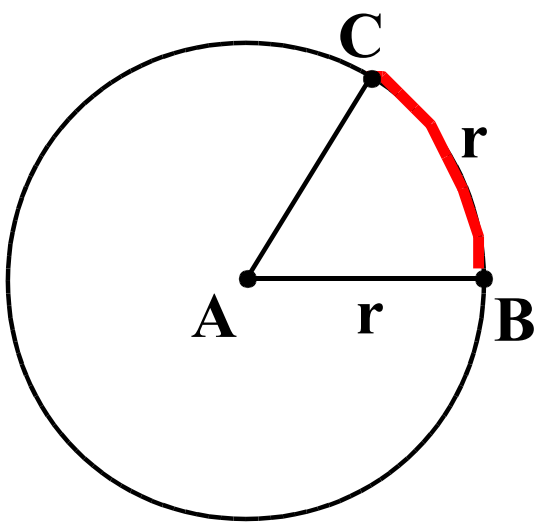

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It is important to know the relationship between various units so that you can convert from one unit to another. Here, we have found that one radian is a little less that 60 degrees. We need to be more precise. We can use the definition of radian measure to determine a more precise relationship.

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Part 3 : Radian Measure

Our goal is to determine a more precise relationship between degree measure and radian measure.

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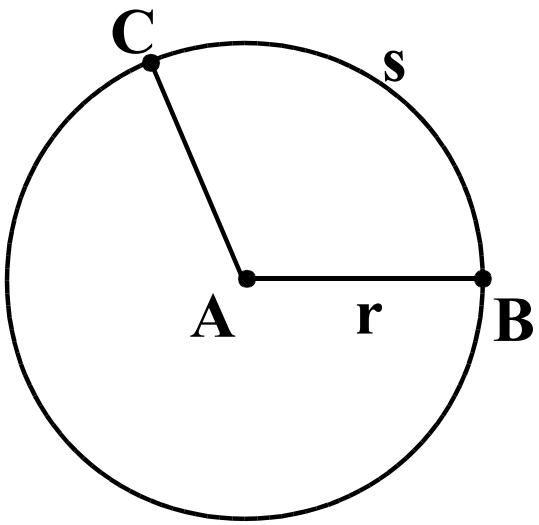

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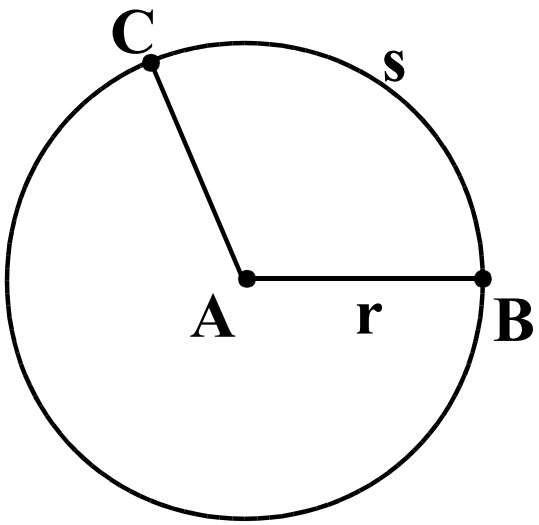

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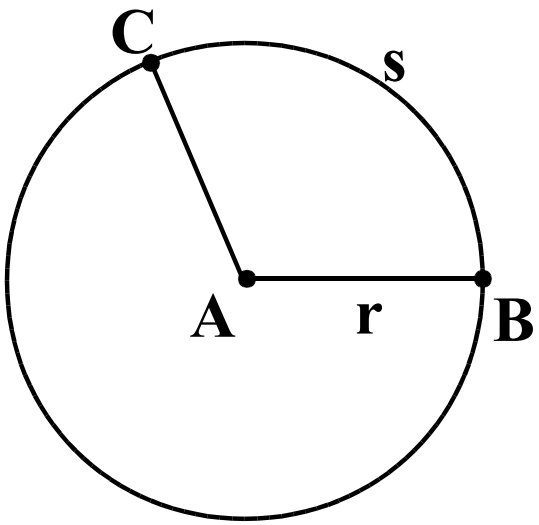

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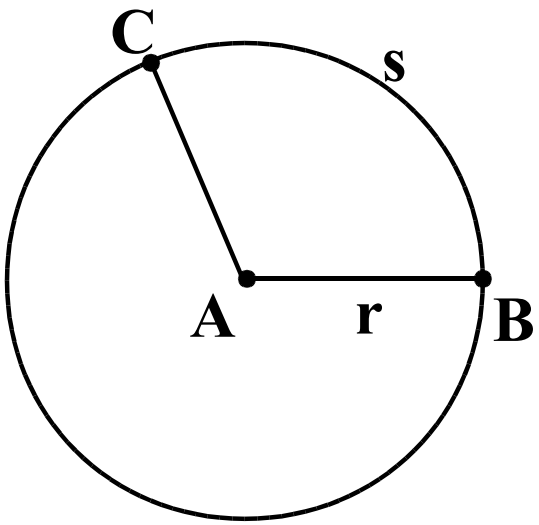

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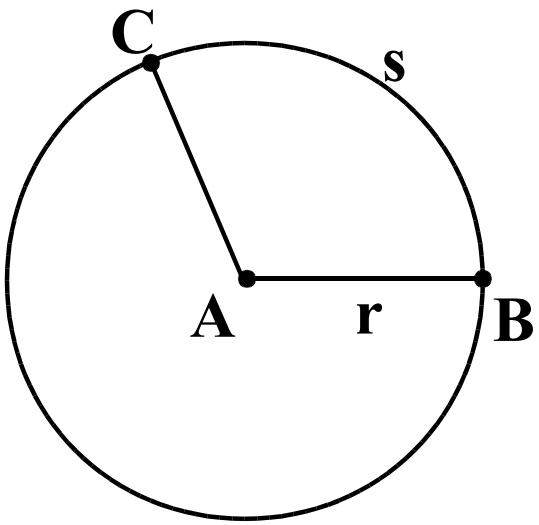

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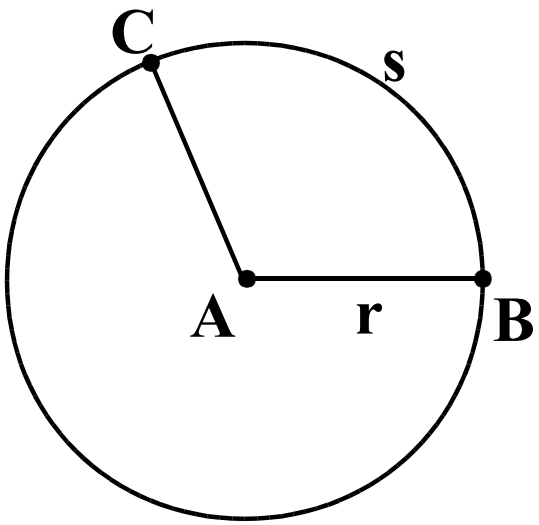

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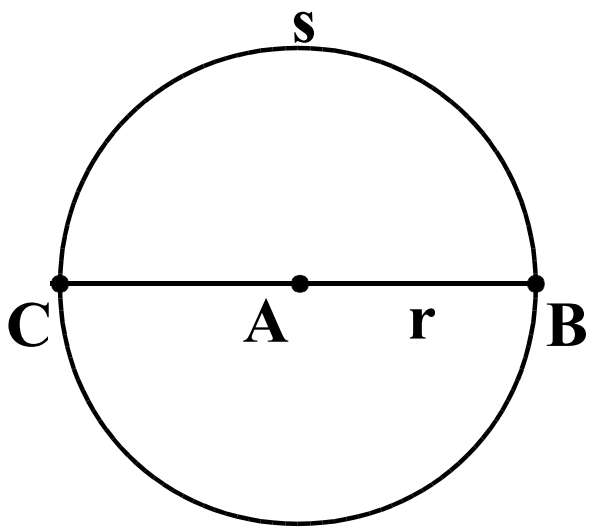

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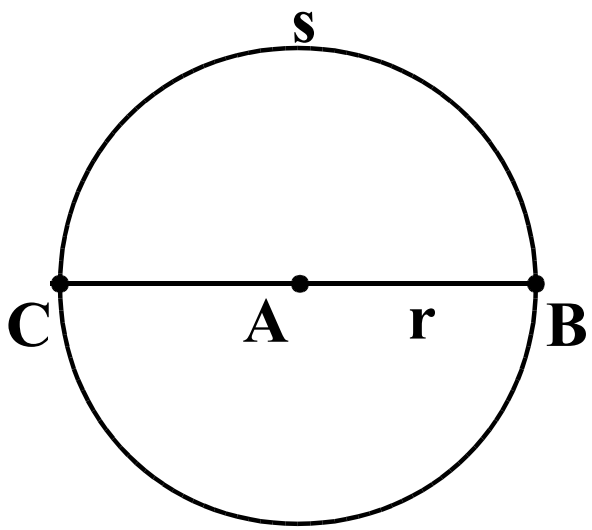

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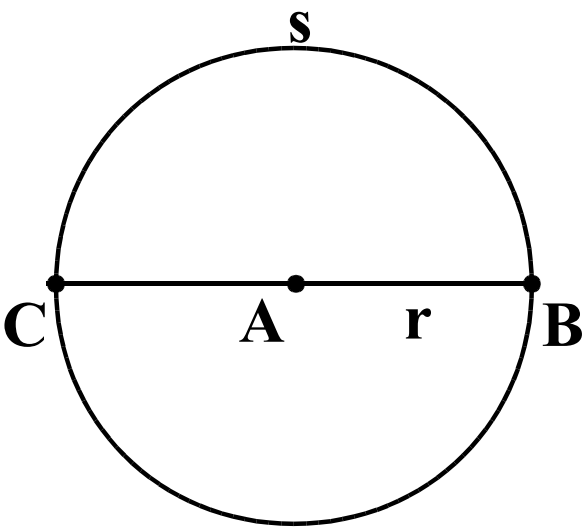

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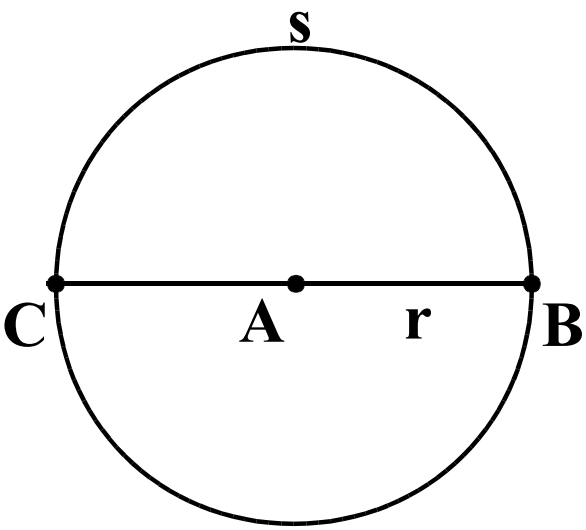

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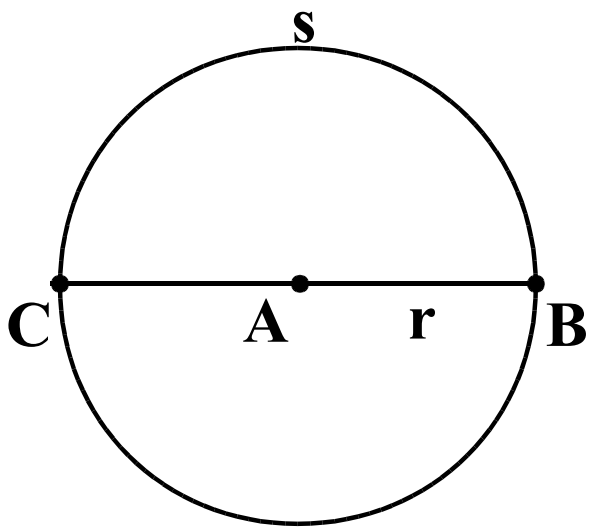

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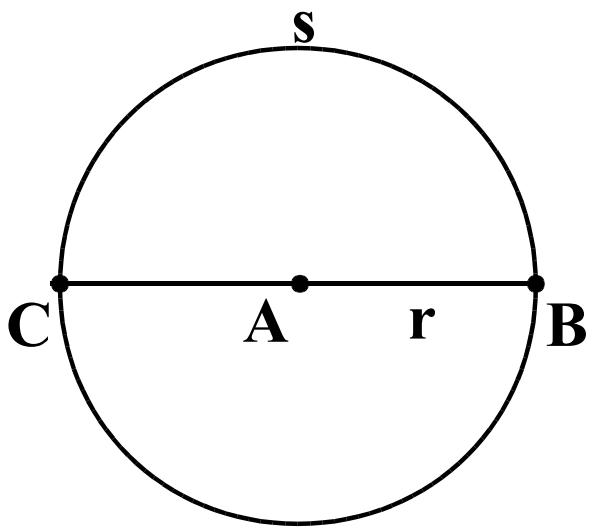

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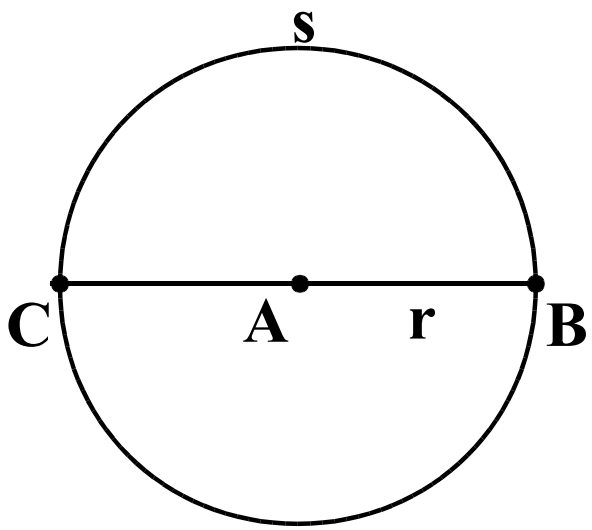

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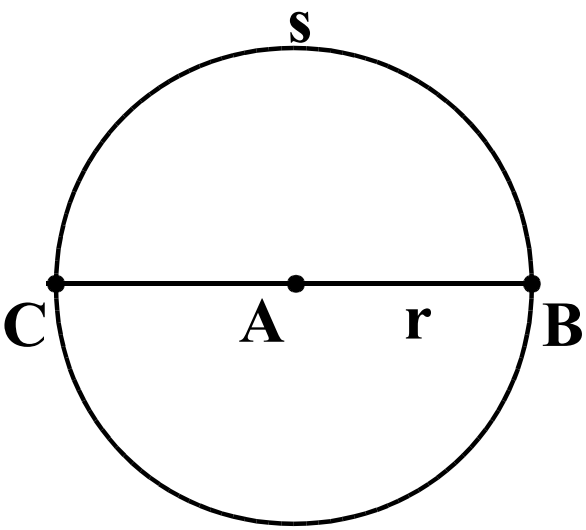

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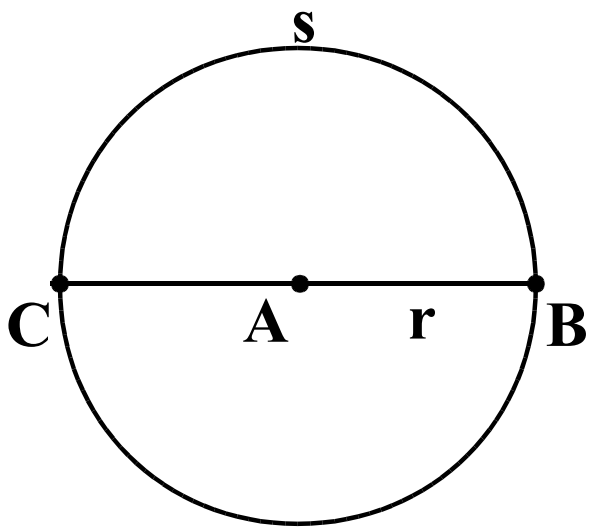

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Therefore, 180 degrees is equivalent to π radians !!

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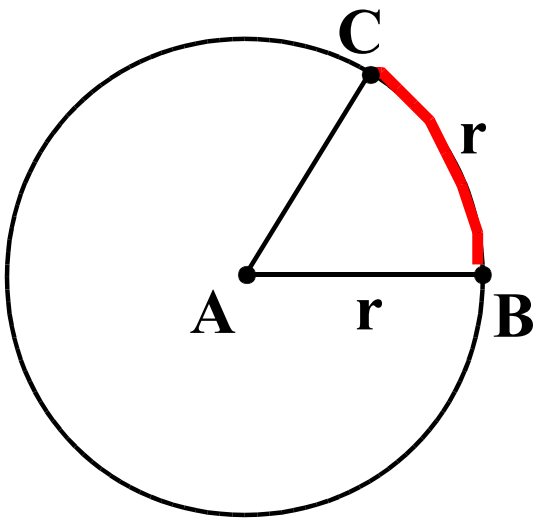
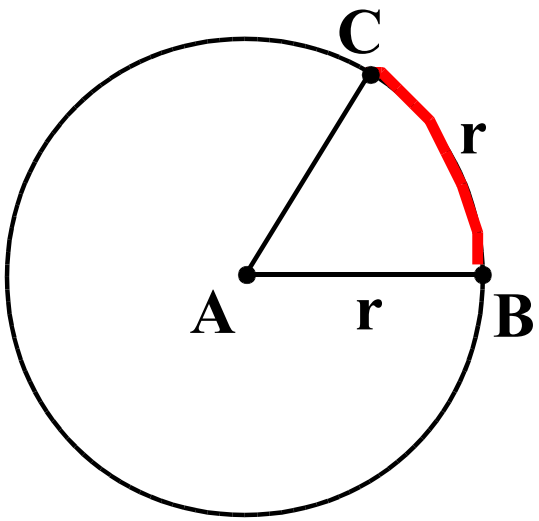
Part 3 : Radian Measure

Let's return to this diagram.



Teach Yourself Trigonometry

Part 3 : Radian Measure

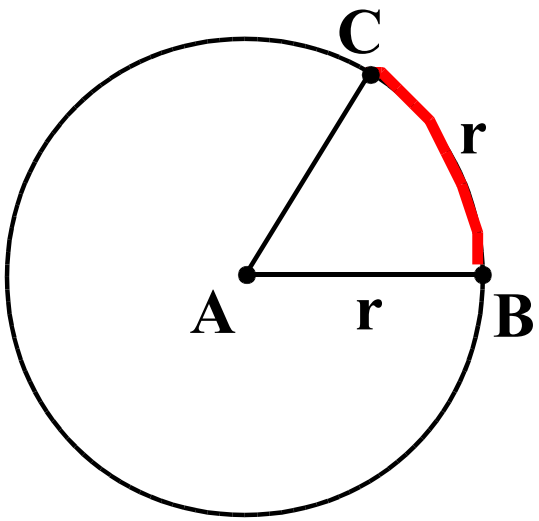


Let's return to this diagram.

Recall that angle CAB has a radian measure of 1.

Teach Yourself Trigonometry

Part 3 : Radian Measure

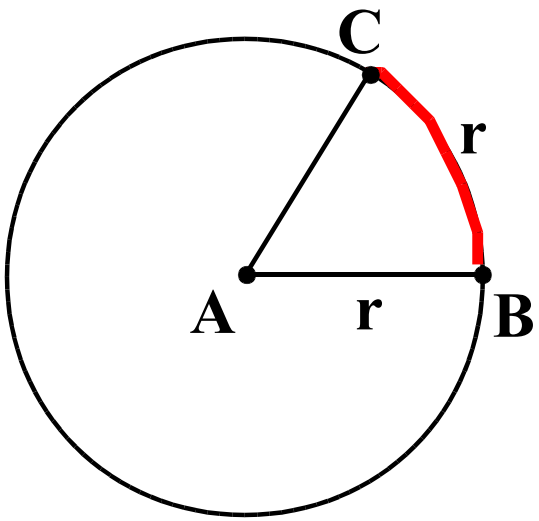


Let's return to this diagram.

Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

Teach Yourself Trigonometry

Part 3 : Radian Measure



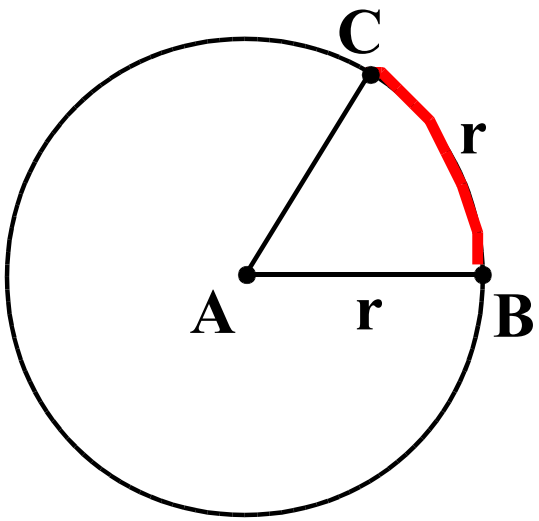
Let's return to this diagram.

Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

Teach Yourself Trigonometry

Part 3 : Radian Measure



Let's return to this diagram.

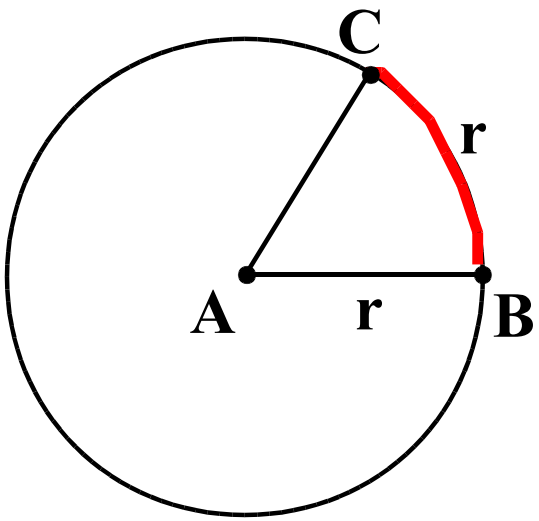
Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

Therefore, 1 radian =

Teach Yourself Trigonometry

Part 3 : Radian Measure



Let's return to this diagram.

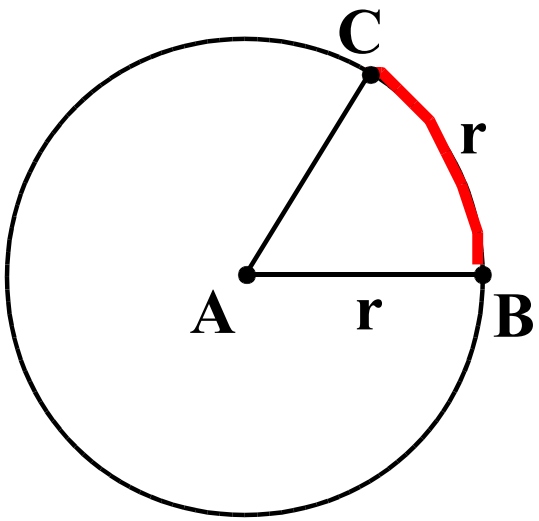
Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

Therefore, 1 radian = $\frac{180}{}$

Teach Yourself Trigonometry

Part 3 : Radian Measure



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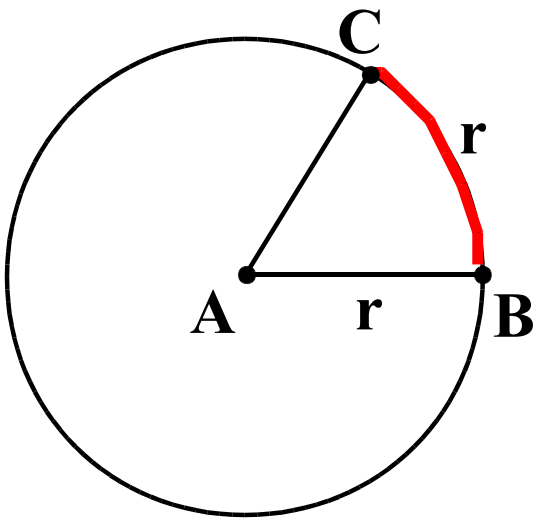
Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

Therefore, 1 radian = $\frac{180}{\pi}$

Teach Yourself Trigonometry

Part 3 : Radian Measure



Let's return to this diagram.

Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

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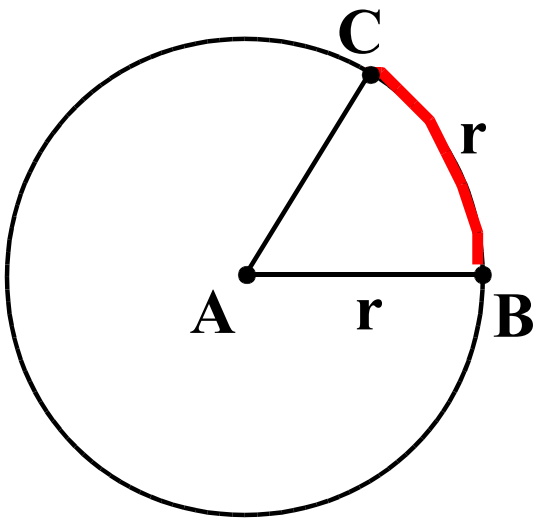
Therefore, 1 radian = $\frac{180}{\pi}$ degrees

Teach Yourself Trigonometry

Part 3 : Radian Measure



Let's return to this diagram.

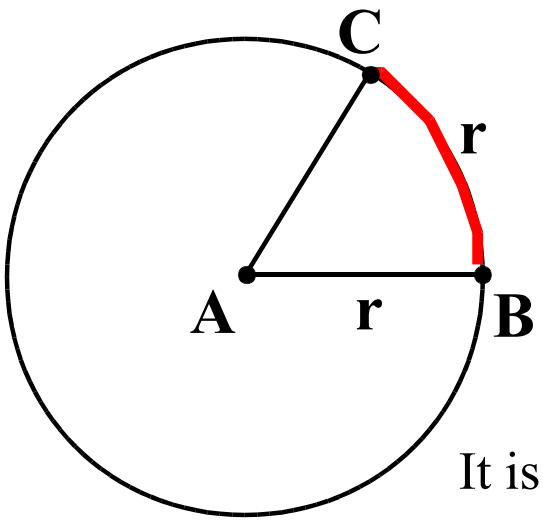
Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

Therefore, 1 radian = $\frac{180}{\pi}$ degrees or about 57.3 degrees.

Teach Yourself Trigonometry

Part 3 : Radian Measure



Let's return to this diagram.

Recall that angle CAB has a radian measure of 1. We estimated that one radian is a little less than 60 degrees.

We have since proven that π radians = 180 degrees.

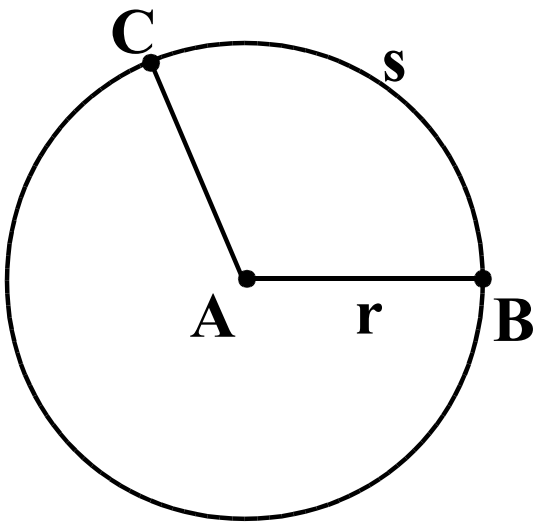
Therefore, 1 radian = $\frac{180}{\pi}$ degrees or about 57.3 degrees.

It is very important to <u>understand</u> that **π radians = 180 degrees**.

Teach Yourself Trigonometry

Part 3 : Radian Measure

Let's return to this diagram and the definition of radian measure.



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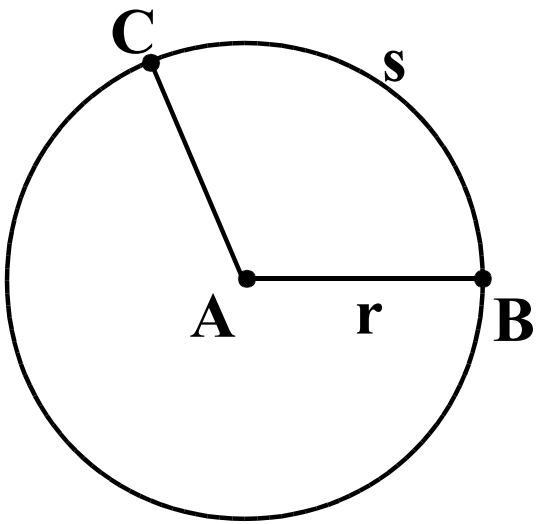

Recall that the radian measure of angle CAB is $\frac{s}{r}$.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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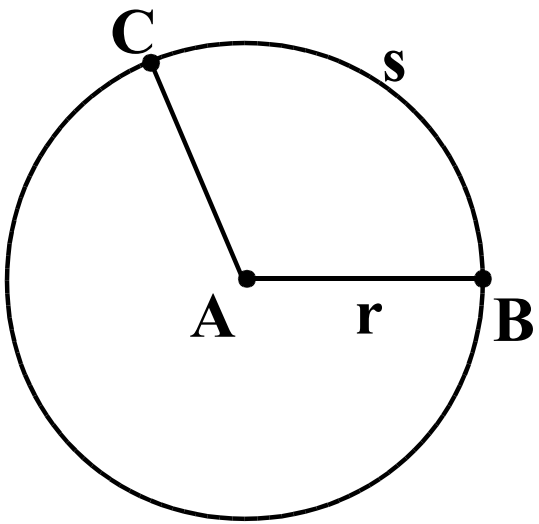

Recall that the radian measure of angle CAB is $\frac{s}{r}$.

It is important to realize that s and r must be expressed using the same units.

Teach Yourself Trigonometry

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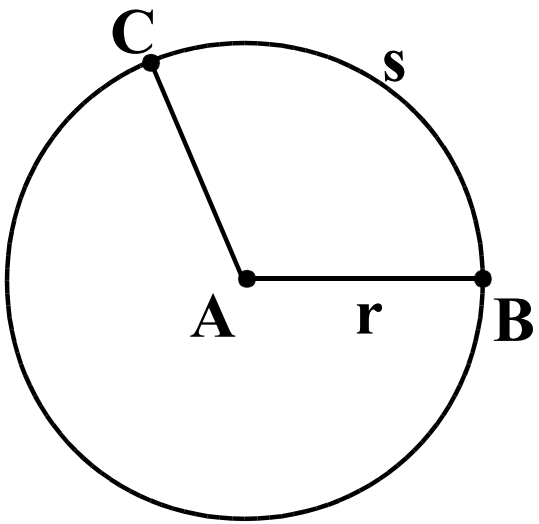


Recall that the radian measure of angle CAB is $\frac{s}{r}$.

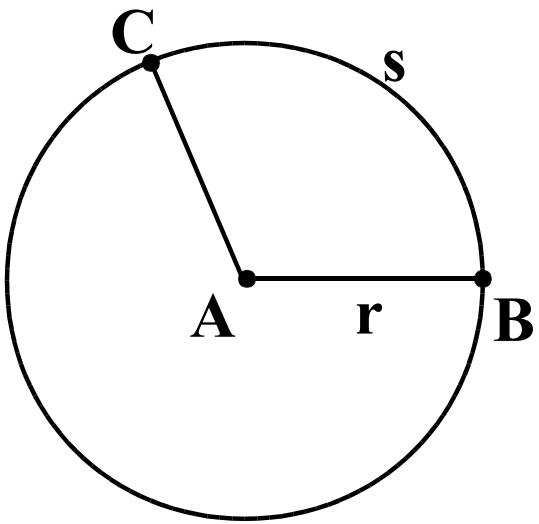
It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches,

Teach Yourself Trigonometry

Part 3 : Radian Measure

Let's return to this diagram and the definition of radian measure.



Recall that the radian measure of angle CAB is $\frac{s}{r}$.

It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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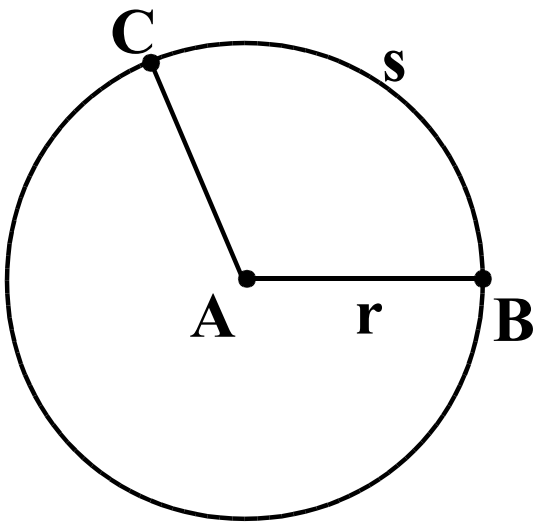

Recall that the radian measure of angle CAB is $\frac{s}{r}$.

It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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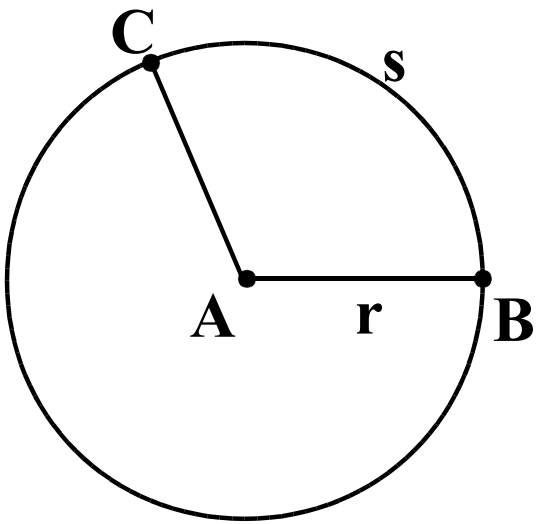

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For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

The radian measure of angle CAB =

Teach Yourself Trigonometry

Part 3 : Radian Measure

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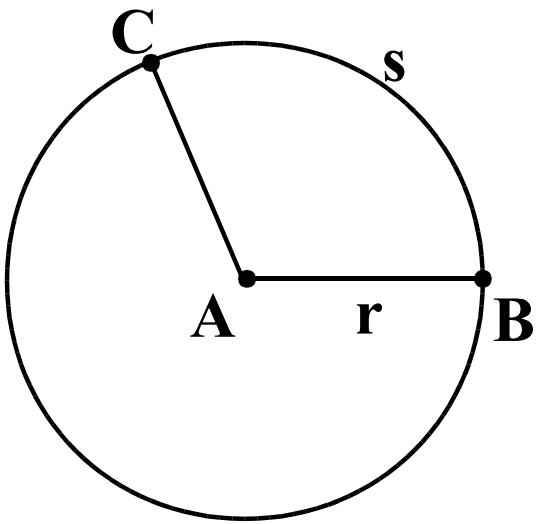

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It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

The radian measure of angle CAB = $\frac{9 \text{ inches}}{}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

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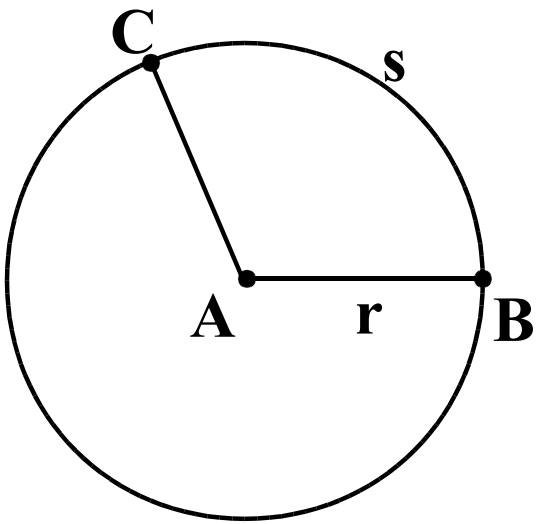

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It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

The radian measure of angle CAB = $\frac{9 \text{ inches}}{5 \text{ inches}}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

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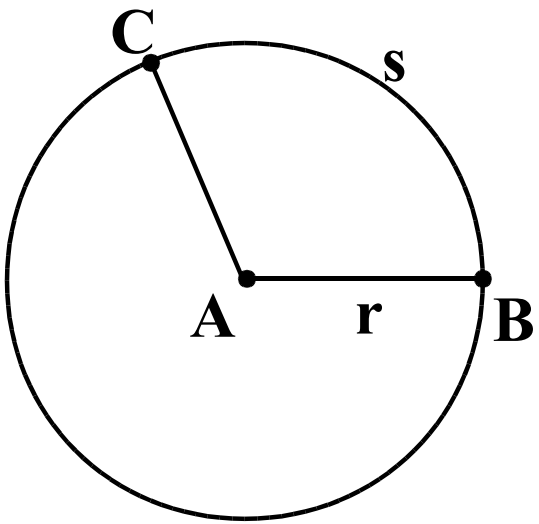

Recall that the radian measure of angle CAB is $\frac{s}{r}$.

It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

The radian measure of angle CAB = $\frac{9 \text{ inches}}{5 \text{ inches}}$ = **1.8**

Teach Yourself Trigonometry

Part 3 : Radian Measure

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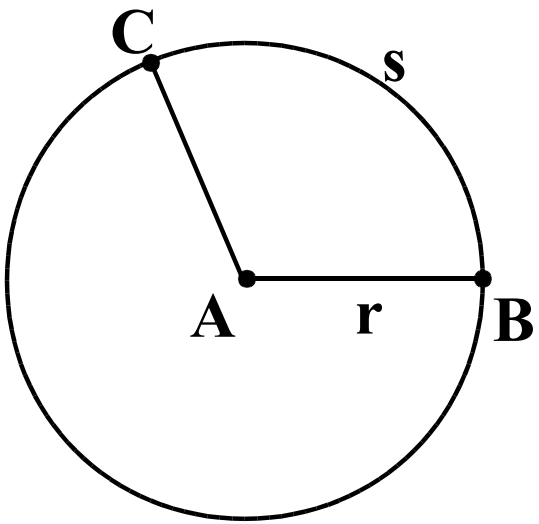

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It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

$$\text{The radian measure of angle CAB} = \frac{9 \text{ inches}}{5 \text{ inches}} = \mathbf{1.8}$$

Notice that the units 'cancel'.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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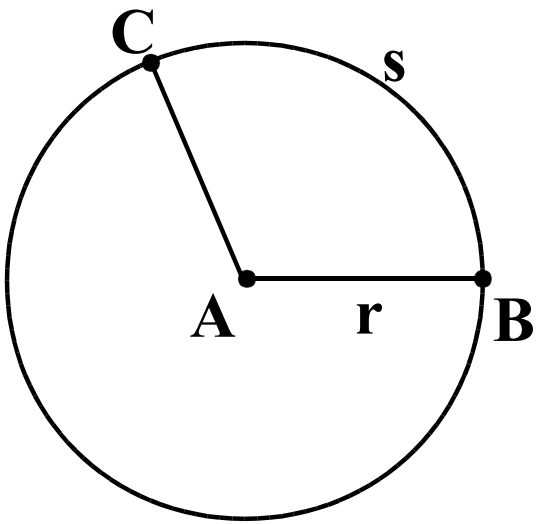

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$$\text{The radian measure of angle CAB} = \frac{9 \text{ inches}}{5 \text{ inches}} = \mathbf{1.8}$$

Notice that the units 'cancel'. In other words, the radian measure of an angle is a '**pure number**'.

Teach Yourself Trigonometry

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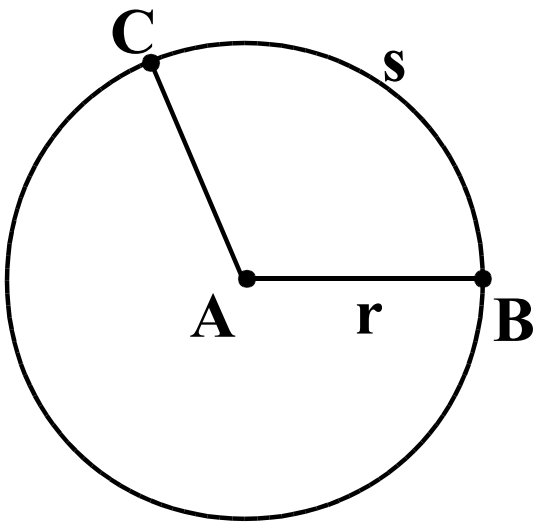

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$$\text{The radian measure of angle CAB} = \frac{9 \text{ inches}}{5 \text{ inches}} = \mathbf{1.8}$$

Notice that the units 'cancel'. In other words, the radian measure of an angle is a '**pure number**' – **without units**.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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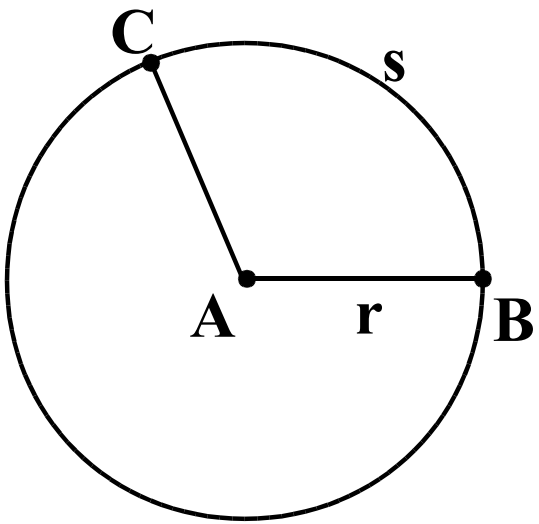

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It is important to realize that s and r must be expressed using the same units.

For example, if r = 5 inches, then s would also need to be measured in inches before this definition could be applied. Suppose s = 9 inches.

$$\text{The radian measure of angle CAB} = \frac{9 \text{ inches}}{5 \text{ inches}} = \mathbf{1.8}$$

Notice that the units 'cancel'. In other words, the radian measure of an angle is a '**pure number**' – **without units** – although we customarily say 'radians'.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Teach Yourself Trigonometry

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So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

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Degree Measure	Radian Measure

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$

Make sure you understand this.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$

Make sure you understand this.

One way to understand this is to take the equation $180^{\circ} = \pi$

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$

Make sure you understand this.

One way to understand this is to take the equation $180^{\circ} = \pi$ and divide both sides by 6.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	

Teach Yourself Trigonometry

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So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure

Teach Yourself Trigonometry

Part 3 : Radian Measure

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^{\circ}}$.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^{\circ}}$.

In general, to change from radian measure to degree measure

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180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^{\circ}}$.

In general, to change from radian measure to degree measure multiply by $\frac{180^{\circ}}{\pi}$.

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180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^\circ}$.

In general, to change from radian measure to degree measure multiply by $\frac{180^\circ}{\pi}$.

These are called conversion factors.

Teach Yourself Trigonometry

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So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^\circ}$.

In general, to change from radian measure to degree measure multiply by $\frac{180^\circ}{\pi}$.

These are called conversion factors.
Notice that they are both equal to 1 !!

Teach Yourself Trigonometry

Part 3 : Radian Measure

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Degree Measure	Radian Measure
180°	π
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
360°	2π

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^\circ}$.

In general, to change from radian measure to degree measure multiply by $\frac{180^\circ}{\pi}$.

These are called conversion factors.
Notice that they are both equal to 1 !!

Let's practice.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Convert each of the following angles to radian measure.

1. $270^\circ =$

2. $120^\circ =$

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Note that the degree units cancel.

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Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

It is quite common to express radian measure in terms of π.

Convert each of the following angles to radian measure.

1. $270^\circ = \overset{3}{\cancel{270}^\circ} \cdot \dfrac{\pi}{\underset{2}{\cancel{180}^\circ}} = \dfrac{3\pi}{2}$

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So far we have proven that 180 degrees is equivalent to a radian measure of π.

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It is quite common to express radian measure in terms of π. Here are their approximations.

Convert each of the following angles to radian measure.

1. $270^\circ = \overset{3}{\cancel{270}^\circ} \cdot \dfrac{\pi}{\underset{2}{\cancel{180}^\circ}} = \boxed{\dfrac{3\pi}{2} \approx 4.7}$

2. $120^\circ = \overset{2}{\cancel{120}^\circ} \cdot \dfrac{\pi}{\underset{3}{\cancel{180}^\circ}} = \boxed{\dfrac{2\pi}{3} \approx 2.1}$

3. $63^\circ = \overset{7}{\cancel{63}^\circ} \cdot \dfrac{\pi}{\underset{20}{\cancel{180}^\circ}} = \boxed{\dfrac{7\pi}{20} \approx 1.1}$

In general, to change from degree measure to radian measure multiply by $\dfrac{\pi}{180^\circ}$.

In general, to change from radian measure to degree measure multiply by $\dfrac{180^\circ}{\pi}$.

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So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Convert each of the following to degree measure.

4. $\frac{3\pi}{5} =$

5. $\frac{5\pi}{12} =$

6. $1.4 =$

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^{\circ}}$.

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Convert each of the following to degree measure.

4. $\frac{3\pi}{5} = \frac{3\cancel{\pi}}{\cancel{5}_{1}} \cdot \frac{\cancel{180^\circ}^{36^\circ}}{\cancel{\pi}_{1}}$

5. $\frac{5\pi}{12} =$

6. $1.4 =$

In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^\circ}$.

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Convert each of the following to degree measure.

4. $\frac{3\pi}{5} = \frac{3\cancel{\pi}}{\cancel{5}_{1}} \cdot \frac{\cancel{180}^{36}{}^{\circ}}{\cancel{\pi}_{1}} = 108^{\circ}$

5. $\frac{5\pi}{12} =$

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These are called conversion factors. Notice that they are both equal to 1 !!

Let's practice.

Teach Yourself Trigonometry

Part 3 : Radian Measure

So far we have proven that 180 degrees is equivalent to a radian measure of π.

Using this fact, we can build a table giving the radian measure of common angles measured in degrees.

Convert each of the following to degree measure.

4. $\frac{3\pi}{5} = \frac{3\cancel{\pi}}{\cancel{5}_{1}} \cdot \frac{\cancel{180}^{36}{}^{\circ}}{\cancel{\pi}_{1}} = 108^{\circ}$

5. $\frac{5\pi}{12} = \frac{5\cancel{\pi}}{\cancel{12}_{1}} \cdot \frac{\cancel{180}^{15}{}^{\circ}}{\cancel{\pi}_{1}} = 75^{\circ}$

6. $1.4 = 1.4 \cdot \frac{180^{\circ}}{\pi}$

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In general, to change from degree measure to radian measure multiply by $\frac{\pi}{180^{\circ}}$.

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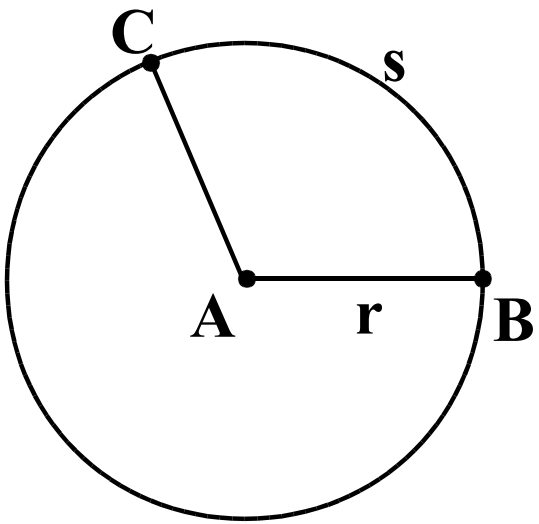

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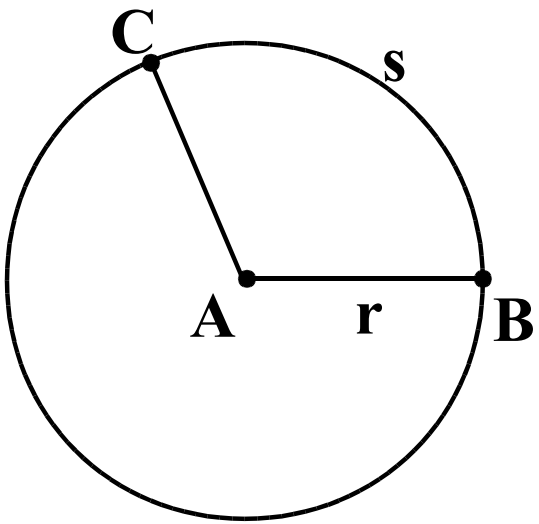

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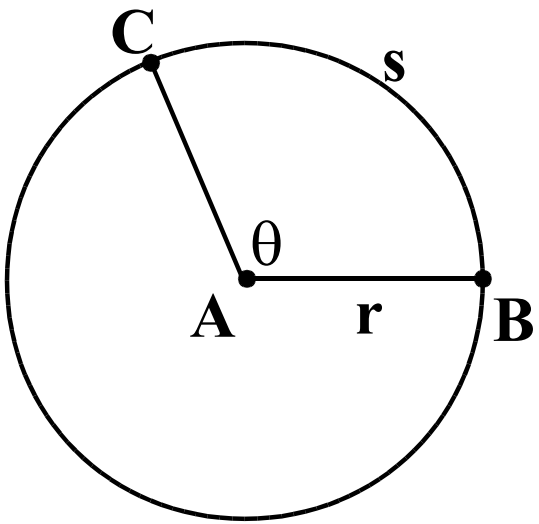

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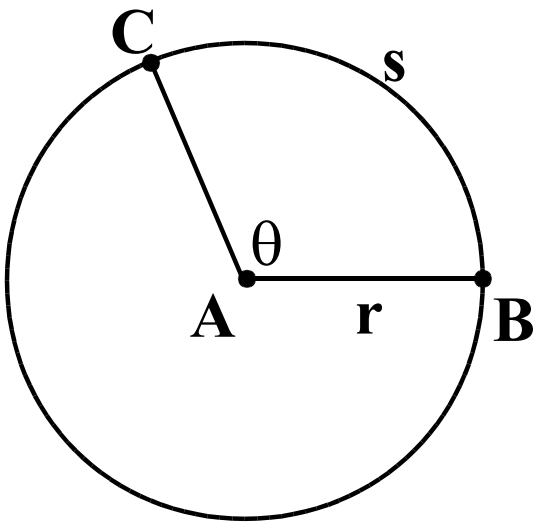

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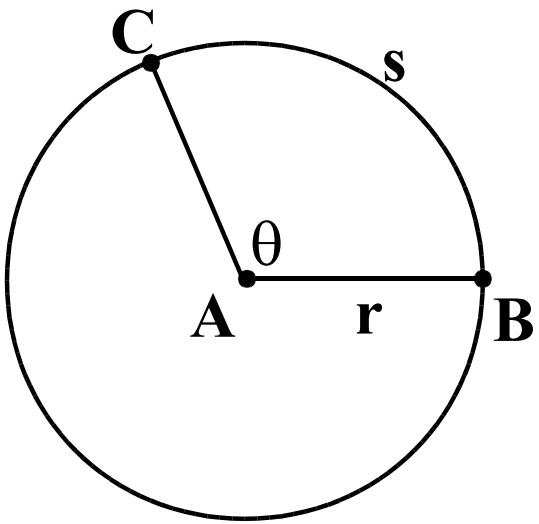

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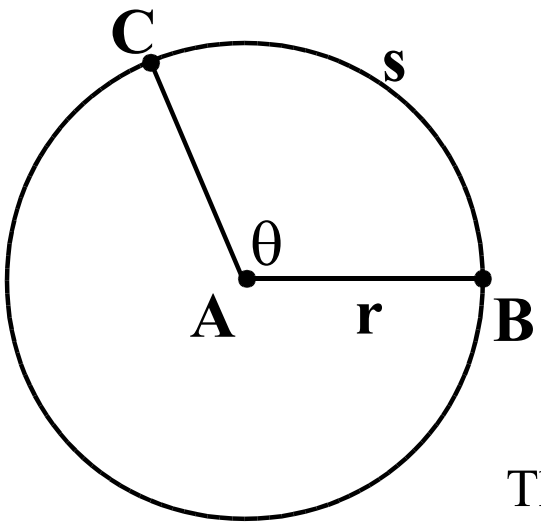

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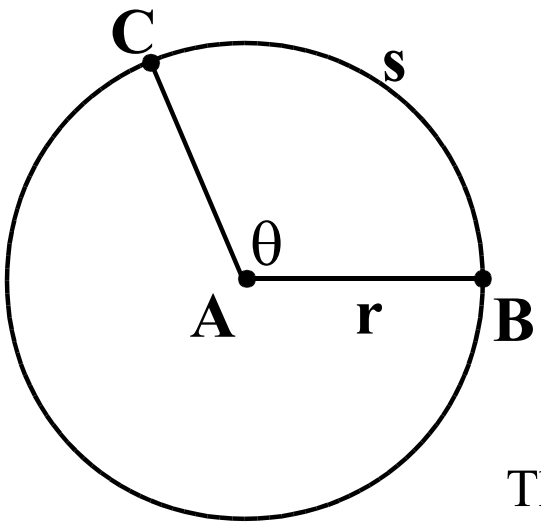

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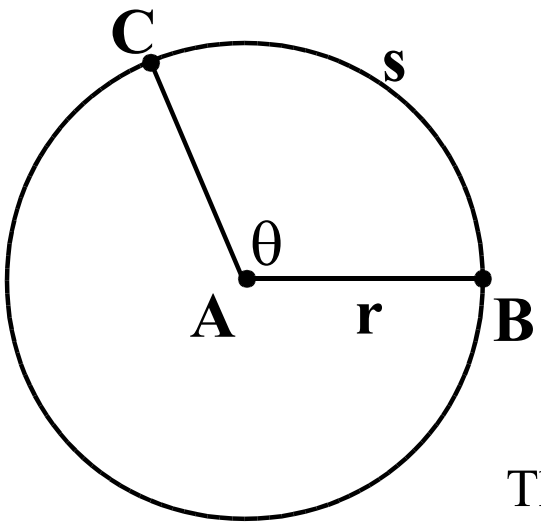

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Example: Find s if r = 20 feet and θ = 72 degrees.

Teach Yourself Trigonometry

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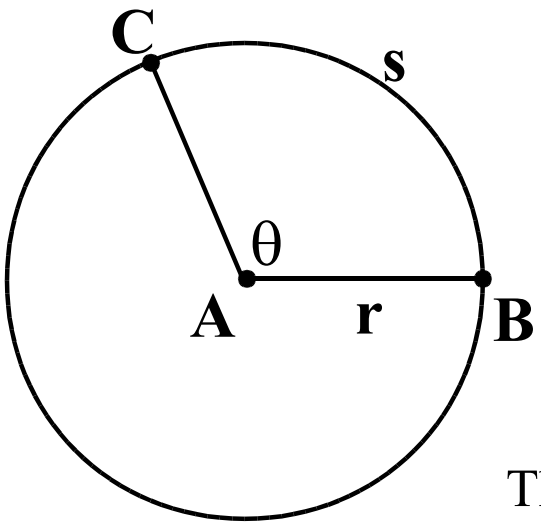

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Example: Find s if r = 20 feet and θ = 72 degrees.

Step 1: Convert θ to radian measure.

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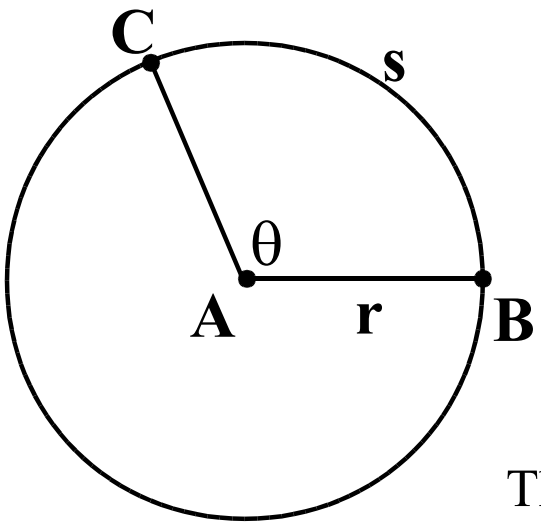

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Example: Find s if r = 20 feet and θ = 72 degrees.

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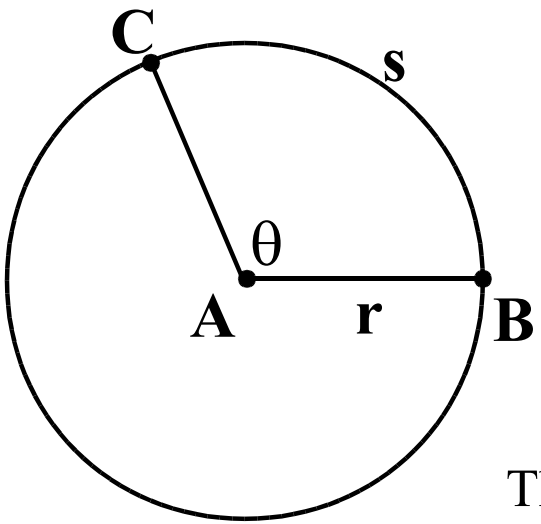

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Example: Find s if r = 20 feet and θ = 72 degrees.

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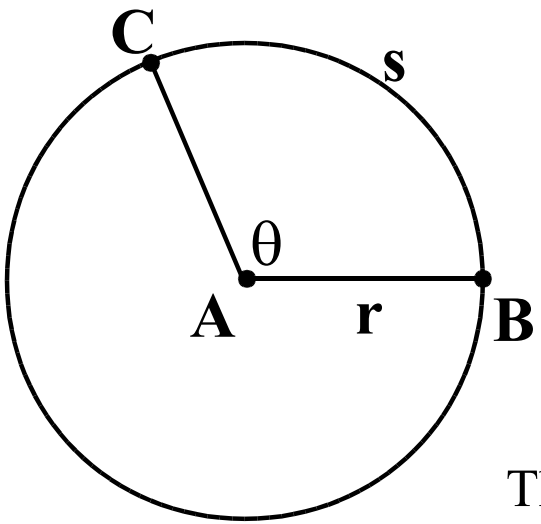

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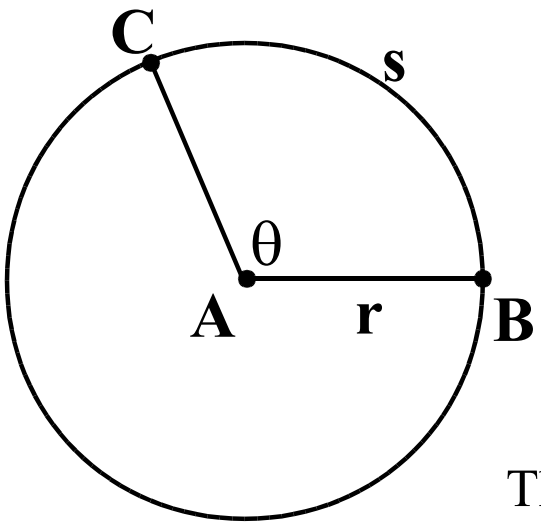

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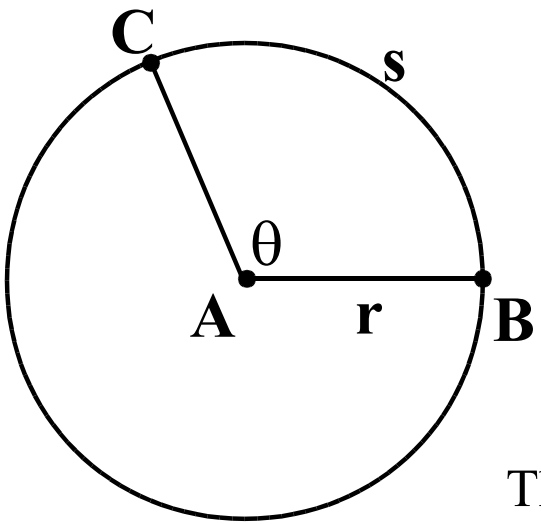

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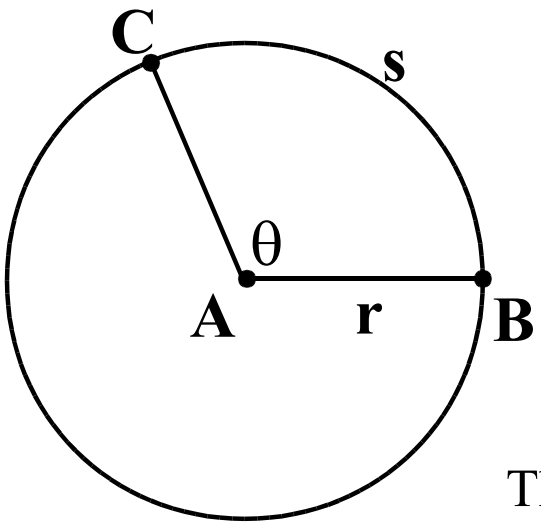

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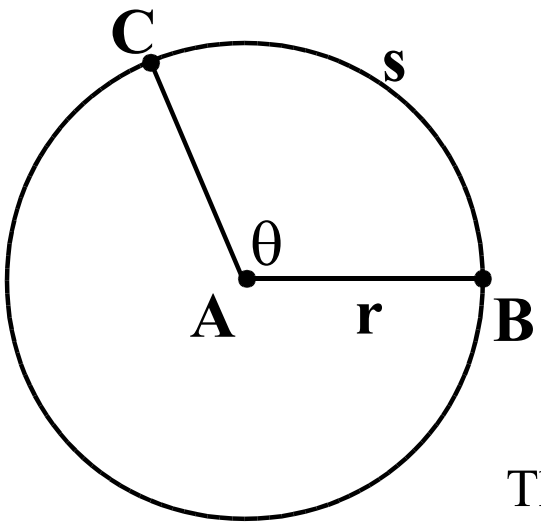

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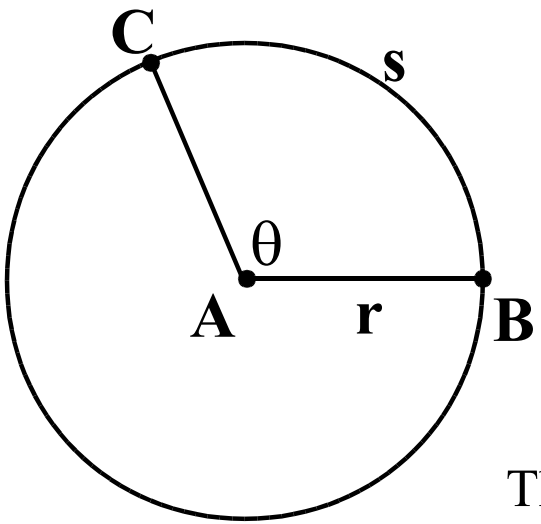

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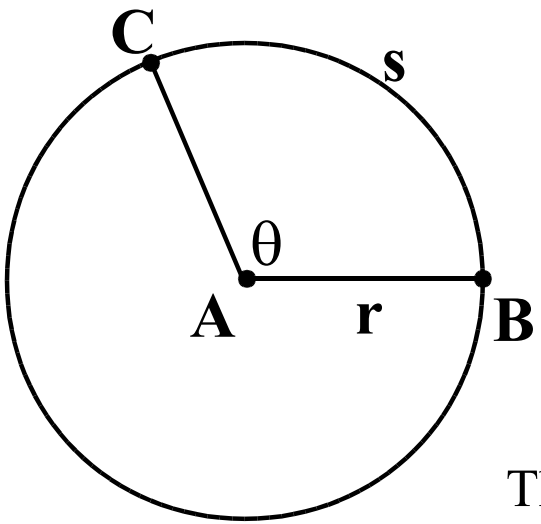

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Teach Yourself Trigonometry

Part 3 : Radian Measure

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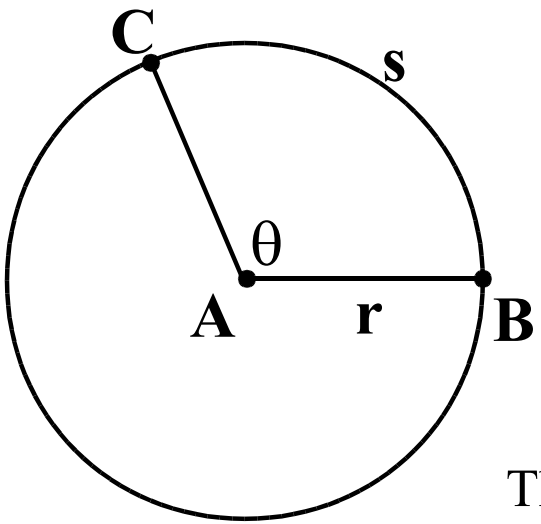

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The arc is about 25.1 feet long.

Teach Yourself Trigonometry

Part 3 : Radian Measure

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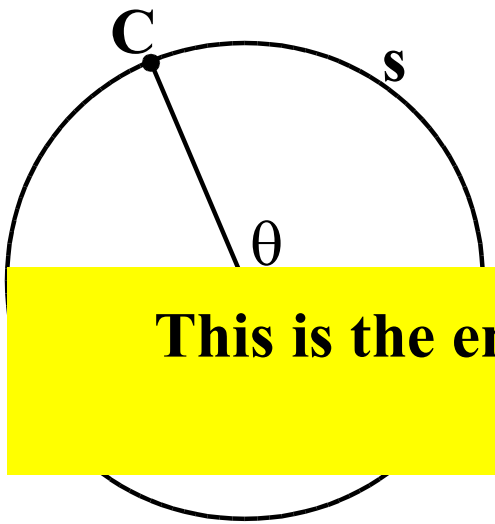

Recall that the **radian measure** of angle CAB is $\frac{s}{r}$.

We will now label angle CAB as θ.

This is the end of this lesson.

This can be used to find the **length of an arc** of a circle.

Important: The angle, θ, in this formula must be expressed using **radian measure**.

Example: Find s if r = 20 feet and θ = 72 degrees.

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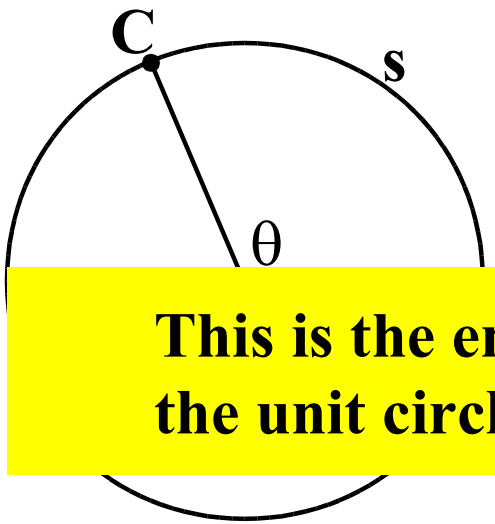

Recall that the **radian measure** of angle CAB is $\frac{s}{r}$.

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This is the end of this lesson. Part 4 introduces the unit circle and the 'Wrapping Function'.

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