CHAPTER 6
NOMENCLATURE OF INORGANIC COMPOUNDS

SOLUTIONS TO REVIEW QUESTIONS

1. (a) NaClO₃ (d) Cu₂O
   (b) H₂SO₄ (e) Zn(HCO₃)₂
   (c) Sn(C₂H₃O₂)₂ (f) Fe₂(CO₃)₃

2. No, if elements combine in a one-to-one ratio the charges on their ions must be equal and opposite in sign. They could be +1, −1, or +2, −2 or +3, −3 etc.

3. (a) HBrO hypobromous acid (b) HIO hypoiodous acid
   HBrO₂ bromous acid HIO₂ iodic acid
   HBrO₃ bromic acid HIO₃ periodic acid
   HBrO₄ perbromic acid HIO₄ periodiciod acid

4. The system for naming binary compounds composed of two nonmetals uses the name of the first element and the stem of the second element plus the suffix -ide. A prefix is attached to each element indicating the number of atoms of that element in the formula. Thus N₂O₅ is named dinitrogen pentoxide.

5. Chromium(III) compounds
   (a) Cr(OH)₃ (d) Cr(HCO₃)₃ (g) CrPO₄ (j) CrF₃
   (b) Cr(NO₃)₃ (e) Cr₂(CO₃)₃ (h) Cr₂(C₂O₄)₃
   (c) Cr(NO₂)₃ (f) Cr₂(Cr₂O₇)₃ (i) Cr₂O₃

6. Magnesium forms only one series of compounds in which the cation is always Mg²⁺. Thus the name for MgCl₂ (magnesium chloride) does not need to be distinguished from any other compound. Copper forms two series of compounds in which the copper ion is Cu⁺ or Cu²⁺. Thus the name copper chloride does not indicate which compound is in question. Therefore, CuCl₂ is called copper(II) chloride to indicate that the compound contains the Cu²⁺ ion.

7. (a) Metals are located in groups 1A (except for hydrogen), 2A, 1B–8B and atomic numbers 13, 31, 49, 50, 81, 82, 83, lanthanides and actinides.
   (b) The nonmetals include hydrogen, group 7A, the noble gases and atomic numbers 6–9, 15–17, 34, 35, 53 and 85.
   (c) The transition metals are located in groups 1B–8B in the center of the periodic table. The lanthanides and actinides are located below the main body of the periodic table.

8. water (H₂O)–dihydrogen monoxide
   ammonia (NH₃)–nitrogen trihydride
CHAPTER 6
SOLUTIONS TO EXERCISES

1. Formulas of compounds.
   (a) Na and I NaI
   (b) Ba and F BaF₂
   (c) Al and O Al₂O₃
   (d) K and S K₂S
   (e) Cs and Cl CsCl
   (f) Sr and Br SrBr₂

2. Formulas of compounds.
   (a) Ba and O BaO
   (b) H and S H₂S
   (c) Al and Cl AlCl₃
   (d) Be and Br BeBr₂
   (e) Li and Se Li₂Se
   (f) Mg and P Mg₃P₂

3. sodium Na⁺  cobalt(II) Co²⁺
magnesium Mg²⁺  barium Ba⁺
aluminum Al³⁺  hydrogen H⁺
copper(II) Cu²⁺  mercury(II) Hg²⁺
iron(II) Fe²⁺  tin(II) Sn²⁺
iron(III) Fe³⁺  chromium(III) Cr³⁺
lead(II) Pb²⁺  tin(IV) Sn⁴⁺
silver Ag⁺  manganese(II) Mn²⁺
           bismuth(III) Bi³⁺

4. chloride Cl⁻  hydrogen sulfate HSO₄⁻
bromide Br⁻  hydrogen sulfite HSO₃⁻
fluoride F⁻  chromate CrO₄²⁻
iiodide I⁻  carbonate CO₃⁻
cyănide CN⁻  hydrogen carbonate HCO₃⁻
oxide O²⁻  acetate C₂H₃O₂⁻
hydroxide OH⁻  chlorate ClO₃⁻
sulfide S²⁻  permanganate MnO₄⁻
sulfate SO₄²⁻  oxalate C₂O₄²⁻

5. (a) dinitrogen monoxide
   (b) calcium carbonate
   (c) aluminum oxide
   (d) lead(II) sulfide
   (e) hydrochloric acid
   (f) sodium chloride

6. (a) calcium hydroxide
   (b) sodium nitrate
   (c) sulfur
   (d) sodium hydrogen carbonate
   (e) iron(II) sulfide
   (f) potassium carbonate
7. | Ion | Br$^-$ | O$^{2-}$ | NO$_3^-$ | PO$_4^{3-}$ | CO$_3^{2-}$ |
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<tr>
<td>K$^+$</td>
<td>KBr</td>
<td>K$_2$O</td>
<td>KNO$_3$</td>
<td>K$_3$PO$_4$</td>
<td>K$_2$CO$_3$</td>
</tr>
<tr>
<td>Mg$^{2+}$</td>
<td>MgBr$_2$</td>
<td>MgO</td>
<td>Mg(NO$_3$)$_2$</td>
<td>Mg$_3$(PO$_4$)$_2$</td>
<td>MgCO$_3$</td>
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<tr>
<td>Al$^{3+}$</td>
<td>AlBr$_3$</td>
<td>Al$_2$O$_3$</td>
<td>Al(NO$_3$)$_3$</td>
<td>AlPO$_4$</td>
<td>Al$_2$(CO$_3$)$_3$</td>
</tr>
<tr>
<td>Zn$^{2+}$</td>
<td>ZnBr$_2$</td>
<td>ZnO</td>
<td>Zn(NO$_3$)$_2$</td>
<td>Zn$_3$(PO$_4$)$_2$</td>
<td>ZnCO$_3$</td>
</tr>
<tr>
<td>H$^+$</td>
<td>HBr</td>
<td>H$_2$O</td>
<td>HNO$_3$</td>
<td>H$_3$PO$_4$</td>
<td>H$_2$CO$_3$</td>
</tr>
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8. | Ion | SO$_4^{2-}$ | OH$^-$ | AsO$_4^{3-}$ | C$_2$H$_3$O$_2^-$ | CrO$_4^{2-}$ |
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<tr>
<td>NH$_4^+$</td>
<td>(NH$_4$)$_2$SO$_4$</td>
<td>NH$_4$OH</td>
<td>(NH$_4$)$_3$AsO$_4$</td>
<td>NH$_4$C$_2$H$_3$O$_2$</td>
<td>(NH$_4$)$_2$CrO$_4$</td>
</tr>
<tr>
<td>Ca$^{2+}$</td>
<td>CaSO$_4$</td>
<td>Ca(OH)$_2$</td>
<td>Ca$_3$(AsO$_4$)$_2$</td>
<td>Ca(C$_2$H$_3$O$_2$)$_2$</td>
<td>CaCrO$_4$</td>
</tr>
<tr>
<td>Fe$^{3+}$</td>
<td>Fe$_2$(SO$_4$)$_3$</td>
<td>Fe(OH)$_3$</td>
<td>FeAsO$_4$</td>
<td>Fe(C$_2$H$_3$O$_2$)$_3$</td>
<td>Fe$_2$(CrO$_4$)$_3$</td>
</tr>
<tr>
<td>Ag$^+$</td>
<td>Ag$_2$SO$_4$</td>
<td>AgOH</td>
<td>Ag$_3$AsO$_4$</td>
<td>AgC$_2$H$_3$O$_2$</td>
<td>Ag$_2$CrO$_4$</td>
</tr>
<tr>
<td>Cu$^{2+}$</td>
<td>CuSO$_4$</td>
<td>Cu(OH)$_2$</td>
<td>Cu$_3$(AsO$_4$)$_2$</td>
<td>Cu(C$_2$H$_3$O$_2$)$_2$</td>
<td>CuCrO$_4$</td>
</tr>
</tbody>
</table>

Mg$^{2+}$ compounds: magnesium bromide, magnesium oxide, magnesium nitrate, magnesium phosphate, magnesium carbonate.
Al$^{3+}$ compounds: aluminum bromide, aluminum oxide, aluminum nitrate, aluminum phosphate, aluminum carbonate.
Zn$^{2+}$ compounds: zinc bromide, zinc oxide, zinc nitrate, zinc phosphate, zinc carbonate.
H$^+$ compounds: hydrogen bromide (or hydrobromic acid), water, nitric acid, phosphoric acid, carbonic acid.

10. NH$_4^+$ compounds: ammonium sulfate, ammonium hydroxide, ammonium arsenate, ammonium acetate, ammonium chromate.
Ca$^{2+}$, Ca$_4^+$ compounds: calcium sulfate, calcium hydroxide, calcium arsenate, calcium acetate, calcium chromate.
Fe$^{3+}$ compounds: iron(III) sulfate, iron(III) hydroxide, iron(III) arsenate, iron(III) acetate, iron(III) chromate.
Ag$^+$ compounds: silver sulfate, silver hydroxide, silver arsenate, silver acetate, silver chromate.
Cu$^{2+}$ compounds: copper(II) sulfate, copper(II) hydroxide, copper(II) arsenate, copper(II) acetate, copper(II) chromate.
11. Nonmetal binary compound formulas

(a) carbon monoxide, CO
(b) sulfur trioxide, SO₃
(c) carbon tetrabromide, CBr₄
(d) Phosphorus trichloride, PCl₃
(e) nitrogen dioxide, NO₂
(f) dinitrogen pentoxide, N₂O₅
(g) iodine monobromide, IBr
(h) silicon tetrachloride, SiCl₄
(i) phosphorus pentiodide, PI₅
(j) diboron trioxide, B₂O₃

12. (a) sodium nitrate, NaNO₃
(b) magnesium fluoride, MgF₂
(c) barium hydroxide, Ba(OH)₂
(d) ammonium sulfate, (NH₄)₂SO₄
(e) silver carbonate, Ag₂CO₃
(f) calcium phosphate, Ca₃(PO₄)₂
(g) potassium nitrite, KNO₂
(h) strontium oxide, SrO

13. Naming binary nonmetal compounds:

(a) CO₂ carbon dioxide
(b) N₂O dinitrogen oxide
(c) PCl₅ phosphorus pentachloride
(d) CCl₄ carbon tetrachloride
(e) SO₂ sulfur dioxide
(f) N₂O₄ dinitrogen tetroxide
(g) P₂O₅ diphosphorus pentoxide
(h) OF₂ oxygen difluoride
(i) NF₃ nitrogen trifluoride
(j) CS₂ carbon disulfide

14. (a) K₂O, potassium oxide
(b) NH₄Br, ammonium bromide
(c) CaI₂, calcium iodide
(d) BaCO₃, barium carbonate
(e) Na₃PO₄, sodium phosphate
(f) Al₂O₃, aluminum oxide
(g) Zn(NO₃)₂, zinc nitrate
(h) Ag₂SO₄, silver sulfate

15. (a) CuCl₂ copper(II) chloride
(b) CuBr copper(I) bromide
(c) Fe(NO₃)₂ iron(II) nitrate
(d) FeCl₃ iron(III) chloride
(e) SnF₂ tin(II) fluoride
(f) HgCO₃ mercury(II) carbonate

16. Formulas:

(a) tin(IV) bromide SnBr₄
(b) copper(I) sulfate Cu₂SO₄
(c) iron(III) carbonate Fe₂(CO₃)₃
(d) mercury(II) nitrite Hg(NO₂)₂
(e) titanium(IV) sulfide TiS₂
(f) iron(II) acetate Fe(C₂H₃O₂)₂

17. Acid formulas:

(a) hydrochloric acid, HCl
(b) chloric acid, HClO₃
(c) nitric acid, HNO₃
(d) carbonic acid, H₂CO₃
(e) sulfurous acid, H₂SO₃
(f) phosphoric acid, H₃PO₄
18. **Formulas of acids:**

   (a) acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$
   (b) hydrofluoric acid, $\text{HF}$
   (c) hydrosulfuric acid, $\text{H}_2\text{S}$
   (d) boric acid, $\text{H}_3\text{BO}_3$
   (e) nitrous acid, $\text{HNO}_2$
   (f) hypochlorous acid, $\text{HClO}$

19. **Naming acids:**

   (a) nitrous acid
   (b) sulfuric acid
   (c) oxalic acid
   (d) $\text{HBr}$, hydrobromic acid
   (e) phosphorous acid
   (f) acetic acid
   (g) HF, hydrofluoric acid
   (h) HBrO$_3$, bromic acid

20. **Naming acids:**

   (a) phosphoric acid
   (b) carbonic acid
   (c) iodic acid
   (d) $\text{HCl}$, hydrochloric acid
   (e) H$_3$PO$_3$, phosphorous acid
   (f) nitric acid
   (g) HI, hydroiodic acid
   (h) HClO$_4$, perchloric acid

21. **Formulas for:**

   (a) silver sulfite
   (b) cobalt(II) bromide
   (c) tin(II) hydroxide
   (d) aluminum sulfate
   (e) manganese(II) fluoride
   (f) ammonium carbonate
   (g) chromium(III) oxide
   (h) cupric chloride
   (i) potassium permanganate
   (j) barium nitrite
   (k) sodium peroxide
   (l) iron(II) sulfate
   (m) potassium dichromate
   (n) bismuth(III) chromate

22. **Formulas for:**

   (a) sodium chromate
   (b) magnesium hydride
   (c) nickel(II) acetate
   (d) calcium chlorate
   (e) lead(II) nitrate
   (f) potassium dihydrogen phosphate

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23. Names for:
(a) ZnSO₄ \hspace{1cm} \text{zinc sulfate}
(b) HgCl₂ \hspace{1cm} \text{mercury(II) chloride}
(c) CuCO₃ \hspace{1cm} \text{copper(II) carbonate}
(d) Cd(NO₃)₂ \hspace{1cm} \text{cadmium nitrate}
(e) Al(C₂H₃O₂)₃ \hspace{1cm} \text{aluminum acetate}
(f) CoF₂ \hspace{1cm} \text{cobalt(II) fluoride}
(g) Cr(ClO₃)₃ \hspace{1cm} \text{chromium(III) chlorate}
(h) Ag₃PO₄ \hspace{1cm} \text{silver phosphate}
(i) NiS \hspace{1cm} \text{nickel(II) sulfide}
(j) BaCrO₄ \hspace{1cm} \text{barium chromate}

24. Names for:
(a) Ca(HSO₄)₂ \hspace{1cm} \text{calcium hydrogen sulfate}
(b) As₂(SO₃)₃ \hspace{1cm} \text{arsenic(III) sulfite}
(c) Sn(NO₂)₂ \hspace{1cm} \text{tin(II) nitrite}
(d) FeBr₃ \hspace{1cm} \text{iron(III) bromide}
(e) KHCO₃ \hspace{1cm} \text{potassium hydrogen carbonate}
(f) BiAsO₄ \hspace{1cm} \text{bismuth(III) arsenate}
(g) Fe(BrO₃)₂ \hspace{1cm} \text{iron(II) bromate}
(h) (NH₄)₂HPO₄ \hspace{1cm} \text{ammonium monohydrogen phosphate}
(i) NaClO \hspace{1cm} \text{sodium hypochlorite}
(j) KMnO₄ \hspace{1cm} \text{potassium permanganate}

25. Formulas for:
(a) baking soda \hspace{1cm} \text{NaHCO₃}
(b) lime \hspace{1cm} \text{CaO}
(c) Epsom salts \hspace{1cm} \text{MgSO₄ \cdot 7 H₂O}
(d) muriatic acid \hspace{1cm} \text{HCl}
(e) vinegar \hspace{1cm} \text{HC₂H₃O₂}
(f) potash \hspace{1cm} \text{K₂CO₃}
(g) lye \hspace{1cm} \text{NaOH}
26. Formulas for:
   (a) fool’s gold   FeS₂
   (b) saltpeter    NaNO₃
   (c) limestone    CaCO₃
   (d) cane sugar   C₁₂H₂₂O₁₁
   (e) milk of magnesia    Mg(OH)₂
   (f) washing soda    Na₂CO₃ · 10 H₂O
   (g) grain alcohol    C₂H₅OH

27. (a) K → K⁺ + e⁻  (d) Fe → Fe²⁺ + 2e⁻
    (b) I + e⁻ → I⁻  (e) Ca → Ca²⁺ + 2e⁻
    (c) Br + e⁻ → Br⁻  (f) O + 2e⁻ → O²⁻

28. (a) sulfate  (d) chlorate
    (b) phosphate (e) hydroxide
    (c) nitrate  (f) carbonate

29. (a) CaSO₄
    (b) Ca₃(PO₄)₂
    (c) Ca(NO₃)₂
    (d) Ca(ClO₃)₂
    (e) Ca(OH)₂
    (f) CaCO₃

30. (a) K₂SO₄
    (b) K₃PO₄
    (c) KNO₃
    (d) KClO₃
    (e) KOH
    (f) K₂CO₃

31. (a) CBr₄ carbon tetrabromide
    (b) BF₃ boron trifluoride
    (c) PCl₅ phosphorus pentachloride

32. Formula: KCl
    Name: potassium chloride

33. *ide:*  suffix is used to indicate a binary compound except for hydroxides, cyanides, and ammonium compounds.

   *ous:*  used as a suffix to name an acid that has a lower oxygen content than the *-ic* acid (e.g. HNO₂, nitrous acid and HNO₃, nitric acid). Also used as a suffix to name the lower ionic charge of a multivalent metal (e.g. Fe²⁺, ferrous and Fe³⁺, ferric).

   *ic:*  used as a suffix to name an acid that has a higher oxygen content than the *-ous* acid (e.g. HNO₃ nitric acid and HNO₂ nitrous acid). Also used as a suffix to name the higher ionic charge of a multivalent metal (e.g. Fe²⁺, ferrous and Fe³⁺, ferric).

   *hypo:*  used as a prefix in naming an acid that has a lower oxygen content that the *-ous* acid when there are more than two oxyacids with the same elements (e.g. HClO, hypochlorous acid and HClO₂, chlorous acid).

   *per:*  used as a prefix in naming an acid that has a higher oxygen content than the *-ic* acid when there are more than two oxyacids with the same elements (e.g. HClO₄, perchloric acid and HClO₃, chloric acid).
ite: the suffix used in naming a salt derived from an -ous acid. For example, HNO₂ (nitrous acid); NaNO₂ (sodium nitrite).

ate: the suffix used in naming a salt derived from an -ic acid. For example, H₂SO₄ (sulfuric acid); CaSO₄ (calcium sulfate).

Roman numerals: In the Stock System Roman numerals are used in naming compounds that contain metals that may exist as more than one type of cation. The charge of a metal is indicated by a Roman numeral written in parenthesis immediately after the name of the metal. For example, FeCl₂ [iron (II) chloride].

34. (a) AgNO₃ + NaCl → AgCl + NaNO₃
(b) Fe₂(SO₄)₃ + Ca(OH)₂ → Fe(OH)₃ + CaSO₄
(c) KOH + H₂SO₄ → K₂SO₄ + H₂O

35. (a) 50 e⁻, 50 p  (b) 48e⁻, 50 p  (c) 46 e⁻, 50 p

36. The formula for a compound must be electrically neutral. Therefore X = +3 and Y = -2 since in X₂Y₃ this would give 2(+3) + 3(-2) = 0.

37. Li₃Fe(CN)₆
  AlFe(CN)₆
  Zn₃[Fe(CN)₆]₂

38. (a) N³⁻ nitride One has oxygen the other does not, charges on the ions differ. NO₂⁻ nitrite
(b) NO₂⁻ nitrite The number of oxygens differ, but the charge is the same. NO₃⁻ nitrate
(c) HNO₂ nitrous acid The number of oxygens in the compounds differ but they HNO₃ nitric acid both have only one hydrogen and one nitrogen atom.

39. Let x = molar mass of Y
   2.44x + x = 110.27
   x = 32.06, Y = sulfur (from periodic table)
   2.44x = (110.27 - 32.06) = 78.21
   The compound formula is X₂Y, so the mass of 2X = 78.21
   X = 39.11 which is potassium (from the periodic table)
   X₂Y = K₂S
   Ratio = \frac{78.21}{32.06} = 2.44