Matter - anything that occupies space and has ***mass***.

mass – measure of the quantity of matter

System International

SI unit of mass is the ***kilogram*** (kg)

1 kg = 1000 g = 1 x 10^3 g

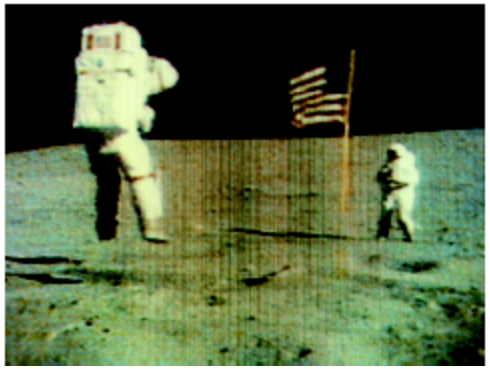
weight – force that gravity exerts on an object

$F = ma$ $F = mg$ dependent on gravity

weight = *c* x mass

on earth, *c* = 1.0

on moon, *c* ~ 0.1



A 1 kg bar will weigh

1 kg on earth

0.1 kg on moon

International System of Units (SI)

TABLE 1.2 SI Base Units

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

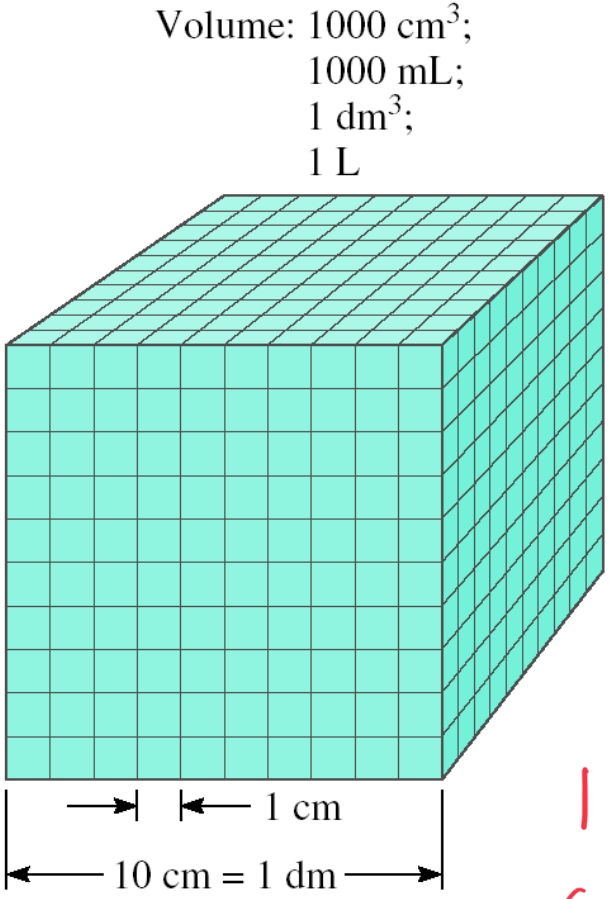
Absolute temperature

amount of a substance

TABLE 1.3 Prefixes Used with SI Units

Prefix	Symbol	Meaning	Example
tera-	T	1,000,000,000,000, or 10^{12}	1 terameter (Tm) = 1×10^{12} m
giga-	G	1,000,000,000, or 10^{9}	1 gigameter (Gm) = 1×10^{9} m
mega-	M	1,000,000, or 10^{6}	1 megameter (Mm) = 1×10^{6} m
kilo-	k	1,000, or 10^{3}	1 kilometer (km) = 1×10^{3} m
deci-	d	1/10, or 10^{-1}	1 decimeter (dm) = 0.1 m
centi-	c	1/100, or 10^{-2}	1 centimeter (cm) = 0.01 m
milli-	m	1/1,000, or 10^{-3}	1 millimeter (mm) = 0.001 m
micro-	μ	1/1,000,000, or 10^{-6}	1 micrometer (μm) = 1×10^{-6} m
nano-	n	1/1,000,000,000, or 10^{-9}	1 nanometer (nm) = 1×10^{-9} m
pico-	p	1/1,000,000,000,000, or 10^{-12}	1 picometer (pm) = 1×10^{-12} m

Volume – SI derived unit for volume is cubic meter (m^3)



$1\ cm^3 = (1 \times 10^{-2}\ m)^3 = 1 \times 10^{-6}\ m^3$

$1\ dm^3 = (1 \times 10^{-1}\ m)^3 = 1 \times 10^{-3}\ m^3$

$1\ L = 1000\ mL = 1000\ cm^3 = 1\ dm^3$

$1\ mL = 1\ cm^3$

$1\ m^3$

"cc" cubic centimeter

$1\ m = 100\ cm$

$(1\ m)^3 = (100\ cm)^3$

$1\ m^3 = 1{,}000{,}000\ cm^3$

1 gram of water = 1 mL water

Volumetric flask

Density – SI derived unit for density is kg/m^3

$1\ g/cm^3 = 1\ g/mL = 1000\ kg/m^3$

$$\text{density} = \frac{\text{mass}}{\text{volume}} \qquad d = \frac{m}{V}$$

$V(D) = \left(\frac{M}{V}\right)V \quad M = \quad M = VD$

A piece of platinum metal with a density of 21.5 g/cm^3 has a volume of 4.49 cm^3. What is its mass?

$$d = \frac{m}{V}$$

$m = d \times V = 21.5\ g/cm^3 \times 4.49\ cm^3 = 96.5\ g$

TABLE 1.4

Densities of Some Substances at 25°C

Substance	Density (g/cm^3)
Air*	0.001
Ethanol	0.79
Water	1.00
Mercury	13.6
Table salt	2.2
Iron	7.9
Gold	19.3
Osmium†	22.6

*Measured at 1 atmosphere.
†Osmium (Os) is the densest element known.

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Nate's NoNuts Donuts

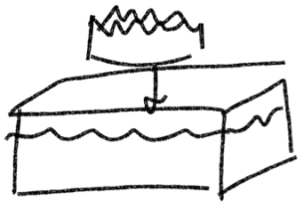
$$D = \frac{M}{V}$$

mass: 28.4 kg

volume: 236 mL

$$D = \frac{M}{V} = \frac{28.4\ kg}{236\ mL} = \boxed{0.120\ \frac{kg}{mL}}$$

Density → intensive property
not dependent on amount.



through water displacement → found volume

mass through counterweights

$$D = \frac{M}{V}$$

Fe iron $\rho = 7.86$ 1 mL block of Fe

$M = ?$

$$V(D) = \left(\frac{M}{V}\right)V$$

$$M = D \cdot V = 7.86\ g/mL \cdot 1\ mL = \boxed{7.86\ g}$$

8.01g

Antimony	Sb	6.697 g/mL
Tungsten	W	19.25 g/mL
Carbon	C	1.82 g/mL
Zinc	Z	7.14 g/mL
Chromium	Cr	7.19 g/mL
Titanium	Ti	4.506 g/mL
Aluminum	Al	2.7 g/mL
Iron	Fe	7.86 g/mL
Molybdenum	Mo	10.2 g/mL
Vanadium	V	6.0 g/mL
Cobalt	Co	8.9 g/mL
Bismuth	Bi	9.8 g/mL
Copper	Cu	8.96 g/mL
Niobium	Nb	8.67 g/mL

Mass: 8.23 kg

Density: 5.30 kg/mL

Volume: ?

$$D = \frac{M}{V}$$

$$V = \frac{M}{D}$$

$$V = \frac{8.23\ \cancel{kg}}{5.30\ \cancel{kg}/mL}$$

$$\boxed{1.55\ mL}$$

$$4 = \frac{12}{3}$$

$$3 = \frac{12}{4}$$