**CHE1031 HW set 1: Introduction & essential knowledge - KEY**

*Please solve these problems on green engineering graph paper.*

*Problems are assigned at each class meeting and are due at the next class.*

*Please number each problem, show all work for credit and box your answer.   
Note that answers to quantitative problems are provided in blue.*

**1.1: Chemistry in context**

**1.** Identify each of the following statements as being most similar to a hypothesis, a law, or a theory. Explain your reasoning.

(a) Falling barometric pressure precedes the onset of bad weather.

(b) All life on earth has evolved from a common, primitive organism through the process of natural selection.

(c) My truck’s gas mileage has dropped significantly, probably because it’s due for a tune-up.

(a) Law because there is not controversial and accepted as fact.

(b) Theory because it is supported by evidence but is complex and we continue to learn more about evolution all the time.

(c) Hypothesis because it’s an educated guess not yet supported by data.

**2.** Identify each as an example of either the macroscopic domain, the microscopic domain, or the symbolic domain of chemistry. For any in the symbolic domain, indicate whether they are symbols for a macroscopic or a microscopic feature.

(a) The mass of a lead pipe is 14 lb.

(b) The mass of a certain chlorine atom is 35 amu.

(c) A bottle with a label that reads Al contains aluminum metal.

(d) Al is the symbol for an aluminum atom.

(a) macroscopic

(b) microscopic

(c) symbolic of macroscopic

(d) symbolic of microscopic

**1.2: Phases and classification of matter**

**3.** What properties distinguish solids from liquids? Liquids from gases? Solids from gases?  
Physical states are distinguished by density, energy level, movement of molecules, ability to conform to containers and compressibility.  
Solids are most dense, lowest energy level, no movement, are not compressible & don’t conform to the shape of their containers.  
Liquids are less dense, have higher energy levels & movement, are not compressible but do conform to the shape of their containers.  
Gases are least dense, have the highest levels of energy & movement, are compressible and do conform to the shape of their containers.

**4.** How does a heterogeneous mixture differ from a homogeneous mixture? How are they similar?  
Homogeneous mixtures are uniform throughout (smooth) while heterogeneous mixtures are not (chunky). All mixtures are combinations of substances at varying ratios.

**5.** Classify each of the following as an element, a compound, or a mixture:

(a) copper

(b) water

(c) nitrogen

(d) sulfur

(a) element

(b) compound

(c) element

(d) element

**6.** We refer to astronauts in space as weightless, but not without mass. Why?  
Astronauts have the same mass (amount of matter) whether they are on earth or in space. But the weight of astronauts is higher on earth because there is gravity on earth but not in space.

**7.** When elemental iron corrodes it combines with oxygen in the air to ultimately form red brown iron(III) oxide which we call rust.

(a) If a shiny iron nail with an initial mass of 23.2 g is weighed after being coated in a layer of rust, would you expect the mass to have increased, decreased, or remained the same? Explain.

(b) If the mass of the iron nail increases to 24.1 g, what mass of oxygen combined with the iron?

(a) Increased because oxygen atoms have been added by the reaction producing rust.

(b) Oxygen = 24.1 g – 23.2 g = 0.9 g

**1.3 Physical and chemical properties**

**8.** Classify the 7 underlined properties in the following paragraph as chemical or physical: Fluorine is a pale, yellow gas that reacts with most substances. The free element melts at −220 °C and boils at −188°C. Finely divided metals burn in fluorine with a bright flame. Nineteen grams of fluorine will react with 1.0 gram of hydrogen.

pale yellow = physical

gas = physical

reacts = chemical

melting point = physical

boiling point = physical

burns with metal = chemical

reacts with hydrogen = chemical

**9.** Classify each of the following changes as physical or chemical:

(a) condensation of steam

(b) burning of gasoline

(c) souring of milk

(d) dissolving of sugar in water

(e) melting of gold

(a) physical

(b) chemical

(c) chemical

(d) physical – the sugar molecules don’t change but disperse in the volume of water

(e) physical

**10.** Identify the following properties as either extensive or intensive.

(a) volume

(b) temperature

(c) humidity

(d) heat

(e) boiling point

(a) extensive

(b) intensive

(c) intensive

(d) extensive: consider the amount of heat possessed by metal at a specific temperature; the more metal you have the more heat you have

(e) intensive

**1.4: Measurements**

**11.** Indicate the SI base units or derived units that are appropriate for the following measurements:

(a) the length of a marathon race (26 miles 385 yards) kilometers

(b) the mass of an automobile kilograms or metric tonnes

(c) the volume of a swimming pool liters

(d) the speed of an airplane km/hour

**12.** Give the name of the prefix and the quantity indicated by the following symbols that are used with SI base units.

(a) c

(b) d

(c) G

(d) k

(a) centi, 1E-2

(b) deci, 1E-1

(c) giga, 1E9

(d) kilo, 1E3

**13.** A large piece of jewelry has a mass of 132.6 g. A graduated cylinder initially contains 48.6 mL water. When the jewelry is submerged in the graduated cylinder, the total volume increases to 61.2 mL.

(a) Determine the density of this piece of jewelry.

(b) Assuming that the jewelry is made from only one substance, what substance is it likely to be? Explain.

(a) The volume of the jewelry is 61.2 – 48.6 mL = 12.6 mL.   
Density = mass = 132.6 g = 10.5 g / 1 mL

volume 12.6 mL

(b) A metal with a density of 10.5 g/mL; silver

**1.5: Measurement, uncertainty, accuracy, and precision**

**14.** Express each of the following numbers in scientific notation with correct significant figures:

(a) 90743

(b) 134.2

(c) 0.05499

(d) 10000.0

(a) 9.0743 E4

(b) 1.342 E2

(c) 5.499 E-2

(d) 1.00000 E4

**15.** Indicate whether each of the following can be determined exactly or must be measured with some degree of uncertainty (i.e. inexact):

(a) the number of eggs in a basket

(b) the mass of a dozen eggs

(c) the number of gallons of gasoline necessary to fill an automobile gas tank

(a) exact

(b) inexact

(c) inexact

**16.** How many significant figures are contained in each of the following measurements?

(a) 38.7 g

(b) 2 × 1018 m

(c) 0.0613 cm3

(d) 0.01400 g/mL

(a) 3

(b) 1

(c) 3

(d) 4

**17.** Round off each of the following numbers to two significant figures:

(a) 0.436

(b) 9.000

(c) 27.2

(a) 0.44

(b) 9.0

(c) 27

**18.** Perform the following calculations and report each answer with the correct number of significant figures.

(a) 628 × 342

(b) (5.63 × 102) × (7.4 × 103)

(c) 28.0 / 13.483

(a) 2.15 E5

(b) 4.4 E5

(c) 2.08

**19.** Classify the following sets of measurements as accurate, precise, both, or neither.

(a) Checking for consistency in the weight of chocolate chip cookies: 17.27 g, 13.05 g, 19.46 g, 16.92 g

(b) Testing the volume of a batch of 25-mL pipettes: 27.02 mL, 26.99 mL, 26.97 mL, 27.01 mL

(c) Determining the purity of gold: 99.9999%, 99.9998%, 99.9998%, 99.9999%

(a) neither

(b) precise

(c) both accurate & precise

**1.6: Mathematical treatment of measurement results**

**20.** The label on a soft drink bottle gives the volume in two units: 2.0 L and 67.6 fl oz. Use this information to derive a conversion factor between the English and metric units. How many significant figures can you justify in this conversion factor?  
67.6 oz / 2.0 L = 33.8 oz / 1.0 L 🡪 34 oz / 1 L with 2 sf

**21.** The diameter of a red blood cell is about 3 × 10−4 in. What is its diameter in centimeters?  
3 E-4 in 2.54 cm = 8 E-4 cm

1 in

**22.** Is a 197-lb weight lifter light enough to compete in a class limited to those weighing 90 kg or less?  
197 lb 1 kg = 89.4 kg So yes, he can compete.

2.20462 lb

**23.** If an aspirin tablet contains 325 mg aspirin, how many grams of aspirin does it contain?

325 mg 1 g = 0.325 g

1 E3 mg

**24.** Complete the following conversions between SI units.

(a) 612 g = \_\_\_\_\_\_\_\_ mg

(b) 8.160 m = \_\_\_\_\_\_\_\_ cm

(c) 3779 μg = \_\_\_\_\_\_\_\_ g

(d) 781 mL = \_\_\_\_\_\_\_\_ L

(e) 4.18 kg = \_\_\_\_\_\_\_\_ g

(a) 6.12 E5 mg

(b) 8.160 E2 cm

(c) 3.779 E-3 g

(d) 0.781 L

(e) 4.18 E3 g

**25.** Gasoline is sold by the liter in many countries. How many liters are required to fill a 12.0-gal gas tank?

12.0 gallons 3.78541 L = 45.4 L

1 gallon

**26.** Make the conversion indicated in each of the following:

(a) the men’s world record long jump, 29 ft 4¼ in., to meters

(b) the greatest depth of the ocean, about 6.5 mi, to kilometers

(c) the area of the state of Oregon, 96,981 mi2, to square kilometers

(a) 29 ft 12 in + 4.25 = 352.25 in 2.54 cm 1 m = 8.95 m 🡪 9 m

1 ft 1 in 100 cm

(b) 6.5 miles 1.6093 km = 1.05 km 🡪 10. km

1 mile

(c) 96981 miles2 1.60932 km2 = 2.5116 E5 km2

12 mile2

**27.** Many chemistry conferences have held a 50-Trillion Angstrom Run (two significant figures). How long is this run in kilometers and in miles? (1 Å = 1 × 10−10 m)

50 E12 Å 1 E-10 m 1 km = 5 km 1 mile = 3 mile

1 Å 1 E3 m 1.6093 km

**28.** The gas tank of a certain luxury automobile holds 22.3 gallons according to the owner’s manual. If the density of gasoline is 0.8206 g/mL, determine the mass in kilograms and pounds of the fuel in a full tank.

22.3 gallon 3.78541 L 1 E3 mL 0.8206 g 1 kg = 69.3 kg 2.2 lb = 152 lb

1 gallon 1 L 1 mL 1 E3 g 1 kg

**29.** In a recent Grand Prix, the winner completed the race with an average speed of 229.8 km/h. What was her speed in miles per hour?  
229.8 km 1 mile = 142.8 miles/hr

1 hr 1.6093 km

**30.** Calculate these masses.

(a) What is the mass of 6.00 cm3 of mercury, density = 13.5939 g/cm3?

(b) What is the mass of 25.0 mL octane, density = 0.702 g/cm3?

(a) 6.00 cm3  13.5939 g = 81.6 g

1 cm3

(b) 25.0 mL 1 cm3 0.702 g = 17.6 g

1 mL 1 cm3

**31.** What is the volume of 3.28 g gaseous hydrogen, density = 0.089 g/L?

3.28 g 1 L = 36.9 L

0.089 g