Chemistry Name: ____________________ Date: _________

Chapter 3 – Scientific Measurement

Chapter 3: 1 – 24, 26 - 28, 32, 34, 38, 40, 42, 46, 51, 56, 57, 62, 85, 87 (39 total)

Section Review 3.1

1. a. What is the difference between a *qualitative* measurement and a *quantitative* measurement?

Qualitative measurements are expressed in descriptive, non-numerical form, whereas quantitative measurements are expressed in a definite form, typically numerical.

b. How is a number converted to scientific notation?

It is written as the product of a coefficient greater than or equal to one and less than ten, plus ten raised to a power.

2. Classify each statement as either qualitative or quantitative.

a. The basketball is brown. qualitative

b. The diameter of the basketball is 31 centimeters. quantitative

c. The air pressure in the basketball is 12 pounds per square inch. quantitative

d. The surface of the basketball has indented seams. qualitative

3. Write each measurement in scientific notation.

a. the length of a football field, 91.4 meters. 9.14×10 meters

b. the diameter of a carbon atom, 0.000 000 000 154 meter. 1.54×10^{-10} meters

c. the radius of Earth, 6 378 000 meters 6.378×10^{6} meters

d. the diameter of a human hair, 0.000 008 meter. 8×10^{-6} meters

e. the average distance between the center of the sun and the center of Earth, 149 600 000 000 meters. 1.496×10^{11} meters

4. Solve each problem, and express each answer in correct scientific notation.

a. $(4 \times 10^{7})(2 \times 10^{-3}) = 8 \times 10^{4}$

b. $(6.3 \times 10^{-2})/ 2.1 \times 10^{4} = 3.0 \times 10^{-6}$

c. $(4.6 \times 10^{3}) – (1.8 \times 10^{3}) = 2.8 \times 10^{3}$

d. $(7.1 \times 10^{-2}) + (5 \times 10^{-3}) = 7.6 \times 10^{-2}$

Practice Problems

5. Determine the number of significant figures in each measurement.

a. 0.057 30 meter – 4 significant figures

b. 8765 meters – 4 significant figures

c. 0.000 73 meter – 2 significant figures

d. 40.007 meters – 5 significant figures

6. How many significant figures are in each measurement?

a. 143 grams – 3 significant figures

b. 0.074 meter – 2 significant figures

c. 8.750 x 10^{-2} gram – 4 significant figures

d. 1.072 meters – 4 significant figures

Practice Problems

7. Round each measurement to three significant figures. Write your answers in scientific notation.

a. 87.073 meters; 8.71 x 10 meters

b. 4.3621 x 10^{8} meters; 4.36 x 10^{8} meters

c. 0.015 52 meter; 1.55 x 10^{-2} meters

d. 9009 meters; 9.01 x 10^{3} meters

e. 1.777 x 10^{-3} meter; 1.78 x 10^{-3} meters

f. 629.55 meters; 6.30 x 10^{2} meters

8. Round each measurement in Practice Problem 7 to one significant figure. Write your answers in scientific notation.

a. 9 x 10 meters
b. 4 x 10^{8} meters
c. 2 x 10^{-2} meters

d. 9 x 10^{3} meters
e. 2 x 10^{-3} meters
f. 6 x 10^{2} meters

Practice Problems

9. Perform each operation. Provide your answers to the correct number of significant figures.

a. 61.2 meters + 9.35 meters + 8.6 meters = 79.2 meters

b. 9.44 meters – 2.11 meters = 7.33 meters

c. 1.36 meters + 10.17 meters = 11.53 meters

d. 34.61 meters – 17.3 meters = 17.3 meters

Recollect when adding or subtracting significant figures, report your final answer to the accuracy in decimal places of the *least accurate number*. For problem 9a, the values of 8.6 and 61.2 are less accurate than 9.35; thus, you should report the final value to only the tenths place.

10. Find the total mass of three diamonds that have masses of 14.2 grams, 8.73 grams and 0.912 gram.

Since the least accurate number of these three (14.2 grams) stops at the tenths place, report your final calculation to the tenths place: 23.8 grams.

Practice Problems

11. Solve each problem. Provide your answers to the correct number of significant figures and in scientific notation.

Rules for multiplying and dividing significant figures are differing from adding and subtracting. The least number of significant figures in any number that's part of the problem determines the number of significant figures you report in your answer.

a. 8.3 meters x 2.22 meters = 1.8×10 m^2

b. 8432 meters/ 12.5 = 6.75×10^2 m

c. 35.2 seconds x 1 minute/ 60 seconds = 5.86×10 minutes

12. Calculate the volume of a warehouse that has inside dimensions of 22.4 meters by 11.3 meters by 5.2 meters. (Volume = *l* x *w* x *h*)

1,316.22 m^3 or 1.3×10^3 m^3

Section Review 3.2

13. Explain the differences between *accuracy*, *precision*, and *error* of a measurement.

Accuracy is a measure of how close a measurement is to its true value. Precision is a measurement of how close a series of measurements are to one another. Error is the difference between an accepted value, and experimental value.

14. Determine the number of significant figures in each of the following measurements and calculations results.

a. 12 basketball players; unlimited

b. 0.010 square meter; 2 significant figures

c. 507 thumbtacks; unlimited

d. 0.070 020 meter; 5 significant figures

e. 10 800 meters; 3 significant figures

f. 5.00 cubic meters; 3 significant figures

15. Solve the following and express each answer in scientific notation.

a. $(5.3 \times 10^4) + (1.3 \times 10^4) = 6.6 \times 10^4$

b. $(7.2 \times 10^{-4}) / (1.8 \times 10^3) = 4.0 \times 10^{-7}$

c. $10^4 \times 10^{-3} \times 10^6 = 10^7$

d. $(9.12 \times 10^{-1}) – (4.7 \times 10^{-2}) = 8.7 \times 10^{-1}$

e. $(5.4 \times 10^4) \times (3.5 \times 10^9) = 1.9 \times 10^{14}$

f. $(1.2 \times 10^2) \times (8.9 \times 10^2) = 1.1 \times 10^5$

16. A technician experimentally determined the boiling point of octane to be 124.1℃. The actual boiling point of octane is 125.7℃. Calculate the error and the percent error.

Error = │accepted value - experimental│, Error = │125.7℃ - 124.1℃│= 1.6℃

% error = (│actual value - experimental│/ accepted value) x 100;

% error = (│125.7℃ - 124.1℃│/ 125.7℃) x 100 = 1.3%

Section Review 3.3

17. Name the quantity measured by each of the following SI units and provide the SI symbol of the unit.

a. mole - describes the amount of a substances, SI symbol = mol

b. kilogram/ cubic meter – density of a substance; symbol is ρ expressed in kg/m^3

c. second – a time measurement, expressed simply as *s*

d. pascal – measurement of pressure, expressed as *Pa*

e. meter – measures the length of an object, expressed as *m*

f. kilogram – measurement of mass of a substance, expressed as *kg*

18. Explain the difference between *mass* and *weight*.

Mass is a measure of the amount of matter in a substance or object, whereas weight is a measure of the forces of gravity on a substance or object. Whether an object is "weighed" on the moon or earth, the mass remains constant, it will be the weight that changes.

19. What is the symbol and meaning of each prefix?

a. *milli*-; m, 10^{-3} b. *nano*-; *n*, 10^{-9} c. *deci*-; *d*, 10^{-1}; d. *centi*-; *c*, 10^{-2}

20. As you climbed a mountain and the force of gravity decreased, would your weight increase, decrease, or remain constant? How would your mass change?

When climbing the mountain, your weight would decrease (force due to gravity is less), but your mass would remain the same, since the amount of matter is constant.

21. What is the volume of a paperback book 21 cm tall, 12 cm wide, and 3.5 cm thick?

Volume = 21 cm x 12 cm x 3.5 cm; Volume = 8.8×10^2 cm^3

22. List these units in order, from largest to smallest.

a. 1 dm^3 b. 1 μL c. 1 mL d. 1 L e. 1 cL f. 1 dL

1 dm^3 > 1 L > 1 dL > 1 cL > 1 mL > 1 μL; these are all units of volume

Practice Problems

23. A student finds a shiny piece of metal that she thinks is aluminum. In the lab, she determines that the metal has a volume of 245 cm^3 and a mass of 612 g. Calculate the density. Is the metal aluminum?

ρ = m/ V; ρ = 612 g/ 245 cm^3 = 2.50 g/ cm^3; in comparing this value with Table 3.7, this value comes pretty close to Al density value of 2.70 g/ cm^3. The sample is either slightly impure, or there was an error in the measurement.

24. The density of silver at 20℃ is 10.5 g/ cm^3. What is the volume of a 68-g bar of silver?

Use ρ = m/V, rearranging this equation to solve for volume: V = m/ ρ

V = 68-g silver/ 10.5 g/ cm^3; V = 6.5 cm^3

Section Review 3.4

26. A weather balloon is inflated to a volume of 2.2×10^3 L with 37.4 g of helium. What is the density of helium, in grams per liter?

Use ρ = m/ V; ρ = 37.4 g helium/ 2.2×10^3 L; ρ = 1.7×10^{-2} g/ L

27. List some applications of the measurement of specific gravity.

Physicians use this measurement for checking a patient's urine to diagnose certain diseases/ syndromes; acid concentration inside a car battery; checking the antifreeze amount in a solution, etc.

28. A plastic ball with a volume of 19.7 cm^3 has a mass of 15.8 g. What is its density? Would this ball sink or float in a container of gasoline?

Use ρ = m/ V; ρ = 15.8 g/ 19.7 cm^3 = 0.802 g/ cm^3; since the plastic ball has a density greater than that of gasoline (Table 3.7: 0.66 to 0.69), we would expect the ball to sink.

Section Review 3.5

32. State the relationship between degrees Celsius and kelvins.

Degrees Celsius is calculated accordingly: ℃ = K – 273. If you know the temperature value of a substance in degrees kelvins, then simply subtract 273 from that value to obtain degrees Celsius. If you know the value of a substance in degrees Celsius and you want kelvins, then add 273 to the Celsius value.

34. Surgical instruments may be sterilized by heating at 170℃ for 1.5 hours. Convert 170℃ to kelvins.

K = ℃ + 273; K = 170 + 273 = 443 K

Chapter 3 Review

38. Under what circumstances could a series of measurements of the same quantity be precise but inaccurate? 3.2

If the series of measurements all have values that are close to one another, but still far from the accepted value, then there is probably a problem with the measuring device – it needs to be calibrated.

40. Comment on the accuracy and precision of these basketball free-throw shooters. 3.2

a. 99 of 100 shots are made – through the hoop.

Accurate and precise – sign the kid up for the NBA!

b. 99 of 100 shots hit the front of the rim and bounce off.

Inaccurate, but precise

c. 33 of 100 shots are made; the rest miss.

Inaccurate and imprecise – get that kid private lessons!

42. Round each of these measurements to three significant figures. 3.2

a. 98.473 L; 98.5 L

b. 0.000 763 21 cg; 0.000 763 cg

c. 57.048 m; 57.0 m

d. 12.17℃; 12.1℃

e. 0.007 498 3 x 10^4 mm; 0.00750 x 10^4mm

f. 1764.9 mL; 1760 mL

46. How are the error and the percent error of a measurement calculated? 3.2

The error is the difference between the accepted and experimental values. Percent error is the absolute value of the error divided by the accepted value and multiplied by 100.

51. List the SI base unit of measurement for each of these quantities. 3.3

a. time; second, s

b. length; meter, m

c. temperature; kelvin, K

d. mass; kilogram, kg

56. Match the appropriate volume with each item. 3.3

__2___	a.	Orange	1.	30 m^3
__3___	b.	Basketball	2.	200 cm^3
__1___	c.	Van	3.	20 L
__4___	d.	Aspirin tablet	4.	200 mm^3

57. How many grams are in each of these quantities?

a. 1 cg; 0.01 g

b. 1 μg; 0.000001 g

c. 1 kg; 1000 g

d. 1 mg; 0.001 g

62. Why doesn't a measure of specific gravity have a unit? 3.4

Specific gravity is a ratio of two density measurements, so the density units of each measurement cancel each other.

85. The mass of a cube of iron is 355 g. Iron has a density of 7.87 g/ cm^3. What is the mass of a cube of lead that has the same dimensions?

First, you need to calculate the volume of iron, by using $\rho = m/V$, rearranging the equation: $V_{iron} = m_{iron}/\rho_{iron}$ = 355 g/ 7.87 g/ cm^3; V_{iron} = 45.1 cm^3

Then, calculate the mass of a 45.1 cm^3 lead sample: use $\rho_{lead} = m_{lead}/V_{lead}$, rearranging the equation: $m_{lead} = \rho_{lead} \times V_{lead}$ = (11.4 g/ cm^3)(45.1 cm^3) = 514 g lead.

87. Plot these data that show how the mass of sulfur increases with an increase in volume. Determine the density of sulfur from the slope of the line.

Mass of sulfur (g)	Volume of sulfur (cm^3)
23.5	11.4
60.8	29.2
115	55.5
168	81.1

For this problem, plot volume on the x-axis and mass on the y-axis. You should get a value of about 2.07 g/ cm^3;