

# Grouping the Elements

## Objectives

- **Explain** why elements in a group often have similar properties.
- **Describe** the properties of the elements in the groups of the periodic table.

# I. Group I: Alkali Metals

## A. Highly Reactive Metals

Alkali metals are the most reactive metals because their atoms can easily give away the one outer-level electron.

| 1   | 2  | 3   |
|---|--|---|
| <div>37.0</div> <div>Li</div> <div>Lithium</div>  | <div>9.0</div> <div>Be</div> <div>Beryllium</div>  |   |
| <div>23.0</div> <div>Na</div> <div>Sodium</div>   | <div>24.3</div> <div>Mg</div> <div>Magnesium</div> |   |
| <div>39</div> <div>K</div> <div>Potassium</div>   | <div>40.0</div> <div>Ca</div> <div>Calcium</div>   | <div>45.0</div> <div>Sc</div> <div>Scandium</div> |
| <div>85.5</div> <div>Rb</div> <div>Rubidium</div> | <div>87.6</div> <div>Sr</div> <div>Strontium</div> | <div>88.9</div> <div>Y</div> <div>Yttrium</div>   |
| <div>132.9</div> <div>Cs</div> <div>Caesium</div> | <div>137.3</div> <div>Ba</div> <div>Barium</div>   | <div>1</div> <div>La</div> <div>Lanthanum</div>   |
| <div>223</div> <div>Fr</div> <div>Fransium</div>  | <div>226</div> <div>Ra</div> <div>Radium</div>     | <div>1</div> <div>Ac</div> <div>Actinium</div>    |

## II. Group 2: Earth Metals

- **Less Reactive Metals**  
Alkaline-earth metals are less reactive than alkali metals are. Atoms of alkaline-earth metals have two outer-level electrons. It is more difficult for atoms to give two electrons than to give one when joining with other atoms.

| 1                                | 2                                 | 3                                |
|----------------------------------|-----------------------------------|----------------------------------|
| 3 7.0<br><b>Li</b><br>Lithium    | 4 9.0<br><b>Be</b><br>Beryllium   |                                  |
| 11 23.0<br><b>Na</b><br>Sodium   | 12 24.3<br><b>Mg</b><br>Magnesium |                                  |
| 19 39<br><b>K</b><br>Potassium   | 20 40.0<br><b>Ca</b><br>Calcium   | 21 45.0<br><b>Sc</b><br>Scandium |
| 37 85.5<br><b>Rb</b><br>Rubidium | 38 87.6<br><b>Sr</b><br>Strontium | 39 88.9<br><b>Y</b><br>Yttrium   |
| 55 132.9<br><b>Cs</b><br>Caesium | 56 137.3<br><b>Ba</b><br>Barium   | 57 1<br><b>La</b><br>Lanthanum   |
| 87 223<br><b>Fr</b><br>Fransium  | 88 226<br><b>Ra</b><br>Radium     | 89 1<br><b>Ac</b><br>Actinium    |



# IV. Group 13: Boron Group

**A. Aluminum and More** The most common element from Group 13 is aluminum. In fact, aluminum is the most abundant metal in Earth's crust.

1

1A

11A

2

IIA

2A

13

IIIA

3A

14

IVA

4A

15

VA

5A

16

VIA

6A

17

VIIA

7A

18

VIIIA

8A

1

H

Hydrogen

1.0079

2

He

Helium

4.00260

3

Li

Lithium

6.941

4

Be

Beryllium

9.01218

11

Na

Sodium

22.989768

12

Mg

Magnesium

24.305

19

K

Potassium

39.0983

20

Ca

Calcium

40.078

37

Rb

Rubidium

85.4678

38

Sr

Strontium

87.62

55

Cs

Cesium

132.90545

56

Ba

Barium

137.327

87

Fr

Francium

223.0197

88

Ra

Radium

226.0254

3

IIIb

3B

4

IVb

4B

5

VB

5B

6

VIB

6B

7

VIIB

7B

8

VIII

8

9

VIII

8

10

VIII

8

11

IB

1B

12

IIB

2B

13

Al

Aluminum

26.981539

14

Si

Silicon

28.0855

15

P

Phosphorus

30.973762

16

S

Sulfur

32.066

17

Cl

Chlorine

35.4527

18

Ar

Argon

39.948

29

Cu

Copper

63.546

30

Zn

Zinc

65.39

49

In

Indium

114.818

50

Sn

Tin

118.71

51

Sb

Antimony

121.760

52

Te

Tellurium

127.6

53

I

Iodine

126.90447

54

Xe

Xenon

131.29

81

Tl

Thallium

204.3833

82

Pb

Lead

207.2

83

Bi

Bismuth

208.98037

84

Po

Polonium

[209]

85

At

Astatine

209

86

Rn

Radon

222.0176

113

Uut

Ununtrium

unknown

114

Uuq

Ununquadium

[289]

115

Uup

Ununpentium

unknown

116

Uuh

Ununhexium

[289]

117

Uus

Ununseptium

unknown

118

Uuo

Ununoctium

unknown

57

La

Lanthanum

138.9055

58

Ce

Cerium

140.115

59

Pr

Praseodymium

140.90765

60

Nd

Neodymium

144.24

61

Pm

Promethium

144.9127

62

Sm

Samarium

150.36

63

Eu

Europium

151.9655

64

Gd

Gadolinium

157.25

65

Tb

Terbium

158.92534

66

Dy

Dysprosium

162.50

67

Ho

Holmium

164.93032

68

Er

Erbium

167.26

69

Tm

Thulium

168.93421

70

Yb

Ytterbium

173.04

71

Lu

Lutetium

174.967

89

Ac

Actinium

227.0278

90

Th

Thorium

232.0381

91

Pa

Protactinium

231.03688

92

U

Uranium

238.02891

93

Np

Neptunium

237.0462

94

Pu

Plutonium

244.0642

95

Am

Americium

243.0614

96

Cm

Curium

247.0703

97

Bk

Berkelium

247.0703

98

Cf

Californium

251.0796

99

Es

Einsteinium

[254]

100

Fm

Fermium

257.0951

101

Md

Mendelevium

258.1

102

No

Nobelium

259.1009

103

Lr

Lawrencium

[262]

Alkali Metal

Alkaline Earth

Transition Metal

Basic Metal

Semimetals

Nonmetals

Halogens

Noble Gas

Lanthanides

Actinides



# V. Group 14: Carbon Group

- **Carbon: Important for Life** The nonmetal carbon can be found uncombined in nature. Carbon also forms a wide variety of compounds. Some of these compounds, such as proteins, fats, and carbohydrates, are necessary for living things on Earth.

# Periodic Table of the Elements

|                                 |                                 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                   |                                    |                                    |                                   |                                    |                                   |                            |                                |                             |                                 |                             |
|---------------------------------|---------------------------------|-----------------------------------|---------------------------------|---------------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|------------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|----------------------------|--------------------------------|-----------------------------|---------------------------------|-----------------------------|
| 1<br>1IA<br>11A                 |                                 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                   |                                    |                                    |                                   | 13<br>3A                           | 14<br>4A                          | 15<br>5A                   | 16<br>6A                       | 17<br>7A                    | 18<br>8A                        |                             |
| 1<br>H<br>Hydrogen<br>1.0079    | 2<br>IIA<br>2A                  |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                   |                                    |                                    |                                   |                                    | 5<br>B<br>Boron<br>10.811         | 6<br>C<br>Carbon<br>12.011 | 7<br>N<br>Nitrogen<br>14.00674 | 8<br>O<br>Oxygen<br>15.9994 | 9<br>F<br>Fluorine<br>18.998403 | 10<br>Ne<br>Neon<br>20.1797 |
| 3<br>Li<br>Lithium<br>6.941     | 4<br>Be<br>Beryllium<br>9.01218 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                   |                                    |                                    |                                   |                                    |                                   |                            |                                |                             |                                 |                             |
| 11<br>Na<br>Sodium<br>22.989769 | 12<br>Mg<br>Magnesium<br>24.305 | 3<br>IIIB<br>3B                   | 4<br>IVB<br>4B                  | 5<br>VB<br>5B                         | 6<br>VIB<br>6B                   | 7<br>VIIB<br>7B                    | 8<br>VIII<br>8                    | 9<br>VIII<br>8                    | 10<br>VIII<br>8                  | 11<br>IB<br>1B                     | 12<br>IIB<br>2B                     |                                   | 13<br>Al<br>Aluminum<br>26.981539 | 14<br>Si<br>Silicon<br>28.0855     | 15<br>P<br>Phosphorus<br>30.973762 | 16<br>S<br>Sulfur<br>32.065       | 17<br>Cl<br>Chlorine<br>35.4527    | 18<br>Ar<br>Argon<br>39.948       |                            |                                |                             |                                 |                             |
| 19<br>K<br>Potassium<br>39.0983 | 20<br>Ca<br>Calcium<br>40.078   | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.88   | 23<br>V<br>Vanadium<br>50.9415        | 24<br>Cr<br>Chromium<br>51.9961  | 25<br>Mn<br>Manganese<br>54.938    | 26<br>Fe<br>Iron<br>55.847        | 27<br>Co<br>Cobalt<br>58.9332     | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546       | 30<br>Zn<br>Zinc<br>65.39           |                                   | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64     | 33<br>As<br>Arsenic<br>74.92159    | 34<br>Se<br>Selenium<br>78.96     | 35<br>Br<br>Bromine<br>79.904      | 36<br>Kr<br>Krypton<br>83.80      |                            |                                |                             |                                 |                             |
| 37<br>Rb<br>Rubidium<br>85.4678 | 38<br>Sr<br>Strontium<br>87.62  | 39<br>Y<br>Yttrium<br>88.90585    | 40<br>Zr<br>Zirconium<br>91.224 | 41<br>Nb<br>Niobium<br>92.90638       | 42<br>Mo<br>Molybdenum<br>95.94  | 43<br>Tc<br>Technetium<br>98.9072  | 44<br>Ru<br>Ruthenium<br>101.07   | 45<br>Rh<br>Rhodium<br>102.9055   | 46<br>Pd<br>Palladium<br>106.42  | 47<br>Ag<br>Silver<br>107.8682     | 48<br>Cd<br>Cadmium<br>112.411      |                                   | 49<br>In<br>Indium<br>114.818     | 50<br>Sn<br>Tin<br>118.71          | 51<br>Sb<br>Antimony<br>121.760    | 52<br>Te<br>Tellurium<br>127.6    | 53<br>I<br>Iodine<br>126.90447     | 54<br>Xe<br>Xenon<br>131.29       |                            |                                |                             |                                 |                             |
| 55<br>Cs<br>Cesium<br>132.90543 | 56<br>Ba<br>Barium<br>137.327   | 57-71                             |                                 | 72<br>Hf<br>Hafnium<br>178.49         | 73<br>Ta<br>Tantalum<br>180.9479 | 74<br>W<br>Tungsten<br>183.85      | 75<br>Re<br>Rhenium<br>186.207    | 76<br>Os<br>Osmium<br>190.23      | 77<br>Ir<br>Iridium<br>192.22    | 78<br>Pt<br>Platinum<br>195.08     | 79<br>Au<br>Gold<br>196.9665        | 80<br>Hg<br>Mercury<br>200.59     | 81<br>Tl<br>Thallium<br>204.3833  | 82<br>Pb<br>Lead<br>207.2          | 83<br>Bi<br>Bismuth<br>208.98037   | 84<br>Po<br>Polonium<br>[209]     | 85<br>At<br>Astatine<br>[210]      | 86<br>Rn<br>Radon<br>222.0176     |                            |                                |                             |                                 |                             |
| 87<br>Fr<br>Francium<br>223.017 | 88<br>Ra<br>Radium<br>226.0254  | 89-103                            |                                 | 104<br>Rf<br>Rutherfordium<br>[261]   | 105<br>Db<br>Dubnium<br>[262]    | 106<br>Sg<br>Seaborgium<br>[266]   | 107<br>Bh<br>Bohrium<br>[264]     | 108<br>Hs<br>Hassium<br>[277]     | 109<br>Mt<br>Meitnerium<br>[268] | 110<br>Ds<br>Darmstadtium<br>[289] | 111<br>Rg<br>Roentgenium<br>[271]   | 112<br>Cn<br>Copernicium<br>[285] | 113<br>Uut<br>Ununtrium<br>[288]  | 114<br>Uuq<br>Ununquadium<br>[289] | 115<br>Uup<br>Ununpentium<br>[289] | 116<br>Uuh<br>Ununhexium<br>[289] | 117<br>Uus<br>Ununseptium<br>[294] | 118<br>Uuo<br>Ununoctium<br>[294] |                            |                                |                             |                                 |                             |
| Lanthanide Series               |                                 | 57<br>La<br>Lanthanum<br>138.9055 | 58<br>Ce<br>Cerium<br>140.115   | 59<br>Pr<br>Praseodymium<br>140.90765 | 60<br>Nd<br>Neodymium<br>144.24  | 61<br>Pm<br>Promethium<br>144.9127 | 62<br>Sm<br>Samarium<br>150.36    | 63<br>Eu<br>Europium<br>151.9655  | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.92534   | 66<br>Dy<br>Dysprosium<br>162.50    | 67<br>Ho<br>Holmium<br>164.93032  | 68<br>Er<br>Erbium<br>167.26      | 69<br>Tm<br>Thulium<br>168.93421   | 70<br>Yb<br>Ytterbium<br>173.04    | 71<br>Lu<br>Lutetium<br>174.967   |                                    |                                   |                            |                                |                             |                                 |                             |
| Actinide Series                 |                                 | 89<br>Ac<br>Actinium<br>227.0277  | 90<br>Th<br>Thorium<br>232.0381 | 91<br>Pa<br>Protactinium<br>231.03688 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237.0482  | 94<br>Pu<br>Plutonium<br>244.0642 | 95<br>Am<br>Americium<br>243.0614 | 96<br>Cm<br>Curium<br>247.0753   | 97<br>Bk<br>Berkelium<br>247.0753  | 98<br>Cf<br>Californium<br>251.0788 | 99<br>Es<br>Einsteinium<br>[254]  | 100<br>Fm<br>Fermium<br>257.0851  | 101<br>Md<br>Mendelevium<br>258.1  | 102<br>No<br>Nobelium<br>259.1069  | 103<br>Lr<br>Lawrencium<br>[262]  |                                    |                                   |                            |                                |                             |                                 |                             |
|                                 |                                 | Alkali Metal                      | Alkaline Earth                  | Transition Metal                      |                                  |                                    |                                   | Basic Metal                       | Semimetals                       | Nonmetals                          | Halogens                            | Noble Gas                         | Lanthanides                       | Actinides                          |                                    |                                   |                                    |                                   |                            |                                |                             |                                 |                             |

# VI. Group 15: Nitrogen Group

- **From Air to Fertilizers** Nitrogen, which is a gas at room temperature, makes up about 80% of the air you breathe. Nitrogen removed from air can be reacted with hydrogen to make ammonia for fertilizers.

# Periodic Table of the Elements

|                                  |                                 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     |                                    |                                    |                                      |                                   |                                      |                                     |
|----------------------------------|---------------------------------|-----------------------------------|-------------------------------------|---------------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|-----------------------------------|-------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|
| 1<br>1IA<br>11A                  |                                 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     |                                    |                                    |                                      |                                   |                                      | 18<br>VIII<br>8A                    |
| 1<br>H<br>Hydrogen<br>1.0079     | 2<br>IIA<br>2A                  |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     | 13<br>IIIA<br>3A                   | 14<br>IVA<br>4A                    | 15<br>VA<br>5A                       | 16<br>VIA<br>6A                   | 17<br>VIIA<br>7A                     | 2<br>He<br>Helium<br>4.00260        |
| 3<br>Li<br>Lithium<br>6.941      | 4<br>Be<br>Beryllium<br>9.01218 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     | 5<br>B<br>Boron<br>10.811          | 6<br>C<br>Carbon<br>12.011         | 7<br>N<br>Nitrogen<br>14.00574       | 8<br>O<br>Oxygen<br>15.9994       | 9<br>F<br>Fluorine<br>18.998403      | 10<br>Ne<br>Neon<br>20.1797         |
| 11<br>Na<br>Sodium<br>22.989768  | 12<br>Mg<br>Magnesium<br>24.305 | 3<br>IIIB<br>3B                   | 4<br>IVB<br>4B                      | 5<br>VB<br>5B                         | 6<br>VIB<br>6B                   | 7<br>VIIB<br>7B                    | 8<br>↓                            | 9<br>VIII<br>8                    | 10<br>↓                            | 11<br>IB<br>1B                    | 12<br>IIB<br>2B                     | 13<br>Al<br>Aluminum<br>26.981539  | 14<br>Si<br>Silicon<br>28.0855     | 15<br>P<br>Phosphorus<br>30.973762   | 16<br>S<br>Sulfur<br>32.066       | 17<br>Cl<br>Chlorine<br>35.4527      | 18<br>Ar<br>Argon<br>39.948         |
| 19<br>K<br>Potassium<br>39.0983  | 20<br>Ca<br>Calcium<br>40.078   | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.88       | 23<br>V<br>Vanadium<br>50.9415        | 24<br>Cr<br>Chromium<br>51.9961  | 25<br>Mn<br>Manganese<br>54.938    | 26<br>Fe<br>Iron<br>55.847        | 27<br>Co<br>Cobalt<br>58.9332     | 28<br>Ni<br>Nickel<br>58.6934      | 29<br>Cu<br>Copper<br>63.546      | 30<br>Zn<br>Zinc<br>65.39           | 31<br>Ga<br>Gallium<br>69.723      | 32<br>Ge<br>Germanium<br>72.64     | 33<br>As<br>Arsenic<br>74.92159      | 34<br>Se<br>Selenium<br>78.96     | 35<br>Br<br>Bromine<br>79.904        | 36<br>Kr<br>Krypton<br>83.80        |
| 37<br>Rb<br>Rubidium<br>85.4678  | 38<br>Sr<br>Strontium<br>87.62  | 39<br>Y<br>Yttrium<br>88.90585    | 40<br>Zr<br>Zirconium<br>91.224     | 41<br>Nb<br>Niobium<br>92.90638       | 42<br>Mo<br>Molybdenum<br>95.94  | 43<br>Tc<br>Technetium<br>98.9062  | 44<br>Ru<br>Ruthenium<br>101.07   | 45<br>Rh<br>Rhodium<br>102.9055   | 46<br>Pd<br>Palladium<br>106.42    | 47<br>Ag<br>Silver<br>107.8682    | 48<br>Cd<br>Cadmium<br>112.411      | 49<br>In<br>Indium<br>114.818      | 50<br>Sn<br>Tin<br>118.71          | 51<br>Sb<br>Antimony<br>121.760      | 52<br>Te<br>Tellurium<br>127.6    | 53<br>I<br>Iodine<br>126.90447       | 54<br>Xe<br>Xenon<br>131.29         |
| 55<br>Cs<br>Cesium<br>132.90545  | 56<br>Ba<br>Barium<br>137.327   | 57-71                             | 72<br>Hf<br>Hafnium<br>178.49       | 73<br>Ta<br>Tantalum<br>180.9479      | 74<br>W<br>Tungsten<br>183.85    | 75<br>Re<br>Rhenium<br>186.207     | 76<br>Os<br>Osmium<br>190.23      | 77<br>Ir<br>Iridium<br>192.22     | 78<br>Pt<br>Platinum<br>195.08     | 79<br>Au<br>Gold<br>196.9665      | 80<br>Hg<br>Mercury<br>200.59       | 81<br>Tl<br>Thallium<br>204.3833   | 82<br>Pb<br>Lead<br>207.2          | 83<br>Bi<br>Bismuth<br>208.98037     | 84<br>Po<br>Polonium<br>[209]     | 85<br>At<br>Astatine<br>[210]        | 86<br>Rn<br>Radon<br>222.0176       |
| 87<br>Fr<br>Francium<br>223.0197 | 88<br>Ra<br>Radium<br>226.0254  | 89-103                            | 104<br>Rf<br>Rutherfordium<br>[261] | 105<br>Db<br>Dubnium<br>[262]         | 106<br>Sg<br>Seaborgium<br>[266] | 107<br>Bh<br>Bohrium<br>[264]      | 108<br>Hs<br>Hassium<br>[269]     | 109<br>Mt<br>Meitnerium<br>[268]  | 110<br>Ds<br>Darmstadtium<br>[269] | 111<br>Rg<br>Roentgenium<br>[272] | 112<br>Cn<br>Copernicium<br>[277]   | 113<br>Uut<br>Ununtrium<br>unknown | 114<br>Uuq<br>Ununquadium<br>[289] | 115<br>Uup<br>Ununpentium<br>unknown | 116<br>Uuh<br>Ununhexium<br>[298] | 117<br>Uus<br>Ununseptium<br>unknown | 118<br>Uuo<br>Ununoctium<br>unknown |
| Lanthanide Series                |                                 | 57<br>La<br>Lanthanum<br>138.9055 | 58<br>Ce<br>Cerium<br>140.115       | 59<br>Pr<br>Praseodymium<br>140.90765 | 60<br>Nd<br>Neodymium<br>144.24  | 61<br>Pm<br>Promethium<br>144.9127 | 62<br>Sm<br>Samarium<br>150.36    | 63<br>Eu<br>Europium<br>151.9655  | 64<br>Gd<br>Gadolinium<br>157.25   | 65<br>Tb<br>Terbium<br>158.92534  | 66<br>Dy<br>Dysprosium<br>162.50    | 67<br>Ho<br>Holmium<br>164.93032   | 68<br>Er<br>Erbium<br>167.26       | 69<br>Tm<br>Thulium<br>168.93421     | 70<br>Yb<br>Ytterbium<br>173.04   | 71<br>Lu<br>Lutetium<br>174.967      |                                     |
| Actinide Series                  |                                 | 89<br>Ac<br>Actinium<br>227.0278  | 90<br>Th<br>Thorium<br>232.0381     | 91<br>Pa<br>Protactinium<br>231.03688 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237.0462  | 94<br>Pu<br>Plutonium<br>244.0642 | 95<br>Am<br>Americium<br>243.0614 | 96<br>Cm<br>Curium<br>247.0703     | 97<br>Bk<br>Berkelium<br>247.0703 | 98<br>Cf<br>Californium<br>251.0796 | 99<br>Es<br>Einsteinium<br>[254]   | 100<br>Fm<br>Fermium<br>257.0951   | 101<br>Md<br>Mendelevium<br>258.1    | 102<br>No<br>Nobelium<br>259.1009 | 103<br>Lr<br>Lawrencium<br>[262]     |                                     |
|                                  |                                 | Alkali Metal                      | Alkaline Earth                      | Transition Metal                      | Basic Metal                      | Semimetals                         | Nonmetals                         | Halogens                          | Noble Gas                          | Lanthanides                       | Actinides                           |                                    |                                    |                                      |                                   |                                      |                                     |

- **Getting Burned** Oxygen makes up about 20% of air. Oxygen is necessary for substances to burn. Oxygen is also important to most living things.

|                                    |  |                                 |  |   |  |                                     |  |  |  |                                       |  |   |  |                                   |  |  |  |                                       |  |                                    |  |                                   |  |                         |  |
|------------------------------------|--|---------------------------------|--|---|--|-------------------------------------|--|--|--|---------------------------------------|--|---|--|-----------------------------------|--|--|--|---------------------------------------|--|------------------------------------|--|-----------------------------------|--|-------------------------|--|
| Periodic Table of the Elements     |  |                                 |  |   |  |                                     |  |  |  |                                       |  |   |  |                                   |  |  |  | VIII<br>8A                            |  |                                    |  |                                   |  |                         |  |
| I<br>1A<br>H<br>Hydrogen<br>1.0079 |  |                                 |  |   |  |                                     |  | III<br>3A<br>Al<br>Aluminum<br>26.981539 |  | IV<br>4A<br>Si<br>Silicon<br>28.0855  |  | V<br>5A<br>P<br>Phosphorus<br>30.973762 |  | VI<br>6A<br>S<br>Sulfur<br>32.06  |  | VII<br>7A<br>Cl<br>Chlorine<br>35.4527 |  | He<br>Helium<br>4.002602              |  |                                    |  |                                   |  |                         |  |
| 3<br>Li<br>Lithium<br>6.941        |  | 4<br>Be<br>Beryllium<br>9.01218 |  |   |  |                                     |  |  |  | 5<br>B<br>Boron<br>10.81              |  | 6<br>C<br>Carbon<br>12.011              |  | 7<br>N<br>Nitrogen<br>14.00644    |  | 8<br>O<br>Oxygen<br>15.9994            |  | 9<br>F<br>Fluorine<br>18.998463       |  | 10<br>Ne<br>Neon<br>20.1797        |  |                                   |  |                         |  |
| 11<br>Na<br>Sodium<br>22.989768    |  | 12<br>Mg<br>Magnesium<br>24.305 |  | 3<br>IIIB<br>Sc<br>Scandium<br>44.95591 |  | 4<br>IVB<br>Ti<br>Titanium<br>47.88 |  | 5<br>VB<br>V<br>Vanadium<br>50.9415      |  | 6<br>VIB<br>Cr<br>Chromium<br>51.9961 |  | 7<br>VIIB<br>Mn<br>Manganese<br>54.938  |  | 8<br>VIII<br>Fe<br>Iron<br>55.847 |  | 9<br>VIII<br>Co<br>Cobalt<br>58.9332   |  | 10<br>VIII<br>Ni<br>Nickel<br>58.6934 |  | 11<br>IB<br>Cu<br>Copper<br>63.546 |  | 12<br>IIB<br>Zn<br>Zinc<br>65.38  |  |                         |  |
| 19<br>K<br>Potassium<br>39.0983    |  | 20<br>Ca<br>Calcium<br>40.078   |  | 21<br>Sc<br>Scandium<br>44.95591        |  | 22<br>Ti<br>Titanium<br>47.88       |  | 23<br>V<br>Vanadium<br>50.9415           |  | 24<br>Cr<br>Chromium<br>51.9961       |  | 25<br>Mn<br>Manganese<br>54.938         |  | 26<br>Fe<br>Iron<br>55.847        |  | 27<br>Co<br>Cobalt<br>58.9332          |  | 28<br>Ni<br>Nickel<br>58.6934         |  | 29<br>Cu<br>Copper<br>63.546       |  | 30<br>Zn<br>Zinc<br>65.38         |  |                         |  |
| 37<br>Rb<br>Rubidium<br>85.4678    |  | 38<br>Sr<br>Strontium<br>87.62  |  | 39<br>Y<br>Yttrium<br>88.90585          |  | 40<br>Zr<br>Zirconium<br>91.224     |  | 41<br>Nb<br>Niobium<br>92.90638          |  | 42<br>Mo<br>Molybdenum<br>95.94       |  | 43<br>Tc<br>Technetium<br>98.9062       |  | 44<br>Ru<br>Ruthenium<br>101.07   |  | 45<br>Rh<br>Rhodium<br>102.9055        |  | 46<br>Pd<br>Palladium<br>106.42       |  | 47<br>Ag<br>Silver<br>107.8682     |  | 48<br>Cd<br>Cadmium<br>112.411    |  |                         |  |
| 55<br>Cs<br>Cesium<br>132.90543    |  | 56<br>Ba<br>Barium<br>137.327   |  | 57-71<br>La<br>Lanthanum<br>138.9055    |  | 72<br>Hf<br>Hafnium<br>178.49       |  | 73<br>Ta<br>Tantalum<br>180.9479         |  | 74<br>W<br>Tungsten<br>183.85         |  | 75<br>Re<br>Rhenium<br>186.207          |  | 76<br>Os<br>Osmium<br>190.23      |  | 77<br>Ir<br>Iridium<br>192.22          |  | 78<br>Pt<br>Platinum<br>195.08        |  | 79<br>Au<br>Gold<br>196.9665       |  | 80<br>Hg<br>Mercury<br>200.59     |  |                         |  |
| 87<br>Fr<br>Francium<br>223.017    |  | 88<br>Ra<br>Radium<br>226.0254  |  | 89-103<br>Ac<br>Actinium<br>227.0278    |  | 104<br>Rf<br>Rutherfordium<br>[261] |  | 105<br>Db<br>Dubnium<br>[262]            |  | 106<br>Sg<br>Seaborgium<br>[266]      |  | 107<br>Bh<br>Bohrium<br>[264]           |  | 108<br>Hs<br>Hassium<br>[269]     |  | 109<br>Mt<br>Meitnerium<br>[268]       |  | 110<br>Ds<br>Darmstadtium<br>[269]    |  | 111<br>Rg<br>Roentgenium<br>[272]  |  | 112<br>Cn<br>Copernicium<br>[277] |  |                         |  |
| Lanthanide Series                  |  | 57 La Lanthanum 138.9055        |  | 58 Ce Cerium 140.115                    |  | 59 Pr Praseodymium 140.90765        |  | 60 Nd Neodymium 144.24                   |  | 61 Pm Promethium 144.9127             |  | 62 Sm Samarium 150.36                   |  | 63 Eu Europium 151.9655           |  | 64 Gd Gadolinium 157.25                |  | 65 Tb Terbium 158.92534               |  | 66 Dy Dysprosium 162.50            |  | 67 Ho Holmium 164.93032           |  | 68 Er Erbium 167.26     |  |
| Actinide Series                    |  | 89 Ac Actinium 227.0278         |  | 90 Th Thorium 232.0381                  |  | 91 Pa Protactinium 231.03688        |  | 92 U Uranium 238.0289                    |  | 93 Np Neptunium 237.0462              |  | 94 Pu Plutonium 244.0642                |  | 95 Am Americium 243.0614          |  | 96 Cm Curium 247.075                   |  | 97 Bk Berkelium 247.075               |  | 98 Cf Californium 251.0796         |  | 99 Es Einsteinium [254]           |  | 100 Fm Fermium 257.0951 |  |
|                                    |  | 101 Md Mendelevium 258.1        |  | 102 No Nobelium 259.1069                |  | 103 Lr Lawrencium [262]             |  |  |  |                                       |  |   |  |                                   |  |  |  |                                       |  |                                    |  |                                   |  |                         |  |
|                                    |  | Alkali Metal                    |  | Alkaline Earth                          |  | Transition Metal                    |  | Basic Metal                              |  | Semimetals                            |  | Nonmetals                               |  | Halogens                          |  | Noble Gas                              |  | Lanthanides                           |  | Actinides                          |  |                                   |  |                         |  |



# VIII. Group 17: Halogens

- **Reactive Nonmetals** Halogens are very reactive nonmetals because their atoms need to gain only one electron to have a complete outer level.

**Periodic Table of the Elements**

|                                  |                                 |                                  |                                     |                                  |                                       |                                   |                                    |                                   |                                    |                                   |                                   |                                     |                                   |                                    |                                    |                                   |                                    |                                   |
|----------------------------------|---------------------------------|----------------------------------|-------------------------------------|----------------------------------|---------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|------------------------------------|------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|
| 1<br>1A<br>11A                   | 2<br>IIA<br>2A                  |                                  |                                     |                                  |                                       |                                   |                                    |                                   |                                    |                                   |                                   |                                     | 13<br>IIIA<br>3A                  | 14<br>IVA<br>4A                    | 15<br>VA<br>5A                     | 16<br>VIA<br>6A                   | 17<br>VIIA<br>7A                   | 18<br>VIIIA<br>8A                 |
| 1<br>H<br>Hydrogen<br>1.0079     |                                 |                                  |                                     |                                  |                                       |                                   |                                    |                                   |                                    |                                   |                                   |                                     |                                   |                                    |                                    |                                   |                                    | 2<br>He<br>Helium<br>4.00260      |
| 3<br>Li<br>Lithium<br>6.941      | 4<br>Be<br>Beryllium<br>9.01218 |                                  |                                     |                                  |                                       |                                   |                                    |                                   |                                    |                                   |                                   |                                     | 5<br>B<br>Boron<br>10.811         | 6<br>C<br>Carbon<br>12.011         | 7<br>N<br>Nitrogen<br>14.00674     | 8<br>O<br>Oxygen<br>15.9994       | 9<br>F<br>Fluorine<br>18.998403    | 10<br>Ne<br>Neon<br>20.1797       |
| 11<br>Na<br>Sodium<br>22.989769  | 12<br>Mg<br>Magnesium<br>24.305 | 3<br>IIIB<br>3B                  | 4<br>IVB<br>4B                      | 5<br>VB<br>5B                    | 6<br>VIB<br>6B                        | 7<br>VIIB<br>7B                   | 8<br>VIII<br>8                     | 9<br>VIII<br>8                    | 10<br>VIII<br>8                    | 11<br>IB<br>1B                    | 12<br>IIB<br>2B                   |                                     | 13<br>Al<br>Aluminum<br>26.981539 | 14<br>Si<br>Silicon<br>28.0855     | 15<br>P<br>Phosphorus<br>30.973762 | 16<br>S<br>Sulfur<br>32.065       | 17<br>Cl<br>Chlorine<br>35.4527    | 18<br>Ar<br>Argon<br>39.948       |
| 19<br>K<br>Potassium<br>39.0983  | 20<br>Ca<br>Calcium<br>40.078   | 21<br>Sc<br>Scandium<br>44.95591 | 22<br>Ti<br>Titanium<br>47.88       | 23<br>V<br>Vanadium<br>50.9415   | 24<br>Cr<br>Chromium<br>51.9961       | 25<br>Mn<br>Manganese<br>54.938   | 26<br>Fe<br>Iron<br>55.847         | 27<br>Co<br>Cobalt<br>58.9332     | 28<br>Ni<br>Nickel<br>58.6934      | 29<br>Cu<br>Copper<br>63.546      | 30<br>Zn<br>Zinc<br>65.39         |                                     | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64     | 33<br>As<br>Arsenic<br>74.92159    | 34<br>Se<br>Selenium<br>78.96     | 35<br>Br<br>Bromine<br>79.904      | 36<br>Kr<br>Krypton<br>83.80      |
| 37<br>Rb<br>Rubidium<br>85.4678  | 38<br>Sr<br>Strontium<br>87.62  | 39<br>Y<br>Yttrium<br>88.90585   | 40<br>Zr<br>Zirconium<br>91.224     | 41<br>Nb<br>Niobium<br>92.90638  | 42<br>Mo<br>Molybdenum<br>95.94       | 43<br>Tc<br>Technetium<br>98.9072 | 44<br>Ru<br>Ruthenium<br>101.07    | 45<br>Rh<br>Rhodium<br>102.9055   | 46<br>Pd<br>Palladium<br>106.42    | 47<br>Ag<br>Silver<br>107.8682    | 48<br>Cd<br>Cadmium<br>112.411    |                                     | 49<br>In<br>Indium<br>114.818     | 50<br>Sn<br>Tin<br>118.71          | 51<br>Sb<br>Antimony<br>121.760    | 52<br>Te<br>Tellurium<br>127.6    | 53<br>I<br>Iodine<br>126.90447     | 54<br>Xe<br>Xenon<br>131.29       |
| 55<br>Cs<br>Cesium<br>132.90543  | 56<br>Ba<br>Barium<br>137.327   | 57-71<br>Lanthanide Series       | 72<br>Hf<br>Hafnium<br>178.49       | 73<br>Ta<br>Tantalum<br>180.9479 | 74<br>W<br>Tungsten<br>183.85         | 75<br>Re<br>Rhenium<br>186.207    | 76<br>Os<br>Osmium<br>190.23       | 77<br>Ir<br>Iridium<br>192.22     | 78<br>Pt<br>Platinum<br>195.08     | 79<br>Au<br>Gold<br>196.9665      | 80<br>Hg<br>Mercury<br>200.59     |                                     | 81<br>Tl<br>Thallium<br>204.3833  | 82<br>Pb<br>Lead<br>207.2          | 83<br>Bi<br>Bismuth<br>208.98037   | 84<br>Po<br>Polonium<br>[209]     | 85<br>At<br>Astatine<br>208.9771   | 86<br>Rn<br>Radon<br>222.0175     |
| 87<br>Fr<br>Francium<br>223.0197 | 88<br>Ra<br>Radium<br>226.0254  | 89-103<br>Actinide Series        | 104<br>Rf<br>Rutherfordium<br>[261] | 105<br>Db<br>Dubnium<br>[262]    | 106<br>Sg<br>Seaborgium<br>[266]      | 107<br>Bh<br>Bohrium<br>[264]     | 108<br>Hs<br>Hassium<br>[285]      | 109<br>Mt<br>Meitnerium<br>[288]  | 110<br>Ds<br>Darmstadtium<br>[289] | 111<br>Rg<br>Roentgenium<br>[271] | 112<br>Cn<br>Copernicium<br>[285] |                                     | 113<br>Uut<br>Ununtrium<br>[289]  | 114<br>Uuq<br>Ununquadium<br>[289] | 115<br>Uup<br>Ununpentium<br>[289] | 116<br>Uuh<br>Ununhexium<br>[289] | 117<br>Uus<br>Ununseptium<br>[289] | 118<br>Uuo<br>Ununoctium<br>[289] |
|                                  |                                 |                                  | 57<br>La<br>Lanthanum<br>138.9055   | 58<br>Ce<br>Cerium<br>140.115    | 59<br>Pr<br>Praseodymium<br>140.90765 | 60<br>Nd<br>Neodymium<br>144.24   | 61<br>Pm<br>Promethium<br>144.9127 | 62<br>Sm<br>Samarium<br>150.36    | 63<br>Eu<br>Europium<br>151.9655   | 64<br>Gd<br>Gadolinium<br>157.25  | 65<br>Tb<br>Terbium<br>158.92534  | 66<br>Dy<br>Dysprosium<br>162.50    | 67<br>Ho<br>Holmium<br>164.93032  | 68<br>Er<br>Erbium<br>167.26       | 69<br>Tm<br>Thulium<br>168.93421   | 70<br>Yb<br>Ytterbium<br>173.04   | 71<br>Lu<br>Lutetium<br>174.967    |                                   |
|                                  |                                 |                                  | 89<br>Ac<br>Actinium<br>227.0278    | 90<br>Th<br>Thorium<br>232.0381  | 91<br>Pa<br>Protactinium<br>231.03588 | 92<br>U<br>Uranium<br>238.0289    | 93<br>Np<br>Neptunium<br>237.0482  | 94<br>Pu<br>Plutonium<br>244.0642 | 95<br>Am<br>Americium<br>243.0614  | 96<br>Cm<br>Curium<br>247.0703    | 97<br>Bk<br>Berkelium<br>247.0703 | 98<br>Cf<br>Californium<br>251.0796 | 99<br>Es<br>Einsteinium<br>[254]  | 100<br>Fm<br>Fermium<br>257.0951   | 101<br>Md<br>Mendelevium<br>258.1  | 102<br>No<br>Nobelium<br>259.1008 | 103<br>Lr<br>Lawrencium<br>[262]   |                                   |
|                                  |                                 |                                  | Alkali Metal                        | Alkaline Earth                   | Transition Metal                      | Basic Metal                       | Semimetals                         | Nonmetals                         | Halogens                           | Noble Gas                         | Lanthanides                       | Actinides                           |                                   |                                    |                                    |                                   |                                    |                                   |

# IX. Group 18: Noble Gases

- **Stable Elements** Noble gases are unreactive nonmetals and are in Group 18 of the periodic table. The atoms of these elements have a full set of electrons in their outer level.

|                                  |                                 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                  |                                    |                                    |                                    |                                    |                                   |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
|----------------------------------|---------------------------------|-----------------------------------|---------------------------------|---------------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|------------------------------------|-------------------------------------|-----------------------------------|----------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-----------------------------------|---------------------------------|--------------------------------|-----------------------------|---------------------------------|-----------------------------|--|--|--|--|--|--|--|--|--|--|--|--|---------------------------------|-----------------------------|
| Periodic Table of the Elements   |                                 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                  |                                    |                                    |                                    |                                    | 18<br>VIIIA<br>8A                 |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 1<br>1IA<br>11A                  |                                 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                  |                                    |                                    |                                    | 13<br>IIIA<br>3A                   | 14<br>IVA<br>4A                   | 15<br>VA<br>5A                  | 16<br>VIA<br>6A                | 17<br>VIIA<br>7A            | 2<br>He<br>Helium<br>4.00260    |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 1<br>H<br>Hydrogen<br>1.0079     | 2<br>IIA<br>2A                  |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                  |                                    |                                    |                                    |                                    | 5<br>B<br>Boron<br>10.811         | 6<br>C<br>Carbon<br>12.011      | 7<br>N<br>Nitrogen<br>14.00674 | 8<br>O<br>Oxygen<br>15.9994 | 9<br>F<br>Fluorine<br>18.998403 | 10<br>Ne<br>Neon<br>20.1797 |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 3<br>Li<br>Lithium<br>6.941      | 4<br>Be<br>Beryllium<br>9.01218 |                                   |                                 |                                       |                                  |                                    |                                   |                                   |                                  |                                    |                                     |                                   |                                  |                                    |                                    |                                    |                                    | 11<br>Na<br>Sodium<br>22.989768   | 12<br>Mg<br>Magnesium<br>24.305 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  | 17<br>Cl<br>Chlorine<br>35.4527 | 18<br>Ar<br>Argon<br>39.948 |
| 11<br>Na<br>Sodium<br>22.989768  | 12<br>Mg<br>Magnesium<br>24.305 | 3<br>IIIB<br>3B                   | 4<br>IVB<br>4B                  | 5<br>VB<br>5B                         | 6<br>VIB<br>6B                   | 7<br>VIIB<br>7B                    | 8<br>VIII<br>8                    |                                   |                                  | 9<br>VIII<br>9                     | 10<br>VIII<br>10                    | 11<br>IB<br>1B                    | 12<br>IIB<br>2B                  | 13<br>Al<br>Aluminum<br>26.981539  | 14<br>Si<br>Silicon<br>28.0855     | 15<br>P<br>Phosphorus<br>30.973762 | 16<br>S<br>Sulfur<br>32.066        | 17<br>Cl<br>Chlorine<br>35.4527   | 18<br>Ar<br>Argon<br>39.948     |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 19<br>K<br>Potassium<br>39.0983  | 20<br>Ca<br>Calcium<br>40.078   | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.88   | 23<br>V<br>Vanadium<br>50.9415        | 24<br>Cr<br>Chromium<br>51.9961  | 25<br>Mn<br>Manganese<br>54.938    | 26<br>Fe<br>Iron<br>55.847        | 27<br>Co<br>Cobalt<br>58.9332     | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546       | 30<br>Zn<br>Zinc<br>65.39           | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92159    | 34<br>Se<br>Selenium<br>78.96      | 35<br>Br<br>Bromine<br>79.904      | 36<br>Kr<br>Krypton<br>83.80       |                                   |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 37<br>Rb<br>Rubidium<br>85.4678  | 38<br>Sr<br>Strontium<br>87.62  | 39<br>Y<br>Yttrium<br>88.90585    | 40<br>Zr<br>Zirconium<br>91.224 | 41<br>Nb<br>Niobium<br>92.90638       | 42<br>Mo<br>Molybdenum<br>95.94  | 43<br>Tc<br>Technetium<br>98.9072  | 44<br>Ru<br>Ruthenium<br>101.07   | 45<br>Rh<br>Rhodium<br>102.9055   | 46<br>Pd<br>Palladium<br>106.42  | 47<br>Ag<br>Silver<br>107.8682     | 48<br>Cd<br>Cadmium<br>112.411      | 49<br>In<br>Indium<br>114.818     | 50<br>Sn<br>Tin<br>118.71        | 51<br>Sb<br>Antimony<br>121.760    | 52<br>Te<br>Tellurium<br>127.6     | 53<br>I<br>Iodine<br>126.90447     | 54<br>Xe<br>Xenon<br>131.29        |                                   |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 55<br>Cs<br>Cesium<br>132.90543  | 56<br>Ba<br>Barium<br>137.327   | 57-71                             |                                 | 72<br>Hf<br>Hafnium<br>178.49         | 73<br>Ta<br>Tantalum<br>180.9479 | 74<br>W<br>Tungsten<br>183.85      | 75<br>Re<br>Rhenium<br>186.207    | 76<br>Os<br>Osmium<br>190.23      | 77<br>Ir<br>Iridium<br>192.22    | 78<br>Pt<br>Platinum<br>195.08     | 79<br>Au<br>Gold<br>196.9665        | 80<br>Hg<br>Mercury<br>200.59     | 81<br>Tl<br>Thallium<br>204.3833 | 82<br>Pb<br>Lead<br>207.2          | 83<br>Bi<br>Bismuth<br>208.98037   | 84<br>Po<br>Polonium<br>[209]      | 85<br>At<br>Astatine<br>[210]      | 86<br>Rn<br>Radon<br>222.0176     |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| 87<br>Fr<br>Francium<br>223.0197 | 88<br>Ra<br>Radium<br>226.0254  | 89-103                            |                                 | 104<br>Rf<br>Rutherfordium<br>[261]   | 105<br>Db<br>Dubnium<br>[262]    | 106<br>Sg<br>Seaborgium<br>[266]   | 107<br>Bh<br>Bohrium<br>[264]     | 108<br>Hs<br>Hassium<br>[269]     | 109<br>Mt<br>Meitnerium<br>[268] | 110<br>Ds<br>Darmstadtium<br>[269] | 111<br>Rg<br>Roentgenium<br>[272]   | 112<br>Cn<br>Copernicium<br>[277] | 113<br>Uut<br>Ununtrium<br>[289] | 114<br>Uuq<br>Ununquadium<br>[289] | 115<br>Uup<br>Ununpentium<br>[289] | 116<br>Uuh<br>Ununhexium<br>[289]  | 117<br>Uus<br>Ununseptium<br>[289] | 118<br>Uuo<br>Ununoctium<br>[289] |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| Lanthanide Series                |                                 | 57<br>La<br>Lanthanum<br>138.9055 | 58<br>Ce<br>Cerium<br>140.115   | 59<br>Pr<br>Praseodymium<br>140.90765 | 60<br>Nd<br>Neodymium<br>144.24  | 61<br>Pm<br>Promethium<br>144.9127 | 62<br>Sm<br>Samarium<br>150.36    | 63<br>Eu<br>Europium<br>151.9655  | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.92534   | 66<br>Dy<br>Dysprosium<br>162.50    | 67<br>Ho<br>Holmium<br>164.93032  | 68<br>Er<br>Erbium<br>167.26     | 69<br>Tm<br>Thulium<br>168.93421   | 70<br>Yb<br>Ytterbium<br>173.04    | 71<br>Lu<br>Lutetium<br>174.967    |                                    |                                   |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| Actinide Series                  |                                 | 89<br>Ac<br>Actinium<br>227.0278  | 90<br>Th<br>Thorium<br>232.0381 | 91<br>Pa<br>Protactinium<br>231.03688 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237.0482  | 94<br>Pu<br>Plutonium<br>244.0642 | 95<br>Am<br>Americium<br>243.0614 | 96<br>Cm<br>Curium<br>247.0703   | 97<br>Bk<br>Berkelium<br>247.0703  | 98<br>Cf<br>Californium<br>251.0796 | 99<br>Es<br>Einsteinium<br>[254]  | 100<br>Fm<br>Fermium<br>257.0951 | 101<br>Md<br>Mendelevium<br>258.1  | 102<br>No<br>Nobelium<br>259.1009  | 103<br>Lr<br>Lawrencium<br>[262]   |                                    |                                   |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |
| Alkali Metal                     |                                 | Alkaline Earth                    |                                 | Transition Metal                      |                                  | Basic Metal                        |                                   | Semimetals                        |                                  | Nonmetals                          |                                     | Halogens                          |                                  | Noble Gas                          |                                    | Lanthanides                        |                                    | Actinides                         |                                 |                                |                             |                                 |                             |  |  |  |  |  |  |  |  |  |  |  |  |                                 |                             |

# X. Hydrogen

- An Element Apart** The properties of hydrogen do not match the properties of any single group, so hydrogen is set apart from the other elements in the table. Hydrogen is above Group 1 because atoms of the alkali metals also have only one electron in their outer level. Atoms of hydrogen can give away one electron when they join with other atoms.

| Periodic Table of the Elements   |                                 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     |                                    |                                    |                                      |                                   |                                      |                                     | 18<br>VIIIA<br>8A |
|----------------------------------|---------------------------------|-----------------------------------|-------------------------------------|---------------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|-----------------------------------|-------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|-------------------|
| 1<br>1IA<br>11A                  |                                 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     |                                    |                                    |                                      |                                   |                                      | 2<br>VIIIA<br>8A                    |                   |
| 1<br>H<br>Hydrogen<br>1.0079     | 2<br>IIA<br>2A                  |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     | 13<br>IIIA<br>3A                   | 14<br>IVA<br>4A                    | 15<br>VA<br>5A                       | 16<br>VIA<br>6A                   | 17<br>VIIA<br>7A                     | 2<br>He<br>Helium<br>4.0026         |                   |
| 3<br>Li<br>Lithium<br>6.941      | 4<br>Be<br>Beryllium<br>9.01218 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     | 5<br>B<br>Boron<br>10.811          | 6<br>C<br>Carbon<br>12.011         | 7<br>N<br>Nitrogen<br>14.00674       | 8<br>O<br>Oxygen<br>15.9994       | 9<br>F<br>Fluorine<br>18.998403      | 10<br>Ne<br>Neon<br>20.1797         |                   |
| 11<br>Na<br>Sodium<br>22.989768  | 12<br>Mg<br>Magnesium<br>24.305 | 3<br>IIIB<br>3B                   | 4<br>IVB<br>4B                      | 5<br>VB<br>5B                         | 6<br>VIB<br>6B                   | 7<br>VIIB<br>7B                    | 8<br>VIII<br>8                    | 9<br>VIII<br>8                    | 10<br>VIII<br>8                    | 11<br>IB<br>1B                    | 12<br>IIB<br>2B                     | 13<br>Al<br>Aluminum<br>26.981539  | 14<br>Si<br>Silicon<br>28.0855     | 15<br>P<br>Phosphorus<br>30.973762   | 16<br>S<br>Sulfur<br>32.065       | 17<br>Cl<br>Chlorine<br>35.4527      | 18<br>Ar<br>Argon<br>39.948         |                   |
| 19<br>K<br>Potassium<br>39.0983  | 20<br>Ca<br>Calcium<br>40.078   | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.88       | 23<br>V<br>Vanadium<br>50.9415        | 24<br>Cr<br>Chromium<br>51.9961  | 25<br>Mn<br>Manganese<br>54.938    | 26<br>Fe<br>Iron<br>55.847        | 27<br>Co<br>Cobalt<br>58.9332     | 28<br>Ni<br>Nickel<br>58.6934      | 29<br>Cu<br>Copper<br>63.546      | 30<br>Zn<br>Zinc<br>65.39           | 31<br>Ga<br>Gallium<br>69.723      | 32<br>Ge<br>Germanium<br>72.64     | 33<br>As<br>Arsenic<br>74.92159      | 34<br>Se<br>Selenium<br>78.96     | 35<br>Br<br>Bromine<br>79.904        | 36<br>Kr<br>Krypton<br>83.80        |                   |
| 37<br>Rb<br>Rubidium<br>85.4678  | 38<br>Sr<br>Strontium<br>87.62  | 39<br>Y<br>Yttrium<br>88.90585    | 40<br>Zr<br>Zirconium<br>91.224     | 41<br>Nb<br>Niobium<br>92.90638       | 42<br>Mo<br>Molybdenum<br>95.94  | 43<br>Tc<br>Technetium<br>98.9072  | 44<br>Ru<br>Ruthenium<br>101.07   | 45<br>Rh<br>Rhodium<br>102.9055   | 46<br>Pd<br>Palladium<br>106.42    | 47<br>Ag<br>Silver<br>107.8682    | 48<br>Cd<br>Cadmium<br>112.411      | 49<br>In<br>Indium<br>114.818      | 50<br>Sn<br>Tin<br>118.71          | 51<br>Sb<br>Antimony<br>121.760      | 52<br>Te<br>Tellurium<br>127.6    | 53<br>I<br>Iodine<br>126.90447       | 54<br>Xe<br>Xenon<br>131.29         |                   |
| 55<br>Cs<br>Cesium<br>132.90545  | 56<br>Ba<br>Barium<br>137.327   | 57-71                             | 72<br>Hf<br>Hafnium<br>178.49       | 73<br>Ta<br>Tantalum<br>180.9479      | 74<br>W<br>Tungsten<br>183.85    | 75<br>Re<br>Rhenium<br>186.207     | 76<br>Os<br>Osmium<br>190.23      | 77<br>Ir<br>Iridium<br>192.22     | 78<br>Pt<br>Platinum<br>195.08     | 79<br>Au<br>Gold<br>196.9665      | 80<br>Hg<br>Mercury<br>200.59       | 81<br>Tl<br>Thallium<br>204.3833   | 82<br>Pb<br>Lead<br>207.2          | 83<br>Bi<br>Bismuth<br>208.98037     | 84<br>Po<br>Polonium<br>[209]     | 85<br>At<br>Astatine<br>[209]        | 86<br>Rn<br>Radon<br>222.0176       |                   |
| 87<br>Fr<br>Francium<br>223.0197 | 88<br>Ra<br>Radium<br>226.0254  | 89-103                            | 104<br>Rf<br>Rutherfordium<br>[261] | 105<br>Db<br>Dubnium<br>[262]         | 106<br>Sg<br>Seaborgium<br>[266] | 107<br>Bh<br>Bohrium<br>[264]      | 108<br>Hs<br>Hassium<br>[269]     | 109<br>Mt<br>Meitnerium<br>[268]  | 110<br>Ds<br>Darmstadtium<br>[269] | 111<br>Rg<br>Roentgenium<br>[272] | 112<br>Cn<br>Copernicium<br>[277]   | 113<br>Uut<br>Ununtrium<br>unknown | 114<br>Uuq<br>Ununquadium<br>[289] | 115<br>Uup<br>Ununpentium<br>unknown | 116<br>Uuh<br>Ununhexium<br>[298] | 117<br>Uus<br>Ununseptium<br>unknown | 118<br>Uuo<br>Ununoctium<br>unknown |                   |
| Lanthanide Series                |                                 | 57<br>La<br>Lanthanum<br>138.9055 | 58<br>Ce<br>Cerium<br>140.115       | 59<br>Pr<br>Praseodymium<br>140.90765 | 60<br>Nd<br>Neodymium<br>144.24  | 61<br>Pm<br>Promethium<br>144.9127 | 62<br>Sm<br>Samarium<br>150.36    | 63<br>Eu<br>Europium<br>151.965   | 64<br>Gd<br>Gadolinium<br>157.25   | 65<br>Tb<br>Terbium<br>158.92534  | 66<br>Dy<br>Dysprosium<br>162.50    | 67<br>Ho<br>Holmium<br>164.93032   | 68<br>Er<br>Erbium<br>167.26       | 69<br>Tm<br>Thulium<br>168.93421     | 70<br>Yb<br>Ytterbium<br>173.04   | 71<br>Lu<br>Lutetium<br>174.967      |                                     |                   |
| Actinide Series                  |                                 | 89<br>Ac<br>Actinium<br>227.0278  | 90<br>Th<br>Thorium<br>232.0381     | 91<br>Pa<br>Protactinium<br>231.03688 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237.0482  | 94<br>Pu<br>Plutonium<br>244.0642 | 95<br>Am<br>Americium<br>243.0614 | 96<br>Cm<br>Curium<br>247.0703     | 97<br>Bk<br>Berkelium<br>247.0703 | 98<br>Cf<br>Californium<br>251.0796 | 99<br>Es<br>Einsteinium<br>[254]   | 100<br>Fm<br>Fermium<br>257.0951   | 101<br>Md<br>Mendelevium<br>258.1    | 102<br>No<br>Nobelium<br>259.1009 | 103<br>Lr<br>Lawrencium<br>[262]     |                                     |                   |
| Alkali Metal                     |                                 | Alkaline Earth                    |                                     | Transition Metal                      |                                  | Basic Metal                        |                                   | Semimetals                        |                                    | Nonmetals                         |                                     | Halogens                           |                                    | Noble Gas                            |                                   | Lanthanides                          |                                     |                   |
|                                  |                                 |                                   |                                     |                                       |                                  |                                    |                                   |                                   |                                    |                                   |                                     |                                    |                                    |                                      |                                   | Actinides                            |                                     |                   |