

Solutions to Suggested Problems From Chapter 5

1. Base your answer on ionization energies, with the lower ionization energy being the more reactive element; thus (a) K, (b) Na, (c) Ca, (d) Ca.
9. The alkali metals all have a valence shell electron configuration of ns^1 and easily lose one electron to give a noble gas electron configuration.
12. From K^+ ; both have the same electron configuration, but K^+ has a larger nuclear charge and already has a +1 charge.
21. The alkaline earths become larger from Be \rightarrow Ra because the valence shell is further from the nucleus (n gets larger).
30. C could be -4, P would be -3, S would be -2, I would be -1
32. Ba forms a +2 cation, fluoride is a -1 anion, hydride is a -1 anion, sulfide is a -2 anion, nitride is a -3 anion and oxide is -2 anion; thus, BaF_2 , BaH_2 , BaS , Ba_3N_2 , BaO
40. Cr is $[Ar]4s^23d^4$, which usually is better written as $[Ar]4s^13d^5$ (one of the exceptions to the usual filling of orbitals); the most common ions are Cr^{2+} and Cr^{3+}
43. To form an oxide that is XO, then X must form a +2 cation. A hydride of XH_2 also tells us that X is a +2 cation. Of the options, only Mg fits.
44. The formula of the hydride and oxide suggests that X must be capable of a +4 charge; only group IVA does this.
46. Na forms only a +1 cation; the IE_2 to give Na^{2+} is too large.
55. $Zn + F_2 \rightarrow ZnF_2$
 $2Al + 3F_2 \rightarrow 2AlF_3$
 $Sn + F_2 \rightarrow SnF_2$ or $Sn + 2F_2 \rightarrow SnF_4$
 $Mg + 2F_2 \rightarrow MgF_2$
 $2Bi + 3F_2 \rightarrow 2BiF_3$
60. BeO
66. (a) The attractive force depends upon the magnitude of q_+ and q_- , and the distance between the charges

(b) greater for +2/-2 because the F is directly proportional to the charges

(c) at a smaller distance since force is indirectly proportional to distance

(d) NaCl as Na^+ is smaller than K^+ , which means that the distance is smaller between Na^+ and Cl^- than between K^+ and Cl^-

(e) For Li_2O , where the radii are 0.068 and 0.14, the force is -46.2 and for CaO , where the radii are 0.099 and 0.14, the force is -70.0; thus the attraction is stronger for CaO .

75. Metals are larger than other elements in their period and have smaller nuclear charges; both contribute to relatively low ionization energies and lower AVEE values.

77. Metallic bonds have electrons that are totally delocalized, whereas ionic bonds have electrons that are completely localized to one atom. Covalent bonds also have localized electrons, but the electrons are localized between a specific pair of atoms.

78. The difference between the two types of bonds (ionic and covalent) is the extent to which electrons are shared by the two atoms, ranging from 50:50 for pure covalent bonding to 0:100 for pure ionic bonding.

81. Using the bond triangle, we have: CO as covalent, H_2O as covalent, BeF_2 as ionic/covalent, MgBr_2 as ionic, AlI_3 as ionic/covalent, ZnS as ionic/covalent and CdLi as metallic.

85. From the bond triangle, MgO and KI are ionic.

87. OF_2 is covalent; CS_2 is covalent; MgO is ionic; Na_2S is ionic

90. When ΔEN is greater than 2.6 the compound is always ionic.

92. (a) MgZn_2 , AlSb , SiH_4

(b) MgH_2 , BaCl_2 , MgF_2

(c) ICl , NP , HgO

(d) MgBr_2 , AlN , P_4O_7

(e) BaSi_2 , MgH , CO_2

93. The relevant information is here:

Compound	Mean EN	Δ EN	type
Hg ₂ S	2.18	0.83	covalent
GaSb	1.87	0.22	semimetal
Li ₃ N	1.99	2.16	ionic
NaBr	1.78	1.82	ionic
SnBr ₄	2.26	0.87	covalent
Na ₃ P	1.56	1.38	ionic/metallic
InP	1.96	0.59	covalent
InN	2.37	1.41	ionic/covalent
TeO ₂	2.88	1.45	covalent

101. (a) melting point and lack of conductivity suggest covalent

(b) high melting point and solid conductor suggests metal

(c) high melting point and conductor when molten suggests ionic

P₄O₆ has Δ EN of 1.34 and mean EN of 2.93, suggesting it is covalent and (a)

Mg₃N₂ has Δ EN of 1.78 and mean EN of 2.18, suggesting it is ionic and (c)

Mg₃Sb has Δ EN of 0.69 and mean EN of 1.64, suggesting it is metallic and (b)

103. Re₂Cl₈²⁻ → each Cl is -1 for a total of -9; two Re must be a total of +6 to leave a net charge of -2; each Re, therefore, is +3

Cr₂Cl₉³⁻ → each Cl is -1 for a total of -9; two Cr must be a total of +6 to leave a net charge of -3; each Cr is +3

Mo₂Cl₈⁴⁻ → each Cl is -1 for a total of -8; two Mo must be a total of +4 to leave a net charge of -4; each Mo is +2

104. K₃P → each K is +1 for a total of +3; thus, P is -3 to obtain a neutral compound

Na₃PO₄ → each Na is +1 for a total of +3 and each O is -2 for a total of -8 accounting for net charge of -5; thus, P is +5 to obtain a neutral compound

PO₃³⁻ → each O is -2 for a total of -6; thus, P is +3 to give total charge of -3

P₂Cl₄ → each Cl is -1 for a total of -4; thus, each P is +2 to obtain a neutral compound

105. $\text{LiAlH}_4 \rightarrow$ each H is -1 (bound to metal) for a total of -4 and the Li is +1 for a total charge of -3; thus, Al is +3.

$\text{Al}(\text{H}_2\text{O})_6^{3+} \rightarrow$ each water molecule is neutral; thus, Al is +3

$\text{Al}(\text{OH})_4^- \rightarrow$ each O is -2 for a total of -8 and each hydrogen is +1 for a total of +4 and a net of -4; thus, the Al is +3 to give the final charge of -1

106. $\text{NaAl}(\text{OH})_2\text{CO}_3 \rightarrow$ the Na is +1, the carbonate ion, CO_3^{2-} , is -2 and each OH^- is -1 for a total of -2; thus, the Al is +3 to give a neutral compound

116. $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \rightarrow$ the three $\text{Fe}(\text{CN})_6^{4-}$ ions have a total charge of -12; thus, the remaining iron must be +3 each

121. In HCl there are two bonding electrons between the H and Cl and three non-bonding pairs of electrons on the Cl. A calculation of formal charges gives 0 on H and 0 on Cl. A calculation of the partial charges gives +0.110 on H and -0.110 on Cl. The oxidation state for H is +1 and the oxidation state for Cl is -1.