LECTURE NOTES FOR GENERAL CHEMISTRY ©MM 2007

CHAPTER 1 MATTER AND MEASUREMENT

CHEMISTRY IS THE STUDY OF MATTER

MATTER IS THAT WHICH HAS MASS AND OCCUPIES SPACE

ATOMS ARE THE SMALLEST UNIT OF MATTER

MOLECULES ARE LARGER UNITS OF MATTER WITH 2 OR MORE ATOMS

MATTER HAS PHYSICAL PROPERTIES (SUBSTANCE DOES NOT CHANGE)

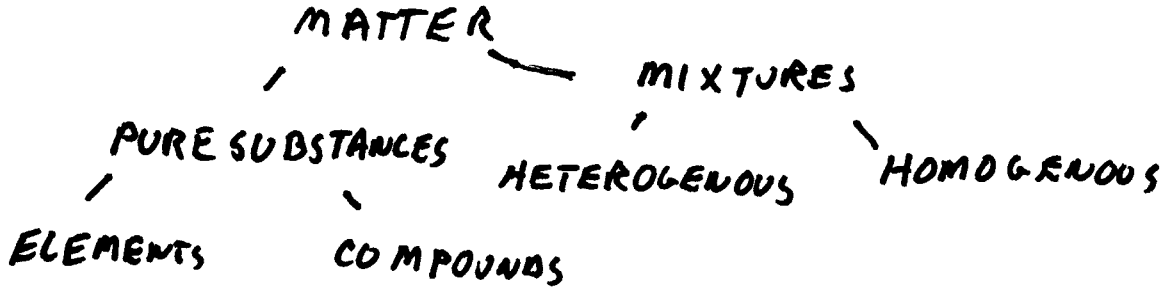
ODOR, TASTE, SOLUBILITY

MASS, MELTING POINT, BOILING PT. DENSITY → MEASURABLE

MATTER HAS CHEMICAL PROPERTIES (SUBSTANCE CHANGES)

BURNING, RUSTING, EXPLODING

MATTER MODEL



SCIENTIFIC METHOD

SCIENTIFIC KNOWLEDGE IS: TESTABLE, REPRODUCIBLE, EXPLANATORY, PREDICTIVE AND TENTATIVE

HYPOTHESIS - TENTATIVE EXPLANATION

EXPERIMENT - TEST OF HYPOTHESIS

LAW OR MODEL - TESTED EXPLANATION "HERE IS WHAT WILL HAPPEN"

THEORY - EXPANATION "HERE IS WHY IT HAPPENS"

A MODEL CAN BE MODIFIED OR EVEN DISCARDED IF IT IS INCONSISTENT WITH EXPERIMENT

MEASUREMENT

WE USE THE METRIC (SI) SYSTEM (TABLE 1.3)

MEMORIZE THE SI PREFIXES (TABLE 1.4)

LENGTH

METER (m)

KILO METER = 1000 m = 1×10^{3} m

CENTI METER = 0.01 m = 1×10^{-2} m

MILLI METER = 0.001 m = 1×10^{-3} m

NANO METER = 0.000000001 m = 1×10^{-9} m

VOLUME VOLUME

LITER = 1000 cm^3

(L)

MILLILITER = 1 cm^3 (cc)

MASS

KILOGRAM = 1000 grams (g)

(kg)

1 MILLIGRAM = 0.001 g = 1×10^{-3} g

TIME

SECOND (s)

1 MILLI SECOND = 0.001 s = 1×10^{-3} s

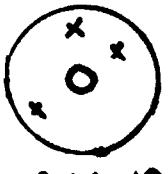
TEMPERATURE

KELVIN (K) MOST LAB MEASUREMENTS ARE MADE IN DEGREES CELCIUS (^{o}C)

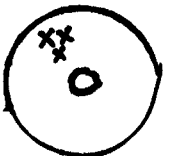
$K = {}^{o}C + 273.15$

ACCURACY - HOW CLOSE TO THE CORRECT VALUE

PRECISION - HOW CLOSE ARE THE MEASUREMENTS TO EACH OTHER

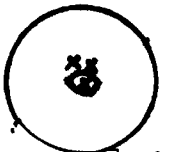


LOW ACCURACY
LOW PRECISION



LOW ACCURACY
HIGH PRECISION

HIGH ACCURACY
LOW PRECISION



HIGH ACCURACY
HIGH PRECISION

SIGNIFICANT FIGURES

- ALL DIGITS KNOWN WITH CERTAINTY, PLUS THE FIRST UNCERTAIN ONE
- REFLECTS UNCERTAINTY IN THE MEASUREMENT

RULES

- ZEROS BETWEEN SIGNIFICANT DIGITS ARE SIGNIFICANT 707 = 3 SF
- LEADING ZEROS ARE NOT SF 0.00707 = 3 SF
  THEY SERVE TO POSITION THE DECIMAL POINT
- TRAILING ZEROS ARE SIGNIFICANT AFTER THE DECIMAL POINT 707.00 = 5 SF
- TRAILING ZEROS WITHOUT A DECIMAL MAY BE SIGNIFICANT OR NOT 70700 = 3, 4, OR 5 SF
  USE SCIENTIFIC NOTATION

$7.07 \times 10^4 = 3\ SF$

$7.070 \times 10^4 = 4\ SF$

$7.0700 \times 10^4 = 5\ SF$

EXACT NUMBERS ARE EXEMPT FROM SF RULES

12 = 1 DOZEN 1 ML = 1000 μL

SF IN CALCULATIONS

IN MULTIPLICATION AND DIVISION THE RESULT CAN HAVE NO MORE THAN THE FACTOR WITH THE FEWEST SF

IN ADDITION AND SUBTRACTION THE RESULT CAN HAVE NO MORE SF TO THE RIGHT OF THE DECIMAL POINT THAN THE VALUE WITH THE FEWEST NUMBER OF SF TO THE RIGHT OF THE DECIMAL POINT

DIMENSIONAL ANALYSIS (FACTOR UNIT METHOD)

A CONVERSION FACTOR IS A RATIO OF 2 TERMS
IT HAS THE NUMERICAL VALUE OF 1

WHEN ANY 2 TERMS ARE EQUAL TO ONE ANOTHER,
2 CONVERSION FACTORS RESULT

$$1 \text{ inch} = 2.54 \text{ cm} \rightarrow \frac{1 \text{ in.}}{2.54 \text{ cm}} \text{ OR } \frac{2.54 \text{ cm}}{1 \text{ IN.}}$$

HOW MANY CM IN 10.72 INCHES?

$$10.72 \text{ IN} \times \frac{2.54 \text{ cm}}{1 \text{ IN}} = 27.2 \text{ CM} \quad 3 \text{ SF}$$

SEVERAL CONVERSION FACTORS MAY BE NEEDED

HOW MANY SECONDS ARE THERE IN 1 YEAR?

1 YEAR = 365 DAYS
1 DAY = 24 HRS
1 HR = 60 MIN
1 MIN = 60 SEC

$$1 \text{ YR} \times \frac{365 \text{ DAYS}}{1 \text{ YR}} \times \frac{24 \text{ HRS}}{1 \text{ DAY}} \times \frac{60 \text{ MIN}}{1 \text{ HR}} \times \frac{60 \text{ SEC}}{1 \text{ MIN}} = \frac{1 \times 365 \times 24 \times 60 \times 60}{1 \times 1 \times 1 \times 1}$$

31,536,000 SEC = 1 YR

CONVERSION FACTORS
MAY BE RAISED TO POWERS SEE EXAMPLE 1.8

FOR VOLUME, WHICH = LENGTH x LENGTH x LENGTH

$$\frac{2.54 \text{ cm}}{1 \text{ IN.}} \qquad \frac{(2.54)^3 \text{ cm}^3}{1^3_{\text{IN.}}} \qquad \text{SO, } \frac{16.4 \text{ cm}^3}{1 \text{ IN}^3}$$

DENSITY IS THE MASS PER UNIT VOLUME OF A SUBSTANCE

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

WE OFTEN USE g/cm^3 OR g/mL FOR UNITS

A SAMPLE OF AN UNKNOWN METAL HAS A MASS OF 0.667g AND A VOLUME OF $0.250\ cm^3$. WHAT IS ITS DENSITY?

$$D = \frac{m}{V} \quad \frac{0.667\ g}{0.250\ cm^3} = 2.668\ g/cm^3 \quad 3\ SF \rightarrow 2.67\ g/cm^3$$

USE TABLE 1.7 TO DETERMINE WHAT METAL IT IS

DENSITY CALCULATIONS USING DIMENSIONAL ANALYSIS

DENSITY RELATES MASS AND VOLUME

DENSITY OF GASOLINE IS ABOUT 0.70 g/mL

1 ML GAS = 0.70g GAS

WHAT IS THE MASS OF THE GAS IN YOUR CAR'S 50L TANK?

$$50\ L\ GAS \times \frac{1000\ mL}{1\ L} \times \frac{0.70\ g\ GAS}{1\ mL\ GAS} = 35{,}000\ g\ GAS\ (2\ SF)$$

IN Kg, $35{,}000\ g\ GAS \times \frac{1\ kg}{1000\ g} = 35\ Kg\ GAS$

IN LBs $35\ Kg \times \frac{2.21\ lb}{1\ kg} = 77.35\ lbs. \rightarrow 2SF\ 77\ lbs.$

CHAPTER 1

SKILLS	QUESTIONS
UNDERSTAND SCIENTIFIC METHOD	3, 4, 6
UNDERSTAND THE MATTER MODEL	1, 10, 12, 23, 24
GIVE EXAMPLES OF:	
PHYSICAL CHANGES AND PROPERTIES	8, 9, 25, 26
CHEMICAL CHANGES AND PROPERTIES	
WORK WITH THE METRIC SYSTEM	35, 41, 43
INTERCONVERT METRIC UNITS	
WORK WITH SIG FIGS	49, 51, DOWN LOAD
USE DIMENSIONAL ANALYSIS	47, 78
DO DENSITY, MASS, VOLUME CALCULATIONS	59, 61, 63
ADDITIONAL PROBLEMS	86