

# 1A Final Review - Part 1

①

1. a. stronger IMFs, & higher mp  $C_{20}H_{42}$  (stronger London forces)
- b. LiF F<sup>-</sup> is smaller than Br<sup>-</sup> smaller ions  $\Rightarrow$  stronger attractions
- c. Mg<sub>3</sub>N<sub>2</sub> higher charges  $\Rightarrow$  stronger attractions
- d. MgO higher charges. Then NaF, then  $C_2H_{26}$  (molecular - only London forces)  
ionic bonds are much stronger than dispersion forces.

2. higher bp higher ~~VP~~ VP higher  $\Delta H_{\text{trap}}$

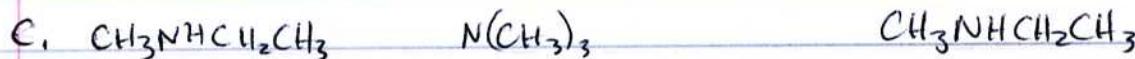


(much stronger London forces)



can H-bond

a little polar,  
but can't H-bond



can H-bond

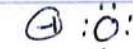
can't H bond



$6+6+2(7)$

$26 \text{ ve}^-$

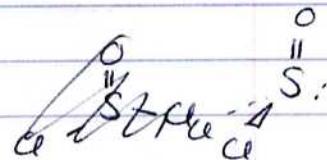
FC



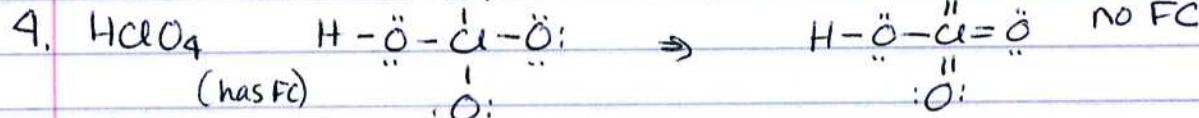
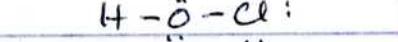
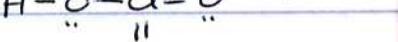
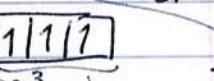
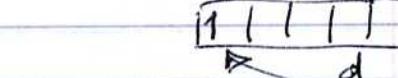
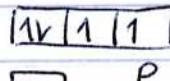
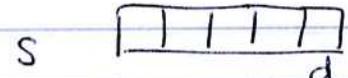
$\text{FC}$



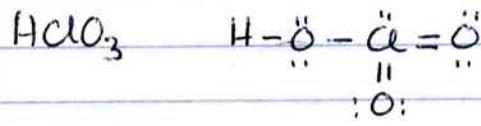
NO FC



$sp^3$  hybridized  
trigonal pyramid



(has FC)



:O:

no FC on any of them!



Mead

(2)

5. a)  $\text{Br}_2(\text{l}) \rightarrow \text{Br}_2(\text{g})$  breaking London forces  
 b)  $\text{Br}_2(\text{g}) \rightarrow 2\text{Br}$  breaking all Br-Br covalent bonds! Covalent bonds are much stronger than London forces

$$6. \text{a. } \Delta H_{xn} = [2(-285.8) + 2(-296.1)] - [2(-20.15) + 3(0)] \\ \Delta H_{xn} = -1123.5 \text{ kJ}$$

$$\text{b. } W = -\Delta n g_s RT = -(2-5 \text{ mol})(8.314 \text{ J/mol}\cdot\text{K})(298 \text{ K}) = 7432.7 \text{ J} \\ W = +7.4327 \text{ kJ}$$

$$E = q + w = -1123.5 \text{ kJ} + 7.4327 \text{ kJ} = -1116.067 \text{ } \textcircled{-1116.1 \text{ kJ}}$$

$$\text{c. } (3.00 \text{ g H}_2\text{S}) \left( \frac{1 \text{ mol H}_2\text{S}}{34.086 \text{ g}} \right) \left( \frac{-1116.1 \text{ kJ}}{2 \text{ mol H}_2\text{S}} \right) = -49.115 \text{ kJ} \text{ given off}$$

+ 49.115 kJ absorbed by  $\text{H}_2\text{O}$  and calorimeter

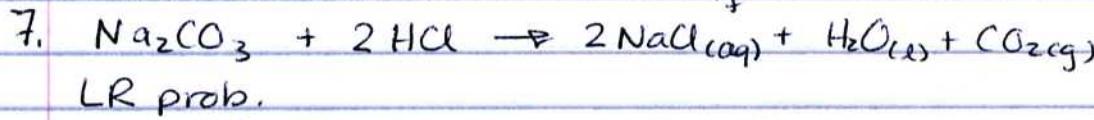
$$-q_{xn} = q_{\text{bomb}} + q_{\text{water}}$$

$$q_{\text{bomb}} = C\Delta T = \frac{742 \text{ J}}{\text{°C}} \Delta T \quad q_w = \left( \frac{4.184 \text{ J}}{\text{g°C}} \right) (2000 \text{ g})(\Delta T)$$

$$49.115 \text{ J} = 742 \Delta T + 8368 \Delta T$$

$$\frac{49.115}{9110} = \frac{9110 \Delta T}{9110} \quad \Delta T = 5.39 \text{ °C}$$

$$T_f = 20.00 + 5.39 \Rightarrow \textcircled{25.39 \text{ °C}}$$



$$(0.150 \text{ L}) \left( \frac{1.45 \text{ mol}}{\text{L}} \right) = 0.2175 \text{ mol Na}_2\text{CO}_3 \quad \text{need } \frac{2 \text{ HCl}}{1 \text{ Na}_2\text{CO}_3}$$

$$(0.230 \text{ L}) \left( \frac{1.53 \text{ mol}}{\text{L}} \right) = 0.3519 \text{ mol HCl} \quad \text{have } \frac{0.3519 \text{ HCl}}{0.2175 \text{ Na}_2\text{CO}_3} = \frac{1.617 \text{ HCl}}{1 \text{ Na}_2\text{CO}_3}$$

HCl is LR.

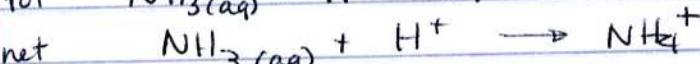
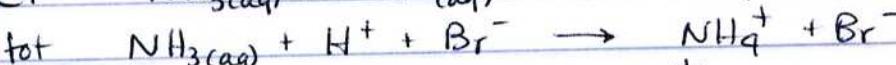
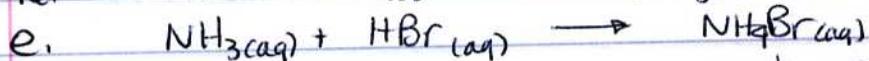
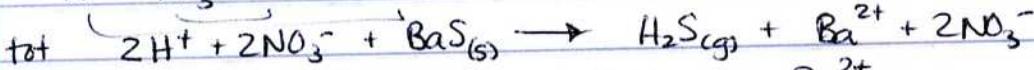
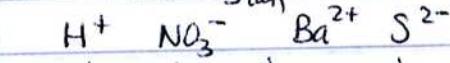
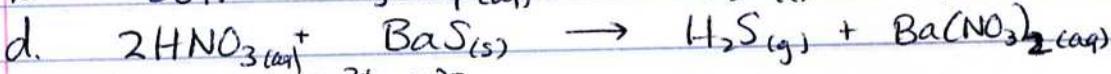
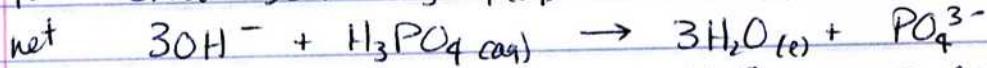
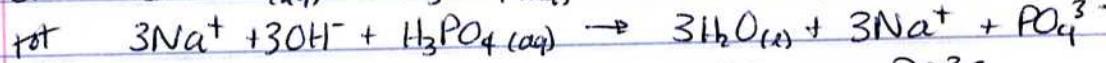
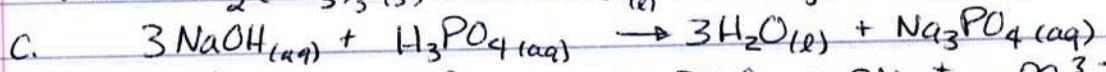
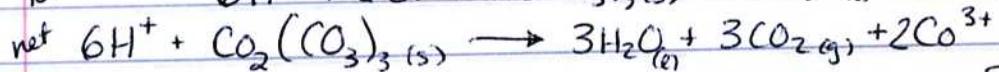
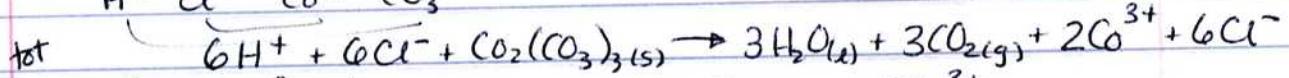
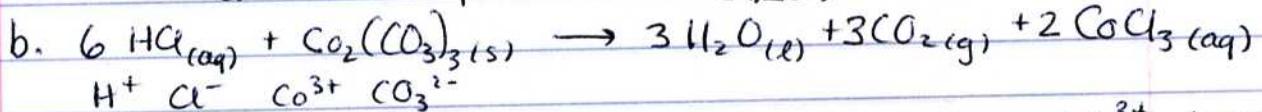
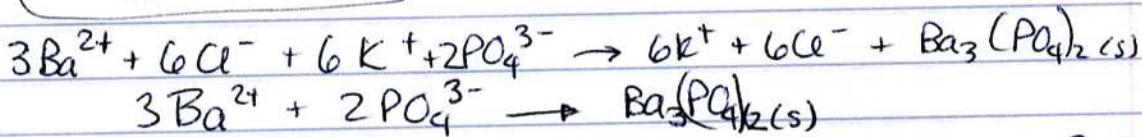
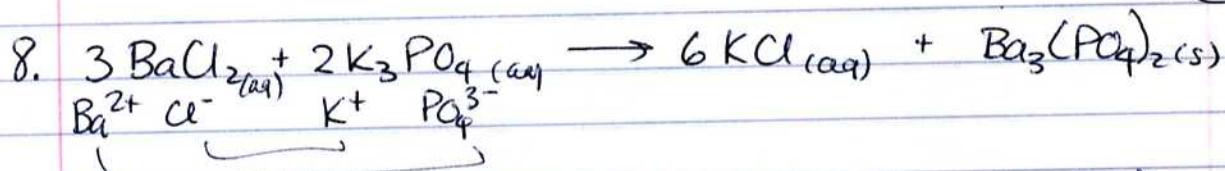
$$(0.3519 \text{ mol HCl}) \left( \frac{1 \text{ mol CO}_2}{2 \text{ mol HCl}} \right) \left( \frac{22.4 \text{ L}}{1 \text{ mol}} \right) = 3.94 \text{ L CO}_2$$

$$\text{or: } 0.17595 \text{ mol CO}_2$$

$$PV = nRT \quad V = \frac{nRT}{P} = \frac{(0.17595 \text{ mol})(0.08206)(273 \text{ K})}{1 \text{ atm}}$$

$$V = 3.94 \text{ L CO}_2$$

(3)



9. ① ice warms  $-20 \rightarrow 0^\circ\text{C}$   $q_1 = \text{sm}\Delta T = (2.06 \frac{\text{J}}{\text{g}\cdot\text{C}})(50.0\text{g})(+20.0^\circ\text{C}) = 2060\text{J}$   
 $q_1 \oplus$

② ice melts @  $0^\circ\text{C}$   $q_2 \oplus$   $q_2 = (50.0\text{g})(333 \frac{\text{J}}{\text{g}}) = 16650\text{ J}$

③ ice water warms  $0 \rightarrow 10^\circ\text{C}$   $q_3 \oplus$   $q_3 = (4.184 \frac{\text{J}}{\text{g}\cdot\text{C}})(50.0\text{g})(+10.0^\circ\text{C}) = 2092\text{ J}$

④ water cools  $25.0 \rightarrow 10.0$

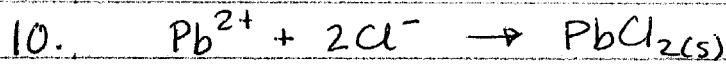
$q_4 = (4.184 \frac{\text{J}}{\text{g}\cdot\text{C}})(m)(-15.0^\circ\text{C}) = -62.76\text{m J}$

$-q_4 = q_1 + q_2 + q_3 = 2060 + 16650 + 2092\text{ J} = 20802\text{ J}$

$-(-62.76\text{m J}) = 20802\text{ J}$

$m = \frac{20802\text{ J}}{62.76\text{ J}} = 331\text{ g H}_2\text{O}$

(4)



$$(0.0300 \text{ L}) / \underline{0.100 \text{ mol}} = 0.00300 \text{ mol Pb}(\text{NO}_3)_2 = 0.00300 \text{ mol Pb}^{2+}$$

$$0.00600 \text{ mol NO}_3^-$$

$$(0.0500 \text{ L}) / \underline{0.100 \text{ mol}} = 0.00500 \text{ mol NaCl} = 0.00500 \text{ mol Na}^+$$

$$0.00500 \text{ mol Cl}^-$$

Need:  $\frac{2\text{Cl}^-}{1 \text{Pb}^{2+}}$  have:  $\frac{0.00500 \text{ mol Cl}^-}{0.00300 \text{ mol Pb}^{2+}} = \frac{1.67 \text{ mol Cl}^-}{1 \text{ mol Pb}^{2+}}$  not enough  $\text{Cl}^-$   
so  $\text{Cl}^-$  is LR.

(a)  $(0.00500 \text{ mol Cl}^-) / \left( \frac{1 \text{ mol PbCl}_2}{2 \text{ mol Cl}^-} \right) / \left( \frac{278.10 \text{ g PbCl}_2}{1 \text{ mol PbCl}_2} \right) = 0.695 \text{ g PbCl}_2 \text{ formed}$

(b) Ions remaining:  $[\text{Cl}^-] = 0$  (LR - gets used up.)

$\text{Na}^+$  and  $\text{NO}_3^-$  are spectator ions + don't get used up. (They get diluted)

$$[\text{NO}_3^-] = \frac{0.00600 \text{ mol}}{0.0800 \text{ L}} = 0.0750 \text{ M} \quad [\text{Na}^+] = \frac{0.00500 \text{ mol}}{0.0800 \text{ L}} = 0.0625 \text{ M}$$

$[\text{Pb}^{2+}]$ : how much used up?

$$(0.00500 \text{ mol Cl}^-) / \left( \frac{1 \text{ mol Pb}^{2+}}{2 \text{ mol Cl}^-} \right) = 0.00250 \text{ mol Pb}^{2+} \text{ used}$$

$$0.00300 \text{ mol Pb}^{2+} \text{ start}$$

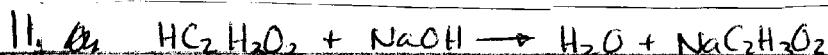
$$- 0.00250 \text{ mol used}$$

$$0.00050 \text{ mol Pb}^{2+} \text{ left (2sf)}$$

$$\frac{0.00050 \text{ mol Pb}^{2+}}{0.0800 \text{ L}} = 0.00625 \text{ M}$$

rounds to  
0.0062 M

(ends w/ exactly 5)



$$(0.05610 \text{ L NaOH}) / \underline{0.115 \text{ mol NaOH}} / \left( \frac{1 \text{ HAc}}{1 \text{ NaOH}} \right) / \left( \frac{60.052 \text{ g}}{1 \text{ mol HC}_2\text{H}_3\text{O}_2} \right) = 0.3874 \text{ g HAc}$$

$$\frac{0.3874 \text{ g HAc}}{7.94 \text{ g vinegar}} \times 100 = 4.88\% \text{ HC}_2\text{H}_3\text{O}_2$$

7.94 g vinegar

12.  $q_{rxn} = -q_{heat}$   $q_w = \text{sm}\Delta T = (4.1 \text{ J/gC})(45.3 \text{ g})(1.6^\circ\text{C}) = 297.168 \text{ J}$

$$q_{rxn} = -297.168 \text{ J}$$

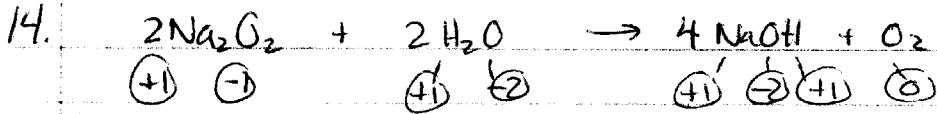
$$\Delta H_{rxn} = \frac{q}{\# \text{ mol KOH}} = \frac{(0.300 \text{ g})(\frac{1 \text{ mol}}{56.108 \text{ g}})}{0.005347 \text{ mol}} = 0.005347 \text{ mol KOH}$$

$$\frac{-297.168 \text{ J}}{0.005347 \text{ mol}} = -5558 \times 10^4 \text{ J/mol} = -56 \text{ kJ/mol}$$

15.2

(5)

13. used when  $PV=nRT$  doesn't work: at low T and/or high P.  
 Takes into acct • volume of gas molecules • attractions between gas molecules



a) skip

b)   $P_{\text{inside tube}} < P_{\text{atm}}$   $P_{\text{atm}} = P_{\text{O}_2} + P_{\text{H}_2\text{O}} + P_{\text{correction}}$

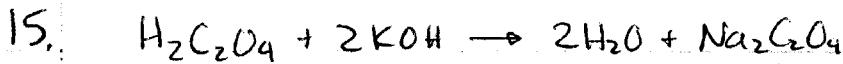
$$P_{\text{correction}} = \frac{\rho g h_{\text{corr}}}{d_{\text{Hg}}} = \frac{(1.00 \text{ g/mL})(25.0 \text{ mm})}{13.6 \text{ g/mL}} = 18.38 \text{ mm Hg}$$

$$P_{\text{O}_2} = P_{\text{atm}} - P_{\text{H}_2\text{O}} - P_{\text{corr}} = 771 - 17.54 - 18.38 = 735.08 \text{ mm Hg}$$

$$= 0.9672 \text{ atm}$$

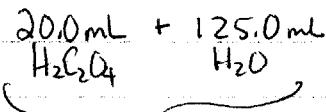
$$\text{PV} = nRT \quad n = \frac{PV}{RT} = \frac{(0.9672 \text{ atm})(0.0310 \text{ L})}{(0.08206 \frac{\text{L atm}}{\text{K mol}})(293 \text{ K})} = 0.001247 \text{ mol O}_2$$

$$(0.001247 \text{ mol O}_2) \left( \frac{2 \text{ mol Na}_2\text{O}_2}{1 \text{ mol O}_2} \right) \left( \frac{77.98 \text{ g}}{1 \text{ mol Na}_2\text{O}_2} \right) = (0.194 \text{ g Na}_2\text{O}_2)$$



$$(0.01548 \text{ L}) \left( \frac{0.3017 \text{ mol KOH}}{1 \text{ L}} \right) \left( \frac{1 \text{ mol H}_2\text{C}_2\text{O}_4}{2 \text{ mol KOH}} \right) = 0.002335 \text{ mol H}_2\text{C}_2\text{O}_4$$

$$\frac{0.002335 \text{ mol}}{0.02500 \text{ L}} = 0.093406 \text{ M H}_2\text{C}_2\text{O}_4$$



$$\text{H}_2\text{C}_2\text{O}_4 \text{ (aq)} = 0.093406 \text{ M}$$

$$M_1 V_1 = M_2 V_2$$

$$M_1 = \frac{M_2 V_2}{V_1} = \frac{(0.093406 \text{ M})(145.0 \text{ mL})}{20.0 \text{ mL}}$$

$$M_1 = 0.6772 \text{ M} \quad 0.677 \text{ M}$$

16.  $X_{\text{nap}} = 0.159 = \frac{0.159 \text{ mol nap}}{1 \text{ mol total}} \quad 1 - 0.159 = 0.841 \text{ mol benz}$

$$(0.841 \text{ mol C}_6\text{H}_6) \left( \frac{78.11 \text{ g}}{1 \text{ mol}} \right) = 65.69 \text{ g benz}$$

$$\frac{0.159 \text{ mol nap}}{0.06569 \text{ kg benz}} = 2.4204 \text{ m}$$

$$\Delta T_b = K_b \cdot C_m = (2.61^\circ\text{C/m})(2.4204 \text{ m}) = 6.32^\circ\text{C}$$

$$80.1 + 6.32 = 86.4^\circ\text{C}$$

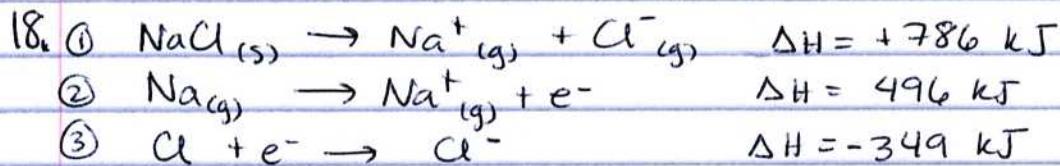
bp solution

(6)

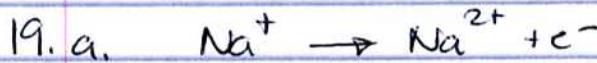
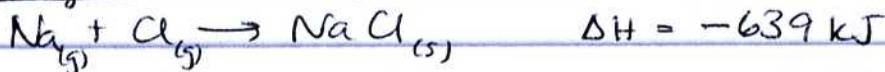
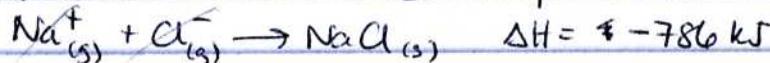
$$17. 10.098 - 9.42 = 0.678 \text{ (2 dp)} \quad \frac{0.678}{1.100} = 0.61636 \quad (0.62) \quad 2sf$$

$$\begin{array}{rcl} 5360 & \pm 10 \\ 12.98 & \pm 0.01 \\ \hline 500 & \pm 100 \end{array}$$

$$5872.98 \pm 100 \Rightarrow 5900$$



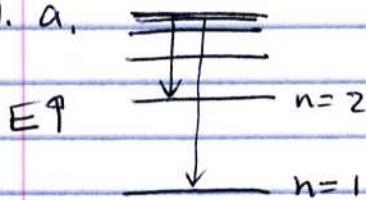
Rxn (1): Reverse Rxn (2): keep Rxn (3): keep



$$20. \Delta E_{\text{electron}} = E_{\text{photon}} = h\nu = \frac{hc}{\lambda}$$

$$E = \frac{(6.626 \times 10^{-34} \text{ J.sec})(3.00 \times 10^8 \text{ m/sec})}{422.7 \times 10^{-9} \text{ m}} = (4.70 \times 10^{-19} \text{ J})$$

21. a.



b.  $5 \rightarrow 2$  energy emitted

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left( \frac{1}{2^2} - \frac{1}{5^2} \right)$$

$$\Delta E = -2.18 \times 10^{-18} \text{ J} (0.21) = -4.58 \times 10^{-19} \text{ J}$$

c.  $5 \rightarrow 1$  larger  $\Delta E$   
so UV region.

visible

22. a. allowed. 6p  
b. allowed. 5f

- c. not allowed.  $l \neq n$   
d. not allowed.  $m_l \neq 0$  or  $m_s \neq 1$

(7)

$$23. \text{ 6.45 g unk} + 50.0 \text{ mL benz} \quad (500 \text{ mL benz}) \left( \frac{0.879 \text{ g}}{1 \text{ mL}} \right) = 43.95 \text{ g benz}$$

$$\Delta T_f = K_f C_m \quad C_m = \frac{\Delta T_f}{K_f} = \frac{4.16^\circ\text{C}}{5.12^\circ\text{C/m}} = 0.8125 \text{ m} = \frac{0.8125 \text{ mol unk}}{1 \text{ kg benz}}$$

$$(0.04395 \text{ kg benz}) \left( \frac{0.8125 \text{ mol unk}}{1 \text{ kg benz}} \right) = 0.035709 \text{ mol unk}$$

$$\frac{6.45 \text{ g}}{0.035709 \text{ mol}} = 180.62 \text{ g/mol}$$

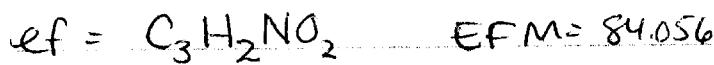
$$(42.9 \text{ g C}) \left( \frac{1 \text{ mol}}{12.01 \text{ g C}} \right) = 3.572 \text{ mol C}$$

$$(2.4 \text{ g H}) \left( \frac{1 \text{ mol}}{1.008 \text{ g H}} \right) = 2.381 \text{ mol H}$$

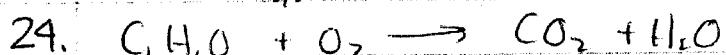
$$(16.7 \text{ g N}) \left( \frac{1 \text{ mol}}{14.01 \text{ g N}} \right) = 1.192 \text{ mol N} \leftarrow \begin{matrix} \text{smallest} \\ \# \text{ moles} \end{matrix}$$

$$(38.1 \text{ g O}) \left( \frac{1 \text{ mol}}{16.00 \text{ g O}} \right) = 2.381 \text{ mol O}$$

$$\frac{3.572 \text{ mol C}}{1.192 \text{ mol N}} = \frac{3 \text{ C}}{1 \text{ N}} \quad \frac{2.381 \text{ mol H}}{1.192 \text{ mol N}} = \frac{2 \text{ H}}{1 \text{ N}} \quad \frac{2.381 \text{ O}}{1.192 \text{ N}} = \frac{2 \text{ O}}{1 \text{ N}}$$



$$\frac{180.62 \text{ g/mol}}{84.056 \text{ g/mol}} = 2.14 \quad (x2) \quad MF = C_6H_4N_2O_4$$



$$(4.40 \text{ g } O_2) \left( \frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2} \right) \left( \frac{1 \text{ mol C}}{1 \text{ mol } CO_2} \right) \left( \frac{12.01 \text{ g C}}{1 \text{ mol C}} \right) = 1.20 \text{ g C}$$

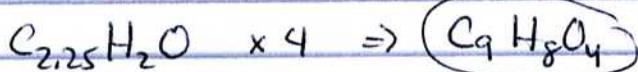
$$(0.800 \text{ g } H_2O) \left( \frac{1 \text{ mol } H_2O}{18.016 \text{ g } H_2O} \right) \left( \frac{2 \text{ mol H}}{1 \text{ mol } H_2O} \right) \left( \frac{1.008 \text{ g H}}{1 \text{ mol H}} \right) = 0.08952 \text{ g H}$$

$$\begin{array}{rcl} 2.00 \text{ g compound} & (1.20 \text{ g C}) \left( \frac{1 \text{ mol}}{12.01 \text{ g}} \right) = 0.0999 \text{ mol C} \\ - 1.20 \text{ g C} & & \\ + 0.08952 \text{ g H} & & \\ \hline 0.710 \text{ g O} & (0.08952 \text{ g H}) \left( \frac{1 \text{ mol}}{1.008 \text{ g}} \right) = 0.0888 \text{ mol H} \\ & (0.710 \text{ g O}) \left( \frac{1 \text{ mol O}}{16.00 \text{ g}} \right) = 0.0444 \text{ mol O} \end{array}$$

(8)

$$\frac{0.0999 \text{ mol C}}{0.0444 \text{ mol O}} = \frac{2.25 \text{ mol C}}{1 \text{ mol O}}$$

$$\frac{0.0888 \text{ H}}{0.0444 \text{ O}} = \frac{2 \text{ H}}{1 \text{ O}}$$



26. ~~from~~  $\frac{\text{dist Xe}}{\text{dist CO}_2} = \sqrt{\frac{M}{M}}$

$$CO_2 \text{ MM} = 44.01 \text{ g/mol}$$

$$Xe \text{ MM} = 131.3 \text{ g/mol}$$

$CO_2$  is lighter and will go farther.

$$\text{dist } CO_2 > \text{dist Xe}$$

so larger MM on bottom.

$$\frac{d Xe}{d CO_2} = \sqrt{\frac{MM_{CO_2}}{MM_{Xe}}}$$

$$d_{Xe} = d_{CO_2} \sqrt{\frac{M_{CO_2}}{M_{Xe}}}$$

$$d_{Xe} = 11.2 \text{ cm} \sqrt{\frac{44.01}{131.3}} = (6.48 \text{ cm})$$

27.  $\sqrt{\frac{MM_{unk}}{MM_{NH_3}}}^2 = \frac{\text{time}}{\text{time}}$

Unknown is slower than  $NH_3 \therefore$  heavier

higher MM on top, so larger time must be on top.

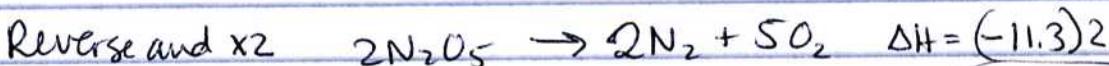
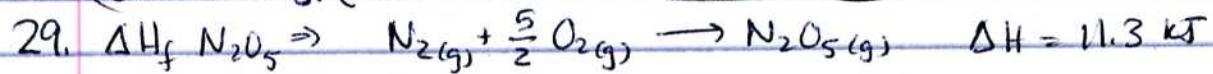
$$\sqrt{\frac{MM_{unk}}{MM_{NH_3}}} = \frac{t_{unk}}{t_{NH_3}}$$

$$M_{unk} = M_{NH_3} \left( \frac{t_{unk}}{t_{NH_3}} \right)^2$$

$$M_{unk} = 17.034 \text{ g/mol} \left( \frac{18.1 \text{ min}}{9.34 \text{ min}} \right)^2$$

$$M_{unk} = 64.0 \text{ g/mol}$$

28.  $\left( \frac{2.70 \text{ g}}{\text{cm}^3} \right) \left( \frac{1 \text{ lb}}{454 \text{ g}} \right) \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3 = (0.0975 \text{ lb/in}^3)$



$$= -22.6 \text{ kJ}$$

$$\frac{0.0975}{0.0975 \text{ lb}} \left( \frac{12 \text{ in}}{1 \text{ ft}} \right)^3 = (168 \text{ lb/ft}^3)$$