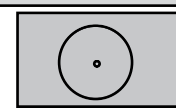
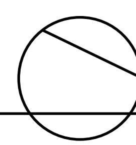
Name:__________________________________ **Date:**______ **Period:**______

SECTION 9.5 CIRCLES

VOCABULARY

DEFINITION	EXAMPLE
Center: The point at the middle of a circle, such that all the points of the circle are the same distance from the center	The point is the center. 
Diameter: line segment connecting two points on the circle and passing through the center P	Diameter is often represented by *d*
Circumference: distance around the circle (like the perimeter of a polygon)	The formula for circumference is of a circle with radius r and diameter d is $C = 2\pi r$ or $C = \pi d$
π **:** the exact ratio of the circle's circumference to its diameter, the number pi	π is approximately 3.14
Constant: a number which does not change (not a variable)	an example is 8
Coefficient: a constant multiplied by a variable, for example: in the product of a constant 2 and a variable x, 2 is called the coefficient of the product 2x	5 is the coefficient of 5x
Radius: fixed distance r from the center P to a point on the circle	The radius is 5 cm if the diameter is 10 cm.
Chord: any line segment that can be drawn from one point of the circle to another	
Semicircle: the diameter cuts the circle in half, forming two semicircles	

Big Idea: What are the important attributes of circles? How do we compute area and circumference of circles?

Everyone has seen circles of various sizes, but what is the definition of a circle? How do you draw a circle? Try to describe a circle to someone without using the word "circle." (answers will vary, but may include "round" or "perfectly smooth")

EXPLORATION 1: DRAWING A CIRCLE

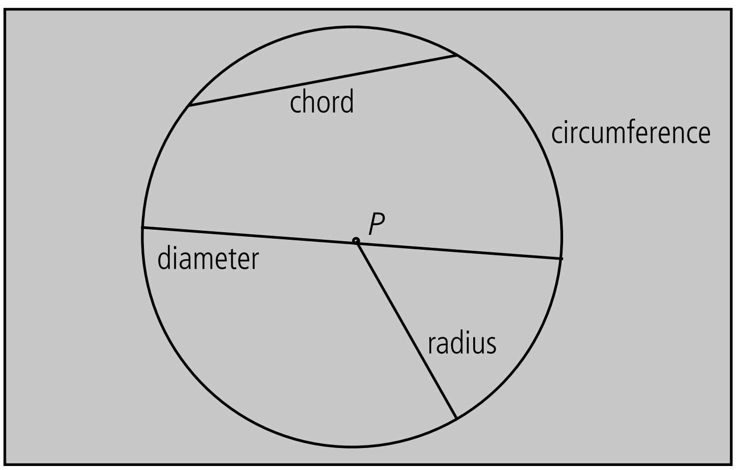
How do you draw a circle? Once you have drawn a circle, write directions someone could follow to draw a circle.

Draw a point, then go away from that point. Starting at the second point, curve the "line" you draw around the first point.

Now, state your definition of a circle.

All points that are the same distance from the center point.

In general, one way to draw a circle is to first draw and label a point. Do so in the space below: (Hint: you need to make your point in the middle of the space!)



Take a length of string, *r* units long, placing one end on the point and attach the other end to your pencil. Stretch the string to its full length and draw the circle with your pencil. A circle is named by its center point. What is the name of your circle? ___________P_____________ What can you say about the distance of any given point on your circle to the center point? It's always the same, it's about [distance] away everywhere.

The fixed distance, *r*, from the center point to any point on the circle is called the _____radius____. Any line segment that can be drawn from one point on the circle to another is called a _____chord________. A line segment connecting two points on the circle AND passing through the center point is a special chord called a ________diameter______ . The length of the diameter is equal to the length of 2 ________radii_________. Radii is the plural form of radius.

In the circle you drew above, draw and label a radius, chord, and diameter.

Notice that the _______diameter_________ cuts the circle in half, forming two semi-circles. Also, notice that it is the longest line segment that can be drawn from one _____point_____ to another on the circle.

Are all diameters considered chords? _______yes______________

Are all chords considered diameters? ________no______________

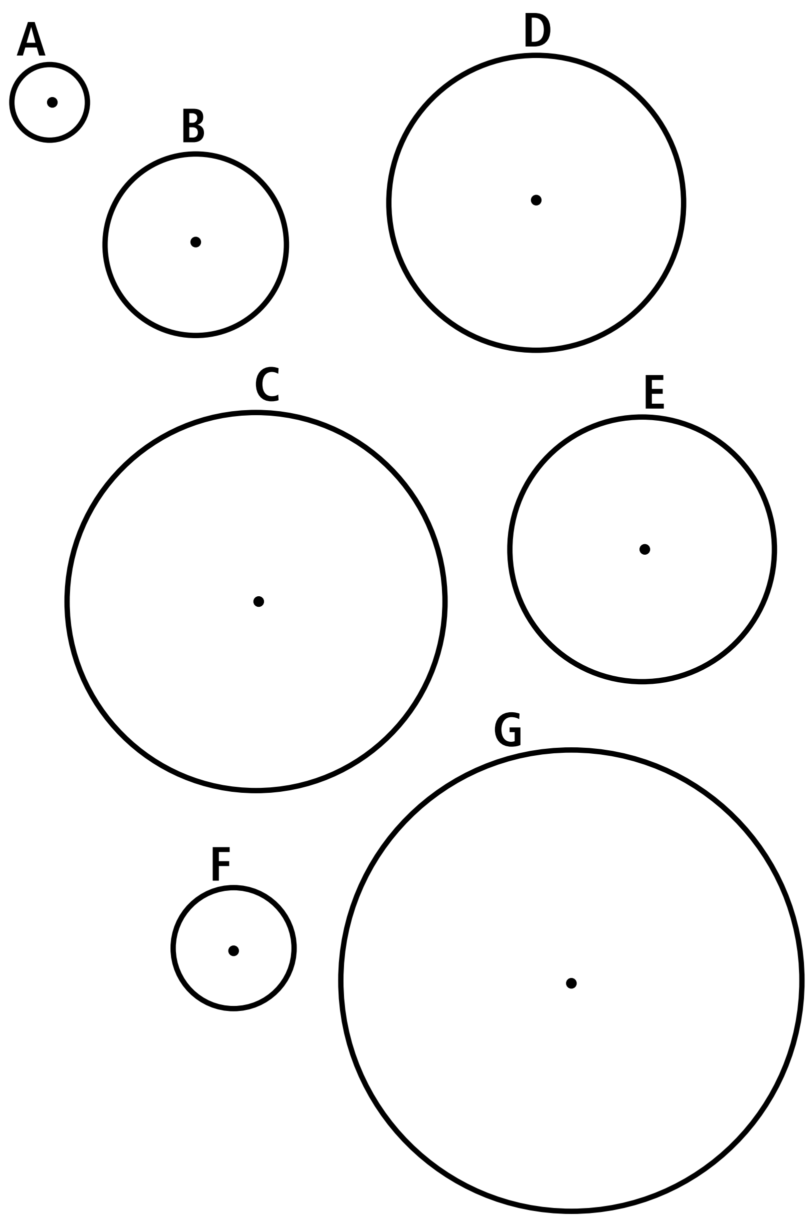
The distance around the circle is called the ____________circumference______________, and is like the perimeter of a polygon.

Is a circle a polygon? ____no______ Why or why not? ______it does not have line segment sides_________

Label the circumference of your own circle.

EXPLORATION 2: RELATIONSHIPS

Use the circles below to complete the activity. Using a ruler and piece of string, carefully measure the radius and circumference of each circle. Record your results in the table that follows.



Circle:	Radius (*r*):	Diameter (*d*):	Circumference (*C*):	$\frac{C}{d}$:
A	answers **will** vary! .5 cm	1 cm	3.1 cm	3.14
B	1.2 cm	2.4 cm	7.5 cm	3.14
C	2.4 cm	4.8 cm	15.1 cm	3.14
D	1.9 cm	3.8 cm	11.9 cm	3.14
E	1.5 cm	3 cm	9.4 cm	3.14
F	.7 cm	1.4 cm	4.4 cm	3.14
G	2.8 cm	5.6 cm	17.6 cm	3.14

Do you notice a relationship between the radius and the diameter? ____the radius is half the diameter or the diameter is twice the radius__________

Using the variable, d, to represent the length of the diameter, express the diameter in terms of the radius, r.

_______________d=2r____

What is the relationship between the circumference of a circle and its diameter? _______ The circumference is about 3 times the length of the diameter. ________

Compute the ratio of the circumference to its diameter. What do you notice about the ratio? _____________

________The ratio is very close to 3.14______________________

The ratio you computed approximates the exact ratio of the circle's circumference to its diameter, the number pi, written as the Greek letter ____ π ___ . This ratio, π, of the _____circumference________ to _____the diameter_________ is the same regardless of the size of the circle.

What would happen to the ratio $\frac{C}{d}$, if one of the circles was scaled by a factor of 2, making the radius twice as large? ________The diameter would be twice as large and the circumference would be twice as large, so the ratio would stay the same. ____________

When the radius doubles, what happens to the circumference?

__________The circumference also doubles._________________________________

Let's summarize what we have learned. Use the variables *C* for circumference, *d* for diameter, and *r* for radius and write an equation finding each in terms of the others.

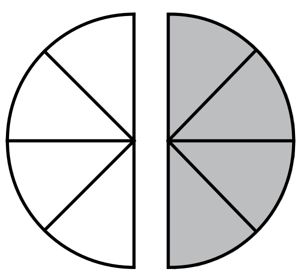
$C =$ ____ $2\pi r$ or πd ______ $d =$ ______ $2r$ (not as common: $\frac{C}{\pi}$)_________

$r =$ ______ $\frac{1}{2}d$ ____(_not as common:__ $\frac{C}{2\pi}$ __)__________

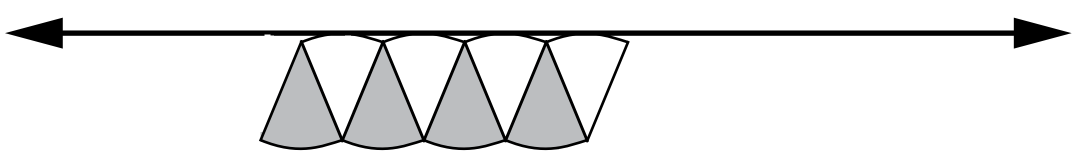
EXPLORATION 3: AREAS OF CIRCLES

What is the area, *A*, of a circle whose radius is 1?

To do this exploration, you will need to draw your circle on a separate sheet of scratch paper. Draw a circle with a radius of 1 unit and circumference of 2π units. Cut the circle in half, and then continue to cut each half into as many small pie slices of equal size, as illustrated below:



Take the slices from one half of the circle and lay the points of the slices along the line drawn for you:



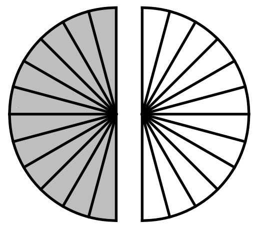
Do the same with the other half of the circle, filling in the spaces. (All of your slices should be on the same side of the line.) You may glue your slices to this page for your records.

What shape does this look like? ________parallelogram (or rectangle)_________________

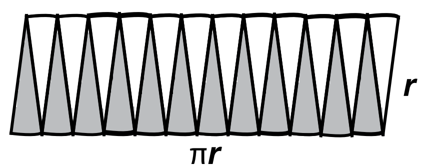
Imagine if you cut each slice in half again and repeated the process of laying the slices on the line. What shape do you think this would resemble? ________rectangle___________________

If this cutting process continued infinitely, the area of the circle with radius of 1 unit would approximate the area of a rectangle with length π and width 1 unit.

What happens to the area of the circle when its radius is a number r? One way to visualize this is to create slices in the circle with radius r, like the previous process with radius 1.



Cut the circle into two equal semicircles as you did in the unit circle and fit one semicircle into the other semicircle.



What is the length of this rectangular shape? What is its width? What is the area of the rectangle?

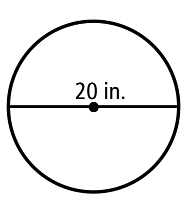
In this rectangle the length is πr, which is half the circumference $2\pi r$ and the width is r. The area of the rectangle is length times width or $\pi r \cdot r$ or πr^2. Any area is measured in square units. So if r is measured in inches, $r \cdot r$, or r^2, is measured in square inches. To summarize:

Formula 9.5: Area of a Circle
The area of a circle with radius r is $A = \pi r^2$ square units.

PROBLEMS

1. Find the circumference of the following circles with the given radius or diameter. Find your answer in terms of π, then use 3.14 as an approximation for π.

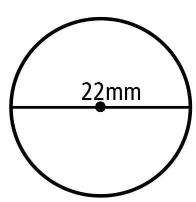
a.



$C =$ _ $\pi d = 20\pi$ in_

$C \approx$ __(20)(3.14)=62.8 in__

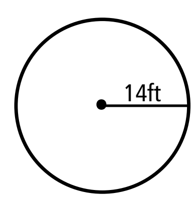
b.



$C =$ _ $\pi d = 22\pi$ mm

$C \approx$ _(22)(3.14) = 69.08 mm

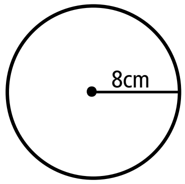
c.



$C = 2\pi r = 2\pi(14) = 28\pi$ ft.__
2

$C \approx$ __(28)(3.14) = 87.92 ft_

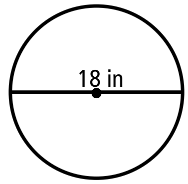
d.



$C =$ __2 π r = 2 π 8 = 16 π cm_

$C \approx$ __(16)(3.14) = 50.24 cm _

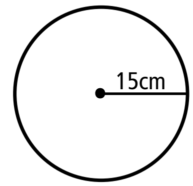
e.



$C =$ ___ π d_ = 18 π in______

$C \approx$ _____18(3.14) = 56.52 in _

f.



$C =$ _2 π r = 2 π 15 = 30 π cm_

$C \approx$ __ 30(3.14) = 94.2 cm_____

2. Using the information provided in the table, complete the missing cells.

Radius, *r*	**Diameter, *d***	**Circumference, *C***
9 cm	18 cm	18 π cm
8.2 ft.	**16.4 ft.**	16.4 π ft.
2.5 in	5 in	5 π in
21.4 mm	**42.8 mm**	42.8 π mm
32.5 m	**65 m**	65 π m

3. How does the radius relate to the diameter? _________The radius is one half of the diameter______

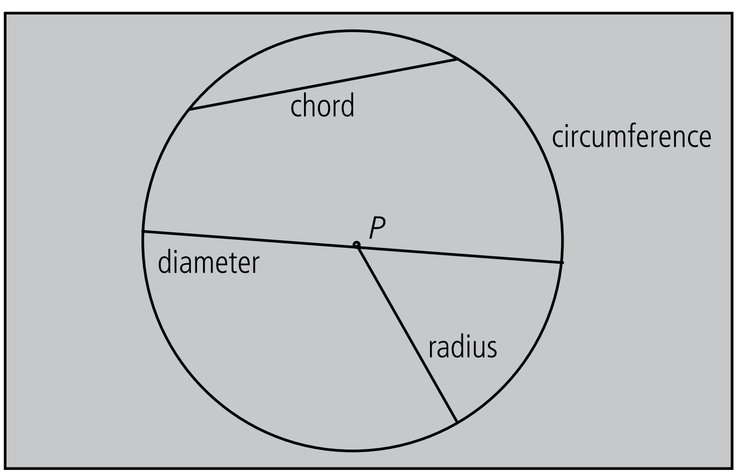
To the circumference? ______The radius is half of the coefficient of pi, or about $\frac{1}{6}$ of the circumference.____

________The radius is the circumference divided by 2 π .

4. Find the area of each of the circles and complete the table below:

Radius, ***r***	**Diameter,** ***d***	**Circumference,** ***C***	**Area,** ***A***
5 in	10 in	10π in	25π sq. in
.7 mm	**1.4 mm**	1.4π mm	$.49\pi$ sq. mm
3 ft.	6 ft.	6π ft.	9π sq. ft.
3.2 mm	**6.4 mm**	6.4π mm	10.24π sq. mm
1 m	2 m	2π m	π sq. m

5. Draw a circle and label the following: circumference, chord, radius, and diameter.



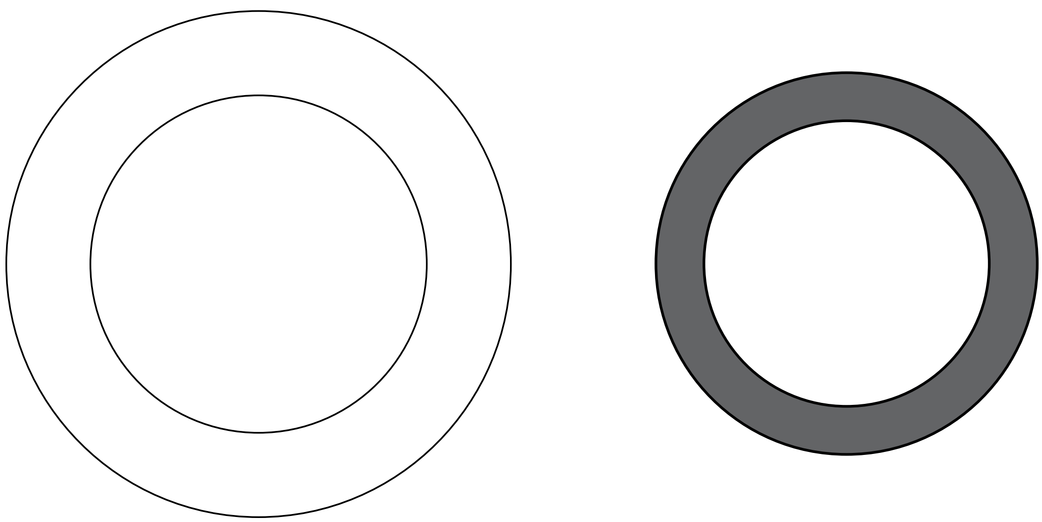
6. A spoke from a unicycle wheel is 10 ft. How many feet will the unicycle travel after 5 rotations?

After 5 rotations, the unicycle will travel 5 times the circumference.
$C = 2\pi r = 2\pi(10) = 20\pi$ ft.

But the unicycle rotated 5 times, so the distance travelled is $5C = 5(20\pi) = 100\pi$ ft.

The unicycle will travel ___100_____ feet after 5 rotations.

7. Ricardo draws a circle with a 6-inch diameter. He draws another circle inside the first, this one with a 5-inch diameter. He is going to paint between the two circles and wants to know the area he has to cover. Use the diagram below to assist you in solving this problem. Begin by shading the area Ricardo wants to paint.



Radius of the larger circle is $r = (.5)d = (.5)(6) = 3$ in.
Area of the larger circle is $A = \pi r^2 = \pi(3)^2 = 9\pi$ sq. in

Radius of the smaller circle is $r = (.5)d = (.5)(5) = 2.5$ in
Area of the smaller circle is $A = \pi r^2 = \pi(2.5)^2 = 6.25\pi$ sq. in

Area of the shaded area is $A = 9\pi - 6.25\pi = 2.75\pi$ sq. in

Ricardo will paint _______ 2.75π ________ square inches.

SUMMARY (What I learned in this section)