Chapter 9

PERIODIC TRENDS

Exercises

9.2 (a) The similarities in properties between the same oxidation state of an element of Group (*n*) and Period (*m*) with the element of Group (*n*+2) and Period (*m*+1).
(b) A polyatomic ion that behaves very similarly to that of an ion of an element or groups of elements.

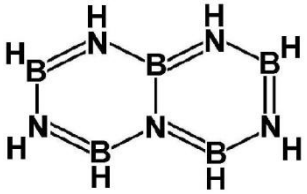
9.4 They both form anhydrous chlorides that react with water to release hydrogen chloride gas while their hexahydrates are water soluble. The anhydrous chlorides both function as Friedel-Craft catalysts. In the gas phase, their chlorides exist as dimers, Al_2Cl_6 and Fe_2Cl_6, respectively. On the other hand, iron(III) oxide is basic, while the oxide of aluminum is amphoteric. Also, iron(III) compounds are colored, while those of aluminum are white.

9.6 KH (d. 417°C); CaH_2 (m.p. 816°C); GaH_3 (m.p. –15°C); GeH_4 (m.p. –165°C); AsH_3 (m.p. –116°C); H_2Se (m.p. –86°C); HBr (m.p. –89°C) [information from www.webelements.com].
The bonding in the potassium and calcium hydrides is ionic, while that for the germanium, arsenic, selenium, bromine, and krypton compounds is covalent. The gallium compound does not fit the pattern of a network covalent between the ionic and small molecule covalent. It is too low to be ionic and not low enough to match the others in the period. In fact, GaH_3 is a dimer, Ga_2H_6 (analogous to diborane). Thus it is a small molecule covalent species, but with a doubled molecular mass and number of electrons, it has a higher melting point.

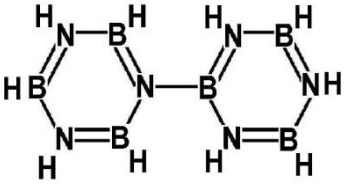
9.8 (a) They both form strongly oxidizing oxo-anions, MnO_4^- and ClO_4^-.
They both form explosive oxides, Mn_2O_7 and Cl_2O_7.
However, chlorine(VII) compounds are mostly colorless while those of manganese(VII) are intensely colored.
(b) There are, in fact, almost no similarities between these two ions.

Few silver(I) salts are soluble while nearly all rubidium salts are soluble. Silver(I) forms a normal oxide, Ag_2O, while rubidium forms the dioxide(2–), RbO_2.

9.10 (a)



(b)



9.12 $SiCl_4(l) + H_2O(l) \rightarrow SiO_2(s) + 4\ HCl(g)$
$TiCl_4(l) + H_2O(l) \rightarrow TiO_2(s) + 4\ HCl(g)$

9.14 Cl_2O_7 and Mn_2O_7. ClO_2 and MnO_2.

9.16 The physical properties of aluminum resemble those of Group 3 more than those of Group 13. Aluminum has a high reduction potential like Group 3 and unlike Group 13. The aluminum 3+ ion has a "closed shell" electron configuration like that of Group 3 and unlike the lower members of Group 13 that have a filled d^{10} electron set. Like scandium, the aluminum ion hydrolyses in water. There are several isomorphous compounds of aluminum and scandium.

9.18 Vanadium, $VOCl_3$.

9.20 $AlPO_4 \cdot 2\ H_2O$.

9.22 Cerium has the electron configuration $[Xe]6s^2 4f^9$. Forming the Ce^{4+} ion would give the ion the half-filled *d* orbital set.

9.24 (a) Indium(III) and bismuth(III); (b) zinc(II) and tin(II).

9.26 SgO_4^{2-} and $Sg_2O_7^{2-}$.

9.28 Using Table 9.22, barium should form a stable dioxide(2–). In fact, BaO_2 is formed when barium is heated in excess oxygen. Thus the prediction using charge densities is valid.

Beyond the Basics

9.30 $SiH_4(g) + 2\ O_2(g) \rightarrow SiO_2(s) + 2\ H_2O(g)$

9.32 If the transition metals are removed, then magnesium and zinc have a diagonal relationship (see below).

1	2	H	13	14	15	16	17	18
								He
Li	Be		B	C	N	O	F	Ne
Na	Mg	12	Al	Si	P	S	Cl	Ar
K	Ca	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Uub	Uut	Uuq	Uup	Uuh		Uuo

9.34 Cesium-137 is a particularly hazardous material because all common cesium salts are highly water soluble; thus any water, such as rain, on a broken gauge will result in the radioactive cesium dispersing into the environment.

9.36 IF_7. The compound does exist. The nonexistence of ClF_7 might result from the central chlorine atom being too small for seven large iodine atoms to be fitted around it.

9.38 +1, +2, +3, –4, –3, –2, –1 for Period 2.
+1, +2, +3, +4, ±3*, –2, –1 for Period 3.
* depending upon electronegativity scale used.

There is a trend to a maximum value of four followed by a decrease back down to one.

9.40 See table below.

	Group 2	Group 13	Group 14	Group 15	Group 16	Group 17
Group 14		BC_2^{5-}	C_3^{4-}	C_2N^{3-}		
Group 15		BN_2^{3-}	CN_2^{2-}	N_3^-	N_2O	N_2F^+
Group 16	BeO_2^{2-}	BO_2^-	CO_2	NO_2^+		
Group 17	BeF_2					