P231 Week 1: measurements

Goals of Week 1:

- Learn about base and derived units
- Learn dimensions and dimensional analysis
- Understand the need for errors and significant figures
- Learn how to propagate errors in +, -, ×, and ÷
- Understand how μ, σ, and σ_μ are related to measurements and errors

Units

Base Units

Mechanical

Quantity	**MKS unit**	**cgs unit**
mass	kg (kilogram)	g
length	m (meter)	cm
time	s (second)	s

Other

Quantity	**MKS unit**
temperature	K (Kelvin)
current	A (amps)
amount of matter	mol (mole)
luminous intensity	cd (candela)

Derived Units

miles/hour
km/s
mol/liter
kg m/s^2
etc.
etc.
etc.

Unit systems

System	L	M	T
SI or “mks”	m	kg	s
cgs	cm	g	s
US Customery	ft (foot)	slug	s

Making convenient units with prefixes

TABLE 1.2 Multiples and Prefixes for Metric Units*

Multiple†	Prefix (and Abbreviation)	Pronunciation	Multiple†	Prefix (and Abbreviation)	Pronunciation
10^{24}	yotta- (Y)	yot'ta (*a* as in *a*bout)	10^{-1}	deci- (d)	des'i (as in *deci*mal)
10^{21}	zetta- (Z)	zet'ta (*a* as in *a*bout)	10^{-2}	centi- (c)	sen'ti (as in *senti*mental)
10^{18}	exa- (E)	ex'a (*a* as in *a*bout)	10^{-3}	milli- (m)	mil'li (as in *mili*tary)
10^{15}	peta- (P)	pet'a (as in *pet*al)	10^{-6}	micro- (μ)	mi'kro (as in *micro*phone)
10^{12}	tera- (T)	ter'a (as in *terr*ace)	10^{-9}	nano- (n)	nan'oh (*an* as in *an*nual)
10^{9}	giga- (G)	ji'ga (*ji* as in *ji*ggle, *a* as in *a*bout)	10^{-12}	pico- (p)	pe'ko (*peek-oh*)
10^{6}	mega- (M)	meg'a (as in *mega*phone)	10^{-15}	femto- (f)	fem'toe (*fem* as in *fem*inine)
10^{3}	kilo- (k)	kil'o (as in *kilo*watt)	10^{-18}	atto- (a)	at'toe (as in an*at*omy)
10^{2}	hecto- (h)	hek'to (*heck-toe*)	10^{-21}	zepto- (z)	zep'toe (as in *zep*pelin)
10	deka- (da)	dek'a (*deck* plus *a* as in *a*bout)	10^{-24}	yocto- (y)	yock'toe (as in *sock*)

*For example, 1 gram (g) multiplied by 1000 (10^3) is 1 kilogram (kg); 1 gram multiplied by 1/1000 (10^{-3}) is 1 milligram (mg).

†The most commonly used prefixes are printed in color. Note that the abbreviations for the multiples 10^6 and greater are capitalized, whereas the abbreviations for the smaller multiples are lowercased.

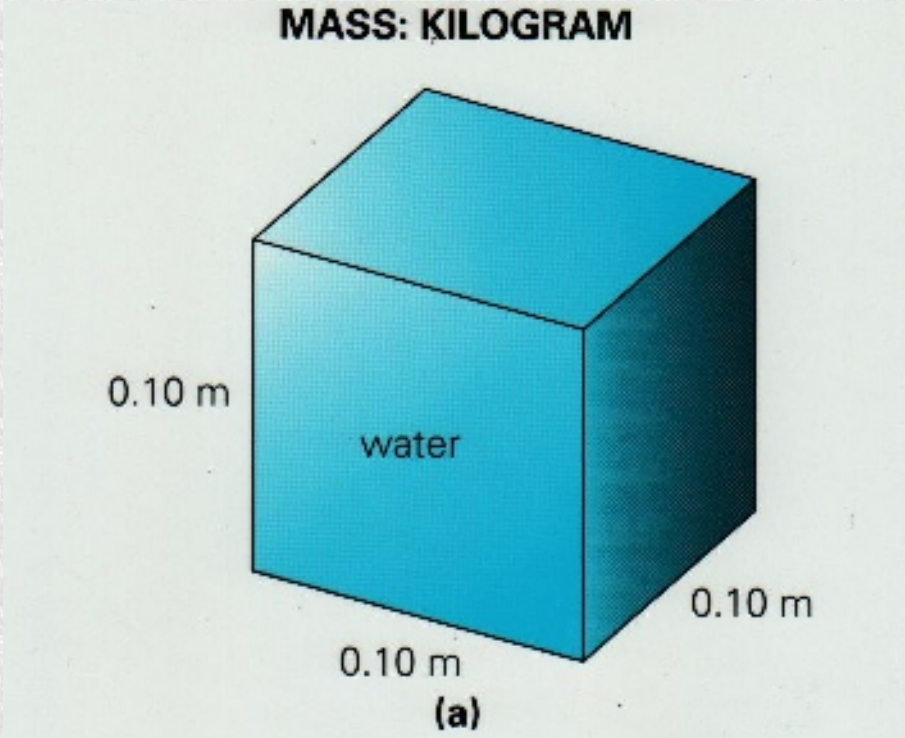
Unit Standards

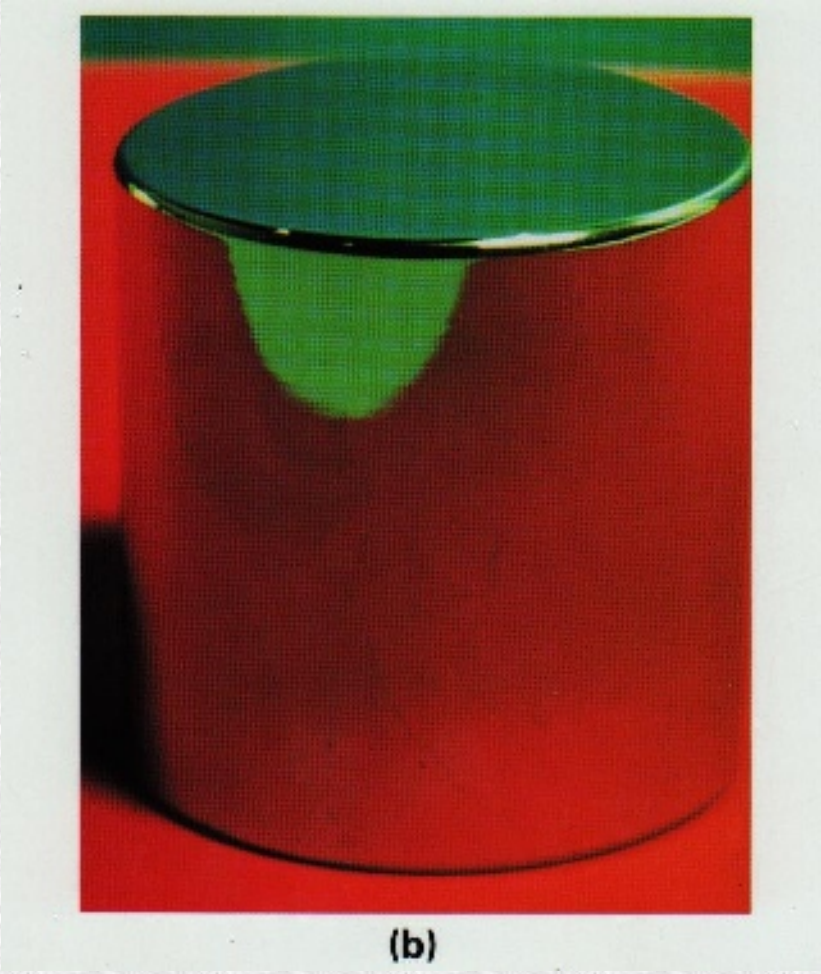
Standard: a real-life object or thing which defines a unit.

Why do we need standards?
Communication!

- **between scientists discussing experimental results**
- **between international businessmen selling goods "by the gallon" or "by the pound"**
- **between Earth and alien life (some day?)**

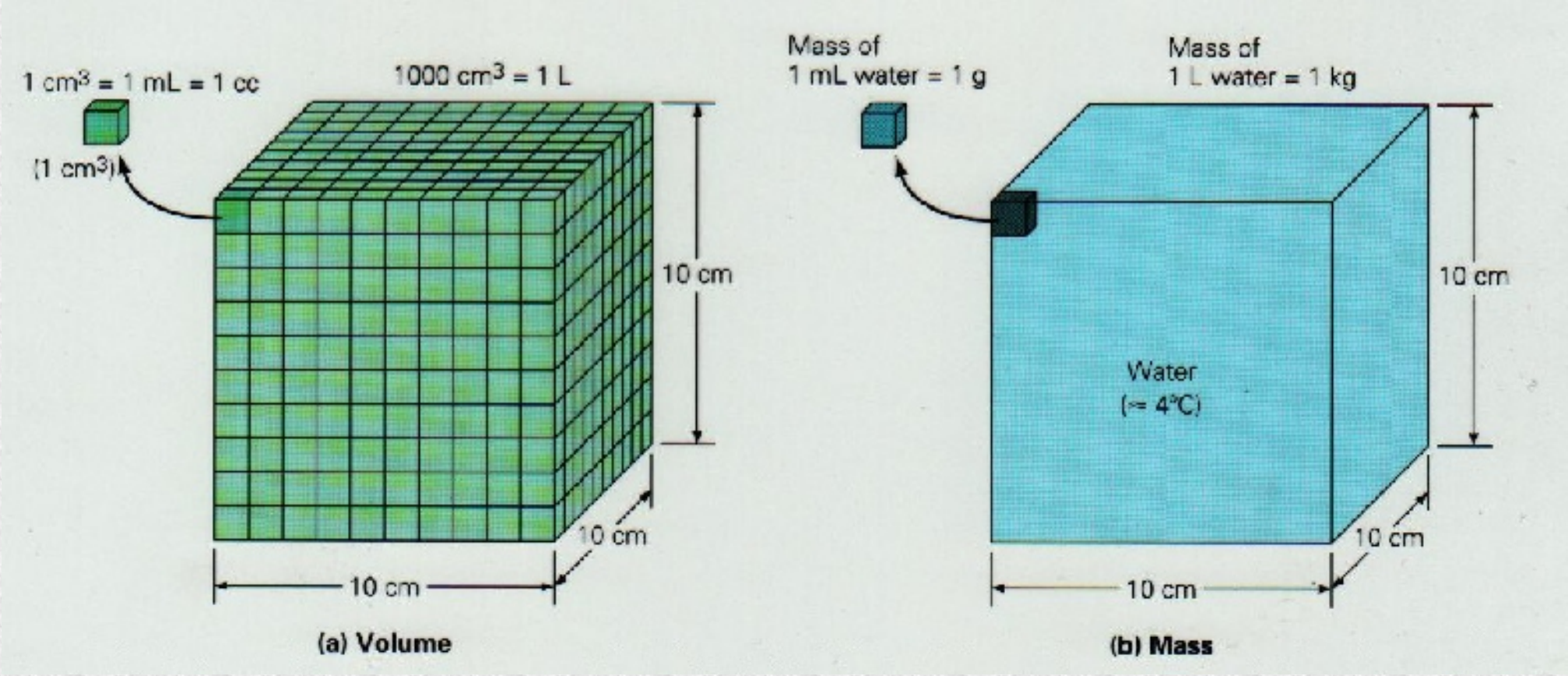
Unit Standards
Mass





PtIr cylinder in Sevres, France

Unit Standards
Volume based on mass of H_2O



(1mL=1g is strictly true at T = 4 °C.)