Fossum

part 1

Chem 30A - Answers to review questions (Final)

1. $V_{solid} = 13.1 - 10.3\ mL = 2.8\ mL$ $d = \frac{m}{V} = \frac{54.98g}{2.8mL} = 1\bar{9}.6\ g/mL$

$= 20.\ g/mL$

2. same material, so same density $= 1\bar{9}.6\ g/mL$

$(50.0\ cm^3)\left(\frac{1\ mL}{1\ cm^3}\right)\left(\frac{1\bar{9}.6\ g}{1\ mL}\right)\left(\frac{1\ kg}{1000\ g}\right) = 0.98\ kg$

3. $(5.0\ gal)\left(\frac{4\ qt}{1\ gal}\right)\left(\frac{1\ L}{1.06\ qt}\right)\left(\frac{1000\ mL}{1\ L}\right) = 1.9 \times 10^4\ mL$

4. P - group 5, so 5 valence e^-

5. Ca - group 2   Charge $= +2$ Ca^{2+}

6. S 16 ve⁻ $1s^2 2s^2 2p^6 3s^2 3p^4$

Fe 26 ve⁻ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ or $[Ar]4s^2 3d^6$

Mg^{2+} $12p^+$, $10e^-$ $1s^2 2s^2 2p^6$

Fe^{3+} 26 ve⁻ − 3 = 23 ve⁻ transition metals lose e⁻ from the outermost s orbital first. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

or $[Ar]3d^5$

7. period - horizontal row of periodic table

group - vertical column " "

Br: period 4, group 7A.

8. $^{32}_{15}P$ $15p^+$, $15e^-$, $32 - 15 = 17n^\circ$

9. $q = sm\Delta T$ $s = 0.092\ cal/g°C$ $\Delta T = 193 - 25 = 168°C$

$m = \frac{q}{s\Delta T}$ $q = (4.0 \times 10^2\ kcal)\left(\frac{1000\ cal}{1\ kcal}\right) = 4.0 \times 10^5\ cal$

$m = \frac{4.0 \times 10^5\ cal}{(0.092\ cal/g°C)(168°C)} = 2.\bar{5}88 \times 10^4\ g\ Cu$

$(2.588 \times 10^4\ g)\left(\frac{1\ kg}{1000\ g}\right) = 26\ kg\ Cu$

10. $q = sm\Delta T$

$\Delta T = \frac{q}{sm} = \frac{(90.0\ cal)}{(0.106\ cal/g°C)(7.00\ g)} =$ $12\bar{1}.3\ °C = \Delta T$

$T_{final} = 23°C + 121.3 = 144°C$

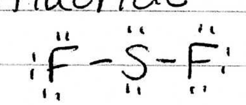
$T_i + \Delta T$

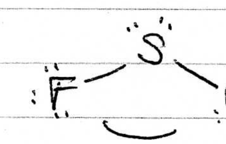
m = molecular
i = ionic

11. PCl_5 (m) phosphorus pentachloride
$Pb(OH)_2$ (i) lead (II) hydroxide
$Zn_3(PO_4)_2$ (i) zinc phosphate
$FeSO_3$ Fe^{2+}, SO_3^{2-} (i) iron (II) sulfite
NF_3 (m) nitrogen trifluoride
$AgCl$ (i) silver chloride
Na_3P (i) sodium phosphide
$Ca(HCO_3)_2$ (i) calcium bicarbonate OR calcium hydrogen carbonate
dinitrogen monoxide (m) N_2O
copper (II) sulfide (i) Cu^{2+}, S^{2-} — CuS
gold (III) carbonate (i) Au^{3+}, CO_3^{2-} — $Au_2(CO_3)_3$
tin (II) bromide (i) Sn^{2+}, Br^- — $SnBr_2$
silver nitride (i) Ag^+, N^{3-} — Ag_3N
chromium (III) nitrate (i) Cr^{3+}, NO_3^- — $Cr(NO_3)_3$
barium acetate (i) $Ba^{2+}, C_2H_3O_2^-$ — $Ba(C_2H_3O_2)_2$
mercury (II) chloride (i) Hg^{2+}, Cl^- — $HgCl_2$

12. $2\,C_5H_{12}O + 15\,O_2 \rightarrow 10\,CO_2 + 12\,H_2O$ combustion
$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$ redox
$2\,Al + 3\,CuSO_4 \rightarrow 3\,Cu + Al_2(SO_4)_3$ single replacement + redox
$C_7H_{16} + 11\,O_2 \rightarrow 7\,CO_2 + 8\,H_2O$ combustion

13. SF_2 sulfur difluoride
$6 + 2(7) = 20\ ve^-$



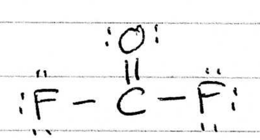


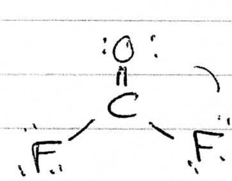
$<109.5°$

polar (not symmetric)

4 groups e^-, 2 lp ⇒ bent

COF_2
$4 + 6 + 2(7) = 24\ ve^-$

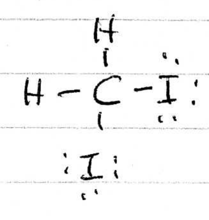


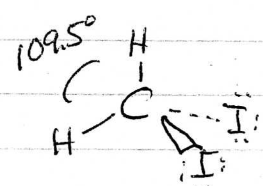


120°

trigonal planar, polar

CH_2I_2
$4 + 2(1) + 2(7)$
$20\ ve^-$

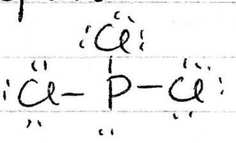


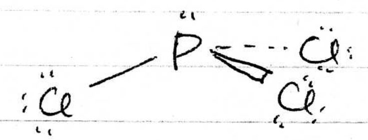


tetrahedral
polar

13. PCl_3 phosphorus trichloride

5+3(7)
26 ve⁻

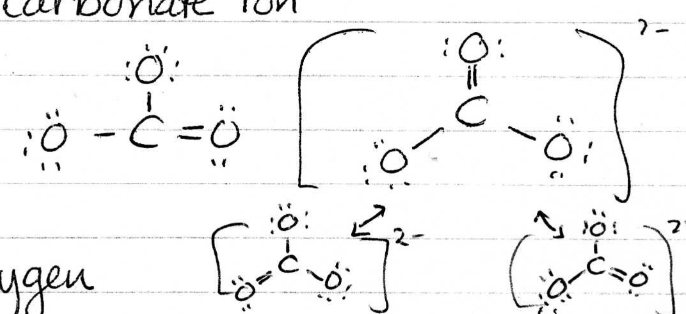




trigonal pyramid
< 109.5°
polar

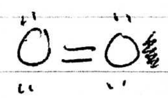
CO_3^{2-} carbonate ion

4+3(6)+2
24 ve⁻



trigonal planar
120°
nonpolar
(symmetric)
has resonance

O_2 oxygen
6+6 = 12



linear
nonpolar

14. a 10.778 ← 3dp
− 2.3344 ← 4dp
8.44$\bar{3}$6 ← 3 dp = 8.444

b. 0.00345 × 1.889 = 0.0065$\bar{1}$7   0.00652
3sf   4sf   3sf

c. 10.098 3dp
− 9.423 3dp
0.675 3dp

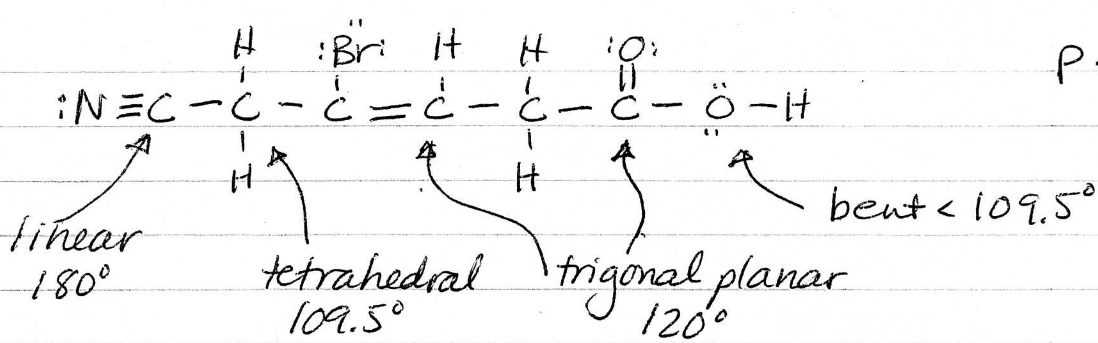
$\frac{0.675}{1.100}$ ← 3 sf, ↑ 4sf = 0.61$\bar{3}$6 = 0.614
3sf

d. 5360 ± 10
12.98 ± 0.01
500 ± 100
5$\bar{8}$72.98 ± 100 rounds to 5900 (2sf)

e. 3.456 × 45.74 = 158.0$\bar{7}$7 ... (4sf) now 1 dec place
+ 986.88 2 dec places
1144.$\bar{9}$57 1 dec place

⇒ 1145.0

15.



16. 6.70×10^{-6}

17. $°F = 1.8\ °C + 32$ $\qquad \frac{°F - 32}{1.8} = °C$

$\frac{95°F - 32}{1.8} = 35\ °C$

18. $(352\ g)\left(\frac{2260\ J}{g}\right)\left(\frac{1\ kJ}{1000\ J}\right) = 795.52\ kJ$ to vaporize
$= 796\ kJ$

use ΔH_{vap}

to melt: $(352\ g)\left(\frac{333\ J}{g}\right)\left(\frac{1\ kJ}{1000\ J}\right) = 117\ kJ$ to melt

19.

Start	100%
1 half-life	50%
2	25%

16 days

2 half-lives = 16 days
so 1 half life = 8 days

20. a) $Pb(NO_3)_{2\,(aq)} + Na_2S_{(aq)} \rightarrow PbS_{(s)} + 2\,NaNO_{3\,(aq)}$

Pb^{2+} NO_3^- Na^+ S^{2-}

tot $Pb^{2+} + 2NO_3^- + 2Na^+ + S^{2-} \rightarrow PbS_{(s)} + 2Na^+ + 2NO_3^-$

net $Pb^{2+} + S^{2-} \rightarrow PbS_{(s)}$

b) $2\,CrCl_{3\,(aq)} + 3K_2CO_{3\,(aq)} \rightarrow Cr_2(CO_3)_{3\,(s)} + 6KCl_{(aq)}$

Cr^{3+} Cl^- K^+ CO_3^{2-}

tot $2Cr^{3+} + 6Cl^- + 6K^+ + 3CO_3^{2-} \rightarrow Cr_2(CO_3)_{3\,(s)} + 6K^+ + 6Cl^-$

net $2Cr^{3+} + 3CO_3^{2-} \rightarrow Cr_2(CO_3)_{3\,(s)}$

c) $H_3PO_{4\,(aq)} + 3\,NaOH_{(aq)} \rightarrow 3H_2O_{(l)} + Na_3PO_{4\,(aq)}$

H^+ PO_4^{3-} Na^+ OH^-

20 c. continued H_3PO_4 is a weak acid, so it doesn't ionize completely.

tot $H_3PO_{4\,(aq)} + 3Na^+ + 3OH^- \rightarrow 3H_2O_{(l)} + 3Na^+ + PO_4^{3-}$

net $H_3PO_{4\,(aq)} + 3OH^- \rightarrow 3H_2O_{(l)} + PO_4^{3-}$

d. $NH_3 + HNO_3 \rightarrow NH_4NO_{3\,(aq)}$

weak $H^+ + NO_3^-$

tot $NH_3 + H^+ + NO_3^- \rightarrow NH_4^+ + NO_3^-$

net $NH_3 + H^+ \rightarrow NH_4^+$

e. $2HCl_{(aq)} + CrCO_{3\,(s)} \rightarrow H_2O_{(l)} + CO_{2\,(g)} + CrCl_{2\,(aq)}$

$H^+ \quad Cl^- \quad Cr^{2+} \quad CO_3^{2-}$

tot $2H^+ + 2Cl^- + CrCO_{3\,(s)} \rightarrow H_2O_{(l)} + CO_{2\,(g)} + Cr^{2+} + 2Cl^-$

net $2H^+ + CrCO_{3\,(s)} \rightarrow H_2O_{(l)} + CO_{2\,(g)} + Cr^{2+}$

21. Use $2CrCl_3 + 3K_2CO_3 \rightarrow Cr_2(CO_3)_3 + 6KCl$

$$(10.0\text{g } CrCl_3)\left(\frac{1 \text{ mol } CrCl_3}{158.35\text{g}}\right)\left(\frac{3 \text{ mol } K_2CO_3}{2 \text{ mol } CrCl_3}\right)\left(\frac{138.21\text{g } K_2CO_3}{1 \text{ mol } K_2CO_3}\right)$$

$$= 13.1 \text{ g } K_2CO_3$$

22. $$(15.0\text{g } K_2CO_3)\left(\frac{1 \text{ mol } K_2CO_3}{138.21\text{g } K_2CO_3}\right)\left(\frac{1 \text{ mol } Cr_2(CO_3)_3}{3 \text{ mol } K_2CO_3}\right)\left(\frac{284.03 \text{ g } Cr_2(CO_3)_3}{1 \text{ mol } Cr_2(CO_3)_3}\right)$$

$$= 10.3 \text{ g } Cr_2(CO_3)_3$$

23. Use $2HCl + CrCO_3 \rightarrow H_2O + CO_2 + CrCl_2$

$$(0.0300 \text{ L } HCl)\left(\frac{1.50 \text{ mol } HCl}{1 \text{ L}}\right)\left(\frac{1 \text{ mol } CO_2}{2 \text{ mol } HCl}\right)\left(\frac{\overset{STP}{22.4 \text{ L } CO_2}}{1 \text{ mol } CO_2}\right) = 0.504 \text{ L } CO_2$$

24. $PV = nRT$ $\quad (0.335\text{g } N_2O)\left(\frac{1 \text{ mol}}{44.02\text{g}}\right) = 0.007610\bar{2} \text{ mol } N_2O$

$T = \frac{PV}{nR}$ $\quad (654 \text{ torr})\left(\frac{1 \text{ atm}}{760 \text{ torr}}\right) = 0.86\bar{0}526 \text{ atm}$

Part 1

24. cont $T = \frac{PV}{nR} = \frac{(0.86\bar{0}526\ atm)(1.22\ L)}{(0.0076102\ mol)(0.08206\ \frac{L \cdot atm}{K\,mol})} = 16\bar{8}1\ K$

-273

$14\bar{0}8\ °C$

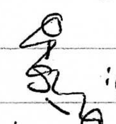
$1410\ °C$

25. a) C_6H_{14} C_8H_{18}

both are nonpolar + only have London forces. C_8H_{18} has the higher molar mass, so stronger London forces. higher bp: C_8H_{18}

Higher ΔH_{vap}: C_8H_{18} higher vp: C_6H_{14}

b) CO_2 SO_2



$:\ddot{O}-\ddot{S}=\ddot{O}$

MM = 44 g/mol 64 g/mol

$O=C=O$ $6 \times 3 = 18\ ve^-$ bent

linear, nonpolar | London, polar

only London forces | dipole-dipole and stronger London forces.

higher vp higher bp, ΔH_{vap}

c) CH_3NH_2 CH_3F

MM 31 g/mol 34 g/mol

Similar MM, so similar London forces.

can H-bond, polar can't H bond but polar

Stronger IMFs overall

higher bp, ΔH_{vap} higher vp

d) $CH_3CH_2CH_2CH_2OH$ CH_3CH_2OH

higher MM lower MM Both can H-bond,

but this one ↑ has a significantly higher MM and stronger London forces.

higher bp, ΔH_{vap} higher vp

26. a) neither soluble in water, smaller one C_6H_{14} is slightly more soluble than the other.

b) polar one is more soluble in water SO_2

c) CH_3NH_2 more soluble – can H-bond with water.

d) CH_3CH_2OH more soluble – smaller nonpolar section.

27. $PV = nRT$ $\quad P_{total}V = n_{total}RT$ $\quad n_{tot} = 0.660$ mol

$$V = \frac{nRT}{P} = \frac{(0.660\,mol)(0.08206\,\frac{L \cdot atm}{K\,mol})(308\,K)}{(2.55\,atm)} = 6.54\,L$$

28. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad V_2 = \frac{V_1 T_2}{T_1} = \frac{(35.0\,L)(273\,K)}{(298\,K)} = 32.1\,L$

T ↓, V should ↓.

29. Evaporation requires energy. Takes energy from your skin.

30. $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $\quad V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{(1.02\,atm)(43.0\,mL)(288\,K)}{(304\,K)(2.40\,atm)}$

$V_2 = 17.3\,mL$

31.

	start	0.40 mCi
1	5.26y	0.20 mCi
2	10.52y	0.10 mCi
3	15.78y	0.050 mCi

32. Higher temp, higher vp (more molecules have enough energy to escape)

CH_3CH_2OH vs CH_3OCH_3 ← weaker IMFs so higher vp (easier to vaporize)

can H-bond — can't H-bond

Highest vp: weakest IMFs and highest temp. d

33. a. $^{240}_{95}Am + ^{4}_{2}He \rightarrow ^{243}_{97}Bk + ^{1}_{0}n$

b. $^{238}_{92}U + ^{12}_{6}C \rightarrow ^{244}_{98}Cf + 6\,^{1}_{0}n$

c. $^{1}_{1}H + ^{14}_{7}N \rightarrow ^{11}_{6}C + ^{4}_{2}He$

34.

	Start	6.0 μCi
1	2.9 hr	3.0 μCi
2	5.8 hr	1.5 μCi
3	8.7 hr	0.75
4	11.6 hr	0.375 μCi

35. a. $2Fe_{(s)} + 3Cl_{2(g)} \rightarrow 2FeCl_{3(s)}$

b. $(5.00\,g\ Fe)\left(\frac{1\ mol\ Fe}{55.85\,g\ Fe}\right)\left(\frac{3\ mol\ Cl_2}{2\ mol\ Fe}\right)\left(\frac{70.90\,g\ Cl_2}{1\ mol\ Cl_2}\right) = 9.52\,g\ Cl_2$

$(5.00\,g\ Fe)\left(\frac{1\ mol\ Fe}{55.85\,g\ Fe}\right)\left(\frac{2\ mol\ FeCl_3}{2\ mol\ Fe}\right)\left(\frac{162.2\,g}{1\ mol\ FeCl_3}\right) = 14.\bar{5}2\,g\ FeCl_3$ $14.5\,g\ FeCl_3$

36. a. $2Al + 3Br_2 \rightarrow 2AlBr_3$ combination rxn

b. $(4.00\,g\ Al)\left(\frac{1\ mol\ Al}{26.98\,g}\right)\left(\frac{2\ mol\ AlBr_3}{2\ mol\ Al}\right)\left(\frac{266.68\,g\ AlBr_3}{1\ mol\ AlBr_3}\right) = 39.\bar{5}37\ g\ AlBr_3$

for part C see p. 10

$\%\ yield = \frac{actual}{theoretical} \times 100 = \frac{38.2\,g}{39.\bar{5}37\,g} \times 100 = 96.6\%\ yield$

37. $TiCl_4 + 4Na \rightarrow 4NaCl + Ti$

a. $(50.0\,g\ TiCl_4)\left(\frac{1\ mol\ TiCl_4}{189.68\,g}\right)\left(\frac{4\ mol\ Na}{1\ mol\ TiCl_4}\right)\left(\frac{22.99\,g\ Na}{1\ mol\ Na}\right) = 24.2\,g\ Na$

b. $(3.0\ mol\ Na)\left(\frac{1\ mol\ Ti}{4\ mol\ Na}\right)\left(\frac{6.022\times10^{23}\ atoms\ Ti}{1\ mol\ Ti}\right) = 4.5\times10^{23}\ atoms\ Ti$

c.

$(20.0\,L)\left(\frac{1000\,mL}{1\,L}\right)\left(\frac{1\,cm^3}{1\,mL}\right)\left(\frac{4.50\,g}{1\,cm^3}\right)\left(\frac{1\ mol\ Ti}{47.88\,g}\right)\left(\frac{1\ mol\ TiCl_4}{1\ mol\ Ti}\right)\left(\frac{189.68\,g}{1\ mol\ TiCl_4}\right)$

$= 3.5\bar{6}54\times10^5\,g$ then $(3.5\bar{6}54\times10^5\,g)\left(\frac{1\ lb}{453.6\,g}\right) = 786\ lb\ TiCl_4$

$(20.0\,L)\left(\frac{1000\,mL}{1\,L}\right)\left(\frac{1\,cm^3}{1\,mL}\right)\left(\frac{4.50\,g}{1\,cm^3}\right)\left(\frac{1\ mol\ Ti}{47.88\,g}\right)\left(\frac{4\ mol\ Na}{1\ mol\ Ti}\right)\left(\frac{22.99\,g\ Na}{1\ mol\ Na}\right)$

for part d, see p. 10

$\times \left(\frac{1\ lb}{453.6\,g}\right) = 381\ lb\ Na$

38. a. $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$

for part b, see p. 11

$(3.77g\ Al)\left(\frac{1\ mol\ Al}{26.98g}\right)\left(\frac{3\ mol\ H_2}{2\ mol\ Al}\right) = 0.2096\ mol\ H_2$

$PV = nRT$ $\quad (764)\left(\frac{1\ atm}{760}\right) = 1.00526\ atm$

$V = \frac{nRT}{P}$ $\quad V = \frac{(0.2096\ mol)(0.08206\ \frac{L\cdot atm}{K\ mol})(293\ K)}{1.00526\ atm}$

$V = 5.01\ L\ H_2$

39. $(5.0 \times 10^{20}\ molec\ HCl)\left(\frac{1\ mol}{6.022\times10^{23}\ molec}\right)\left(\frac{2\ mol\ Al}{6\ mol\ HCl}\right)\left(\frac{26.98g\ Al}{1\ mol\ Al}\right) =$

$= 0.0075\ g\ Al$

40. a) $CuSO_{4\,(aq)} + 2NaOH_{(aq)} \rightarrow Cu(OH)_{2\,(s)} + Na_2SO_{4\,(aq)}$

$Cu^{2+}\ SO_4^{2-}\ Na^+\ OH^-$

tot $Cu^{2+} + SO_4^{2-} + 2Na^+ + 2OH^- \rightarrow Cu(OH)_{2\,(s)} + 2Na^+ + SO_4^{2-}$

net $Cu^{2+} + 2OH^- \rightarrow Cu(OH)_{2\,(s)}$

b). $2HBr_{(aq)} + Ba(OH)_{2\,(aq)} \rightarrow 2H_2O_{(l)} + BaBr_{2\,(aq)}$

$H^+\ Br^-\ Ba^{2+}\ OH^-$

tot $2H^+ + 2Br^- + Ba^{2+} + 2OH^- \rightarrow 2H_2O_{(l)} + Ba^{2+} + 2Br^-$

net $2H^+ + 2OH^- \rightarrow 2H_2O_{(l)}$

$H^+ + OH^- \rightarrow H_2O_{(l)}$

c) $3Ni(NO_3)_{2\,(aq)} + 2K_3PO_{4\,(aq)} \rightarrow Ni_3(PO_4)_{2\,(s)} + 6KNO_{3\,(aq)}$

$Ni^{2+},\ NO_3^-\ K^+\ PO_4^{3-}$

tot $3Ni^{2+} + 6NO_3^- + 6K^+ + 2PO_4^{3-} \rightarrow Ni_3(PO_4)_{2\,(s)} + 6K^+ + 6NO_3^-$

net $3Ni^{2+} + 2PO_4^{3-} \rightarrow Ni_3(PO_4)_{2\,(s)}$

40 d. $HBr_{(aq)} + NH_{3(aq)} \rightarrow NH_4Br_{(aq)}$

$H^+ \quad Br^- \qquad NH_3$

tot $H^+ + Br^- + NH_3 \rightarrow NH_4^+ + Br^-$

net $H^+ + NH_3 \rightarrow NH_4^+$

e. $MgCO_{3(s)} + 2HBr_{(aq)} \rightarrow MgBr_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

$Mg^{2+} \quad CO_3^{2-} \quad H^+ \quad Br$

tot. $MgCO_{3(s)} + 2H^+ + 2Br^- \rightarrow Mg^{2+} + 2Br^- + H_2O_{(l)} + CO_{2(g)}$

net $MgCO_{3(s)} + 2H^+ \rightarrow Mg^{2+} + H_2O_{(l)} + CO_{2(g)}$

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36 c. limiting reactant problem

$$(3.00\,g\ Al)\left(\frac{1\ mol\ Al}{26.98\,g\ Al}\right)\left(\frac{2\ mol\ AlBr_3}{2\ mol\ Al}\right)\left(\frac{266.68\,g\ AlBr_3}{1\ mol\ AlBr_3}\right) = 29.\overline{6}53\,g\ AlBr_3$$

(from all Al reacting)

$$(3.00\,g\ Br_2)\left(\frac{1\ mol\ Br_2}{159.8\,g\ Br_2}\right)\left(\frac{2\ mol\ AlBr_3}{3\ mol\ Br_2}\right)\left(\frac{266.68\,g\ AlBr_3}{1\ mol\ AlBr_3}\right) = 3.3\overline{3}77\,g\ AlBr_3$$

(from all Br_2 reacting)

so Br_2 is the limiting reactant and only 3.34 g $AlBr_3$ will form (theoretically)

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37 d. LR problem (given amts of two reactants)

$$(2.00\,g\ TiCl_4)\left(\frac{1\ mol\ TiCl_4}{189.68\,g}\right)\left(\frac{4\ mol\ NaCl}{1\ mol\ TiCl_4}\right)\left(\frac{58.44\,g\ NaCl}{1\ mol\ NaCl}\right) = 2.4\overline{6}48\,g\ NaCl$$

or

$$(0.500\,g\ Na)\left(\frac{1\ mol\ Na}{22.99\,g}\right)\left(\frac{4\ mol\ NaCl}{4\ mol\ Na}\right)\left(\frac{58.44\,g\ NaCl}{1\ mol\ NaCl}\right) = 1.27\,g\ NaCl$$

smaller amt.

Na is LR and 1.27 g NaCl will form.

37 e. LR problem - given (a way to find) moles of 2 things.

$$(1.00\times10^{23}\ atoms\ Na)\left(\frac{1\ mol\ Na}{6.022\times10^{23}\ atoms}\right)\left(\frac{1\ mol\ Ti}{4\ mol\ Na}\right)\left(\frac{47.88\,g\ Ti}{1\ mol\ Ti}\right)\left(\frac{1\ cm^3\ Ti}{4.50\,g\ Ti}\right) = 0.4417\ cm^3\ Ti$$

LR $\rightarrow$ $$(1.00\,g\ TiCl_4)\left(\frac{1\ mol\ TiCl_4}{189.68\,g}\right)\left(\frac{1\ mol\ Ti}{1\ mol\ TiCl_4}\right)\left(\frac{47.88\,g\ Ti}{1\ mol\ Ti}\right)\left(\frac{1\ cm^3\ Ti}{4.50\,g\ Ti}\right) = 0.0561\ cm^3$$

amt formed

$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_{2(g)}$ p. 11

38 b. LR problem - given specific amounts of two ~~products~~ reactants,
at STP 22.4L/mol for any gas.

$$(5.00g\ Al)\left(\frac{1\ mol\ Al}{26.98g\ Al}\right)\left(\frac{3\ mol\ H_2}{2\ mol\ Al}\right)\left(\frac{22.4\ L\ H_2}{1\ mol\ H_2}\right) = 6.23\ L\ H_2$$

(from Al)

$$(25.0mL\ HCl)\left(\frac{1L\ HCl}{1000\ mL\ HCl}\right)\left(\frac{5.00\ mol\ HCl}{1L}\right)\left(\frac{3\ mol\ H_2}{6\ mol\ HCl}\right)\left(\frac{22.4L\ H_2}{1\ mol\ H_2}\right) = 1.4L$$

LR is HCl.

1.40 L $H_{2(g)}$ formed at STP

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41. $Co_3(PO_4)_2$ cobalt (II) phosphate

$$\%Co = \frac{\text{mass Co}}{\text{total mass}} \times 100$$

$Co_3(PO_4)_2$ MM = $3(58.93) + 2(30.97) + 8(16.00) = 366.73$ g/mol

$$\%Co = \frac{3(58.93)\,g\ Co}{366.73\ g\ total} \times 100 = 48.21\%\ Co$$

$$\%P = \frac{2(30.97)\,g\ P}{366.73\ g\ total} \times 100 = 16.89\%\ P$$

$$\%O = \frac{8(16.00)\,g\ O}{366.73\ g\ total} \times 100 = 34.90\%\ O$$

42. Mass Fe in 25.0 g $Fe_2(CO_3)_3$ MM = $2(55.85) + 3(12.01) + 9(16.00)$
= 291.73 g/mol

$$(25.0g\ Fe_2(CO_3)_3)\left(\frac{1\ mol\ Fe_2(CO_3)_3}{291.73\ g\ Fe_2(CO_3)_3}\right)\left(\frac{2\ mol\ Fe}{1\ mol\ Fe_2(CO_3)_3}\right)\left(\frac{55.85\ g\ Fe}{1\ mol\ Fe}\right) =$$

= 9.57 g Fe

43. 57.0 g $C_5H_{12}O_2$ MM = $5(12.01) + 12(1.008) + 2(16.00) = 104.146$ g/mol

$$(57.0g\ C_5H_{12}O_2)\left(\frac{1\ mol\ C_5H_{12}O_2}{104.146\ g\ C_5H_{12}O_2}\right)\left(\frac{5\ mol\ C}{1\ mol\ C_5H_{12}O_2}\right)\left(\frac{6.022\times10^{23}\ C\ atoms}{1\ mol\ C}\right) = 1.65\times10^{24}\ C\ atoms$$

44. $168\ ft^2$

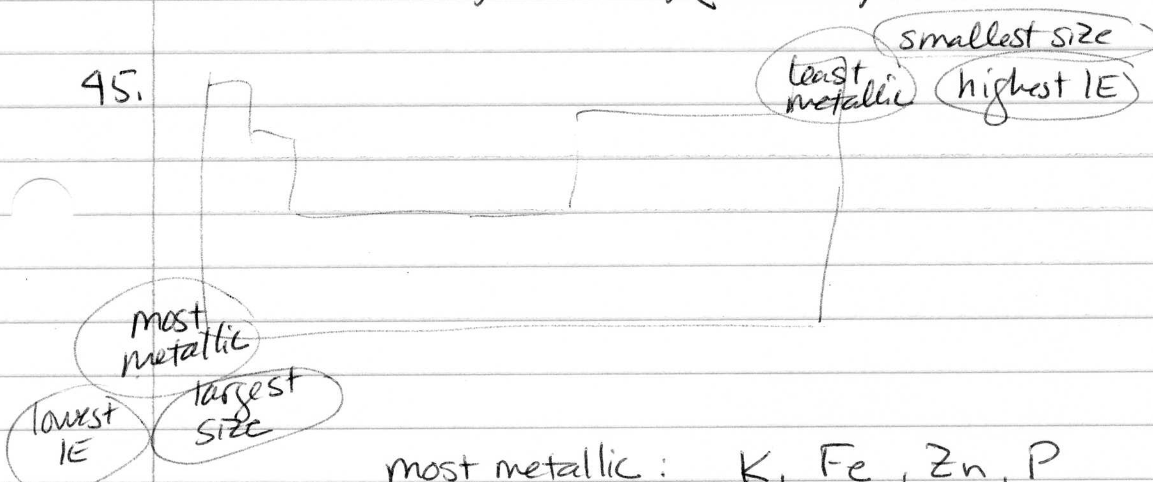
$1\ ft = 12\ in$
$1\ in = 2.54\ cm$
$1\ m = 100\ cm$

a. $168\ ft^2 \left(\frac{12\ in}{1\ ft}\right)^2 = 24{,}192\ in^2$ $\quad 2.42 \times 10^4\ in^2$

square whole conversion factor

b. $(168\ ft^2)\left(\frac{12\ in}{1\ ft}\right)^2\left(\frac{2.54\ cm}{1\ in}\right)^2\left(\frac{1\ m}{100\ cm}\right)^2 = 15.6\ m^2$

45.



most metallic: K, Fe, Zn, P $\quad$ least

46. small to large: O, Al, Ag $\quad$ large

47. IE: amount of energy needed to remove an e^-.
increasing IE $\quad$ small IE → large IE

Ba, Ni, N, Ne $\quad$ large IE

easy to remove e^- $\quad$ hard to remove e^-

48. Dilution
$50.0\ mL^{V_1}$ $3.00\ M^{M_1}$ Na_2SO_4 → $1.00\ M^{M_2}$ $\quad$ V water?

$M_1V_1 = M_2V_2$

$V_2 = \frac{M_1V_1}{M_2} = \frac{(3.00\ M)(50.0\ mL)}{(1.00\ M)} = 150.\ mL = V_2$

$V_{water} = 150. - 50.0\ mL$
$= 100.\ mL$ H_2O to add

49. 400.0 g solution   18.0% NH_3 moles NH_3?

$\frac{18.0\text{ g } NH_3}{100\text{ g solution}}$

$(400.0\text{ g solution})\left(\frac{18.0\text{ g } NH_3}{100\text{ g solution}}\right)\left(\frac{1\text{ mol } NH_3}{17.034\text{ g } NH_3}\right) = 4.2268\text{ mol } NH_3$

4.23 mol NH_3

50. ? mass solution   5.0% $HC_2H_3O_2$

$\frac{5.0\text{ g } HC_2H_3O_2}{100\text{ g solution}}$

$(7.88\text{ g } HC_2H_3O_2)\left(\frac{100\text{ g solution}}{5.0\text{ g } HC_2H_3O_2}\right) = 157.6\text{ g solution}$

160 g solution

51. pOH = 4.88

pH = 14.00 − 4.88 = 9.12 pH   basic solution (pH > 7)

$[H_3O^+] = 10^{-pH} = 10^{-9.12} = 7.6 \times 10^{-10}\text{ M } H_3O^+$ (7.586×10^{-10})

$[OH^-] = 10^{-pOH} = 10^{-4.88} = 1.3 \times 10^{-5}\text{ M } OH^-$ (1.318×10^{-5})

OR $[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.318 \times 10^{-5}} = 7.6 \times 10^{-10}\text{ M } H_3O^+$

52. HNO_3 is a strong acid. $[H_3O^+] = 0.040$ M

$pH = -\log[H_3O^+] = 1.3979 = 1.40$ pH   acidic

$[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{0.040} = 2.5 \times 10^{-13}\text{ M } OH^-$

53. $H_{2(g)}$, $N_{2(g)}$ both are diatomic.

$H_{2(g)} + N_{2(g)} \rightarrow NH_{3(g)}$ balance

$3H_{2(g)} + N_{2(g)} \rightarrow 2NH_{3(g)}$ Combination rxn

also redox rxn.

54. $KClO_{3(s)}$ $O_{2(g)}$ diatomic $KCl_{(s)}$

$2\ KClO_{3(s)} \longrightarrow 3\ O_{2(g)} + 2\ KCl_{(s)}$ decomposition and redox.

55. Ca_3P_2 (ionic) calcium phosphide Ca^{2+}, P^{3-}
SO_3 (molecular) sulfur trioxide
$Sn(MnO_4)_4$ (ionic) tin(IV) permanganate Sn^{4+}, MnO_4^-
N_2O_3 (molecular) dinitrogen trioxide
LiCN (ionic) Li^+, CN^- lithium cyanide
H_2SO_3 (oxyacid) has SO_3^{2-} sulfite sulfurous acid
$KHSO_4$ (ionic) has K^+, HSO_4^- potassium hydrogen sulfate or potassium bisulfate
HBr (binary acid) hydrobromic acid
NH_4ClO_4 (ionic) NH_4^+ ClO_4^- ammonium perchlorate
$Au_2Cr_2O_7$ (ionic) Au^+, $Cr_2O_7^{2-}$ gold(I) chromate
H_3PO_4 (oxyacid) contains PO_4^{3-} (phosphate) ~~phosphoric acid~~ phosphoric acid
$Pb(OH)_2$ (ionic) Pb^{2+}, OH^- lead(II) hydroxide
IBr_5 (molecular) iodine pentabromide
Cu_2S (ionic) Cu^+, S^{2-} copper(I) sulfide

56.

Ca^{2+}, CrO_4^{2-}	$CaCrO_4$	Fe^{3+}, ClO_2^-	$Fe(ClO_2)_3$
binary acid	HF	Hg^{2+}, F^-	HgF_2
	SF_6	Ni^{2+}, ClO_4^-	$Ni(ClO_4)_2$
contains ClO^- hypochlorite	HClO	Ag^+ PO_4^{3-}	Ag_3PO_4
		contains CO_3^{2-} carbonate	H_2CO_3
Zn^{2+} HCO_3^-	$Zn(HCO_3)_2$		
Co^{3+}, SO_4^{2-}	$Co_2(SO_4)_3$	contains S^{2-}	H_2S

57. a. $2C_2H_6 + 7O_2 \rightarrow 6H_2O + 4CO_2$

(-3) (+1) (∅) (+1) (-2) (+4) (-2)

C $-3 \rightarrow +4$ ox # increases - C is oxidized

O $\emptyset \rightarrow -2$ ox # $\downarrow$ O is reduced.

ox agent: O_2

red agent: C_2H_6

b. $2HBr + Mg \rightarrow MgBr_2 + H_2$

(+1) (-1) (∅) (+2) (-1) (∅)

H $+1 \rightarrow \emptyset$ ox # $\downarrow$ H is reduced

~~Br~~ Mg $\emptyset \rightarrow +2$ ox # $\uparrow$ Mg is oxidized

oxidizing agent: HBr

reducing agent: Mg

c. $Cr_2O_7^{2-} + 2NO + 6H^+ \rightarrow 2Cr^{3+} + 2NO_3^- + 3H_2O$

(+6) (-2) (+2) (-2) (+1) (+3) (+5) (-2) (+1) (-2)

Cr $+6 \rightarrow +3$ ox # $\downarrow$ reduced Cr

N $+2 \rightarrow +5$ ox # $\uparrow$ oxidized N

ox agent: $Cr_2O_7^{2-}$ red agent: NO

58. $Ni + Mn(NO_3)_2$ NR

$\boxed{\text{if } A + BC \rightarrow B + AC \text{ occurs, then A is more active than B}}$

Ni is <u>not</u> more active than Mn, So Mn is more active

59. Sn more active than H

So $Sn + 2HCl \rightarrow SnCl_2 + H_2$ this <u>will</u> happen.

Sn <u>will</u> react with acids

60. Sn is more active than Pb

$Sn + Pb(NO_3)_2 \rightarrow Pb + Sn(NO_3)_2$ yes, this <u>will</u> occur.