

Chemistry 150

Exam 2

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for non-multiple choice problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} units/mol

$32.00^\circ\text{F} = 0.000^\circ\text{C} = 273.15\text{K}$

1 foot = 12 inches

1 inch = 2.54cm (exactly)

1 pound = 453.6 g = 16 ounces

1 amu = 1.6605×10^{-24} g

Masses of subatomic particles:

Proton $1.00728\text{amu} = 1.6726 \times 10^{-24}$ g

Neutron $1.00866\text{amu} = 1.6749 \times 10^{-24}$ g

Electron $0.000549\text{amu} = 9.1094 \times 10^{-28}$ g

Density of Water = 1.000g/mL

$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$

$PV = nRT$

1 H 1.0079																	2 He 4.0026				
3 Li 6.941	4 Be 9.0122															5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305															13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80				
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29				
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra 226.03	89 Ac 227.03	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (279)		116 (289)						

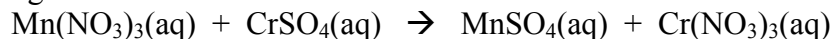
58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.94	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (258)	101 Md (258)	102 No (259)	103 Lr (260)

Multiple Choice: Circle the letter of the most correct response. (7pts. per question)

- Under which of the following conditions is a gas most “ideal”?
 - High temperature, high pressure
 - High volume, low pressure
 - Low pressure, high temperature**
 - High pressure, high volume
 - Room temperature, 25°C
- Consider the following reaction:
$$a \text{K}_3\text{PO}_4(\text{aq}) + b \text{Ca}(\text{NO}_3)_2(\text{aq}) \rightarrow c \text{Ca}_3(\text{PO}_4)_2(\text{s}) + d \text{KNO}_3(\text{aq})$$
For every mol of $\text{K}_3\text{PO}_4(\text{aq})$ that reacts, how many mols of $\text{Ca}_3(\text{PO}_4)_2(\text{s})$ are formed?
 - 0.25 mols
 - 0.5 mols**
 - 1 mol
 - 2 mols
 - 3 mols
- Which of the following is a correct gas law relationship?
 - $PT = nRV$
 - $n_1T_1 = n_2T_2$**
 - $V_1n_1 = V_2n_2$
 - $P_1T_1 = P_2T_2$
 - $P_1 / V_1 = P_2 / V_2$
- Which of the following combinations of aqueous solutions would you expect to form a precipitate?
 - Ammonium phosphate + Potassium carbonate
 - Sodium hydroxide + Nitric acid
 - Hydrochloric acid + Lithium sulfite
 - Sodium acetate + Nickel(II) nitrate
 - Silver(I) nitrate + Potassium carbonate**
- Which of the following is **not** a redox reaction?
 - $\text{Mg}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 - $4 \text{Fe}(\text{s}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{Fe}_2\text{O}_3(\text{s})$
 - $2 \text{C}_2\text{H}_2(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$
 - $\text{NH}_4\text{NO}_3(\text{aq}) + \text{NaC}_2\text{H}_3\text{O}_2(\text{aq}) \rightarrow \text{NH}_4\text{C}_2\text{H}_3\text{O}_2(\text{aq}) + \text{NaNO}_3(\text{aq})$**
 - $2 \text{CuNO}_3(\text{aq}) + \text{Sn}(\text{s}) \rightarrow 2 \text{Cu}(\text{s}) + \text{Sn}(\text{NO}_3)_2(\text{aq})$
- In which of the following formulas does phosphorus have the **lowest** oxidation number?
 - Na_3PO_4
 - PH_3**
 - H_3PO
 - P_4
 - KH_2PO_3

7. Which of the following would you expect to be *insoluble* in water?
- NaI
 - Pb(NO₃)₂
 - NH₄C₂H₃O₂
 - BaSO₄**
 - FeSO₄

8. Consider the following reaction:



What is being *oxidized* in this reaction?

- Mn(NO₃)₃(aq)
- CrSO₄(aq)**
- MnSO₄(aq)
- Cr(NO₃)₃(aq)
- This is not a redox reaction

Multiple Choice Calculations (12pts each):

9. What is the pressure of 4.936mols of ideal gas at 28.61°C in a 50.0L vessel?
- 0.0862atm
 - 0.232atm
 - 2.44atm**
 - 4.31atm
 - 11.6atm
10. A 2.65L steel tank contains an ideal gas at 15.83°C and 1.15atm. What is the temperature of the tank if the pressure changes to 1.48atm?
- 48.6°C
 - 12.3°C
 - 20.4°C
 - 98.8°C**
 - 155°C
11. A reaction produces 834.1mL of ideal gas at 1.06atm pressure and 32.87°C. How many mols of gas did the reaction produce?
- 0.0352 mols**
 - 0.328 mols
 - 1.06 mols
 - 35.2 mols
 - 328 mols
12. You have dissolved 10.00g of magnesium acetate in enough water to make 250.00mL of solution. What is the concentration of the resulting solution?
- 2.809x10⁻⁴ M
 - 4.799x10⁻⁴ M
 - 7.023x10⁻² M
 - 0.2809 M**
 - 0.4799 M

Problems: (23pts each)

13. You would like to take some atmospheric measurements. You fill a weather balloon to a volume of 375.0L at 22.18°C and 0.938atm pressure. How many mols of gas are contained in the balloon? After you release the balloon, it rises to an altitude where the temperature is -8.46°C and the pressure is 0.613atm. A small hole in the balloon has allowed 12.50% of the original gas to escape. What is the volume of the balloon at this altitude?

The first part is an ideal gas law problem, $PV = nRT$. Let's organize our variables: $P_1 = 0.938\text{atm}$, $V_1 = 375.0\text{L}$, $T_1 = 22.18 + 273.15 = 295.33\text{K}$. Plugging in:

$$(0.938\text{atm})(375.0\text{L}) = n(0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K})(295.33\text{K})$$

$$n = 14.5\text{mols}$$

The second half of the problem has multiple conditions changing, so we should use the comparative form of the ideal gas law. Again, let's start by organizing our variables: $P_1 = 0.938\text{atm}$, $V_1 = 375.0\text{L}$, $T_1 = 22.18 + 273.15 = 295.33\text{K}$, $n_1 = 14.5\text{mols}$, $P_2 = 0.613\text{atm}$, $T_2 = -8.46 + 273.15 = 264.69\text{K}$, $n_2 = (14.5\text{mols})(0.875) = 12.7\text{mols}$. Plugging in:

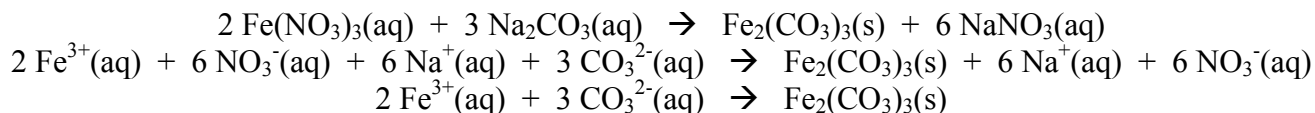
$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

$$\frac{(0.938\text{atm})(375.0\text{L})}{(14.5\text{mols})(295.33\text{K})} = \frac{(0.613\text{atm})V_2}{(12.7\text{mols})(264.69\text{K})}$$

$$V_2 = 450.\text{L}$$

14. 100.0mL of 1.183M iron(III) nitrate solution is combined with 100.0mL of 1.299M sodium carbonate solution.

- Write a correctly balanced net ionic equation for the reaction that takes place.
- How many grams of precipitate will this reaction form?
- You recover 9.614g of precipitate. What is the percent yield?



The first equation is the "full molecular" equation, the second is the "full ionic" equation, the third is the net ionic. Now that we have a balanced equation, we can use the stoichiometry to determine the limiting reagent:

If $\text{Fe}^{3+}(\text{aq})$ is limiting:

$$(0.1000\text{L Fe}(\text{NO}_3)_3(\text{aq})) \left(\frac{1.183\text{mols Fe}(\text{NO}_3)_3(\text{aq})}{1\text{L Fe}(\text{NO}_3)_3(\text{aq})} \right) \left(\frac{1\text{mol Fe}_2(\text{CO}_3)_3(\text{s})}{2\text{mol Fe}(\text{NO}_3)_3(\text{aq})} \right) \left(\frac{291.718\text{g Fe}_2(\text{CO}_3)_3(\text{s})}{1\text{mol Fe}_2(\text{CO}_3)_3(\text{s})} \right) = 17.26\text{g Fe}_2(\text{CO}_3)_3(\text{s})$$

If $\text{CO}_3^{2-}(\text{aq})$ is limiting:

$$(0.1000\text{L Na}_2\text{CO}_3(\text{aq})) \left(\frac{1.299\text{mols Na}_2\text{CO}_3(\text{aq})}{1\text{L Na}_2\text{CO}_3(\text{aq})} \right) \left(\frac{1\text{mol Fe}_2(\text{CO}_3)_3(\text{s})}{3\text{mol Na}_2\text{CO}_3(\text{aq})} \right) \left(\frac{291.718\text{g Fe}_2(\text{CO}_3)_3(\text{s})}{1\text{mol Fe}_2(\text{CO}_3)_3(\text{s})} \right) = 12.63\text{g Fe}_2(\text{CO}_3)_3(\text{s})$$

Since the amount of carbonate we're using produces less product, it must be limiting, so the theoretical yield of precipitate for this mixture is 12.63g of $\text{Fe}_2(\text{CO}_3)_3(\text{s})$.

To calculate the percent yield,

$$(9.614\text{g} / 12.63\text{g}) \times 100\% = 76.11\% \text{ yield.}$$