

NAME (please print) _____

(last)

first)

1.
 - a. Determine the percent composition (by weight) of the chemical compound $C_{27}H_{34}N_2O_6 \cdot 2H_2O$
 - b. What mass of this compound would contain 0.110 grams of oxygen?

2.
 - a. What number of chlorine atoms are present in 1.25×10^{-5} moles of $Mg(ClO_3)_2$?
 - b. What mass of water would contain the same number of molecules as are present in 0.110 grams of hydrastinine, $C_{11}H_{13}NO_6$?
 - c. How many moles of chlorine atoms are contained in 0.110 grams of the compound hexachloro-ethane, C_2Cl_6 .

3. Chemical analysis of a compound composed of chlorine, oxygen, and sulfur, shows that it contains 25.25 % sulfur and 55.85 % chlorine.
 - a. Determine the empirical formula of the compound.
 - b. How many grams of compound would contain 0.110 grams of oxygen?

4.
 - a. Write a balanced chemical equation for the reaction of chromium(III) sulfide with hydrogen chloride to form chromium(III) chloride and hydrogen sulfide. (at.no chromium=24, at.no. sulfur=16, at.no.chlorine=17)
 - b. When 0.6289 grams of chromium sulfide is reacted with 0.6537 grams of hydrogen chloride, how many grams of hydrogen sulfide will be formed?
 - c. How many grams of the reagent present in an excess amount will remain unreacted after the reaction is over?

5. When a sample of 2.0176 grams of a compound composed of carbon, hydrogen, and oxygen, is burned in an excess of oxygen, then 4.5030 grams of carbon dioxide, and 0.7895 grams of water are formed.
 - a. Use this information to determine the empirical formula of the compound.
 - b. Write a balanced chemical equation for the combustion reaction of this compound.

6.
 - a.
 - i. Write a balanced chemical equation for the reaction of iron(II) oxide with aluminum to form elemental iron and aluminum oxide. (at.no. iron=26, at.no aluminum=13)
 - ii. How many grams of iron can be formed from 1.2934 grams of iron(II) oxide, if this reaction is assumed to have 94 % yield?
 - b.
 - i. Write a balanced chemical equation for the reaction of vanadium(III) oxide with carbon dioxide to form vanadium(III) carbonate, $V_2(CO_3)_3$ (at.no. vanadium= 23)
 - ii. How many grams of carbon dioxide would be required to form 3.9256 grams of vanadium(III) carbonate, if the reaction is assumed to have 87 % yield?

7.
 - a. Write a balanced chemical equation for the reaction of sodium oxide with hydrogen bromide to form sodium bromide and water. (at.no. sodium=11, at.no. bromine=35)
 - b. If 3.6724 grams of hydrogen bromide were reacted with 1.7381 grams of sodium oxide, how many grams of water would be formed?
 - c. How many grams of the reagent present in an excess amount will remain unreacted after the reaction is over?

8. a. Write brief directions for preparing 500 mL of a 0.0521 M solution of KMnO_4 , potassium permanganate. Limit your narrative to 15 words or less.
- b. What volume of a 0.125 M solution of magnesium chloride, MgCl_2 , will contain 0.075 moles of chloride anion?
- c. How many moles of sodium cations are present in 29.34 mL of a 0.0831 M solution of sodium phosphate, Na_3PO_4 ?
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1.	a.	MW:	carbon	$27(12) = 324$	%C	$324 / 518 = 62.55$
			hydrogen	$38(1) = 38$	H	$38 / 518 = 7.33$
			nitrogen	$2(14) = 28$	N	$28 / 518 = 5.41$
			oxygen	$8(16) = 128$	O	$128 / 518 = 24.71$
				MW = 518		

b. ? grams compd = 0.110 grams oxygen $\left[\frac{518 \text{grams}(\text{compd})}{128 \text{grams}(\text{oxygen})} \right] = 0.4452 \text{ grams compd}$

2. a. ? Cl atoms = $1.25\text{E-}5 \text{ mole Mg}(\text{ClO}_3)_2 \left[\frac{2 \text{mole}(\text{Cl})}{1 \text{mole}(\text{Mg}(\text{ClO}_3)_2)} \right] \left[\frac{6.02\text{E} + 23(\text{Cl})}{1 \text{mole}(\text{Cl})} \right]$

? Cl atoms = $1.51\text{E} + 19$

b. i. ? mole $\text{C}_{11}\text{H}_{13}\text{NO}_6 = 0.110 \text{g } \text{C}_{11}\text{H}_{13}\text{NO}_6 \left[\frac{1 \text{mole}(\text{compd})}{255 \text{g}(\text{compd})} \right] = 4.31\text{E-}4 \text{ moles}$

ii. ? grams water = $4.31\text{E-}4 \text{ moles} \left[\frac{18 \text{grams}(\text{water})}{1 \text{mole}(\text{water})} \right] = 7.77\text{E-}3 \text{ grams water}$

c. ? mole Cl atoms = $0.110 \text{ grams } \text{C}_2\text{Cl}_6 \left[\frac{1 \text{mole}(\text{compd})}{237 \text{grams}(\text{compd})} \right] \left[\frac{6 \text{mole}(\text{Cl})}{1 \text{mole}(\text{compd})} \right]$

? mole Cl atoms = $2.79\text{E-}3$

3. a. i. find % oxygen $\text{Cl} + \text{S} = 81.10, \quad \text{oxygen} = 100 - 81.10 = 18.90$

ii. calculate moles $\text{moles S} = 25.25 / 32 = 0.789$

$\text{Cl} = 55.85 / 35.5 = 1.5732$

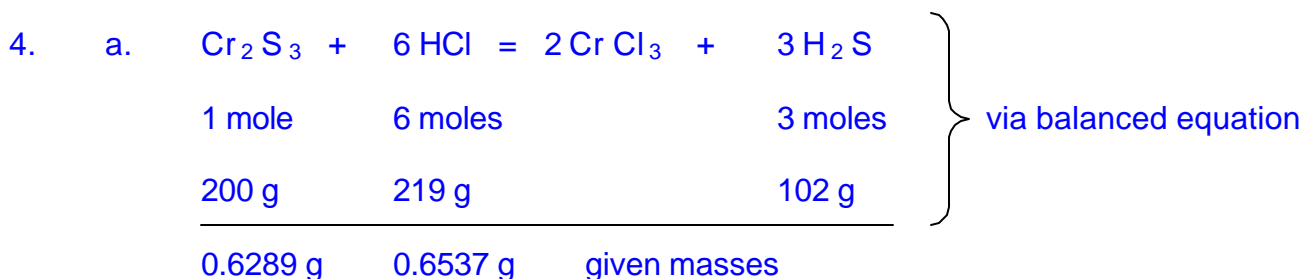
$\text{O} = 18.90 / 16 = 1.1813$

Empirical formula is simplest interger ratio of moles...

$\text{S}_{0.789} \text{Cl}_{1.5732} \text{O}_{1.1813} \quad \text{same as} \quad \text{S}_{1.0} \text{Cl}_{1.994} \text{O}_{1.497}$



$$b. \quad ? \text{ grams cmpd} = 0.110 \text{ grams O} \left[\frac{100 \text{ g(cmpd)}}{18.90 \text{ g(O)}} \right] = 0.582 \text{ grams cmpd}$$



$$i. \quad ? \text{ g H}_2\text{S} = 0.6289 \text{ g Cr}_2\text{S}_3 \left[\frac{102 \text{ g(H}_2\text{S)}}{200 \text{ g(Cr}_2\text{S}_3)} \right] = 0.3207 \text{ g product}$$

$$ii. \quad ? \text{ g H}_2\text{S} = 0.6537 \text{ g HCl} \left[\frac{102 \text{ g(H}_2\text{S)}}{219 \text{ g(HCl)}} \right] = 0.3037 \text{ g product}$$

HCl is the limiting reagent. Only 0.3037 grams of product can be formed.

Cr₂S₃ is the reagent present in an excess amount.

$$b. \quad ? \text{ grams Cr}_2\text{S}_3 = 0.3047 \text{ g H}_2\text{S} \left[\frac{200 \text{ g(Cr}_2\text{S}_3)}{102 \text{ g(H}_2\text{S)}} \right] = 0.5970 \text{ g Cr}_2\text{S}_3 \text{ needed to}$$

prepare 0.3047 g H₂S

initial amt Cr ₂ S ₃	0.6289 g
reacted amt	<u>-0.5970 g</u>
unreacted amt	0.0319 g

5.	a.	$? \text{ grams C} = 4.5030 \text{ g CO}_2 \left[\frac{12 \text{ g(C)}}{44 \text{ g(CO}_2)} \right] = 1.2281 \text{ g carbon}$	}	C + H = 1.3158 g
		$? \text{ grams H} = 0.7895 \text{ g H}_2\text{O} \left[\frac{2 \text{ g(H)}}{18 \text{ g(H}_2\text{O)}} \right] = 0.0877 \text{ g hydrogen}$		

$$? \text{ oxygen} = 2.0176 \text{ g(cmpd)} - 1.3158 \text{ g (C+H)} = 0.7018 \text{ g oxygen}$$

calculate moles:

$$? \text{ mole C} = 1.2281 / 12 = 0.1023$$

$$? \text{ mole H} = 0.0877 / 1 = 0.0877$$

$$? \text{ mole O} = 0.7018 / 16 = 0.0439$$

Empirical formula is a simplest integer ratio of moles...



ii. $? \text{ g Fe} = 1.2934 \text{ g FeO} \left[\frac{55.85 \text{ g}(\text{Fe})}{71.85 \text{ g}(\text{FeO})} \right] = 1.005 \text{ g Fe (if 100\% yield)}$

actual amt product would be less: $0.94(1.005) = 0.9450 \text{ g Fe}$



ii. $\text{CO}_2 = 3.9256 \text{ g V}_2(\text{CO}_3)_3 \left[\frac{132 \text{ g}(\text{CO}_2)}{282 \text{ g}(\text{cmpd})} \right] = 1.8375 \text{ g CO}_2 \text{ (if 100\%)}$

actual amt reactant needed w/b more: $1.8375 / 0.87 = 2.1121 \text{ g CO}_2$



1 mole	2 moles	1 mole	}	via balanced equation
62 g	162 g	18 g		
1.7381 g	3.6724 g	given amts		

b. $? \text{ g H}_2 \text{O} = 1.7381 \text{ g Na}_2 \text{O} \left[\frac{18 \text{ g}(\text{H}_2 \text{O})}{62 \text{ g}(\text{Na}_2 \text{O})} \right] = 0.5046 \text{ g product}$

$? \text{ g H}_2 \text{O} = 3.6724 \text{ g HBr} \left[\frac{18 \text{ g}(\text{H}_2 \text{O})}{162 \text{ g}(\text{HBr})} \right] = 0.4080 \text{ g product}$

H Br is the limiting reagent and only 0.4080 g water c/b formed.

Na₂O is the reagent present in an excess amount.

$$c. \quad ? \text{ g Na}_2\text{O} = 0.4080 \text{ g H}_2\text{O} \left[\frac{62 \text{ g}(\text{Na}_2\text{O})}{18 \text{ g}(\text{H}_2\text{O})} \right] = 1.4055 \text{ g Na}_2\text{O reacts}$$

initial amt 1.7381 g

reacted amt -1.4055 g

unreacted 0.3326 g

$$8. \quad a. \quad \text{Molarity} = \frac{\text{moles solute}}{\text{vol.in Liter units}} \quad \text{moles solute} = 0.0521 \text{ M} (0.500 \text{ L}) = 0.02605$$

$$? \text{ g KmnO}_4 = 0.02605 \text{ moles} \left[\frac{159 \text{ g}}{1 \text{ mole}} \right] = 4.1420 \text{ g}$$

DIRECTIONS: weigh out 4.1420 g KmnO₄, and

add enough water to form 500 mL solution.

b. Solute magnesium chloride, MgCl₂, contains TWO chloride anions per formula unit, so if [MgCl₂] = 0.125 M, then [Cl¹⁻] = 2 x 0.125 = 0.250 M

$$? \text{ Vol.in L units} = 0.075 \text{ moles Cl}^{1-} \left[\frac{1.0 \text{ Liter}}{0.250 \text{ moles}(\text{Cl}^{1-})} \right] = 0.300 \text{ Liter} = 300 \text{ mL}$$

c. Solute sodium phosphate, Na₃PO₄, contains THREE sodium cations per formula unit, so if [Na₃PO₄] = 0.0831 M, then [Na¹⁺] = 3 x 0.0831 = 0.2493 M

$$? \text{ moles Na}^{1+} = (0.2493 \text{ M in Na}^{1+}) (0.02934 \text{ L}) = 7.31 \text{ E} - 3 \text{ moles Na}^{1+}$$