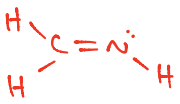
① $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

② $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4 5s^1$

③ $c = \lambda\nu$

$\lambda = 650\,nm \left| \frac{10^{-9}\,m}{1\,nm} \right. = 6.50 \times 10^{-7}\,m$

$\nu = \frac{2.998 \times 10^{8}\,m/s}{6.5 \times 10^{-7}\,m} = 4.61 \times 10^{14}\,s^{-1}$

④ 

C=N has 1σ + 1π

$E = 6.626 \times 10^{-34}\,Js \left(\nu \right) =$

$E = 3.05 \times 10^{-19}\,J$

⑤ Li < Be

adding an e^- to the same subshell (2s), so no extra shielding. Be has an extra proton in the nucleus, so the 2s electrons are more attracted to the nucleus than in Li

Be > B

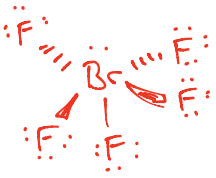
The 5th e^- in B goes into a 2p orbital.

Be: $1s^2 2s^2 \rightarrow 1s^2 2s^1$

B: $1s^2 2s^2 2p^1 \rightarrow 1s^2 2s^2$ ← stable

Stable

Ionization of Be creates an unstable config, so it is not favorable.



6. sp^3d^2 7. sp^3 8. octahedral

9. Square Pyramidal 10. yes 11. LDF + dipole/dipole

12. a. $17.82\,g\,C \left| \frac{mol}{12.011\,g} \right. = 1.48\,mol$

b. $4.569 \times 10^{18}\,C\,atoms \left| \frac{1\,mol}{6.022 \times 10^{23}} \right.$

$7.59 \times 10^{-6}\,moles$

c. $86.3\,kg\,Fe \left| \frac{10^3\,g}{1\,kg} \right| \frac{mol}{55.85\,g} = 1545\,mol\,Fe$

d. $3.892 \times 10^{12}\,atoms \left| \frac{1\,mol}{6.022 \times 10^{23}\,atoms} \right.$

$6.46 \times 10^{-12}\,moles$

13. NaClO $22.99 + 35.45 + 16 = 74.44\,g/mol$

$Pb(BrO_4)_4$ $207.2 + 4(79.9) + 16(16) = 782.8\,g/mol$

14. $NaBrO_4$ $22.99 + 16(4) + 79.9 = 166.89$ g/mol

$$\frac{10\text{ g}}{166.89\text{ g}} \text{ mol} = 0.06 \text{ mol}$$

$Pb(OCl)_4$ $207.2 + 4(35.45) + 4(16) = 413$ g/mol

$$\frac{10\text{ g}}{413\text{ g}} \text{ mol} = 0.024 \text{ mol}$$

15. Na_2CO_3 $22.99(2) + 12.011 + 3(16) = 105.991$ g/mol

$$\frac{\text{mass C}}{\text{mass } Na_2CO_3} = \frac{x}{100\text{ g}}$$

$$100\text{ g } Na_2CO_3 \left| \frac{\text{mol}}{105.991\text{ g}} \right| \frac{1\text{ mol C}}{1\text{ mol } Na_2CO_3} \left| \frac{12.01\text{ g}}{\text{mol C}} \right. = 11.3\text{ g}$$

$$\frac{11.3\text{ g C}}{100\text{ g } Na_2CO_3} \times 100 = 11.3\%$$

$Pb(C_2H_4O_2)_2 \longrightarrow 207.2 + 4(12.011) + 8(1.008) + 4(16) = 327.3$ g/mol

$$\frac{\text{mass C}}{100\text{ g}} \times 100$$

$$100\text{ g} \left| \frac{\text{mol}}{327.3\text{ g}} \right| \frac{4\text{ mol C}}{1\text{ mol } Pb(C_2H_4O_2)_2} \left| \frac{12.011\text{ g}}{1\text{ mol}} \right. = 14.68\text{ g}$$

$$\frac{14.68}{100} \times 100 = 14.68\%$$

16. a. $14.7\text{ g C} \left| \frac{\text{mol}}{12.011\text{ g}} \right. = 1.22\text{ mol C} \div 0.615 = 2$

$65.09\text{ g Cl} \left| \frac{\text{mol}}{35.45\text{ g}} \right. = 1.84\text{ mol Cl} \div 0.615 = 3$

$19.59\text{ g O} \left| \frac{\text{mol}}{16\text{ g}} \right. = 1.22\text{ mol O} \div 0.615 = 2$

$0.62\text{ g H} \left| \frac{\text{mol}}{1.008\text{ g}} \right. = 0.615\text{ mol H} \div 0.615 = 1$

$C_2Cl_3O_2H$

163.8 g/mol

16 b. $34.07\ g\ C \mid \frac{mol}{12.011\ g} = 2.85\ mol\ C \div 0.71 = 4$

$51.28\ g\ Cl \mid \frac{mol}{35.45\ g} = 1.45\ mol\ Cl \div 0.71 = 2$

$11.34\ g\ O \mid \frac{mol}{16.\ g} = 0.71\ mol\ O \div 0.71 = 1$

$4.30\ g\ H \mid \frac{mol}{1.008\ g} = 4.26\ mol\ H \div 0.71 = 6$

$C_4Cl_2OH_6$

140.99 g/mol

$\frac{846.02}{140.99} = 6$

$C_{24}Cl_{12}O_6H_{36}$

c. $22.04\ g\ C \mid \frac{mol}{12.011\ g} = 1.83\ mol\ C \div 0.46 = 4$

$65.16\ g\ Cl \mid \frac{mol}{35.45\ g} = 1.84\ mol\ Cl \div 0.46 = 4$

$7.34\ g\ O \mid \frac{mol}{16\ g} = 0.46\ mol\ O \div 0.46 = 1$

$5.52\ g\ H \mid \frac{mol}{1.008\ g} = 5.5\ mol \div 0.46 = 12$

$C_4Cl_4O_1H_{12}$

217.94 g/mol

$\frac{1089.8}{217.94} = 5$

$C_{20}Cl_{20}O_5H_{60}$

17 a. combustion b. single displacement c. decomposition d. double displacement

18 a. $PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(l) + 5HCl(g)$

b. $2Li(s) + 2CO_2(g) + 2H_2O(l) \rightarrow 2LiHCO_3(s) + H_2(g)$

c. $4C_3H_7(g) + 19\ O_2(g) \rightarrow 12CO_2(g) + 14H_2O(l)$

d. $3N_2H_4(g) \rightarrow 4NH_3(g) + N_2(g)$

19. $4C_3H_7(g) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(l)$

$43.089\ g/mol$ $\quad 44.01\ g/mol \quad 18.016\ g/mol$

$$17\ g \left| \frac{mol}{43.089\ g} \right. = 0.3945\ mol\ C_3H_7$$

$$0.3945\ C_3H_7 \left| \frac{12\ mol\ CO_2}{4\ mol\ C_3H_7} \right| \frac{44.0\ g}{mol} = 52.1\ g\ CO_2$$

$$0.3945\ C_3H_7 \left| \frac{14\ mol\ H_2O}{4\ mol\ C_3H_7} \right| \frac{18.016\ g}{mol} = 24.88\ g\ H_2O$$

$PCl_5(s) + 4H_2O(l) \rightarrow H_3PO_4(l) + 5HCl(g)$

$208.2\ g/mol \quad 97.99\ g/mol \quad 36.46\ g/mol$

$$17\ g\ PCl_5 \left| \frac{mol}{208.2\ g} \right. = 0.0816\ mol\ PCl_5 \left| \frac{1\ mol\ H_3PO_4}{1\ mol\ PCl_5} \right| \frac{97.99\ g}{mol} = 8.00\ g\ H_3PO_4$$

$$0.0816\ mol\ PCl_5 \left| \frac{5\ mol\ HCl}{1\ mol\ PCl_5} \right| \frac{36.46\ g}{mol} = 14.89\ g\ HCl$$

20 & 21. $3H_2 + N_2 \rightarrow 2NH_3$

$$1.8\ g\ H_2 \left| \frac{mol}{2.016\ g} \right| \frac{2\ mol\ NH_3}{3\ mol\ H_2} \left| \frac{17.034\ g}{mol} \right. = 10.14\ g\ NH_3$$

$$1.8\ g\ N_2 \left| \frac{1\ mol}{28.02\ g} \right| \frac{2\ mol\ NH_3}{1\ mol\ N_2} \left| \frac{17.034\ g}{mol} \right. = 2.19\ g\ NH_3$$

$$2.19\ g\ NH_3 \left| \frac{mol}{17.034\ g} \right| \frac{3\ mol\ H_2}{2\ mol\ NH_3} \left| \frac{2.016\ g}{mol} \right. = 0.389\ g\ H_2\ used$$

$1.8 - 0.389 = 1.41\ g\ H_2\ left$

b. $3MgO + 2FeCl_3 \longrightarrow 3MgCl_2 + Fe_2O_3$

MgO: 40.31 g/mol; $FeCl_3$: 162.2 g/mol; Fe_2O_3: 159.7 g/mol

$$1.5\text{ g } MgO \left| \frac{\text{mol}}{40.31\text{ g}} \right| \frac{1\text{ mol } Fe_2O_3}{3\text{ mol } MgO} \left| \frac{159.7\text{ g}}{\text{mol}} \right. = 2.38\text{ g } Fe_2O_3$$

$$1.8\text{ g } FeCl_3 \left| \frac{1\text{ mol}}{162.2\text{ g}} \right| \frac{1\text{ mol } Fe_2O_3}{2\text{ mol } FeCl_3} \left| \frac{159.7\text{ g}}{\text{mol}} \right. = \boxed{0.886\text{ g } Fe_2O_3}$$

$$0.886\text{ g } Fe_2O_3 \left| \frac{1\text{ mol}}{159.7\text{ g } Fe_2O_3} \right| \frac{3\text{ mol } MgO}{1\text{ mol } Fe_2O_3} \left| \frac{40.31\text{ g}}{\text{mol}} \right. = 0.671\text{ g used}$$

$1.8 - 0.671\text{ g} = 1.129\text{ g } MgO$ remaining

22. a. $Pb(C_2H_3O_2)_2(aq) + 2NH_4Br(aq) \longrightarrow PbBr_2(s) + 2NH_4Br(aq)$

$Pb^{2+} + 2C_2H_3O_2^- + 2NH_4^+ + 2Br^- \longrightarrow PbBr_2(s) + 2NH_4^+ + 2Br^-$

Net ionic: $Pb^{2+} + 2Br^- \longrightarrow PbBr_2(s)$

b. $Ba(NO_3)_2(aq) + (NH_4)_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NH_4NO_3(aq)$

$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4(s)$

c. $Na_2S(aq) + MgCl_2(aq) \longrightarrow 2NaCl(aq) + MgS(aq)$

Everything is aqueous. No reaction.

d. $3Ca(NO_3)_2(aq) + 2Na_3PO_4(aq) \longrightarrow 6NaNO_3 + Ca_3(PO_4)_2(s)$

$3Ca^{2+} + 6NO_3^- + 6Na^+ + 2PO_4^{3-} \longrightarrow 6Na^+ + 6NO_3^- + Ca_3(PO_4)_2(s)$

Net: $3Ca^{2+} + 2PO_4^{3-} \longrightarrow Ca_3(PO_4)_2(s)$

23. a. $2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$

$$3.5\text{ g } C_2H_6 \left| \frac{\text{mol}}{30.07\text{ g}} \right| \frac{6\ H_2O}{2\ C_2H_7} \left| \frac{18.016\text{ g}}{\text{mol}} \right. = 6.29\text{ g } H_2O$$

theoretical

$$\frac{1.02\text{ g}}{6.29\text{ g}} \times 100 = 16.2\%$$

b. $2C_6H_6 + 15O_2 \longrightarrow 12CO_2 + 6H_2O$

$$3.5\text{ g } C_6H_6 \left| \frac{\text{mol}}{78.114\text{ g}} \right| \frac{6\text{ mol } H_2O}{2\text{ mol } C_6H_6} \left| \frac{18.016\text{ g}}{\text{mol}} \right. = 2.42\text{ g } H_2O$$

$$\frac{1.02}{2.42} \times 100 = 42.1\%$$

c. $4C_3H_5 + 17O_2 \longrightarrow 12CO_2 + 10H_2O$

$$3.5\text{ g } C_3H_5 \left| \frac{\text{mol}}{41.073\text{ g}} \right| \frac{10\text{ mol } H_2O}{4\text{ mol } C_3H_5} \left| \frac{18.016\text{ g}}{\text{mol}} \right. = 3.84\text{ g } H_2O$$

$$\frac{1.02}{3.84} \times 100 = 26.6\%$$

24. $AlCl_3(aq) + 3Ag(C_2H_3O_2)(aq) \longrightarrow 3AgCl(s) + Al(C_2H_3O_2)(aq)$

$$26\text{ mg} \left| \frac{10^{-3}\text{ g}}{1\text{ mg}} \right| \frac{\text{mol}}{133.33\text{ g}} \left| \frac{3\ AgCl_3}{1\ AlCl_3} \right| \frac{143.3\text{ g}}{\text{mol}} = 0.0838\text{ g } AgCl$$

$$1.2\text{ L} \left| \frac{526\text{ mmol}}{\text{L}} \right| \frac{10^{-6}\text{ mol}}{1\text{ mmol}} \left| \frac{3\ AgCl}{3Ag(C_2H_3O_2)} \right| \frac{143.3\text{ g}}{\text{mol}} = 0.090\text{ g } AgCl$$

$MnBr_2(aq) + Pb(NO_3)_2(aq) \rightarrow PbBr_2(s) + Mn(NO_3)_2(aq)$

$$4.28\,g \left| \frac{mol}{214.7\,g} \right| \frac{1\,mol\ PbBr_2}{1\,mol\ MnBr_2} \left| \frac{367\,g}{mol} \right| = 7.31\,g\ PbBr_2$$

$$526\,mL \left| \frac{10^{-3}\,L}{1\,mL} \right| \frac{1.2\,mol}{L} \left| \frac{1\,mol\ PbBr_2}{1\,mol\ Pb(NO_3)_2} \right| \frac{367\,g}{mol} = 231.65\,g\ PbBr_2$$

25. $Al(ClO)_3$ $181.33\,g/mol$ $\quad 1.8\,L \left| \frac{252\,mmol}{L} \right| \frac{10^{-3}\,mol}{1\,mmol} \left| \frac{181.33\,g}{mol} \right| = 82.3\,g$

$BiSO_4$ $305.05\,g/mol$ $\quad 2.52\,L \left| \frac{1.86\,mol}{L} \right| \frac{305.05\,g}{mol} = 1429.8\,g$

26. a. $Mg(NO_3)_2 \cdot (H_2O)_7$

$274.442\,g/mol$ $\quad$ JUST nitrate!

$$1.4\,L \left| \frac{462\,mmol\ NO_3^-}{L} \right| \frac{10^{-3}\,mol}{1\,mmol} \left| \frac{1\,mol\ Mg(NO_3)_2 \cdot (H_2O)_7}{2\,mol\ NO_3^-} \right| \frac{274.442\,g}{mol}$$

$88.75\,g$

b. $Ti(ClO_4)_4 \cdot (H_2O)_4$ $517.74\,g/mol$ $\quad$ looking for ClO_4^-

$$2.4\,L \left| \frac{250\,mmol\ ClO_4^-}{L} \right| \frac{10^{-6}\,mol}{1\,mmol} \left| \frac{1\,mol\ Ti(ClO_4)_4 \cdot (H_2O)_4}{4\,mol\ ClO_4^-} \right| \frac{517.74\,g}{mol} = 0.078\,g$$

27. Starting: $3.2\,L \left| \frac{1.02\,mol\ MgCl_2}{L} \right| \frac{2\,mol\ Cl^-}{1\,mol\ MgCl_2} = 6.528\,mol\ Cl^-$

after dilution, $V = 3.2\,L + 1.0\,L = 4.2\,L$

$$\frac{6.528\,mol\ Cl^-}{4.2\,L} = 1.55\,M$$

b. $0.288\,L \left| \frac{0.5\,mol\ FeCl_3}{L} \right| \frac{3\,mol\ Cl^-}{1\,mol\ FeCl_3} = \frac{0.432\,mol\ Cl^-}{0.512\,L + 0.218\,L} = 0.54\,M$

28. $Fe(NO_3)_3(aq) + 3NaOH(aq) \rightarrow 3NaNO_3(aq) + Fe(OH)_3(s)$

$$2.13\,L \left| \frac{0.868\ mol\ NaOH}{L} \right| \frac{1\ mol\ Fe(OH)_3}{3\ mol\ NaOH} \left| \frac{106.88\ g}{mol} \right. = 65.84\ g\ Fe(OH)_3$$

$$3.41\,L \left| \frac{562\ mmol\ Fe(NO_3)_3}{L} \right| \frac{10^{-3}\ mol}{1\ mmol} \left| \frac{1\ mol\ Fe(OH)_3}{1\ mol\ Fe(NO_3)_3} \right| \frac{89.87\ g}{mol} = 172.23\ g\ Fe(OH)_3$$

$Fe(NO_3)_3$ used:

$$55.85\ g\ Fe(OH)_3 \left| \frac{mol}{89.87\ g} \right| \frac{1\ mol\ Fe(NO_3)_3}{1\ mol\ Fe(OH)_3} = 0.621\ mol\ Fe(NO_3)_3\ used$$

started: $3.41\,L \left| \frac{562\ mmol}{L} \right| \frac{10^{-3}\ mol}{1\ mmol} = 1.916\ mol$

left over: $1.916 - 0.621 = \frac{1.295\ mol\ Fe(NO_3)_3}{3.41\,L + 2.13\,L} = 0.234\ M$

b. $3Ca(OH)_2(aq) + 2FeCl_3(aq) \rightarrow 2Fe(OH)_3(s) + 3CaCl_2(aq)$

$$5.86\ mL \left| \frac{10^{-6}\,L}{1\ mL} \right| \frac{7.31\ mol\ Ca(OH)_2}{L} \left| \frac{2\ mol\ Fe(OH)_3}{3\ mol\ Ca(OH)_2} \right| \frac{89.87\ g}{mol} = 0.0257\ g\ Fe(OH)_3$$

$$1.00\,L \left| \frac{12\ mmol\ FeCl_3}{L} \right| \frac{10^{-6}\ mol}{1\ mmol} \left| \frac{2\ mol\ Fe(OH)_3}{2\ mol\ FeCl_3} \right| \frac{89.87\ g}{mol} = 0.00108\ g\ Fe(OH)_3$$

$Ca(OH)_2$ used: $0.00108\ g\ Fe(OH)_3 \left| \frac{mol}{89.87\ g} \right| \frac{3\ mol\ Ca(OH)_2}{2\ mol\ FeOH} = 1.8 \times 10^{-5}\ mol\ Ca(OH)_2\ used$

starting: $5.86\ mL \left| \frac{10^{-6}\,L}{1\ mL} \right| \frac{7.31\ mol\ Ca(OH)_2}{L} = 4.28 \times 10^{-5}\ mol$

$$\frac{4.28 \times 10^{-5} - 1.8 \times 10^{-5}}{5.86 \times 10^{-6} + 1.00} = 2.48 \times 10^{-5}\ M\ Ca(OH)_2$$

29. a. yes b. no c. yes (IIA are exceptions for OH^-)
d. No. Phosphate is typically not soluble

30. a. sodium sulfide b. Iron(III) sulfide
c. calcium hydroxide d. Molybdenum(IV) phosphate

31. a. NH_3 — polar + H-bonds b. NaCl ($AgCl$ = not soluble)
c. CH_3OH H-bonds d. CH_3OH Better H-bonds

32. a. P + T are constant, so V = constant (n) $V \propto n$
- so treat V as moles!

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

$$2.8\,L\ N_2 \left| \frac{3\ NH_3}{1\ N_2} \right. = 8.4\,L \qquad 4.4\,L\ H_2 \left| \frac{2\ NH_3}{3\ H_2} \right. = 2.93\,L$$

b) $2N_2 + 5O_2 \longrightarrow 2N_2O_5$

$$2.8\,L\ N_2 \left| \frac{2\ N_2O_5}{2\ N_2} \right. = 2.8\,L\ N_2O_5 \qquad 4.4\,L\ O_2 \left| \frac{2\ N_2O_5}{5\ O_2} \right. = 1.76\,L$$

33. a. V = 0.5 L
T = 490 K
$$P = 385.27\ kPa \left| \frac{1\ atm}{101.25\ kPa} \right. = 3.81\ atm$$

$$n = \frac{PV}{RT} = \frac{3.81\ atm\ (0.5\,L)}{0.0826\ (490\,K)}$$

$$n = 0.0473\ mol$$

$$MW = \frac{12\,g}{0.0473\ mol} = 253.6\ g/mol \div 2 = 126.8\ g/mol = \text{Iodine}$$

... so I_2

b. $T = 26.85\ ^\circ C + 273.15 = 300\ K$

$V = 0.25\ L$

$P = 779.51\ kPa \left| \frac{1\ atm}{101.25\ kPa} \right. = 7.699\ atm$

O_2

$n = \frac{7.699\ atm\ (0.252)}{300K\ (0.08206)} = 0.078\ mol$

$\frac{2.5\ g}{0.078\ mol} = 31.98\ g/mol$

34.a $2P(s) + 5Cl_2(g) \longrightarrow 2PCl_5(s)$

$5\ g \left| \frac{mol}{30.97\ g} \right| \frac{2\ mol\ PCl_5}{2\ mol\ P} \left| \frac{208.21\ g}{mol} \right. = 33.61\ g\ PCl_5$

$n_{Cl_2} = \frac{4L\ (1.4\ atm)}{0.08206\ (273.15+212)} = 0.141\ mol\ Cl_2 \left| \frac{2\ PCl_5}{5\ Cl_2} \right| \frac{208.21\ g}{mol} = 11.71\ g$

Cl_2 is the L.R. AND the only gas. Since all moles gas are consumed, $P = 0$

b. $I_2(s) + 5F_2(g) \longrightarrow 2IF_5(s)$

$12\ g\ I_2 \left| \frac{mol}{253.8\ g} \right| \frac{2\ mol\ IF_5}{1\ mol\ I_2} \left| \frac{221.9\ g}{mol} \right. = 20.98\ g\ IF_5$

$n = \frac{1.8\ atm\ (5\ atm)}{0.08206\ (100+273.15)} = 0.294\ mol\ F_2$ (starting F_2) $\left| \frac{2\ mol\ IF_5}{5\ mol\ F_2} \right| \frac{221.9\ g}{mol} = 26.095\ g$

$20.98\ g\ IF_5 \left| \frac{mol}{221.9\ g} \right| \frac{5\ mol\ F_2}{2\ mol\ IF_5} = 0.236\ mol$ used

$0.294\ mol\ F_2 - 0.236\ mol\ F_2 = 0.0576\ mol\ F_2$ left

$T = 373.15 + 25 = 398.15$

$V = 1.8 \times 2 = 3.6\ L$

$P = \frac{nRT}{V} = \frac{0.0576\ (0.08206)\ (398.15)}{3.6}$

$P = 0.523\ atm$

35a. $0.52(680) = 353.6$ torr

b. $0.14(107) = 14.98$ kPa

36a. $2(C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$

250 mL

Density $= \frac{703\ kg}{m^3} \left| \frac{10^3\ g}{1\ kg} \right| \frac{10^{-2}\ m}{1\ cm} \left| \frac{10^{-2}\ m}{1\ cm} \right| \frac{10^{-2}\ m}{1\ cm} \left| \frac{1\ cm^3}{1\ mL} \right| = 0.703 \frac{g}{mL}$

$250\ mL \left| \frac{0.703\ g}{mL} \right| \frac{mol}{114.232\ g} \left| \frac{16\ mol\ CO_2}{2\ mol\ C_8H_{18}} \right| = 12.31\ mol\ CO_2$

$n_{O_2} = \frac{1.82\ atm\ (2.00\ L)}{373.15\ K\ (0.08206)} = 0.1189\ mol\ O_2 \left| \frac{16\ mol\ CO_2}{25\ mol\ O_2} \right| = 0.076\ mol\ CO_2$

O_2 = L.R.

0.076 mol CO_2 produced

$0.076\ mol\ CO_2 \left| \frac{18\ mol\ H_2O}{16\ mol\ CO_2} \right| = 0.0856\ mol\ H_2O$ produced

NO O_2 left $\quad n_{total} = 0.076 + 0.0856 = 0.1616\ mol$

$P = \frac{0.1616\ mol\ (0.08206)(373.15)}{2.00\ L} = 2.474\ atm$

b. $C_2H_6O_{(l)} + 3O_2(g) \rightarrow 2CO_2 + 3H_2O$

$789 \frac{kg}{m^3} = 0.789\ g/mL$ (see above for % conversion)

$12.5\ mL \left| \frac{0.789\ g}{mL} \right| \frac{mol}{46.07\ g} \left| \frac{2\ mol\ CO_2}{1\ mol\ C_2H_6O} \right| = 19.725\ mol\ CO_2$

$n_{O_2} = \frac{1.00\ L\ (0.52\ atm)}{0.08206\ (373.15\ K)} = 0.01829\ mol\ O_2 \left| \frac{2\ mol\ CO_2}{3\ mol\ O_2} \right| = 0.01219\ mol\ CO_2$

$0.01215 \text{ mol } CO_2 \left| \frac{3 \text{ mol } H_2O}{2 \text{ mol } CO_2} \right. = 0.01829 \text{ mol } H_2O$

$n_{total} = 0.01829 + 0.01219 = 0.0305 \text{ mol}$

$P = \frac{0.0305 \text{ mol } (0.08206)(373.15 \text{ K})}{1.00 \text{ L}} = 0.933 \text{ atm}$

37. a. $\text{rate} = k[C_0]^a[OH]^b$

1 vs. 2 $\quad \frac{2.04 \times 10^{-3}}{0.0123} = \frac{K}{K}\left(\frac{0.468}{0.468}\right)^a\left(\frac{0.14733}{0.884}\right)^b$

$0.166 = (0.167)^b \qquad \log 0.166 = b \log 0.166 \qquad \boxed{b = 1}$

2 vs. 3 $\quad \frac{0.0123}{0.1101} = \frac{K}{K}\left(\frac{0.468}{1.404}\right)^a\left(\frac{0.884}{0.884}\right)^b$

$0.1117 = 0.333^a \qquad \log 0.1117 = a \log 0.333 \qquad \boxed{a = 2}$

$\text{rate} = k[C_0]^2[OH^-]^1$

$0.1101 \frac{mM}{min} = k(1.404 \text{ mM})^2(0.884 \text{ mM}) \qquad K = 0.063 \text{ mM}^{-2}\text{min}^{-1}$

b. $\text{rate} = k[NH_3]^a[H_2]^b$

1 vs 2 $\quad \frac{0.42}{1.26} = \frac{K}{K}\left(\frac{1.866}{1.866}\right)^a\left(\frac{0.15}{0.26}\right)^b$

2 vs. 3 $\quad \frac{1.26}{1.03} = \frac{K}{K}\left(\frac{1.866}{1.52}\right)^a\left(\frac{0.26}{0.26}\right)^b$

$1.22 = 1.22^a$

$\boxed{a = 1}$

$0.333 = 0.577^b$

$\log 0.333 = b \log 0.577$

$-0.478 = -0.239\, b$

$\boxed{b = 2}$

$\text{rate} = k[NH_3]^1[H_2]^2$

$1.03 \frac{mM}{sec} = K(1.52 \text{ mM})(0.26 \text{ mM})^2 \qquad K = 10.02 \text{ mM}^{-2}\text{s}^{-1}$

38. a) $\text{rate} = 0.063 \text{ mM}^{-2}\text{min}^{-1}(0.5 \text{ mM})^2(0.5 \text{ mM}) = 0.00788 \text{ mM/min}$

b) $\text{rate} = 10.02 \text{ mM}^{-2}\text{s}^{-1}(0.5 \text{ mM})(0.5 \text{ mM})^2 = 1.253 \text{ mM/sec}$

39. plot of $\ln A$ vs. t is linear ($r^2 = 1$) slope $= -4.23$, y-int $= 13.816$

a) 1ST order

b) $k = 4.23\ min^{-1}$

c) rate $= 4.23\ min^{-1}[C_2H_5Cl]$

d) $b = \ln[A]_0$

$\ln[A]_0 = 13.816$

$[A]_0 = 1{,}000{,}486\ \mu M$

e) rate $= 4.23\ min^{-1}(1{,}000{,}486\ \mu M) = 4{,}232{,}055\ \mu M/min$

f) $y = -4.23x + 13.816$

$t = 30\ sec = 0.5\ min$

$y = -4.23(0.5) + 13.816 = 11.701$

$\ln[A] = 11.701$

$[A] = [C_2H_5Cl] = 120692\ \mu M$

$$rate = -\frac{\Delta[C_2H_5Cl]}{\Delta t} = \frac{-(120692 - 1{,}000{,}486)}{30 - 0} = 29{,}326.5\ \mu M/sec$$

$$rate = \frac{\Delta[HCl]}{\Delta t} = \frac{x - 0}{30 - 0} \qquad x = [HCl] = 879{,}793\ \mu M$$

$$rate = \frac{\Delta[C_2H_4]}{\Delta t} = \frac{x - 0}{30 - 0} \qquad x = [C_2H_4] = 879{,}793\ \mu M$$

$\frac{1}{[A]}$ is linear

$y = 0.013 + 2$

a) 2nd order

b) $k = 0.013\ M^{-1}s^{-1}$

c) rate $= 0.013\ M^{-1}s^{-1}[HCl]^2$

d) $b = \frac{1}{[A]_0} = 2$ $[A]_0 = 1/2\ M$

e) rate $= 0.013\ M^{-1}s^{-1}(0.5\ M)^2 = 0.00325\ \frac{M}{s}$

f) HCl: $y = 0.013x + 2$

$y = 0.013(30) + 2 = 2.39 = \frac{1}{[A]}$ $[A] = 0.418\ M$

g) $rate = -\frac{1}{2}\frac{\Delta[HCl]}{\Delta t} = -\frac{1}{2}\frac{(0.418 - 0.5)}{30 - 0} = 0.00137\ M$

$$\text{rate} = \frac{\Delta[H_2]}{\Delta t} = \frac{x-0}{30} \qquad x = [H_2] = 0.041\ M$$

$$\text{rate} = \frac{\Delta[Cl_2]}{\Delta t} = \frac{x-0}{30} \qquad x = [Cl_2] = 0.041\ M$$