Chem 105 Exam 3 Name_____

This exam is schedule for 75 minutes and I anticipate it to take the full time allotted. You are free to leave if you finish. In multiple part problems, points awarded will not be penalized for incorrect answer on previous parts, so simply **move on if you get stuck on one part**. If you need to, make up an answer for the previous part. Always neatly show work for partial credit. You are welcome to "buy" hints to any question – it will cost you points, but this is often a better alternative than having the wrong problem solving strategy.

1. How many oxygen atoms are found in 27.3 grams of sodium phosphate?

2. Determine [NO_3^-] when 46.8 g of iron (II) nitrate is dissolved in 2.95 L of water.

3. What is the mass of nitrogen found in 244.5 mL of NO_2 gas at 3.64 atm and 145 °C

4. Determine the empirical formula of a compound that is 3.26% hydrogen, 19.36% carbon, and 77.38% oxygen by mass.

5. What does **reaction order** mean and why is it important in the study of reaction rates?

6. What are three ways that the rate of a chemical reaction can be changed? Clearly explain the reason that each can influence the rate. You are welcome to use equations and concepts in your answer.

7. Consider a flask that contains O_2 gas at a pressure of 2 atm. In your own words, explain how (i.e. up or down) and why pressure changes as each of the following are changed:
    a. Temperature is increased

    b. Volume is decreased

    c. O_2 gas is removed from the flask

    d. N_2 gas is added to the flask. No chemical reaction occurs.

8. Clearly explain why potassium nitrate will dissolve in water. Your answer should include foundational chemical concepts, not just reciting solubility rules.

9. 480 mL of water is added to a 386 mM solution of Na_2SO_4. If the $[Na^+]$ after dilution is 300 mM, what was the original volume of the sodium sulfate solution?

10. Barium sulfate can be made when magnesium sulfate is mixed together with barium chloride.
    a. Write a balanced reaction.

    b. What type of reaction is described here?

    c. Write a net ionic equation for this reaction.

    d. If 5.000 grams of each reactant are combined, determine the mass of barium sulfate that will be made if the reaction proceeds with a **90% yield**.

11. For each pair, identify which compound will be more soluble in water. **Clearly justify your answer.**

H_2O or H_2S NCl_3 or PCl_3 $(NH_4)_2CO_3$ or $CaCO_3$

12. Given the following data,
    a. Determine the rate law – make sure to include values for the order with respect to each reactant and the value of the rate constant with the correct units.
    b. Determine the rate of the reaction when the concentration of all reactants is 0.35 M.

Experiment	$[O_2]$ (mM)	$[H_2]$ (mM)	Rate (mM min^{-1})
1	0.468	0.147	0.007551
2	0.468	0.884	0.045306
3	1.404	0.884	1.223274

13. Consider the following reaction:

$$4\ HNO_3\ (aq) + Cu\ (s) \rightarrow Cu(NO_3)_2\ (aq) + 2\ NO_2\ (g) + 2\ H_2O\ (l)$$

88.6 mL of 3.18 M HNO_3 is added to a flask containing 2604 mg of solid copper. If the reaction occurs in a 4.00 L flask held at 100 °C, determine each of the following (make sure to include units!): No credit will be awarded without your work clearly shown.

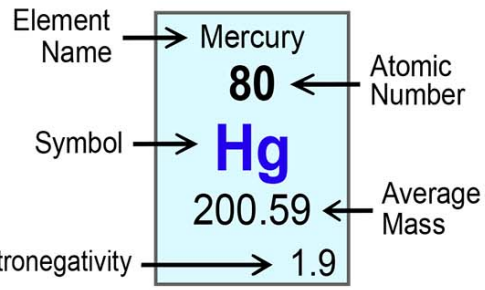
a. The total pressure once the reaction is complete. _____

b. The concentration of $Cu(NO_3)_2$ that is produced. _____

c. The mass of Cu (s) remaining. _____

d. The concentration of HNO_3 remaining. _____

Periodic Table of the Elements



Average relative masses are rounded to two decimal places.

All average masses are to be treated as measured and subject to figure rules.

1	2		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hydrogen 1 H 1.01 2.1																	Helium 2 He 4.00 ---
Lithium 3 Li 6.94 1.0	Beryllium 4 Be 9.01 1.5											Boron 5 B 10.81 2.0	Carbon 6 C 12.01 2.5	Nitrogen 7 N 14.01 3.0	Oxygen 8 O 16.00 3.5	Fluorine 9 F 19.00 4.0	Neon 10 Ne 20.18 ---
Sodium 11 Na 22.99 0.9	Magnesium 12 Mg 24.31 1.2											Aluminum 13 Al 26.98 1.5	Silicon 14 Si 28.09 1.8	Phosphorus 15 P 30.97 2.1	Sulfur 16 S 32.07 2.5	Chlorine 17 Cl 35.45 3.0	Argon 18 Ar 39.95 ---
Potassium 19 K 39.10 0.8	Calcium 20 Ca 40.08 1.0		Scandium 21 Sc 44.96 1.3	Titanium 22 Ti 47.88 1.5	Vanadium 23 V 50.94 1.6	Chromium 24 Cr 52.00 1.6	Manganese 25 Mn 54.94 1.5	Iron 26 Fe 55.85 1.8	Cobalt 27 Co 58.93 1.8	Nickel 28 Ni 58.69 1.8	Copper 29 Cu 63.55 1.9	Zinc 30 Zn 65.39 1.6	Gallium 31 Ga 69.72 1.6	Germanium 32 Ge 72.61 1.8	Arsenic 33 As 74.92 2.0	Selenium 34 Se 78.96 2.4	Bromine 35 Br 79.90 2.8	Krypton 36 Kr 83.80 3.0
Rubidium 37 Rb 85.47 0.8	Strontium 38 Sr 87.62 1.0		Yttrium 39 Y 88.91 1.2	Zirconium 40 Zr 91.22 1.4	Niobium 41 Nb 92.91 1.6	Molybdenum 42 Mo 95.94 1.8	Technetium 43 Tc (98) 1.9	Ruthenium 44 Ru 101.07 2.2	Rhodium 45 Rh 102.91 2.2	Palladium 46 Pd 106.42 2.2	Silver 47 Ag 107.87 1.9	Cadmium 48 Cd 112.41 1.7	Indium 49 In 114.82 1.7	Tin 50 Sn 118.71 1.8	Antimony 51 Sb 121.76 1.9	Tellurium 52 Te 127.60 2.1	Iodine 53 I 126.90 2.5	Xenon 54 Xe 131.29 2.6
Cesium 55 Cs 132.91 0.7	Barium 56 Ba 137.33 0.9	57-70 *	Lutetium 71 Lu 174.97 1.1	Hafnium 72 Hf 178.49 1.3	Tantalum 73 Ta 180.95 1.5	Tungsten 74 W 183.84 1.7	Rhenium 75 Re 186.21 1.9	Osmium 76 Os 190.23 2.2	Iridium 77 Ir 192.22 2.2	Platinum 78 Pt 195.08 2.2	Gold 79 Au 196.97 2.4	Mercury 80 Hg 200.59 1.9	Thallium 81 Tl 204.38 1.8	Lead 82 Pb 207.20 1.8	Bismuth 83 Bi 208.98 1.9	Polonium 84 Po (209) 2.0	Astatine 85 At (210) 2.2	Radon 86 Rn (222) 2.4
Francium 87 Fr (223) 0.7	Radium 88 Ra (226) 0.9	89-102 **	Lawrencium 103 Lr (262) ---	Rutherfordium 104 Rf (261) ---	Dubnium 105 Db (262) ---	Seaborgium 106 Sg (266) ---	Bohrium 107 Bh (264) ---	Hassium 108 Hs (269) ---	Meitnerium 109 Mt (268) ---	Darmstadtium 110 Ds (271) ---	Roegentium 111 Rg (272) ---	Copernicium 112 Cn (277) ---	Ununtrium 113 Uut (284) ---	Flerovium 114 Fl (289) ---	Ununpentium 115 Uup (288) ---	Livermorium 116 Lv (293) ---	Ununseptium 117 Uus (294) ---	Ununoctium 118 Uuo (294) ---

*lanthanides	Lanthanum 57 La 138.91 1.1	Cerium 58 Ce 140.12 1.1	Praseodymium 59 Pr 140.91 1.1	Neodymium 60 Nd 144.24 1.1	Promethium 61 Pm (145) 1.1	Samarium 62 Sm 150.36 1.2	Europium 63 Eu 151.97 1.1	Gadolinium 64 Gd 157.25 1.2	Terbium 65 Tb 158.93 1.1	Dysprosium 66 Dy 162.50 1.2	Holmium 67 Ho 164.93 1.2	Erbium 68 Er 167.26 1.2	Thulium 69 Tm 168.93 1.3	Ytterbium 70 Yb 173.04 1.1
**actinides	Actinium 89 Ac (227) 1.1	Thorium 90 Th 232.04 1.3	Protactinium 91 Pa 231.04 1.5	Uranium 92 U 238.03 1.4	Neptunium 93 Np (237) 1.4	Plutonium 94 Pu (244) 1.3	Americium 95 Am (243) 1.3	Curium 96 Cm (247) 1.3	Berkelium 97 Bk (247) 1.3	Californium 98 Cf (251) 1.3	Einsteinium 99 Es (252) 1.3	Fermium 100 Fm (257) 1.3	Mendelevium 101 Md (258) 1.3	Nobelium 102 No (259) 1.3

Equations and constants:

$E = h\nu$ $\quad c = 2.998\ x\ 10^{8}\ {}^{m}/_{S}$ $\quad c = \lambda\nu$ $\quad h = 6.626\ x\ 10^{-34} J$

$E_n = \frac{-2.18x10^{-18} J}{n^2}$ $\quad KE = \frac{1}{2}mv^2$ $\quad E_{coulomb} = 231pm \cdot aJ \frac{q_1 q_2}{r}$

$m_{electron} = 9.109x10^{31} kg$ $\quad \lambda = \frac{h}{m\nu}$ $\quad V_{cylinder} = \pi r^2 h$

$N_A = 6.022x10^{23} mol^{-1}$ $\quad PV = nRT$ $\quad R = 0.08206\ \frac{L \cdot atm}{mol \cdot K}$

$P = \frac{F}{area}$ $\quad F = ma$

$1atm = 760\ mmHg = 760\ torr$ $\quad 1atm = 1.01325\ bar$ $\quad 1atm = 101325\ Pa$

$k = Ae^{\frac{-E_a}{RT}}$

Soluble Compounds	
Compounds	Notable Exceptions:
Group 1A ions	None
Ammonium	None
Acetate	None
Nitrate	None
Halides	Ag^+, Pb^{2+}, Hg_2^{2+}
Sulfate	Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}

Insoluble Compounds	
Compounds Containing	Notable Exceptions
Carbonate	Group IA and NH_4^+
Phosphate	Group IA and NH_4^+
Sulfide	Group IA, IIA, and NH_4^+
Hydroxide	Group IA, NH_4^+, Ca^{2+}, Sr^{2+}, Ba^{2+}