

Dear students,

Q9 was converted to a
bonus question, so....

$$\frac{+20 \text{ bonus points}}{60} = \text{grade.}$$

- The numerical grade that you ~~see~~ have in Brightspace ~~reflects~~ this change.
- The grade on your exam does not ~~reflect~~ this change. So....

$$\boxed{\frac{\text{your grade}}{60} = \text{grade on brightspace}}$$

CHM1311A – Exam 1A

Last name: CORRECTED EXAM

First name: _____

Student number: _____

Reminder:

- Circle your final answer
- Calculators are permitted
- Circle your final answer
- Make sure there are 13 pages to this exam

No units? (-0.5)

No sigfigs? (-0.5)

Exam 1A

3. Given 2.34 mg of porphyrin, $C_{20}H_{14}N_4$:
- Calculate the number of moles of nitrogen in porphyrin



$$\frac{2.34 \text{ mg}}{1000} = 0.00234 \text{ g} \times \frac{1 \text{ mol}}{310.3516 \text{ g}} = 0.000007539 \text{ mol} \quad (2)$$

$$0.000007539 \text{ mol } C_{20}H_{14}N_4 \times \frac{4 \text{ mol N}}{1 \text{ mol } C_{20}H_{14}N_4} = 3.02 \times 10^{-5} \text{ mol N} \quad (2)$$

- Calculate the number of atoms of hydrogen in porphyrin

$$0.000007539 \text{ mol } C_{20}H_{14}N_4 \times \frac{14 \text{ mol H}}{1 \text{ mol } C_{20}H_{14}N_4} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 6.35 \times 10^{19} \text{ atoms} \quad (4)$$

4. At 1.09 atm and 1.13°C, a 3.85 g sample of gas occupies a volume of 2390 mL. Calculate the molar mass of the gas.

$$MM = \frac{gRT}{PV} = \frac{(3.85 \text{ g}) \times (0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (274.28 \text{ K})}{(1.09 \text{ atm}) \times (2.390 \text{ L})} \quad (2)$$

$$MM_{\text{gas}} = 33.3 \text{ g/mol} \quad (4)$$

5. What is the rms speed of molecular oxygen at 448K?

$$\rightarrow O_2: 31.9988 \text{ g/mol} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.0319988 \frac{\text{kg}}{\text{mol}} \quad (1)$$

$$v_{\text{rms}} = \sqrt{\frac{3 \times (8.31451 \frac{\text{J}}{\text{mol}\cdot\text{K}}) \times (448 \text{ K})}{0.0319988 \frac{\text{kg}}{\text{mol}}}}$$

$$v_{\text{rms } O_2} = 590.95 \text{ or } 591 \frac{\text{m}}{\text{s}} \quad (3)$$

Exam 1A

6. Strychnine, a deadly poison, has a molecular mass of 334 g/mol and a percentage composition by mass of 75.42% C, 6.63% H, 8.38% N, and the balance is oxygen.
 a. Calculate the empirical formula

assume 100% or 100g:

$$75.42 \text{ g C} \times \frac{1 \text{ mol}}{12.011 \text{ g}} = 6.279244 \text{ mol C} \quad (1.5)$$

$$6.63 \text{ g H} \times \frac{1 \text{ mol}}{1.00794 \text{ g}} = 6.57777 \text{ mol H} \quad (1.5)$$

$$8.38 \text{ g N} \times \frac{1 \text{ mol}}{14.00674 \text{ g}} = 0.598283 \text{ mol N} \quad (1.5)$$

$$9.57 \text{ g O} \times \frac{1 \text{ mol}}{15.9994 \text{ g}} = 0.598147 \text{ mol O} \quad (1.5)$$

$$\begin{array}{cccc} \text{C} & \text{H} & \text{N} & \text{O} \\ \frac{6.279244}{0.598147} & \frac{6.57777}{0.598147} & \frac{0.598283}{0.598147} & \frac{0.598147}{0.598147} \end{array} = \text{C}_{10.49} \text{H}_{10.99} \text{N}_{1.00} \text{O}_{1.00}$$

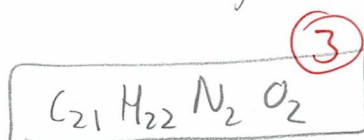
6 must x 2: $\boxed{\text{C}_{21} \text{H}_{22} \text{N}_2 \text{O}_2}$ (3)

(1.5 pts)

- b. Calculate the molecular formula

$$\text{C}_{21} \text{H}_{22} \text{N}_2 \text{O}_2 = \frac{334 \text{ g}}{\text{mol}}$$

$$\frac{\text{Empirical mm}}{\text{molecular mm}} = \frac{334 \text{ g/mol}}{334 \text{ g/mol}} = 1$$



Exam 1A

7. A brass alloy contains 74.7% copper, Cu, by mass with the remainder of the alloy being zinc, Zn.

a. Determine the number of moles of zinc in 43.6 g of the brass alloy.

Brass alloy: 74.7% Cu, 25.3% Zn (1)

$$43.6 \text{ g alloy} \times 0.253 = \underline{11.0308 \text{ g Zn}} \text{ (2)}$$

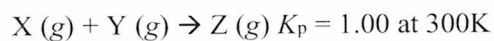
$$11.0308 \text{ g Zn} \times \frac{1 \text{ mol Zn}}{65.39 \text{ g}} = 0.16869 \text{ or } \boxed{0.169 \text{ mol Zn}} \text{ (3)}$$

b. Determine the number of atoms of zinc in 43.6 g of the brass alloy.

$$0.16869 \text{ mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol Zn}} = \boxed{1.02 \times 10^{23} \text{ atoms Zn}} \text{ (5)}$$

Exam 1A

8. In which direction will the reaction below proceed given the conditions:



a. $[X] = [Y] = [Z] = 1.0 \text{ M}$

$$K_c = \frac{k_p}{RT^{\Delta n}}$$

$$\textcircled{1} Q_c = \frac{[Z]}{[X][Y]} = \frac{(1.00)}{(1.00)(1.00)} = 1$$

$$K_c = \frac{1.00}{\left(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(300)^{1-2}}$$

$$\textcircled{2} K_c = 24.6$$

$Q_c < K_c$, PRODUCTS ARE FAVORED $\textcircled{1}$
MUST PROVE!

b. $P_x = P_z = 1.0 \text{ atm}$, $P_y = 0.50 \text{ atm}$

$$Q_p = \frac{P_z}{P_x P_y} = \frac{(1.0)}{(1.0)(0.50)} = 2 \quad \textcircled{2}$$

$Q_p > K_p$, REACTANTS ARE FAVORED $\textcircled{2}$

Bonus Question

9. Chlorine trifluoride, ClF_3 , is a valuable reagent because it can be used to convert metal oxides to metal fluorides:



- a. Balance the chemical reaction above.



- b. What mass of NiO will react with ClF_3 gas if the gas has a pressure of 250 mmHg at 20.0°C in a 2.50-L flask?

$$n_{\text{ClF}_3} = \frac{PV}{RT} = \frac{(0.3289 \text{ atm})(2.50 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(293.15 \text{ K})}$$

$$250 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 0.3289 \text{ atm}$$

$$n_{\text{ClF}_3} = 0.0342 \text{ mol} \quad \textcircled{2}$$

If all ClF_3 reacts: $0.0342 \text{ mol ClF}_3 \times \frac{6 \text{ mol NiO}}{4 \text{ mol ClF}_3} = 0.0513 \text{ mol NiO} \quad \textcircled{2}$

$$\hookrightarrow 0.0513 \text{ mol NiO} \times \frac{74.6928 \text{ g}}{1 \text{ mol}} = 3.8317 \text{ g} \quad \text{or} \quad \boxed{3.8 \text{ g NiO} (s)} \quad \textcircled{2}$$

Exam 1A

- c. If the ClF_3 described in part (b) is completely consumed, what are the partial pressures of Cl_2 and O_2 in the 2.5-L flask at 20.0°C (in kPa)?

$$n_{\text{ClF}_3} = 0.0342 \text{ mol}$$

$$0.0342 \text{ mol ClF}_3 \times \frac{2 \text{ mol Cl}_2}{4 \text{ mol ClF}_3} = 0.0171 \text{ mol Cl}_2$$

$$0.0342 \text{ mol ClF}_3 \times \frac{3 \text{ mol O}_2}{4 \text{ mol ClF}_3} = 0.02565 \text{ mol O}_2$$

$$P_{\text{Cl}_2} = \frac{nRT}{V} = \frac{(0.0171 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (293.15 \text{ K})}{(2.5 \text{ L})} = 16.67 \text{ kPa} \text{ or } 17 \text{ kPa}$$

$$P_{\text{O}_2} = \frac{nRT}{V} = \frac{(0.02565 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (293.15 \text{ K})}{(2.5 \text{ L})} = 25.01 \text{ kPa} \text{ or } 25 \text{ kPa}$$

- d. What is the total pressure in the flask following part (c)?

$$P_{\text{Total}} = P_{\text{O}_2} + P_{\text{Cl}_2} = 17 \text{ kPa} + 25 \text{ kPa} = 42 \text{ kPa}$$

- e. Given the partial pressures in part c, calculate the percent yield (by mass) if 0.090 atm of Cl_2 (g) and 0.060 atm of O_2 (g) was generated in the reaction.

Theoretical yields:

$$m_{\text{Cl}_2} = 0.0171 \text{ mol Cl}_2 \times \frac{70.9054 \text{ g}}{1 \text{ mol}} = 1.212 \text{ g Cl}_2$$

$$m_{\text{O}_2} = 0.02565 \text{ mol O}_2 \times \frac{31.9988 \text{ g}}{1 \text{ mol}} = 0.8207 \text{ g O}_2$$

$$m_{\text{Cl}_2(\text{actual})} = \frac{mmPV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.090 \text{ atm}) \times (2.5 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (293.15 \text{ K})} = 0.6632 \text{ g}$$

$$m_{\text{O}_2(\text{actual})} = \frac{mmPV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.060 \text{ atm}) \times (2.5 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (293.15 \text{ K})} = 0.1995 \text{ g}$$

$$\% \text{ yield Cl}_2 = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{0.6632 \text{ g}}{1.212 \text{ g}} \times 100 = 54.7\%$$

$$\% \text{ yield O}_2 = \frac{0.1995 \text{ g}}{0.8207 \text{ g}} \times 100 = 24.3\%$$

CHM1311A – Exam 1B

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No units? (-0.5)

No sig figs? (-0.5)

Exam 1B

Question	Points	Points received
1	6	
2	6	
3	8	
4	6	
5	4	
6	12	
7	10	
8	8	
9	20	
Total	80	

Exam 1B

1. Given the systemic and common (trivial) names below, determine the chemical formula:

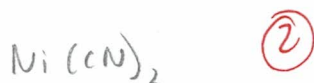
a. Cuprous bisulfate



b. Boron trichloride



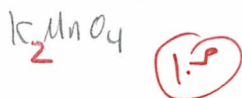
c. Nickel (II) cyanide



2. Which of the following chemical formulas are incorrect (circle those that are incorrect)?

Write the correct formula where possible.

a. MgO_4K



(-1 pt) IF STUDENTS
CONVERT CORRECT
TO INC.

b. CaF



c. NaO_2



d. CaCrO_4

e. $\text{Ca}_2\text{Cr}_2\text{O}_7$



Exam 1B

3. Given 3.43 mg of porphyrin, $C_{20}H_{14}N_4$:

a. Calculate the number of moles of nitrogen in porphyrin

$$\frac{3.43 \text{ mg}}{1000} = 0.00343 \text{ g} \times \frac{1 \text{ mol}}{310.3916 \text{ g}} = 0.000011051 \text{ mol} \quad (2)$$

$$0.000011051 \text{ mol } C_{20}H_{14}N_4 \times \frac{4 \text{ mol N}}{1 \text{ mol } C_{20}H_{14}N_4} = 4.42 \times 10^{-5} \text{ mol N} \quad (2)$$

b. Calculate the number of atoms of hydrogen in porphyrin

$$0.000011051 \text{ mol } C_{20}H_{14}N_4 \times \frac{14 \text{ mol H}}{1 \text{ mol } C_{20}H_{14}N_4} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol H}} = 9.31 \times 10^{19} \text{ atoms H} \quad (4)$$

4. At 1.36 atm and 36.56°C, a 4.07 g sample of gas occupies a volume of 2180 mL. Calculate the molar mass of the gas.

$$mm = \frac{gRT}{PV} = \frac{(4.07 \text{ g}) \times (0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) \times (309.71 \text{ K})}{(1.36 \text{ atm}) (2.180 \text{ L})} \quad (2)$$

$$mm_{\text{gas}} = 34.9 \text{ g/mol} \quad (4)$$

5. What is the rms speed of molecular nitrogen at 448 K?

$$M_{N_2} = 28.01348 \frac{\text{g}}{\text{mol}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.028013 \frac{\text{kg}}{\text{mol}} \quad (1)$$

$$v_{\text{rms}, N_2} = \sqrt{\frac{3 \times (8.31451 \frac{\text{J}}{\text{mol} \cdot \text{K}}) \times (448 \text{ K})}{0.028013 \text{ kg/mol}}}$$

$$v_{\text{rms}, N_2} = 631.59 \frac{\text{m}}{\text{s}} \text{ or } 632 \frac{\text{m}}{\text{s}} \quad (3)$$

Exam 1B

6. Strychnine, a deadly poison, has a molecular mass of 334 g/mol and a percentage composition by mass of 75.42% C, 6.63% H, 8.38% N, and the balance is oxygen.
 a. Calculate the empirical formula

assume 100% or 100g:

$$75.42 \text{ g C} \times \frac{1 \text{ mol}}{12.011 \text{ g}} = 6.279244 \text{ mol C} \quad (1.5)$$

$$6.63 \text{ g H} \times \frac{1 \text{ mol}}{1.00794 \text{ g}} = 6.57777 \text{ mol H} \quad (1.5)$$

$$8.38 \text{ g N} \times \frac{1 \text{ mol}}{14.00674 \text{ g}} = 0.598283 \text{ mol N} \quad (1.5)$$

$$9.57 \text{ g O} \times \frac{1 \text{ mol}}{15.9994 \text{ g}} = 0.598147 \text{ mol O} \quad (1.5)$$

$$\begin{array}{cccc} \text{C} & \text{H} & \text{N} & \text{O} \\ \frac{6.279244}{0.598147} & \frac{6.57777}{0.598147} & \frac{0.598283}{0.598147} & \frac{0.598147}{0.598147} \end{array}$$

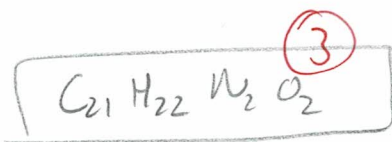
$$\text{C}_{10.49} \text{H}_{10.99} \text{N}_{1.00} \text{O}_{1.00} \times 2 = \boxed{\text{C}_{21} \text{H}_{22} \text{N}_2 \text{O}_2} \quad (3)$$

-1.5

- b. Calculate the molecular formula

$$\text{MM } \text{C}_{21} \text{H}_{22} \text{N}_2 \text{O}_2 = 334 \text{ g/mol}$$

$$\frac{\text{empirical}}{\text{molecular}} = \frac{334 \text{ g/mol}}{334 \text{ g/mol}} = 1$$



Exam 1B

7. A brass alloy contains 81.5% copper, Cu, by mass with the remainder of the alloy being zinc, Zn.

a. Determine the number of moles of zinc in 44.4 g of the brass alloy.

Brass alloy : 81.5% Cu, 18.5% Zn (1)

$$44.4 \text{ g alloy} \times 0.185 = \underline{8.214 \text{ g Zn}} \quad (2)$$

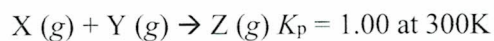
$$8.214 \text{ g Zn} \times \frac{1 \text{ mol Zn}}{65.39 \text{ g}} = 0.1256 \text{ or } \boxed{0.126 \text{ mol Zn}} \quad (3)$$

b. Determine the number of atoms of zinc in 44.4 g of the brass alloy.

$$0.1256 \text{ mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol Zn}} = \boxed{7.56 \times 10^{22} \text{ atoms Zn}} \quad (5)$$

Exam 1B

8. In which direction will the reaction below proceed given the conditions:



a. $[X] = [Y] = [Z] = 0.85 \text{ M}$

$$K_c = \frac{K_p}{RT^{\Delta n}}$$

$$K_c = \frac{1.00}{\left(\frac{0.08206 \text{ L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right) (300)^{-1}}$$

② $K_c = 24.6$

① $Q_c = \frac{[Z]}{[X][Y]} = \frac{[0.85]}{[0.85 \times 0.85]} = 1.176$

$Q_c < K_c$, PRODUCT FAVORED ①
MUST PROVE

b. $P_x = P_z = 0.8 \text{ atm}$, $P_y = 0.75 \text{ atm}$

$$Q_p = \frac{P_z}{P_x P_y} = \frac{0.8}{0.8 \times 0.75} = 1.33 \quad \text{②}$$

$Q_p > K_p$, REACTANT FAVORED ②

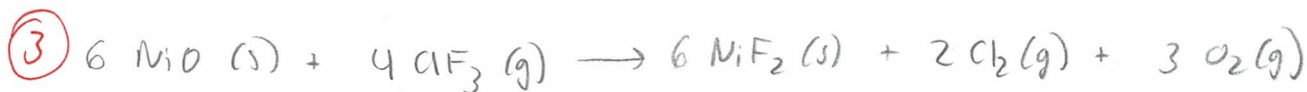
Donna Westwood

Exam 1B

9. Chlorine trifluoride, ClF_3 , is a valuable reagent because it can be used to convert metal oxides to metal fluorides:



a. Balance the chemical reaction above.



b. What mass of NiO will react with ClF_3 gas if the gas has a pressure of 270 mmHg at 24.0°C in a 2.70-L flask?

$$n_{\text{ClF}_3} = \frac{PV}{RT} = \frac{(0.3553 \text{ atm}) \times (2.70 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (297.15 \text{ K})} = 0.039342 \text{ ClF}_3$$

$270 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 0.3553 \text{ atm}$

IF all ClF_3 reacted: $0.039342 \text{ mol ClF}_3 \times \frac{6 \text{ mol NiO}}{4 \text{ mol ClF}_3} = 0.05901 \text{ mol NiO}$

$$0.05901 \text{ mol NiO (s)} \times \frac{74.6928 \text{ g}}{1 \text{ mol}} = 4.4079 \text{ g NiO (s)}$$

4.4 g NiO (s)

Exam 1B

- c. If the ClF_3 described in part (b) is completely consumed, what are the partial pressures of Cl_2 and O_2 in the 2.7-L flask at 24.0°C (in kPa)?

$$n_{\text{ClF}_3} : 0.039342 \text{ mol ClF}_3$$

$$0.039342 \text{ mol ClF}_3 \times \frac{2 \text{ mol Cl}_2}{4 \text{ mol ClF}_3} = 0.019671 \text{ mol Cl}_2$$

$$0.039342 \text{ mol ClF}_3 \times \frac{3 \text{ mol O}_2}{4 \text{ mol ClF}_3} = 0.02951 \text{ mol O}_2$$

$$P_{\text{Cl}_2} = \frac{nRT}{V} = \frac{(0.019671 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (297.15 \text{ K})}{(2.7 \text{ L})} = 18.000 \text{ or } 18 \text{ kPa}$$

$$P_{\text{O}_2} = \frac{nRT}{V} = \frac{(0.02951 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (297.15 \text{ K})}{(2.7 \text{ L})} = 27.00 \text{ or } 27 \text{ kPa}$$

- d. What is the total pressure in the flask following part (c)?

$$P_{\text{Total}} = P_{\text{Cl}_2} + P_{\text{O}_2} = 18 \text{ kPa} + 27 \text{ kPa} = 45 \text{ kPa}$$

- e. Given the partial pressures in part c, calculate the percent yield (by mass) if 0.080 atm of Cl_2 (g) and 0.055 atm of O_2 (g) was generated in the reaction.

THEORETICAL :

$$0.019671 \text{ mol Cl}_2 \times \frac{70.9054 \text{ g}}{1 \text{ mol}} = 1.395 \text{ g Cl}_2$$

$$0.02951 \text{ mol O}_2 \times \frac{31.9988 \text{ g}}{1 \text{ mol}} = 0.9443 \text{ g O}_2$$

ACTUAL :

$$m_{\text{Cl}_2} : \frac{mPV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.080 \text{ atm}) \times (2.7 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (297.15 \text{ K})} = 0.62809 \text{ g}$$

$$m_{\text{O}_2} : \frac{mPV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.055 \text{ atm}) \times (2.7 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (297.15 \text{ K})} = 0.19487 \text{ g}$$

$$\% \text{ yield Cl}_2 = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{0.62809 \text{ g}}{1.395 \text{ g}} \times 100 = 45.0\%$$

$$\% \text{ yield O}_2 = \frac{0.19487 \text{ g}}{0.9443 \text{ g}} \times 100 = 20.6\%$$

CHM1311A – Exam 1C

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No units? (-0.5)

No sig figs? (-0.5)

Exam 1C

Question	Points	Points received
1	6	
2	6	
3	8	
4	6	
5	4	
6	12	
7	10	
8	8	
9	20	
Total	80	

*W/ Bonus Q, exam 1C +20 bonus points
/60*

Exam 1C

1. Given the systemic and common (trivial) names below, determine the chemical formula:

a. Iron (III) oxide



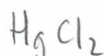
(2)

b. Xenon tetrafluoride



(2)

c. Mercuric chloride



~~Hg₂Cl₂~~



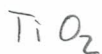
(2)

2. Which of the following chemical formulas are incorrect? Write the correct formula where possible.

a. FeSO₃

b. NH₄H₂PO₄

c. TiO₃



(2)

d. BaBr₃



(2)

e. Na₂Cl



(2)

-1pt IF STUDENTS
CONVERT CORRECT
TO INCORRECT

Exam 1C

3. Given 4.34 mg of porphyrin, $C_{20}H_{14}N_4$:

a. Calculate the number of moles of nitrogen in porphyrin

$$C_{20}H_{14}N_4 : 310.3516 \text{ g}$$

$$\frac{4.34 \text{ mg}}{1000} = 0.00434 \text{ g} \times \frac{1 \text{ mol}}{310.3516 \text{ g}} = 0.000013984 \text{ mol} \quad (2)$$

$$0.000013984 \text{ mol } C_{20}H_{14}N_4 \times \frac{4 \text{ mol N}}{1 \text{ mol } C_{20}H_{14}N_4} = 5.59 \times 10^{-5} \text{ mol N} \quad (2)$$

b. Calculate the number of atoms of hydrogen in porphyrin

$$0.000013984 \text{ mol } C_{20}H_{14}N_4 \times \frac{14 \text{ mol H}}{1 \text{ mol } C_{20}H_{14}N_4} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol H}} = 1.18 \times 10^{20} \text{ atoms H} \quad (4)$$

4. At 1.17 atm and 17.67°C, a 3.35 g sample of a gas occupies a volume of 2104 mL.
Calculate the molar mass of the gas.

$$mm = \frac{gRT}{PV} = \frac{(3.35 \text{ g}) \times (0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (290.82 \text{ K})}{(1.17 \text{ atm}) \times (2.104 \text{ L})} \quad (2)$$

$$mm_{\text{gas}} = 32.5 \text{ g/mol} \quad (4)$$

5. What is the rms speed of molecular chlorine at 448K?

$$M_{Cl_2} : 70.9054 \frac{\text{g}}{\text{mol}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.070905 \frac{\text{kg}}{\text{mol}} \quad (1)$$

$$v_{\text{rms}} = \sqrt{\frac{3 \times (8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}}) \times (448 \text{ K})}{0.070905 \frac{\text{kg}}{\text{mol}}}}$$

$$v_{\text{rms}} = 396.489 \text{ m/s} \approx 397 \frac{\text{m}}{\text{s}} \quad (3)$$

Exam 1C

6. Strychnine, a deadly poison, has a molecular mass of 334 g/mol and a percentage composition by mass of 75.42% C, 6.63% H, 8.38% N, and the balance is oxygen.

a. Calculate the empirical formula

assume 100% or 100g

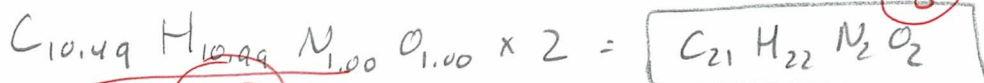
$$75.42 \text{ g C} \times \frac{1 \text{ mol}}{12.011 \text{ g}} = 6.279244 \text{ mol C} \quad (1.5)$$

$$6.63 \text{ g H} \times \frac{1 \text{ mol}}{1.00794 \text{ g}} = 6.57777 \text{ mol H} \quad (1.5)$$

$$8.38 \text{ g N} \times \frac{1 \text{ mol}}{14.00674 \text{ g}} = 0.598283 \text{ mol N} \quad (1.5)$$

$$9.57 \text{ g O} \times \frac{1 \text{ mol}}{15.9994 \text{ g}} = 0.598147 \text{ mol O} \quad (1.5)$$

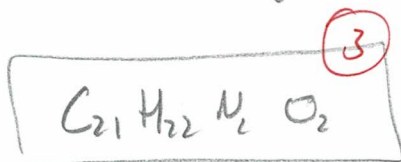
$$\begin{array}{cccc} \text{C} & \text{H} & \text{N} & \text{O} \\ \frac{6.279244}{0.598147} & \frac{6.57777}{0.598147} & \frac{0.598283}{0.598147} & \frac{0.598147}{0.598147} \end{array}$$



b. Calculate the molecular formula



$$\frac{\text{emp.}}{\text{mol}} = \frac{334 \text{ g/mol}}{334 \text{ g/mol}} = 1$$



Exam 1C

7. A brass alloy contains 85.6% copper, Cu, by mass with the remainder of the alloy being zinc, Zn.

a. Determine the number of moles of zinc in 46.5 g of the brass alloy

Brass alloy: 85.6% Cu, 14.4% Zn (1)

$$46.5 \text{ g} \times 0.144 = \underline{6.696 \text{ g Zn}} \text{ (2)}$$

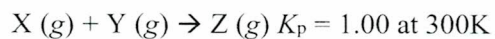
$$6.696 \text{ g Zn} \times \frac{1 \text{ mol}}{65.39 \text{ g}} = 0.102401 \text{ or } \boxed{0.102 \text{ mol Zn}} \text{ (3)}$$

b. Determine the number of atoms of zinc in 46.5 g of the brass alloy

$$0.102401 \text{ mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol Zn}} = \boxed{6.16 \times 10^{22} \text{ atoms Zn}} \text{ (5)}$$

Exam 1C

8. In which direction will the reaction below proceed given the conditions:



a. $[X] = [Y] = [Z] = 1.5 \text{ M}$

$$K_c = \frac{k_p}{RT^{\Delta n}}$$

$$K_c = \frac{(1.00)}{\left(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right) (300)^{-1}}$$

② $K_c = 24.6$

① $Q_c = \frac{[Z]}{[X][Y]} = \frac{(1.5)}{(1.5 \times 1.5)} = 0.66$

$Q_c < K_c$, PRODUCTS FAVORED
 must prove ①

b. $P_x = P_z = 0.75 \text{ atm}$, $P_y = 0.67 \text{ atm}$

$$Q_p = \frac{P_z}{P_x P_y} = \frac{0.75}{(0.75 \times 0.67)} = 1.49 \text{ ②}$$

$Q_p > K_p$, REACTANTS FAVORED ②

Bonus Question!!
Exam 1C

9. Chlorine trifluoride, ClF_3 , is a valuable reagent because it can be used to convert metal oxides to metal fluorides:



a. Balance the chemical reaction above.



b. What mass of NiO will react with ClF_3 gas if the gas has a pressure of 290 mmHg at 29.0°C in a 2.90-L flask?

$$n_{\text{ClF}_3} = \frac{PV}{RT} = \frac{(0.3816 \text{ atm}) \times (2.90 \text{ L})}{\left(\frac{0.08206 \text{ atm} \cdot \text{L}}{\text{mol} \cdot \text{K}}\right) \times (302.15 \text{ K})} = 0.04463 \text{ mol}$$

$290 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 0.3816 \text{ atm}$

assume all ClF_3 : $0.04463 \text{ mol ClF}_3 \times \frac{6 \text{ mol NiO}}{4 \text{ mol ClF}_3} = 0.066945 \text{ mol NiO}$

$$0.066945 \text{ mol NiO} \times \frac{74.6928 \text{ g}}{1 \text{ mol NiO}} = 5.0003 \text{ or } \boxed{5.0 \text{ g NiO}}$$

Exam 1C

- c. If the ClF_3 described in part (b) is completely consumed, what are the partial pressures of Cl_2 and O_2 in the 2.9-L flask at 29.0°C (in kPa)?

$$n_{\text{ClF}_3} = 0.04463 \text{ mol}$$

$$0.04463 \text{ mol ClF}_3 \times \frac{2 \text{ mol Cl}_2}{4 \text{ mol ClF}_3} = 0.022315 \text{ mol Cl}_2$$

$$0.04463 \text{ mol ClF}_3 \times \frac{3 \text{ mol O}_2}{4 \text{ mol ClF}_3} = 0.033472 \text{ mol O}_2$$

$$P_{\text{Cl}_2} = \frac{nRT}{V} = \frac{(0.022315 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (302.15 \text{ K})}{(2.9 \text{ L})} = 19.33 \text{ or } 19 \text{ kPa}$$

$$P_{\text{O}_2} = \frac{nRT}{V} = \frac{(0.033472 \text{ mol}) \times (8.31451 \frac{\text{L}\cdot\text{kPa}}{\text{mol}\cdot\text{K}}) \times (302.15 \text{ K})}{(2.9 \text{ L})} = 28.99 \text{ or } 29 \text{ kPa}$$

- d. What is the total pressure in the flask following part (c)?

$$P_{\text{total}} = P_{\text{O}_2} + P_{\text{Cl}_2} = 29 \text{ kPa} + 19 \text{ kPa} = 48 \text{ kPa}$$

- e. Given the partial pressures in part c, calculate the percent yield (by mass) if 0.098 atm of Cl_2 (g) and 0.065 atm of O_2 (g) was generated in the reaction.

$$\text{THEORETICAL: } 0.022315 \text{ mol Cl}_2 \times \frac{70.9054 \text{ g}}{1 \text{ mol}} = 1.5823 \text{ g Cl}_2$$

$$0.033472 \text{ mol O}_2 \times \frac{31.9988 \text{ g}}{1 \text{ mol}} = 1.07106 \text{ g O}_2$$

$$m_{\text{Cl}_2} = \frac{mPV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.098 \text{ atm}) \times (2.9 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (302.15 \text{ K})} = 0.8127 \text{ g Cl}_2$$

$$m_{\text{O}_2} = \frac{mPV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.065 \text{ atm}) \times (2.9 \text{ L})}{(0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}) \times (302.15 \text{ K})} = 0.2432 \text{ g O}_2$$

$$\% \text{ yield Cl}_2 = \frac{\text{actual}}{\text{theoretical}} = \frac{0.8127 \text{ g}}{1.5823 \text{ g}} \times 100 = 51.4\%$$

$$\% \text{ yield O}_2 = \frac{0.2432 \text{ g}}{1.07106 \text{ g}} \times 100 = 22.7\%$$