CHE1031 Practice set 1: Introduction & essential knowledge – KEY

These are optional practice problems. It's up to you how to solve them and they don't need to be completed or passed in. As the answer key is posted with this problem set, you may find them useful in 'reverse engineering' HW problems or in studying for quizzes and exams.

1.1: Chemistry in context

1. Explain how you could experimentally determine whether the outside temperature is higher or lower than 0 °C (32 °F) without using a thermometer.
If water is liquid the temperature is above freezing and if water is ice it's below freezing.

2. According to one theory, the pressure of a gas increases as its volume decreases because the molecules in the gas have to move a shorter distance to hit the walls of the container. Does this theory follow a macroscopic or microscopic description of chemical behavior? Explain your answer.
Microscopic, because the statement talks about the behavior of gas molecules which are not visible to the naked eye.

1.2: Phases and classification of matter

3. Classify each of the following as an element, a compound, or a mixture:
(a) air
(b) sucrose
(c) a substance composed of molecules each of which contains two iodine atoms
(d) gasoline
(a) mixture, homogenous
(b) compound
(c) natural form of the element iodine & a diatomic molecule
(d) compound = octane (though some may view gas as a mixture of hydrocarbons)

4. How are the molecules in oxygen gas, the molecules in hydrogen gas, and water molecules similar? How do they differ?
All molecules are combinations of two or more atoms combined at a constant ratio and held together by chemical bonds. Oxygen (O_2) and hydrogen (H_2) gases are both diatomic molecules. Water is made of both oxygen and hydrogen atoms, H_2O. All have different (unique) molecular formulas.

5. Yeast converts glucose to ethanol and carbon dioxide during anaerobic fermentation as depicted in the simple chemical equation here:

glucose ⟶ ethanol + carbon dioxide

(a) If 200.0 g of glucose is fully converted, what will be the total mass of ethanol and carbon dioxide produced?

(b) If the fermentation is carried out in an open container, would you expect the mass of the container and contents after fermentation to be less than, greater than, or the same as the mass of the container and contents before fermentation? Explain.

(c) If 97.7 g of carbon dioxide is produced, what mass of ethanol is produced?

(a) The mass of the products, ethanol & carbon dioxide, must be the same as the mass of the reactant, glucose.

(b) The mass would decrease a tiny bit as some carbon dioxide gas will be lost.

(c) Mass of ethanol = mass of glucose – mass of carbon dioxide = 200 – 97.7 g = 102.3 g.

1.3 Physical and chemical properties

6. A 2.0-liter volume of hydrogen gas combined with 1.0 liter of oxygen gas to produce 2.0 liters of water vapor. Does oxygen undergo a chemical or physical change?

Chemical change as oxygen reacts with hydrogen to make water

1.4: Measurements

7. Is one liter about an ounce, a pint, a quart, or a gallon?

About a quart

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

(a) the density of gold kg/L or g/mL

(b) the area of a football field square meters

(c) the maximum temperature at the South Pole on April 1, 1913 degrees Celsius

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

(a) m

(b) n

(c) p

(d) T

(a) milli, 1E-3

(b) nano, 1E-9

(c) pico, 1E-12

(d) tera, 1E12

1.5: Measurement, uncertainty, accuracy, and precision

10. Express each of the following numbers in scientific notation with correct significant figures:
(a) 711.0
(b) 0.239
(c) 0.000000738592
(a) 7.110 E2
(b) 2.39 E-1
(c) 7.38592 E-7

11. 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 cm in 2 m
(b) the mass of a textbook
(c) the time required to drive from San Francisco to Kansas City at an average speed of 53 mi/h
(a) exact
(b) inexact
(c) exact if using a given value for distance, inexact if driving

12. How many significant figures are contained in each of the following measurements?
(a) 3,486,002 kg
(b) 9.74150×10^{-4} J
(c) 17.0 kg
(a) 7
(b) 6
(c) 3

13. Round off each of the following numbers to two significant figures:
(a) 135
(b) 1.497×10^{-3}
(c) 0.445
(a) 140
(b) 1.5 E-3
(c) 0.45

14. Perform the following calculations and report each answer with the correct number of significant figures.
(a) 8119 × 0.000023
(b) 14.98 + 27,340 + 84.7593
(c) 42.7 + 0.259
(a) 0.19
(b) 27440
(c) 43.0

1.6: Mathematical treatment of measurement results

15. Write conversion factors (as ratios) for the number of:

(a) yards in 1 meter
(b) liters in 1 liquid quart
(c) pounds in 1 kilogram

(a) 1.09361 yards / 1 m
(b) 0.946353 L / 1 qt
(c) 2.20462 lb / 1 kg

16. Soccer is played with a round ball having a circumference between 27 and 28 in. and a weight between 14 and 16 oz. What are these specifications in units of centimeters and grams?

$$\frac{27\ \text{in}}{1\ \text{in}} \times \frac{2.54\ \text{cm}}{} = 69 - 71\ \text{cm}$$

$$\frac{14\ \text{oz}}{1\ \text{oz}} \times \frac{28.3495\ \text{g}}{} = 4.0 - 4.5\ \text{E2 g}$$

17. Complete the following conversions between SI units.

(a) 27.8 m = _____ km
(b) 0.13 mL = _____ L
(c) 1738 km = _____ m
(d) 1.9 Gg = _____ g

(a) 2.78 E-2 m
(b) 1.3 E-4 L
(c) 1.738 E6 m
(d) 1.9 E9 g

18. Make the conversion indicated in each of the following:

(a) the volume of 1 gill (exactly 4 oz) to milliliters
(b) the estimated volume of the oceans, 330,000,000 mi^3, to cubic kilometers.
(c) the mass of a 3525-lb car to kilograms
(d) the mass of a 2.3-oz egg to grams

(a) $\frac{4\ \text{oz}}{1\ \text{oz}} \times \frac{29.5735\ \text{mL}}{} = 100\ \text{mL}$

(b) $\frac{330000000\ \text{miles}^3}{1^3\ \text{mile}^3} \times \frac{1.6093^3\ \text{km}^3}{} = 1.4\ \text{E9 km}^3$

(c) $\frac{3525\ \text{lb}}{2.20462\ \text{lb}} \times \frac{1\ \text{kg}}{} = 1600\ \text{kg} = 1.602\ \text{E3 kg}$

(d) $\frac{2.3\ \text{oz}}{1\ \text{oz}} \times \frac{28.3495\ \text{g}}{} = 65\ \text{g}$

19. To prepare for a laboratory period, a student lab assistant needs 125 g of a compound. A bottle containing ¼ lb is available. Did the student have enough of the compound?

$$\frac{0.25\ \text{lb}}{} \ \frac{453.59\ \text{g}}{1\ \text{lb}} = 113.39 \rightarrow 110\ \text{g}$$ Nope, this won't be enough.

20. In a recent Grand Prix, the winner completed the race with an average speed of 229.8 km/h. What was her speed in meters per second, and feet per second?

$$\frac{229.8\ \text{km}}{1\ \text{hr}} \ \frac{1\ \text{E3 m}}{1\ \text{km}} \ \frac{1\ \text{hr}}{60\ \text{min}} \ \frac{1\ \text{min}}{60\ \text{s}} = 63.83\ \text{m/s}$$

$$\frac{142.8\ \text{miles}}{1\ \text{hr}} \ \frac{5280\ \text{ft}}{1\ \text{mile}} \ \frac{1\ \text{hr}}{60\ \text{min}} \ \frac{1\ \text{min}}{60\ \text{s}} = 209.4\ \text{ft/s}$$

21. Calculate the density of aluminum if 27.6 cm^3 has a mass of 74.6 g.

$$\text{density} = \frac{74.6\ \text{g}}{27.6\ \text{cm}^3} = 2.70\ \text{g/cm}^3$$

22. What is the volume of 25 g iodine, density = 4.93 g/cm^3?

$$\frac{25\ \text{g}}{4.93\ \text{g}} \ \frac{1\ \text{cm}^3}{} = 5.1\ \text{cm}^3$$