Dear students,

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

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

- The numerical grade that you ~~current~~ 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)

3. Given 2.34 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 g/mol

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

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

   b. Calculate the number of atoms of hydrogen in porphyrin

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

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

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

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

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

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

$U_{rms_{O_2}} = 590.95$ or $591 \frac{m}{s}$ (3)

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

assume 100% or 100g:

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

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

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

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

$C_{\frac{6.279244}{0.598147}} H_{\frac{6.57777}{0.598147}} N_{\frac{0.598283}{0.598147}} O_{\frac{0.598147}{0.598147}} = C_{10.49} H_{10.99} N_{1.00} O_{1.00}$

-1.5 pts

∴ must ×2: $C_{21}H_{22}N_2O_2$ (3)

   b. Calculate the molecular formula

$C_{21}H_{22}N_2O_2 = 334\ \frac{g}{mol}$

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

(3)

$C_{21}H_{22}N_2O_2$

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 g alloy x 0.253 = 11.0308 g Zn (2)

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

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

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

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

$$X\ (g) + Y\ (g) \rightarrow Z\ (g)\quad K_P = 1.00 \text{ at } 300K$$

a. [X] = [Y] = [Z] = 1.0 M

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

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

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

(2) $K_c = 24.6$

$Q_c < K_c$, PRODUCTS ARE FAVORED (1)

MUST PROVE!

b. $P_x = P_z = 1.0$ atm, $P_y = 0.50$ atm

$Q_P = \frac{P_Z}{P_X P_Y} = \frac{(1.0)}{(1.0)(0.50)} = 2$ (2)

$Q_P > K_P$, REACTANTS ARE FAVORED (2)

Bonus Question :)

Exam 1A

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

$$NiO\ (s) + ClF_3\ (g) \rightarrow NiF_2\ (s) + Cl_2\ (g) + O_2\ (g)$$

a. Balance the chemical reaction above.

(3) $6\ NiO\ (s) + 4\ ClF_3\ (g) \longrightarrow 6\ NiF_2\ (s) + 2\ Cl_2\ (g) + 3\ O_2\ (g)$

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?

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

$n_{ClF_3} = \frac{PV}{RT} = \frac{(0.3289\ atm)(2.50\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K}) \times (293.15\ K)}$

$n_{ClF_3} = 0.0342\ mol$ (2)

If all ClF_3 reacts: $0.0342\ mol\ ClF_3 \times \frac{6\ mol\ NiO}{4\ mol\ ClF_3} = 0.0513\ mol\ NiO$ (2)

↳ $0.0513\ mol\ NiO \times \frac{74.6928\ g}{1\ mol} = 3.8317\ g$ or $3.8\ g\ NiO\ (s)$ (2)

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 20.0oC (in kPa)?

$n_{ClF_3} = 0.0342$ mol

$0.0342 \text{ mol } ClF_3 \times \frac{2 \text{ mol } Cl_2}{4 \text{ mol } ClF_3} = 0.0171 \text{ mol } Cl_2$ (1)

$0.0342 \text{ mol } ClF_3 \times \frac{3 \text{ mol } O_2}{4 \text{ mol } ClF_3} = 0.02565 \text{ mol } O_2$ (1)

$P_{Cl_2} = \frac{nRT}{V} = \frac{(0.0171 \text{ mol}) \times \left(8.31451 \frac{L \cdot kPa}{mol \cdot K}\right) \times (293.15 K)}{(2.5 L)} = 16.67 \text{ kPa}$ or $\boxed{17 \text{ kPa}}$ (1)

$P_{O_2} = \frac{nRT}{V} = \frac{(0.02565 \text{ mol}) \times \left(8.31451 \frac{L \cdot kPa}{mol \cdot K}\right) \times (293.15 K)}{(2.5 L)} = 25.01 \text{ kPa}$ or $\boxed{25 \text{ kPa}}$ (1)

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

$P_{Total} = P_{O_2} + P_{Cl_2} = 17 \text{ kPa} + 25 \text{ kPa} = \boxed{42 \text{ kPa}}$ (2)

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:

$m_{Cl_2} = 0.0171 \text{ mol } Cl_2 \times \frac{70.9054 g}{1 \text{ mol}} = 1.212 g \; Cl_2$ (1)

$m_{O_2} = 0.02565 \; O_2 \times \frac{31.9988 g}{1 \text{ mol}} = 0.8207 g \; O_2$ (1)

$m_{Cl_2}(\text{actual}) = \frac{mm\,PV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.090 \text{ atm}) \times (2.5 L)}{\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right) \times (293.15 K)} = 0.6632 g$ (1)

$m_{O_2}(\text{actual}) = \frac{mm\,PV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.060 \text{ atm}) \times (2.5 L)}{\left(0.08206 \frac{L \cdot atm}{mol \cdot K}\right) \times (293.15 K)} = 0.1995 g$ (1)

$\% \text{ yield } Cl_2 = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{0.6632 g}{1.212 g} \times 100 = \boxed{54.7\%}$ (0.5)

$\% \text{ yield } O_2 = \frac{0.1995 g}{0.8207 g} \times 100 = \boxed{24.3\%}$ (0.5)

CHM1311A – Exam 1B

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 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

   $CuHSO_4$ (2)

   b. Boron trichloride

   BCl_3 (2)

   c. Nickel (II) cyanide

   $Ni(CN)_2$ (2)

2. Which of the following chemical formulas are incorrect (circle those that are incorrect)? Write the correct formula where possible.
   a. MgO_4K

   K_2MnO_4 (1.5)

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

   b. CaF

   CaF_2 (1.5)

   c. NaO_2

   Na_2O (1.5)

   d. $CaCrO_4$

   e. $Ca_2Cr_2O_7$

   $CaCr_2O_7$ (1.5)

3. Given 3.43 mg of porphyrin, $C_{20}H_{14}N_4$:
   a. Calculate the number of moles of nitrogen in porphyrin

$C_{20}H_{14}N_4 = 310.3516$ g/mol

$\frac{3.43 \text{ mg}}{1000} = 0.00343 \text{ g} \times \frac{1 \text{ mol}}{310.3516 \text{ g}} = 0.000011051 \text{ mol}$ (2)

$0.000011051 \text{ g } C_{20}H_{14}N_4 \times \frac{4 \text{ mol N}}{1 \text{ mol } C_{20}H_{14}N_4} = \boxed{4.42\times10^{-5} \text{ mol N}}$ (2)

   b. Calculate the number of atoms of hydrogen in porphyrin

$0.000011051 \text{ mol } C_{20}H_{14}N_4 \times \frac{14 \text{ mol H}}{1 \text{ mol } C_{20}H_{14}N_4} \times \frac{6.02\times10^{23} \text{ atoms}}{1 \text{ mol H}} = \boxed{9.31\times10^{19} \text{ atoms H}}$ (4)

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

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

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

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

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

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

$U_{rms_{N_2}} = 631.59 \frac{m}{s}$ or $\boxed{632 \frac{m}{s}}$ (3)

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

assume 100% or 100g:

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

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

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

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

$C_{\frac{6.279244}{0.598147}} H_{\frac{6.57777}{0.598147}} N_{\frac{0.598283}{0.598147}} O_{\frac{0.598147}{0.598147}}$

$C_{10.49} H_{10.99} N_{1.00} O_{1.00} \times 2 = C_{21}H_{22}N_2O_2$ (3)

(-1.5)

   b. Calculate the molecular formula

mm $C_{21}H_{22}N_2O_2$ = 334 g/mol

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

$C_{21}H_{22}N_2O_2$ (3)

7. A brass alloy contains 81.5% copper, Cu, by mass with the remainder of the allow 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 g alloy × 0.185 = 8.214 g Zn (2)

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

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

$$0.1256\ mol\ Zn \times \frac{6.02\times10^{23}\ atoms}{1\ mol\ Zn} = \boxed{7.56\times10^{22}\ atoms\ Zn}$$ (5)

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

$$X(g) + Y(g) \rightarrow Z(g) \quad K_p = 1.00 \text{ at } 300K$$

a. $[X] = [Y] = [Z] = 0.85$ M

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

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

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

(2) $K_c = 24.6$

$Q_c < K_c$, PRODUCT FAVORED (1)

MUST PROVE

b. $P_x = P_z = 0.8$ atm, $P_y = 0.75$ atm

$Q_p = \frac{P_z}{P_x P_y} = \frac{0.8}{0.8 \times 0.75} = 1.33$ (2)

$Q_p > K_p$, REACTANT FAVORED (2)

Donya Curestro ☺

Exam 1B

(7)

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

$$NiO\ (s) + ClF_3\ (g) \rightarrow NiF_2\ (s) + Cl_2\ (g) + O_2\ (g)$$

a. Balance the chemical reaction above.

(3) $6\ NiO\ (s) + 4\ ClF_3\ (g) \longrightarrow 6\ NiF_2\ (s) + 2\ Cl_2\ (g) + 3\ O_2\ (g)$

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

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

$$n_{ClF_3} = \frac{PV}{RT} = \frac{(0.3553\ atm) \times (2.70\ L)}{\left(0.08206\ \frac{L \cdot atm}{mol \cdot K}\right) \times (297.15\ K)} = 0.039342\ ClF_3$$ (2)

if all ClF_3 reacted:

$$0.039342\ mol\ ClF_3 \times \frac{6\ mol\ NiO}{4\ mol\ ClF_3} = 0.05901\ mol\ NiO$$ (2)

$$0.05901\ mol\ NiO\ (s) \times \frac{74.6928\ g}{1\ mol} = 4.4079 \text{ or } \boxed{4.4\ g\ NiO\ (s)}$$ (2)

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_{ClF_3} : 0.039342 mol ClF_3

$0.039342 \text{ mol } ClF_3 \times \frac{2 \text{ mol } Cl_2}{4 \text{ mol } ClF_3} = 0.019671 \text{ mol } Cl_2$ (1)

$0.039342 \text{ mol } ClF_3 \times \frac{3 \text{ mol } O_2}{4 \text{ mol } ClF_3} = 0.02951 \text{ mol } O_2$ (1)

$P_{Cl_2} = \frac{nRT}{V} = \frac{(0.019671 \text{ mol}) \times (8.31451 \frac{L \cdot kPa}{mol \cdot K}) \times (297.15 K)}{(2.7 L)} = 18.000$ or **18 kPa** (1)

$P_{O_2} = \frac{nRT}{V} = \frac{(0.02951 \text{ mol}) \times (8.31451 \frac{L \cdot kPa}{mol \cdot K}) \times (297.15 K)}{(2.7 L)} = 27.00$ or **27 kPa** (1)

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

$P_{Total} = P_{Cl_2} + P_{O_2} = 18 \text{ kPa} + 27 \text{ kPa} = $ **45 kPa** (2)

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:

$0.019671 \text{ mol } Cl_2 \times \frac{70.9054 g}{1 \text{ mol}} = 1.395 g \; Cl_2$ (1)

$0.02951 \text{ mol } O_2 \times \frac{31.9988 g}{1 \text{ mol}} = 0.9443 g \; O_2$ (1)

ACTUAL:

$m_{Cl_2} = \frac{MmPV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.080 \text{ atm}) \times (2.7 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K}) \times (297.15 K)} = 0.62809 g$ (1)

$m_{O_2} = \frac{MmPV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.055 \text{ atm}) \times (2.7 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K}) \times (297.15 K)} = 0.19487 g$ (1)

$\% \text{ yield}_{Cl_2} = \frac{\text{actual}}{\text{theoretical}} = \frac{0.62809 g}{1.395 g} \times 100 = $ **45.0 %** (0.5)

$\% \text{ yield}_{O_2} = \frac{0.19487 g}{0.9443 g} \times 100 = $ **20.6 %** (0.5)

CHM1311A – Exam 1C

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 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 is +20 bonus points /60

Exam 1C

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

   Fe_2O_3

   (2)

   b. Xenon tetrafluoride

   XeF_4 (2)

   c. Mercuric chloride

   $HgCl_2$ (2)

2. Which of the following chemical formulas are incorrect? Write the correct formula where possible.
   a. $FeSO_3$

   (−1pt) IF STUDENTS CONVERT CORRECT TO INCORRECT

   b. $NH_4H_2PO_4$

   c. TiO_3 TiO_2 (2)

   d. $BaBr_3$ $BaBr_2$ (2)

   e. Na_2Cl

   $NaCl$ (2)

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 g

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

$0.000013984\ mol\ C_{20}H_{14}N_4 \times \frac{4\ mol\ N}{1\ mol\ C_{20}H_{14}N_4} = \boxed{5.59\times10^{-5}\ mol\ N}$ (2)

   b. Calculate the number of atoms of hydrogen in porphyrin

$0.000013984\ mol\ C_{20}H_{14}N_4 \times \frac{14\ mol\ H}{1\ mol\ C_{20}H_{14}N_4} \times \frac{6.02\times10^{23}\ atoms}{1\ mol\ H} = \boxed{1.18\times10^{20}\ atoms\ H}$ (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.

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

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

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

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

$U_{rms} = \sqrt{\frac{3 \times (8.31451\ \frac{J}{mol\cdot K}) \times (448K)}{0.070905\ \frac{kg}{mol}}}$

$U_{rms} = 396.989 \approx \boxed{397\ \frac{m}{s}}$ (3)

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

assume 100% or 100g

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

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

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

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

$C_{\frac{6.279244}{0.598147}} H_{\frac{6.57777}{0.598147}} N_{\frac{0.598283}{0.598147}} O_{\frac{0.598147}{0.598147}}$

$C_{10.49} H_{10.99} N_{1.00} O_{1.00} \times 2 = C_{21} H_{22} N_2 O_2$ (8)

(−1.5)

   b. Calculate the molecular formula

$C_{21} H_{22} N_2 O_2$: 334 g/mol

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

(3)

$C_{21} H_{22} N_2 O_2$

7. A brass alloy contains 85.6% copper, Cu, by mass with the remainder of the allowing 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 g × 0.144 = 6.696 g Zn (2)

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

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

(5)

$0.102401\text{ mol Zn} \times \frac{6.02\times10^{23}\text{ atoms}}{1\text{ mol Zn}} =$ **6.16×10^{22} atoms Zn**

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

$$X\ (g) + Y\ (g) \rightarrow Z\ (g)\quad K_p = 1.00 \text{ at } 300K$$

a. [X] = [Y] = [Z] = 1.5 M

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

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

(2) $K_c = 24.6$

(1) $Q_c = \frac{[Z]}{[X][Y]} = \frac{(1.5)}{(1.5 \times 1.5)} = 0.6\overline{6}$

$Q_c < K_c$, PRODUCTS FAVORED (1)

MUST PROVE

b. $P_x = P_z = 0.75$ atm, $P_y = 0.67$ atm

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

$$NiO\ (s) + ClF_3\ (g) \rightarrow NiF_2\ (s) + Cl_2\ (g) + O_2\ (g)$$

a. Balance the chemical reaction above.

(3) $6\ NiO\ (s) + 4\ ClF_3\ (g) \longrightarrow 6\ NiF_2\ (s) + 2\ Cl_2\ (g) + 3\ O_2\ (g)$

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

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

$n_{ClF_3} = \frac{PV}{RT} = \frac{(0.3816\ atm) \times (2.90\ L)}{\left(0.08206\ \frac{L \cdot atm}{mol\ K}\right) \times (302.15\ K)} = 0.04463\ mol$ (2)

assume all ClF_3: $0.04463\ mol\ ClF_3 \times \frac{6\ mol\ NiO}{4\ mol\ ClF_3} = 0.066945\ mol\ NiO$ (2)

$0.066945\ mol\ NiO \times \frac{74.6928\ g}{1\ mol\ NiO} = 5.0003$ or $\boxed{5.0\ g\ NiO}$ (2)

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)?

$n_{ClF_3} = 0.04463$ mol

$0.04463 \text{ mol } ClF_3 \times \frac{2 \text{ mol } Cl_2}{4 \text{ mol } ClF_3} = 0.022315 \text{ mol } Cl_2$ (1)

$0.04463 \text{ mol } ClF_3 \times \frac{3 \text{ mol } O_2}{4 \text{ mol } ClF_3} = 0.033472 \text{ mol } O_2$ (1)

$P_{Cl_2} = \frac{nRT}{V} = \frac{(0.022315 \text{ mol}) \times (8.31451 \frac{L \cdot kPa}{mol \cdot K}) \times (302.15 K)}{(2.9 L)} = 19.33$ or $\boxed{19 \text{ kPa}}$ (1)

$P_{O_2} = \frac{nRT}{V} = \frac{(0.033472 \text{ mol}) \times (8.31451 \frac{L \cdot kPa}{mol \cdot K}) \times (302.15 K)}{(2.9 L)} = 28.99$ or $\boxed{29 \text{ kPa}}$ (1)

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

$P_{Total} = P_{O_2} + P_{Cl_2} = 29 \text{ kPa} + 19 \text{ kPa} = \boxed{48 \text{ kPa}}$ (2)

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.

THEORETICAL:

$0.022315 \text{ mol } Cl_2 \times \frac{70.9054 g}{1 \text{ mol}} = 1.5823 \text{ g } Cl_2$ (1)

$0.033472 \text{ mol } O_2 \times \frac{31.9988 g}{1 \text{ mol}} = 1.07106 \text{ g } O_2$ (1)

$m_{Cl_2} = \frac{mmPV}{RT} = \frac{(70.9054 \text{ g/mol}) \times (0.098 \text{ atm}) \times (2.9 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K}) \times (302.15 K)} = 0.8127 \text{ g } Cl_2$ (1)

$m_{O_2} = \frac{mmPV}{RT} = \frac{(31.9988 \text{ g/mol}) \times (0.065 \text{ atm}) \times (2.9 L)}{(0.08206 \frac{L \cdot atm}{mol \cdot K}) \times (302.15 K)} = 0.2432 \text{ g } O_2$ (1)

$\% \text{ yield}_{Cl_2} = \frac{\text{actual}}{\text{theoretical}} = \frac{0.8127 g}{1.5823 g} \times 100 = \boxed{51.4\%}$ (0.5)

$\% \text{ yield}_{O_2} = \frac{0.2432 g}{1.07069} \times 100 = \boxed{22.7\%}$ (0.5)