

Fall 2024 CHM 2045 Exam 1 Review

The material covered is from chapters 1-5

1. The two most abundant isotopes of chlorine are ^{35}Cl (34.99 amu) and ^{37}Cl (36.99 amu). What are their percent abundances? (Hint: Use value from periodic table)

- a) ^{35}Cl is 37%; ^{37}Cl is 63%
- b) ^{35}Cl is 23%; ^{37}Cl is 77%
- c) ^{35}Cl is 77%; ^{37}Cl is 23%
- d) ^{35}Cl is 63%; ^{37}Cl is 37%
- e) ^{35}Cl is 50%; ^{37}Cl is 50%

$$\begin{aligned}
 & \%^{35}\text{Cl} \rightarrow x \\
 & \%^{37}\text{Cl} \rightarrow y \\
 & 1 = x + y \\
 & 35.45 = 34.99x + 36.99(1-x) \\
 & 35.45 = 34.99x + 36.99 - 36.99x \\
 & 35.45 - 36.99 = -2x \\
 & -1.54 = -2x \\
 & x = 0.77 \rightarrow 77\%
 \end{aligned}$$

2. Given the name of the compound, write its molecular formula.

- a) Vanadium(V) nitride: $\text{V}^{+5} \text{N}^{3-} = \text{V}_3\text{N}_5$
- b) Iron(II) nitrate: $\text{Fe}^{+2} \text{NO}_3^- = \text{Fe}(\text{NO}_3)_2$
- c) Tin(IV) fluoride: $\text{Sn}^{+4} \text{F}^- = \text{SnF}_4$
- d) Copper(II) phosphate: $\text{Cu}^{+2} \text{PO}_4^{3-} = \text{Cu}_3(\text{PO}_4)_2$
- e) Ammonium dichromate: $\text{NH}_4^+ \text{Cr}_2\text{O}_7^{2-} = (\text{NH}_4)_2\text{Cr}_2\text{O}_7$

$$\begin{aligned}
 & x = 0.77 \rightarrow 77\% \\
 & \downarrow \times 100 \\
 & \rightarrow 77\% \\
 & 1 = x + y \\
 & 1 - 0.77 = y \\
 & 0.23 = y \\
 & \times 100 = 23\%
 \end{aligned}$$

3. What are the moles of each ion and the number of each atom in 78.5 g of aluminum sulfate?

- I. 0.241 mol Al^{3+}
- II. 0.459 mol Al^{3+}
- III. 0.987 mol SO_4^{2-}
- IV. 0.688 mol SO_4^{2-}
- V. 2.76×10^{23} atoms Al
- VI. 5.47×10^{24} atoms Al
- VII. 4.14×10^{23} atoms S
- VIII. 6.35×10^{25} atoms S
- IX. 1.66×10^{24} atoms O
- X. 9.32×10^{23} atoms O

- a) II, IV, V, VII, IX
- b) I, III, VI, VIII, X
- c) I, II, IV, VI, VIII, X
- d) II, III, V, VII, IX
- e) None of the above

$$\begin{aligned}
 & 78.5 \text{ g } \text{Al}_2(\text{SO}_4)_3 \cdot \frac{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3}{342.15 \text{ g } \text{Al}_2(\text{SO}_4)_3} = 0.2294 \text{ mol } \text{Al}_2(\text{SO}_4)_3 \\
 & 0.2294 \text{ mol } \text{Al}_2(\text{SO}_4)_3 \cdot \frac{2 \text{ mol Al}}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3} = 0.459 \text{ mol } \text{Al}^{3+} \\
 & 0.459 \text{ mol } \text{Al}^{3+} \cdot 6.022 \times 10^{23} \text{ atoms/mol} = 2.76 \times 10^{23} \text{ atoms Al} \\
 & 0.2294 \text{ mol } \text{Al}_2(\text{SO}_4)_3 \cdot \frac{3 \text{ mol } \text{SO}_4}{1 \text{ mol } \text{Al}_2(\text{SO}_4)_3} = 0.688 \text{ mol } \text{SO}_4^{2-} \\
 & 0.688 \text{ mol } \text{SO}_4^{2-} \cdot 6.022 \times 10^{23} \text{ atoms/mol} = 4.14 \times 10^{23} \text{ atoms S} \\
 & 0.688 \text{ mol } \text{SO}_4^{2-} \cdot \frac{4 \text{ mol O}}{1 \text{ mol } \text{SO}_4} \cdot 6.022 \times 10^{23} \text{ atoms/mol} = 1.66 \times 10^{24} \text{ atoms O}
 \end{aligned}$$

4. You have a concentrated stock solution of HCl. The concentration is 8.2 M and there is 1.5 L of stock solution. 752 mL of stock solution are taken and diluted to 1.2 L in a volumetric flask. 65 mL of this new solution are taken and diluted to 125 mL in another volumetric flask. What is the final concentration?

- a) 2.7 M
- b) 6.2 M
- c) 8.2 M
- d) 3.4 M
- e) 4.5 M

$M = \frac{\text{mol}}{\text{L}}$

$M_1 V_1 = M_2 V_2$

8.2 M (.752 L) = 1.2 L (x) (1st dilution)

x = 5.139 M

$M_3 V_3 = M_4 V_4$

* $M_3 = M_2 = x = 5.139 \text{ M}$

(5.139 M) (.065 L) = (.125 L) \cdot y

y = 2.7 M

* Temperature always has to be in Kelvin
 P, for gas laws T

5. In an experiment, 25.0 mL of a gas with a pressure of 1.00 atm is contained in a balloon at 25.00°C. The balloon's temperature is adjusted until the pressure is 0.75 atm at a volume of 31.1 mL. What is the final temperature of the gas under the new conditions?

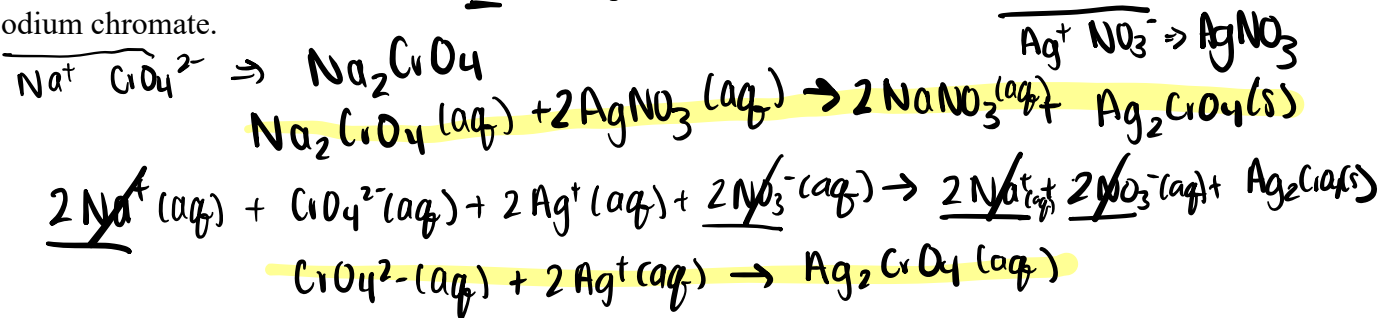
a) 278°C
 b) 5°C
 c) 23°C
 d) 273°C

$$x \cdot \frac{(25 \text{ mL})(1 \text{ atm})}{298.15 \text{ K}} = \frac{(0.75 \text{ atm})(31.1 \text{ mL})}{x} \cdot x \cdot \frac{298.15 \text{ K}}{25 \text{ mL} \cdot 1 \text{ atm}}$$

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

$$x = 278 \text{ K} \rightarrow 278 \text{ K} - 273.15 = 5^\circ\text{C}$$

6. Write the balanced molecular and net ionic equations for the combination of silver nitrate and sodium chromate.



7. Given 2.68 M of strontium phosphate, what are the mols of phosphate ion in 689 mL?

a) 9.81 mol
 b) 3.69 mol
 c) 7.78 mol
 d) 2.43 mol
 e) 6.75 mol

$$\text{Sr}^{2+} \text{PO}_4^{3-} \rightarrow \text{Sr}_3(\text{PO}_4)_2$$

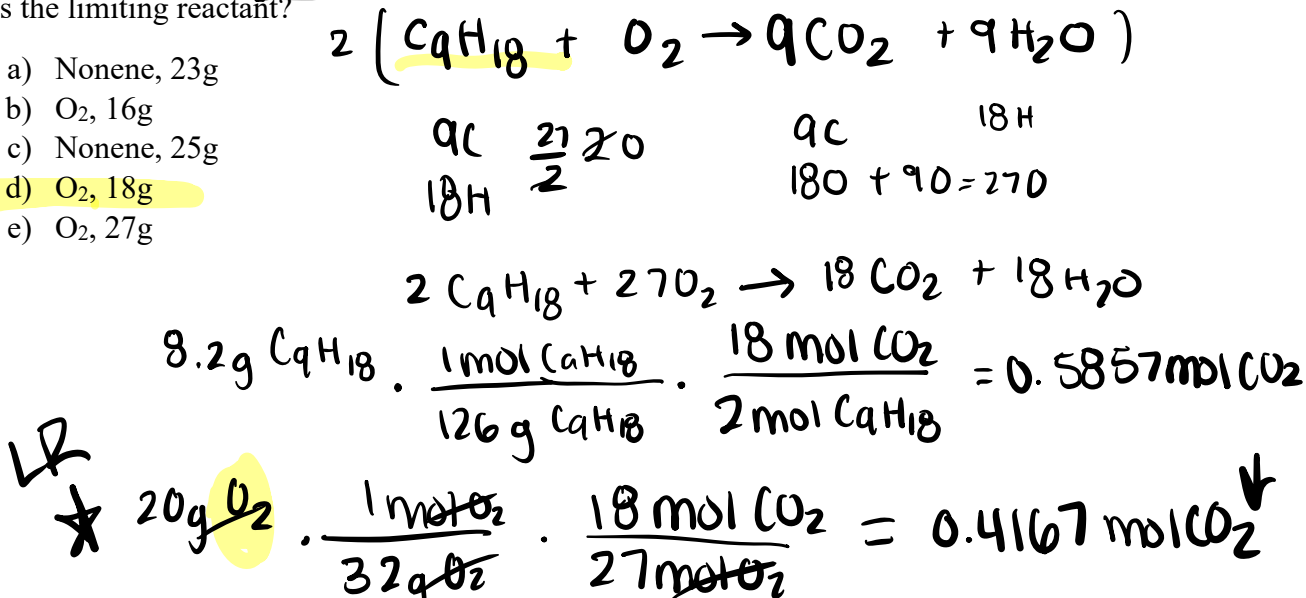
$$\frac{2.68 \text{ mol Sr}_3(\text{PO}_4)_2}{14} \cdot 689 \text{ mL} \cdot \frac{2 \text{ mol PO}_4^{3-}}{1 \text{ mol Sr}_3(\text{PO}_4)_2} = 3.69 \text{ mol PO}_4^{3-}$$

8. Gypsum is a common hydrate salt. It has the general formula $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$. If the molar mass of gypsum is 172.17 g/mol, what is x?

a) 1
 b) 2
 c) 3
 d) 4
 e) 5

$$\begin{array}{r} \text{Ca} \rightarrow 40.08 \\ \text{S} \rightarrow 32.07 \\ \text{O} \rightarrow (16) 4 = 64 \end{array} \quad \begin{array}{r} 40.08 \\ 32.07 \\ 64 \\ \hline 136.15 \text{ g/mol} \end{array} \quad \begin{array}{l} 172.17 - 136.15 = 36.02 \text{ g/mol} \\ \text{H}_2\text{O} \rightarrow \sim 18 \\ \frac{36.02}{18.02} = \sim 2 \end{array}$$

9. What is the mass of CO_2 if 8.2g of nonene (C_9H_{18}) and 20g of O_2 are combusted? And which is the limiting reactant?



$$.416 \text{ mol CO}_2 \cdot \frac{44 \text{ g CO}_2}{1 \text{ mol CO}_2} = 18.3 \text{ g CO}_2 \text{ produced}$$

10. Consider 2.00 moles of Argon, an ideal gas, at a density of 5.00 g/L and a pressure of 2.00 atm. What is the closest value to the temperature (in K) of this gas?

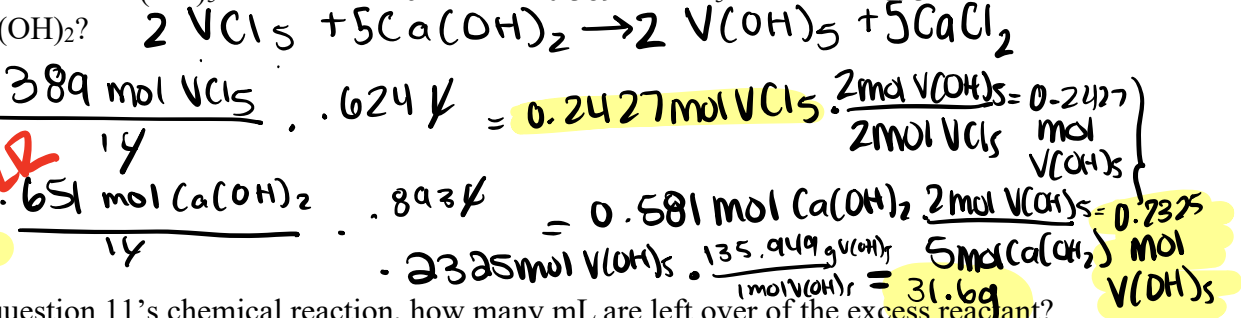
- a. 172 K
- b. 273 K
- c. 304 K
- d. 195 K

$$d = \frac{MP}{RT} \Rightarrow \frac{5.00 \text{ g/L}}{5 \text{ g/L}} = \frac{(39.95 \text{ g/mol})(2 \text{ atm})}{(0.08206 \frac{\text{L atm}}{\text{K mol}}) \cdot T}$$

$$T = 195 \text{ K}$$

11. What is the mass of V(OH)₅ formed when 624 mL of 0.389 M VCl₅ reacts with 893 mL of 0.651 M of Ca(OH)₂?

- a. 30.6g
- b. 98.2g
- c. 33.0g
- d. 74.6g
- e. 31.6g



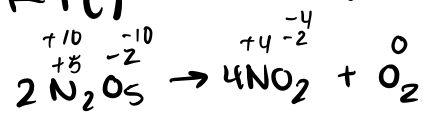
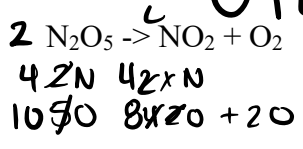
12. Using the question 11's chemical reaction, how many mL are left over of the excess reactant?

- a. 30mL
- b. 90mL
- c. 512mL
- d. 26mL
- e. 410mL

$$0.2427 \text{ mol VCl}_5 - 0.2325 \text{ mol VCl}_5 = 0.0102 \text{ mol VCl}_5$$

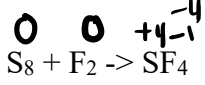
$$0.0102 \text{ mol VCl}_5 \cdot \frac{1 \text{ L}}{389 \text{ mol}} = 0.0262 \text{ L} = 26.2 \text{ mL}$$

13. Balance and identify the type of reaction, oxidizing agent, and reducing agent of each equation:



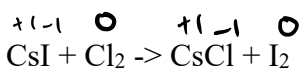
N: +5 → +4 reduced
O: -2 → 0 oxidized

N₂O₅ is RA & OA
Decomposition



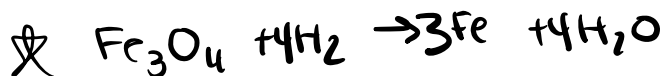
S: 0 → +4 oxidized
F: 0 → -1 reduced

S₈ = RA
F₂ = OA
Combination



I: -1 → 0 oxidized
Cl: 0 → -1 reduced

CsI = RA
Cl₂ = OA
Single displacement



14. Given the reaction $\text{Fe}_3\text{O}_4 + \text{H}_2 \rightarrow \text{Fe} + \text{H}_2\text{O}$, if 0.250g H₂ makes 1.49 g of H₂O, what is the percent yield?

- a. 52.3%
- b. 66.7%
- c. 95.2%
- d. 12.4%
- e. 75.3%

Actual yield

$$\% \text{ yield} = \frac{\text{theoretical}}{\text{actual}}$$

$$0.250 \text{ g H}_2 \cdot \frac{1 \text{ mol H}_2}{2.0 \text{ g H}_2} \cdot \frac{4 \text{ mol H}_2\text{O}}{4 \text{ mol H}_2} \cdot \frac{18.0 \text{ g}}{1 \text{ mol H}_2\text{O}}$$

$$= 2.25 \text{ g H}_2\text{O} = \frac{1.49 \text{ g}}{2.25 \text{ g}} \times 100\% = 66.7\%$$

15. Given 7.13×10^{19} Ca atoms, what is the mass of calcium in grams?

- a. 5.23×10^{-3}
- b. 6.35×10^{-3}
- c. 4.74×10^{-3}
- d. 9.24×10^{-3}
- e. 4.93×10^{-3}

$$7.13 \times 10^{19} \text{ Ca atoms} \cdot \frac{1 \text{ mol Ca}}{6.022 \times 10^{23} \text{ atoms}} \cdot \frac{40.08 \text{ g}}{1 \text{ mol}}$$

$$= 0.004745 \text{ g Ca} = 4.74 \times 10^{-3}$$

16. Given 1 mol, what is the mass percent of each element in C₆H₁₂O₆?

- I. 60% C
- II. 40% C

- III. 6.7% H
- IV. 8.4% H

- V. 31.6% O
- VI. 53.3% O

- a. I, IV, VI
- b. II, IV, VI
- c. I, IV, V
- d. II, III, VI
- e. II, IV, V

180.096

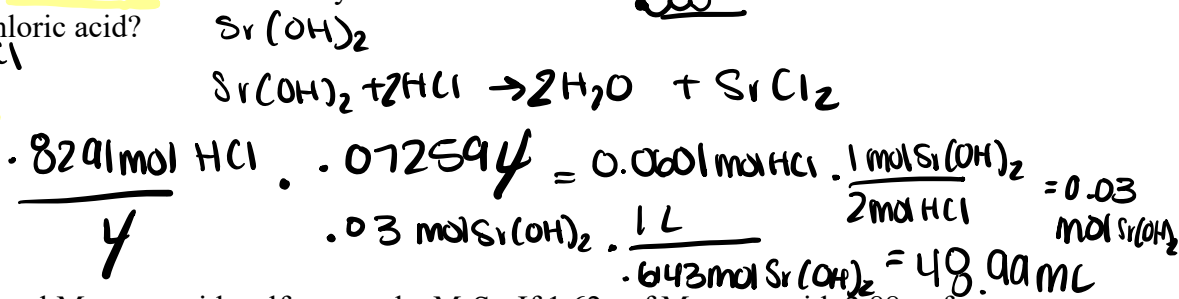
$$\text{C: } \frac{6 \times 12}{180.096} \times 100\% = 39.97\% \approx 40\%$$

$$\text{H: } \frac{12 \times 1.008}{180.096} = 6.7\%$$

$$\text{O: } \frac{6(16)}{180.096} = 53.3\%$$

17. What volume of 0.6143 M of strontium hydroxide would neutralize 72.59 mL of a 0.8291 M solution of hydrochloric acid?

- a. 62.43 mL
- b. 48.99 mL
- c. 75.12 mL
- d. 36.25 mL
- e. 95.13 mL



18. An unknown metal M reacts with sulfur to make M₂S₃. If 1.62g of M reacts with 2.88g of sulfur, what is M and the name of M₂S₃?

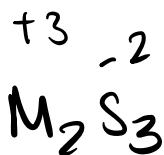
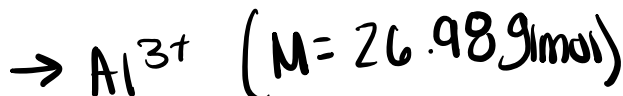
- a. V; vanadium (iii) sulfide
- b. Fe; iron (iii) sulfide
- c. Au; gold (iii) sulfide
- d. Al; aluminum sulfide
- e. Cr; chromium (iii) sulfide



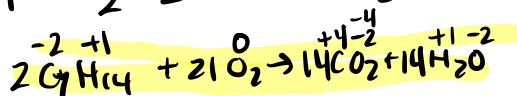
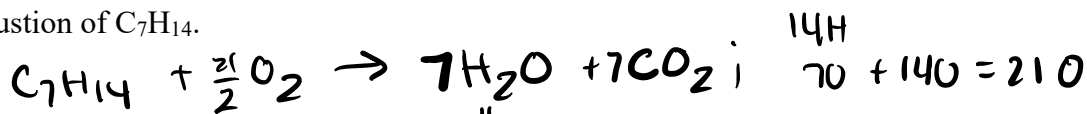
$$1.62 \text{ g M}$$

$$2.88 \text{ g S} \cdot \frac{1 \text{ mol S}}{32.06 \text{ g S}} \cdot \frac{2 \text{ mol M}}{3 \text{ mol S}} = 0.0599 \text{ mol M}$$

$$\frac{1.62 \text{ g}}{0.0599 \text{ mol}} = 27.05$$



19. Balance the equation and identify the oxidation numbers, oxidizing agent, and reducing agent for the combustion of C_7H_{14} .



C: $-2 \rightarrow +4$ oxidized C_7H_{14} = reducing agent

O: $0 \rightarrow -2$ reduced O_2 = oxidizing agent

20. What is the empirical formula of a compound that is 40% C, 6.71% H, and 53.3% O? What is the molecular formula given that the molar mass is 240.24 g/mol?

a. CH_2O ; $C_9H_{18}O_9$

b. C_2HO ; $C_{16}H_8O_8$

c. CH_2O ; $C_8H_{16}O_8$

d. CHO_2 ; $C_9H_9O_{18}$

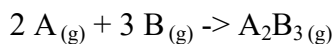
e. CH_2O ; $C_6H_{12}O_6$

$$40g C \cdot \frac{1 \text{ mol C}}{12g} = \frac{3.33 \text{ mol C}}{3.33} \rightarrow 1 \text{ empirical: } CH_2O$$

$$6.71g H \cdot \frac{1 \text{ mol H}}{1.008g} = \frac{6.6567 \text{ mol H}}{3.33} \rightarrow 2 \quad 12g + 2.016g + 16 = 30.16g/mol$$

$$53.3g O \cdot \frac{1 \text{ mol O}}{16g O} = \frac{3.33 \text{ mol O}}{3.33} \rightarrow 1$$

21. Consider the following reaction in a closed reaction flask:



$$\frac{240.24 \text{ g/mol}}{30.16 \text{ g/mol}} = 28$$

If 1.20 atm of gas A is allowed to react with 1.20 atm of gas B, and the reaction goes to completion at constant temperature and volume, what is the total pressure (in atm) in the reaction flask at the end of the reaction?

a. 0.4 atm

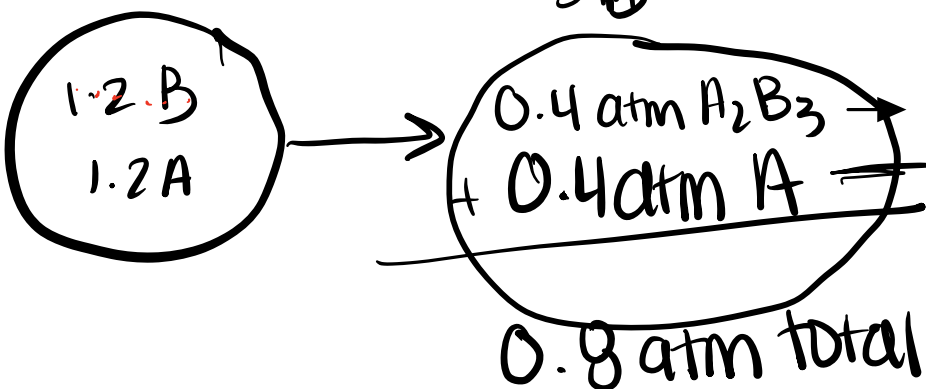
b. 0.8 atm

c. 1.2 atm

d. 2.4 atm

$$1.2 \text{ atm A} \cdot \frac{1 \text{ mol } A_2B_3}{2 \text{ mol A}} = 0.6 \text{ atm } A_2B_3$$

$$1.2 \text{ atm B} \cdot \frac{1 \text{ mol } A_2B_3}{3 \text{ mol B}} = 0.4 \text{ atm } A_2B_3 \cdot \frac{2A}{1A_2B_3}$$



$$= 0.8 \text{ atm A}$$

↑
used

$$1.2 \text{ atm A} - 0.8 \text{ atm A} = 0.4$$

initial used left over

