

# ANSWERS

Key

TABLE 3.8 Rules for Writing Formulas of Binary Ionic Compounds

Rules for Names	Examples	
	magnesium phosphide	aluminum bromide
1. Identify each ion and its charge.	magnesium: $Mg^{+2}$ phosphide: $P^{-3}$	aluminum: $Al^{+3}$ bromide: $Br^{-1}$
2. Determine the total charges needed to balance positive with negative.	$Mg^{+2}$ : $+2 +2 +2 = +6$ $P^{-3}$ : $-3 -3 = -6$	$Al^{+3}$ : $= +3$ $Br^{-1}$ : $-1 -1 -1 = -3$
3. Note the ratio of positive ions to negative ions.	3 $Mg^{+2}$ ions for every 2 $P^{-3}$ ions	1 $Al^{+3}$ ion for every 3 $Br^{-1}$ ions
4. Use subscripts to write the formula. Omit "1" where only one ion is needed.	$Mg_3P_2$	$AlBr_3$

## Study Prep

1. Write the formulas of the ionic compounds containing the following ions:

- a)  $Na^{+1}$  with  $F^{-1}$       NaF
- b)  $Mg^{+2}$  with  $Br^{-1}$        $MgBr_2$
- c)  $Cs^{+1}$  with  $S^{-2}$        $Cs_2S$
- d)  $Ba^{+2}$  with  $O^{-2}$       BaO
- e)  $Ca^{+2}$  with  $P^{-3}$        $Ca_3P_2$

2. Write the formulas of the following binary ionic compounds:

- a) potassium chloride      KCl
- b) strontium nitride       $Sr_3N_2$
- c) silver sulphide       $Ag_2S$
- d) zinc selenide       $ZnSe$
- e) beryllium sulphide      BeS
- f) rubidium oxide       $Rb_2O$
- g) lithium nitride       $Li_3N$
- h) radium iodide       $RaI_2$
- i) aluminum phosphide      AlP
- j) magnesium sulphide      MgS
- k) lithium fluoride      LiF
- l) beryllium iodide       $BeI_2$
- m) magnesium oxide      MgO
- n) radium nitride       $Ra_3N_2$
- o) potassium sulphide       $K_2S$

3. Write the names of the following binary ionic compounds:

- a) CsI CESIUM IODIDE
- b) Ba<sub>3</sub>N<sub>2</sub> BARIUM NITRIDE
- c) CdCl<sub>2</sub> CADMIUM CHLORIDE
- d) AlF<sub>3</sub> ALUMINUM FLUORIDE
- e) Li<sub>2</sub>O LITHIUM OXIDE
- f) K<sub>2</sub>O POTASSIUM OXIDE
- g) Na<sub>2</sub>O SODIUM OXIDE
- h) CaI<sub>2</sub> CALCIUM IODIDE
- i) Sr<sub>3</sub>P<sub>2</sub> STRONTIUM PHOSPHIDE
- j) CaO CALCIUM OXIDE
- k) Cd<sub>3</sub>N<sub>2</sub> CADMIUM NITRIDE
- l) RaBr<sub>2</sub> RADIUM BROMIDE
- m) RbF RUBIDIUM FLUOR FLUORIDE
- n) AlCl<sub>3</sub> ALUMINUM CHLORIDE
- o) NaBr SODIUM BROMIDE

### Metals with More Than One Combining Capacity

An element that can form more than one stable ion is called a **multivalent** element. Most metals in the middle of the periodic table are multivalent. Their combining capacities are listed in the periodic table, with the most common one listed first. For example, iron can have either a +2 or a +3 ion, but the +3 ion is the most common. The symbols and names of the iron ions are:

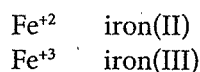


TABLE 3.9  
Roman Numerals

Number	Roman Numeral
1	I
2	II
3	III
4	IV
5	V
6	VI
7	VII
8	VIII

Notice that the Roman numeral in the ion's name corresponds to the charge on the ion. A list of Roman numerals is given in Table 3.9.

Table 3.10 gives some examples of the names of binary ionic compounds containing a multivalent metal ion.

TABLE 3.10 Compounds with Multivalent Ions

Name	Formula
iron(III) iodide	FeI <sub>3</sub>
iron(II) iodide	FeI <sub>2</sub>
manganese(IV) sulphide	MnS <sub>2</sub>
copper(I) nitride	Cu <sub>3</sub> N

Table 3.11 shows examples of how the compound's name is used to write the formula.

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1. Write the names and formulas of the ionic compounds containing the following ions:

- a)  $\text{Cu}^{+1}$  with  $\text{S}^{-2}$  Copper (I) sulfide  $\text{Cu}_2\text{S}$
- b)  $\text{Cu}^{+2}$  with  $\text{S}^{-2}$  Copper (II) sulfide  $\text{CuS}$
- c)  $\text{Cr}^{+2}$  with  $\text{F}^{-1}$  Chromium (II) fluoride  $\text{CrF}_2$
- d)  $\text{Cr}^{+3}$  with  $\text{F}^{-1}$  Chromium (III) fluoride  $\text{CrF}_3$
- e)  $\text{Fe}^{+2}$  with  $\text{N}^{-3}$  Iron (II) nitride  $\text{Fe}_3\text{N}_2$
- f)  $\text{Fe}^{+3}$  ion with  $\text{Br}^{-}$  bromide ion  $\text{FeBr}_3$
- g)  $\text{Pb}^{+4}$  ion with  $\text{I}^{-}$  iodide ion  $\text{PbI}_4$
- h)  $\text{Pb}^{+2}$  ion with  $\text{I}^{-}$  iodide ion  $\text{PbI}_2$
- i)  $\text{Co}^{+3}$  ion with  $\text{P}^{-3}$  phosphide ion  $\text{CoP}$
- j)  $\text{Pt}^{+4}$  ion with  $\text{Se}^{-2}$  selenide ion  $\text{PtSe}_2$

2. Write the name of each ionic compound below. Remember to use a Roman numeral as part of the metal ion's name.

- a)  $\text{FeCl}_2$  IRON (II) CHLORIDE
- b)  $\text{FeCl}_3$  IRON (III) CHLORIDE
- c)  $\text{Cu}_2\text{O}$  COPPER (I) OXIDE
- d)  $\text{CuO}$  COPPER (II) OXIDE
- e)  $\text{PbS}$  LEAD (II) SULFIDE
- f)  $\text{PbS}_2$  LEAD (IV) SULFIDE
- g)  $\text{MnBr}_2$  MANGANESE (II) BROMIDE
- h)  $\text{MnBr}_3$  MANGANESE (III) BROMIDE
- i)  $\text{Ti}_3\text{N}_4$  TITANIUM (IV) NITRIDE
- j)  $\text{TiP}$  TITANIUM (III) PHOSPHIDE
- k)  $\text{SnF}_2$  TIN (II) FLUORIDE
- l)  $\text{TiS}_2$  TITANIUM (IV) SULFIDE
- m)  $\text{Co}_3\text{N}_2$  COBALT (II) NITRIDE
- n)  $\text{PtI}_2$  PLATINUM (II) IODIDE
- o)  $\text{Cu}_3\text{P}$  COPPER (I) PHOSPHIDE

Continued

3. Write the formulas of the following ionic compounds:

- a) iron(II) iodide  $\text{FeI}_2$   
b) chromium(III) chloride  $\text{CrCl}_3$   
c) copper(II) bromide  $\text{CuBr}_2$   
d) mercury(II) oxide  $\text{HgO}$   
e) tin(IV) nitride  $\text{Sn}_3\text{N}_4$   
f) tin(II) nitride  $\text{Sn}_3\text{N}_2$   
g) titanium(III) phosphide  $\text{TiP}$   
h) gold(III) sulphide  $\text{Au}_2\text{S}_3$   
i) manganese(IV) iodide  $\text{MnI}_4$   
j) mercury(II) selenide  $\text{HgSe}$   
k) gold(I) iodide  $\text{AuI}$   
l) titanium(IV) nitride  $\text{Ti}_3\text{N}_4$   
m) manganese(IV) oxide  $\text{MnO}_2$   
n) cobalt(II) chloride  $\text{CoCl}_2$   
o) chromium(III) bromide  $\text{CrBr}_3$

### Polyatomic Ions

Some ions are made up of several atoms joined together by sharing electrons, just like a molecule. The difference is that this combination of atoms has an electric charge. It can have either a positive or a negative charge. A **polyatomic ion** is a group of atoms that are covalently bonded and have an overall electric charge ("poly" means *many*).

In the compound NaOH, for example, the sodium has a charge of +1. The oxygen and hydrogen together form the polyatomic ion hydroxide ( $\text{OH}^{-1}$ ), which has a charge of -1. Another example of a polyatomic ion is the phosphate ion ( $\text{PO}_4^{-3}$ ). It is made up of one phosphorus atom and four oxygen atoms joined together. They behave like a single unit with a charge of -3.

Table 3.13 gives some examples of common polyatomic ions. Page 1 of the *Data Booklet* lists the names and formulas of these and other common ions.

There are a few points worth noting about the ions in Table 3.13:

- There are many more negative ions than positive ions.
- The most common positive polyatomic ion is ammonium ( $\text{NH}_4^{+1}$ ). Ammonium phosphate is the most common fertilizer ingredient in the world.

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## Study Prep

- Write the name of each compound below:
  - $\text{Li}_2\text{CO}_3$  LITHIUM CARBONATE
  - $\text{Mg}(\text{HCO}_3)_2$  MAGNESIUM BICARBONATE
  - $\text{Na}_2\text{SO}_4$  SODIUM SULFATE
  - $\text{K}_2\text{SO}_3$  POTASSIUM SULFITE
  - $\text{Ba}(\text{OH})_2$  BARIUM HYDROXIDE
  - $\text{Al}(\text{CN})_3$  ALUMINIUM CYANIDE
  - $(\text{NH}_4)_3\text{PO}_4$  AMMONIUM PHOSPHATE
  - $\text{Fe}(\text{NO}_3)_2$  IRON (II) NITRATE
  - $\text{Mg}(\text{OH})_2$  MAGNESIUM HYDROXIDE
  - $\text{Cu}_3\text{PO}_4$  COPPER (I) PHOSPHATE
  - $\text{Ag}_2\text{CrO}_4$  SILVER CHROMATE
  - $\text{Rb}_2\text{Cr}_2\text{O}_7$  RUBIDIUM DICHROMATE
  - $\text{NH}_4\text{F}$  AMMONIUM FLUORIDE
  - $\text{Co}(\text{HSO}_3)_2$  COBALT (I) BISULFITE
- Write the formula for each compound below:
  - sodium carbonate  $\text{Na}_2\text{CO}_3$
  - strontium chlorate  $\text{Sr}(\text{ClO}_3)_2$
  - cesium cyanide — OMIT —
  - barium hydrogen carbonate  $\text{Ba}(\text{HCO}_3)_2$
  - zinc hydrogen sulphate  $\text{Zn}(\text{HSO}_4)_2$
  - strontium phosphate  $\text{Sr}_3(\text{PO}_4)_2$
  - calcium hydroxide  $\text{Ca}(\text{OH})_2$
  - ammonium sulphide  $(\text{NH}_4)_2\text{S}$
  - ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$
  - ammonium sulphite  $(\text{NH}_4)_2\text{SO}_3$
  - copper(II) nitrate  $\text{Cu}(\text{NO}_3)_2$
  - chromium(III) hydrogen sulphide  $\text{Cr}(\text{HS})_3$
  - potassium dichromate  $\text{K}_2\text{Cr}_2\text{O}_7$
  - sodium oxalate  $\text{Na}_2\text{C}_2\text{O}_4$
  - manganese(II) thiocyanate — OMIT —
  - magnesium sulphite  $\text{MgSO}_3$
  - lead(II) perchlorate  $\text{Pb}(\text{ClO}_4)_2$
  - tin(IV) phosphate  $\text{Sn}_3(\text{PO}_4)_4$
  - aluminum hydroxide  $\text{Al}(\text{OH})_3$
  - beryllium carbonate  $\text{BeCO}_3$

Table 3.18 gives some examples of how names of molecular compounds can be written from their formulas.

TABLE 3.18 Hints for Writing Names of Molecular Compounds

Formula	Name	Hints for Writing Names
$\text{CS}_2$	carbon disulphide	Do not use a prefix when there is only one atom of the first element.
$\text{O}_2\text{F}_2$	dioxygen difluoride	Do not reduce the name to "oxygen fluoride."
$\text{CCl}_4$	carbon tetrachloride	Do not use a prefix when there is only one atom of the first element.
$\text{P}_4\text{O}_{10}$	tetraphosphorus decaoxide	Use rules 1 to 3.

### Study Prep

1. Write the names of the following compounds:

- $\text{CO}_2$  CARBON DIOXIDE
- $\text{N}_2\text{O}$  DINITROGEN MONOXIDE
- $\text{PCl}_3$  PHOSPHOROUS TRICHLORIDE
- $\text{PBr}_5$  PHOSPHOROUS PENTA BROMIDE
- $\text{SO}_2$  SULFUR DIOXIDE
- $\text{N}_2\text{O}_4$  DINITROGEN TETROXIDE
- $\text{P}_4\text{S}_{10}$  TETRA PHOSPHORUS DECA SULFIDE
- $\text{S}_2\text{F}_{10}$  DISULFUR DECA FLUORIDE
- $\text{NI}_3$  NITROGEN TRI IODIDE
- $\text{NO}$  NITROGEN MONOXIDE

2. Write the formulas of the following compounds:

- nitrogen tribromide  $\text{NBr}_3$
- sulphur hexafluoride  $\text{SF}_6$
- dinitrogen tetrasulphide  $\text{N}_2\text{S}_4$
- oxygen difluoride  $\text{OF}_2$
- carbon tetraiodide  $\text{CI}_4$
- sulphur trioxide  $\text{SO}_3$
- phosphorus pentachloride  $\text{PCl}_5$
- diiodine hexachloride  $\text{I}_2\text{Cl}_6$
- dichlorine monoxide  $\text{Cl}_2\text{O}$
- xenon hexafluoride  $\text{XeF}_6$