CHEMISTRY
UNIT 4 Review Packet

MESA Charter High School

NAME ______________________________
Date _______________

<u>Directions:</u> Read the notes for each learning goal, and answer the review questions. Complete ALL the practice problems for each learning goal you are assigned.

Learning Goals In This Review:

Current Grade	Half-way	Final Grade	#	Learning Goal
			4.1	I can distinguish between quantitative and qualitative data and when to use each.
			4.2	I can identify and use the correct SI base unit and prefix for various measurement applications.
			4.3	I can calculate density and volume of liquid and solid substances.
			4.4	I can convert between temperature scales (Celsius, Fahrenheit and Kelvin).
			4.5	I can convert between scientific (exponential) notation and decimal notation, and perform calculations in exponential notation.
			4.6	I can determine precision, accuracy and percent error; describe ways to improve precision and accuracy in experimental measurement.
			4.7	I can determine and use significant figures in calculations.

Learning Goal 4.1: I can distinguish between quantitative and qualitative data and when to use each.

SKILLS:
Identifying qualitative vs. quantitative data
Describing data using qualitative or quantitative observations

REVIEW NOTES:

Qualitative Data
- Deals with descriptions.
- Data can be observed but not measured.
- We use our 5 SENSES so: smell, touch, sight, hearing, taste
- Qualitative → Quality

Quantitative Data
- Deals with numbers.
- Data which can be measured.
- Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, ages, etc.
- Quantitative → Quantity

REVIEW QUESTIONS:
1. What makes good data?

2. What makes bad data?

3. When would we use qualitative descriptions?

4. When would we use quantitative descriptions?

5. When would we use both?

6. What are some possible problems when using qualitative data? (Think: The science community is very DIVERSE with people from all over the world)

7. What are some possible problems that can come up when not having the right tools? (Think: measuring the size of the classroom vs. the size of the school building)

4.1 Practice Problems

Organize the following data as Qualitative or Quantitative:

Green ball
Blonde girl
Brunette man
26.4 years old
1.95072 meters tall
Rough
Prickly like a cactus
36 spines on the cactus
82 inch diameter
45 seconds
Taller than Michael
345 Kelvin
4.3 sec faster than Jaz
Smells like apple pie
Bright like a diamond

Qualitative	Quantitative

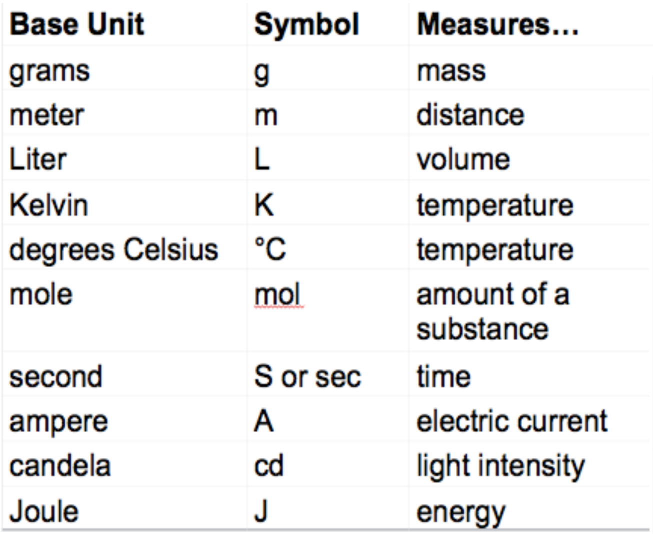
Learning Goal 4.2: I can identify and use the correct SI base unit and prefix for various measurement applications.

SKILLS:
Identifying SI base units
Converting between SI prefix units

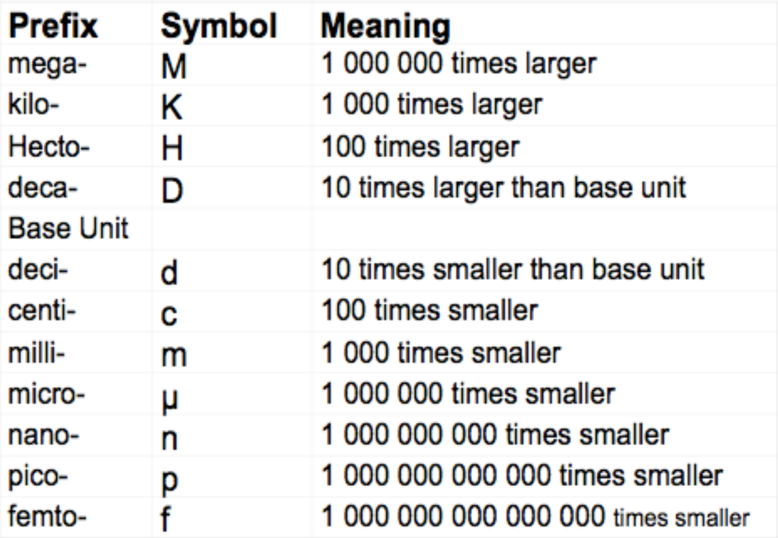
REVIEW NOTES:
Standard International Units (SI units) are a system of units designed to be a common system used by many countries. The SI system is designed to be easy to use for scientists and engineers.

The SI system:
- Uses decimals instead of fractions - decimals are more “computationally friendly”
- Multiples of ten
- Eliminates LARGE numbers by using prefixes
- Scientifically based

In the SI system:
- Quantitative measurements must include a number AND a unit.
- Base units are used with prefixes to indicate fractions or multiples of a unit.



Base Unit	Symbol	Measures…
grams	g	mass
meter	m	distance
Liter	L	volume
Kelvin	K	temperature
degrees Celsius	°C	temperature
mole	mol	amount of a substance
second	S or sec	time
ampere	A	electric current
candela	cd	light intensity
Joule	J	energy



Prefix	Symbol	Meaning
mega-	M	1 000 000 times larger
kilo-	K	1 000 times larger
Hecto-	H	100 times larger
deca-	D	10 times larger than base unit
Base Unit		
deci-	d	10 times smaller than base unit
centi-	c	100 times smaller
milli-	m	1 000 times smaller
micro-	μ	1 000 000 times smaller
nano-	n	1 000 000 000 times smaller
pico-	p	1 000 000 000 000 times smaller
femto-	f	1 000 000 000 000 000 times smaller

To help you remember the order of the prefixes, use this mnemonic:

King **H**ector **D**oesn’t **U**nderstand **D**umb **C**hildish **M**onkeys
Kilo- **H**ecto- **D**eca- **U**nit (base) **d**eci- **c**enti- **m**ili-

Measuring Length/Width/Height/Distance

- Base unit = Meters (m)
- Centimeters (for smaller units of length)
    - 100 cm = 1 m
- Millimeters (very small units of length)
    - 10 mm = 1 cm
- Kilometers (for large units of length)
    - 1000m = 1 km
- Similar to inches, feet and miles in the US system
- 1 meter is approximately 3 feet.

Measuring Mass

- Base unit = grams (g)
- Kilograms (for large units of mass)
    - 1000 g = 1 kg
- Similar to pounds in the US system
- 1 kilogram is approximately 2.2 pounds

Measuring Volume

- Base unit = liters (L)
- Milliliters (for small volumes)
    - 1000 mL = 1 L
- Microliters (for extremely small volumes)
- Similar to ounces and gallons in the US system
- 1 ounce is approximately 30 mL
- 1 gallon is approximately 3.7 L

REVIEW QUESTIONS:

1. What are some potential issues with countries having different measurement systems? Give at least three reasons.

2. Why is the SI unit system easier to use than the US system? Give at least three reasons.

3. What is the definition of a prefix?

4. A unit of measurement in the SI system consists of two parts. What are they? Which goes first?
    a. What is the purpose of the prefix?
    b. What is the purpose of the base unit?
5. What SI base unit is used to measure height?
    a. What unit would you use to measure the height of a person?
    b. What unit would you use to measure the height of an office building?
    c. What unit would you use to measure the height of a blade of grass?
6. What SI base unit is used to measure mass?
    a. What unit would you use to measure the mass of a person?
    b. What unit would you use to measure the mass of a car?
    c. What unit would you use to measure the mass of a pencil case?
    d. What unit would you use to measure the mass of a sewing needle?
7. What SI base unit is used to measure volume?
    a. What unit would you use to measure the volume of a bowl of soup?
    b. What unit would you use to measure the volume of a fish tank?

8. List the SI prefix units, in order from smallest to largest.

9. When we convert between different units, do we change the base unit or change the prefix?

    a. What effect would changing the base unit have?

    b. What effect would changing the prefix have?

10. How can we convert between different sizes for the same base unit?

4.2 Practice Problems

Circle the units that work best for measuring each object.

(1) The distance to the moon

[✓ kilometers] meters

(2) Your sister's hair

centimeters meters

(3) The length of a lizard

meters centimeters

(4) The height of the grass outside

meters centimeters

(5) The length of your arm

centimeters meters

(6) The diameter of the Earth

meters kilometers

(7) A pencil

kilograms grams

(8) How far you can throw a ball

kilometers meters

(9) The string needed to fly a kite

centimeters meters

(10) A butter knife

meters millimeters

(11) The height of an office tower

kilometers meters

(12) A flagpole

meters centimeters

(13) A notecard

millimeters meters

(14) Your school's playground

meters centimeters

(15) A small motorcycle

kilograms grams

(16) The width of a street

meters millimeters

(17) The height of your desk

centimeters meters

(18) A stop sign

centimeters meters

Use the factor label method, and show your work, including setting up your unit equivalency equations and canceling your units:

1. Convert 6.0 deciliters into liters
2. Convert 0.8 kilograms into grams
3. Convert 42.0 milliliters into liters
4. Convert 897.0 centimeters into meters
5. Convert 5,684.0 millimeters into meters
6. Convert 4 milliliters into deciliters
7. Convert 87 decimeters into centimeters
8. Convert 206 hectograms into decagrams
9. Convert 4.5 centiliters into milliliters
10. Convert 34,567 millimeters into meters
11. Convert 3.09 hectograms into milligrams

Learning Goal 4.3: I can calculate density and volume of liquid and solid substances.

SKILLS:

Calculating density of an object
Calculating volume or mass of an object given density data

REVIEW NOTES:

Density

- Density is the measure of a substances mass per unit volume. It is a way to relate mass and volume together.
- Very dense objects have a lot of mass contained in a small volume of space. (a bag full of bricks)
- Less dense objects have a their mass spread throughout a larger volume. (a bag full of feathers)
- Density is a derived unit which is found by dividing a substances mass by its volume.
- Density Equation:
    - Density = mass ÷ volume
    - $density = \frac{mass}{volume}$
- Common Units =
    - g/mL [grams per milliliter] *(for liquid substances)*
    - g/cm^3 [grams per centimeters cubed] *(for solid substances)*

REVIEW QUESTIONS

1. Which weighs more, a kilogram of bricks or a kilogram of feathers? Explain.

2. Which is more dense, a kilogram of bricks of a kilogram of feathers? Explain.

3. Which is less dense, a cubic meter of bricks or a cubic meter of feathers? Explain.

4.3 Practice Problems

Density = Mass / Volume

1) Rearrange the density equation for the following:

   Mass =   Volume =

2) Calculate the density of a material that has a mass of 52.457 g and a volume of 13.5 cm^3.

3) A student finds a rock on the way to school. In the laboratory he determines that the volume of the rock is 22.7 mL, and the mass in 39.943 g. What is the density of the rock?

4) The density of silver is 10.49 g/cm^3. If a sample of pure silver has a volume of 12.993 cm^3, what is the mass?

5) What is the mass of a 350 cm^3 sample of pure silicon with a density of 2.336 g/cm^3?

6) Pure gold has a density of 19.32 g/cm^3. How large would a piece of gold be if it had a mass of 318.97 g?

7) The density of lead is 11.342 g/mL. What would be the volume of a 200.0 g sample of this metal?

8) The mass of a toy spoon is 7.5 grams, and its volume is 3.2 ml. What is the density of the toy spoon?

9) A mechanical pencil has the density of 3 grams per cubic centimeter. The volume of the pencil is 15.8 cubic centimeters. What is the mass of the pencil?

10) A screwdriver has the density of 5.5 grams per cubic centimeter. It also has the mass of 2.3 grams. What is the screwdriver's volume?

Learning Goal 4.4: I can convert between temperature scales (Celsius, Fahrenheit and Kelvin).

SKILLS:
Converting between Kelvin and Celsius
Converting between Celsius and Fahrenheit
Converting between Kelvin and Fahrenheit

REVIEW NOTES:

What is Temperature?

- All matter has kinetic energy and is in motion (vibrating) at the microscopic level.
- Kinetic energy is the energy of motion
- This random movement of matter due to its kinetic energy is called ***Brownian Motion.***
- The measure of the average kinetic energy of a substance is what we refer as the ***temperature.***
- ***Absolute zero*** is when this motion stops and the kinetic energy is zero.
- Higher temperature = more kinetic energy (more motion)
- Lower temperature = less kinetic energy (less motion)

Three Temperature Scales:

Fahrenheit

- Based on normal body temperature
- Freezing point for water = 32°F
- Boiling point for water = 212°F
- Body temperature = 98.6°F
- Below 0 is negative

Celsius (also called Centigrade)

- Based on water
- Freezing point for water = 0°C
- Boiling point for water = 100°C
- Body temperature = 37°C
- Below 0 is negative.

Kelvin

- Measures molecular movement
- Theoretical point of ABSOLUTE ZERO is when all molecular motion stops (no negative numbers)
- Divisions (degrees) are the same as in Celsius
- Freezing point for water = 273K
- Boiling point for water = 373K
- Body temperature = 310K
- No negative temperatures.

$$\mathbf{K = {}^\circ C + 273}$$
$$\mathbf{{}^\circ C = K - 273}$$
$$\mathbf{{}^\circ F = ({}^\circ C \times 9/5) + 32}$$
$$\mathbf{{}^\circ C = ({}^\circ F - 32) \times 5/9}$$

*****NOTE: to convert between Fahrenheit and Kelvin, you must first convert to Celsius, and then from Celsius to either Fahrenheit or Kelvin, as needed.**

REVIEW PROBLEMS:

1. What is Brownian motion? What objects have Brownian motion? Do our cells have Brownian motion too?
2. What is kinetic energy?
3. What is the definition of temperature? What does temperature really measure?
4. If you are monitoring a sick patient at a hospital, which temperature scale would you choose to use? Why?
5. If you are monitoring temperature changes in a lake throughout the year, which temperature scale would you choose to use? Why?
6. If you are monitoring an experiment using extremely high temperatures to melt metals and build machines, which temperature scale would you use? Why?
7. If you are monitoring an experiment using extremely cold temperatures to freeze molecules into crystals, which temperature scale would you use? Why?

4.4 Practice Problems

Convert the following to Fahrenheit and to Kelvin

1) 10^{o} C ________ F ________ K

2) 30^{o} C ________ F ________ K

3) 40^{o} C ________ F ________ K

4) 37^{o} C ________ F ________ K

5) 0^{o} C ________ F ________ K

Convert the following to Celsius and Kelvin

6) 32^{o} F ________ C ________ K

7) 45^{o} F ________ C ________ K

8) 70^{o} F ________ C ________ K

9) 80^{o} F ________ C ________ K

10) 90^{o} F ________ C ________ K

11) 212^{o} F ________ C ________ K

Convert the following to Kelvin and Fahrenheit

12) 0° C ________ K ________ F

13) -50° C ________ K ________ F

14) 90° C ________ K ________ F

15) -20° C ________ K ________ F

Convert the following to Celsius and Fahrenheit

16) 100 K ________ C ________ F

17) 200 K ________ C ________ F

18) 273 K ________ C ________ F

19) 350 K ________ C ________ F

20) 115 K ________ C ________ F

Learning Goal 4.5: I can convert between scientific (exponential) notation and decimal notation, and perform calculations in exponential notation.

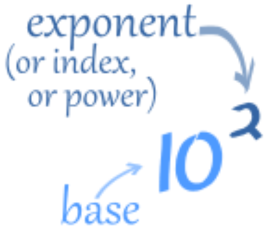
SKILLS:

Converting from standard notation to scientific notation
Converting from scientific notation to standard notation
Multiplying and dividing numbers in scientific notation
Adding and subtracting numbers in scientific notation

REVIEW NOTES:

Scientific Notation is a way to express:

- extremely LARGE numbers
- extremely SMALL numbers



Scientific notation shows a number as the product of two numbers:

- **number x 10 $^{\text{exponent}}$**

Converting standard numbers to scientific notation:

- There should only be **one digit** in front of the decimal point.
- Move the decimal to the right or the left until there is only one number in front of the decimal. Count how many times the decimal must be moved
- The exponent (power of 10) will be the same as the number of times the decimal was moved.
- When the number is 10 or greater, the decimal point has to move to the left, and the power of 10 will be positive.
- When the number is smaller than 1, the decimal point has to move to the right, so the power of 10 will be negative.

Converting scientific notation to standard numbers:

- The exponent (or power) of a number says
  - how many times to use the number in a **multiplication**.
- 10^2 means **10** × **10** = 100 (It says **10** is used **2** times in the multiplication)
- so multiply the number by the power of ten indicated in the exponent to convert it back to standard numbers
- This is the same as moving the decimal
  - Move the decimal to the right if the exponent is positive (the final number will be greater than 10)
  - Move the decimal the left if the exponent is negative (final number will be less than 1)
- Negative powers of ten indicate that we should divide the number by 10, instead of multiplying it. This is equivalent to moving the decimal to the left, so that the final number is less than 1.

Multiplying with scientific notation:

- Multiply the numbers
- Add the exponents
- Put the number back in scientific notation (one number in front of the decimal) if necessary.
  Example:
  $(2.0 \times 10^4) \times (2.0 \times 10^3) = 4.0 \times 10^7$

Dividing with scientific notation:

- Divide the numbers
- Subtract the exponents
- Put the number back in scientific notation (one number in front of the decimal) if necessary.
  Example:
  3.0 x 10^4 ÷ 2.0 x 10^2 = 1.5 x 10^2

Adding and Subtracting with Scientific Notation:

- The exponents must be the same number!
- Move the decimal place right or left until the exponents are the same
- Then add or subtract the numbers, keeping the exponents the same
- Make sure the final answer is back in scientific notation
  Example
  5.40 x 10^3 + 6.0 x 10^2 = 6.00 x 10^3

6.0 x 10^2 = 0.60 x6.0 x 10^2 = 0.60 x 10^3

REVIEW PROBLEMS:

1. Why is scientific notation useful?

2. When do we use scientific notation?

3. A number in scientific notation consists of two parts. What are they?

4. How many numbers are allowed in front of the decimal point in scientific notation?

5. Positive exponents indicate numbers that are… greater than 10 / less than 1?

6. Negative exponents indicate numbers that are… greater than 10 / less than 1?

7. When converting standard numbers to scientific notation, what do you do?

8. When converting scientific notation to standard numbers, what do you do?

9. What do you do when you are multiplying numbers in scientific notation?

10. What do you do when you are dividing numbers in scientific notation?

11. What do you do when you are adding or subtracting numbers in scientific notation?

4.5 Practice Problems

Learning Goal 4.6: I can determine precision, accuracy and percent error; describe ways to improve precision and accuracy in experimental measurement.

SKILLS:
Defining precision and accuracy
Calculating percent error
Determining if an experiment is precise
Determining if an experiment is accurate.

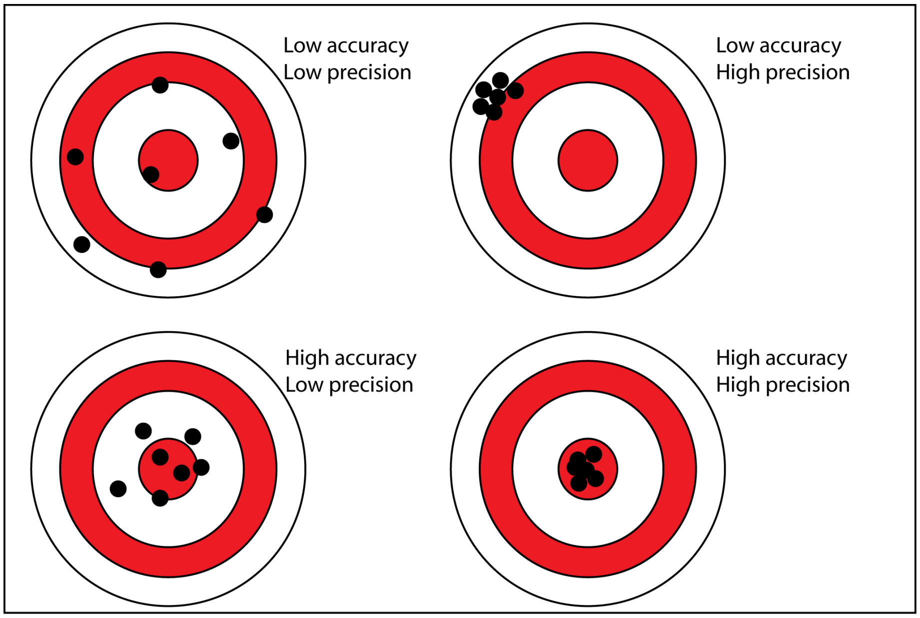
REVIEW NOTES:

Accuracy

- How close a measured value is to the actual (true) value.

Precision

- How close measured values are to each other.



Percent Error

- Comparison of your results to what was supposed to happen
- A high percent error means your results were not accurate
- Use this formula:

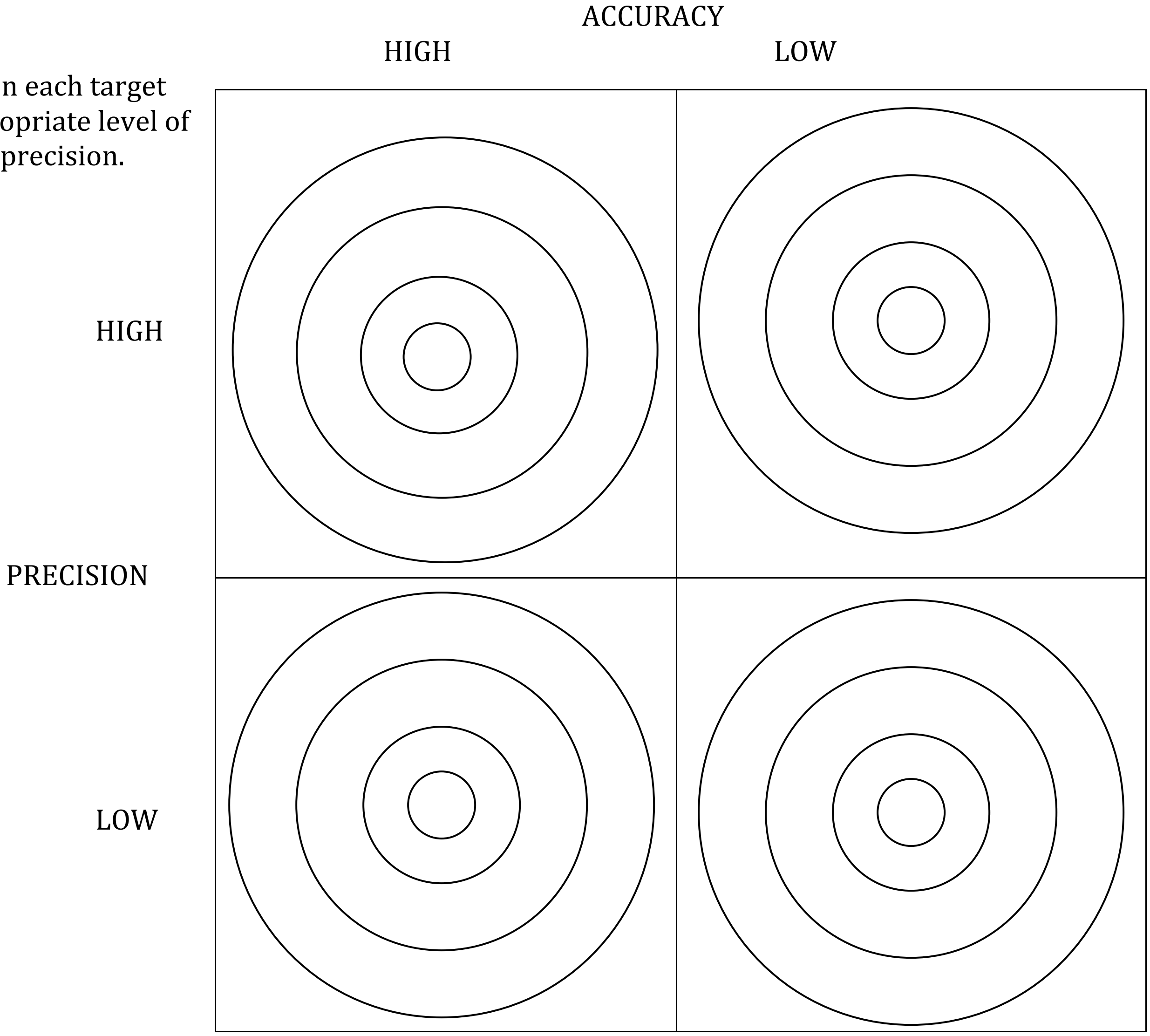
$$Percent\ Error = \frac{Experiment\ value - theoretical\ value}{theoretical\ value}\ x\ 100\%$$

REVIEW PROBLEMS:

1. Define accuracy.
2. Define precision.
3. Can a measurement be precise but not accurate? Explain.
4. Can a measurement be accurate but not precise? Explain.
5. What is the purpose of calculating percent error?
6. What does a high percent error value mean for your experiment? Explain.
7. What does a low percent error value man for your experiment? Explain.

4.6 Practice Problems

Place 4 dots on each target with the appropriate level of accuracy and precision.



Mark each set of numbers as having a high or low accuracy and precision.

	Accuracy		**Precision**	
	High	**Low**	**High**	**Low**
Ex: Object measured is 1.0 meter long 1.15 1.10 1.12 1.30	_____	__X__	__X__	_____
	average is 1.17, not 1.0 lowest#		spread = highest# – spread = 1.30 – 1.10 = 0.2 small spread means high precision	
1) Object measured is 50 cm length 52 60 48 41	_____	_____	_____	_____
2) Object measured is 27 mL volume 27.5 33.0 21.8 22.8	_____	_____	_____	_____
3) Object measured is 15 cm2 area 13.21 13.25 13.19 13.22	_____	_____	_____	_____
4) Object measured is 32 g mass 40 55 32 50	_____	_____	_____	_____
5) Object measured is 0.31 g/cm3 density 0.30 0.32 0.31 0.31	_____	_____	_____	_____
6) Object measured is 30C temperature 30.6 30.9 30.7 30.8	_____	_____	_____	_____

Directions: For each of the following situations, set up the equation and solve for the percent error involved. Be careful in determining the measured vs. theoretical value.

1. Samantha S. Sloppiness measured the volume of her soda before she drank it for her midmorning snack. She measured the volume of the 12 oz. bottle to be 14 oz.

2. Clyde Clumsy was directed to weigh a 500 g mass on the balance. After diligently goofing off for ten minutes, he quickly weighed the object and reported 458 g.

3. Pretty Patty Pestilence had casually recorded her grades for the nine weeks in her notebook. She concluded she had 250 points out of 300 for the grading period. However, Miraculous (chem teacher) determined she had 225 points out of 300 and awarded her a "C" for the grading period.

4. Drew D. Dingaling came to Miraculous with a problem. Drew was told to measure 50 cm of copper wire to use in an experiment. Since his ruler only measured to 45 cm he used this amount of wire and his experiment was a failure.

5. Henry Heavyfoot was just arrested for speeding by Officer O'Rourke for traveling 65 mph in a 55 mph zone. Henry claimed his speedometer said 55 mph not 65 mph.

6. Willomina Witty was assigned to determine the density of a sample of nickel metal. When she finished, she reported the density of nickel as 5.59 g/ml. However, Miraculous knew the density of nickel was 6.44 g/ml.

7. An experiment to determine the volume of a "mole" of a gas was assigned to Barry Bungleditup. He didn't read the experiment carefully and concluded the volume was 18.7 liters. Miraculous knew he should have obtained 22.4 liters.

Learning Goal 4.7: I can determine and use significant figures in calculations.

SKILLS:
Identifying number of significant figures in a number
Adding and subtracting with significant figures
Multiplying and Dividing with significant figures

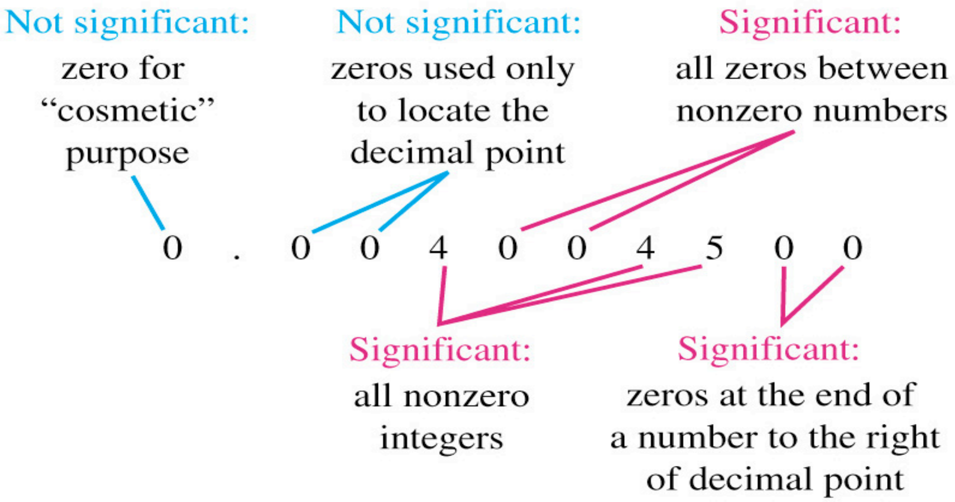
REVIEW NOTES:

Significant figures

- How many important digits you have
- Give an idea of how precise your data are
- More significant digits = more precise data
- All non-zero numbers ARE significant

Rules for Zeros:

- Leading – in front of the first non-zero number (ex: 0.0035)
  - Not significant
  - Start counting from first nonzero number
  - Zeros in front of the decimal are considered "cosmetic" – only there to look nice.
- Trailing – after the last not-zero number, with no decimals involved (ex: 12,000)
  - Not significant
- Sandwiched – zeros between two non-zero numbers (ex: 53,607)
  - Significant!
- Zeros after a decimal (ex: 0.034000 or 1.2000)
  - Significant!



Multiplying and Dividing with significant figures:

- Answer is rounded to the same number of **significant figures** as the **least precise measurement** (least number of significant figures).

Adding and Subtracting with significant figures

- Answer has the same number of **decimal places** as the **least precise measurement** (least number of significant figures).

REVIEW PROBLEMS:

1. Why do we care about significant figures?
2. If two measurements for the same object have different numbers of significant figures, what does that mean about the two measurements?
3. If one measurement has two significant figures, and one measurement has five significant figures, which measurement is more precise?
4. What are the rules concerning non-zero numbers?
5. What are the rules concerning significant and non-significant zeros?
6. What is the rule for adding and subtracting numbers with significant figures?
7. What is the rule for multiplying and dividing number with significant figures?

4.7 Practice Problems