

of the end of the formula. Thus, included in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ are ten H atoms and five O atoms (five from the water

Solved Problems

INTRODUCTION

- 6.1. Explain why the following three compounds, with such similar-looking formulas, have such different names:

KCl	Potassium chloride
CuCl	Copper(I) chloride
BrCl	Bromine monochloride

BINARY COMPOUNDS OF NONMETALS

- 6.2. Name the following compounds: (a) ClF, (b) CO_2 , (c) BrF_3 , (d) CCl_4 , (e) PF_5 , and (f) SF_6 .
- 6.3. Name the following compounds: (a) P_4O_{10} , (b) Cl_2O , and (c) ClO_2 .
- 6.4. Name the following: (a) a compound with two oxygen atoms and one chlorine atom per molecule; (b) a compound with one iodine atom and five fluorine atoms per molecule; and (c) a compound with one sulfur atom and six fluorine atoms per molecule.
- 6.5. Write formulas for each of the following compounds: (a) carbon tetrafluoride, (b) xenon hexafluoride, and (c) sulfur difluoride.
- 6.6. Name (a) H_2O and (b) NH_3 .
- 6.7. Write formulas for each of the following compounds: (a) dinitrogen trioxide, (b) carbon disulfide, and (c) carbon tetrabromide.
- 6.8. Write formulas for each of the following compounds: (a) dichlorine monoxide, (b) dichlorine trioxide, and (c) chlorine dioxide.

Ans.

NAMING IONIC COMPOUNDS

- 6.9. Name NH_3 and NH_4^+ .
- 6.10. How can a beginning student recognize an ionic compound?
- 6.11. Name (a) CuO and (b) Cu_2O .
- 6.12. In naming NO_3^- , professional chemists might say *nitrate* or *nitrate ion*, but in naming Na^+ , they always say *sodium ion*. Explain the difference.
- 6.13. What is the difference in the rules for remembering charges on monatomic anions and oxyanions?
- 6.14. Name the following ions: (a) Co^{3+} , (b) Fe^{2+} , (c) Pt^{2+} , and (d) Hg_2^{2+} .
Ans
- 6.15. Which metals in each of the following periodic groups form ions of only one charge? (a) IA, (b) IIA, (c) IIIA, (d) IB, and (e) IIB?
- 6.16. What is the charge on each of the following ions? (a) cyanide, (b) hydroxide, (c) peroxide, (d) nitride, and (e) chloride.
- 6.17. Using the periodic table if necessary, write formulas for the following compounds: (a) hydrogen sulfide, (b) barium chloride, (c) ammonium phosphate, (d) aluminum sulfate, (e) calcium bromide, (f) lithium sulfide, and (g) sodium fluoride.
- 6.18. Write formulas for copper(I) sulfide and (b) copper(II) sulfide.
- 6.19. Name the following compounds: (a) AgClO_3 and (b) $\text{Al}(\text{ClO})_3$.

- 6.20. Name the following ions: (a) Pb^{2+} , (b) IO_3^- , (c) IO_4^- , and (d) N^{3-} .
- 6.21. Name the following ions: (a) PO_3^{3-} , (b) S^{2-} , and (c) SO_4^{2-} .
- 6.22. Write formulas for each of the following compounds: (a) sodium chloride, (b) sodium chlorate, (c) sodium chlorite, (d) sodium hypochlorite, and (e) sodium perchlorate.
- 6.23. What is the difference between SO_3 and SO_3^{2-} ?
- 6.24. (a) Write the formula for calcium sulfide, calcium sulfite, and calcium sulfate. (b) How many elements are implied in the compound by the *-ide* ending? by the *-ite* ending? by the *-ate* ending? (c) Name a particular element that is implied by the *-ate* ending.
- 6.25. Name the following compounds: (a) CrCl_2 , (b) CrCl_3 , (c) CrO , (d) Cr_2O_3 , and (e) CrPO_4 .
- 6.26. Write formulas for the following compounds: (a) sodium chloride, (b) sodium sulfate, and (c) sodium phosphate.
- 6.27. Write formulas for the following compounds: (a) ammonium chloride, (b) ammonium sulfide, and (c) ammonium phosphate.
- 6.28. Name the following compounds: (a) $\text{Ca}_3(\text{PO}_4)_2$ and (b) $\text{Cr}_2(\text{SO}_4)_3$.

Ans.

- 6.29. Fill in the table with the formula of the compound whose cation is named at the left and whose anion is named at the column head.

	Chloride	Sulfate	Phosphate	Hydroxide
Ammonium				
Lithium				
Lead(II)				
Vanadium(III)				

Ans.	Chloride	Sulfate	Phosphate	Hydroxide
Ammonium				
Lithium				
Lead(II)				
Vanadium(III)				

- 6.30. Name the following ions: (a) ClO^- , (b) NO_2^- , and (c) SO_4^{2-} .
- 6.31. Name the following ions: (a) MnO_4^- , (b) O_2^{2-} , (c) CrO_4^{2-} , (d) $\text{Cr}_2\text{O}_7^{2-}$, and (e) $\text{C}_2\text{H}_3\text{O}_2^-$.
- 6.32. Name the following ions: (a) H^+ , (b) OH^- , (c) H^- , (d) NH_4^+ , and (e) CN^- .
- 6.33. Write formulas for each of the following compounds: (a) calcium cyanide, (b) calcium hydroxide, (c) calcium peroxide, and (d) calcium hydride.
- 6.34. What is the difference between the names *phosphorus* and *phosphorous*?
- 6.35. Write formulas for each of the following compounds: (a) barium bromide, (b) copper(II) bromate, (c) titanium(III) fluoride, and (d) aluminum hydride.
- 6.36. Name and write formulas for each of the following: (a) the compound of potassium and bromine; (b) the compound of calcium and bromine; and (c) the compound of aluminum and bromine.
- 6.37. Name and write formulas for each of the following: (a) the compound of lithium and sulfur; (b) the compound of barium and sulfur; and (c) the compound of aluminum and sulfur.
- 6.38. Name and write formulas for each of the following: (a) two compounds of copper and chlorine, (b) two compounds of platinum and fluorine, and (c) two compounds of cobalt and bromine. (If necessary, see Table 6-4 for data.)
- 6.39. Name and write formulas for each of the following: (a) two compounds of iron and bromine, (b) two compounds of palladium and bromine, and (c) two compounds of mercury and bromine.

- 6.40. Name and write formulas for each of the following: (a) the compound of bromine and potassium (b) the compound of bromine and calcium, and (c) the compound of bromine and aluminum.
- 6.41. Write the formula for each of the following compounds: (a) aluminum hydride, (b) calcium chloride, (c) lithium oxide, (d) silver nitrate, (e) iron(II) sulfite, (f) aluminum chloride, (g) ammonium carbonate, (h) zinc sulfate, (i) iron(III) oxide, (j) sodium phosphate, (k) iron(III) acetate, (l) ammonium chloride, and (m) copper(I) cyanide.

NAMING INORGANIC ACIDS

- 6.42. Name the following acids: (a) HCl, (b) HClO, (c) HClO₂, (d) HClO₃, and (e) HClO₄.
- 6.43. Which acids of the prior problem are strong acids?
- 6.44. Name the following compounds: (a) HCl (pure) and (b) HCl (in water solution).
- 6.45. Write formulas for each of the following acids: (a) hydrobromic acid, (b) phosphorous acid, and (c) hypobromous acid.
- 6.46. Name H₂S in two ways.
- 6.47. How many ionizable hydrogen atoms are there in HC₄H₇O₂?

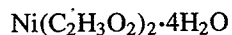
ACID SALTS

- 6.48. Write formulas for each of the following compounds: (a) ammonium hydrogen sulfate, (b) sodium hydrogen sulfide, and (c) nickel(II) hydrogen carbonate.
- 6.49. Write formulas for each of the following compounds: (a) sodium hydrogen phosphate, (b) sodium dihydrogen phosphate, and (c) magnesium hydrogen phosphate.

- 6.50. Write formulas for each of the following compounds: (a) calcium hydrogen carbonate, (b) disodium hydrogen phosphate, (c) sodium dihydrogen phosphate, and (d) calcium dihydrogen phosphate.

HYDRATES

- 6.51. Name the following compound, and state how many hydrogen atoms it contains per formula unit:



- 6.52. Write formulas for barium dihydrogen hypophosphite and barium dihydrogen hypophosphite monohydrate.

Supplementary Problems

- 6.53. Name (a) H^+ , (b) H^- , (c) NaH , and (d) BeH_2 .
- 6.54. Explain why the formula for mercury(I) ion is Hg_2^{2+} rather than Hg^+ .
- 6.55. Explain why mercury(I) ion, Hg_2^{2+} , has the Roman numeral I in it.
- 6.56. Write formulas for each of the following compounds: (a) ammonium nitrate, (b) mercury(I) cyanide, and (c) uranyl carbonate.
- 6.57. Write a formula for each of the following compounds: (a) diphosphorus pentasulfide, (b) iodine heptafluoride, and (c) dinitrogen monoxide.
- 6.58. State the meaning of each of the following terms: (a) *per-*, (b) *hypo-*, (c) *hydro-*, (d) hydrogen (as part of an ion).
- 6.59. What relationship is there in the meaning of the prefix *per-* when used with an oxyanion and when used in peroxide?
- 6.60. What are the differences among the following questions? (a) What is the formula of the compound of sulfur and calcium? (b) What is the formula of the compound of Ca^{2+} and S^{2-} ? (c) What is the formula for calcium sulfide?

- 6.61. Name (a) Cu_2O and (b) CuO .
- 6.62. Distinguish between ClO_2 and ClO_2^- .
- 6.63. Use the periodic table relationships to write formulas for (a) the selenate ion and (b) the arsenate ion.

- 6.64. Complete the following table by writing the formula of the compound formed by the cation at the left and the anion at the top. NH_4Cl is given as an example.

	Cl^-	ClO^-	ClO_2^-	SO_3^{2-}	PO_4^{3-}
NH_4^+	NH_4Cl				
K^+					
Ba^{2+}					
Al^{3+}					

Ans.

	Cl^-	ClO^-	ClO_2^-	SO_3^{2-}	PO_4^{3-}
NH_4^+					
K^+					
Ba^{2+}					
Al^{3+}					

- 6.65. From the data of Table 6-4, determine which charge is most common for first transition series elements (those elements in period 4 among the transition groups).

- 6.66. Name the compounds of Problem 6.64.

Ans.

	Cl^-	ClO^-	ClO_2^-	SO_3^{2-}	PO_4^{3-}
NH_4^+					
K^+					
Ba^{2+}					
Al^{3+}					

water) compound with a designation for the number of water molecules appended. Thus, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is called copper(II) sulfate pentahydrate. The 5, written on line, multiplies everything after it until the next centered dot or the end of the formula. Thus, included in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ are ten H atoms and nine O atoms (five from the water and four in the sulfate ion).

Solved Problems

INTRODUCTION

- 6.1. Explain why the following three compounds, with such similar-looking formulas, have such different names:

KCl	Potassium chloride
CuCl	Copper(I) chloride
BrCl	Bromine monochloride

Ans. The three compounds belong to different nomenclature classes. Potassium in its compounds always forms $1+$ ions, and thus there is no need to state $1+$ in the name. Copper forms $1+$ and $2+$ ions, and we need to designate which of these exists in this compound. BrCl is a binary nonmetal-nonmetal compound, using a prefix to denote the number of chlorine atoms.

BINARY COMPOUNDS OF NONMETALS

- 6.2. Name the following compounds: (a) ClF, (b) CO_2 , (c) BrF_3 , (d) CCl_4 , (e) PF_5 , and (f) SF_6 .

Ans. (a) Chlorine monofluoride (b) Carbon dioxide (c) Bromine trifluoride (d) Carbon tetrachloride
(e) Phosphorus pentafluoride (f) Sulfur hexafluoride

- 6.3. Name the following compounds: (a) P_4O_{10} , (b) Cl_2O , and (c) ClO_2 .

Ans. (a) Tetraphosphorus decoxide (b) Dichlorine monoxide (c) Chlorine dioxide

- 6.4. Name the following: (a) a compound with two oxygen atoms and one chlorine atom per molecule; (b) a compound with one iodine atom and five fluorine atoms per molecule; and (c) a compound with one sulfur atom and six fluorine atoms per molecule.

Ans. (a) Chlorine dioxide (b) Iodine pentafluoride (c) Sulfur hexafluoride

- 6.5. Write formulas for each of the following compounds: (a) carbon tetrafluoride, (b) xenon hexafluoride, and (c) sulfur difluoride.

Ans. (a) CF_4 (b) XeF_6 (c) SF_2

- 6.6. Name (a) H_2O and (b) NH_3 .

Ans. (a) Water (b) Ammonia

- 6.7. Write formulas for each of the following compounds: (a) dinitrogen trioxide, (b) carbon disulfide, and (c) carbon tetrabromide.

Ans. (a) N_2O_3 (b) CS_2 (c) CBr_4

- 6.8. Write formulas for each of the following compounds: (a) dichlorine monoxide, (b) dichlorine trioxide, and (c) chlorine dioxide.

Ans. (a) Cl_2O (b) Cl_2O_3 (c) ClO_2

NAMING IONIC COMPOUNDS

6.9. Name NH_3 and NH_4^+ .

Ans. Ammonia and ammonium ion. Note carefully the differences between these names and these formulas.

6.10. How can a beginning student recognize an ionic compound?

Ans. If the compound contains the NH_4^+ ion or a metal it is most likely ionic. (It might have *internal* covalent bonds.) If it is a strong acid in water solution, it is ionic. Otherwise, it is covalent.

6.11. Name (a) CuO and (b) Cu_2O .

Ans. (a) Copper(II) oxide (b) Copper(I) oxide. This example again emphasizes the difference between the Arabic numerals in a formula and the Roman numerals in a name.

6.12. In naming NO_3^- , professional chemists might say *nitrate* or *nitrate ion*, but in naming Na^+ , they always say *sodium ion*. Explain the difference.

Ans. *Nitrate* is always an ion; *sodium* might refer to the element, the atom, or the ion, and so a distinction must be made.

6.13. What is the difference in the rules for remembering charges on monatomic anions and oxyanions?

Ans. Monatomic anions have charges equal to the group number minus 8. The oxyanions have even charges for even-group central atoms and odd charges for odd-group central atoms, but the rule does not give a simple way to determine the charge definitely for oxyanions as it does for monatomic anions.

6.14. Name the following ions: (a) Co^{3+} , (b) Fe^{2+} , (c) Pt^{2+} , and (d) Hg_2^{2+} .

Ans. (a) Cobalt(III) ion (b) Iron(II) ion (c) Platinum(II) ion (d) Mercury(I) ion

6.15. Which metals in each of the following periodic groups form ions of only one charge? (a) IA, (b) IIA, (c) IIIA, (d) IB, and (e) IIB?

Ans. (a) All the alkali metals (but not hydrogen) (b) All the alkaline earth metals (c) Aluminum ion (d) Silver ion (e) Zinc and cadmium ions

6.16. What is the charge on each of the following ions? (a) cyanide, (b) hydroxide, (c) peroxide, (d) nitride, and (e) chloride.

Ans. (a) 1^- (b) 1^- (c) 2^- (d) 3^- (e) 1^-

6.17. Using the periodic table if necessary, write formulas for the following compounds: (a) hydrogen sulfide, (b) barium chloride, (c) ammonium phosphate, (d) aluminum sulfate, (e) calcium bromide, (f) lithium sulfide, and (g) sodium fluoride.

Ans. (a) H_2S (b) BaCl_2 (c) $(\text{NH}_4)_3\text{PO}_4$ (d) $\text{Al}_2(\text{SO}_4)_3$ (e) CaBr_2 (f) Li_2S (g) NaF

6.18. Write formulas for copper(I) sulfide and (b) copper(II) sulfide.

Ans. (a) Cu_2S (b) CuS

6.19. Name the following compounds: (a) AgClO_3 and (b) $\text{Al}(\text{ClO})_3$.

Ans. (a) Silver chlorate and (b) aluminum hypochlorite. Note that parentheses enclose the ClO^- ions, because there is a subscript to show that there are three of them. In (a), there is only one anion that contains three oxygen atoms.

- 6.20. Name the following ions: (a) Pb^{2+} , (b) IO_3^- , (c) IO_4^- , and (d) N^{3-} .
Ans. (a) Lead(II) ion (b) Iodate ion (c) Periodate ion (d) Nitride ion
- 6.21. Name the following ions: (a) PO_3^{3-} , (b) S^{2-} , and (c) SO_4^{2-} .
Ans. (a) Phosphite ion (b) Sulfide ion (c) Sulfate ion
- 6.22. Write formulas for each of the following compounds: (a) sodium chloride, (b) sodium chlorate, (c) sodium chlorite, (d) sodium hypochlorite, and (e) sodium perchlorate.
Ans. (a) NaCl (b) NaClO_3 (c) NaClO_2 (d) NaClO (e) NaClO_4
- 6.23. What is the difference between SO_3 and SO_3^{2-} ?
Ans. The first is a compound, sulfur trioxide; the second is an ion, the sulfite ion. The sulfite ion has two extra electrons, as shown by the 2- charge.
- 6.24. (a) Write the formula for calcium sulfide, calcium sulfite, and calcium sulfate. (b) How many elements are implied in the compound by the *-ide* ending? by the *-ite* ending? by the *-ate* ending? (c) Name a particular element that is implied by the *-ate* ending.
Ans. (a) CaS , CaSO_3 , and CaSO_4 .
 (b) *-ide*: at least two (a monatomic anion); *-ite* and *-ate*: at least three.
 (c) There is oxygen (plus another element) in the anion.
- 6.25. Name the following compounds: (a) CrCl_2 , (b) CrCl_3 , (c) CrO , (d) Cr_2O_3 , and (e) CrPO_4 .
Ans. (a) Chromium(II) chloride (b) Chromium(III) chloride (c) Chromium(II) oxide (d) Chromium(III) oxide (e) Chromium(III) phosphate
- 6.26. Write formulas for the following compounds: (a) sodium chloride, (b) sodium sulfate, and (c) sodium phosphate.
Ans. (a) NaCl (b) Na_2SO_4 (c) Na_3PO_4
 The only indication that there are one, two, and three sodium ions in the compound lies in the knowledge of the charges on the ions.
- 6.27. Write formulas for the following compounds: (a) ammonium chloride, (b) ammonium sulfide, and (c) ammonium phosphate.
Ans. (a) NH_4Cl (b) $(\text{NH}_4)_2\text{S}$ (c) $(\text{NH}_4)_3\text{PO}_4$
 Note that the last two formulas require parentheses around the ammonium ion, but that the first one does not since there is only one ammonium ion per formula unit.
- 6.28. Name the following compounds: (a) $\text{Ca}_3(\text{PO}_4)_2$ and (b) $\text{Cr}_2(\text{SO}_4)_3$.
Ans. (a) Calcium phosphate (b) Chromium(III) sulfate. We recognize that chromium has a 3+ charge in this compound because two chromium ions are needed to balance three sulfate ions, each of which has a 2- charge.
- 6.29. Fill in the table with the formula of the compound whose cation is named at the left and whose anion is named at the column head.

	Chloride	Sulfate	Phosphate	Hydroxide
Ammonium				
Lithium				
Lead(II)				
Vanadium(III)				

<i>Ans.</i>	Chloride	Sulfate	Phosphate	Hydroxide
Ammonium	NH ₄ Cl	(NH ₄) ₂ SO ₄	(NH ₄) ₃ PO ₄	NH ₄ OH (unstable)
Lithium	LiCl	Li ₂ SO ₄	Li ₃ PO ₄	LiOH
Lead(II)	PbCl ₂	PbSO ₄	Pb ₃ (PO ₄) ₂	Pb(OH) ₂
Vanadium(III)	VCl ₃	V ₂ (SO ₄) ₃	VPO ₄	V(OH) ₃

6.30. Name the following ions: (a) ClO⁻, (b) NO₂⁻, and (c) SO₄²⁻.

Ans. (a) Hypochlorite ion (b) Nitrite ion (c) Sulfate ion

6.31. Name the following ions: (a) MnO₄⁻, (b) O₂²⁻, (c) CrO₄²⁻, (d) Cr₂O₇²⁻, and (e) C₂H₃O₂⁻.

Ans. (a) Permanganate ion (b) Peroxide ion (c) Chromate ion (d) Dichromate ion (e) Acetate ion

6.32. Name the following ions: (a) H⁺, (b) OH⁻, (c) H⁻, (d) NH₄⁺, and (e) CN⁻.

Ans. (a) Hydrogen ion (b) Hydroxide ion (c) Hydride ion (d) Ammonium ion (e) Cyanide ion

6.33. Write formulas for each of the following compounds: (a) calcium cyanide, (b) calcium hydroxide, (c) calcium peroxide, and (d) calcium hydride.

Ans. (a) Ca(CN)₂ (b) Ca(OH)₂ (c) CaO₂ (from Table 6-6) (d) CaH₂

6.34. What is the difference between the names *phosphorus* and *phosphorous*?

Ans. The first is the name of the element; the second is the name of the acid with fewer oxygen atoms than phosphoric acid—H₃PO₃, phosphorous acid.

6.35. Write formulas for each of the following compounds: (a) barium bromide, (b) copper(II) bromate, (c) titanium(III) fluoride, and (d) aluminum hydride.

Ans. (a) BaBr₂ (b) Cu(BrO₃)₂ (c) TiF₃ (d) AlH₃

6.36. Name and write formulas for each of the following: (a) the compound of potassium and bromine; (b) the compound of calcium and bromine; and (c) the compound of aluminum and bromine.

Ans. (a) Potassium bromide, KBr (b) Calcium bromide, CaBr₂ (c) Aluminum bromide, AlBr₃
The bromide ion has a 1- charge. The potassium, calcium, and aluminum ions have charges of 1+, 2+, and 3+, respectively, and the subscripts given are the smallest possible to just balance the charges.

6.37. Name and write formulas for each of the following: (a) the compound of lithium and sulfur; (b) the compound of barium and sulfur; and (c) the compound of aluminum and sulfur.

Ans. (a) Lithium sulfide, Li₂S (b) Barium sulfide, BaS (c) Aluminum sulfide, Al₂S₃
The sulfide ion has a 2- charge. The lithium, barium, and aluminum ions have charges of 1+, 2+, and 3+, respectively, and the subscripts given are the smallest possible to just balance the charges.

6.38. Name and write formulas for each of the following: (a) two compounds of copper and chlorine, (b) two compounds of platinum and fluorine, and (c) two compounds of cobalt and bromine. (If necessary, see Table 6-4 for data.)

Ans. (a) Copper(I) chloride and copper(II) chloride, CuCl and CuCl₂ (b) Platinum(II) fluoride and platinum(IV) fluoride, PtF₂ and PtF₄ (c) Cobalt(II) bromide and cobalt(III) bromide, CoBr₂ and CoBr₃

6.39. Name and write formulas for each of the following: (a) two compounds of iron and bromine, (b) two compounds of palladium and bromine, and (c) two compounds of mercury and bromine.

Ans. (a) Iron(II) bromide and iron(III) bromide, FeBr_2 and FeBr_3 (b) Palladium(II) bromide and palladium(IV) bromide, PdBr_2 and PdBr_4 (c) Mercury(I) bromide and mercury(II) bromide, Hg_2Br_2 and HgBr_2 .
(The charges on the cations can be obtained from Table 6-4.)

- 6.40. Name and write formulas for each of the following: (a) the compound of bromine and potassium (b) the compound of bromine and calcium, and (c) the compound of bromine and aluminum.

Ans. This answer is exactly the same as that of Problem 6.36. The metal is named first even if it is given last in the statement of the problem.

- 6.41. Write the formula for each of the following compounds: (a) aluminum hydride, (b) calcium chloride, (c) lithium oxide, (d) silver nitrate, (e) iron(II) sulfite, (f) aluminum chloride, (g) ammonium carbonate, (h) zinc sulfate, (i) iron(III) oxide, (j) sodium phosphate, (k) iron(III) acetate, (l) ammonium chloride, and (m) copper(I) cyanide.

Ans. (a) AlH_3 (b) CaCl_2 (c) Li_2O (d) AgNO_3 (e) FeSO_3 (f) AlCl_3 (g) $(\text{NH}_4)_2\text{CO}_3$ (h) ZnSO_4
(i) Fe_2O_3 (j) Na_3PO_4 (k) $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_3$ (l) NH_4Cl (m) CuCN

NAMING INORGANIC ACIDS

- 6.42. Name the following acids: (a) HCl , (b) HClO , (c) HClO_2 , (d) HClO_3 , and (e) HClO_4 .

Ans. (a) Hydrochloric acid (b) Hypochlorous acid (c) Chlorous acid (d) Chloric acid (e) Perchloric acid

- 6.43. Which acids of the prior problem are strong acids?

Ans. (a), (d), and (e)

- 6.44. Name the following compounds: (a) HCl (pure) and (b) HCl (in water solution).

Ans. (a) Hydrogen chloride (b) Hydrochloric acid

- 6.45. Write formulas for each of the following acids: (a) hydrobromic acid, (b) phosphorous acid, and (c) hypobromous acid.

Ans. (a) HBr (b) H_3PO_3 (c) HBrO

- 6.46. Name H_2S in two ways.

Ans. Hydrogen sulfide and hydrosulfuric acid.

- 6.47. How many ionizable hydrogen atoms are there in $\text{HC}_4\text{H}_7\text{O}_2$?

Ans. One. Ionizable hydrogen atoms are written first. (The other seven hydrogen atoms will not react with metal hydroxides.)

ACID SALTS

- 6.48. Write formulas for each of the following compounds: (a) ammonium hydrogen sulfate, (b) sodium hydrogen sulfide, and (c) nickel(II) hydrogen carbonate.

Ans. (a) NH_4HSO_4 (b) NaHS (c) $\text{Ni}(\text{HCO}_3)_2$

- 6.49. Write formulas for each of the following compounds: (a) sodium hydrogen phosphate, (b) sodium dihydrogen phosphate, and (c) magnesium hydrogen phosphate.

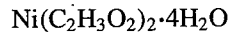
Ans. (a) Na_2HPO_4 (b) NaH_2PO_4 (c) MgHPO_4
(The charges must balance in each case.)

- 6.50. Write formulas for each of the following compounds: (a) calcium hydrogen carbonate, (b) disodium hydrogen phosphate, (c) sodium dihydrogen phosphate, and (d) calcium dihydrogen phosphate.

Ans. (a) $\text{Ca}(\text{HCO}_3)_2$ (the single charge on one HCO_3^- ion is not sufficient to balance the 2+ charge on Ca^{2+} ; two anions are necessary) (b) Na_2HPO_4 (c) NaH_2PO_4 (d) $\text{Ca}(\text{H}_2\text{PO}_4)_2$
[The same prefix is used to denote two atoms in (b), (c), and (d) as in nonmetal-nonmetal compounds.]

HYDRATES

- 6.51. Name the following compound, and state how many hydrogen atoms it contains per formula unit:



Ans. Nickel(II) acetate tetrahydrate. It contains 14 H atoms per formula unit.

- 6.52. Write formulas for barium dihydrogen hypophosphite and barium dihydrogen hypophosphite monohydrate.

Ans. $\text{Ba}(\text{H}_2\text{PO}_2)_2$ and $\text{Ba}(\text{H}_2\text{PO}_2)_2 \cdot \text{H}_2\text{O}$

Supplementary Problems

- 6.53. Name (a) H^+ , (b) H^- , (c) NaH , and (d) BeH_2 .

Ans. (a) Hydrogen ion (b) Hydride ion (c) Sodium hydride (d) Beryllium hydride

- 6.54. Explain why the formula for mercury(I) ion is Hg_2^{2+} rather than Hg^+ .

Ans. The actual formula shows that the two mercury atoms are covalently bonded.

- 6.55. Explain why mercury(I) ion, Hg_2^{2+} , has the Roman numeral I in it.

Ans. The average charge on the two Hg atoms is 1+. (See Sec. 14.2.)

- 6.56. Write formulas for each of the following compounds: (a) ammonium nitrate, (b) mercury(I) cyanide, and (c) uranyl carbonate.

Ans. (a) NH_4NO_3 (from Table 6-3) (b) $\text{Hg}_2(\text{CN})_2$ (from Tables 6-3 and 6-6) (c) UO_2CO_3 (from Table 6-3)

- 6.57. Write a formula for each of the following compounds: (a) diphosphorus pentasulfide, (b) iodine heptafluoride, and (c) dinitrogen monoxide.

Ans. (a) P_2S_5 (b) IF_7 (one of the few times the prefix *hepta-* is used) (c) N_2O

- 6.58. State the meaning of each of the following terms: (a) *per-*, (b) *hypo-*, (c) *hydro-*, (d) hydrogen (as part of an ion).

Ans. (a) *Per-* means "more oxygen atoms." For example, the perchlorate ion (ClO_4^-) has more oxygen atoms than does the chlorate ion (ClO_3^-). (b) *Hypo-* means "fewer oxygen atoms." For example, the hypochlorite ion (ClO^-) has fewer oxygen atoms than does the chlorite ion (ClO_2^-). (c) *Hydro-* means "no oxygen atoms." For example, hydrochloric acid (HCl) has no oxygen atoms, in contrast to chloric acid (HClO_3). (d) Hydrogen signifies an acid salt, such as NaHS —sodium hydrogen sulfide.

- 6.59. What relationship is there in the meaning of the prefix *per-* when used with an oxyanion and when used in peroxide?

Ans. In both cases, it means "one more oxygen atom."

- 6.60. What are the differences among the following questions? (a) What is the formula of the compound of sulfur and calcium? (b) What is the formula of the compound of Ca^{2+} and S^{2-} ? (c) What is the formula for calcium sulfide?

Ans. In each case, the answer is CaS. Part (b) gives the ions and their charges and so is perhaps easiest to answer. Part (a) gives the elements, so it is necessary to know that periodic group IIA elements always form 2+ ions in all their compounds and that sulfur forms a 2- ion in its compounds with metals. It is also necessary to remember that the metal is named first. In part (c), the fact that there is only one compound of these two elements is reinforced by the fact that the calcium is stated with no Roman numeral, and that sulfide is a specific ion with a specific (2-) charge.

6.61. Name (a) Cu₂O and (b) CuO.

Ans. (a) Copper(I) oxide (b) Copper(II) oxide.

6.62. Distinguish between ClO₂ and ClO₂⁻.

Ans. ClO₂ is a compound, and ClO₂⁻ is an ion—part of a compound.

6.63. Use the periodic table relationships to write formulas for (a) the selenate ion and (b) the arsenate ion.

Ans. Selenium is below sulfur in the periodic table, and arsenic is below phosphorus. We write formulas analogous to those for sulfate and phosphate: (a) SeO₄²⁻ and (b) AsO₄³⁻.

6.64. Complete the following table by writing the formula of the compound formed by the cation at the left and the anion at the top. NH₄Cl is given as an example.

	Cl ⁻	ClO ⁻	ClO ₂ ⁻	SO ₃ ²⁻	PO ₄ ³⁻
NH ₄ ⁺	NH ₄ Cl				
K ⁺					
Ba ²⁺					
Al ³⁺					

Ans.

	Cl ⁻	ClO ⁻	ClO ₂ ⁻	SO ₃ ²⁻	PO ₄ ³⁻
NH ₄ ⁺	NH ₄ Cl	NH ₄ ClO	NH ₄ ClO ₂	(NH ₄) ₂ SO ₃	(NH ₄) ₃ PO ₄
K ⁺	KCl	KClO	KClO ₂	K ₂ SO ₃	K ₃ PO ₄
Ba ²⁺	BaCl ₂	Ba(ClO) ₂	Ba(ClO ₂) ₂	BaSO ₃	Ba ₃ (PO ₄) ₂
Al ³⁺	AlCl ₃	Al(ClO) ₃	Al(ClO ₂) ₃	Al ₂ (SO ₃) ₃	AlPO ₄

6.65. From the data of Table 6-4, determine which charge is most common for first transition series elements (those elements in period 4 among the transition groups).

Ans. The 2+ charge is seen to be most common, occurring with every element in the first transition series that is listed. (Only Sc has no 2+ ion.)

6.66. Name the compounds of Problem 6.64.

Ans.

	Cl ⁻	ClO ⁻	ClO ₂ ⁻	SO ₃ ²⁻	PO ₄ ³⁻
NH ₄ ⁺	Ammonium chloride	Ammonium hypochlorite	Ammonium chlorite	Ammonium sulfite	Ammonium phosphate
K ⁺	Potassium chloride	Potassium hypochlorite	Potassium chlorite	Potassium sulfite	Potassium phosphate
Ba ²⁺	Barium chloride	Barium hypochlorite	Barium chlorite	Barium sulfite	Barium phosphate
Al ³⁺	Aluminum chloride	Aluminum hypochlorite	Aluminum chlorite	Aluminum sulfite	Aluminum phosphate