Biochemistry Summer Packet

Science Basics

Metric Conversions

All measurements in chemistry are made using the metric system. In using the metric system you must be able to convert between one value and another. You must memorize the factors, prefixes and symbols in the chart below.

There are numerous ways to do metric conversion. I present one method below that I have used in my Honors and Chemistry I classes.

Example: Convert 1.83 x 10^{-1} kilograms to centigrams.

Step 1. Subtract the power of ten value you are solving for from the power of ten value you are given.
In this problem you are given 1.83 kilograms and you are converting to centigrams. Kilograms have a power of ten value of 3; centigrams have a power of ten value of -2. 3-(-2) = 5

Step 2. Write your result as the power of ten value of your answer.
In this problem our answer is 1.83 x 10^{-1} **x 10^{5}**.

Step 3. Put your answer in proper scientific notation.
1.83 x 10^{-1} x 10^{5} is converted to **1.83x10^{4}**. Remember that when multiplying using powers of ten you add.

Factor	Prefix	Symbol
1 x 10^{12}	tera-	T
1 x 10^{9}	giga-	G
1 x 10^{6}	meg -	M
1 x 10^{3}	kilo-	k
1 x 10^{2}	hecto-	h
1 x 10^{1}	deca-	D
1 x 10^{0}	---	---
1 x 10^{-1}	deci-	d
1 10^{-2}	centi-	c
1 x 10^{-3}	milli-	m
1 x 10^{-6}	micro-	µ
1 x 10^{-9}	nano-	n
1 x 10^{-10}	angstrom	Å
1 x 10^{-12}	pico-	p

Uncertainty in Measurement

- Depends on the precision of the measuring device
  - For example a measurement of 1 682956 grams is a more precise measurement than 1.7 grams
- Reliability in Measurements
  - Accuracy – closeness to the actual scientific value
  - Precision – getting repeated measurements in repeated trials
- Types of Errors
  - Random: error in measurement has equal probability of being high or low
  - Systematic: errors all occur in the same direction

General Rules for determining if a Number is Significant

1. Draw a box around all nonzero digits beginning with the leftmost nonzero digit and ending with the rightmost nonzero digit in the number.
2. If a decimal is present, draw a box around any trailing zeros **to the right of the original box**.
3. Consider any all boxed digits significant.

Example 1: 20406: 5 significant digits
Example 2: 0.0045: 2 significant digits
Example 3: 4000: 1 significant digit
Example 4: 4000. : 4 significant digits
Example 5: 0.002500: 4 significant digits
Example 6: 3.00: 3 significant digits

Addition or Subtraction using Significant Figures

The answer can only be as precise as the least precise measurement.

Example	2.8701	(precise **four** places to the right of the decimal)
	0.0673	(precise **four** places to the right of the decimal)
	+ 301.520	(precise **three** places to the right of the decimal)

304.4574 → rounds off to 304.457 (answer must be precise **three** places after the decimal)

Multiplication or Division using Significant Figures

The answer can have no more total significant figures than there are in the measurement with the smallest total number of significant figures.

Example:	12.257	(5 total significant figures)
	x 1.162	(4 total significant figures)
	14.2426 → rounds off to 14.24	(4 total significant figures)

As a general rule, if you are unsure how many significant figures to us on the AP exam, use 3 significant figures. This may not always work but it will work most times. However you should always pay close attention to using the correct number of significant figures in all calculations.

Scientific Notation

In chemistry, we often use numbers that are either very large (1 mole = 602 200 000 000 000 000 000 000 atoms) or very small (the mass of an electron = 0.000 000 000 000 000 000 000 000 000 000 910 939 kg). Writing numbers with so many digits would be tedious and difficult. To make writing very large and small numbers easier, scientists use an abbreviation method known as scientific notation. In scientific notation the numbers mentioned above would be written as 6.022×10^{23} and 9.10939×10^{-31}.

Converting a number to or from scientific notation

- If you move the decimal place to the left, the power of 10 value increases.
- If you move the decimal place to the right, the power of 10 value decreases.

Example 1: Look at the first number from above: 602 200 000 000 000 000 000 000
To put this number in scientific notation you would move your decimal place until there is one number to the left of the decimal. To do this, we must move our decimal 23 places to the left. When you move the decimal to the left, the power of 10 value increases. It increases from 0 to 23. Thus, the answer is **6.022×10^{23}**

Look at the second number from above: 0.000 000 000 000 000 000 000 000 000 000 910 939
To put this number in scientific notation we must move our decimal 31 places to the right. **REMEMBER: You should always have one digit to the left of the decimal when writing numbers in scientific notation.** Since we are moving our decimal to the right, we must decrease our power of 10 value. It decreases from 0 to –31. The answer is **9.10939×10^{-31}**

Rules for multiplying & dividing using scientific notation:

- **When multiplying two numbers in scientific notation, ADD their power of 10 values**.

For example: $(3.45 \times 10^6)(4.3 \times 10^5) = 14.835 \times 10^{11}$. But, we must also remember to express our answer in significant figures. Thus, the final answer is **1.5×10^{12}**

- **When dividing numbers in scientific notation, SUBTRACT the denominator's power of 10 value from the numerator's power of 10 value**.

For example: $(2.898 \times 10^{12}) \div (3.45 \times 10^{15}) = 0.840 \times 10^{-3}$ (I had to add the zero at the end to get the three significant figures needed.) I got 10^{-3} because 12 – 15 = –3. Make sure your answer is in proper scientific notation (one number to the left of the decimal). In this problem we have to move the decimal one place to the right. When we move our decimal to the right, we decrease our power of 10. –3 decreases by 1 to –4. Our fi al answer is: **8.40×10^{-4}**

Dimensional Analysis

- Used to convert a number from one system of units to another.
- **Understanding dimensional analysis is crucial. This process will help you when performing difficult calculations later in the year.**
- You will find a complete listing of English/Metric Equivalents on the last page of your text book. Conversion factors **do not** need to be memorized.

Example: Calculate how many kilometers there are in 5 miles.
Solution: (Needed Equivalents: 1 mile = 1760 yards, 1 meter = 1.094 yards)
5 miles x 1760 yards x 1 meter x 1 kilometer = 8.04 (rounded to) 8
kilometers 1 mile 1.094 yards 1000 meters

Example: Convert 55.0 miles/hour to meters/second
Solution: (Needed Equivalents: 1 mile = 1760 yards, 1 meter = 1.094 yards, 1 hour = 60.0 minutes, 1 minute = 60.0 seconds)
55.0 miles x 1760 yards x 1 meter x 1 hour x 1 minute = 24.5785 (rounded to) 24.6 m/s hour 1 mile 1.094 yards 60.0 minutes 60.0 seconds

General Rules for Rounding Numbers in Chemistry

- **Rule 1. If the digit following the last significant figure is less than 5, the last significant figure remains unchanged. The digits after the last significant figure are dropped.**
  Example: Round 23.437 to three significant figures. Answer: 23.4
  Explanation: 4 is the last significant figure. The next number is 3. 3 is less than 5. Thus, 4 remains unchanged and 37 is dropped.

- **Rule 2. If the digit following the last significant figure is 5 or greater, then 1 is added to the last significant figure. The digits after the last significant figure are dropped.**
  Example: Round 5.383 to two significant figures. Answer: 5.4
  Explanation: 3 is the last significant figure. The next number is 8. 8 is greater than 5. Thus, 1 is added to 3 making it 4. The 83 is dropped.

- As a rule, when performing a series of calculations, **wait until the very end to round off to the proper number of significant figures instead of rounding off each intermediate result unless you are changing from addition /subtraction to multiplication/division or vice versa.**

  Example 1: 10.82 + 2.5 + 2.64 =
  WRONG: 10.82 + 2.5 = 13.32 (rounded to 13.3) 13.3 + 2.64 = 15.94 (rounded to) 15.9
  CORRECT: 10.82 + 2.5 + 2.64 = 15.96 (rounded to) 16.0 (precise to 1 place after the decimal)

  Example 2: (12.00 – 10.00) ÷ 12.00 =
  In this case you s h ould subtract and ROUND to the proper number of significant figures and then divide because you are changing between significant figure rules.
  CORRECT: (12.00-10.00) = 2.00 (precise to 2 places after the decimal)
  2.00 ÷ 12.00 = 0.167 (rounded to 3 total significant figures)

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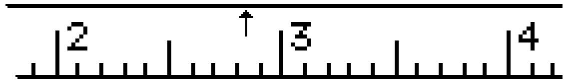
Practice Problems

Measurements

Record the measurements for each of the following pieces of equipment. Be sure to include the number with the correct number of significant figures and the label on the number. Assume the rulers are in centimeters (cm), the thermometers in Celsius (C), the graduated cylinders in milliliters (ml), and the triple beam balance in grams (g).

1. 

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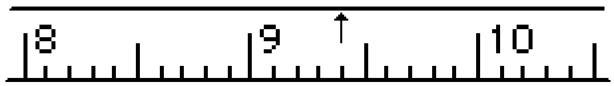
2. 

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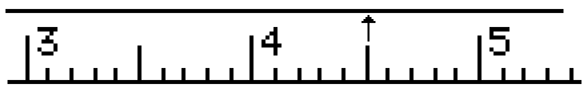
3. 

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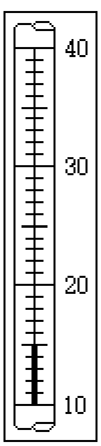
4. 

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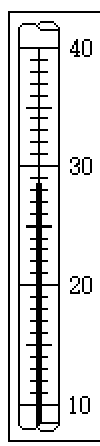
5. 

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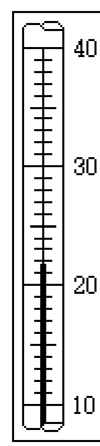
6. 

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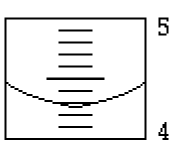
7. 

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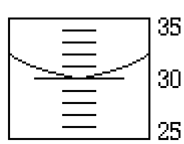
8. 

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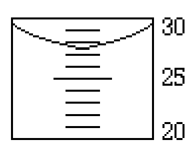
9. 

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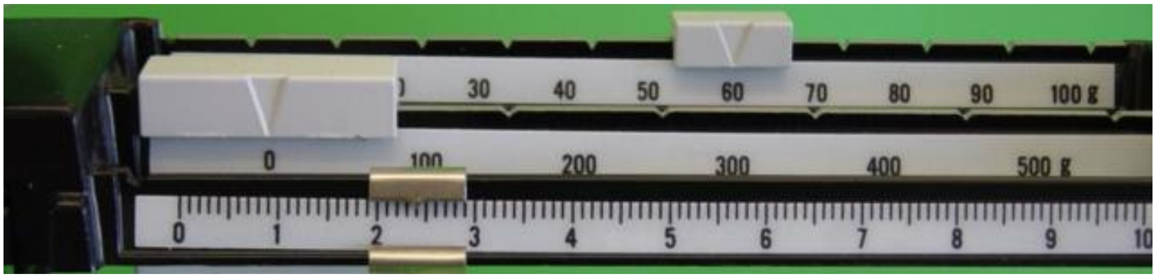

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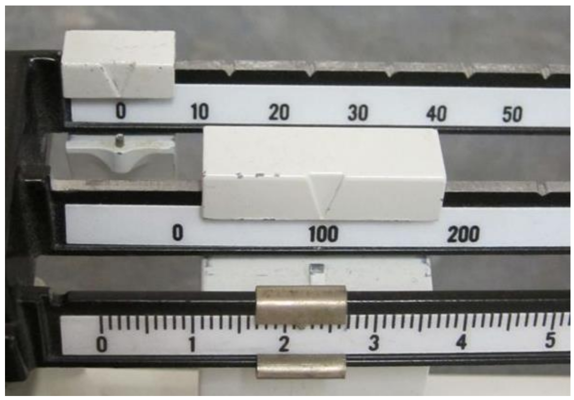

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Metric to Metric Conversions

1) 2000 mg = ________ g

2) 104 km = ________ m

3) 480 cm = ______ m

4) 5.6 kg = ______ g

5) 8 mm = ______ cm

6) 5 L = ________ mL

7) 198 g = ________ kg

8) 75 mL = ______ L

9) 50 cm = ______ m

10) 5.6 m = ______ cm

Scientific Notation

Convert the following numbers into scientific notation:

1) 3,400 ___________________________________
2) 0.000023 ___________________________________
3) 101,000 ___________________________________
4) 0.010 ___________________________________
5) 45.01 ___________________________________

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Convert the following numbers into standard notation:

6) 2.30×10^{4} ________________________________
7) 1.76×10^{-3} ________________________________
8) 1.901×10^{-7} ________________________________
9) 8.65×10^{-1} ________________________________
10) 9.11×10^{3} ________________________________

Unit Conversions

A nurse weighs a patient. The patient's weight is 70.67 kg. How many pounds is this?

A man is rushed to the emergency room after a severe accident. He is given 7.2 ounces of blood. How many pints is this?

A 140 pound woman is going into surgery. She is given a sedative, and the anesthesiologist injects 1 ounce fluid for every 1000 grams of the patient's mass. How many ounces does the anesthesiologist need to inject into the IV?

A child has strep throat and is administered amoxicillin. The correct dosage is for every 50 kg, 1 teaspoon is needed. The child weighs 60 lbs. How many teaspoons should the child take?

Significant Figures

1. How many sig figs does each value have?

3.00 ___________ 6.0900 ___________ 100000 __________

12.60 __________ .0009000 ___________ 2.600×10^{5} _________

0.0045 __________ 0.120003 __________ 1.01080×10^{-3} _________

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2. Perform the calculations with the correct sig figs.

10.0369 + 1.23 = ___________ 6010 + 17.78 ______________

3.0963 x 2.682 = ___________ 5890/120.2 = ___________

3. Round to 3 sig figs.

8.01603 m ___________

4.5992 g______________

7 L _______________

The Scientific Method

Scientists use an experiment to search for cause and effect relationships in nature. In other words they design an experiment so that changes to one item cause something else to vary in a predictable way. These changing quantities are called variables. A **variable** is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled.

The **independent variable** is a factor that is changed or manipulated by the scientist. To insure a fair test, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she observes what happens. The scientist focuses his or her observations on the dependent variable to see how it responds to the change made to the independent variable. The **dependent variable** is measured to determine if the manipulation of the independent variable had any effect. The dependent variable "depends" on the independent variable. Experiments also have controlled variables. **A control group** or a **control** is quantities that a scientist wants to remain constant or unchanged. Most experiments have more than one controlled variable. Lastly, in a good experiment, the scientist must be able to **measure** the values for each variable. Weight or mass is an example of a variable that is very easy to measure.

Example: To test a hypothesis that eating carrots improves vision, the experimenter would manipulate whether or not subjects ate carrots. Thus, eating carrots is the independent variable. Each subject's vision would be tested to see if carrot eating had any effect. Thus, vision is the dependent variable. The subjects assigned to eat carrots are in the experimental group, whereas subjects not eating carrots are in the control group.

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Identify the independent variable, dependent variable, experimental and control groups in the following studies.

1. The company Office Max thinks that a special juice will increase the productivity of its workers. The company creates two groups of 50 workers each and assigns each group the same task (in this case, they're supposed to staple a set of papers). Group A is given the special juice to drink while they work. Group B is not given the special juice. After an hour, the company counts how many stacks of papers each group has made. Group A made 3,587 stacks, Group B made 1,113 stacks.

Independent variable:

Dependent variable:

Experimental group:

Control group:

What should the company's conclusion be?

2. A group of college students were given a short course in speed-reading. The instructor was curious if a monetary incentive would influence performance on a reading test taken at the end of the course. Seventy students were offered $15 for obtaining a certain level of performance on the test, and another seventy students were not offered any money. The students that were offered $15 scored an average of 75% on the test. The students that were not offered any money scored an average of 86%.

Independent variable:

Dependent variable:

Experimental group:

Control group:

What should the instructor's conclusion about monetary incentive be?

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Practice: Write a hypothesis for each of the questions and identify the variables, control group, and experimental group.

1. Does cigarette smoking increase the risk of lung cancer?

Hypothesis: If____, then
____

Independent Variable:

Dependent Variable:

Control Group:

Experimental Group:

2. Does eating breakfast increase performance in school?

Hypothesis: If____, then
____

Independent Variable:

Dependent Variable:

Control Group:

Experimental Group: