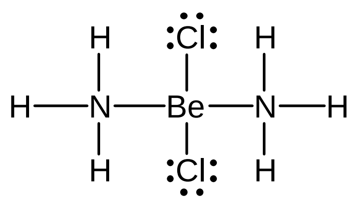
Homework 7

12. Size decreases from left to right and increases going down the periodic table. So, going one element right and one element down would result in a similar size for the two elements diagonal to each other. The ionization energies will be similar for the diagonal elements since the periodic trends also oppose each other. Electron affinities are harder to predict, but atoms with similar size and ionization energy should also have similar electron affinities.

18. $4\ Li(s) + O_2(g) \rightarrow 2\ Li_2O(s)$
$16\ Li(s) + S_8(s) \rightarrow 8\ Li_2S(s)$; $2\ Li(s) + Cl_2(g) \rightarrow 2\ LiCl(s)$
$12\ Li(s) + P_4(s) \rightarrow 4\ Li_3P(s)$; $2\ Li(s) + H_2(g) \rightarrow 2\ LiH(s)$
$2\ Li(s) + 2\ H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$; $2\ Li(s) + 2HCl(aq) \rightarrow 2LiCl(aq) + H_2(g)$

26. $BeCl_2$, with only four valence electrons, needs four more electrons to satisfy the octet rule. NH_3 has a lone pair electrons on the N atom. Therefore, $BeCl_2$ will react with two NH_3 molecules in order to achieve the octet rule, making $BeCl_2(NH_3)_2$ the likely product in excess ammonia. $BeCl_2(NH_3)_2$ has 2 + 2(7) + 2(5) + 6(1) = 32 valence electrons.



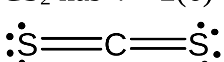
28.

	$CaCO_3(s)$	$\leftrightarrow$	$Ca^{2+}(aq)$	+	$CO_3^{2-}(aq)$
Initial	s = solubility (mol/L)		0		0
Equil.			s		s

$K_{sp} = 8.7 \cdot 10^{-9} = [Ca^{2+}][CO_3^{2-}] = s^2$, $s = 9.3 \cdot 10^{-5}$ mol/L

34. $B_2O_3(s) + 3Mg(g) \rightarrow 3\ MgO(s) + 2\ B(s)$

40. CS_2 has 4 + 2(6) = 16 valence electrons. C_3S_2 has 3(4) + 2(6) = 24 valence electrons.



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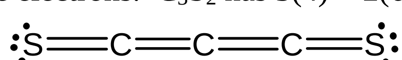

linear

48. SiC would have a covalent network structure similar to diamond.

52. The Be^{2+} ion is a Lewis acid and has a strong affinity for the lone pairs of electrons on oxygen in water. Thus, the compound is not dehydrated easily. The ion in solution is $Be(H_2O)_4^{2+}$. The acidic solution results from the reaction:
$Be(H_2O)_4^{2+}(aq) \rightarrow Be(H_2O)_3(OH)^+(aq) + H^+(aq)$

60. Pb_3O_4: We assign -2 for the oxidation state of O. The sum of the oxidation states of Pb must be +8. We get this if two of the lead atoms are Pb(II) and one is Pb(IV). Therefore, the mole ratio of lead(II) to lead(IV) is 2:1.

64. $SiCl_4(l) + 2H_2O(l) \rightarrow SiO_2(s) + 4H^+(aq) + 4Cl^-(aq)$

$\Delta H° = -911 + 4(0) + 4(-167) = [-687 + 2(-286)] = -320.$ kJ

$\Delta S° = 42 = 4(0) + 4(57) – [240. + 2(70.)] = -110.$ J/K; $\Delta G° = \Delta H° - T\Delta S°$

$\Delta G° = 0$ when $T = \Delta H°/\Delta S° = -320.•10^3$ J/(-110. J/K) = 2910 K

Due to the favorable $\Delta H°$ term, this reaction is spontaneous at temperatures below 2910 K.

The corresponding reaction for CCl_4 is:

$CCl_4(l) + 2H_2O(l) \rightarrow CO_2(g) + 4H^+(aq) + 4Cl^-(aq)$

$\Delta H° = -393.5 + 4(0) + 4(-167) – [-135 + 2(-286)] = -355$ kJ

$\Delta S° = 214 + 4(0) + 4(57) – [216 + 2(70.)] = 86$ J/K

Thermodynamics predict that this reaction would be spontaneous at any temperature. The answer must lie with kinetics. $SiCl_4$ reacts because an activated complex can form by a water molecule attaching to silicon in $SiCl_4$. The activated complex requires silicon to form a fith bond. Silicon has low energy 3d orbitals available to expand the octet. Carbon will not break the octet rule; therefore, CCl_4 cannot form this activated complex. CCl_4 and H_2O require a different pathway to get to products. The different pathway has a higher activation energy and, in turn, the reaction is much slower.