Honors UNIT 1: Sig Figs, Properties of Matter, and Intro to Change

Section 1: Significant Figures

Section 2: Properties of Matter

Section 3: Changes in Matter

Section 4: Dimensional Analysis

Section 5: Scientific Notation

Section 1: Significant Figures

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Section 1: Significant Figures / Objectives

After this lesson I can…

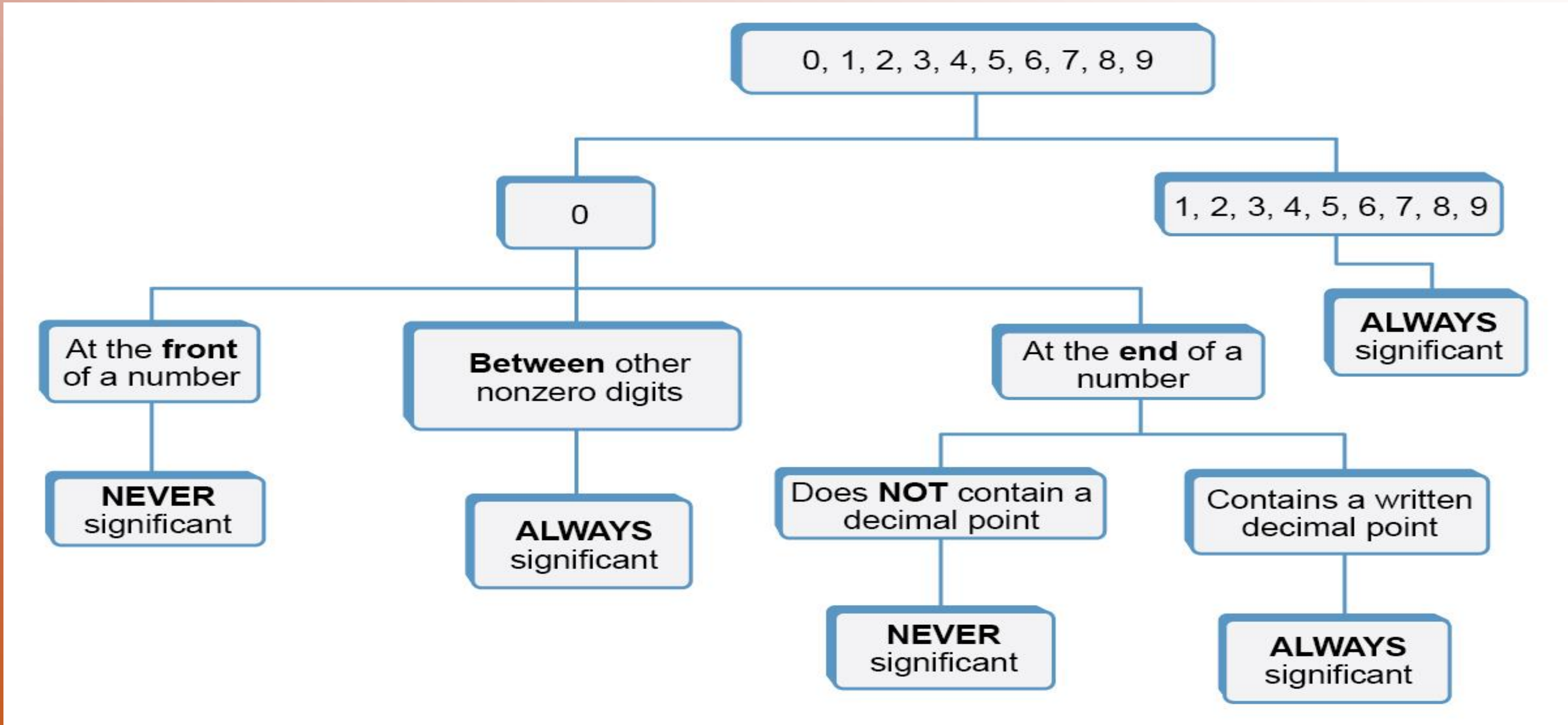
- …*explain* the importance of **significant figures.”**
- …*identify* the zeros in a measurement that are significant and zeros that are not (all non-zeros are always significant).”
- …*solve* addition & subtraction problems *using* significant figures.
- …*solve* multiplication and division problems *using* significant figures.”
- …*solve problems* involving **density.”**
- …*graph* density.”

Significant Figures

- Significant figures are what scientists, researchers, and engineers use to keep it real. In other words, it is what we use to represent the level of precision in our measurements and calculations. You don't want to represent a higher level of precision than you really have.
- You can also explain sigifnicant figures as being the "rules for rounding" when doing math.
- Before we look at any of that though, we first need to determine when zeros in a measurement are significant and when they are not.

Significant Figures

- Knowing how to identify the sig figs in a measurement is not always as simple as what your scale reads. Furthermore, the measurement might have been taken by someone else. If this is the case they must record the measurement in a way that other scientist like yourself might understand. See below:



Significant Figures Examples

Measurement	Significant Figures
0.00304 g	3 sig figs
10,000 ml	1 sig figs
10,000. ml	5 sig figs
104,000 m	3 sig figs
.0123192 in.	6 sig figs
4,809 ft	4 sig figs
.0023022 kg	5 sig figs
1.002 mg	4 sig figs
.00004 kg	1 sig figs
103,900 m	4 sig figs
123,000 L	3 sig figs
120,000,001 g	9 sig figs

Practice Problems: Significant Figures

Directions: Determine the number of Significant Figures in the following numbers

1) .00981 grams
2) 3,900 L
3) 10.009 mg
4) .0200 g
5) 101.009 m
6) 15.000 ml
7) .0005608 sec
8) 100. meters
9) .13003 km
10) 10 kg
11) .1005 g
12) 12.007 ml
13) .004 g
14) 900,000,000 lbs.

Significant Figures Rules for Arithmetic

- The rules for significant figures during addition and subtraction is

Round your answer to the least number of decimal places of any number in the operation.

- The rule for significant figures when two or more numbers are multiplied or divided is

The answer contains no more significant figures than the least number of significant figures used in the operation.

Significant Figures in Addition & Subtraction Examples

55.9212 g – 12.9 g	= 43.0212 g = <u>43.0 g</u> **(rounds to 1 decimal places)**
12.00 J + 77.0000 J	= 89.0000 J = <u>89.00 J</u> **(rounds to 2 decimal places)**
334.002 kg – 2.2442 kg	= 331.7578 kg = <u>331.759 kg</u> **(rounds to 3 decimal places)**
89.0050 g – 90.010000 g	= -1.005 g = <u>-1.0050 g</u> **(rounds to 4 decimal places. note we added a zero!)**
1,892 W + 13.2312 W	= 1,905.2312 W = <u>1,905 W</u> **(rounds to 0 decimal places)**
956.20 g + 123.80000 g	= 1080 g = <u>1080.00 g</u> **(rounds to 2 decimal places. Note we added two zeros!)**

Significant Figures in Multiplication & Division Examples

3.45 g / 45.001 ml	= .076664963 = <u>.0767 g/ml</u> **(rounds to 3 sig figs)**
341.12 kg / 512.905 L	= .665074429 = <u>.66507 kg/L</u> **(rounds to 5 sig figs)**
12.01 g × 334 J/g	= 4011.34 J = <u>4010 J</u> **(rounds to 3 sig figs)**
400 kg / 12 L	= 33.3333333 kg / L = <u>30 kg/L</u> **(rounds to 1 sig fig)**
543.00 g / 137.2 ml	= 3.957725948 = <u>3.958 g/ml</u> **(rounds to 4 sig figs)**
10,003 g × 2,210 J/g	= 22,106,630 J = <u>22,100,000 J</u> **(rounds to 3 sig figs)**

Practice Problems: Significant Figures in Addition & Subtraction

Directions: Solve the following problems and record your answer with the correct number of sig figs

1) 12.484 g + 3.6 g

2) 9.117 L – 8.11 L

3) 88.489 ml + 7.133 ml + 6.5 ml

4) 16.221 mg – 8.28 mg

5) 8.31g + 7.2 g + 9.4626 g

6) 19.8 lbs – 8.75 lbs + 11 lbs

7) 7.6924 g + 9.6 g – 4.888 g

Practice Problems: Significant Figures in Multiplication & Division

Directions: Solve the following problems and record your answer with the correct number of sig figs

1) .00981 grams / .005 ml

2) 23.7 g × 3.8 J/g

3) 28.367 g / 3.74 ml

4) 45.76 g × .25 J/g

5) 1.678 g / 0.42 ml

6) 81.04 J/g × .010 g

7) 6.47 g × 64.5 J/g

8) 4,278 g / 2 L

Video Time !!!

- Tyler Dewitt's Video: "Why Use Significant Figures"

Section 1 Additional Resources & Links…

- Bozeman Science Video on Significant Figures
- Tyler Dewitt's Video: "Why Use Significant Figures"
- Tyler Dewitt's Video: "Significant Figures and Zeros"
- Tyler Dewitt's Video: "Significant Figures Practice Problems"
- Tyler Dewitt's Video: "Significant Figures Practice Problems with multiplication and division."
- Khan Academy Video on Significant Figures

Section 2: Properties of Matter

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Section 2: Properties of Matter / Objectives

After this lesson I can…

- …*distinguish* between **intrinsic** and **extrinsic properties of matter**
- …*give* examples of intrinsic and extrinsic properties of matter
- …*distinguish* between **physical** and **chemical properties**
- …*give* examples of physical and chemical properties of matter.
- …*explain* how intrinsic properties of matter can be used to identify substances (lab 1)
- …*identify* substances based on their density (Lab 1)

Matter Review

- **Matter** is anything that has mass and takes up space.
- **Mass** is one way to measure how much matter we have.
- All matter is made of atoms, and we will look at atoms in depth in our second unit.

Properties of Matter

- The unique properties of a substance can be classified in several ways.
- Here are a couple of the ways we classify matter:
  - Physical state (a.k.a. phase)
  - Intrinsic properties
  - Extrinsic properties
  - Physical properties
  - Chemical Properties
- Physical state or the **phase** of matter you are familiar with (solid, liquid, gas)
- **Extrinsic properties** are things about a substance that depends on the amount of substance you have.
- **Intrinsic properties** are things about a substance that do NOT depend on the amount of substance you have. They are essentially part of that substance's identity. They are what make it, it! For example water being a liquid at room temperature or clear when it is pure are the same regardless if you have a lot or little amount of water.
- On a side note, intrinsic is sometimes referred to as intensive, and extrinsic is sometimes referred to as extensive.

Examples of Intrinsic & Extrinsic Properties

- Extrinsic Properties
  - Mass
  - Volume
  - Shape
- Intrinsic Properties
  - Density
  - Melting and Boiling Point
  - Appearance (color, luster, order, smell)
  - Hardness
  - Reactivity

Video Time !!!

- Chem Academy Video: “Intensive and Extensive Properties”

Physical & Chemical Properties

- The reactivity of a substance is a noteworthy intrinsic property because the reactivity of a substance is also known as it's **chemical properties**.
- Chemical properties address questions like; "What will it react with?" "What won't it react with?" "what are the conditions for it to react?" "What happens when it reacts?"
- Three examples of chemical properties I'd like you to know
  - Flammability
  - Corrosiveness
  - Toxicity
- Physical properties, on the other hand, are basically everything else. This includes all extrinsic properties, physical state, and all the intrinsic properties of a substance that are unrelated to it reacting to form a new substance.

Video Time !!!

- Chem Academy Video: “Physical vs Chemical Properties – Explained”

Section 2 Additional Resources & Links…

- The Organic Chemistry Tutor Video: “Physical vs. Chemical Properties explained, examples”

Section 3: Changes in Matter

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Section 3: Changes in Matter / Objectives

After this lesson I can…

- …*distinguish* **physical** and **phase change."**
- …*define* **phase**, **nuclear**, and **chemical change."**
- …*label* the parts of a **chemical equation."**
- … *identify* equations that represent phase, nuclear, or chemical change."

Physical, Chemical, & Nuclear Change

- Physical change is when the form of a substance changes, but the chemical composition does not change.
- Most us are familiar with **phase change** which is when a substance changes physical state like melting or condensing.
- A phase change is a physical change, but physical changes can also include something much more simple like cutting a substance in half or grinding it up into a powder.
- In **chemical change**, a substance changes into another substance. In this type of change, atoms get rearranged and bonded to different atoms. The old substances are called the **reactants** and the new substances are called the **products.**
- Finally there is nuclear change. In a **nuclear change**, the atoms themselves change. That is to say, atoms turn into different atoms.

Phase Change Model

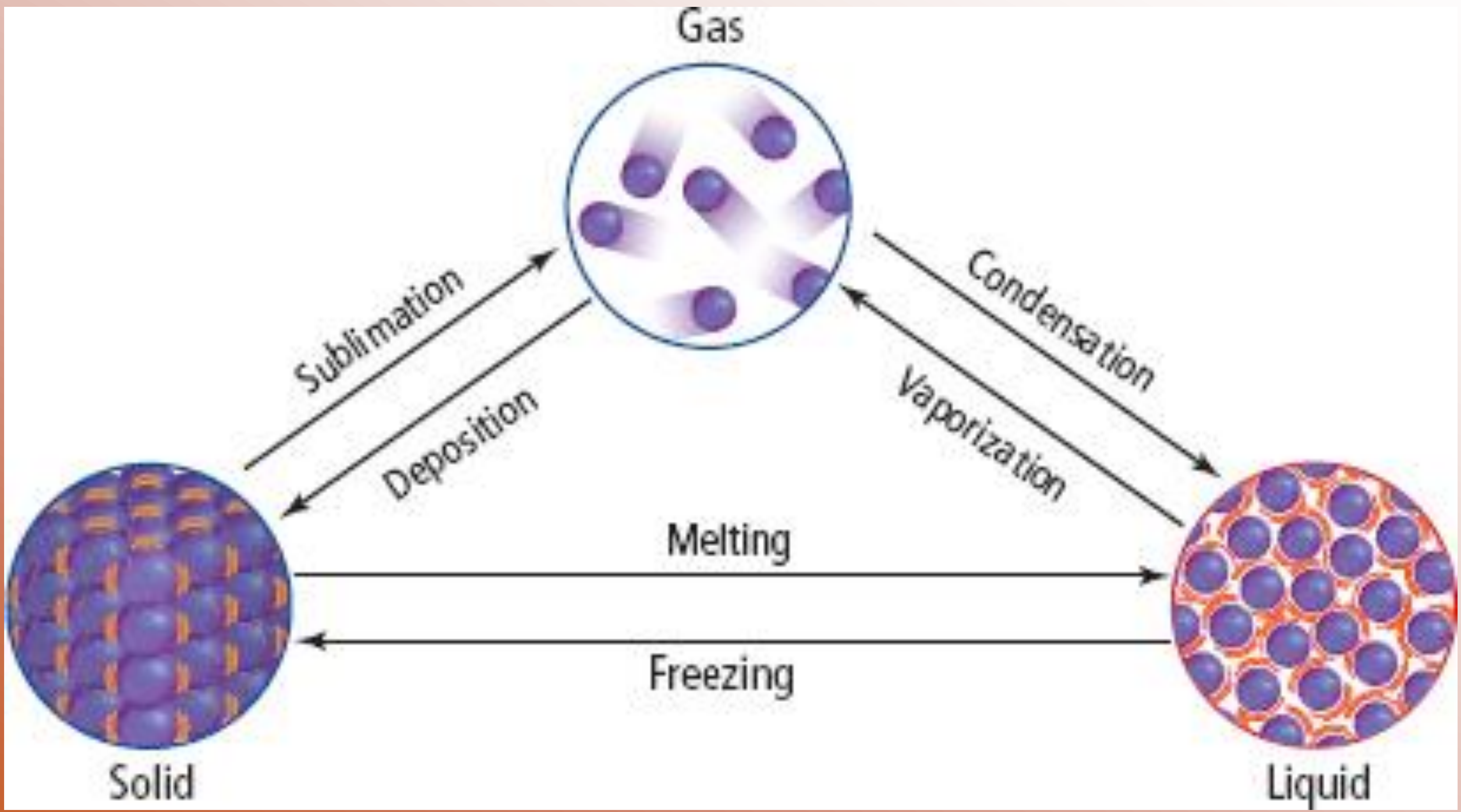
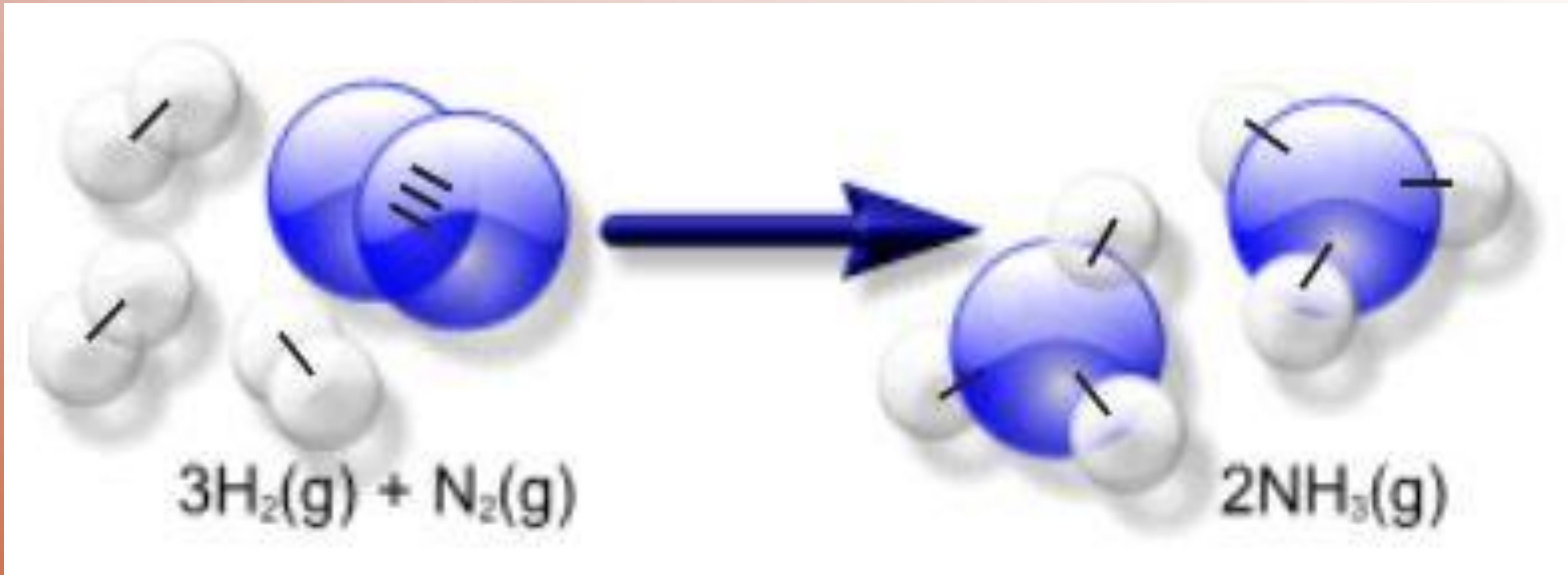


Image Credit: : http://glencoe.mheducation.com/

Chemical Change Model



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Nuclear Change Model

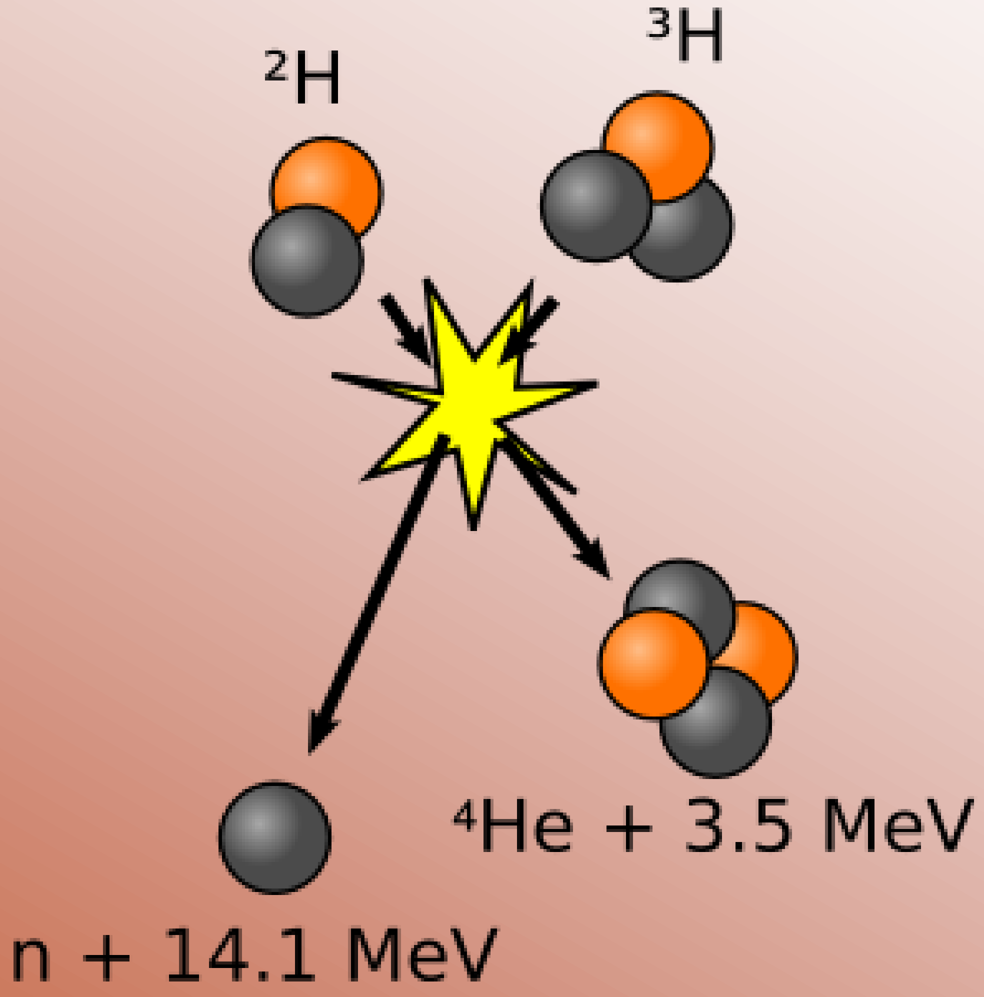
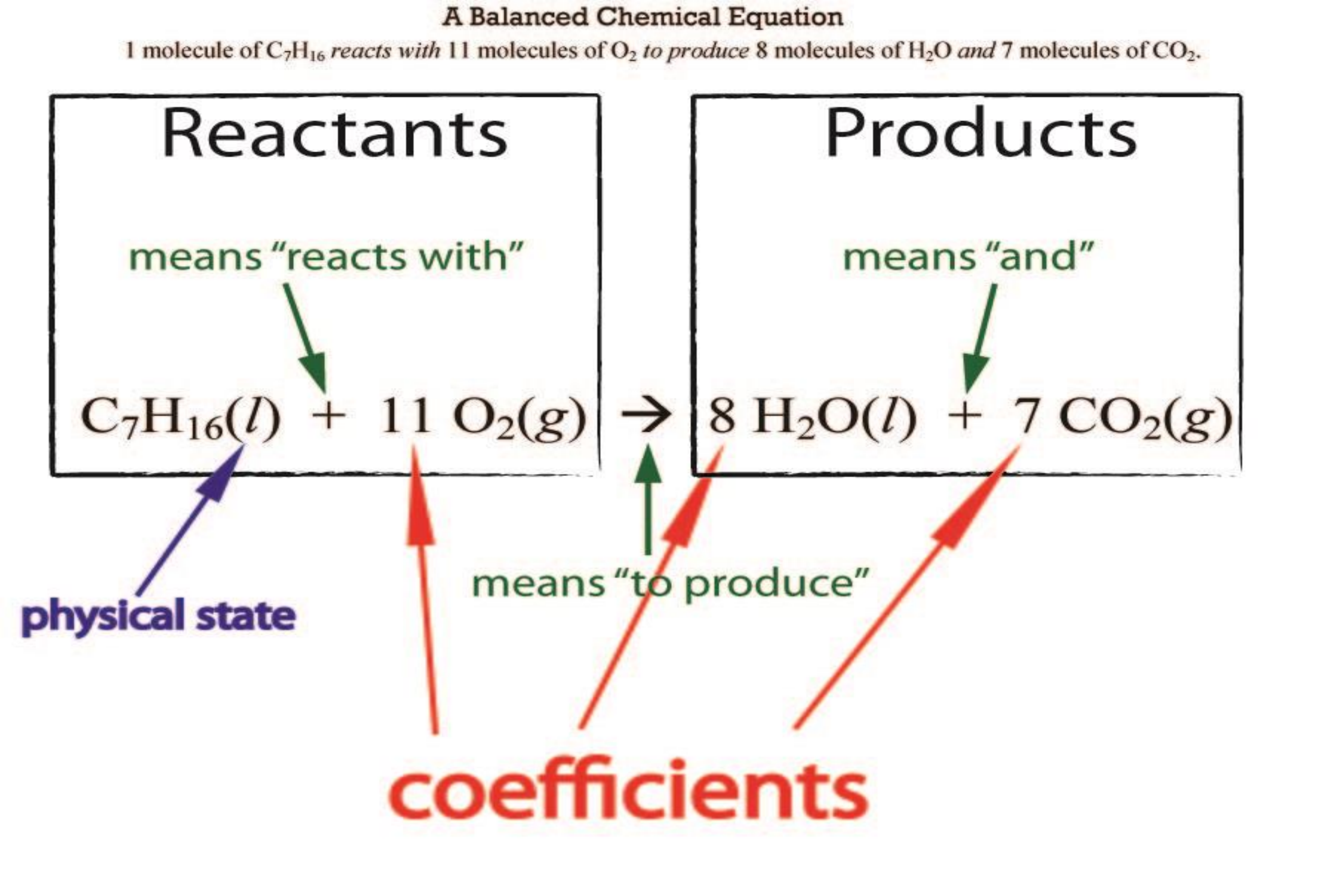


Image Credit: Wikipedia

Chemical Equations

- One of the most important models in chemistry are **chemical equations**. Chemical equations provide information about the reactants and the products.
- Here are a few chemical equations for chemical reactions you might be familiar with:
- Octane or gasoline reacts with air:
  - $2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 16\ CO_2(g) + 18\ H_2O(l)$
- A plant uses photosynthesis to turn carbon dioxide and water into oxygen and sugar:
  - $6\ CO_2(g) + 6\ H_2O(l) \rightarrow C_6H_{12}O_6(s) + 6\ O_2(g)$
- A piece of Iron rusts:
  - $4\ Fe(s) + 3\ O_2(g) \rightarrow 2\ Fe_2O_3\ (s)$
- Note that the same elements are in the products and reactants, they are just combined in different ways.
- On the next slide, all of the parts of a chemical equation are identified and labeled.

Parts of a Chemical Equation



Nuclear Changes are Also Modeled Using a “Chemical Equation”

- Even though they are called “chemical equations” they are useful in modeling nuclear changes as well.
- As mentioned on the previous slide, in a nuclear change, the atoms themselves change.
- Here are some examples of nuclear changes you might be familiar with.
- A Uranium atom splits apart like when an atomic bond detonates:
  - $^{1}n + {}^{235}U \rightarrow {}^{92}Kr + {}^{141}Ba + 3\ {}^{1}n$
- Hydrogen atoms are fused into helium atoms inside the sun:
  - $^{2}H + {}^{3}H \rightarrow {}^{4}He + {}^{1}n$
- Radon atoms in air radioactively decay:
  - $^{222}Rn \rightarrow {}^{4}He + {}^{218}Po$
- Note that in nuclear change equations, the atoms in the products and reactants are different.

Phase Changes can be modeled with "chemical equations" too

- Phase changes can also be modeled using "chemical equations."
- These equations are incredibly simple:
- Some examples you are hopefully familiar with:
- Ice Melting
  - $H_2O(s) \rightarrow H_2O(l)$
- Condensation:
  - $H_2O(g) \rightarrow H_2O(l)$
- Note that the product and reactant are the same substance, it's just in a different physical state.

Practice Problems: Identifying Change Equations

Directions: Label each equation as representing a chemical, nuclear, or phase change

1) $C_5H_{12}(l) + 8\ O_2(g) \rightarrow 5\ CO_2(g) + 6\ H_2O(g)$
2) $H_2O(l) \rightarrow H_2O(s)$
3) $2\ Ca(s) + O_2(g) \rightarrow 2\ CaO(s)$
4) $NiC_{10}H_{10}(s) \rightarrow NiC_{10}H_{10}(g)$
5) $^{256}Fm \rightarrow {}^{140}Xe + {}^{112}Pd + 4\ {}^{1}n$
6) $H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$
7) $^{60}Ti \rightarrow {}^{60}V + \beta$
8) $2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$
9) $Pb(NO_3)_2(aq) + 2\ KI(l) \rightarrow PbI_2(s) + 2\ KNO_3(aq)$
10) $^{3}H + {}^{3}H \rightarrow {}^{4}He + {}^{1}n$
11) $C_2H_6O(g) \rightarrow C_2H_6O(l)$

Section 3 Additional Resources & Links…

- Some Random Teacher's Video: "Parts of a Chemical Equation"

Section 4: Dimensional Analysis & Unit Conversions

Section 4: Dimensional Analysis and Unit Conversions / Objectives

After this lesson I can…

- …*identify* the **conversion factor(s)** in a given problem or look them up in reference materials and then *use* **dimensional analysis** to *convert* between units.

Intro to Dimensional Analysis

- Many of you have already used dimensional analysis in the past to convert between units. Some people call it "fence posting"
- If you look up dimensional analysis on Wikipedia you will get a very accurate but confusing definition. The best way to define **dimensional analysis** is that it is a *technique* for converting between units or solving problems.
- This technique is especially useful when you have to do multiple conversions, like when you have to go to pounds to kilograms and then to grams.
- Dimensional Analysis is about canceling out units until you arrive at your desired unit (the answer).
- It is also very useful for things like physics and engineering and those of you who go on to take those classes will be re-introduced to D.A.

Steps for Using D.A. (beginners)

1) Identify the conversion factors you need to use and write them off to the side using an equal sign.

2) Write down what you are given.

3) Next to the quantity you are given, draw a number of “fence posts” equal to the number of conversion factors you are using (example: 3 conversion factors needs 3 fence posts, 5 conversion factors needs 5 fence posts). Keep in mind some teachers like parenthesis and fractions instead of fence posts but it’s the same idea.

4) Find the conversion factor you need to cancel out the unit that you start with and then write that conversion factor as a fraction in the first fence post. Put the canceling unit in the denominator and the other unit in the numerator (Remember: “Whatever comes up, must come down”)

5) Repeat step 5 with subsequent conversion factors until you have arrived at the unit the question is asking for.

6) Cancel out units and multiply all fractions.

Practice Problems: D.A. (one conversion)

"There are 2.54 centimeters in 1 inch. Convert 22.5 inches to centimeters"

"There are 2.54 centimeters in 1 inch. Convert 11.7 centimeters to inches"

Practice Problems: D.A. (one conversion)

"The guy at the game store will give you 1 PS4 game for 3 xbox games. How many PS4 games can you get with 15 xbox games?"

"How many xbox games can you get with 17 PS4 games?"

Practice Problems: D.A. (two conversions)

"6 bags of chips can be traded for 4 Gatorades. 24 Gatorades can be traded for 2 pizzas. How many pizzas can you get with 138 bags of chips?"

"There are 2.2 lbs in a kilogram. There are 1,000 grams in a kilogram. How many grams are there in 3.8 lbs?"

Practice Problems: D.A. (two & three conversions)

"there are 2.54 cm in an inch. There are 100 cm in a meter. Give the length in meters for my son JJ if he is 21.5 inches long last time we checked."

"Game tokens are 100 for a dollar. The crane game takes 25 tokens. If you play the crane game 2 times you win 5 pieces of candy. It takes 12 pieces of candy to make you sick for 2 hours. How many hours will little Jimmy be sick if he's got 9 dollars?"

Section 4 Additional Resources & Links…

- Tyler Dewitt's Video: "Understanding Conversion Factors"
- Tyler Dewitt's Video: "Converting Units using conversion Factors"
- Tyler Dewitt's Video: "Converting Units using Multiple Conversion Factors"

Section 5: Scientific Notation

Section 5: Scientific Notation / Objectives

After this lesson I can…

- …*convert* numbers to their **scientific notation** equivilant and vice versa.
- …*solve* problems involving scientific notation and arithmetic (calculator use okay)
- …*convert* numbers to their scientific notation equivalent and vice versa using significant digits.

Scientific Notation Intro

- Scientific notation is just a way to express really big and really small numbers in a way that doesn't require writing out a bunch of numbers
- Examples of really big numbers:
  - 4,000,000,000,000,000 = 4×10^{15}
  - 602,200,000,000,000,000,000,000 = 6.022×10^{23}
- Examples of really small numbers:
  - .000000000000020 = 2.0×10^{-14}
  - .0000000000000000000067 = 6.7×10^{-21}
- Sig figs apply to scientific notation. For example:
  - 14,000.0 should really be written 1.40000×10^4 (note that in this example in order to keep our sig figs we almost defeat the purpose of using scientific notation)
  - 14,000 should be written as 1.4×10^4
- In some cases, scientific notation can actually "save you" on sig figs. For example if you answer was 72,000,000 and you hand to round it to 4 sig figs, you could express it in scientific notation as 7.200×10^7

Practice Problems: Converting Scientific Notation Back and Forth

Directions: convert the following numbers to scientific notation and keep your sig figs…

1) 534,000,000,000,000
2) 0.0000024
3) 930,000
4) 890,000,000.0
5) 0.0006457

Directions: covert the following numbers from scientific notation to not scientific notation…

1) 9.44×10^{13}
2) 4.1×10^{12}
3) 7.2×10^{-7}
4) 8.2×10^{-11}

Multiplying and Dividing Scientific Notation

- You can rely on your calculator when multiplying and dividing scientific notation in *this* class. Here is a brief set of steps for doing it without though.
- When **multiplying** numbers that are in scientific notation, the digit terms are multiplied like normal, but the exponents are added.
- Examples:
  - $(6.4 \times 10^{6})(2.3 \times 10^{8}) = (6.4)(2.3) \times 10^{(6 + 8)} = 14.72 \times 10^{14} = 1.5 \times 10^{15}$
  - $(1.7 \times 10^{-19})(4.4 \times 10^{-6}) = (1.7)(4.4) \times 10^{(-19 + -6)} = 7.5 \times 10^{-25}$
- When **dividing** numbers that are in scientific notation, the digit terms are divided like normal, but the exponents are subtracted
- Examples:
  - $(5.6 \times 10^{28}) / (6.022 \times 10^{23}) = (5.6/6.022) \times 10^{(28-23)} = .930 \times 10^{5} = 9.3 \times 10^{4}$
  - $(9.5 \times 10^{5}) / (2.2 \times 10^{9}) = (9.5/2.2) \times 10^{(5-9)} = 4.3 \times 10^{-4}$

Section 5 Additional Resources & Links…

- Tyler Dewitt's Video: "Scientific Notation: An Introduction"
- Tyler Dewitt's Video: "Scientific Notation: Multiplying & Dividing"
- Tyler Dewitt's Video: "Scientific Notation: Practice Problems"
- Tyler Dewitt's Video: "Scientific Notation & Sig Figs"
- Tyler Dewitt's Video: "Scientific Notation & Sig Figs – another video"