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Topic 1: Significant Figures

1. Determine the number of significant figures in each of the following:
   a. 0.7540 4
   b. 12500 3
   c. 10000.01 7
   d. 1200 2
   e. 1.04×10^3 3
   f. 0.0080050 5

2. Perform the following calculations and round to the appropriate number of significant figures.
   a. 34.66 + 333.0 = 367.66 = 367.7
   b. 1.23 + 9.66 = 10.89
   c. 445 - 1.22 = 443.78 = 444
   d. 18.2×1.998 = 36.3636 = 36.4
   e. $10.2 \div 1.34$ = 7.6119 = 7.61
   f. $\frac{100.23+59.4}{5.22}$ = $\frac{159.63}{5.22}$ = $\frac{159.6}{5.22}$ = 30.57 = 30.6

3. Round each of the following numbers to three significant figures.
   a. 167.789 168
   b. 0.00000445345 0.00000445
   c. 25.0545 25.1
   d. 3.1415926536 3.14
   e. 8504.0435 8.50×10^3
   f. 14.4355 14.4

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Topic 2: Metric and Temperature Conversions

1. Use dimensional analysis (factor-label method) to make the following metric conversions:

   a. 3.40 m to cm $\frac{3.40\ m \mid 100\ cm}{\mid 1\ m} = 340\ cm = 3.40 \times 10^{2}$ (must use sci not to have 3 sig figs in answer)

   b. 289 cm to nm $\frac{289\ cm \mid 1\ m \mid 1 \times 10^{9}\ nm}{\mid 100\ cm \mid 1\ m} = 2.89 \times 10^{9}\ nm$

   c. 125145 J to kJ $\frac{125145\ J \mid 1\ kJ}{\mid 1000\ J} = 125.145\ kJ$

   d. 164 mg to g $\frac{164\ mg \mid 1\ g}{\mid 1000\ mg} = 0.164\ g$

   e. 46.5 mL to L $\frac{46.5\ mL \mid 1\ L}{\mid 1000\ mL} = 0.0465\ L$

2. Make the following temperature conversions.

   a. 162°F to °C $(162° - 32)\frac{5}{9} = 72.2°C$

   b. 0.0 °F to K $(0.0° - 32)\frac{5}{9} = 17.78 = 18\ K$

   c. -18 °C to K $-18°C + 273 = 255\ K$

   d. 212 K to °C $212\ K - 273 = -51°C$

   e. 98.6 °F to K $(98.6° - 32)\frac{5}{9} = 37\ K$

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Topic 3: Nomenclature

1. Name or write the formula for the following ionic compounds:

a. LiCl	lithium chloride	g. tin(II) bromide	$SnBr_2$
b. $Mg(OH)_2$	magnesium hydroxide	h. potassium phosphate	K_3PO_4
c. K_3P	potassium phosphide	i. nickel(II) perchlorate	$Ni(ClO_4)_2$
d. Fe_2O_3	iron (III) oxide	j. sodium hydroxide	$NaOH$
e. FeO	iron (II) oxide	k. zinc phosphate	$Zn_3(PO_4)_2$
f. $ZnCl_2$	zinc chloride	l. ammonium sulfate	$(NH_4)_2SO_4$

2. Name or write the formula for the following covalent compounds:

a. CO	Carbon monoxide	e. nitrogen tribromide	NBr_3
b. CBr_4	carbon tetrabromide	f. tetraphosphorus decaoxide	P_4O_{10}
c. SO_2	Sulfur dioxide	g. xenon hexafluoride	XeF_6
d. N_2O_4	dinitrogen tetrachloride	h. dicarbon tetrafluoride	C_2F_4

3. Name or write the formula for the following acids:

a. HCl	hydrochloric acid	e. hydrobromic acid	HBr
b. HNO_3	nitric acid	f. hydronitric acid	H_3N
c. $HC_2H_3O_2$	acetic acid	g. phosphoric acid	H_3PO_4
d. H_2SO_4	Sulfuric acid	h. hydrosulfuric acid	H_2S

mnemonic device

example, (g)

① I ate an acid + it was icky ⇒ phosphate: PO_4^{3-} becomes phosphoric acid

② I too a bike + it was delicious ⇒ phosphite: PO_3^{3-} becomes phosphorous acid

③ a nonmetal w/o oxygen w/ hydrogen ⇒ H_3P: Hydrophosphoric acid becomes hydro___ic acid

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Topic 4: Atomic Structure

1. Determine the number of protons, neutrons and electrons in each of the following:
   a. $^{39}_{19}K$ $p^+ = 19$, $n^\circ = 20$, $e^- = 19$
   b. $^{23}_{11}Na^{1+}$ $p^+ = 11$, $n^\circ = 12$, $e^- = 10$
   c. $^{208}_{82}Pb$ $p^+ = 82$, $n^\circ = 106$, $e^- = 82$
   d. $^{33}_{15}P^{3-}$ $p^+ = 15$, $n^\circ = 18$, $e^- = 18$

2. Write the symbol for the atom that contains
   a. 24 protons, 21 electrons and 24 neutrons
      $^{48}_{24}Cr^{3+}$
   b. 34 protons, 45 neutrons, 34 electrons
      $^{79}_{34}Se$
   c. 8 protons, 10 neutrons, 10 electrons
      $^{18}_{8}O^{2-}$

3. What experimental evidence supports these statements?
   a. The nucleus of an atom is small.

      Rutherfords Gold Foil Experiment:

      positive alpha particles were fired at a thin piece of gold most went through, only a few bounced back

   b. The atom consists of both positive and negative charges.

      JJ Thompson's Cathode Ray Tube:

      When neg particles went through a cathode ray tube they were deflected away from the neg. plate + attracted to the pos.

   c. The nucleus of the atom is positive.

      Rutherfords Gold Foil Experiment:

      B'c the positive particles were deflected the nucleus must be positive

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Topic 5: Writing and Balancing Chemical Equations

1. Balance the following chemical equations

   a. $\_4\_ Cr_{(s)} + \_3\_ O_{2(g)} \rightarrow \_2\_ Cr_2O_{3(s)}$

   b. $\_1\_ SiH_{4(g)} \rightarrow \_1\_ Si_{(s)} + \_2\_ H_{2(g)}$

   c. $\_2\_ SO_{3(g)} \rightarrow \_2\_ SO_{2(g)} + \_1\_ O_{2(g)}$

   d. $\_2\_ Pb(NO_3)_{2(s)} \rightarrow \_2\_ PbO_{(s)} + \_4\_ NO_{2(g)} + \_1\_ O_{2(g)}$

   e. $\_1\_ C_3H_{8(g)} + \_5\_ O_{2(g)} \rightarrow \_3\_ CO_{2(g)} + \_4\_ H_2O_{(g)}$

   f. $\_1\_ C_2H_5OH_{(l)} + \_3\_ O_{2(g)} \rightarrow \_2\_ CO_{2(g)} + \_3\_ H_2O_{(g)}$

2. Write a balanced chemical equation for each of the following reaction descriptions.

   a. When solid calcium carbonate is heated, solid calcium oxide and gaseous carbon dioxide are formed.

   $CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$

   b. Aluminum metal reacts with oxygen to form solid aluminum oxide.

   $4\,Al_{(s)} + 3\,O_{2(g)} \rightarrow 2\,Al_2O_3$

   c. When solid mercury(II) sulfide is heated with oxygen, liquid mercury metal and gaseous sulfur dioxide are produced.

   $HgS_{(s)} + O_{2(g)} \longrightarrow Hg_{(\ell)} + SO_{2(g)}$

   d. When aqueous solutions of aluminum sulfate and barium chloride are mixed, solid barium sulfate and aqueous aluminum chloride are formed.

   $Al_2(SO_4)_{3\,(aq)} + 3BaCl_{2\,(aq)} \rightarrow 3BaSO_{4(s)} + 2AlCl_{3\,(aq)}$

   e. Solid sodium bicarbonate reacts with hydrochloric acid to produce sodium chloride, water, and carbon dioxide gas.

   $NaHCO_{3\,(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(\ell)} + CO_{2(g)}$

   IUPAC prefers Hydrogen carbonate rather than bicarbonate which comes from an outdated naming system

   f. Gaseous ammonia and oxygen react to produce nitrogen monoxide gas and water vapor.

   $4\,NH_{3(g)} + 5\,O_{2(g)} \rightarrow 4\,NO_{(g)} + 6\,H_2O_{(g)}$

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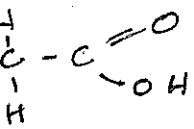
Topic 6: Moles and Stoichiometry

1. Vinegar is a dilute solution of acetic acid, CH_3COOH. ← also known as $HC_2H_3O_2$ OR



   a. Calculate the molar mass of acetic acid.

   $MM = 2(12.01) + 4(1.008) + 2(16.00) = 60.05$ g/mol

   b. How many molecules of CH_3COOH are contained within 43.4 g of acetic acid?

   $$43.4\text{g } CH_3COOH \left| \frac{1 \text{ mol } CH_3COOH}{60.05 \text{ g } CH_3COOH} \right| \frac{6.022\times10^{23} \text{ molecules } CH_3COOH}{1 \text{ mol } CH_3COOH} = 4.35\times10^{23} \text{ molecules of } CH_4COOH$$

   c. How much would 0.450 moles of acetic acid weigh?

   $$0.450 \text{ mol } CH_3COOH \left| \frac{60.05 \text{ g}}{1 \text{ mol } CH_3COOH} \right. = 27.0 \text{ g } CH_3COOH$$

2. How many moles of hydrogen gas can be produced if 1.35 g of solid zinc reacts with excess hydrochloric acid according to the equation

   $$Zn + 2\,HCl \rightarrow H_2 + ZnCl_2$$

   $$1.35\text{g Zn} \left| \frac{1 \text{ mol Zn}}{65.39 \text{ g Zn}} \right| \frac{1 \text{ mol } H_2}{1 \text{ mol Zn}} = 0.0206 \text{ mol } H_2$$

3. The reaction for the combustion of propane is

   $$\underline{1}\ C_3H_8 + \underline{5}\ O_2 \rightarrow \underline{3}\ CO_2 + \underline{4}\ H_2O$$

   a. If 20.0 g of C_3H_8 and 20.0 g of O_2 are reacted, how many moles of CO_2 can be produced?

   must determine LR (Limiting Reactant) 1st

   $$20.0\text{g } C_3H_8 \left| \frac{1 \text{ mol } C_3H_8}{44.09 \text{ g } C_3H_8} \right| \frac{3 \text{ mol } CO_2}{1 \text{ mol } C_3H_8} = 1.36 \text{ mol } CO_2$$

   CO_2 is the ER (excess Reactant)

   $$20.0\text{g } O_2 \left| \frac{1 \text{ mol } O_2}{32.0 \text{ g } O_2} \right| \frac{3 \text{ mol } CO_2}{5 \text{ mol } O_2} = \boxed{0.375 \text{ mol } CO_2}$$

   O_2 is the LR

   b. If 20.0 g of C_3H_8 and 80.0 g of O_2 are reacted, how many grams of CO_2 can be produced?

   $$20.0\text{g } C_3H_8 \left| \frac{1 \text{ mol } C_3H_8}{44.09 \text{ g } C_3H_8} \right| \frac{3 \text{ mol } CO_2}{1 \text{ mol } C_3H_8} \left| \frac{44.01 \text{ g } CO_2}{1 \text{ mol } CO_2} \right. = \boxed{59.9 \text{ g } CO_2}$$

   C_3H_8 is LR

   $$80.0\text{g } O_2 \left| \frac{1 \text{ mol } O_2}{32.00 \text{ g } O_2} \right| \frac{3 \text{ mol } CO_2}{5 \text{ mol } O_2} \left| \frac{44.01 \text{ g } CO_2}{1 \text{ mol } CO_2} \right. = 66.0 \text{ g } CO_2$$

   O_2 is ER

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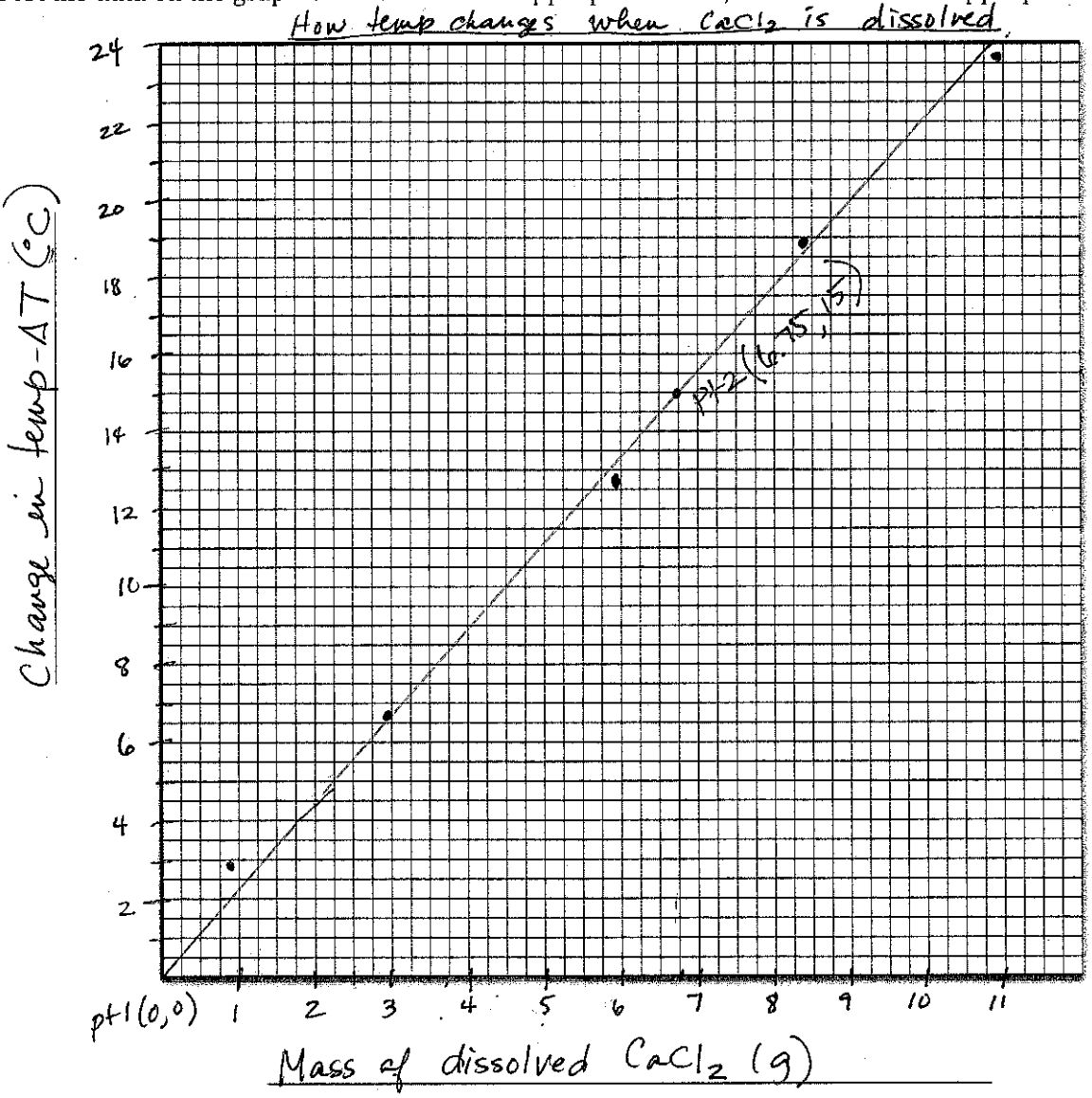
Topic 7: Graphing and Data Analysis

1. When anhydrous calcium chloride is dissolved in water, the temperature of the system changes. A student obtains the following data when dissolving increasing amounts of $CaCl_2$ into 100 mL of water:

Mass of $CaCl_2$ dissolved, g	0.91	2.94	5.92	8.81	10.89
ΔT, °C	1.8	6.6	12.8	18.9	23.2

Plot the data on the graph below. Choose an appropriate scale, and label the axes appropriately.



Refer to the graph to answer the following questions.

Independent Variable: Mass of $CaCl_2$

Dependent Variable: change in temp

Provide a descriptive title for the graph:

How temp changes when $CaCl_2$ dissolves

2. Describe the relationship between grams of calcium chloride salt and change in temperature in a sentence.

an increase in mass has an increase in temp.
- direct relationship

2. Draw a line of best fit. Determine its slope, including units.

$m = \frac{\Delta y}{\Delta x} = \frac{15-0}{6.75-0} = \boxed{2.2\ \frac{g}{°C}}$

3. Predict the change in temperature when

$y = mx + b$
$y = 2.2x$

a. 4.33 g of $CaCl_2$ are dissolved

9.5°C

b. 9.56 g of $CaCl_2$ are dissolved

21°C

c. 15.4 g of $CaCl_2$ are dissolved

34°C

4. Predict what mass of $CaCl_2$ will result in

a. a 12.4°C change in temperature

5.6 g

b. a 44.9 °C change in temperature

2.0×10^{1} g

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Topic 8: Particulate Drawings

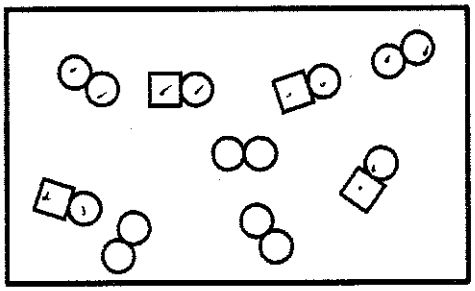
1. Consider the synthesis of nitrogen dioxide

$$2\ NO + 1\ O_2 \rightarrow 2\ NO_2$$

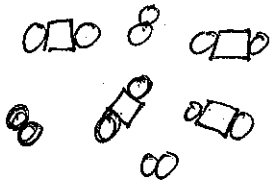
a. In the diagram below, nitrogen atoms are represented with squares and oxygen atoms are represented with circles. Using the conservation of matter, draw what you would expect to find in the reaction vessel once the reaction is complete.

4 NO
4 O2

Before Reaction:



After Reaction



Limiting Reactant:

NO

Excess Reactant:

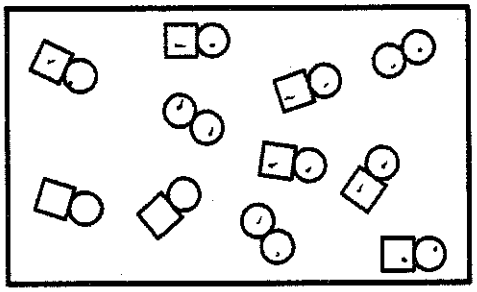
O_2

Explanation

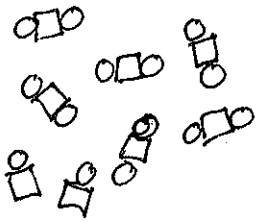
NO runs out 1st ∴ the rxn stops when the NO is gone ∴ there will be leftover O_2. ← means therefore

b. Consider the same reaction, with different starting quantities. Draw the contents of the reaction vessel after the reaction is complete.

Before Reaction:



After Reaction



Limiting Reactant:

O_2

Excess Reactant:

NO

Explanation

O_2 runs out 1st ∴ the rxn stops when the O_2 is gone ∴ there will be leftover NO.

* These do not need to be memorized but try to familiarize yourself w/ the names of these elements + polyatomic ions.

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Topic 9: Elements and Ions to Memorize

1. Prepare flash cards for the following elements/ions and their symbols.

H	hydrogen
He	helium
Li	lithium
Be	beryllium
B	boron
C	carbon
N	nitrogen
O	oxygen
F	fluorine
Ne	neon
Na	sodium
Mg	magnesium
Al	aluminum
Si	silicon
P	phosphorus
S	sulfur
Cl	chlorine
Ar	argon
K	potassium
Ca	calcium
Cr	chromium
Mn	manganese
Fe	iron
Cu	Copper
Zn	zinc
Ag	silver
Pb	lead

Polyatomic Ions

$C_2H_3O_2^-$	acetate
ClO_3^-	chlorate
ClO_2^-	chlorite
CN^-	cyanide
HCO_3^-	bicarbonate
OH^-	Hydroxide
NO_3^-	nitrate
NO_2^-	nitrite
ClO_4^-	perchlorate
MnO_4^-	permanganate
SCN^-	thiocyanate
CO_3^{2-}	carbonate
CrO_4^{2-}	chromate
SO_4^{2-}	sulfate
SO_3^{2-}	sulfite
PO_4^{3-}	phosphate
PO_3^{3-}	phosphite
NH_4^+	ammonium