CHEMISTRY SUMMER PACKETS

COMMON IONS

Acetate $C_2H_3O_2^{-1}$

Ammonium NH_4^{+}

BiCarbonate HCO_3^{-1}

Bisulfate HSO_4^{-1}

Bisulfide HS^{-1}

Bromate BrO_3^{-1}

Carbonate CO_3^{-2}

Chlorate ClO_3^{-1}

Chlorite ClO_2^{-1}

Chromate CrO_4^{-2}

Cyanide CN^{-1}

Dichromate $Cr_2O_7^{-2}$

Hydroxide OH^{-1}

Hypochlorite ClO^{-1}

Iodate IO_3^{-1}

Manganate MnO_4^{-2}

Nitrate NO_3^{-1}

Nitrite NO_2^{-1}

Oxalate $C_2O_4^{-2}$

Perchlorate ClO_4^{-1}

Permanganate MnO_4^{-1}

Peroxide O_2^{-2}

Phosphate PO_4^{-3}

Sulfate SO_4^{-2}

Sulfite SO_3^{-2}

Copper (I) Cu^{+1}

Copper (II) Cu^{+2}

Iron (II) Fe^{+2}

Iron(III) Fe^{+3}

Tin (II) Sn^{+2}

Tin (IV) Sn^{+4}

Name ______________________________ Class __________ Date __________

Significant Figures

See Section 1.18.

The significant figures in a measurement expression are all the digits that are known with certainty, plus the first digit that is uncertain. Significant figures indicate the uncertainty of a measurement. The measurement 5.83 cm is precise to the second decimal place. The digit 3 is the last significant figure and the first uncertain digit. 5.83 cm contains *three* significant figures.

All nonzero digits in a measurement are always significant. Zero, however, is not always a digit. Sometimes, zero is a placeholder. When a zero is a placeholder, it is not a significant figure. The following rules will assist you in determining whether a zero is a significant figure or a placeholder.

Rule	Measurement expression	Significant figures
1. All nonzero digits **are** significant.	83.591 m	5
2. All zeros between two nonzero digits **are** significant.	5007 L	4
	10.0005 g	6
3. Zeros to the **right** of a nonzero digit, but to the **left** of an understood decimal point, are **not** significant **unless** specifically indicated as significant by a bar placed above the rightmost such zero that is significant.	200,800 km	4
	200,8$\bar{0}$0 km	5
	200,80$\bar{0}$ km	6
	1,000,000 g	1
4. All zeros to the **right** of a decimal point but to the **left** of a nonzero digit are **not** significant. A lone zero to the left of a decimal point is never significant.	0.00012 g	2
	0.853 m	3
5. All zeros to the **right** of a decimal point and to the **right** of a nonzero digit **are** significant.	40.00 g	4
	0.005070 kg	4

Sample Problem 1

How many significant figures are there in 21.589 m?

According to rule 1, all **nonzero** digits are significant. There are **five** significant figures.

Sample Problem 2

How many significant figures are there in 28005 km?

According to rule 2, all zeros between two nonzero digits **are** significant. There are **five** significant figures.

Sample Problem 3

How many significant figures are there in 0.00025 kg?

According to rule 4, zeros to the **right** of a **decimal** but to the **left** of a **nonzero** number **are not** significant. Also, the lone zero before the decimal point is never significant. There are only **two** significant figures.

Sample Problem 4

How many significant figures are there in 23,000 L?

According to rule 3, all zeros to the **right** of a nonzero digit but to the **left** of an understood decimal point are **not** significant. The only exception is indicated by a bar placed over the rightmost of the significant zeros. Since there is no bar, there are only **two** significant figures.

Sample Problem 5

How many significant figures are there in 80.0 cm?

According to rule 5, all zeros to the **right** of a **decimal** point and to the **right** of a **nonzero** digit are significant. The last zero is to the right of both the decimal point and a nonzero digit (8). The zero immediately following the "8" is not to the right of the decimal. But this zero is between two significant figures. This zero, therefore, must also be significant. There are **three** significant figures.

Problems for Modern Chemistry
Holt, Rinehart and Winston, Publishers

3

Name ______________________ Class __________ Date __________

Problems

Indicate the number of significant figures in each of the following measurements.

1. 28,875 m [redacted]
2. 0.00051 kg [redacted]
3. 258,000 km [redacted]
4. 505,100 cm [redacted]
5. 0.81 g [redacted]
6. 51.2000 m [redacted]
7. 2.00 g [redacted]
8. 0.00500 kg [redacted]

Operations with Significant Figures

See Section 1.20.

Suppose you wished to multiply 24 cm by 318 cm. How many significant figures should the answer contain? The result of calculations involving measurements can only be as precise as the least precise measurement. In the above problem the answer can only have two significant figures. The following rules will enable you to determine the number of significant figures in the result of calculations involving measurements.

Rule 1—Multiplication and Division

The product or quotient contains the same number of significant figures as the measurement with the least number of significant figures.

NOTE: The position of the decimal point *does not* determine the precision of the answer.

Sample Problem 1

Determine the precision of the product of 24 cm × 31.8 cm.

$\underbrace{24}_{\text{2 significant figures}}$ cm × $\underbrace{31.8}_{\text{3 significant figures}}$ cm = $\underbrace{763.2}_{\text{4 significant figures}}$ cm^2

Since the least precise measurement has only **two** significant figures, the answer must have only **two.** 763.2 cm^2 is rounded off to 760 cm^2. Is the zero a significant figure or a place holder?

Sample Problem 2

Determine the correct number of significant figures for the quotient of 8.40 g ÷ 4.2 mL.

$\underbrace{8.40}_{\text{3 significant figures}}$ g ÷ $\underbrace{4.2}_{\text{2 significant figures}}$ mL = $\underbrace{2}_{\text{1 significant figure}}$ g/mL

The least precise measurement has **two** significant figures. The quotient must have **two.** Since there is only one significant figure, another digit must be added without changing the value of the result. The correct answer is 2.0 g/mL. The numerical value is the same, but the number of significant figures is now **two.** Is the zero a significant figure or a place holder?

Rule 2—Addition and Subtraction

*The sum or difference has the same number of decimal places as the measurement with the **least** number of decimal places.*

NOTE: The position of the decimal point determines the precision of the answer.

Sample Problem 3

Determine the precision of the sum of 49.1 g + 8.001 g.

$49.\underbrace{1}_{\text{1 decimal place}}$ g + $8.\underbrace{001}_{\text{3 decimal places}}$ g = $57.\underbrace{101}_{\text{3 decimal places}}$ g

The least precise measurement has only one decimal place. The answer must have only **one** decimal place. Round off 57.101 g to 57.1 g.

Name ______________________ Class __________ Date __________

Scientific Notation

See Sections 1.19, 1.20.

A number written in scientific notation is written in the form

$$M \times 10^n$$

where M is a number equal to or greater than one and less than ten. M must always have only one digit (other than 0) to the left of the decimal point. n is an integer. The following numbers are in correct scientific notation:

$$1 \times 10^5,\ 3.58 \times 10^{-6},\ 9.9 \times 10^{15}$$

The numbers 12×10^6 and 0.58×10^{-3} are not in scientific notation because M does not have a single digit other than zero to the left of the decimal point.

Sample Problem 1
Write 17,500 in scientific notation.

Step 1: Determine M by moving the decimal point in the original number to the left or right so that only one nonzero digit is to the left of the decimal.

1.7500

Step 2: Determine n by counting the number of places the decimal point has been moved. If moved to the left, n is positive; if moved to the right, n is negative.

1.7500
4 3 2 1
<---- 4 places to the left
$17{,}500 = 1.75 \times 10^4$

NOTE: In scientific notation all digits in M are significant. The zeros in this problem were placeholders.

Sample Problem 2
Write 0.0050 in scientific notation.

Step 1: 0.005.0

Step 2: 0.005.0
123
3 places to the right --->
$0.0050 = 5.0 \times 10^{-3}$

Note that the zero was retained. Why?

When performing mathematical operations with numbers in scientific notation, the rules for exponents apply. The following is a summary of those rules.

1. Multiplication—multiply the M's and add the n's.
2. Division—divide the M's and subtract the n's.
3. Addition—all numbers must be changed to the same value of n. Add the M's and attach the common value of n.
4. Subtraction—both numbers must have the same value of n. Subtract the M's and attach the common value of n.

Sample Problem 3
Find the product of $(3.0 \times 10^5)(5.0 \times 10^{-2})$.

$$(3.0 \times 10^5)(5.0 \times 10^{-2}) = (3.0 \times 5.0) \times 10^{5+(-2)} = 15 \times 10^3 = 1.5 \times 10^4$$

Note that the answer—15×10^3—would not be in scientific notation. The decimal must be moved one place to the **left** and n **increased** by one.

______________________ Class ________ Date __________

Metric System

See Section 1.12.

The following conversion factors will be very useful in making metric conversions.

$$\frac{1000\text{ mm}}{1\text{ m}} \text{ or } \frac{1\text{ m}}{1000\text{ mm}}$$

$$\frac{100\text{ cm}}{1\text{ m}} \text{ or } \frac{1\text{ m}}{100\text{ cm}}$$

$$\frac{1000\text{ m}}{1\text{ km}} \text{ or } \frac{1\text{ km}}{1000\text{ m}}$$

These conversion factors can be used for grams and liters as well as meters.

Sample Problem 1
Convert 112 cm to m.

map $\quad \text{cm} \xrightarrow{\frac{\text{m}}{\text{cm}}} \text{m}$

conversion factor $\quad \dfrac{1\text{ m}}{100\text{ cm}}$

Solution: $\quad 112\,\cancel{\text{cm}} \times \dfrac{1\text{ m}}{100\,\cancel{\text{cm}}} = 1.12\text{ m}$

Sample Problem 2
Convert 21,510 mL to L.

map $\quad \text{mL} \xrightarrow{\frac{\text{L}}{\text{mL}}} \text{L}$

conversion factor $\quad \dfrac{1\text{ L}}{1000\text{ mL}}$

Solution: $\quad 21{,}510\,\cancel{\text{mL}} \times \dfrac{1\text{ L}}{1000\,\cancel{\text{mL}}} = 21.51\text{ L}$

Sample Problem 3
Convert 2.18 kg to g.

map $\quad \text{kg} \xrightarrow{\frac{\text{g}}{\text{kg}}} \text{g}$

conversion factor $\quad \dfrac{1000\text{ g}}{1\text{ kg}}$

Solution: $\quad 2.18\,\cancel{\text{kg}} \times \dfrac{1000\text{ g}}{1\,\cancel{\text{kg}}} = 2180\text{ g}$

Sample Problem 4
Convert 208,182 cm to km.

map $\quad \text{cm} \xrightarrow{\frac{\text{m}}{\text{cm}}} \text{m} \xrightarrow{\frac{\text{km}}{\text{m}}} \text{km}$

conversion factors $\quad \dfrac{1\text{ m}}{100\text{ cm}} \qquad \dfrac{1\text{ km}}{1000\text{ m}}$

Solution: $\quad 208{,}182\,\cancel{\text{cm}} \times \dfrac{1\,\cancel{\text{m}}}{100\,\cancel{\text{cm}}} \times \dfrac{1\text{ km}}{1000\,\cancel{\text{m}}} = 2.08182\text{ km}$