The United States signed the International Treaty of the Meter in 1875, the year it was proposed in Paris. The metric system is officially designated *Système International d'Unités,* which, fortunately for us, is abbreviated "SI". More information on this organization is available from their website, www.bipm.fr (a lot of it in French). BIPM says changes to meet "the world's increasingly demanding requirements for measurement" are considered every few years (the next conference is in 2007).

The metric system was devised before the need to express exceedingly large and extremely small quantities (of mass, distance, etc.) were perceived. The original prefixes extended from *milli (for 1/1000)* to *kilo (1000).* In more recent times, scientists have added many prefixes to accommodate ever-larger and ever-smaller quantities. Those you are almost certain to encounter are provided below.

Metric prefix table:

Note the diminutive "-i" endings on these prefixes !

Prefix	Factor (aka)	Prefix Symbol	
tera	1000000000000	T	*(a trillion, 10^{12})*
giga	1000000000	G	*(a billion, 10^{9})*
mega	1000000	M	*(a million, 10^{6})*
myria*	10000	my	
kilo	1000	k	
hecto*	100	h	
deka*	10	da	
BASE	1		
deci	.1 (1/10)	d	
centi	.01 (1/100)	c	
milli	.001 (1/1000)	m	
micro	.000001	µ	*(a millionth, 10^{-6})*
nano	.000000001	n	*(a billionth, 10^{-9})*
pico	.000000000001	p	*(a trillionth, 10^{-12})*

YOU MUST KNOW:

1 km = 1000 m
1 hm = 100 m
1 dam = 10 m

1 m = 10 dm
1 m = 100 cm
1 m = 1000 mm

* These unpopular prefixes are rarely used.

Prefixes which are currently in use, but seen only in scientific works, add *peta, exa, zetta & yotta* abbreviated *P,E,Z,Y* for quadrillion, quintillion, sextillion, and septillion, respectively. The other end of the spectrum uses *femto, atto, zepto & yocto* abbreviated *f,a,z,y* for quadrillionth, quintillionth, etc.

EXAMPLE of prefixes in use– **Linear (distance) units:**

	Unit	Equivalent to	Symbol
Metric:	kilometer	1000m	km
	hectometer[1]	100 m	hm
	dekameter[1]	10 m	dam
	meter	☆	m
	decimeter[1]	.1 m	dm
	centimeter	.01 m	cm
	millimeter	.001 m	mm
	micrometer	.000001 m	µm

☆METER: 1/10,000,000 the distance from the equator to the North Pole, on the meridian through Paris of course.
☆NOW: Distance traveled by light in a vacuum in 1/299,792,458 of a second

(µm is also called a "micron")

For comparison, here are the units of length we commonly use:

English:	mile	5280 ft	mi
	yard	3 ft	yd
	foot	12 in	ft or '
	inch		in or "

English-Metric:
1 meter ≐ 39.37 in.
1 kilometer ≐ .62137 mi.
1 mile ≐ 1.60934 km.
1 inch ≐ 2.540005 cm

***Just FYI Note regarding binary prefixes**, such as those used to denote disk-drive sizes on computers: Since 2^{10} , which is 1024, is so close to a 1000, some people refer to these values interchangeably, which leads to some confusion. To alleviate this problem, the International Electrotechnical Commission (IEC) has established binary prefixes, which are recognizable by the "i" in their abbreviations.*
kibi Ki kilobinary for 2^{10}, e.g. KiB = kibibyte = 2^{10} B (B= byte) *while a kilobyte is kB = 10^{3} B*
mebi Mi megabinary for (2^{10})^{2}; e.g. a mebibyte = MiB = 2^{20} B *... a megabyte is MB = 10^{6}B.*

*This binary prefix terminology is **not in general use** at this time– the world is resisting the IEC standard!*

Although US agencies adopted metric measures in the early 1800s, shortly after their definition by Europeans, growth of use of the metric system has been slow. In 1875 the International Treaty of the Meter was formulated by 17 countries including US! In 1893 Congress legislated redefinition of our traditional English units of measure in terms of metric units. The Metric Conversion Act of 1975 attempted to complete the conversion to metric measure, and established the Metric Board to encourage "voluntary compliance"; in 1982 the Metric Board was dissolved. Use of the English system persists, although metric usage is also widespread. With the Omnibus Trade and Competitiveness Act of 1988, Congress declared the metric system the *"Preferred system of weights and measures"*.

CONVERSION FACTORS and DIMENSIONAL ANALYSIS

There are a multitude of units of measure that are rarely used. You need to know these few:

1 mile = 5280 feet
1 yard = 3 feet
1 foot = 12 inches

1 mi = 5280 ft
1 yd = 3 ft
1 ft = 12 in

Using *Dimensional Analysis* we can determine the relationship between miles and yards:

$$1\text{ mi} = 1\text{ mi} \times \frac{5280\text{ ft}}{\text{mi}} \times \frac{1\text{ yd}}{3\text{ ft}} = 1760\text{ yd}$$

Such conversions are much simpler in the metric system. For example, suppose we know the Washington monument is 169294 mm. high. If we wish to know what that is in meters, we observe that a *milli*meter is 1/1000 of a meter (.001 of a meter). Thus there are 1000 millimeters in 1 meter.

$$169294\text{ mm} = 169294\text{ mm} \times \frac{1\text{ m}}{1000\text{ mm}} \doteq 169\text{ m}$$

Notice this fraction is ONE! 1m = 1000mm
"m" is 1000 times the size of "mm" !

Suppose a horse is running at 72 km/hr and we are asked how many meters per second that is.

$$\frac{72\text{ km}}{\text{hr}} = \frac{72\text{ km}}{\text{hr}} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ hr}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ s}} = \frac{72000\text{ m}}{60\cdot 60\text{ s}} = 20\text{ m/s}$$

You might also need to know that there are 39.37 inches in one meter. From this you can compute:

$$1\text{ km} = 1\text{ km} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{39.37\text{ in}}{1\text{ m}} \times \frac{1\text{ ft}}{12\text{ in}} \times \frac{1\text{ mi}}{5280\text{ ft}} = \frac{39370}{12\cdot 5280}\text{ mi} = .6213699\text{ mi}$$

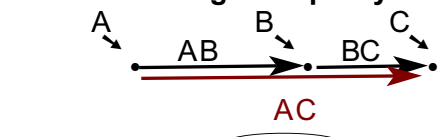
Distance

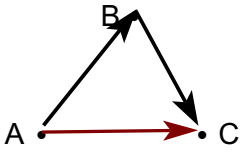
...is never negative: AB, the distance between the points A & B, is non-negative (> 0 or = 0).

...is directionless: For any two points A & B: AB = BA.

The shortest distance between 2 points is ....

The Triangle Inequality: For any three points, A& B & C: **AC ≤ AB + BC**



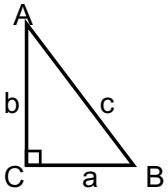


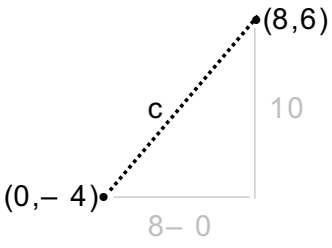
What is "AC"?
"AC" = Length of segment $\overline{AC}$

Distance between two points: use the Pythagorean Theorem:

In a right triangle (and ONLY in a right triangle)
the sum of the squares of the two shorter sides
= the square of the longest side ("hypotenuse")

$$a^2 + b^2 = c^2$$





Find the distance between points (0,– 4) and (8,6) in the Cartesian Plane.

Draw a right triangle with c as the hypotenuse.
Find the lengths of the "arms" of the right triangle.
Write the equation and solve.

$8^2 + 10^2 = c^2$

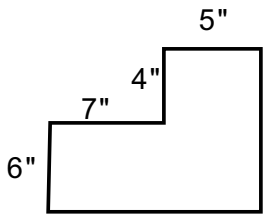
$c = \sqrt{164}$

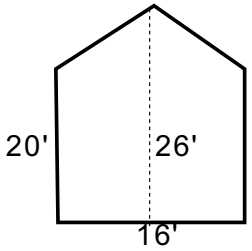
11-1A Linear measure– off on a tangent

PERIMETER of a simple closed curve in a plane is the "distance around the curve".

Find the perimeter:

(Assume right angles.)





(Assume symmetric)

CIRCUMFERENCE is the name we give to the PERIMETER OF THE CIRCLE.

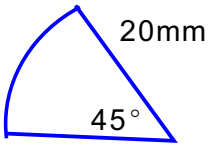
Definition of π: π is the name of the ratio of the circumference of the circle to its diameter, and is approximately 3.14159. It's irrational, so we *cannot* write its full decimal expansion, and it *cannot* be written as a simple fraction (ratio of two integers).

Since $\pi = C/D$, it follows that $C = \pi D$
and, since $D = 2r$, $C = 2\pi r$

What is the circumference of a circle whose diameter is 80 cm? 80π cm

John drew a quarter-circle arc, using his compass, opened to a radius of 10 cm. What is the length of the curve he drew? 5π cm

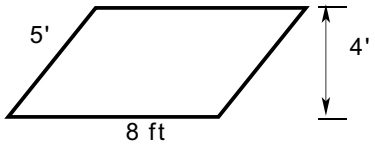
Susan drew this sector of a circle:
What is the length of the curve she drew?



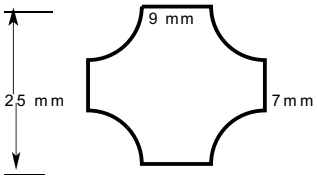
$(40 + 5\pi)$ mm

1. What is the perimeter of a square whose sides are 12 cm each? 48cm

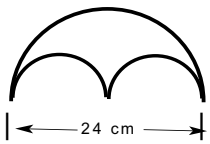
2. Find Perimeters for the following (assume all curvy parts are semi- or quarter-circles).



26'



$(32 + 18\pi)$mm



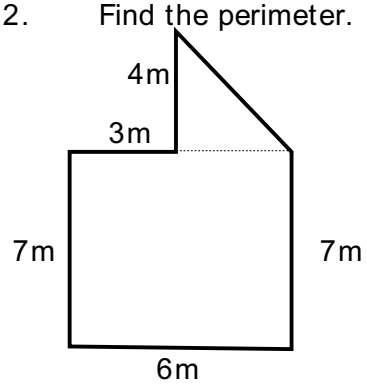
24πcm

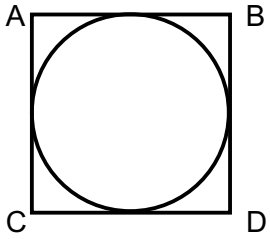
Measure- One dimensional- Sample Questions

1. Complete this table:

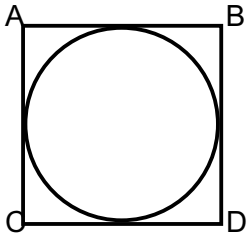
	Meters	Centimeters	Millimeters	Kilometers
2 meter sticks				
Mo's height	1.83 m			
Width of Pencil		.65 cm		
Distance to admin	167 m			

2. Find the perimeter. (Assume all angles that appear right *are* right.)



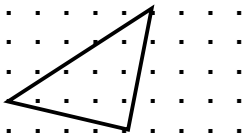
3. 

Assume a circle is inscribed in a square ABCD as shown.
If the square has perimeter 15 inches,
what is the *total length* of the curve drawn?

4. 

Assume a circle is inscribed in a square ABCD as shown.
Assume the circle has circumference 6π m.
What is the perimeter of the square?

5. Find the perimeter of the polygon shown.



6. What is the perimeter of a sector, with central angle 40°, from a circle of radius 10cm?