THE SI SYSTEM AND UNITS OF MEASUREMENT

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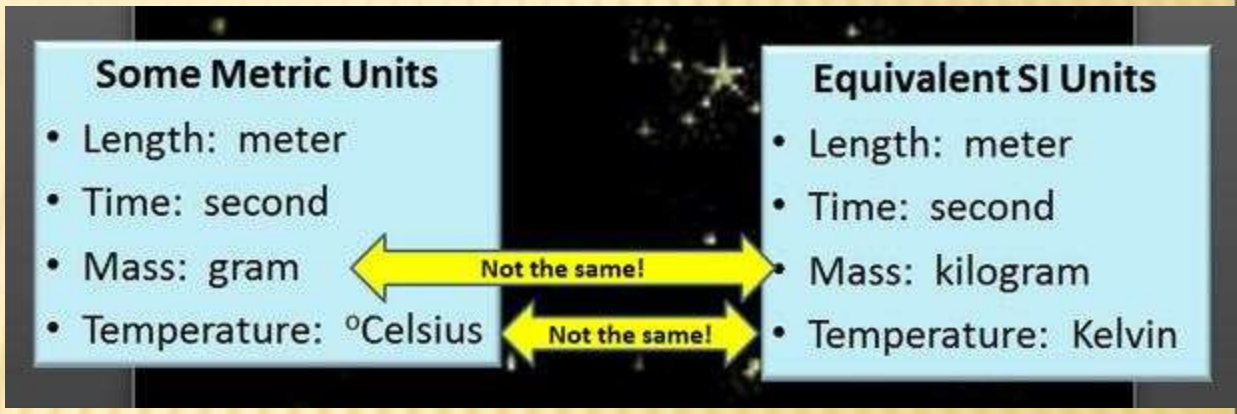
MEASUREMENT

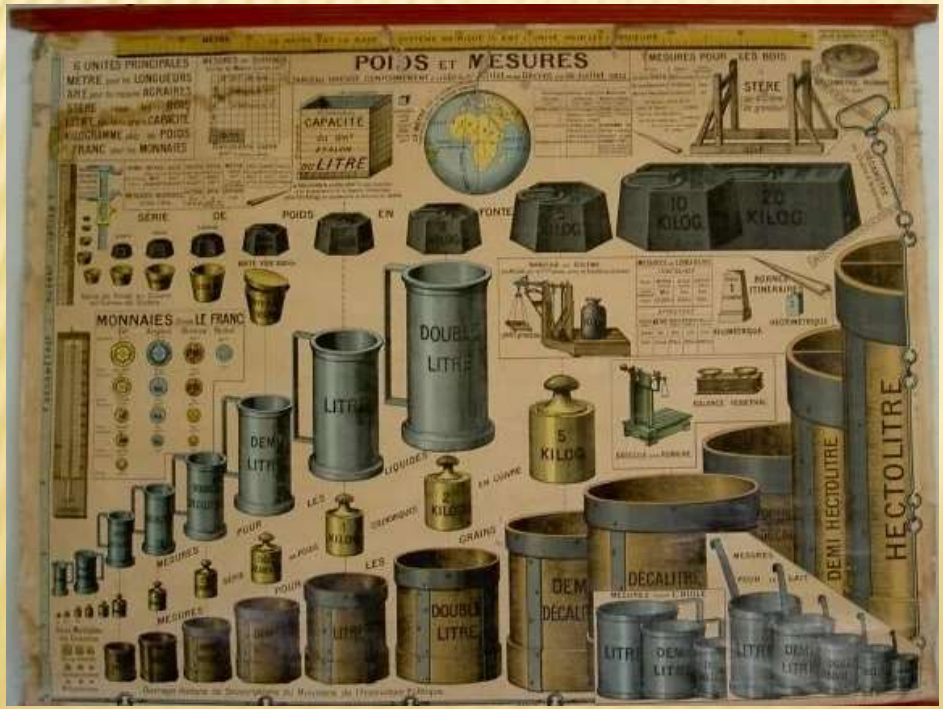
- In the late 18th century, scientists used the ***metric system***
- The metric system is a precursor to the ***SI System***



- Scientists all over the world use a single measurement system called *Le* ***Systeme International*** *d'unités,* abbreviated SI

SI SYSTEM OF MEASUREMENT

- This system was presented in 1960 by a *General Conference of Weights and Measures*
- SI has both base units and derived units



SI SYSTEM OF MEASUREMENT (CONT.)

- SI system:
  - based on meter-kilogram-second system (**m k s**)
  - replaces both the foot-pound-second system (**f p s**) and centimeter-gram-second system (**c g s**)

System	Length	Mass	Time
F.P.S.	foot	pound	second
C.G.S.	centimetre	gram	second
M.K.S.	metre	kilogram	second

- There are seven SI *base units*: meter, kilogram, second, mole, ampere, Kelvin and candela

SI BASE UNITS

- The most common base units include:

Quantity	Quantity Symbol	Unit name	Unit abbreviation
Length	l	meter	m
Mass	m	kilogram	kg
Time	t	second	s
Temperature	T	Kelvin	K

UNITS IN THE SI SYSTEM

In the metric and SI systems, *one unit* is used for each type of measurement:

Measurement	Metric	SI
Length	meter (m)	meter (m)
Volume	liter (L)	cubic meter (m^3)
Mass	gram (g)	kilogram (kg)
Time	second (s)	second (s)
Temperature	Celsius (°C)	Kelvin (K)

UNITS IN THE SI SYSTEM (CONT.)

BASE QUANTITIES AND THEIR SYMBOLS IN THE SI SYSTEM

Quantity	Unit name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Luminous intensity	candela	cd
Amount of substance	mole	mol

SI PREFIXES

- SI Units system includes a set of *prefixes*
- Use of a prefix makes a unit larger or smaller
- Ranges of SI unit prefixes are listed in the tables 1 and 2

TABLE 1

Prefix	*Symbol*	*Function*	*Divided by*
deci	d	10^{-1}	10
centi	c	10^{-2}	100
milli	m	10^{-3}	1000
micro	μ	10^{-6}	1,000,000
nano	n	10^{-9}	1,000,000,000
pico	p	10^{-12}	1,000,000,000,000
femto	f	10^{-15}	1,000,000,000,000,000

TABLE 2

Prefix	*Symbol*	*Function*	*Multiply by*
deca	da	10^1	10
hector	h	10^2	100
kilo	k	10^3	1000
mega	M	10^6	1,000,000
Giga	G	10^9	1,000,000,000
tera	T	10^{12}	1,000,000,000,000
peta	P	10^{15}	1,000,000,000,000,000

The Metric System Prefixes

Prefix	Symbol	Decimal Value	Scientific	Colloquial
quecto	q	0.000 000 000 000 000 000 000 000 001	10^{-30}	nonillionth
ronto	r	0.000 000 000 000 000 000 000 001	10^{-27}	octillionth
yocto	y	0.000 000 000 000 000 000 001	10^{-24}	septillionth
zepto	z	0.000 000 000 000 000 001	10^{-21}	sextillionth
atto	a	0.000 000 000 000 001	10^{-18}	quintillionth
femto	f	0.000 000 000 001	10^{-15}	quadrillionth
pico	p	0.000 000 001	10^{-12}	trillionth
nano	n	0.000 001	10^{-9}	billionth
micro	µ	0.001	10^{-6}	millionth
milli	m	0.01	10^{-3}	thousandth
centi	c	0.1	10^{-2}	hundredth
deci	d	1	10^{-1}	tenth
-	-	10	10^{0}	one
deka	da	100	10^{1}	ten
hecto	h	1 000	10^{2}	hundred
kilo	k	1 000 000	10^{3}	thousand
mega	M	1 000 000 000	10^{6}	million
giga	G	1 000 000 000 000	10^{9}	billion
tera	T	1 000 000 000 000 000	10^{12}	trillion
peta	P	1 000 000 000 000 000 000	10^{15}	quadrillion
exa	E	1 000 000 000 000 000 000 000	10^{18}	quintillion
zetta	Z	1 000 000 000 000 000 000 000 000	10^{21}	sextillion
yotta	Y	1 000 000 000 000 000 000 000 000 000	10^{24}	septillion
ronna	R	1 000 000 000 000 000 000 000 000 000 000	10^{27}	octillion
quetta	Q	1 000 000 000 000 000 000 000 000 000 000 000	10^{30}	nonillion

MEASUREMENT SYSTEM COMPARISONS

MEASUREMENT	ENGLISH (US)	SI SYSTEM
LENGTH	Foot / Inch	Meter
MASS	Ounce / Pound	Kilogram
VOLUME	Quart	Cubic meter
TEMPERATURE	Fahrenheit	Kelvin
TIME	Second	Second

TEMPERATURE

- The standard unit of measurement for temperature is Kelvins (K)
- Temperature can also be measured in degrees Celsius (°C) and degrees Fahrenheit (°F)
- To convert degrees Celsius (°C) to degrees Fahrenheit (°F) multiply by 1.8 and then add 32. To convert degrees Fahrenheit to degrees Celsius, subtract 32 and then divide by 1.8
- K= °C + 273

DERIVED UNITS

- Derived units are combinations of base units
- They are produced by multiplying or dividing standard units

Quantity	Quantity symbol	Unit	Unit abbreviation
Area	A	square meter	m^2
Volume	V	cubic meter	m^3
Density	D	kilograms per cubic meter	kg/m^3

CONVERSIONS

TABLE 3 UNIT CONVERSION FACTORS

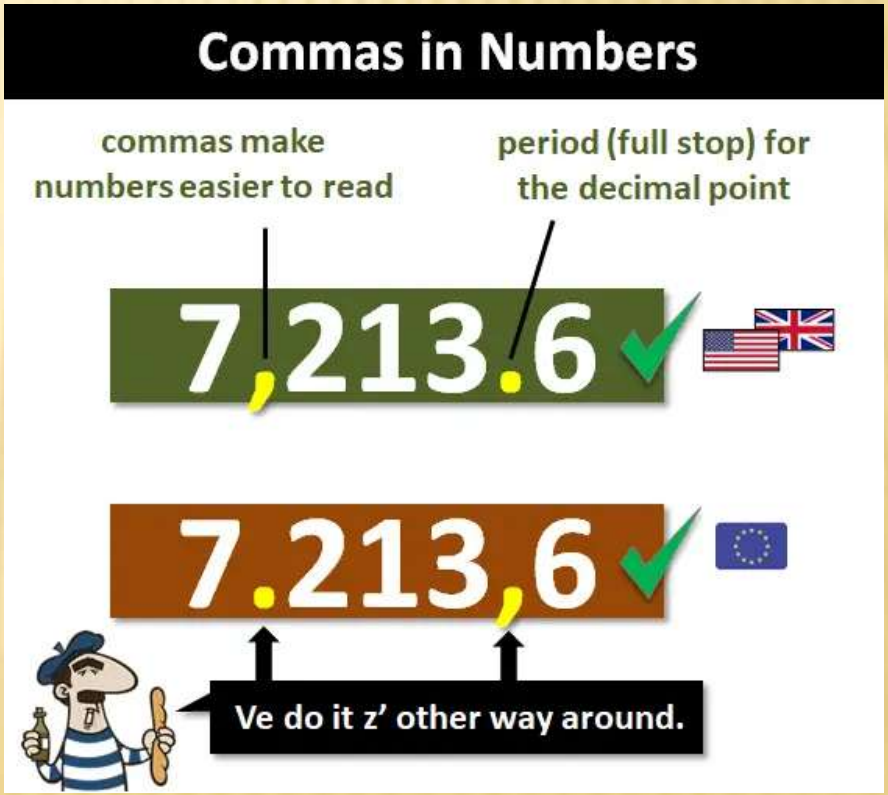
Quantity	To convert from	To	Multiply by
Length	mi	km	1.609 344*
	yd	m	0.9144*
	ft	m	0.304 8*
	ft	mm	304.8*
	in.	mm	25.4*
Area	mi^2	km^2	2.590 00*
	acre	m^2	4 046.87
	acre	ha**	0.404 687
	ft^2	m^2	0.092 903 04*
	$in.^2$	mm^2	645.16*
Volume	yd^3	m^3	0.764 555
	ft^3	m^3	0.028 3168
	100 board feet	m^3	0.235 974
	gal	L	3.785 41
	$in.^3$	cm^3	16.387 064
	$in.^3$	mm^3	16 387.064
Velocity	ft/s	m/s	0.3048
Rate of fluid flow, infiltration	ft^3/s	m^3/s	0.028 3168
	gal/h	mL/s	1.051 50
Acceleration	ft/s^2	m/s^2	0.3048
Mass	lb	kg	0.453 59
Mass per unit area	psf	kg/m^2	4.882 43
Mass density	pcf	kg/m^3	16.018 5
Force	lb	N	4.448 22
Force per unit length	plf	N/m	14.593 9
Pressure, stress	psf	Pa	47.880 26
	psi	kPa	6.894 76
	in. of mercury (in. Hg)	kPa	3.386 38
	in. of Hg (in. Hg)	psf	70.72
	atm***	kPa	101.325

CONVERSIONS (CONT.)

Temperature	°F	°C	5/[9(°F – 32)]
	°F	K	(°F + 459.7)/1.8
Quantity of heat	Btu	J	1055.056
Power	ton (refrigeration)	kW	3.517
	Btu/h	W	0.293 07
	hp	W	745.7
	Btu/(h-ft^2)	W/m^2	3.154 59
Thermal conductivity	Btu-in/(ft^2-h-°F)	W/(m · °C)	0.144 2
Thermal conductance, or thermal transmittace, U	Btu/(ft^2-h-°F)	W/(m^2 · °C)	5.678 263
Thermal resistance	(ft^2-h-°F)/Btu	(m^2 · °C)/W	0.176 110
Thermal capacity	Btu/(ft^2-°F)	kJ/(m^2 · °C)	20.44
Specific heat	Btu/(lb-°F)	J/(kg · °C)	4.186 8
Vapor permeability	perm-in	ng/(Pa · m · s)	1.459 29
Vapor permeance	perm	ng/(Pa · m^2 · s)	57.213 5
Angle	degree	radian	0.017 453

DECIMAL AND THOUSANDS SEPARATORS

- UK and US are 2 places that use the period (.) to indicate decimal place
  - Other countries use a comma instead (,)
  - *Decimal separator* aka “radix character”



DECIMAL AND THOUSANDS SEPARATORS

- Using comma to separate groups of thousands
  - Used in U.K. and U.S.
  - Many other countries use a period instead
  - Some countries separate thousands groups with a thin space
  - See next slide for some commonly used numeric formats

10 000,00
10.000,00
10,000.00

DECIMAL AND THOUSANDS SEPARATORS

Region	Large Number
Canadian (English and French)	4 294 967 295,000
Danish	4 294 967 295,000
Finnish	4 294 967 295,000
French	4 294 967 295,000
German	4 294 967.295,000
Italian	4.294.967.295,000
Norwegian	4.294.967.295,000
Spanish	4.294.967.295,000
Swedish	4 294 967 295,000
UK-English	4,294,967,295.00
US-English	4,294,967,295.00