General Chemistry 200

Practice Exam 2 Stoichiometry Calculations and Aqueous Systems

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Chapter 4 Aqueous Stoichiometry

Periodic Table

	1 IA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 **H** 1.00794	2 IIA																2 **He** 4.0026
2	3 **Li** 6.941	4 **Be** 9.01218											5 **B** 10.811	6 **C** 12.011	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.9984	10 **Ne** 20.179
3	11 **Na** 22.9898	12 **Mg** 24.305	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 **Al** 26.9815	14 **Si** 28.086	15 **P** 30.9738	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
4	19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.9415	24 **Cr** 51.9961	25 **Mn** 54.9380	26 **Fe** 55.847	27 **Co** 58.9332	28 **Ni** 58.6934	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.9216	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
5	37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.9064	42 **Mo** 95.94	43 **Tc** 98.9063	44 **Ru** 101.07	45 **Rh** 102.906	46 **Pd** 106.42	47 **Ag** 107.868	48 **Cd** 112.411	49 **In** 114.82	50 **Sn** 118.710	51 **Sb** 121.757	52 **Te** 127.60	53 **I** 126.905	54 **Xe** 131.29
6	55 **Cs** 132.905	56 **Ba** 137.327	57 **La** 138.906	72 **Hf** 178.49	73 **Ta** 180.948	74 **W** 183.85	75 **Re** 186.207	76 **Os** 190.2	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.967	80 **Hg** 200.59	81 **Tl** 204.383	82 **Pb** 207.19	83 **Bi** 208.980	84 **Po** 208.982	85 **At** 209.987	86 **Rn** 222.017
7	87 **Fr** 223.02	88 **Ra** 226.025	89 **Ac** 227.028	104 **Ku** [261]	105 [262]	106 [263]	107 [262]	108 [265]	109 [268]	110 [269]	111 [272]	112 [277]						

Conversion information:

System	LENGTH:	VOLUME	MASS	Temperature
English:	1 ft = 12 in 1 mile = 5280 ft	1 gal = 4 qt 1 qt = 2 pints 1 pt = 16 fl oz	1 lb = 16 oz 1 ton = 2000 lb	$T_{^\circ F} = 1.8T_{^\circ C} + 32$
SI-English:	2.54 cm = 1 in 1.609 km = 1 mi	0.946 L = 1 qt 3.785 L= 1 gal 29.57 mL = 1 fl oz.	453.6 g = 1 lb 28.35 g = 1 oz 1 kg = 2.205 lb	$T_{^\circ C} = \frac{(T_{^\circ F} - 32)}{1.8}$
Misc. info	1 mole = $6.02 \cdot 10^{23}$		Density H_2O: 1.0 g / cc	

General Solubility Table:

Soluble substances containing -	Exceptions	Insoluble substances containing -	Exceptions
nitrates, (NO_3^-) chlorate (ClO_3-) perchlorate (ClO_4^-) Acetate (CH_3COO^-)	None	carbonate (CO_3^{2-}) Phosphate (PO_4^{3-}) chromate (CrO_4^{2-}) Sulfides (S^{2-})	slightly soluble
Halogens (X^-) X^- = Cl^-, Br^-, I^-	Ag, Hg, Pb	Hydroxides (OH^-)	Ca*, Sr, Ba, Alkali, NH_4^+ * marginally soluble
Sulfates (SO_4^{2-})	Ca, Ba, Hg, Pb		
Alkali & NH_4^+	None		

Soluble - dissolve, no precipitate (aq -phase)
insoluble (or slightly soluble) - does not dissolve, precipitate forms. (s-phase)

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1 Combustion of a sulfide of bismuth compound, Bi_xS_y (50.00g) in O_2 produced 45.30 g of dibismuth trioxide (Bi_2O_3).

i) What is the IUPAC compound name, empirical formula and the formula weight of the bismuth sulfide (Bi_xS_y) compound?

ii) What is the oxidation state of the sulfur and the bismuth in this compound?

iii) Suppose in your combustion experiment, the Bi_xS_y compound also contained some bismuth oxide impurities, how would this affect the x-value in the empirical formula of Bi_xS_y (higher or lower and state your reason)?

iv) Suppose instead of producing 45.30 g dibismuth trioxide in the final product of the combustion, 45.30 g of dibismuth pentaoxide is produced instead, how would this affect the y-value in the empirical formula of Bi_xS_y ?

2 Balance the following equations.

i) ___$KOH_{(aq)}$ + ___$H_2SO_{4(aq)}$ → ___ $K_2SO_{4(aq)}$ + ___$H_2O_{(aq)}$

ii) ___$C_4H_{14(l)}$ + ____$O_{2(g)}$ → ___$CO_{2(g)}$ + ____ $H_2O_{(l)}$

iii) $N_2H_{4(l)}$ + ___$O_{2(g)}$ → ___ $NO_{2\ (g)}$ + ___ $H_2O_{(g)}$

iv) ___$K_2CO_{3\ (aq)}$ + ___$H_3PO_{4(aq)}$ → ___ $K_3PO_{4\ (aq)}$ + ___$CO_{2(g)}$ + ____ $H_2O_{(l)}$

v) Arsenic(III) oxide + Hydrochloric acid → Arsenic(III) chloride + Dihydrogen monoxide

vi) Phosphorus + Bromine → Phosphorus tribromide

vii) Calcium carbonate decomposes to calcium oxide and carbon dioxide

viii) Copper(II) sulfate pentahydrate is dehydrated to _____ + _____

Identify the type of reaction above.

3 A compound of Ca, C, N, and S was subjected to quantitative analysis and formula mass determination, and the following data were obtained. A 0.250 g sample was mixed with Na_2CO_3 to convert all of the Ca to 0.160 g of $CaCO_3$. A 0.0268 g sample of the compound was carried through a series of reactions until all of the S was changed to 0.0802 g of $BaSO_4$. A 0.712g sample was processed to liberate all of its N as NH_3, and 0.155 g NH_3 was obtained. The formula mass was found to be 156 g/mol. Determine the empirical and molecular formulas of this compound.

4 2,4,6-Trinitrotoluene (TNT), $C_7H_5N_3O_6$, can be prepared by the following two step synthesis:

$C_6H_6 + CH_4 \rightarrow C_7H_8 + H_2$

$2\ C_7H_8 + 6\ NO_2 \rightarrow 2\ C_7H_5N_3O_6 + 3\ H_2$

If **each** step in this synthesis gives a 50% yield, how much $C_7H_5N_3O_6$ (TNT) in grams can be produced starting with 780 g of benzene (C_6H_6) ?

5 Ethyl alcohol (booze), C_2H_5OH, also called grain alcohol, can be made by the fermentation of glucose, $C_6H_{12}O_6$, which often comes from starch in grain:

___ $C_6H_{12}O_6(aq) \rightarrow$ ___ $C_2H_5OH(l)$ + ___ $2CO_2(g)$

Determine the maximum mass (theoretical yield) of ethyl alcohol which could be produced from 750 g of glucose. If 150 L of CO_2 is collected after the fermentation, what is the % yield. Density of CO_2 (g) is 1.96 g/ L.

6 Determine which of the following will dissolve in water, then classify these as
(s) strong electrolyte, (w) weak electrolyte or (n) non-electrolyte.

i) NH_3 ii) $PbSO_4$ iii) $KHSO_4$ iv) Hg_2Cl_2 v) HNO3 vi) NH_4OH vii) C_2H_5OH

Explain your answer

7 Write the net ionic equation for any reaction that occurs upon mixing each pair of solution:

i) silver nitrate and barium chloride

ii) Magnesium sulfate and barium hydroxide

iii) Hydrochloric acid and strontium hydroxide.

iv) Iron(III) sulfide and nitric acid

8 In each of the following reaction, indicate which metal ion is the stronger oxidizing agent, that is rank each metal Zn, Ag and Pb in order of ease of oxidation . (i.e., Most easily oxidized > next easily oxidize > most difficult to oxidize)

i) $Zn\ (s) + 2AgNO_3\ (aq) \rightarrow 2\ Ag\ (s) + Zn(NO_3)_{2\ (aq)}$

ii) $Pb\ (s) + 2AgNO_3\ (aq) \rightarrow 2\ Ag\ (s) + Pb(NO_3)_2\ (aq)$

iii) $Pb\ (s) + Zn(NO_3)_{2\ (aq)} \rightarrow$ NR.

9 Some sulfuric acid is spilled on a lab bench. It can be neutralized by sprinkling some sodium bicarbonate on to the sulfuric acid. The reaction produces sodium sulfate, carbon dioxide and water.

i) Write the molecular, ionic and net ionic equation and balance the equation (include the phases).

ii) What is the limiting reagent and how much remains if 35 ml of 6.0 M sulfuric acid is spilled and 50 grams of sodium bicarbonate is added ?

iii) What is the mass of carbon dioxide gas (g) that is produced ?

iv) How many molecules of carbon dioxide is produced ?

v) If 5.00 ml of water is actually produce, what is the % yield of water ?

vi) How many oxygen atoms are involved in this reaction ?

vii) If all the liquid is evaporated, what is the mass of sodium sulfate that is produced ?

viii) What is the concentration of sodium sulfate if 20.0 g sodium sulfate is dissolved in the 5.00 ml water?

ix) Suppose potassium hydroxide is substituted for sodium bicarbonate in the above reaction. What mass of potassium hydroxide is required to neutralize 35 ml of 6.0 M sulfuric acid.

10 Balance the following equations and then answer the questions below.

Potassium permanganate is added to hydrochloric acid to produce

chlorine gas, potassium chloride, manganese(II) chloride and water.

i) How many moles of hydrochloric acid are required to react with 45 grams of potassium permanganate ?

ii) How many chlorine molecules will be produced using 5.0 moles of potassium permanganate ?

iii) To produce 55.0 grams of manganese(II) chloride, what mass of hydrochloric acid is required?

iv) How many moles of water will be produce when 7.00 moles of potassium permanganate is consumed ?

v) What is the maximum weight of chlorine that can be produced by reacting 35.0 g of potassium permanganate with 45.0 g of hydrochloric acid ?`

vi) In v (above), if the %yield of chlorine in the reaction is 76%, how much (g) chlorine was actually recovered ?

11 Consider **100** formula units (or molecules) of each:

a) Tin(IV) hypoiodite b) carbon tetraiodide c) cadmium iodite

i) Which compound contains the largest mass of iodine? How much is this mass in grams?

ii) Which contains the greatest mass of metal atoms? For a 100 unit sample, what is the total of these metal atoms ?

iii) If all three of these substances were mixed and added to water, calculate the total number of ions in solution.