

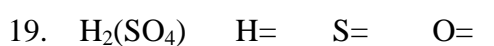
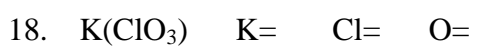
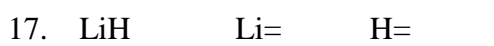
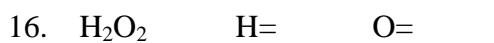
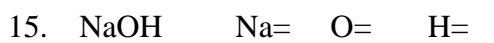
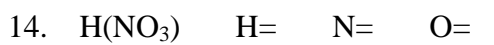
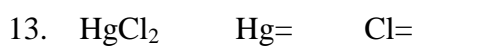
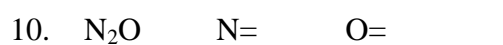
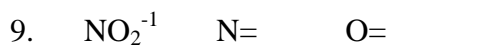
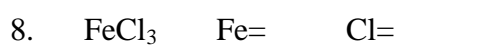
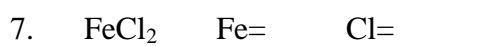
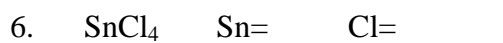
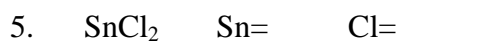
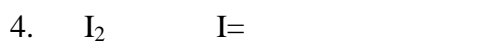
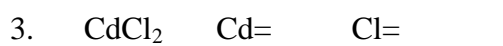
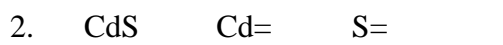
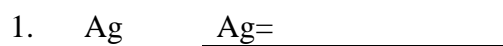
OXIDATION NUMBERS

The **oxidation number** or state refers to the charge an atom would have if the pairs of electrons in each bond of the compound belonged to the atom with the most electronegative charge, as if the electrons had been transferred and not shared. For ionic compounds this is already the case, so the oxidation number and the ionic charge are the same. For a covalently bonded compound the oxidation number is a hypothetical charge. Ionic charges are differentiated from oxidation numbers by the placement of the charge and the number. Ionic charges are written with the charge following the number, however, oxidation numbers are written with the charge is written before the number.

There are several rules that apply to oxidation numbers:

1. The sum of all oxidation numbers in a compound must equal zero.
 - For example: What are the oxidation numbers for sodium and chlorine in NaCl?
Na is +1 and Cl is -1 for a total of zero.
2. The sum of all oxidation numbers in a polyatomic ion must be equal to the charge of the ion.
 - For example: What is the charge on the sulfur in the polyatomic ion SO_4^{2-} ?
Each oxygen carries an oxidation number of -2, for a total of -8. The overall charge must be -2, therefore the sulfur must have an oxidation number of +6.
3. When there is a combination of non-metals, the less electronegative atom will have a positive oxidation number, and the higher electronegative atom will have a negative oxidation number.
 - For example: What are the oxidation numbers of CO_2 ?
Carbon will have an oxidation number of +4 and oxygen will have an oxidation number of -2.
4. The oxidation number of an elementary substance is zero, this also applies to diatomic molecules.
**Review the seven diatomic molecules!
 - For example: What is the oxidation number for the chlorine in Cl_2 ?
Each chlorine is zero, because the atoms have identical electronegativities the electrons will be shared equally.
5. The oxidation number of any one atom ion is equal to its ionic charge.
 - For example: What is the oxidation number for a sodium ion?
The sodium ion's oxidation number is +1.
6. Oxygen's oxidation number is always equal to -2, except when it is in peroxide, then it is equal to -1.
 - For example: What is the oxidation number of oxygen in water?
Water is H_2O , the hydrogen each have +1 oxidation numbers totaling +2. The molecule must have a zero total, therefore, oxygen's oxidation number is -2.
 - What is the oxidation number in hydrogen peroxide, H_2O_2 ?
 H_2 has a total of +2, therefore O_2 must have a value of -2 leaving each oxygen with a -1 oxidation number.
7. Hydrogen has a oxidation number of +1, except when it is in a hydride, then it is equal to -1.
 - For example: What is the oxidation number for hydrogen in HCl?
The chlorine atom has an oxidation number of -1, therefore the hydrogen must be +1.
 - What is the oxidation number of hydrogen in Lithium hydride, LiH?
Lithium has an oxidation number of +1, therefore hydrogen must have an oxidation number of -1.

Practice: Determine the oxidation number for each of the elements in the following molecules and ions.



NOMENCLATURE

Nomenclature is the process of naming a compound or molecule.

I. Ionic Compounds

The name of the compound consists of the name of the metal followed by the -ide form of the non-metal.

Ex. NaCl sodium chloride Ca(C₂H₃O₂)₂ calcium acetate
MgO magnesium oxide

Practice: Name the following compounds.

- | | |
|----------------------------------------------------------|--------------------------------|
| 1. CaO _____ | 4. BaCl ₂ _____ |
| 2. Al ₂ (CO ₃) ₃ _____ | 5. Na(MnO ₄) _____ |
| 3. (NH ₄) ₂ SO ₄ _____ | 6. FeS _____ |

Practice: Write the formula for the following compounds.

- | | |
|--------------------------------|---------------------------|
| 1. Potassium bicarbonate _____ | 4. Ammonium nitrate _____ |
| 2. Zinc acetate _____ | 5. Zinc phosphate _____ |
| 3. Silver dichromate _____ | 6. Lithium chloride _____ |

II. Compounds Having Metals with more than one Oxidation State

The compound is written as normal with the oxidation number in Roman Numerals in parentheses after the name of the metal.

Ex. FeCl₂ Iron (II) chloride Cl = -1 so then Fe = +2, written Iron (II)
FeCl₃ Iron (III) chloride Cl = -1 so then Fe = +3, written Iron (III)
CrO₂ Chromium (IV) oxide O = -2 so then Cr = +4, written Chromium (IV)
CrO₃ Chromium (VI) oxide O = -2 so then Cr = +6, written Chromium (VI)

An alternate method uses the Latin and Greek names of the metals. Add -ous to the lower charge and -ic to the higher charge. – We will not use this method, but most of the world does!

Ex. FeCl₂ Ferrous chloride
FeCl₃ Ferric chloride

Reminders about Polyatomic Ions

Rule: The prefix per- denotes the greatest number of oxygen (if more than two forms). The suffix -ate denotes the most oxygen.*** The suffix -ite denotes fewer oxygen. The prefix hypo- denotes the least number of oxygen.	Ex. ClO ₄ perchlorate ClO₃ chlorate ***the one we memorize ClO ₂ chlorite ClO hypochlorite
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Practice: Name the following compounds.

- | | |
|---------------------------------------------|-------------------------------------------------------------------------|
| 1. Fe(OH) ₃ _____ | 4. Cr(C ₂ H ₃ O ₂) ₂ _____ |
| 2. Cu ₂ (SO ₄) _____ | 5. FeS _____ |
| 3. Pb(NO ₃) ₂ _____ | 6. Pb(SO ₄) _____ |

Practice: Write the formula for the following compounds.

- | | |
|------------------------------|--------------------------------|
| 1. Iron (III) oxide _____ | 4. Copper (II) hydroxide _____ |
| 2. Copper (II) iodide _____ | 5. Lead (II) dichromate _____ |
| 3. Iron (II) phosphate _____ | 6. Mercury (I) chloride _____ |

II. Binary Compounds containing Two Non-Metals

The name consists of the non-metal that is further toward the left and bottom of the periodic table, followed by the -ide form of the second non-metal.

Compounds containing more than one of the non-metal elements can be distinguished by:

Mono – one	Penta – five	Octa – eight
Di – two	Hexa – six	Nona – nine
Tri – three	Hepta – seven	Deca – ten
Tetra – four		

Ex. CO Carbon monoxide
CO₂ Carbon dioxide

Practice: Name the following compounds.

- | | |
|-----------------------------------------|----------------------------------------|
| 1. PBr ₃ _____ | 4. SiO ₂ _____ |
| 2. CS ₂ _____ | 5. N ₂ O ₅ _____ |
| 3. Cl ₂ O ₇ _____ | 6. XeF ₄ _____ |

Practice: Write the formula for the following compounds.

- | | |
|--------------------------------|-----------------------------------|
| 1. Dibromine tetraoxide _____ | 4. Tetrasulfur tetranitride _____ |
| 2. Diiodine tetraoxide _____ | 5. Sulfur hexafluoride _____ |
| 3. Phosphorous triiodide _____ | 6. Oxygen dibromide _____ |

V. Binary Inorganic Compounds (Acids)

Containing a hydrogen and an non-metal. Start with hydrogen then the -ide form of the non-metal. When this type of compound is in an aqueous solution it will form an acid, then state hydro for the hydrogen and add the suffix -ic to the non-metal.

An acid is a molecular substance that when dissolved in water produces hydrogen ions (H⁺).

Ex. HCl(aq) hydrochloric acid
H₂S (aq) hydrosulfuric acid

If the combination is hydrogen and a polyatomic ion change the -ate of the polyatomic ion to -ic.

Ex. C₂H₃O₂⁻ acetate → HC₂H₃O₂ acetic acid
PO₄³⁻ phosphate → H₃PO₄ phosphoric acid

VI. Ternary Compounds (Acids)

Chlorine, nitrogen, sulfur, phosphorus, and others form oxyacids. Oxyacids are ternary compounds with hydrogen and oxygen.

If the acid has the most oxygen then it has the suffix - ic.

If the acid has fewer oxygen then it has the suffix - ous.

If the acid has the greatest number of oxygen it has the prefix per-.

If the acid has the least number of oxygen it has the prefix hypo-.

Ex. HClO₄ Perchloric acid
HClO₃ Chloric acid
HClO₂ Chlorous acid
HClO Hypochlorous acid

Practice: Name the following compounds.

- | | | | |
|-----------------------------|-------|---------------------------------------------------------|-------|
| 1. HI(aq) | _____ | 4. H(C ₂ H ₃ O ₂)(aq) | _____ |
| 2. HBr(aq) | _____ | 5. HF(aq) | _____ |
| 3. H(ClO ₃)(aq) | _____ | 6. H(NO ₂)(aq) | _____ |

Practice: Write the formula for the following compounds.

- | | | | |
|-----------------------|-------|--------------------|-------|
| 1. Sulfurous acid | _____ | 4. Nitric acid | _____ |
| 2. Hydrochloric acid | _____ | 5. Phosphoric acid | _____ |
| 3. Hydrosulfuric acid | _____ | 6. Chlorous acid | _____ |

VII. Hydrates

Compounds that contain water molecules weakly bound in their crystals. When the compound loses the water molecules it is referred to as anhydrous.

To name state the name of the binary compound and then list the number of water molecules attached.

Ex. Copper (II) sulfate is a white powdery substance. When associated with water CuSO₄ · 5 H₂O – copper (II) sulfate pentahydrate is a blue crystal.

Practice: Name the following compounds.

- | | |
|----------------------------------------------------------|-------|
| 1. Na ₂ CO ₃ · 10 H ₂ O | _____ |
| 2. BaCl ₂ · 2 H ₂ O | _____ |
| 3. CuSO ₄ · 5 H ₂ O | _____ |

Practice: Write the formula for the following compounds.

- | | |
|-----------------------------------|-------|
| 1. Magnesium sulfate heptahydrate | _____ |
| 2. Ferric nitrate trihydrate | _____ |

Name: _____ Period: ____ Date: _____

Homework: Oxidation Numbers

Determine the oxidation number for each of the elements in the following molecules and ions.

- | | | | |
|----------------------------------|-------------------|--------------------------------------------|-------------------|
| 1. $\text{Ca}(\text{OH})_2$ | <u>Ca= O= H=</u> | 11. $\text{Ba}(\text{BrO}_3)_2$ | <u>Ba= Br= O=</u> |
| 2. $\text{Bi}(\text{NO}_3)_3$ | <u>Bi= N= O=</u> | 12. NaAsO_2 | <u>Na= As= O=</u> |
| 3. $\text{Ca}(\text{ClO})_2$ | <u>Ca= Cl= O=</u> | 13. $\text{Pb}(\text{Cr}_2\text{O}_7)$ | <u>Pb= Cr= O=</u> |
| 4. $\text{K}(\text{MnO}_4)$ | <u>K= Mn= O=</u> | 14. $\text{Na}(\text{ClO}_4)$ | <u>Na= Cl= O=</u> |
| 5. $\text{Na}_2(\text{CrO}_4)$ | <u>Na= Cr= O=</u> | 15. MnO_2 | <u>Mn= O=</u> |
| 6. $\text{Cu}_2(\text{SO}_4)$ | <u>Cu= S= O=</u> | 16. O_2 | <u>O=</u> |
| 7. Fe_2O_3 | <u>Fe= O=</u> | 17. $\text{Al}_2(\text{Cr}_2\text{O}_7)_3$ | <u>Al= Cr= O=</u> |
| 8. $\text{Na}(\text{MnO}_4)$ | <u>Na= Mn= O=</u> | 18. $\text{Mn}(\text{NO}_3)_2$ | <u>Mn= N= O=</u> |
| 9. Cl_2 | <u>Cl=</u> | 19. KClO | <u>K= Cl= O=</u> |
| 10. $\text{Sb}_2(\text{SO}_4)_3$ | <u>Sb= S= O=</u> | 20. FeCO_3 | <u>Fe= C= O=</u> |

____ 21. What is the oxidation number of chromium in $\text{K}_2\text{Cr}_2\text{O}_7$?

- (1) +12 (3) +3
(2) +2 (4) +6

____ 22. In which substance is the oxidation number of Cl equal to +1?

- (1) Cl_2 (3) AlCl_3
(2) Cl_2O (4) HClO_2

____ 23. In which substance does hydrogen have an oxidation number of zero?

- (1) LiH (3) H_2S
(2) H_2O (4) H_2

____ 24. In which compound does carbon have an oxidation state of -4?

- (1) CO (3) CCl
(2) CO_2 (4) CH_4

____ 25. What is the oxidation number of carbon in $\text{Na}(\text{HCO}_3)$?

- (1) -2 (3) -4
(2) +2 (4) +4

Write the name for the following ionic compounds.

- | | | | |
|--------------------|-------|--------------------|-------|
| 26. Mg_3N_2 | _____ | 31. Ag_2S | _____ |
| 27. $Ca_3(PO_4)_2$ | _____ | 32. $Fe(NO_3)_3$ | _____ |
| 28. $Al_2(SO_4)_3$ | _____ | 33. $Ba(CO_3)$ | _____ |
| 29. $(NH_4)Cl$ | _____ | 34. $Li_2(C_2O_4)$ | _____ |
| 30. K_2O | _____ | 35. CuI_2 | _____ |

Write the formula for the following ionic compounds.

- | | | | |
|---------------------------|-------|----------------------------|-------|
| 36. Calcium sulfide | _____ | 41. Barium phosphate | _____ |
| 37. Magnesium phosphide | _____ | 42. Ammonium nitrite | _____ |
| 38. Sodium sulfate | _____ | 43. Aluminium chloride | _____ |
| 39. Potassium bicarbonate | _____ | 44. Cesium bromide | _____ |
| 40. Zinc bromide | _____ | 45. Potassium permanganate | _____ |

Write the names for the following metallic compounds.

- | | | | |
|------------|-------|---------------|-------|
| 46. $CuCl$ | _____ | 48. Fe_2O_3 | _____ |
| 47. HgO | _____ | 49. Bi_2O_3 | _____ |

Write the formula for the following metallic compounds.

- | | | | |
|---------------------------|-------|---------------------------|-------|
| 50. Tin (IV) chloride | _____ | 55. Mercury (I) nitride | _____ |
| 51. Cobalt (II) fluoride | _____ | 56. Iron (II) oxide | _____ |
| 52. Chromium (II) sulfide | _____ | 57. Copper (II) hydroxide | _____ |
| 53. Lead (II) sulfide | _____ | 58. Iron (III) nitrate | _____ |
| 54. Tin (II) bromide | _____ | 59. Copper (II) iodide | _____ |

Write the name for the following covalent compounds.

- | | | | |
|--------------|-------|---------------|-------|
| 60. NO | _____ | 65. N_2O_3 | _____ |
| 61. P_2O_5 | _____ | 66. S_2Br_2 | _____ |
| 62. PCl_5 | _____ | 67. CS_2 | _____ |
| 63. IF_7 | _____ | 68. ClF_5 | _____ |
| 64. CBr_4 | _____ | 69. SO_3 | _____ |

Write the formula for the following covalent compounds.

- | | | | |
|------------------------------|-------|---------------------------|-------|
| 70. Sulfur trioxide | _____ | 75. Sulfur hexafluoride | _____ |
| 71. Phosphorous trioxide | _____ | 76. Carbon disulfide | _____ |
| 72. Dinitrogen pentoxide | _____ | 77. Dinitrogen trioxide | _____ |
| 73. Oxygen dibromide | _____ | 78. Phosphorous pentoxide | _____ |
| 74. Tetrasulfur tetranitride | _____ | 79. Carbon dioxide | _____ |

Write the names of the following acids.

- | | | | |
|-----------------------------------------|-------|-----------------------------------------|-------|
| 80. HCl(aq) | _____ | 85. HNO ₂ (aq) | _____ |
| 81. H ₂ SO ₄ (aq) | _____ | 86. H ₂ CO ₃ (aq) | _____ |
| 82. HClO ₂ (aq) | _____ | 87. H ₃ PO ₅ (aq) | _____ |
| 83. HBr(aq) | _____ | 88. H ₃ PO ₄ (aq) | _____ |
| 84. H ₂ S(aq) | _____ | 89. HI(aq) | _____ |

Write the formula for the following acids.

- | | | | |
|-----------------------|-------|------------------------|-------|
| 90. Nitric acid | _____ | 95. Hydrosulfuric acid | _____ |
| 91. Hydrofluoric acid | _____ | 96. Sulfurous acid | _____ |
| 92. Hypochlorous acid | _____ | 97. Cyanic acid | _____ |
| 94. Acetic acid | _____ | 98. Perchloric acid | _____ |

Write the name of the following hydrates.

- | | |
|-----------------------------------------------|-------|
| 99. MgSO ₄ • 7 H ₂ O | _____ |
| 100. Ba(OH) ₂ • 8 H ₂ O | _____ |
| 101. CaCl ₂ • 2 H ₂ O | _____ |

Write the formula for the following hydrates.

- | | |
|-----------------------------------------------|-------|
| 102. Sodium sulfate decahydrate | _____ |
| 103. Potassium aluminum sulfate dodecahydrate | _____ |
| 104. Sodium tetraborate decahydrate | _____ |

