

Matter and Measurement

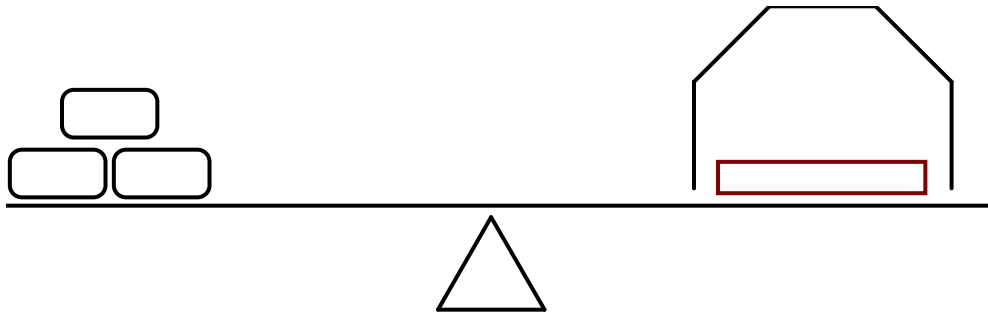
matter- anything that has mass and occupies space

energy- the ability to do work/ transfer heat

Conservation Laws

Law of Conservation of Matter

**Matter cannot be created or destroyed
when a chemical reaction occurs**



Conservation of Energy

Energy cannot be created or destroyed

examples:

slowing a moving car with the brakes

using generated electricity by a powerplant

Energy Changes

A process that absorbs energy
is said to be **endothermic**

A process that releases energy
is said to be **exothermic**

remember:

solid $\xrightarrow{\text{add energy}}$ liquid $\xrightarrow{\text{add energy}}$ gas

water freezing?

alcohol boiling?

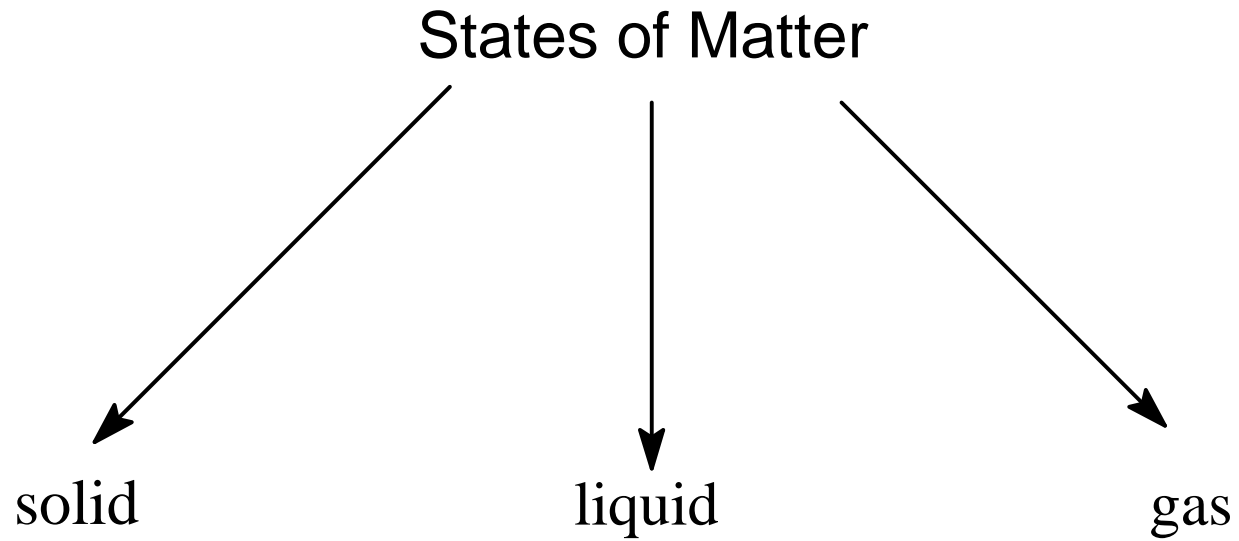
The Atomic Age



$$E=mc^2$$

During the process of a nuclear reaction the mass of the products is less than the mass of reactants. The mass is converted into energy by the Einstein equation.

States of Matter



Chemical and Physical Changes, Properties, and Processes

a change that does not change the composition of the substance is called a physical change

ice and liquid water are the same substance (H_2O)

Chemical Changes

Changes (forever) the composition of the substance

Chemical or Physical?

elasticity of a rubber band ?

an iron nail rusting?

burning wood?

frying an egg?

boiling water?

Characterizing Matter

Matter

heterogeneous

homogeneous

heterogeneous

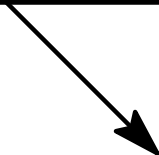
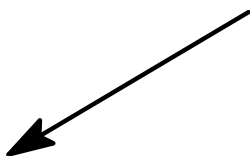
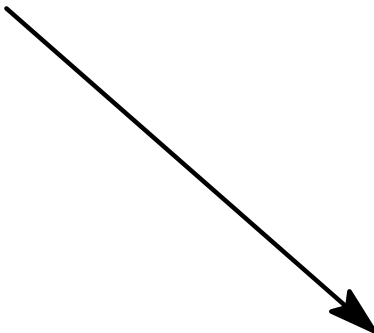
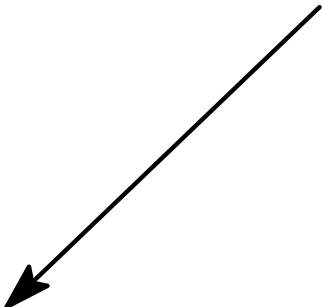
homogeneous

mixture

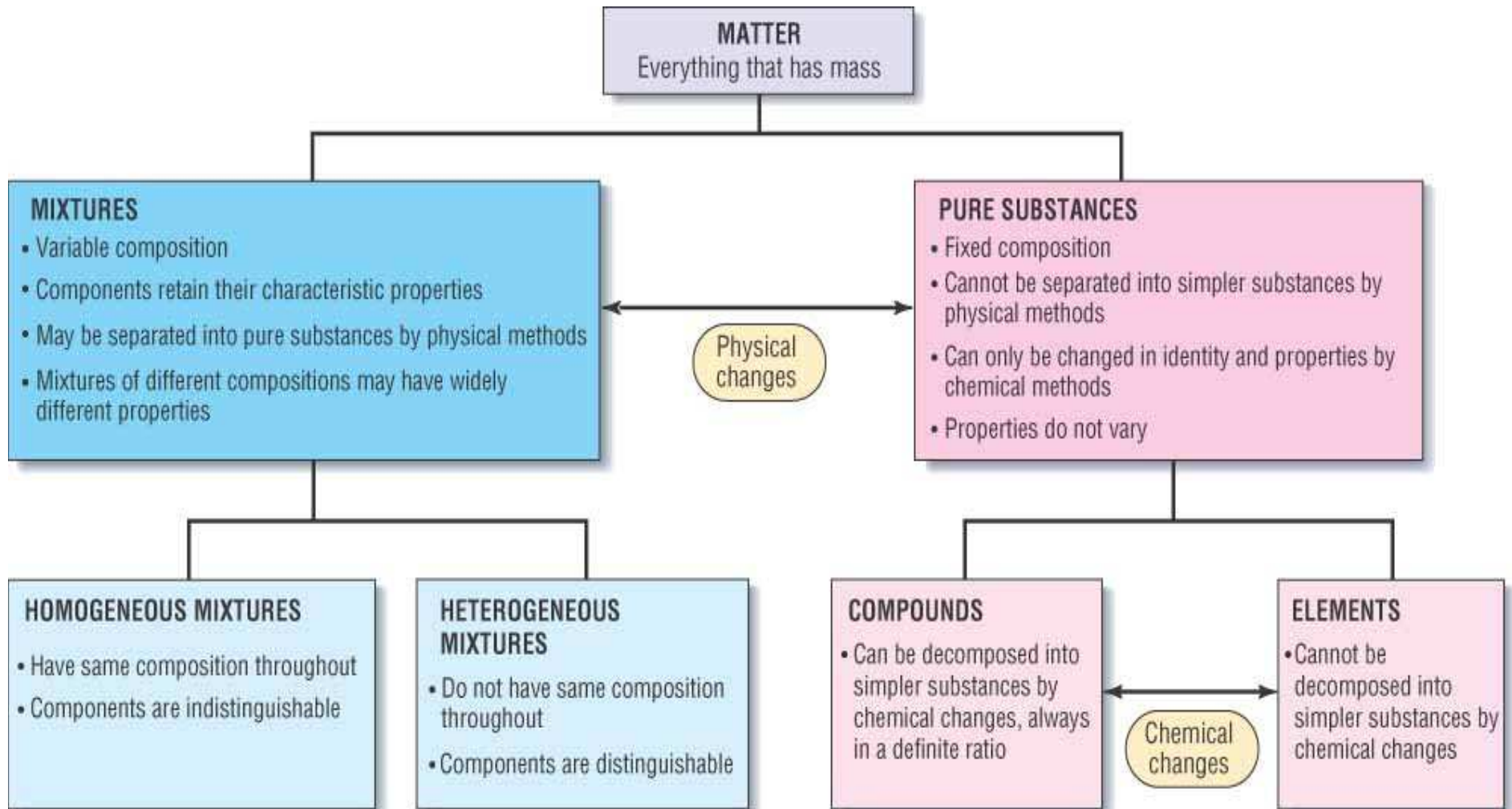
pure
substance

elements

compounds



Another Look



Elements

Names

Symbols

oxygen

O

chlorine

Cl

iron

Fe

Standard Measurement Units

TABLE 1-4

*The Seven Fundamental
Units of Measurement (SI)*

Physical Property	Name of Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
luminous intensity	candela	cd
amount of substance	mole	mol

Common Units of Measure

mass- gram (g)

length- meter(m)

**volume- a derived measure from length
(1 cm³ = 1 mL)**

The Metric System

tera	T	1×10^{12}	
Prefix	Abbreviation	Meaning	Example
giga	G	1×10^9	
mega-	M	10^6	1 megameter (Mm) = 1×10^6 m
kilo-*	k	10^3	1 kilometer (km) = 1×10^3 m
deci-	d	10^{-1}	1 decimeter (dm) = 1×10^{-1} m
centi-*	c	10^{-2}	1 centimeter (cm) = 1×10^{-2} m
milli-*	m	10^{-3}	1 milligram (mg) = 1×10^{-3} g
micro-*	μ^\dagger	10^{-6}	1 microgram (μg) = 1×10^{-6} g
nano-*	n	10^{-9}	1 nanogram (ng) = 1×10^{-9} g
pico-	p	10^{-12}	1 picogram (pg) = 1×10^{-12} g
femto	f	1×10^{-15}	

Scientific Notation calculators

$$4.86 \times 10^7$$

To enter a number in scientific notation

REMEMBER

$$4.86 \times 10^7$$

How it's Done

$$4.86 \times 10^7$$

For negative exponents

$$6.03 \times 10^{-9}$$

Significant Figures

How long is the piece of wood?

What you use to measure defines
how to write the value!

**Rules for determining
the number of significant figures**

All integers are significant 127 yards has 3 sf

SOME 0's are **not** significant

large numbers with no decimal 93,000 miles has 2 sf

small numbers after decimal, before first integer

0.00039 meters has 2 sf

Rules for math operations

When multiplying and dividing,
round answer off to the number
in the calculation with the **fewest sf's**

$$\frac{(2.765)(8100)}{(2340)(87.1)}$$

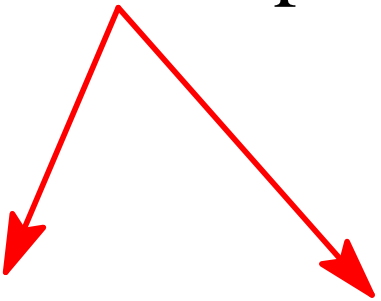
Adding and Subtracting

Report your answer to the number
in the calculation that has
the **fewest decimal places**

$$\begin{array}{r} 8.312 \\ 3.1 \\ 0.0032 \\ \hline \end{array}$$

Be Careful!

Note: not the same exponent of 10


$$(2.863 \times 10^4 - 1.22 \times 10^3) = ?$$

A Practical Application

Determine the density of a liquid if 28.96g occupies 12 mL

$$D = \frac{M}{V} = \frac{28.96\text{g}}{12 \text{ mL}}$$

Last Word on Significant Figures

**Some numbers are exact
(have infinite significance)**

Dimensional Analysis-

A method of problem solving

if

$$a=b$$

$$\frac{a}{b} = ?$$

$$\frac{b}{a} = ?$$

$$c \left(\frac{a}{b} \right) = ?$$

Applying this

$$12 \text{ inches} = 1 \text{ foot}$$

$$\frac{12 \text{ inches}}{1 \text{ foot}} = 1 \quad \frac{1 \text{ foot}}{12 \text{ inches}} = 1$$

Problem: Convert 192 inches to feet

Problem: Convert 13 feet to inches


Terminology

12 inches = 1 foot

Convert 192 inches to feet

A Map

how to get there

where to start  where you are going

The Look of Identities in a Problem

There are 2 dozen cookies in a box

Pack 36 books per carton

A car travels at 55 miles/hour

The Look of Given in a Problem

A car travels for 6 hours

The distance to San Antonio is 71 miles

A beaker contains 65.5 g of mercury

Identities

common knowledge; the problem

**A car has been traveling for 38 miles
at a speed of 45 miles/hr. How many
minutes has the car been traveling?**

38 miles \longrightarrow minutes?

Where Else to Get Identities

from a conversion chart $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$

(see inside back cover to text)

from your knowledge of the metric system

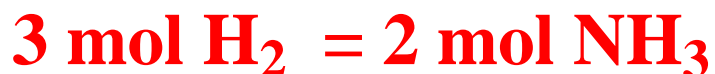
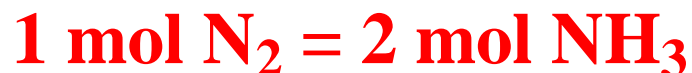
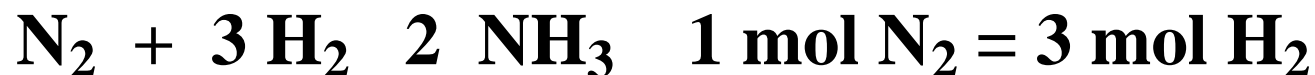
(since nano (n) means 1×10^{-9} : $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$)

from the periodic table

the "atomic mass" of argon is 39.948, $1 \text{ mol Ar} = 39.948 \text{ g}$

the "molar mass" of H_2SO_4 is 98.09 g/mol, $1 \text{ mol H}_2\text{SO}_4 = 98.09 \text{ g}$

from balanced equations



More

from solution concentrations

a **0.150 mol/L** solution of HBr **0.150 mol HBr = 1 L solution**

from percentages

55% of students in a class are female

55 female students = 100 students

a **23.5%** aqueous solution of NaCl

23.5 g NaCl = 100. g solution

76.5 g water = 100. g solution

23.5 g NaCl = 76.5 g water

Last One

From visual inspection

since a bicycle has two tires ... **2 tires = 1 bicycle**

given a formula C_3H_8O ...

- 8 atoms H = 1 molecule C_3H_8O**
- 3 atoms C = 1 molecule C_3H_8O**
- 1 atom O = 1 molecule C_3H_8O**

Practice Problems

**An ant moves at a rate of 2.0 inches per second.
How many feet does the ant travel in 4.0 hours?**

Another

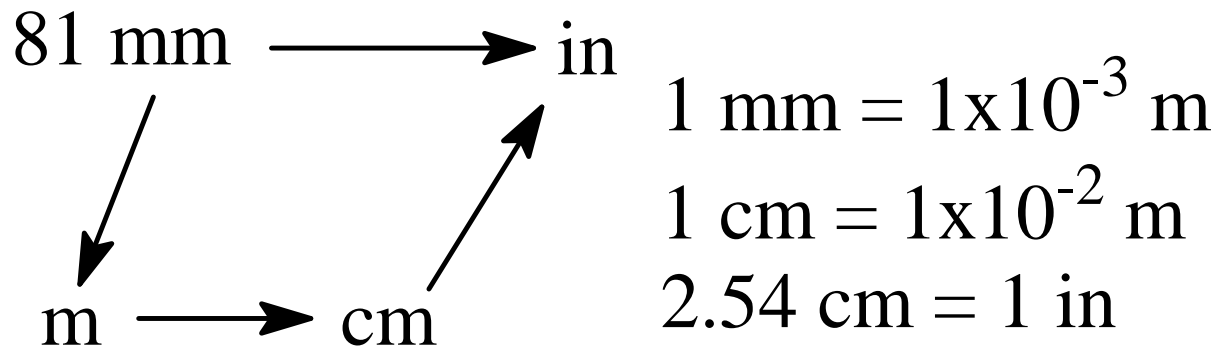
Convert 2.9 kg into ng

2.9 kg \longrightarrow ng

Areas and Volumes

Convert 81mm^2 to in^2

evaluate with linear units first!



One More

Of 130 candies 60.% are chocolate. Of the chocolate candies 22% are filled.

Of the chocolate filled candies, 82% have liquid centers.

How many candies are chocolate with liquid, filled centers?

130 candies \longrightarrow chocolate, liquid filled candies



chocolate candies \longrightarrow chocolate filled candies

Finish this at home!

Density

Use density formula **ONLY** if asked to determine density!

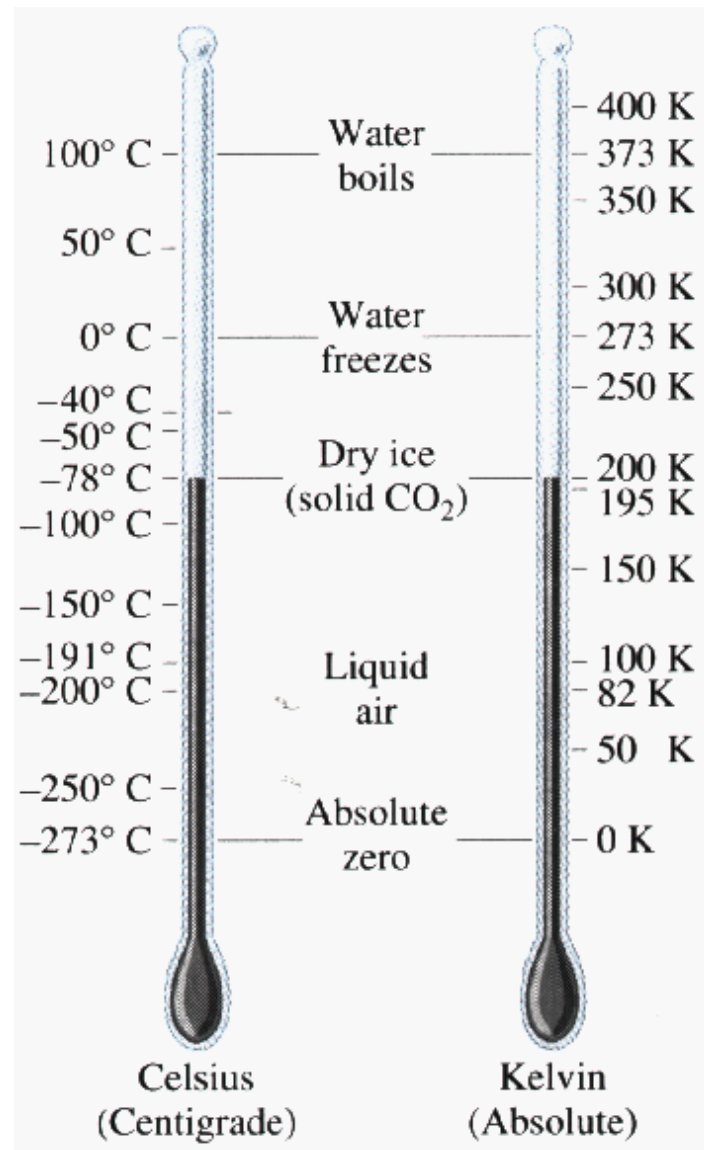
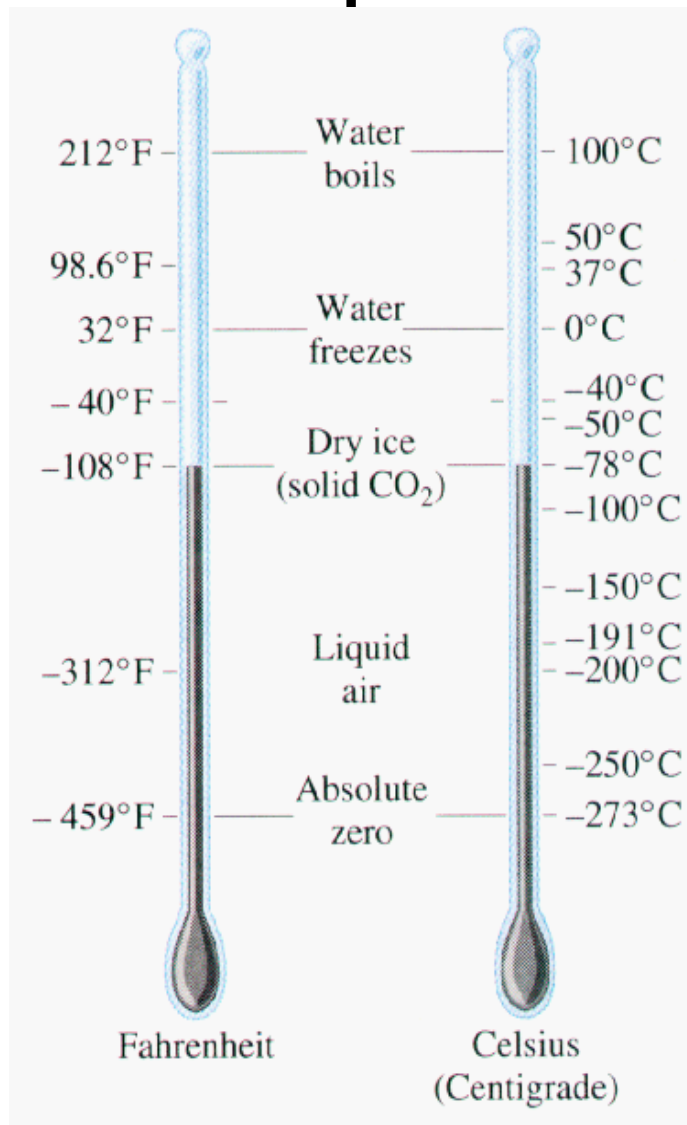
$$D = \frac{M}{V}$$

Use **DIMENSIONAL ANALYSIS** if density is given in the problem

The density of mercury is 13.6 g/cm³.

How many liters does 186 pounds of mercury occupy?

Temperature Scales-Conversions



Heat Calculations

$$q = m c \Delta t$$

a table of specific heats can be found in Appendix E