

<b>DISCOVERING PI</b>				<b>Student/Class Goal</b> Many students memorize, without understanding, formulas used in geometry or mathematics.	
<b>Outcome</b> ( <i>lesson objective</i> ) Students will identify and measure the diameter, circumference and radius of a circle. Discover the approximate value of pi through the relationship between the diameter and circumference and explain the formula.				<b>Time Frame</b> Two 45 minute sessions	
<b>Standard</b> <i>Use Math to Solve Problems and Communicate</i>				<b>NRS EFL 2-4</b>	
<b>Number Sense</b>	<b>Benchmarks</b>	<b>Geometry &amp; Measurement</b>	<b>Benchmarks</b>	<b>Processes</b>	<b>Benchmarks</b>
Words to numbers connection		Geometric figures	3.6, 4.7	Word problems	3.21, 4.25
Calculation	2.2, 3.2, 4.2	Coordinate system		Problem solving strategies	4.26
Order of operations		Perimeter/area/volume formulas	3.8, 4.9	Solutions analysis	
Compare/order numbers		Graphing two-dimensional figures		Calculator	2.19, 3.22, 4.28
Estimation	2.4, 3.4, 4.5	Measurement relationships	2.9, 3.10, 4.11	Mathematical terminology/symbols	2.20, 3.23, 4.29
Exponents/radical expressions		Pythagorean theorem		Logical progression	3.24, 4.30
<b>Algebra &amp; Patterns</b>	<b>Benchmarks</b>	Measurement applications	2.10, 3.11	Contextual situations	
Patterns/sequences	2.13, 3.14, 4.15	Measurement conversions		Mathematical material	
Equations/expressions	2.14, 3.15, 4.16	Rounding	3.13	Logical terms	
Linear/nonlinear representations		<b>Data Analysis &amp; Probability</b>	<b>Benchmarks</b>	Accuracy/precision	
Graphing		Data interpretation	4.20	Real-life applications	
Linear equations		Data displays construction	3.17	Independence/range/fluency	
Quadratic equations		Central tendency	3.18, 4.22		
		Probabilities			
		Contextual probability			
<b>Materials</b> Circular items – jars, lids, coffee can, plate, umbrella, round table, Frisbee, film canisters, etc. Tape measures or string and rulers, one per group <i>Circumference versus Diameter</i> Activity Sheet Welcome to PI Day Teacher Information Resource Discovering PI Learning Objects					
<b>Learner Prior Knowledge</b> Previous awareness of various kinds of shapes and their properties, especially circles. Have discussions with the group about some places in science where pi might be found – DNA, a rainbow, ripples from rain drops or waves. Cryptography (science of coding), Macintosh computer program file names end with pi and hat sizes are calculated using pi and rounding to the nearest 1/8 of an inch.					
<b>Instructional Activities</b> Step 1 - Choose one plastic lid for demonstration purposes. Model the activity by using the dot or bubble in the center of each lid as the center of the circle. Use an overhead so everyone can see. Measure from the dot to an edge – this is the <b>radius</b> . Try measuring from the dot to several points on the edge of the circle, radii should be equal. Students can measure from center to any point on the edge.  Measure from edge to edge, crossing the dot on the lid. This represents the <b>diameter</b> or the distance <i>across</i> a circle. Measure 2 radii. Is there a relationship between the diameter and the radius? Ask students to talk about this and develop a sentence that tells about this relationship. Write it on the chalkboard, and ask students to write it in their journals.  Use the tape measure and measure the outer edge around the lid. This measurement represents the <b>circumference</b> or the distance <i>around</i> the circle. Divide the circumference by the diameter to the nearest tenth. Show students how to do this with calculators.					

Step 2 - Students will practice recording data from the many circular items displayed around the room using the *Circumference versus Diameter* activity sheet. What do you notice about the data – check out the C/D column?

**TEACHER NOTE** Number each circular item, place around the room. Divide the class into teams of three. The three team members rotate roles with each new item. *Recorder* records measurements and division answers. *Measurer* measures distance across and distance around item. *Divider* divides distance across into the distance around.

Step 3 – Compare C/D values for every circle. They should all be at least 3 or very close to the constant ratio pi. Everyone’s chart should be the same. Explain that pi is the ratio of C to D or the circle’s circumference to its diameter. Share the symbol for pi  $\pi$  on the board. Explain to the students that they have just discovered pi, which is very important in finding the circumference of an object. Might want to give some historical information from the Welcome to  $\pi$  Day Teacher Information Resource.

**TEACHER NOTE** You might like to share the book *Sir Cumference and the Dragon of Pi* by Cindy Neuschwandner with the group at this time.

Step 4 - Have students come up with a formula to find the circumference of an object knowing only the diameter of that object and the number that represents pi. Students should prove their formula works by demonstration and measuring to check their results.

Circumference formula  $C = D\pi$  and  $C = 2\pi r$

Students are now ready to use the circumference formula to solve problems. Give students three problems listing only the diameter of each object and have them find the circumference. Or students can find circles in everyday life and create a bank of problems that other students can solve. Just for fun, these can be shared aloud by the teacher with a treat of wrapped round cakes as a prize for correct answers.

Step 5 - Have students write their conclusions for the activities they have just done in their math journals or with the class.

**TEACHER NOTE** Students might enjoy playing the game Mono-pi-ly to reinforce the mathematical concepts related to circle properties. Mono-pi-ly can be found at Kroon, Cindy D. (2006). Playing around with “Mono-pi-ly”. *Mathematics Teaching in the Middle School*, 11 (6), 294-297.

**Assessment/Evidence** *(based on outcome)*

*Circumference versus Diameter* Activity Sheet

Teacher Observation

Group Reports

Written Conclusions

**Teacher Reflection/Lesson Evaluation**

*Not yet completed.*

**Next Steps**

Discovering Pi Learning Objects will give students additional practice with circumference and the area of a circle.

**Technology Integration**

**Purposeful/Transparent**

Students are lead through a process of understanding the formulas connected with the properties of circles.

**Contextual**

Multiple opportunities are given for students to practice using circles that can be found in everyday life. Discussion happens around the usefulness of pi and how it appears in science and math.

**Building Expertise**

Students are using a discovery approach to finding the definition of pi and creating formulas that can be used when needed in their calculations.

# Welcome to $\pi$ Day

3/14

Historians estimate that by 2000 B.C. people had noticed that the ratio of circumference to diameter was the same for all circles. This discovery hinged on the idea of proportion. In today's algebraic notation this implied the formula

$$\pi = \frac{\text{Circumference}}{\text{Diameter}}$$

The significance of this discovery is clear – circles are everywhere. Achieving a greater mathematical understanding of Pi would lead to scientific and technological advances that would further the development of civilization. But one problem remained – what is the numerical value of Pi?

## What is Pi?

Pi is a number, starting with 3.1415926535... ad infinitum; a very common approximation is 3.14. It's the number you get when you divide the circumference of a circle by its diameter and it can't be expressed as a fraction. Pi is an irrational number, which means that it cannot be written as a ratio of two integers and that its decimal expansion goes on forever and is non-repeating. If we stop the decimal expansion of pi at a certain place, we get only an approximation for the number pi; the more decimal places we keep, the better the approximation we get. It goes on forever.

## Did you know?

March 14 is Albert Einstein's birthday. A timeline <http://www.pbs.org/wgbh/nova/einstein/timeline> and historical background information <http://www.aip.org/history/einstein> are excellent resources that chronicle Albert Einstein's life and scientific achievements from his birth in 1879 to his death in 1955.

## Where can I find out more?

Annual Pi Day Celebrations <http://www.exploratorium.edu/pi/>

Contains a short history of Pi, activities, Pi-Ku, Pi limericks, Pi posters and many more links.

Science and Numeracy Special Collection: Pi Day

<http://literacynet.org/sciencelincs/showcase/piday/index.html>

Three excellent sites about Einstein as well as information about Pi.

The Joy of  $\pi$  <http://www.joyofpi.com/>

Links and facts about Pi are available at this site.

About Pi <http://mathforum.org/dr.math/faq/faq.pi.html>

Ask Dr. Math at Math Forum FAQs about Pi, websites from the archives and additional resources.

Pi Through the Ages [http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Pi through the ages.html](http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Pi_through_the_ages.html)

Background of scientists working on their discoveries of Pi.

The First 500 Digits of Pi [http://www.highland.madison.k12.il.us/jbasden/lessons/pi\\_1001\\_digits.html](http://www.highland.madison.k12.il.us/jbasden/lessons/pi_1001_digits.html)

Chart that could be made into overhead to show the first 500 numbers

Your Piece of the Pi <http://library.thinkquest.org/C0110195/main.html>

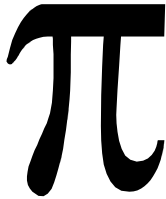
Contains the history, uses and a fun Pi Client

Pi Facts <http://www.freewebs.com/abishek/index.htm>

Pi Wikipedia <http://en.wikipedia.org/wiki/Pi>

Fundamentals, history, properties and uses in math and science

**Teacher Information Resource**



Circumference  
Diameter

To complete these exercises, work in groups of three. Follow the directions on this sheet, beginning with the questions below.

Define diameter

Define circumference

There are ten round items around the room. Measure the circumference and diameter of each object and record your answers on the chart.

Items	C	D	C/D
1 Lid			
2			
3			
4			
5			
6			
7			
8			
9			
10			

How do circumference and diameter appear to be related?

How are radius and diameter related?

How does this tell us that radius and circumference are related?



<http://www.wisconline.org>

**The Circle**

**Author:** Douglas Jensen

**School:** Northeast Wisconsin Technical College

**Description:** In this animated and interactive object, learners examine the definitions and formulas for radius, diameter, circumference, and area. Students also solve practice problems involving the circumference and area of a circle.

[http://www.wisc-online.com/objects/index\\_tj.asp?objID=GEM104](http://www.wisc-online.com/objects/index_tj.asp?objID=GEM104)