2016 Key

Learning Target 1 – *I can count the number of significant figures in a measurement.*
Review Reading: **Zumdahl 9th Ed. Pg 14-17** **Wikipedia: Significant Figures**

1) Count the number of significant figures in the following measurements:

a) 2.71 g 3 b) 0.00047 kg 2 c) 7.0×10^5 m 2 d) 1,030 L 3

e) 150 pencils 2 f) 37500 g 3 g) 0.1010 cm 4

Learning Target 2 – *I can convert numbers to scientific notation while applying significant figures.*
Review Reading: **Zumdahl 9th Ed. Pg 14-17** **Wikipedia: Significant Figures**

2) Express each of the following in proper scientific notation (Pay attention to sig figs and units)

a) 0.000125 m 1.25×10^{-4} m b) 155.0 mL 1.550×10^{2} ml

c) 123,030,000 kg 1.23003×10^{8} kg d) 481.9×10^{-9} cm 4.819×10^{-7} cm

Learning Target 3 - *I can add, subtract, multiply, and divide with the correct number of significant figures.*
Review Reading: **Zumdahl 9th Ed. Pg 14-17** **Wikipedia: Significant Figures**

3) Calculate the correct answer with proper units and sig figs for each of the following:

a) 12 g + 0.677 g + 86.33 g = 99 g

b) (355.78 g) / (0.056 g) = 6,400 g

c) 97.34 mL – 34.1 mL = 63.2 ml

d) 14.68 x 5 = 70

4) Perform the following calculations involving scientific notation. Report your answer with the correct number of significant figures. PEMDAS

a) 0.14 x (6.02×10^{23}) = 8.4×10^{22}

b) $\frac{(9.875 \times 10^4) - (9.795 \times 10^4)}{9.875 \times 10^4} \times 100\ \%$ = 0.8101 (assume 100 is exact)

c) $\frac{(3.8 \times 10^{-12} + 4.0 \times 10^{-13})}{(4 \times 10^{12} + 6.3 \times 10^{13})}$ = $\frac{4.2 \times 10^{-12}}{6.7 \times 10^{13}} = 6.3 \times 10^{-26} = 6 \times 10^{-26}$

Learning Target 4 – *I can use conversions to solve dimensional analysis problems.*
Review Reading: **Zumdahl 9th Ed. Pg 18-22** **Google: Dimensional Analysis links 3 or 4**

5) Solve the following problems using conversions and dimensional analysis.

a) A large railroad car is filled with 1745 gallons of milk. The car springs a leak in the bottom, and milk starts dripping out at a rate of 204.84 mL/sec. If the train is traveling at a speed of 65.4 miles per hour, calculate how many miles it will travel before all the milk has drained out of the car. (1 gal = 3.78 L, 1 mile = 5280 ft, 1 in = 2.54 cm)

$\left(\frac{1745\ gal}{1}\right)\left(\frac{3.78\ L}{1\ gal}\right)\left(\frac{1000\ mL}{1\ L}\right)\left(\frac{1\ sec}{204.84\ mL}\right)\left(\frac{1\ hr}{3600\ s}\right)\left(\frac{65.4\ miles}{1\ hr}\right) = 584.989\ miles$

$= 585\ miles$

b) The world record for the hundred meter dash is 9.77 seconds. What is the corresponding average speed in units of m/sec, km/hr, ft/sec, and miles/hr?

$\frac{100\ m}{9.77\ sec} = 10.25\ m/s$ $\quad \frac{10.25\ m}{sec}\left(\frac{3.281\ feet}{1\ meter}\right) = 33.6\ \frac{ft}{s}$

$\left(\frac{10.25\ m}{s}\right)\left(\frac{3600\ sec}{1\ hr}\right)\left(\frac{1\ km}{1000\ m}\right) = 36.9\ km/hr$ $\quad \left(\frac{33.6\ ft}{s}\right)\left(\frac{1\ mi}{5280\ ft}\right)\left(\frac{3600\ sec}{1\ hr}\right) = 22.9\ \frac{mi}{hr}$

Learning Target 5 – *I can explain density and use the density equation to find an unknown.*
Review Reading: **Zumdahl 9th Ed. Pg 26-27** **Wikipedia: Density**

6) A rectangular block has dimensions of 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 grams. What are the volume and the density of the block?

Volume = $(2.9\ cm)(3.5\ cm)(10.0\ cm) = 101.5\ cm^3$

density = $615.0\ g / 101.6\ cm^3 = 6.19\ g/cm^3$

7) The density of pure silver is 10.5 g/mL at 20°C. If 5.25 grams of pure silver pellets are added to a graduated cylinder containing 11.2 mL of water, to what volume will the water in the cylinder rise?

$D = \frac{m}{V}$ $\quad \frac{10.5\ g}{ml} = \frac{5.25\ g}{V}$ $\quad V = 0.5\ ml$ displaced

$11.2\ ml + 0.5\ ml = 11.7\ ml\ H_2O$

Learning Target 6 – *I can define and explain terms that identify physical/chemical characteristics of matter.*
Review Reading: **Zumdahl 9th Ed. Pg 27-30** **Wikipedia: Matter or Wikipedia any of the terms below**

volume, density, mass, color, bp, mp, lot or flammability, reactivity ← rxn
texture, solubility!

8) Identify the following as a physical property, physical change, chemical property, or chemical change:

a) Ethanol has a density of 0.697 g/mL. physical property

b) The solution turns blue upon mixing water and food coloring. physical change

c) Wood burns in an oven. chemical change (wood actually burning)

d) Methyl alcohol is highly flammable. chemical property

e) Ice melts in a beaker. physical change

f) Methyl ethanoate smells like apples. physical property

g) A car crashes into a wall. physical change

h) Sugar dissolves in water. physical change

* c) The property of wood being flammable would be chem. property

Learning Target 7 – *I can identify the number of protons, neutrons, and electrons in atoms and isotopes.*
Review Reading: **Zumdahl 9th Ed. Pg 47-57** **Wikipedia: Isotopes**

9) What number of protons and neutrons are contained in the nucleus of each of the following atoms? Assuming each atom is uncharged, what number of electrons are present?

	Protons	Neutrons	Electrons
a) $^{235}_{92}U$	92	143	92
b) $^{13}_{6}C$	6	7	6
c) $^{57}_{26}Fe$	26	31	26
d) $^{208}_{82}Pb$	82	126	82

11) Complete the following table:

Name	Mass #	Atomic #	# of Protons	# of Neutrons	# of Electrons	Symbol
Gallium	70	31	31	39	31	Ga
Phosphorous	31	15	15	16	18	$^{31}_{15}P^{-3}$
Strontium-80	80	38	38	42	38	$^{80}_{38}Sr$
Manganese	55	25	25	30	23	$^{55}_{25}Mn^{+2}$

Learning Target 8 – *I can define and use the Law of Definite Proportions and the Law of Multiple Proportions.*
Review Reading: **Zumdahl 9th Ed. Pg 44-47** **Google: Law of Definite Proportions, Law of Multiple Proportions**

12) Explain:

a) Law of Definite Proportions:
Chemical compounds always have a fixed ratio of elements (by mass)

b) Law of Multiple Proportions:
when 2 elements combine to form compounds the ratio of the the mass of 1 element combined w/ mass of the other will be a fixed ratio (whole #)

13) Solve the following problem:

Sn+2 → Sn+4 →

Tin – Oxygen compound	Tin % by mass	Oxygen % by mass	
Stannous oxide	88.10%	11.90%	SnO
Stannic oxide	78.70%	21.30%	SnO_2

Tin – Oxygen compound	Tin mass	Oxygen mass
Stannous oxide	100.0 grams	13.51 g
Stannic oxide	100.0 grams	27.06 g

a) Use the Law of Definite Proportions to determine the mass of oxygen needed to combine with the given masses of tin for stannous oxide and stannic oxide.

Stannous oxide → $.881y = 100$ $y = 113.51 \times .119 =$ 13.51g O

Stannic oxide → $.787y = 100$ $y = 127.1 \times .213 =$ 27.06g O

b) Does the Law of Multiple Proportions hold true in this case? Explain why or why not.

Yes, In chart #1 containing only Sn and O you see the % by mass is different as the # of molecules O change in the compounds.

Learning Target 9 – *I can name and write formulas for ionic compounds.*

Review Reading: **Zumdahl 9th Ed. Pg 60-70** **Wikipedia: IUPAC nomenclature of inorganic compounds**

14) Name or give the formula for the following compounds:

Name	Formula
Sodium fluoride	NaF
Potassium oxide	K_2O
Calcium phosphate	$Ca_3(PO_4)_2$
Iron III chloride	$FeCl_3$
Iron (II) chloride	$FeCl_2$
Mercury I oxide	Hg_2O
Sodium sulfate	Na_2SO_4
Calcium carbonate	$CaCO_3$
Lithium phosphate	Li_3PO_4
Sulfur dioxide	SO_2
Calcium hydroxide	$Ca(OH)_2$
Sulfuric acid	H_2SO_4

Learning Target 10 – *I can write and balance equations.*
Review Reading: **Zumdahl 9th Ed. 103-108** **www.chymist.com/Equations.pdf**

Write and balance the following equations:

a) Iron metal reacts with oxygen to form rust, iron (III) oxide.

$4Fe(s) + 3O_{2(g)} \longrightarrow 2Fe_2O_3$

b) Calcium metal reacts with water to produce aqueous calcium hydroxide and hydrogen gas.

$Ca(s) + 2H_2O_{(l)} \longrightarrow Ca(OH)_{2\,(aq)} + H_{2(g)}$

c) Aqueous barium hydroxide reacts with aqueous sulfuric acid to produce solid barium sulfate and water.

$Ba(OH)_{2\,(aq)} + H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)} + 2H_2O_{(l)}$

Learning Target 11 – *I can do conversions associated with moles.*
Review Reading: **Zumdahl 9th Ed. 85-92** **Google: Mole Calculations**

15) Solve the following problems:

a) Calculate the mass of 500 atoms of iron (Fe).

$\left(\frac{500 \text{ atoms}}{1}\right)\left(\frac{1 \text{ mol Fe}}{6.02\times10^{23} \text{ atoms}}\right)\left(\frac{55.845 \text{ g}}{1 \text{ mol Fe}}\right) = 4.638 = 5\times10^{-20} \text{ g}$

b) How many formula units are present in 87.2 grams of lead (IV) carbonate?

$\left(\frac{87.2 \text{ g Pb}}{1}\right)\left(\frac{1 \text{ mole Pb}}{327.22 \text{ g}}\right)\left(\frac{6.02\times10^{23} \text{ form. units}}{1 \text{ mol}}\right) = 1.60\times10^{23} \text{ form. units}$

c) Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. Aspartame is marketed as Nutra-Sweet. The molecular formula of aspartame is $C_{14}H_{18}N_2O_5$.

i. Calculate the molar mass of aspartame.

$14(12.01) + 18(1.01) + 2(14.01) + 5(16.0) = 294.32 \text{ g/mol}$

ii. Calculate the mass, in grams, of 1.56 mol of aspartame.

$\left(\frac{1.56 \text{ mol asp}}{1}\right)\left(\frac{294.32 \text{ g}}{1 \text{ mol}}\right) = 459 \text{ g asp}$

iii. How many molecules are in 5.0 mg of aspartame?

$\left(\frac{.005 \text{ g}}{1}\right)\left(\frac{1 \text{ mol}}{294.32 \text{ g}}\right)\left(\frac{6.02\times10^{23} \text{ molecules}}{1 \text{ mol}}\right) = 1.0\times10^{19} \text{ molecules}$

iv. How many atoms of nitrogen are in 1.2 g aspartame?

$\left(\frac{1.2 \text{ g}}{1}\right)\left(\frac{1 \text{ mol asp}}{294.32 \text{ g}}\right)\left(\frac{6.02\times10^{23} \text{ mol}}{1 \text{ mole}}\right)\left(\frac{2 \text{ mol N}}{1 \text{ mol asp}}\right) = 4.9\times10^{21} \text{ atoms N}$

v. What is the mass of one molecule of aspartame?

$\left(\frac{294.32 \text{ g}}{\text{mole}}\right)\left(\frac{1 \text{ mol}}{6.02\times10^{23} \text{ molecule}}\right) = 4.8\times10^{-22} \text{ g/molecule}$

Learning Target 12 – *I can calculate percent by mass for an element in a compound.*
Review Reading: **Zumdahl 9th Ed. 94-96** **Google: percent mass**

16) Calculate the percent by mass for each element in aspartame from the previous problem.

C: $\frac{14(12.01)}{294.32} = .5713 \times 100 = 57.1\ \%C$

H: $\frac{18(1.01)}{294.32} = .06177 \times 100 = 6.18\ \%H$

N: $\frac{2(14.01)}{294.32} = .09520 \times 100 = 9.520\ \%N$

O: $\frac{5(16.00)}{294.32} = .2718 \times 100 = 27.2\ \%O$

Learning Target 13 – *I can calculate the average atomic mass of an isotope using percent abundance.*
Review Reading: **Zumdahl 9th Ed. 83-85** **Google: average atomic mass**

17) An element consists of 1.40% of an isotope with a mass of 203.973 amu, 24.10% of an isotope with mass 205.9745 amu, 22.10% of an isotope with mass 206.9759 amu, and 52.40% of an isotope with mass 207.9766 amu. Calculate the average atomic mass and identify the element.

$(203.973)(.014) + (205.9745)(.2410) + 206.9759(.2210) + (207.9766)(.5240) =$

$2.856 + 49.64 + 45.74 + 108.98 = 207.22\ amu$

Learning Target 14 – *I can solve stoichiometry problems, include those with limiting and excess reagents.*
Review Reading: **Zumdahl 9th Ed. 108-123** **Google: stoichiometry problems**

18) The reusable booster rockets of the U.S. space shuttle employs a mixture of aluminum and ammonium perchlorate for fuel. A possible reaction for this is:

	3 Al(s)	+ 3 NH_4ClO_4(s) →	___ Al_2O_3(s)	+ ___ $AlCl_3$(s)	+ 3 NO(g)	+ 6 H_2O(g)
Hg	45	15		5.69(g)		
mol mass	26.98	117.49		133.33		
# mol	1.48	.128		.0427		
1 unit	1.049	.0427	.0427	.0427	.0427	.0427

a) Balance the following reaction:

b) If 4.0 g of aluminum reacted with 15.0 g of ammonium perchlorate, what would be the limiting reactant? How much excess of the other reactant would you have?

Limiting → NH_4ClO_4

Excess → .0063 mol Al or 0.17 g remains

c) Using the previous information, calculate the number of grams of aluminum chloride produced.

$\left(\frac{.0427\ \text{mol}\ AlCl_3}{1}\right)\left(\frac{133.33\ g}{1\ \text{mol}\ AlCl_3}\right) = 5.7\ g\ AlCl_3$

d) If you actually collected 4.18 g of aluminum chloride what would be the percent yield?

$\frac{4.18\ g}{5.7\ g} \times 100 = 73.3\% = 73\%$

19) You add aluminum to a solution of copper (II) chloride and it reacts exothermically. Write and balance the equation here:

$2Al(s) + 3CuCl_2 \rightarrow 3Cu(s) + 2AlCl_3$

a) If you react 1.25 g of Al, how much copper (II) chloride do you need to add for the Al to fully react?

$\left(\frac{1.25\ g\ Al}{1}\right)\left(\frac{1\ \text{mol}\ Al}{26.98\ g}\right)\left(\frac{3\ \text{mol}\ CuCl_2}{2\ \text{mol}\ Al}\right)\left(\frac{134.45}{1\ \text{mol}\ CuCl_3}\right) = 9.34\ g\ CuCl_2$

			63.55	133.33
mol mass				
# mol	.046	.0693	.0693	.046
1 unit	.0231	.0231	.0231	.0231

b) How much of each product would you collect using the amount of Al from part (a)?

$Cu = 4.4\ g$

$AlCl_3 = 6.1\ g$

20) When 125.0 g of ethylene (C_2H_4) burns in 60.0 grams of oxygen to give carbon dioxide and water, how many grams of CO_2 are formed? (Hint: balance the equation and determine limiting reactant first)

(over) on back

Learning Target 15 – *I can determine the empirical and molecular formula by calculation.*

Review Reading: **Zumdahl 7th Ed. 99-103** **Google: empirical formula**

21) Phenol is a compound that contains 76.57% carbon, 6.43% hydrogen, and 17.0% oxygen.

a) Calculate the empirical formula.

C: $\frac{76.57}{12.01} = \frac{6.4}{1.06}$ O: $\frac{17.0}{16.0} = \frac{1.06}{1.06}$ C_6H_6O

H: $\frac{6.43}{1.01} = \frac{6.4}{1.06}$

b) If the molecular weight of phenol is 188 g/mol, what would be its molecular formula?

$12(6) + 6(1.0) + 16 = 94$ mol mass of emp. formula

$\frac{188}{94} = 2\times$ so double # atoms in molecule

$C_{12}H_{12}O_2$

oxygen is problem Menthol + O_2 → CO_2 + H_2O ← Find C & H

Learning Target 16 - *I can calculate the empirical formula of an unknown hydrocarbon using a combustion reaction and calculation.*

Review Reading: **Zumdahl 7th Ed. 99-103** **Google: combustion analysis**

22) One killer of a problem – a GOLD STAR if you can get this one: ⍟

Menthol, the substance we can smell in mentholated cough drops, is composed of carbon, hydrogen, and oxygen. A 0.1005 gram sample of menthol is combusted producing 0.2829 g of CO_2 and 0.1159 g of H_2O. What is the empirical formula for menthol? Show work.

(1)

$\left(\frac{.2829\ g\ CO_2}{1}\right)\left(\frac{1\ mol\ CO_2}{44.0\ g\ CO_2}\right) = .006430\ mol\ CO_2 \times \frac{1\ mol\ C}{1\ mol\ CO_2} = 0.006430\ mol\ C$ ✓

$\left(\frac{.1159\ g\ H_2O}{1}\right)\left(\frac{1\ mol\ H_2O}{18.0\ g\ H_2O}\right) = .006439\ mol\ H_2O \times \frac{2\ mol\ H}{1\ mol\ H_2O} = 0.012886\ mol\ H$

$\left(\frac{.0643\ mol\ C}{1}\right)\left(\frac{12.0\ g\ C}{1\ mol\ C}\right) = .07716\ g\ C$

$\left(\frac{.012886\ mol\ H}{1}\right)\left(\frac{1.01\ g}{1\ mol\ H}\right) = 0.01288\ g\ H$

(3) $.1005\ g - (.01288 + .07716) =$ **.01046 g Oxygen**

(4) $\left(\frac{.01046\ g\ O}{1}\right)\left(\frac{1\ mol}{16.0\ g}\right) =$ ✓ **0.0006538 mol O**

over (5) →

Learning Target 17 - *I can calculate the concentration of solutions*

Review Reading: **Zumdahl 9th Ed. 145-149** **Google: molarity**

23) Calculate the molarity of the following solutions:

a) 28.92 g of HNO_3 in enough water to make 250 mL of solution

$\frac{\frac{28.92}{63.0}}{.250} =$ **1.8 M**

b) 57.61 g of KOH in enough water to make 1250 mL of solution

$\frac{\frac{57.61}{56.1}}{1.250} =$ **.821 M**

24) Describe how to prepare the following solutions from solid reagents and water:

a) 750 mL of 0.5 M $K_2Cr_2O_7$

$.5\ M = \frac{\frac{x}{294.2}}{.750}$

$x =$ **110.3259 g** = **110 g**

Add 110 g $K_2Cr_2O_7$ to vol. flask. Add water to .750 l mark

b) 1 L of 6.0 M Na_2SO_4

$6.0\ M = \frac{\frac{x}{142}}{1}$ **852 g** = **800 g**

Add 852 g Na_2SO_4 to vol flask. Add H_2O to 1 l mark.

25) Describe how to make one concentration from another solution:

a) Make 50 mL of 1.0 M NaCl from 12.0 M NaCl $C_1V_1 = C_2V_2$

$(X)(12\ M) = (.05\ l)(1.\ M)$

$X = .0042\ l =$ **.004 l**

Add 4.2 ml of 12 M NaCl to vol. flask. Add H_2O to 50ml mark

b) Make 350 mL of 0.15 M $FeSO_4$ from 4.0 M $FeSO_4$

$(.350\ l)(.15\ M) = (X)4.0\ M)$

$X = .013\ l$

Add 13 ml of 4.0 M $FeSO_4$ to vol. flask. Add H_2O to the 350ml mark

Ag^+, Pb, Hg → halogens OH → insoluble except group 1 (Sr, Ba, Ca)
Ba, Pb, Ag → SO_4

Learning Target 18 - *I can determine substances that will precipitate in a solution.*
Review Reading: **Zumdahl 9th Ed. 153-158** **Google: solubility rules**

26) A solution contains Pb^{2+}, Ag^+ and Fe^{3+} You want to selectively precipitate the Pb^{2+}. Describe a procedure that will allow you to separate ALL the ions from the sample:
(HINT : Think about the SOLUTILITY RULES and your Quantitative analysis lab!!)

- Add HCl – Fe^{+3} remains in soln; ppt out Ag and Pb
- Add hot H_2O to ppt ($PbCl_2$ soluble in hot H_2O / AgCl is not)
  AgCl remains as ppt / $PbCl_2$ in soln.

Learning Target 19 - *I can write net ionic equations.*
Review Reading: **Zumdahl 9th Ed. 158-160** **Google: net ionic equations**

27) Write **molecular equations**, predicting the expected products for the following:
a) silver nitrate is mixed with sodium chloride

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

b) magnesium nitrate combines with sodium hydroxide

$Mg(NO_3)_2 + 2NaOH \rightarrow Mg(OH)_2 + 2NaNO_3$

c) solid zinc is mixed with hydrochloric acid

$Zn + 2HCl \rightarrow H_2 + ZnCl_2$

28) Write **net ionic equations** for the preceding examples in question #5. Include symbols indicating the states for each species- (s), (l), (g), or (aq)

a) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

b) $Mg^{+2}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$

c) $Zn(s) + 2H^+(aq) \rightarrow Zn^{+2}(aq) + H_2(g)$

Learning Target 20 - *I can calculate stoichiometry problems for basic precipitation reactions.*
Review Reading: **Zumdahl 9th Ed. 160-162** **Google: Stoichiometry of reactions in solutions**

29) Calculate the mass of solid NaCl that must be added to 1.50 L of a 0.100 M $AgNO_3$ solution to precipitate all the Ag^+ ions in the form of AgCl.

over

30) What mass of $Na_2Cr_2O_4$ is required to precipitate all of the silver ions from 75.0 mL of a 0.100M $AgNO_3$?

over. ← oops.... typo of sodium chromate

#29

(29)

	$NaCl$	+ $AgNO_3$	→ $AgCl$	+ $NaNO_3$
#gr	?	(*)		
mol. mass	58.45	(*)		
#mol	0.15 mol	0.15 mol.		
mol Ratio	1	1		
1 unit	0.15 mol	0.15 mol		

(*) $(1.50\,\text{L})\left(.100\,\frac{\text{mol}}{\text{L}}\right) = 0.15\,\text{mol}\ AgNO_3$

Need 8.77 g of NaCl to complete this Rxn

$$Na_2Cr_2O_4 + 2AgNO_3 \rightarrow 2NaNO_3 + Ag_2Cr_2O_4$$

(30) $(0.075\,\text{L})\left(\frac{.100\,\text{mol}}{\text{L}}\right) = .0075$ moles $AgNO_3$

#30

$$\left(\frac{.0075\,\text{mol}\ AgNO_3}{1}\right)\left(\frac{1\,\text{mol}\ Na_2Cr_2O_4}{2\,\text{mol}\ AgNO_3}\right)\left(\frac{214\,\text{g}\ Na_2Cr_2O_4}{1\,\text{mol}\ Na_2Cr_2O_4}\right) = 0.802\,\text{g}\ Na_2Cr_2O_4$$

(OR)

	$Na_2Cr_2O_4$	+ $2AgNO_3$	→ $Ag_2Cr_2O_4$	+ $2NaNO_3$
#gr	.802 g	↓		
mol mass	214 g	.0075		
#moles	.00375	.2		
1 unit	1	.0375		
1 unit	1 : .00375			