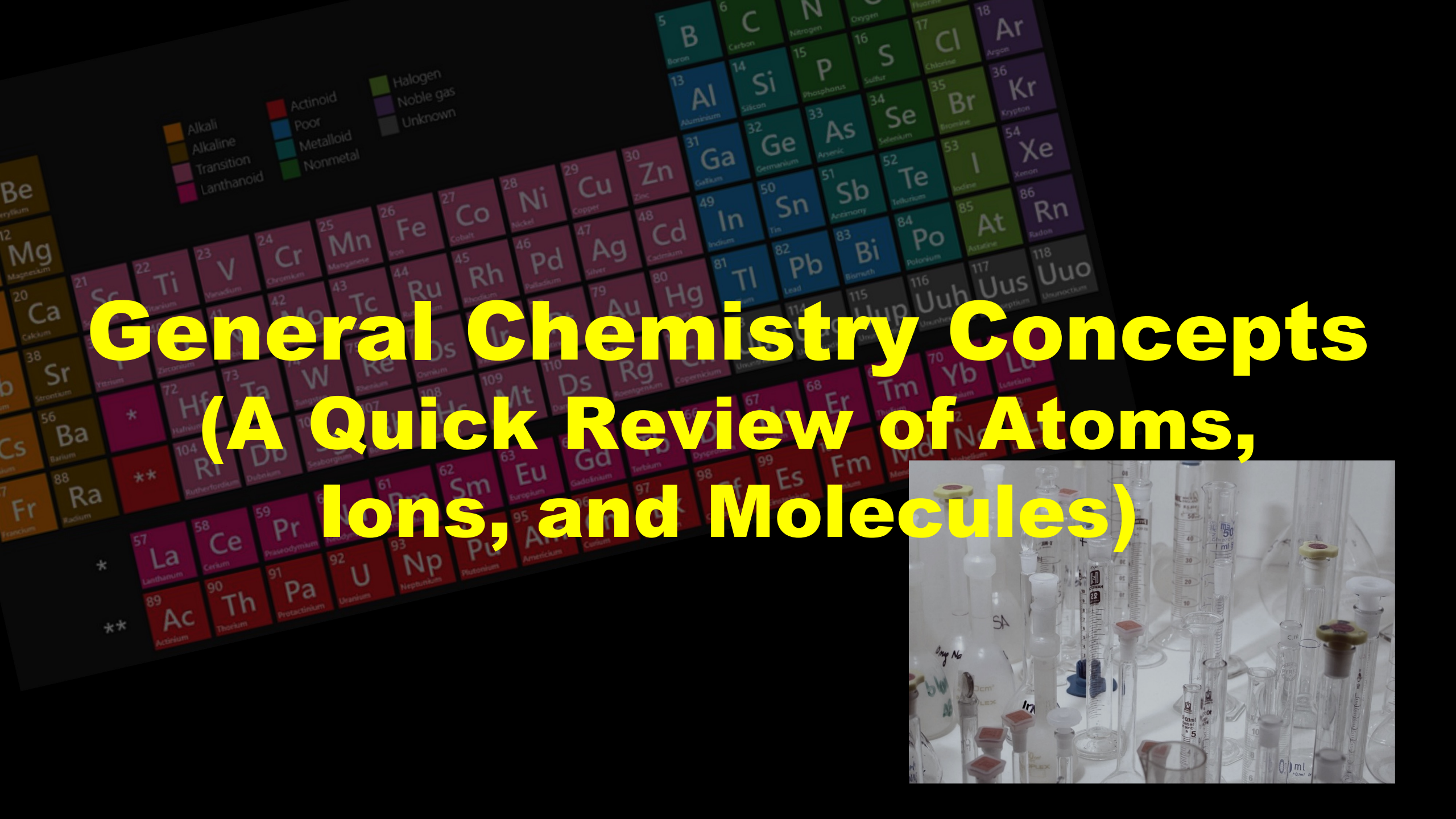
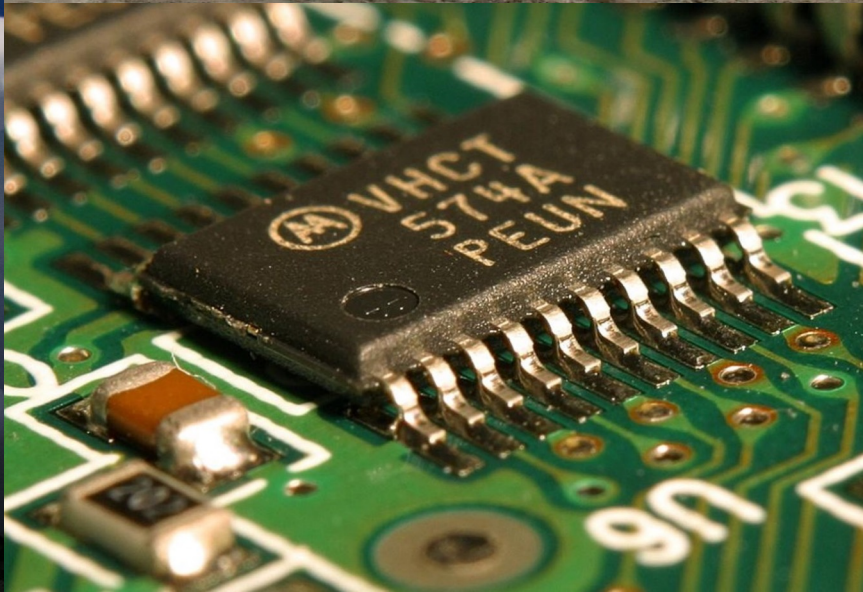
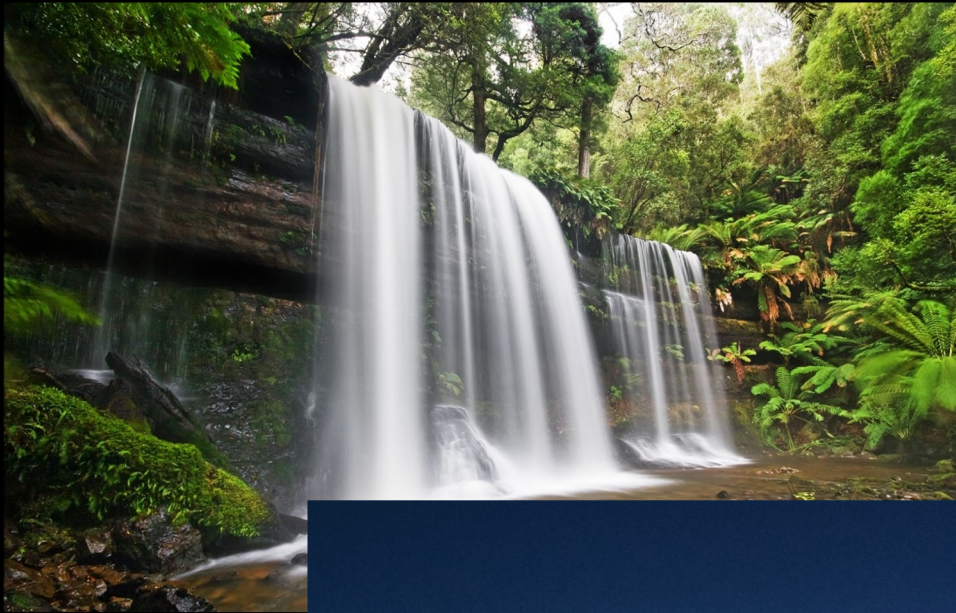


A periodic table of elements is shown in the background, tilted at an angle. It is color-coded by groups: Alkali (orange), Alkaline (yellow), Transition (pink), Lanthanoid (purple), Actinoid (red), Poor (blue), Metalloid (teal), Nonmetal (green), Halogen (dark green), Noble gas (light green), and Unknown (grey).

# General Chemistry Concepts (A Quick Review of Atoms, Ions, and Molecules)





|                      |                       |                       |                            |                          |                         |                        |                       |                         |                           |                          |                          |                         |                           |                           |                          |                           |                          |                      |                   |
|----------------------|-----------------------|-----------------------|----------------------------|--------------------------|-------------------------|------------------------|-----------------------|-------------------------|---------------------------|--------------------------|--------------------------|-------------------------|---------------------------|---------------------------|--------------------------|---------------------------|--------------------------|----------------------|-------------------|
| 1<br>H<br>Hydrogen   |                       |                       |                            |                          |                         |                        |                       |                         |                           |                          |                          |                         |                           |                           |                          |                           | 2<br>He<br>Helium        |                      |                   |
| 3<br>Li<br>Lithium   | 4<br>Be<br>Beryllium  |                       |                            |                          |                         |                        |                       |                         |                           |                          |                          |                         |                           | 5<br>B<br>Boron           | 6<br>C<br>Carbon         | 7<br>N<br>Nitrogen        | 8<br>O<br>Oxygen         | 9<br>F<br>Fluorine   | 10<br>Ne<br>Neon  |
| 11<br>Na<br>Sodium   | 12<br>Mg<br>Magnesium |                       |                            |                          |                         |                        |                       |                         |                           |                          |                          |                         |                           | 13<br>Al<br>Aluminium     | 14<br>Si<br>Silicon      | 15<br>P<br>Phosphorus     | 16<br>S<br>Sulfur        | 17<br>Cl<br>Chlorine | 18<br>Ar<br>Argon |
| 19<br>K<br>Potassium | 20<br>Ca<br>Calcium   | 21<br>Sc<br>Scandium  | 22<br>Ti<br>Titanium       | 23<br>V<br>Vanadium      | 24<br>Cr<br>Chromium    | 25<br>Mn<br>Manganese  | 26<br>Fe<br>Iron      | 27<br>Co<br>Cobalt      | 28<br>Ni<br>Nickel        | 29<br>Cu<br>Copper       | 30<br>Zn<br>Zinc         | 31<br>Ga<br>Gallium     | 32<br>Ge<br>Germanium     | 33<br>As<br>Arsenic       | 34<br>Se<br>Selenium     | 35<br>Br<br>Bromine       | 36<br>Kr<br>Krypton      |                      |                   |
| 37<br>Rb<br>Rubidium | 38<br>Sr<br>Strontium | 39<br>Y<br>Yttrium    | 40<br>Zr<br>Zirconium      | 41<br>Nb<br>Niobium      | 42<br>Mo<br>Molybdenum  | 43<br>Tc<br>Technetium | 44<br>Ru<br>Ruthenium | 45<br>Rh<br>Rhodium     | 46<br>Pd<br>Palladium     | 47<br>Ag<br>Silver       | 48<br>Cd<br>Cadmium      | 49<br>In<br>Indium      | 50<br>Sn<br>Tin           | 51<br>Sb<br>Antimony      | 52<br>Te<br>Tellurium    | 53<br>I<br>Iodine         | 54<br>Xe<br>Xenon        |                      |                   |
| 55<br>Cs<br>Cesium   | 56<br>Ba<br>Barium    | *                     | 72<br>Hf<br>Hafnium        | 73<br>Ta<br>Tantalum     | 74<br>W<br>Tungsten     | 75<br>Re<br>Rhenium    | 76<br>Os<br>Osmium    | 77<br>Ir<br>Iridium     | 78<br>Pt<br>Platinum      | 79<br>Au<br>Gold         | 80<br>Hg<br>Mercury      | 81<br>Tl<br>Thallium    | 82<br>Pb<br>Lead          | 83<br>Bi<br>Bismuth       | 84<br>Po<br>Polonium     | 85<br>At<br>Astatine      | 86<br>Rn<br>Radon        |                      |                   |
| 87<br>Fr<br>Francium | 88<br>Ra<br>Radium    | **                    | 104<br>Rf<br>Rutherfordium | 105<br>Db<br>Dubnium     | 106<br>Sg<br>Seaborgium | 107<br>Bh<br>Bohrium   | 108<br>Hs<br>Hassium  | 109<br>Mt<br>Meitnerium | 110<br>Ds<br>Darmstadtium | 111<br>Rg<br>Roentgenium | 112<br>Cn<br>Copernicium | 113<br>Uut<br>Ununtrium | 114<br>Uuq<br>Ununquadium | 115<br>Uup<br>Ununpentium | 116<br>Uuh<br>Ununhexium | 117<br>Uus<br>Ununseptium | 118<br>Uuo<br>Ununoctium |                      |                   |
| *                    |                       | 57<br>La<br>Lanthanum | 58<br>Ce<br>Cerium         | 59<br>Pr<br>Praseodymium | 60<br>Nd<br>Neodymium   | 61<br>Pm<br>Promethium | 62<br>Sm<br>Samarium  | 63<br>Eu<br>Europium    | 64<br>Gd<br>Gadolinium    | 65<br>Tb<br>Terbium      | 66<br>Dy<br>Dysprosium   | 67<br>Ho<br>Holmium     | 68<br>Er<br>Erbium        | 69<br>Tm<br>Thulium       | 70<br>Yb<br>Ytterbium    | 71<br>Lu<br>Lutetium      |                          |                      |                   |
| **                   |                       | 89<br>Ac<br>Actinium  | 90<br>Th<br>Thorium        | 91<br>Pa<br>Protactinium | 92<br>U<br>Uranium      | 93<br>Np<br>Neptunium  | 94<br>Pu<br>Plutonium | 95<br>Am<br>Americium   | 96<br>Cm<br>Curium        | 97<br>Bk<br>Berkelium    | 98<br>Cf<br>Californium  | 99<br>Es<br>Einsteinium | 100<br>Fm<br>Fermium      | 101<br>Md<br>Mendelevium  | 102<br>No<br>Nobelium    | 103<br>Lr<br>Lawrencium   |                          |                      |                   |

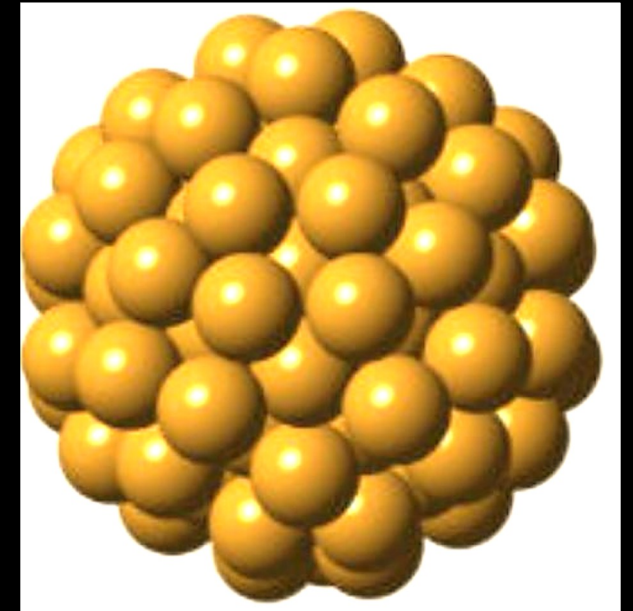
|            |           |           |
|------------|-----------|-----------|
| Alkali     | Actinoid  | Halogen   |
| Alkaline   | Poor      | Noble gas |
| Transition | Metalloid | Unknown   |
| Lanthanoid | Nonmetal  |           |



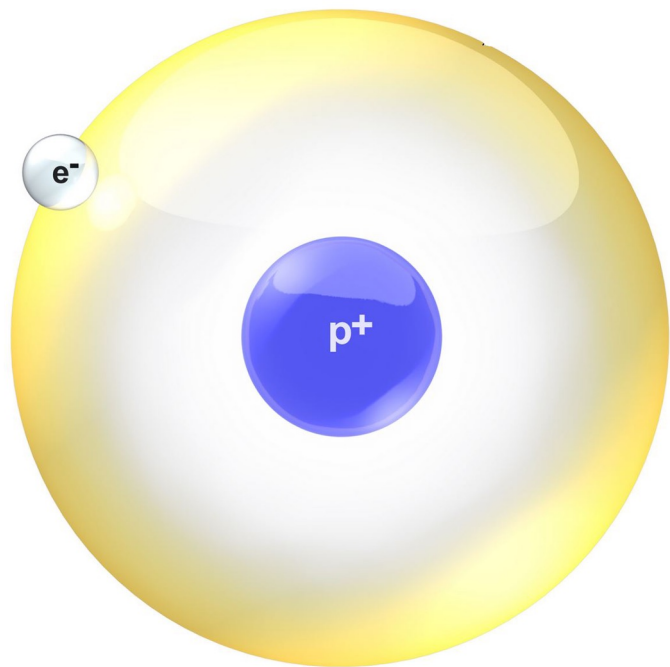


**Atom: the smallest particle or unit of an element**

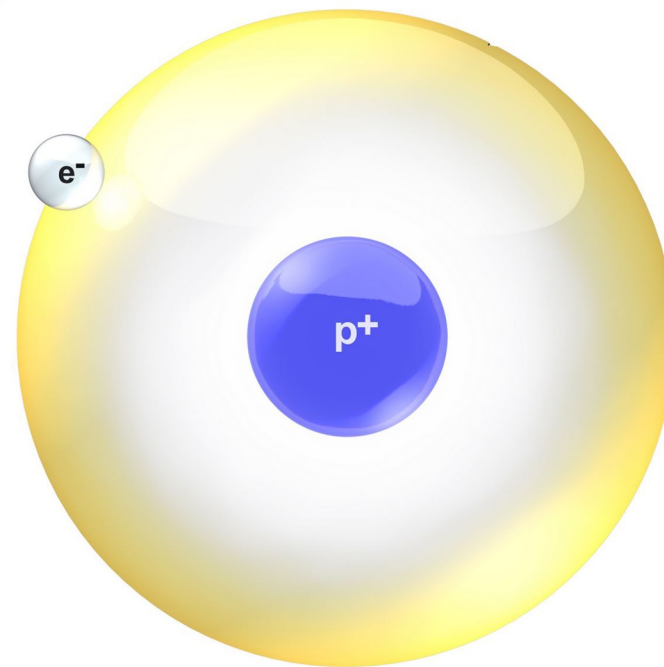
Zoom in



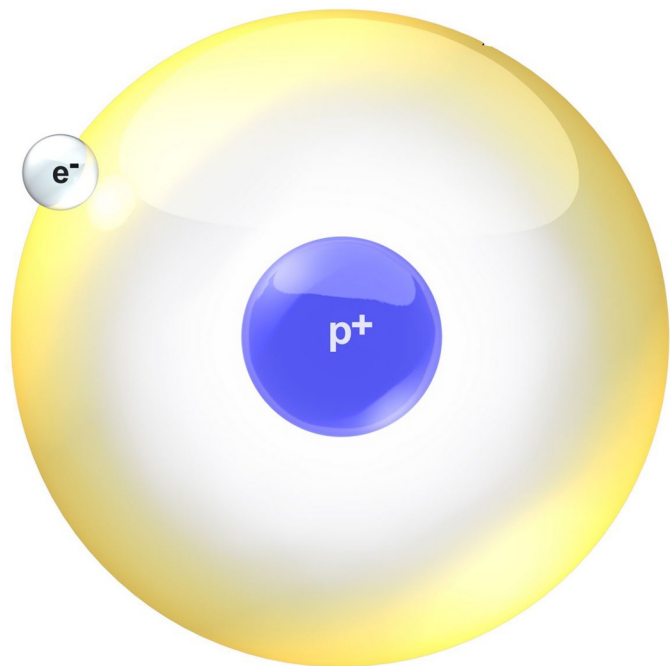
**atoms**



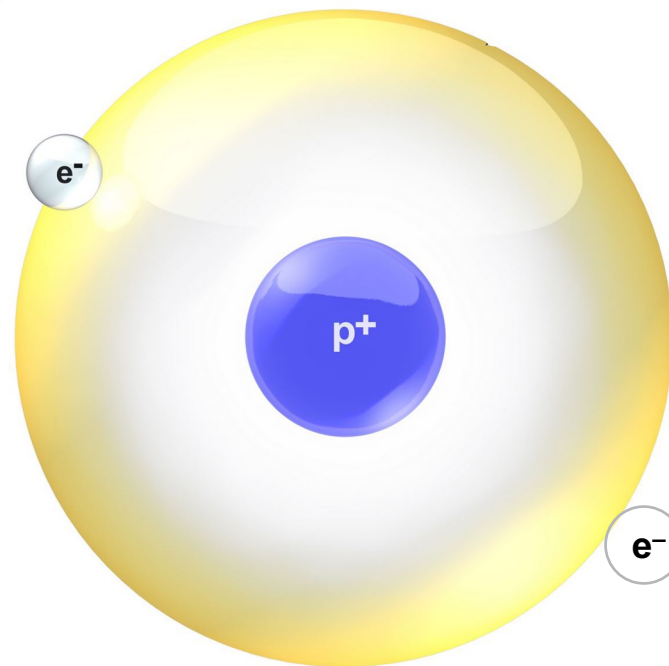
**Hydrogen atom**



**$H^+$**

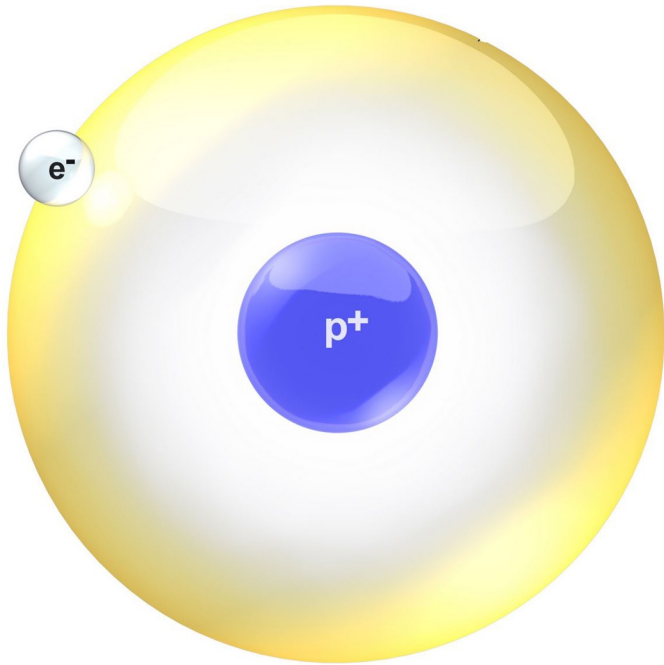


**Hydrogen atom**

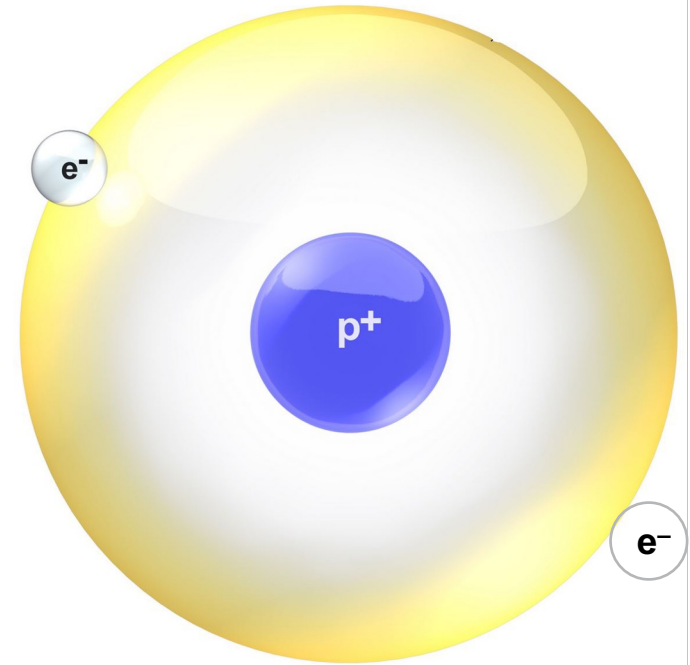


**$H^-$**

**Ions: charged atoms or molecules, formed by adding or removing electrons**



**H<sup>+</sup> ion**



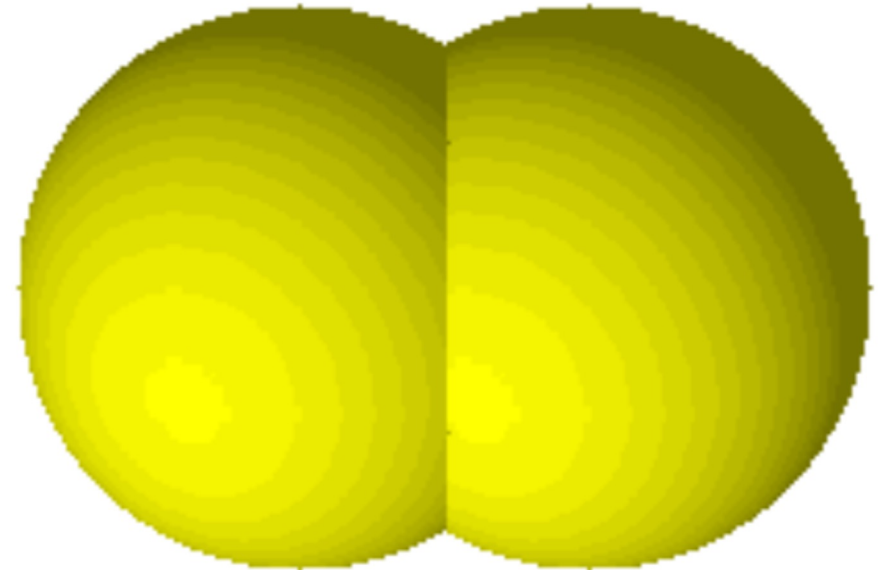
**H<sup>-</sup> ion**

**Molecule: a single structure made of two or more atoms**  
**(The atoms can be the same element or different elements.)**



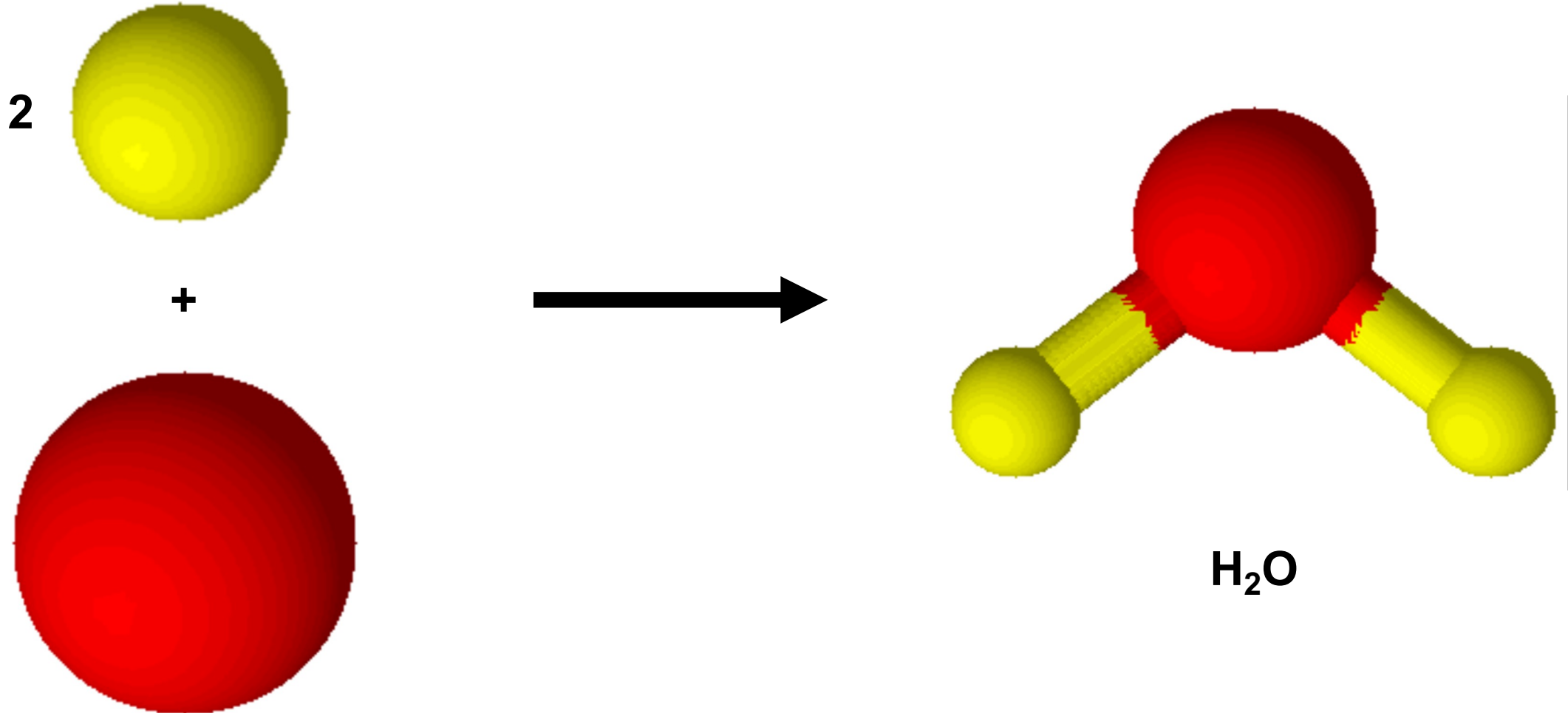
neutral  
hydrogen atom

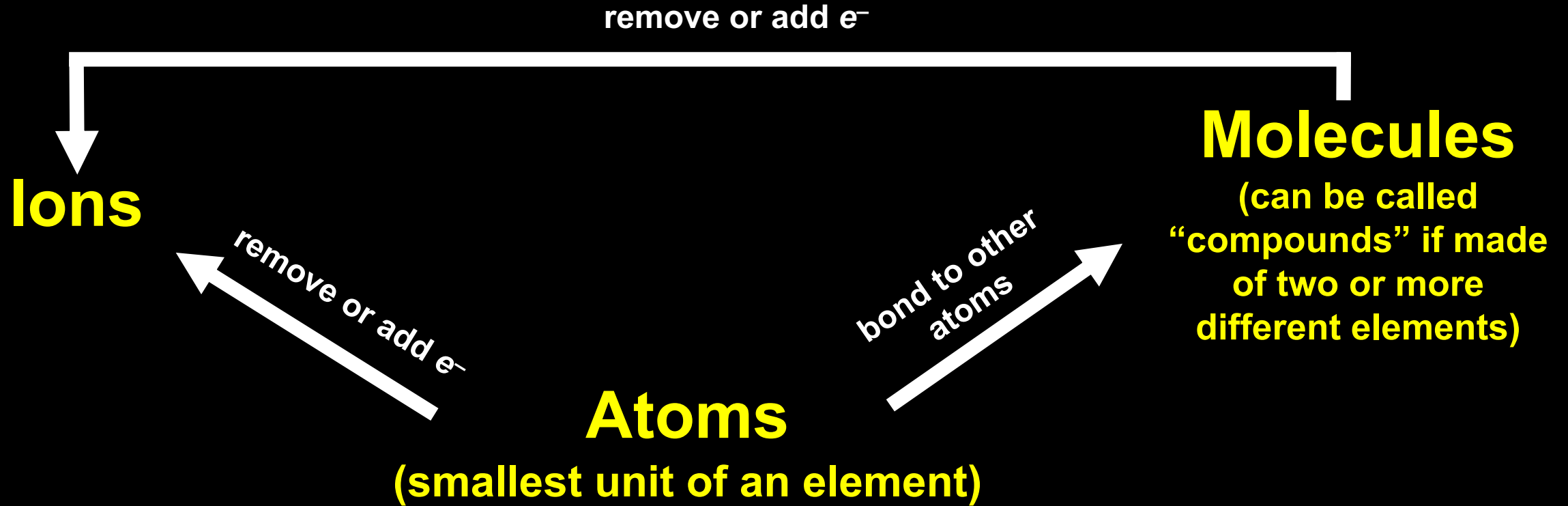
add another H



H<sub>2</sub>

Compound: a structure made of two or more atoms of different elements





# Question

Please identify each of the following as an *atom*, an *element*, an *ion*, a *molecule*, or a *compound*:

- A.  $\text{H}_2\text{O}$
- B.  $\text{NH}_4^+$
- C.  $\text{NH}_3$
- D.  $\text{H}_2$
- E.  $\text{C}_6\text{H}_{12}\text{O}_6$
- F.  $\text{H}_3\text{O}^+$
- G.  $\text{F}^-$
- H.  $\text{Na}$
- I.  $\text{Ar}$
- J.  $\text{O}_2^{2-}$

# Question

Please identify each of the following as an *atom*, an *element*, an *ion*, a *molecule*, or a *compound*: (Note: for some of the listed substances, more than one of these categories may apply.)

A.  $\text{H}_2\text{O}$  molecule

B.  $\text{NH}_4^+$

C.  $\text{NH}_3$

D.  $\text{H}_2$

E.  $\text{C}_6\text{H}_{12}\text{O}_6$

F.  $\text{H}_3\text{O}^+$

G.  $\text{F}^-$

H. Na

I. Ar

J.  $\text{O}_2^{2-}$

A Venn diagram consisting of two concentric circles. The outer circle is white and contains the text 'molecules (2 or more bonded atoms)'. The inner circle is yellow and contains the text 'Compounds (2 or more bonded atoms of different elements)'. The inner circle is entirely contained within the outer circle, illustrating that all compounds are molecules, but not all molecules are compounds.

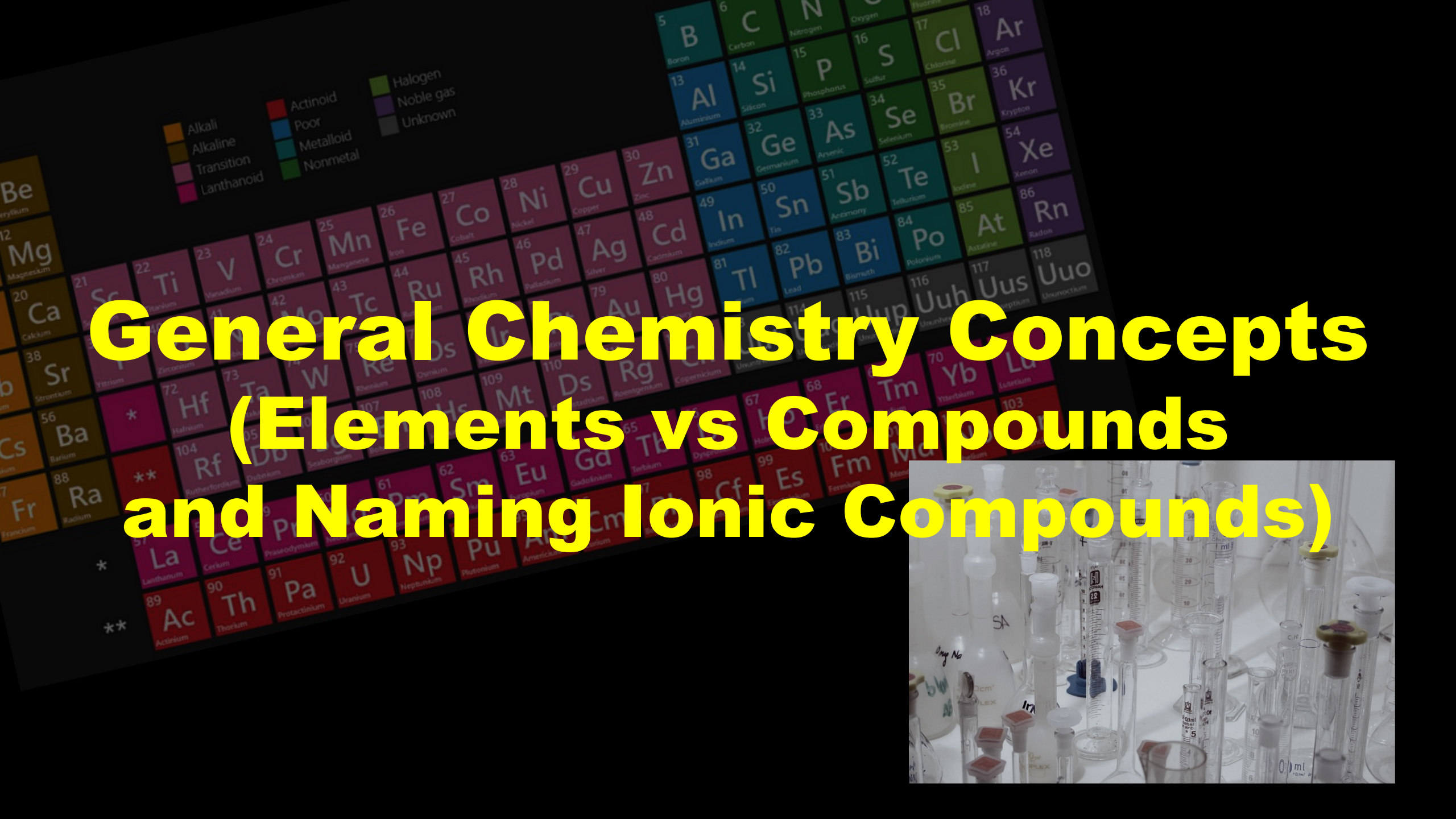
**molecules**  
**(2 or more bonded atoms)**

**Compounds**  
**(2 or more**  
**bonded atoms of**  
**different**  
**elements)**

# Question

Please identify each of the following as an *atom*, an *element*, an *ion*, a *molecule*, or a *compound*: (Note: for some of the listed substances, more than one of these categories may apply.)

- A.  $\text{H}_2\text{O}$  molecule compound
- B.  $\text{NH}_4^+$  ion
- C.  $\text{NH}_3$  molecule compound
- D.  $\text{H}_2$  molecule
- E.  $\text{C}_6\text{H}_{12}\text{O}_6$  molecule compound
- F.  $\text{H}_3\text{O}^+$  ion
- G.  $\text{F}^-$  ion
- H. Na element
- I. Ar element
- J.  $\text{O}_2^{2-}$  ion

A periodic table of elements is shown in the background, tilted at an angle. It is color-coded by groups: Alkali (orange), Alkaline (yellow), Transition (pink), Lanthanoid (purple), Actinoid (red), Poor (blue), Metalloid (teal), Nonmetal (green), Halogen (dark green), Noble gas (light green), and Unknown (grey).

# General Chemistry Concepts (Elements vs Compounds and Naming Ionic Compounds)



# Monatomic and Diatomic Elements

In our last video, we learned that ***atoms*** are the smallest particle or “unit” of an element. You can think of an ***atom*** as being like a single “piece” of a given element.

In their simplest form, most elements can and do have a single-atom formula. For example, elemental sodium’s formula is Na (just one atom); elemental cesium’s formula is Cs (also one atom); and so forth. Such elements are called ***monatomic*** elements.

There are, however, some elements that do NOT stably exist in nature as uncharged single atoms. Instead, these elements –called ***diatomic*** elements– pair up.

# The Seven Diatomic Elements

You should memorize the seven diatomic elements. They are:

|          |          |          |          |           |           |           |           |           |           |           |           |           |           |           |           |           |          |          |
|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|
| 1<br>H   |          |          |          |           |           |           |           |           |           |           |           |           |           |           |           |           | 2<br>He  |          |
| 3<br>Li  | 4<br>Be  |          |          |           |           |           |           |           |           |           |           | 5<br>B    | 6<br>C    | 7<br>N    | 8<br>O    | 9<br>F    | 10<br>Ne |          |
| 11<br>Na | 12<br>Mg |          |          |           |           |           |           |           |           |           |           | 13<br>Al  | 14<br>Si  | 15<br>P   | 16<br>S   | 17<br>Cl  | 18<br>Ar |          |
| 19<br>K  | 20<br>Ca | 21<br>Sc | 22<br>Ti | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu  | 30<br>Zn  | 31<br>Ga  | 32<br>Ge  | 33<br>As  | 34<br>Se  | 35<br>Br  | 36<br>Kr |          |
| 37<br>Rb | 38<br>Sr | 39<br>Y  | 40<br>Zr | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | 47<br>Ag  | 48<br>Cd  | 49<br>In  | 50<br>Sn  | 51<br>Sb  | 52<br>Te  | 53<br>I   | 54<br>Xe |          |
| 55<br>Cs | 56<br>Ba |          |          | 72<br>Hf  | 73<br>Ta  | 74<br>W   | 75<br>Re  | 76<br>Os  | 77<br>Ir  | 78<br>Pt  | 79<br>Au  | 80<br>Hg  | 81<br>Tl  | 82<br>Pb  | 83<br>Bi  | 84<br>Po  | 85<br>At | 86<br>Rn |
| 87<br>Fr | 88<br>Ra |          |          | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg | 112<br>Cn |           |           |           |           |          |          |
|          |          | 57<br>La | 58<br>Ce | 59<br>Pr  | 60<br>Nd  | 61<br>Pm  | 62<br>Sm  | 63<br>Eu  | 64<br>Gd  | 65<br>Tb  | 66<br>Dy  | 67<br>Ho  | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |          |          |
|          |          | 89<br>Ac | 90<br>Th | 91<br>Pa  | 92<br>U   | 93<br>Np  | 94<br>Pu  | 95<br>Am  | 96<br>Cm  | 97<br>Bk  | 98<br>Cf  | 99<br>Es  | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |          |          |

Blue = metal  
Red = nonmetal  
Green = Metalloid

# The Seven Diatomic Elements

This means that these seven elements, in their simplest form (or **formula**), do NOT exist as single atoms by themselves. Instead, they exist as two atoms bonded together.

For example, in its simplest structural formula, hydrogen does not exist as H (though  $\text{H}^+$  and  $\text{H}^-$  **ions** are possible). Instead, it exists as two H atoms bonded together:  $\text{H}_2$ .

The same is true for the rest. Nitrogen's simplest formula is  $\text{N}_2$  (not N). Oxygen's is  $\text{O}_2$  (not O). Fluorine's is  $\text{F}_2$  (not F), and so on, down the line:  $\text{H}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$ , and  $\text{I}_2$ . As far as you need to know, we will assume that other than these seven **diatomic elements**, the rest of the elements' formulas will just be **monatomic**. Note: Some people think helium is **diatomic**. It's not. Its formula is just He, not  $\text{He}_2$ .

# What are Allotropes?

In addition to the seven ***polyatomic*** elements, there are some other elements that CAN (but do not have to) exist in nature with various elemental formulas. For example, oxygen can exist as either O<sub>2</sub> (oxygen gas) or O<sub>3</sub> (ozone). Sulfur has many different elemental formulas, including S<sub>6</sub>, S<sub>8</sub>, and S<sub>12</sub>.

Molecules with different formulas, whose atoms are all of the same element, are called ***allotropes***. In other words, O<sub>2</sub> and O<sub>3</sub> are ***allotropes*** of oxygen, and S<sub>6</sub>, S<sub>8</sub>, and S<sub>12</sub> are three different ***allotropes*** of sulfur.

# Back to Compounds

In our last video, we also learned that ***compounds*** are molecules comprised of two or more different elements bonded together. Examples include H<sub>2</sub>O and CO<sub>2</sub>. I'll now teach you about two different classes of compounds:

## Compounds

***Ionic compounds:*** metal + nonmetal (contain ***ionic bonds***)

***Molecular compounds:*** two or more nonmetals (contain ***covalent bonds***)

# Metals and Nonmetals

And what do I mean when I say *metals* and *nonmetals*?

|          |          |          |          |           |           |           |           |           |           |           |           |           |          |           |           |           |           |          |
|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|-----------|-----------|-----------|----------|
| 1<br>H   |          |          |          |           |           |           |           |           |           |           |           |           |          |           |           |           | 2<br>He   |          |
| 3<br>Li  | 4<br>Be  |          |          |           |           |           |           |           |           |           |           | 5<br>B    | 6<br>C   | 7<br>N    | 8<br>O    | 9<br>F    | 10<br>Ne  |          |
| 11<br>Na | 12<br>Mg |          |          |           |           |           |           |           |           |           |           | 13<br>Al  | 14<br>Si | 15<br>P   | 16<br>S   | 17<br>Cl  | 18<br>Ar  |          |
| 19<br>K  | 20<br>Ca | 21<br>Sc | 22<br>Ti | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu  | 30<br>Zn  | 31<br>Ga  | 32<br>Ge | 33<br>As  | 34<br>Se  | 35<br>Br  | 36<br>Kr  |          |
| 37<br>Rb | 38<br>Sr | 39<br>Y  | 40<br>Zr | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | 47<br>Ag  | 48<br>Cd  | 49<br>In  | 50<br>Sn | 51<br>Sb  | 52<br>Te  | 53<br>I   | 54<br>Xe  |          |
| 55<br>Cs | 56<br>Ba |          |          | 72<br>Hf  | 73<br>Ta  | 74<br>W   | 75<br>Re  | 76<br>Os  | 77<br>Ir  | 78<br>Pt  | 79<br>Au  | 80<br>Hg  | 81<br>Tl | 82<br>Pb  | 83<br>Bi  | 84<br>Po  | 85<br>At  | 86<br>Rn |
| 87<br>Fr | 88<br>Ra |          |          | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg | 112<br>Cn |          |           |           |           |           |          |
|          |          |          | 57<br>La | 58<br>Ce  | 59<br>Pr  | 60<br>Nd  | 61<br>Pm  | 62<br>Sm  | 63<br>Eu  | 64<br>Gd  | 65<br>Tb  | 66<br>Dy  | 67<br>Ho | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |          |
|          |          |          | 89<br>Ac | 90<br>Th  | 91<br>Pa  | 92<br>U   | 93<br>Np  | 94<br>Pu  | 95<br>Am  | 96<br>Cm  | 97<br>Bk  | 98<br>Cf  | 99<br>Es | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |          |

Blue = metal  
Red = nonmetal  
Green = Metalloid

# Back to Compounds

In our last video, we also learned that ***compounds*** are molecules comprised of two or more different elements bonded together. Examples include  $\text{H}_2\text{O}$  and  $\text{CO}_2$ . I'll now teach you about two different classes of compounds:

## Compounds

***Ionic compounds***: metal + nonmetal (contain ***ionic bonds***)

**Examples:  $\text{NaCl}$ ,  $\text{CuCl}_2$**

- **Exception: Although it does not contain any metals,  $\text{NH}_4\text{Cl}$  is ionic.**

***Molecular compounds***: two or more nonmetals (contain ***covalent bonds***)

**Examples:  $\text{H}_2\text{O}$ ,  $\text{CO}_2$**

# Naming Ionic Compounds

1. Name the *metal*.

1. Write the metal's oxidation state as a Roman numeral in parenthesis.

(Skip this step for metals in **Columns I** and **II** of the periodic table, as well as **Al** (it's always +3), **Zn** (always +2), **Cd** (always +2), and **Ag** (always +1).

# Naming Ionic Compounds

No Roman numbers for these metals. For all other metals, you have to put Roman numerals.

|                                                                                                               |                |           |           |           |           |           |           |           |           |                |                |          |          |          |          |                |          |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
|---------------------------------------------------------------------------------------------------------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|----------------|----------|----------|----------|----------|----------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|
| <p>No Roman numbers for these metals. For all <u>other</u> metals, you <u>have</u> to put Roman numerals.</p> |                |           |           |           |           |           |           |           |           |                |                |          |          |          |          |                |          |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
| 1<br>H                                                                                                        |                |           |           |           |           |           |           |           |           |                |                |          |          |          |          | 2<br>He        |          |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
| 3<br>Li                                                                                                       | 4<br>Be        |           |           |           |           |           |           |           |           |                |                |          |          |          |          | 5<br>B         | 6<br>C   | 7<br>N   | 8<br>O   | 9<br>F   | 10<br>Ne |          |          |          |          |          |          |          |           |           |           |           |
| 11<br>Na                                                                                                      | 12<br>Mg       |           |           |           |           |           |           |           |           |                |                |          |          |          |          | +3<br>13<br>Al | 14<br>Si | 15<br>P  | 16<br>S  | 17<br>Cl | 18<br>Ar |          |          |          |          |          |          |          |           |           |           |           |
| +1<br>19<br>K                                                                                                 | +2<br>20<br>Ca | 21<br>Sc  | 22<br>Ti  | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu       | +2<br>30<br>Zn | 31<br>Ga | 32<br>Ge | 33<br>As | 34<br>Se | 35<br>Br       | 36<br>Kr |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
| 37<br>Rb                                                                                                      | 38<br>Sr       | 39<br>Y   | 40<br>Zr  | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | +1<br>47<br>Ag | +2<br>48<br>Cd | 49<br>In | 50<br>Sn | 51<br>Sb | 52<br>Te | 53<br>I        | 54<br>Xe |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
| 55<br>Cs                                                                                                      | 56<br>Ba       |           |           |           |           |           |           |           |           |                |                | 72<br>Hf | 73<br>Ta | 74<br>W  | 75<br>Re | 76<br>Os       | 77<br>Ir | 78<br>Pt | 79<br>Au | 80<br>Hg | 81<br>Tl | 82<br>Pb | 83<br>Bi | 84<br>Po | 85<br>At | 86<br>Rn |          |          |           |           |           |           |
| 87<br>Fr                                                                                                      | 88<br>Ra       | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg | 112<br>Cn      |                |          |          |          |          |                |          |          |          |          |          |          |          |          |          |          |          |          |           |           |           |           |
|                                                                                                               |                |           |           |           |           |           |           |           |           |                |                |          |          |          |          |                |          | 57<br>La | 58<br>Ce | 59<br>Pr | 60<br>Nd | 61<br>Pm | 62<br>Sm | 63<br>Eu | 64<br>Gd | 65<br>Tb | 66<br>Dy | 67<br>Ho | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |
|                                                                                                               |                |           |           |           |           |           |           |           |           |                |                |          |          |          |          |                |          | 89<br>Ac | 90<br>Th | 91<br>Pa | 92<br>U  | 93<br>Np | 94<br>Pu | 95<br>Am | 96<br>Cm | 97<br>Bk | 98<br>Cf | 99<br>Es | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |

# Naming Ionic Compounds

1. Name the *metal*.

1. Write the metal's oxidation state as a Roman numeral in parenthesis.

(Skip this step for metals in **Columns I and II** of the periodic table, as well as **Al** (it's always +3), **Zn** (always +2), **Cd** (always +2), and **Ag** (always +1).

3. Name the *nonmetal* using an “ide” ending.

**NaCl** – sodium chloride

**CsF** – cesium fluoride

**MgO** – magnesium oxide

# Polyatomic Ions

One more issue we have to worry about is the existence of ***polyatomic ions***: ions that are made up of two or more atoms. For instance, I require my students to **memorize** the following ***polyatomic ions***:

## Cations

Ammonium  $\text{NH}_4^+$

## Anions

acetate  $\text{CH}_3\text{COO}^-$

sulfate  $\text{SO}_4^{2-}$

Cyanide  $\text{CN}^-$

carbonate  $\text{CO}_3^{2-}$

Nitrate  $\text{NO}_3^-$

hydroxide  $\text{HO}^-$

Phosphate  $\text{PO}_4^{3-}$

permanganate  $\text{MnO}_4^-$

# Polyatomic Ions

One more issue we have to worry about is the existence of ***polyatomic ions***: ions that are made up of two or more atoms. For instance, I require my students to **memorize** the following ***polyatomic ions***:

However, the EXAM requires you to **memorize** a lot more!

(You can access the full list at  
[https://datbootcamp.com/blog/common-ions-you-need-to-know/.](https://datbootcamp.com/blog/common-ions-you-need-to-know/))

| +1 CHARGE              |            | -1 CHARGE                 |                      | -2 CHARGE                    |                    | -3 CHARGE           |           |
|------------------------|------------|---------------------------|----------------------|------------------------------|--------------------|---------------------|-----------|
| ion                    | name       | ion                       | name                 | ion                          | name               | ion                 | name      |
| $\text{NH}_4^+$        | ammonium   | $\text{H}_2\text{PO}_3^-$ | dihydrogen phosphite | $\text{HPO}_3^{2-}$          | hydrogen phosphite | $\text{PO}_4^{3-}$  | phosphate |
| $\text{H}_3\text{O}^+$ | hydronium  | $\text{H}_2\text{PO}_4^-$ | dihydrogen phosphate | $\text{HPO}_4^{2-}$          | hydrogen phosphate | $\text{AsO}_3^{3-}$ | arsenite  |
| $\text{Hg}_2^{2+}$     | mercury(I) | $\text{HCO}_3^-$          | hydrogen carbonate   | $\text{CO}_3^{2-}$           | carbonate          | $\text{AsO}_4^{3-}$ | arsenate  |
|                        |            | $\text{HSO}_3^-$          | hydrogen sulfite     | $\text{SO}_3^{2-}$           | sulfite            | $\text{N}^{3-}$     | nitride   |
|                        |            | $\text{HSO}_4^-$          | hydrogen sulfate     | $\text{SO}_4^{2-}$           | sulfate            |                     |           |
|                        |            | $\text{NO}_2^-$           | nitrite              | $\text{S}_2\text{O}_3^{2-}$  | thiosulfate        |                     |           |
|                        |            | $\text{NO}_3^-$           | nitrate              | $\text{C}_2\text{O}_4^{2-}$  | oxalate            |                     |           |
|                        |            | $\text{OH}^-$             | hydroxide            | $\text{CrO}_4^{2-}$          | chromate           |                     |           |
|                        |            | $\text{CH}_3\text{COO}^-$ | acetate              | $\text{Cr}_2\text{O}_7^{2-}$ | dichromate         |                     |           |
|                        |            | $\text{CrO}_2^-$          | chromite             | $\text{O}_2^{2-}$            | peroxide           |                     |           |
|                        |            | $\text{CN}^-$             | cyanide              | $\text{S}_2^{2-}$            | disulfide          |                     |           |
|                        |            | $\text{CNO}^-$            | cyanate              | $\text{O}^{2-}$              | Oxide              |                     |           |
|                        |            | $\text{CNS}^-$            | thiocyanate          | $\text{S}^{2-}$              | Sulfide            |                     |           |
|                        |            | $\text{MnO}_4^-$          | permanganate         |                              |                    |                     |           |
|                        |            | $\text{ClO}^-$            | hypochlorite         |                              |                    |                     |           |
|                        |            | $\text{ClO}_2^-$          | chlorite             |                              |                    |                     |           |
|                        |            | $\text{ClO}_3^-$          | chlorate             |                              |                    |                     |           |
|                        |            | $\text{ClO}_4^-$          | perchlorate          |                              |                    |                     |           |
|                        |            | $\text{BrO}^-$            | hypobromite          |                              |                    |                     |           |
|                        |            | $\text{BrO}_2^-$          | bromite              |                              |                    |                     |           |
|                        |            | $\text{BrO}_3^-$          | bromate              |                              |                    |                     |           |
|                        |            | $\text{BrO}_4^-$          | perbromate           |                              |                    |                     |           |
|                        |            | $\text{IO}^-$             | hypoiodite           |                              |                    |                     |           |
|                        |            | $\text{IO}_2^-$           | iodite               |                              |                    |                     |           |
|                        |            | $\text{IO}_3^-$           | iodate               |                              |                    |                     |           |
|                        |            | $\text{IO}_4^-$           | periodate            |                              |                    |                     |           |
|                        |            | $\text{N}_3^-$            | azide                |                              |                    |                     |           |

# Question

Please provide a correct name for each of the following compounds:

- $\text{MgF}_2$
- $\text{FeCl}_3$
- $\text{SnF}_2$
- $\text{SnF}_4$
- $\text{Fe}(\text{NO}_3)_2$
- $\text{NH}_4\text{Cl}$
- $\text{Al}_2\text{O}_3$
- $\text{FeCl}_2$

# Where are metals, non-metals, and metalloids?

|          |          |          |           |           |           |           |           |           |           |           |           |          |          |           |           |           |           |          |          |
|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|
| 1<br>H   |          |          |           |           |           |           |           |           |           |           |           |          |          |           |           |           | 2<br>He   |          |          |
| 3<br>Li  | 4<br>Be  |          |           |           |           |           |           |           |           |           |           |          |          | 5<br>B    | 6<br>C    | 7<br>N    | 8<br>O    | 9<br>F   | 10<br>Ne |
| 11<br>Na | 12<br>Mg |          |           |           |           |           |           |           |           |           |           |          |          | 13<br>Al  | 14<br>Si  | 15<br>P   | 16<br>S   | 17<br>Cl | 18<br>Ar |
| 19<br>K  | 20<br>Ca | 21<br>Sc | 22<br>Ti  | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu  | 30<br>Zn  | 31<br>Ga | 32<br>Ge | 33<br>As  | 34<br>Se  | 35<br>Br  | 36<br>Kr  |          |          |
| 37<br>Rb | 38<br>Sr | 39<br>Y  | 40<br>Zr  | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | 47<br>Ag  | 48<br>Cd  | 49<br>In | 50<br>Sn | 51<br>Sb  | 52<br>Te  | 53<br>I   | 54<br>Xe  |          |          |
| 55<br>Cs | 56<br>Ba |          | 72<br>Hf  | 73<br>Ta  | 74<br>W   | 75<br>Re  | 76<br>Os  | 77<br>Ir  | 78<br>Pt  | 79<br>Au  | 80<br>Hg  | 81<br>Tl | 82<br>Pb | 83<br>Bi  | 84<br>Po  | 85<br>At  | 86<br>Rn  |          |          |
| 87<br>Fr | 88<br>Ra |          | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg | 112<br>Cn |          |          |           |           |           |           |          |          |
|          |          |          | 57<br>La  | 58<br>Ce  | 59<br>Pr  | 60<br>Nd  | 61<br>Pm  | 62<br>Sm  | 63<br>Eu  | 64<br>Gd  | 65<br>Tb  | 66<br>Dy | 67<br>Ho | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |          |          |
|          |          |          | 89<br>Ac  | 90<br>Th  | 91<br>Pa  | 92<br>U   | 93<br>Np  | 94<br>Pu  | 95<br>Am  | 96<br>Cm  | 97<br>Bk  | 98<br>Cf | 99<br>Es | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |          |          |

Blue = metal

Red = nonmetal

Green = Metalloid

Blue = metal

Red = nonmetal

Green = Metalloid

# Periodic Table Blocks

The periodic table is organized into four main blocks based on electron configuration:

- s-block:** Elements with valence electrons in s-orbitals. Includes groups 1 (alkali metals) and 2 (alkaline earth metals).
- f-block:** Elements with valence electrons in f-orbitals. Includes the lanthanide and actinide series, shown separately below the main table.
- d-block:** Elements with valence electrons in d-orbitals. Includes the transition metals (groups 3-10).
- p-block:** Elements with valence electrons in p-orbitals. Includes groups 13-18 (boron group, carbon group, nitrogen group, oxygen group, halogens, and noble gases).

The table also shows the periodic trends of atomic size, ionization energy, and electronegativity. The color-coding helps to distinguish between these different groups of elements.

# Predicting An Ion's Charge

|                 |               |                        |                |                 |                 |                 |                 |                 |                 |                  |                 |                  |                 |                 |                 |                 |                 |                |
|-----------------|---------------|------------------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|
| 1<br>IA         |               |                        |                |                 |                 |                 |                 |                 |                 |                  |                 |                  |                 |                 |                 |                 | 18<br>VIIIA     |                |
| 1<br>H<br>+1/-1 |               |                        |                |                 |                 |                 |                 |                 |                 |                  |                 |                  |                 |                 |                 |                 | 2<br>He         |                |
| 2<br>Li<br>+1   | 2<br>Be<br>+2 |                        |                |                 |                 |                 |                 |                 |                 |                  |                 | 5<br>B<br>+3     | 6<br>C<br>+4    | 7<br>N<br>-3    | 8<br>O<br>-2    | 9<br>F<br>-1    | 10<br>Ne        |                |
| 3<br>Na<br>+1   | 4<br>Mg<br>+2 | 3<br>IIIB              | 4<br>IVB       | 5<br>VB         | 6<br>VIB        | 7<br>VIIB       | 8<br>VIIIB      | 9<br>VIIIB      | 10<br>VIIIB     | 11<br>IB         | 12<br>IIB       | 13<br>Al<br>+3   | 14<br>Si<br>+4  | 15<br>P<br>-3   | 16<br>S<br>-2   | 17<br>Cl<br>-1  | 18<br>Ar        |                |
| 4<br>K<br>+1    | 5<br>Ca<br>+2 | 21<br>Sc               | 22<br>Ti<br>+4 | 23<br>V<br>+5   | 24<br>Cr<br>+6  | 25<br>Mn<br>+7  | 26<br>Fe<br>+3  | 27<br>Co<br>+3  | 28<br>Ni<br>+2  | 29<br>Cu<br>+2   | 30<br>Zn<br>+2  | 31<br>Ga<br>+3   | 32<br>Ge<br>+4  | 33<br>As<br>+3  | 34<br>Se<br>+4  | 35<br>Br<br>-1  | 36<br>Kr        |                |
| 5<br>Rb<br>+1   | 6<br>Sr<br>+2 | 39<br>Y                | 40<br>Zr<br>+4 | 41<br>Nb<br>+5  | 42<br>Mo<br>+6  | 43<br>Tc<br>+7  | 44<br>Ru<br>+3  | 45<br>Rh<br>+3  | 46<br>Pd<br>+2  | 47<br>Ag<br>+1   | 48<br>Cd<br>+2  | 49<br>In<br>+3   | 50<br>Sn<br>+4  | 51<br>Sb<br>+3  | 52<br>Te<br>+4  | 53<br>I<br>-1   | 54<br>Xe        |                |
| 6<br>Cs<br>+1   | 7<br>Ba<br>+2 | 57 - 71<br>lanthanoids |                | 72<br>Hf<br>+4  | 73<br>Ta<br>+5  | 74<br>W<br>+6   | 75<br>Re<br>+7  | 76<br>Os<br>+8  | 77<br>Ir<br>+3  | 78<br>Pt<br>+2   | 79<br>Au<br>+3  | 80<br>Hg<br>+2   | 81<br>Tl<br>+3  | 82<br>Pb<br>+4  | 83<br>Bi<br>+3  | 84<br>Po        | 85<br>At        | 86<br>Rn       |
| 7<br>Fr<br>+1   | 8<br>Ra<br>+2 | 89 - 103<br>actinoids  |                | 104<br>Rf<br>+4 | 105<br>Db<br>+5 | 106<br>Sg<br>+6 | 107<br>Bh<br>+7 | 108<br>Hs<br>+8 | 109<br>Mt<br>+7 | 110<br>Ds<br>+10 | 111<br>Rg<br>+9 | 112<br>Cn<br>+12 | 113<br>Nh<br>+3 | 114<br>Fl<br>+4 | 115<br>Mc<br>+5 | 116<br>Lv<br>+6 | 117<br>Ts<br>+7 | 118<br>Og      |
|                 |               |                        |                | 57<br>La<br>+3  | 58<br>Ce<br>+3  | 59<br>Pr<br>+3  | 60<br>Nd<br>+3  | 61<br>Pm<br>+3  | 62<br>Sm<br>+3  | 63<br>Eu<br>+3   | 64<br>Gd<br>+3  | 65<br>Tb<br>+3   | 66<br>Dy<br>+3  | 67<br>Ho<br>+3  | 68<br>Er<br>+3  | 69<br>Tm<br>+3  | 70<br>Yb<br>+3  | 71<br>Lu<br>+3 |
|                 |               |                        |                | 89<br>Ac<br>+3  | 90<br>Th<br>+4  | 91<br>Pa<br>+5  | 92<br>U<br>+6   | 93<br>Np<br>+7  | 94<br>Pu<br>+4  | 95<br>Am<br>+3   | 96<br>Cm<br>+3  | 97<br>Bk<br>+3   | 98<br>Cf<br>+3  | 99<br>Es<br>+3  | 100<br>Fm<br>+3 | 101<br>Md<br>+3 | 102<br>No<br>+3 | 103<br>Lr      |

# Predicting An Ion's Charge

|                                       |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   |                                  |                                 |
|---------------------------------------|-------------------------------------|-----------------------------------|---------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|---------------------------------|
| 1<br>IA                               |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   | 18<br>VIIIA                      |                                 |
| 1<br>H<br>+1/-1<br>1.00794            |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   | 2<br>He<br>Helium<br>4.002602    |                                 |
| 2<br>Li<br>Lithium<br>6.941           | 3<br>Be<br>Beryllium<br>9.012182    |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   | 5<br>B<br>Boron<br>10.811         | 6<br>C<br>Carbon<br>12.0107      | 7<br>N<br>Nitrogen<br>14.007      | 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>22.98976        | 12<br>Mg<br>Magnesium<br>24.3050    | 3<br>IIIB                         | 4<br>IVB                        | 5<br>VB                              | 6<br>VIB                         | 7<br>VIIB                         | 8<br>VIIIB                      | 9<br>VIIIB                      | 10<br>VIIIB                      | 11<br>IB                             | 12<br>IIB                         | 13<br>Al<br>Aluminum<br>26.98153  | 14<br>Si<br>Silicon<br>28.0855   | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065      | 17<br>Cl<br>Chlorine<br>35.45     | 18<br>Ar<br>Argon<br>39.948      |                                 |
| 19<br>K<br>Potassium<br>+1<br>39.0983 | 20<br>Ca<br>Calcium<br>+2<br>40.078 | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.867  | 23<br>V<br>Vanadium<br>50.9415       | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804 | 26<br>Fe<br>Iron<br>55.845      | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546         | 30<br>Zn<br>Zinc<br>+2<br>65.38   | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96    | 35<br>Br<br>Bromine<br>79.904     | 36<br>Kr<br>Krypton<br>83.798    |                                 |
| 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>95.96  | 43<br>Tc<br>Technetium<br>98.907  | 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>+1<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>118.710       | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60  | 53<br>I<br>Iodine<br>126.9044     | 54<br>Xe<br>Xenon<br>131.293     |                                 |
| 55<br>Cs<br>Caesium<br>132.9054       | 56<br>Ba<br>Barium<br>137.327       | 57-71<br>lanthanoids              |                                 | 72<br>Hf<br>Hafnium<br>178.49        | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84     | 75<br>Re<br>Rhenium<br>186.207  | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217   | 78<br>Pt<br>Platinum<br>195.084      | 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>208.9804  | 84<br>Po<br>Polonium<br>209       | 85<br>At<br>Astatine<br>210      | 86<br>Rn<br>Radon<br>222.018    |
| 87<br>Fr<br>Francium<br>223           | 88<br>Ra<br>Radium<br>226           | 89-103<br>actinoids               |                                 | 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>(271)   | 111<br>Rg<br>Roentgenium<br>(272) | 112<br>Cn<br>Copernicium<br>(285) | 113<br>Nh<br>Nihonium<br>(286)   | 114<br>Fl<br>Flerovium<br>(289)   | 115<br>Mc<br>Moscovium<br>(288)  | 116<br>Lv<br>Livermorium<br>(293) | 117<br>Ts<br>Tennessine<br>(294) | 118<br>Og<br>Oganesson<br>(294) |
|                                       |                                     | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116   | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145)   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964 | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253      | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303   | 68<br>Er<br>Erbium<br>167.259    | 69<br>Tm<br>Thulium<br>168.9342   | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668  |                                  |                                 |
|                                       |                                     | 89<br>Ac<br>Actinium<br>(227)     | 90<br>Th<br>Thorium<br>232.0380 | 91<br>Pa<br>Protactinium<br>231.0358 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>(237)    | 94<br>Pu<br>Plutonium<br>(244)  | 95<br>Am<br>Americium<br>(243)  | 96<br>Cm<br>Curium<br>(247)      | 97<br>Bk<br>Berkelium<br>(247)       | 98<br>Cf<br>Californium<br>(251)  | 99<br>Es<br>Einsteinium<br>(252)  | 100<br>Fm<br>Fermium<br>(257)    | 101<br>Md<br>Mendelevium<br>(258) | 102<br>No<br>Nobelium<br>(259)   | 103<br>Lr<br>Lawrencium<br>(262)  |                                  |                                 |

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Predicting An Ion's Charge

|                                      |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   |                                  |                                 |
|--------------------------------------|-------------------------------------|-----------------------------------|---------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|--------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|---------------------------------|
| 1<br>IA                              |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   | 18<br>VIIIA                      |                                 |
| 1<br>H<br>+1/-1<br>1.00794           |                                     |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   |                                   |                                  |                                   |                                  |                                   | 2<br>He<br>Helium<br>4.002602    |                                 |
| 2<br>Li<br>Lithium<br>6.941          | 3<br>Be<br>Beryllium<br>9.012182    |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                      |                                   | 13<br>B<br>Boron<br>10.811        | 14<br>C<br>Carbon<br>12.0107     | 15<br>N<br>Nitrogen<br>14.007     | 16<br>O<br>Oxygen<br>15.9994     | 17<br>F<br>Fluorine<br>18.998403  | 18<br>Ne<br>Neon<br>20.1797      |                                 |
| 3<br>Na<br>Sodium<br>22.98976        | 4<br>Mg<br>Magnesium<br>24.3050     | 3<br>IIIB                         | 4<br>IVB                        | 5<br>VB                              | 6<br>VIB                         | 7<br>VIIB                         | 8<br>VIIIB                      | 9<br>VIIIB                      | 10<br>VIIIB                      | 11<br>IB                             | 12<br>IIB                         | 13<br>Al<br>Aluminum<br>26.98153  | 14<br>Si<br>Silicon<br>28.0855   | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065      | 17<br>Cl<br>Chlorine<br>35.45     | 18<br>Ar<br>Argon                |                                 |
| 4<br>K<br>Potassium<br>+1<br>39.0983 | 20<br>Ca<br>Calcium<br>+2<br>40.078 | 21<br>Sc<br>Scandium<br>44.95591  | 22<br>Ti<br>Titanium<br>47.867  | 23<br>V<br>Vanadium<br>50.9415       | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804 | 26<br>Fe<br>Iron<br>55.845      | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546         | 30<br>Zn<br>Zinc<br>+2<br>65.38   | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96    | 35<br>Br<br>Bromine<br>79.904     | 36<br>Kr<br>Krypton              |                                 |
| 5<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>95.96  | 43<br>Tc<br>Technetium<br>98.907  | 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>+1<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>118.710       | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60  | 53<br>I<br>Iodine<br>126.9044     | 54<br>Xe<br>Xenon<br>131.293     |                                 |
| 6<br>Cs<br>Caesium<br>132.9054       | 56<br>Ba<br>Barium<br>137.327       | 57 - 71<br>lanthanoids            |                                 | 72<br>Hf<br>Hafnium<br>178.49        | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84     | 75<br>Re<br>Rhenium<br>186.207  | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217   | 78<br>Pt<br>Platinum<br>195.084      | 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>208.9804  | 84<br>Po<br>Polonium<br>209       | 85<br>At<br>Astatine<br>209      | 86<br>Rn<br>Radon<br>222        |
| 7<br>Fr<br>Francium<br>223           | 88<br>Ra<br>Radium<br>226           | 89 - 103<br>actinoids             |                                 | 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>(271)   | 111<br>Rg<br>Roentgenium<br>(272) | 112<br>Cn<br>Copernicium<br>(285) | 113<br>Nh<br>Nihonium<br>(286)   | 114<br>Fl<br>Flerovium<br>(289)   | 115<br>Mc<br>Moscovium<br>(288)  | 116<br>Lv<br>Livermorium<br>(293) | 117<br>Ts<br>Tennessine<br>(294) | 118<br>Og<br>Oganesson<br>(294) |
|                                      |                                     | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116   | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145)   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964 | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253      | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303   | 68<br>Er<br>Erbium<br>167.259    | 69<br>Tm<br>Thulium<br>168.9342   | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668  |                                  |                                 |
|                                      |                                     | 89<br>Ac<br>Actinium<br>(227)     | 90<br>Th<br>Thorium<br>232.0380 | 91<br>Pa<br>Protactinium<br>231.0358 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>(237)    | 94<br>Pu<br>Plutonium<br>(244)  | 95<br>Am<br>Americium<br>(243)  | 96<br>Cm<br>Curium<br>(247)      | 97<br>Bk<br>Berkelium<br>(247)       | 98<br>Cf<br>Californium<br>(251)  | 99<br>Es<br>Einsteinium<br>(252)  | 100<br>Fm<br>Fermium<br>(257)    | 101<br>Md<br>Mendelevium<br>(258) | 102<br>No<br>Nobelium<br>(259)   | 103<br>Lr<br>Lawrencium<br>(262)  |                                  |                                 |

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Question

Please give the ***empirical formula*** for the following molecules:

- Ammonium chloride
- Iron (III) cyanide
- Magnesium sulfate
- Ammonium sulfate

# Predicting An Ion's Charge

|                                 |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                  |                                   |                                   |                                 |                                 |                                  |                                  |          |           |            |  |
|---------------------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|----------------------------------|--------------------------------------|----------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|----------|-----------|------------|--|
| 1<br>IA                         |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                  |                                   |                                   |                                 |                                 | 18<br>VIIIA                      |                                  |          |           |            |  |
| 1<br>H<br>Hydrogen<br>1.00794   |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                  |                                   |                                   |                                 |                                 | 2<br>He<br>Helium<br>4.002602    |                                  |          |           |            |  |
| 2<br>IIA                        |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                  |                                   |                                   |                                 |                                 | 13<br>IIIA                       | 14<br>IVA                        | 15<br>VA | 16<br>VIA | 17<br>VIIA |  |
| 3<br>Li<br>Lithium<br>6.941     | 4<br>Be<br>Beryllium<br>9.012182 |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  | 5<br>B<br>Boron<br>10.811        | 6<br>C<br>Carbon<br>12.0107       | 7<br>N<br>Nitrogen<br>14.00643    | 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>22.98976  | 12<br>Mg<br>Magnesium<br>24.3050 |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  | 13<br>Al<br>Aluminum<br>26.98153 | 14<br>Si<br>Silicon<br>28.0855    | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065     | 17<br>Cl<br>Chlorine<br>35.45   | 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>47.867  | 23<br>V<br>Vanadium<br>50.9415    | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804    | 26<br>Fe<br>Iron<br>55.845       | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934   | 29<br>Cu<br>Copper<br>63.546     | 30<br>Zn<br>Zinc<br>65.38        | 31<br>Ga<br>Gallium<br>69.723    | 32<br>Ge<br>Germanium<br>72.64    | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96   | 35<br>Br<br>Bromine<br>79.904   | 36<br>Kr<br>Krypton<br>83.798    |                                  |          |           |            |  |
| 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>95.96  | 43<br>Tc<br>Technetium<br>98.907     | 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>118.710        | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60 | 53<br>I<br>Iodine<br>126.90447  | 54<br>Xe<br>Xenon<br>131.293     |                                  |          |           |            |  |
| 55<br>Cs<br>Caesium<br>132.9054 | 56<br>Ba<br>Barium<br>137.327    | 57 - 71<br>lanthanoids           |                                 | 72<br>Hf<br>Hafnium<br>178.49     | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84        | 75<br>Re<br>Rhenium<br>186.207   | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217  | 78<br>Pt<br>Platinum<br>195.084  | 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>208.9804 | 84<br>Po<br>Polonium<br>209     | 85<br>At<br>Astatine<br>210      | 86<br>Rn<br>Radon<br>222         |          |           |            |  |
| 87<br>Fr<br>Francium<br>223     | 88<br>Ra<br>Radium<br>226        | 89 - 103<br>actinoids            |                                 | 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>271 | 111<br>Rg<br>Roentgenium<br>272  | 112<br>Cn<br>Copernicium<br>285  | 113<br>Nh<br>Nihonium<br>284      | 114<br>Fl<br>Flerovium<br>289     | 115<br>Mc<br>Moscovium<br>288   | 116<br>Lv<br>Livermorium<br>293 | 117<br>Ts<br>Tennessine<br>294   | 118<br>Og<br>Oganesson<br>294    |          |           |            |  |
|                                 |                                  |                                  |                                 | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116    | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>145   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964  | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253  | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303   | 68<br>Er<br>Erbium<br>167.259   | 69<br>Tm<br>Thulium<br>168.9342 | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668 |          |           |            |  |
|                                 |                                  |                                  |                                 | 89<br>Ac<br>Actinium<br>227       | 90<br>Th<br>Thorium<br>232.0380  | 91<br>Pa<br>Protactinium<br>231.0358 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237    | 94<br>Pu<br>Plutonium<br>244    | 95<br>Am<br>Americium<br>243     | 96<br>Cm<br>Curium<br>247        | 97<br>Bk<br>Berkelium<br>247     | 98<br>Cf<br>Californium<br>251    | 99<br>Es<br>Einsteinium<br>252    | 100<br>Fm<br>Fermium<br>257     | 101<br>Md<br>Mendelevium<br>258 | 102<br>No<br>Nobelium<br>259     | 103<br>Lr<br>Lawrencium<br>262   |          |           |            |  |

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

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## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Predicting An Ion's Charge

|                                 |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                |                               |
|---------------------------------|----------------------------------|-----------------------------------|---------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|--------------------------------|-------------------------------|
| 1<br>IA                         |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  | 18<br>VIIIA                    |                               |
| 1<br>H<br>Hydrogen<br>1.00794   |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  | 2<br>He<br>Helium<br>4.002602  |                               |
| 2<br>IIA                        |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                |                               |
| 3<br>Li<br>Lithium<br>6.941     | 4<br>Be<br>Beryllium<br>9.012182 |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   | 5<br>B<br>Boron<br>10.811        | 6<br>C<br>Carbon<br>12.0107      | 7<br>N<br>Nitrogen<br>14.007      | 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>22.98976  | 12<br>Mg<br>Magnesium<br>24.3050 | 3<br>IIIB                         | 4<br>IVB                        | 5<br>VB                              | 6<br>VIB                         | 7<br>VIIB                         | 8<br>VIIIB                      | 9<br>VIIIB                      | 10<br>VIIIB                      | 11<br>IB                         | 12<br>IIB                         | 13<br>Al<br>Aluminum<br>26.98153 | 14<br>Si<br>Silicon<br>28.0855   | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065      | 17<br>Cl<br>Chlorine<br>35.45    | 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>47.867  | 23<br>V<br>Vanadium<br>50.9415       | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804 | 26<br>Fe<br>Iron<br>55.845      | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546     | 30<br>Zn<br>Zinc<br>65.38         | 31<br>Ga<br>Gallium<br>69.723    | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96    | 35<br>Br<br>Bromine<br>79.904    | 36<br>Kr<br>Krypton<br>83.798  |                               |
| 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>95.96  | 43<br>Tc<br>Technetium<br>98.907  | 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>118.710       | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60  | 53<br>I<br>Iodine<br>126.9044    | 54<br>Xe<br>Xenon<br>131.293   |                               |
| 55<br>Cs<br>Caesium<br>132.9054 | 56<br>Ba<br>Barium<br>137.327    | 57 - 71<br>lanthanoids            |                                 | 72<br>Hf<br>Hafnium<br>178.49        | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84     | 75<br>Re<br>Rhenium<br>186.207  | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217   | 78<br>Pt<br>Platinum<br>195.084  | 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>208.9804  | 84<br>Po<br>Polonium<br>209      | 85<br>At<br>Astatine<br>210    | 86<br>Rn<br>Radon<br>222      |
| 87<br>Fr<br>Francium<br>223     | 88<br>Ra<br>Radium<br>226        | 89 - 103<br>actinoids             |                                 | 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>271 | 111<br>Rg<br>Roentgenium<br>272   | 112<br>Cn<br>Copernicium<br>285  | 113<br>Nh<br>Nihonium<br>284     | 114<br>Fl<br>Flerovium<br>289     | 115<br>Mc<br>Moscovium<br>288    | 116<br>Lv<br>Livermorium<br>293  | 117<br>Ts<br>Tennessine<br>294 | 118<br>Og<br>Oganesson<br>294 |
|                                 |                                  | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116   | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145)   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964 | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253  | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303  | 68<br>Er<br>Erbium<br>167.259    | 69<br>Tm<br>Thulium<br>168.9342   | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668 |                                |                               |
|                                 |                                  | 89<br>Ac<br>Actinium<br>(227)     | 90<br>Th<br>Thorium<br>232.0380 | 91<br>Pa<br>Protactinium<br>231.0368 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>(237)    | 94<br>Pu<br>Plutonium<br>(244)  | 95<br>Am<br>Americium<br>(243)  | 96<br>Cm<br>Curium<br>(247)      | 97<br>Bk<br>Berkelium<br>(247)   | 98<br>Cf<br>Californium<br>(251)  | 99<br>Es<br>Einsteinium<br>(252) | 100<br>Fm<br>Fermium<br>(257)    | 101<br>Md<br>Mendelevium<br>(258) | 102<br>No<br>Nobelium<br>(259)   | 103<br>Lr<br>Lawrencium<br>(262) |                                |                               |

# Question

Please name the following ionic compounds:

- $\text{FeCO}_3$
- $\text{Fe}(\text{CN})_3$
- $\text{MgSO}_4$
- $\text{Al}(\text{OH})_3$
- $\text{CsNO}_3$
- $\text{Zn}_3(\text{PO}_4)_2$
- $(\text{NH}_4)_2\text{SO}_4$

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Predicting An Ion's Charge

|   |                                 |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                |                                   |                             |                                 |                             |
|---|---------------------------------|----------------------------------|-----------------------------------|---------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|--------------------------------|-----------------------------------|-----------------------------|---------------------------------|-----------------------------|
|   | 1<br>IA                         |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                | 18<br>VIIIA                       |                             |                                 |                             |
| 1 | 1<br>H<br>Hydrogen<br>1.00794   | 2<br>He<br>Helium<br>4.002602    |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                |                                   |                             |                                 |                             |
| 2 | 3<br>Li<br>Lithium<br>6.941     | 4<br>Be<br>Beryllium<br>9.012182 |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  | 5<br>B<br>Boron<br>10.811        | 6<br>C<br>Carbon<br>12.0107    | 7<br>N<br>Nitrogen<br>14.0064     | 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 | 11<br>Na<br>Sodium<br>22.98976  | 12<br>Mg<br>Magnesium<br>24.3050 |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  | 13<br>Al<br>Aluminum<br>26.98153 | 14<br>Si<br>Silicon<br>28.0855 | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065 | 17<br>Cl<br>Chlorine<br>35.45   | 18<br>Ar<br>Argon<br>39.948 |
| 4 | 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>47.867  | 23<br>V<br>Vanadium<br>50.9415       | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804 | 26<br>Fe<br>Iron<br>55.845      | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546     | 30<br>Zn<br>Zinc<br>65.38         | 31<br>Ga<br>Gallium<br>69.723    | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96    | 35<br>Br<br>Bromine<br>79.904    | 36<br>Kr<br>Krypton<br>83.798  |                                   |                             |                                 |                             |
| 5 | 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>95.96  | 43<br>Tc<br>Technetium<br>98.907  | 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>118.710       | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60  | 53<br>I<br>Iodine<br>126.90447   | 54<br>Xe<br>Xenon<br>131.293   |                                   |                             |                                 |                             |
| 6 | 55<br>Cs<br>Caesium<br>132.9054 | 56<br>Ba<br>Barium<br>137.327    | 57 - 71<br>lanthanoids            |                                 | 72<br>Hf<br>Hafnium<br>178.49        | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84     | 75<br>Re<br>Rhenium<br>186.207  | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217   | 78<br>Pt<br>Platinum<br>195.084  | 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>208.9804  | 84<br>Po<br>Polonium<br>209      | 85<br>At<br>Astatine<br>210    | 86<br>Rn<br>Radon<br>222          |                             |                                 |                             |
| 7 | 87<br>Fr<br>Francium<br>223     | 88<br>Ra<br>Radium<br>226        | 89 - 103<br>actinoids             |                                 | 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>271 | 111<br>Rg<br>Roentgenium<br>272   | 112<br>Cn<br>Copernicium<br>285  | 113<br>Nh<br>Nihonium<br>284     | 114<br>Fl<br>Flerovium<br>289     | 115<br>Mc<br>Moscovium<br>288    | 116<br>Lv<br>Livermorium<br>293  | 117<br>Ts<br>Tennessine<br>294 | 118<br>Og<br>Oganesson<br>294     |                             |                                 |                             |
|   |                                 |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                  |                                   |                                  |                                  |                                   |                                  |                                  |                                |                                   |                             |                                 |                             |
|   |                                 |                                  | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116   | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145)   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964 | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253  | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303  | 68<br>Er<br>Erbium<br>167.259    | 69<br>Tm<br>Thulium<br>168.9342   | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668 |                                |                                   |                             |                                 |                             |
|   |                                 |                                  | 89<br>Ac<br>Actinium<br>(227)     | 90<br>Th<br>Thorium<br>232.0380 | 91<br>Pa<br>Protactinium<br>231.0368 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>(237)    | 94<br>Pu<br>Plutonium<br>(244)  | 95<br>Am<br>Americium<br>(243)  | 96<br>Cm<br>Curium<br>(247)      | 97<br>Bk<br>Berkelium<br>(247)   | 98<br>Cf<br>Californium<br>(251)  | 99<br>Es<br>Einsteinium<br>(252) | 100<br>Fm<br>Fermium<br>(257)    | 101<br>Md<br>Mendelevium<br>(258) | 102<br>No<br>Nobelium<br>(259)   | 103<br>Lr<br>Lawrencium<br>(262) |                                |                                   |                             |                                 |                             |

# Predicting An Ion's Charge

|                                 |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                    |                                   |                                   |                                  |                                   |                                  |                                   |                                  |                                 |
|---------------------------------|----------------------------------|-----------------------------------|---------------------------------|--------------------------------------|----------------------------------|-----------------------------------|---------------------------------|---------------------------------|----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|----------------------------------|---------------------------------|
| 1<br>IA                         |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                    |                                   |                                   |                                  |                                   |                                  |                                   | 18<br>VIIIA                      |                                 |
| 1<br>H<br>Hydrogen<br>1.00794   |                                  |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                    |                                   |                                   |                                  |                                   |                                  |                                   | 2<br>He<br>Helium<br>4.002602    |                                 |
| 2<br>Li<br>Lithium<br>6.941     | 3<br>Be<br>Beryllium<br>9.012182 |                                   |                                 |                                      |                                  |                                   |                                 |                                 |                                  |                                    |                                   | 5<br>B<br>Boron<br>10.811         | 6<br>C<br>Carbon<br>12.0107      | 7<br>N<br>Nitrogen<br>14.007      | 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>22.98976  | 12<br>Mg<br>Magnesium<br>24.3050 | 3<br>IIIB                         | 4<br>IVB                        | 5<br>VB                              | 6<br>VIB                         | 7<br>VIIB                         | 8<br>VIIIB                      | 9<br>VIIIB                      | 10<br>VIIIB                      | 11<br>IB                           | 12<br>IIB                         | 13<br>Al<br>Aluminum<br>26.98153  | 14<br>Si<br>Silicon<br>28.0855   | 15<br>P<br>Phosphorus<br>30.97376 | 16<br>S<br>Sulfur<br>32.065      | 17<br>Cl<br>Chlorine<br>35.45     | 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>47.867  | 23<br>V<br>Vanadium<br>50.9415       | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804 | 26<br>Fe<br>Iron<br>55.845      | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934    | 29<br>Cu<br>Copper<br>63.546       | 30<br>Zn<br>Zinc<br>65.38         | 31<br>Ga<br>Gallium<br>69.723     | 32<br>Ge<br>Germanium<br>72.64   | 33<br>As<br>Arsenic<br>74.92160   | 34<br>Se<br>Selenium<br>78.96    | 35<br>Br<br>Bromine<br>79.904     | 36<br>Kr<br>Krypton<br>83.798    |                                 |
| 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>95.96  | 43<br>Tc<br>Technetium<br>98.907  | 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>118.710       | 51<br>Sb<br>Antimony<br>121.760   | 52<br>Te<br>Tellurium<br>127.60  | 53<br>I<br>Iodine<br>126.9044     | 54<br>Xe<br>Xenon<br>131.293     |                                 |
| 55<br>Cs<br>Caesium<br>132.9054 | 56<br>Ba<br>Barium<br>137.327    | 57 - 71<br>lanthanoids            |                                 | 72<br>Hf<br>Hafnium<br>178.49        | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84     | 75<br>Re<br>Rhenium<br>186.207  | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217   | 78<br>Pt<br>Platinum<br>195.084    | 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>208.9804  | 84<br>Po<br>Polonium<br>209       | 85<br>At<br>Astatine<br>210      | 86<br>Rn<br>Radon<br>222        |
| 87<br>Fr<br>Francium<br>223     | 88<br>Ra<br>Radium<br>226        | 89 - 103<br>actinoids             |                                 | 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>(271) | 111<br>Rg<br>Roentgenium<br>(272) | 112<br>Cn<br>Copernicium<br>(285) | 113<br>Nh<br>Nihonium<br>(284)   | 114<br>Fl<br>Flerovium<br>(289)   | 115<br>Mc<br>Moscovium<br>(288)  | 116<br>Lv<br>Livermorium<br>(293) | 117<br>Ts<br>Tennessine<br>(294) | 118<br>Og<br>Oganesson<br>(294) |
|                                 |                                  | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116   | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145)   | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964 | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253    | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303   | 68<br>Er<br>Erbium<br>167.259    | 69<br>Tm<br>Thulium<br>168.9342   | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668  |                                  |                                 |
|                                 |                                  | 89<br>Ac<br>Actinium<br>(227)     | 90<br>Th<br>Thorium<br>232.0380 | 91<br>Pa<br>Protactinium<br>231.0368 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>(237)    | 94<br>Pu<br>Plutonium<br>(244)  | 95<br>Am<br>Americium<br>(243)  | 96<br>Cm<br>Curium<br>(247)      | 97<br>Bk<br>Berkelium<br>(247)     | 98<br>Cf<br>Californium<br>(251)  | 99<br>Es<br>Einsteinium<br>(252)  | 100<br>Fm<br>Fermium<br>(257)    | 101<br>Md<br>Mendelevium<br>(258) | 102<br>No<br>Nobelium<br>(259)   | 103<br>Lr<br>Lawrencium<br>(262)  |                                  |                                 |

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Predicting An Ion's Charge

|   |                                 |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                 |                                   |                                 |                                 |                                 |                                  |                                  |
|---|---------------------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|----------------------------------|--------------------------------------|----------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|---------------------------------|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|----------------------------------|----------------------------------|
| 1 | 1<br>IA                         |                                  |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                 |                                   |                                 |                                 |                                 | 18<br>VIIIA                      |                                  |
| 1 | 1<br>H<br>Hydrogen<br>1.00794   | 2<br>He<br>Helium<br>4.002602    |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                 |                                   |                                 |                                 |                                 |                                  |                                  |
| 2 | 3<br>Li<br>Lithium<br>6.941     | 4<br>Be<br>Beryllium<br>9.012182 |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                 |                                   |                                 |                                 | 10<br>Ne<br>Neon<br>20.1797     |                                  |                                  |
| 3 | 11<br>Na<br>Sodium<br>22.98976  | 12<br>Mg<br>Magnesium<br>24.3050 |                                  |                                 |                                   |                                  |                                      |                                  |                                 |                                 |                                  |                                  |                                 |                                   |                                 |                                 | 18<br>Ar<br>Argon<br>39.948     |                                  |                                  |
| 4 | 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>47.867  | 23<br>V<br>Vanadium<br>50.9415    | 24<br>Cr<br>Chromium<br>51.9962  | 25<br>Mn<br>Manganese<br>54.93804    | 26<br>Fe<br>Iron<br>55.845       | 27<br>Co<br>Cobalt<br>58.93319  | 28<br>Ni<br>Nickel<br>58.6934   | 29<br>Cu<br>Copper<br>63.546     | 30<br>Zn<br>Zinc<br>65.38        | 31<br>Ga<br>Gallium<br>69.723   | 32<br>Ge<br>Germanium<br>72.64    | 33<br>As<br>Arsenic<br>74.92160 | 34<br>Se<br>Selenium<br>78.96   | 35<br>Br<br>Bromine<br>79.904   | 36<br>Kr<br>Krypton<br>83.798    |                                  |
| 5 | 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>95.96  | 43<br>Tc<br>Technetium<br>98.907     | 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>118.710        | 51<br>Sb<br>Antimony<br>121.760 | 52<br>Te<br>Tellurium<br>127.60 | 53<br>I<br>Iodine<br>126.9045   | 54<br>Xe<br>Xenon<br>131.293     |                                  |
| 6 | 55<br>Cs<br>Caesium<br>132.9054 | 56<br>Ba<br>Barium<br>137.327    | 57 - 71<br>lanthanoids           |                                 | 72<br>Hf<br>Hafnium<br>178.49     | 73<br>Ta<br>Tantalum<br>180.9478 | 74<br>W<br>Tungsten<br>183.84        | 75<br>Re<br>Rhenium<br>186.207   | 76<br>Os<br>Osmium<br>190.23    | 77<br>Ir<br>Iridium<br>192.217  | 78<br>Pt<br>Platinum<br>195.084  | 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>208.9804 | 84<br>Po<br>Polonium<br>209     | 85<br>At<br>Astatine<br>210      | 86<br>Rn<br>Radon<br>222         |
| 7 | 87<br>Fr<br>Francium<br>223     | 88<br>Ra<br>Radium<br>226        | 89 - 103<br>actinoids            |                                 | 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>271 | 111<br>Rg<br>Roentgenium<br>272  | 112<br>Cn<br>Copernicium<br>285 | 113<br>Nh<br>Nihonium<br>284      | 114<br>Fl<br>Flerovium<br>289   | 115<br>Mc<br>Moscovium<br>288   | 116<br>Lv<br>Livermorium<br>293 | 117<br>Ts<br>Tennessine<br>294   | 118<br>Og<br>Oganesson<br>294    |
|   |                                 |                                  |                                  |                                 | 57<br>La<br>Lanthanum<br>138.9054 | 58<br>Ce<br>Cerium<br>140.116    | 59<br>Pr<br>Praseodymium<br>140.9076 | 60<br>Nd<br>Neodymium<br>144.242 | 61<br>Pm<br>Promethium<br>(145) | 62<br>Sm<br>Samarium<br>150.36  | 63<br>Eu<br>Europium<br>151.964  | 64<br>Gd<br>Gadolinium<br>157.25 | 65<br>Tb<br>Terbium<br>158.9253 | 66<br>Dy<br>Dysprosium<br>162.500 | 67<br>Ho<br>Holmium<br>164.9303 | 68<br>Er<br>Erbium<br>167.259   | 69<br>Tm<br>Thulium<br>168.9342 | 70<br>Yb<br>Ytterbium<br>173.054 | 71<br>Lu<br>Lutetium<br>174.9668 |
|   |                                 |                                  |                                  |                                 | 89<br>Ac<br>Actinium<br>227       | 90<br>Th<br>Thorium<br>232.0380  | 91<br>Pa<br>Protactinium<br>231.0358 | 92<br>U<br>Uranium<br>238.0289   | 93<br>Np<br>Neptunium<br>237    | 94<br>Pu<br>Plutonium<br>244    | 95<br>Am<br>Americium<br>243     | 96<br>Cm<br>Curium<br>247        | 97<br>Bk<br>Berkelium<br>247    | 98<br>Cf<br>Californium<br>251    | 99<br>Es<br>Einsteinium<br>252  | 100<br>Fm<br>Fermium<br>257     | 101<br>Md<br>Mendelevium<br>258 | 102<br>No<br>Nobelium<br>259     | 103<br>Lr<br>Lawrencium<br>262   |

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

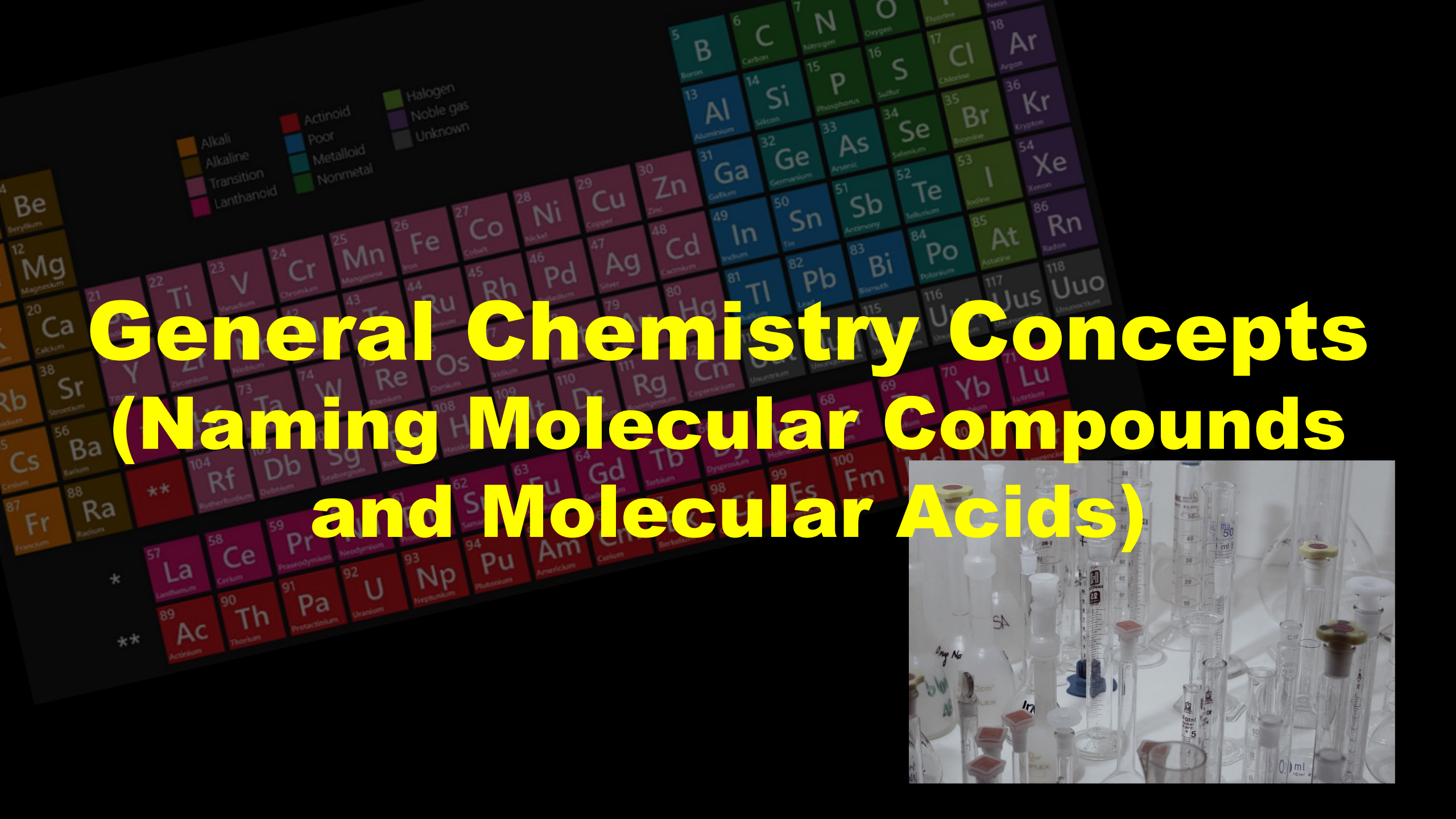
Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$



The background of the slide features a periodic table of elements. The elements are color-coded into groups: Alkali (orange), Alkaline (yellow), Transition (pink), Lanthanoid (light pink), Actinoid (red), Poor (blue), Metalloid (teal), Nonmetal (green), Halogen (light green), Noble gas (purple), and Unknown (grey). A legend in the top left corner identifies these groups. In the bottom right corner, there is an inset image showing various pieces of laboratory glassware, including test tubes, graduated cylinders, and beakers, some containing liquids and others with stoppers.

# General Chemistry Concepts (Naming Molecular Compounds and Molecular Acids)

# Ionic vs. Molecular Compounds

In our last video, we learned about two classes compounds:

## Compounds

***Ionic compounds:*** metal + nonmetal (contain *ionic bonds*)

**Exception:** Although it does not contain any metals,  $\text{NH}_4\text{Cl}$  is ionic.

***Molecular compounds:*** two or more nonmetals (contain *covalent bonds*)

# Metals and Nonmetals

And what do I mean when I say *metals* and *nonmetals*?

|          |          |          |          |           |           |           |           |           |           |           |           |           |           |           |           |           |          |          |
|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|
| 1<br>H   |          |          |          |           |           |           |           |           |           |           |           |           |           |           |           |           | 2<br>He  |          |
| 3<br>Li  | 4<br>Be  |          |          |           |           |           |           |           |           |           |           | 5<br>B    | 6<br>C    | 7<br>N    | 8<br>O    | 9<br>F    | 10<br>Ne |          |
| 11<br>Na | 12<br>Mg |          |          |           |           |           |           |           |           |           |           | 13<br>Al  | 14<br>Si  | 15<br>P   | 16<br>S   | 17<br>Cl  | 18<br>Ar |          |
| 19<br>K  | 20<br>Ca | 21<br>Sc | 22<br>Ti | 23<br>V   | 24<br>Cr  | 25<br>Mn  | 26<br>Fe  | 27<br>Co  | 28<br>Ni  | 29<br>Cu  | 30<br>Zn  | 31<br>Ga  | 32<br>Ge  | 33<br>As  | 34<br>Se  | 35<br>Br  | 36<br>Kr |          |
| 37<br>Rb | 38<br>Sr | 39<br>Y  | 40<br>Zr | 41<br>Nb  | 42<br>Mo  | 43<br>Tc  | 44<br>Ru  | 45<br>Rh  | 46<br>Pd  | 47<br>Ag  | 48<br>Cd  | 49<br>In  | 50<br>Sn  | 51<br>Sb  | 52<br>Te  | 53<br>I   | 54<br>Xe |          |
| 55<br>Cs | 56<br>Ba |          |          | 72<br>Hf  | 73<br>Ta  | 74<br>W   | 75<br>Re  | 76<br>Os  | 77<br>Ir  | 78<br>Pt  | 79<br>Au  | 80<br>Hg  | 81<br>Tl  | 82<br>Pb  | 83<br>Bi  | 84<br>Po  | 85<br>At | 86<br>Rn |
| 87<br>Fr | 88<br>Ra |          |          | 104<br>Rf | 105<br>Db | 106<br>Sg | 107<br>Bh | 108<br>Hs | 109<br>Mt | 110<br>Ds | 111<br>Rg | 112<br>Cn |           |           |           |           |          |          |
|          |          |          |          |           |           |           |           |           |           |           |           |           |           |           |           |           |          |          |
|          |          | 57<br>La | 58<br>Ce | 59<br>Pr  | 60<br>Nd  | 61<br>Pm  | 62<br>Sm  | 63<br>Eu  | 64<br>Gd  | 65<br>Tb  | 66<br>Dy  | 67<br>Ho  | 68<br>Er  | 69<br>Tm  | 70<br>Yb  | 71<br>Lu  |          |          |
|          |          | 89<br>Ac | 90<br>Th | 91<br>Pa  | 92<br>U   | 93<br>Np  | 94<br>Pu  | 95<br>Am  | 96<br>Cm  | 97<br>Bk  | 98<br>Cf  | 99<br>Es  | 100<br>Fm | 101<br>Md | 102<br>No | 103<br>Lr |          |          |

Blue = metal  
Red = nonmetal  
Green = Metalloid

# Ionic vs. Molecular Compounds

In our last video, we also learned about two classes compounds:

## Compounds

***Ionic compounds:*** metal + nonmetal (contain ***ionic bonds***)

**Exception: Although it does not contain any metals,  $\text{NH}_4\text{Cl}$  is ionic.**

***Molecular compounds:*** two or more nonmetals (contain ***covalent bonds***)

In our last video, we also learned how to name ***ionic compounds***. In this video, we'll learn how to name ***molecular compounds*** and ***molecular acids***.

# Naming Molecular Compounds



1. Give the appropriate numerical prefix to the first element:

|                      |                     |                    |
|----------------------|---------------------|--------------------|
| <b>Mono = one</b>    | <b>Di = two</b>     | <b>Tri = three</b> |
| <b>Tetra = four</b>  | <b>Penta = five</b> | <b>Hexa = six</b>  |
| <b>Hepta = seven</b> | <b>Octa = eight</b> | <b>Nona = nine</b> |

(Skip this step if **X = 1**.)

2. Name the first element by using its regular name on the periodic table.
2. Give the appropriate numerical prefix to the second element.

# Naming Molecular Compounds



4. Name the nonmetal using an “ide” ending:

$N_2O$  – dinitrogen monoxide (laughing gas)

$SF_6$  – sulfur hexafluoride (a contrast agent for ultrasound imaging)

$H_2O$  – dihydrogen monoxide

# Naming Binary Acids

**H—one other element**

1. Hydro + insert the name of element 2, replacing “ine” with “ic acid”.

1. Examples:

**HF – hydrofluoric acid**

**HCl – hydrochloric acid**

**HBr – hydrobromic acid**

**HI – hydroiodic acid**

# Naming Oxyacids



1. If **Z = 0-2**, then the name is: ***hypo*** + insert the name of element 2, replacing “ine” with “ous acid”.
1. If **Z = one more**, then the name is: insert the name of element 2, replacing “ine” with “ous acid”.
1. If **Z = one more**, then the name is: insert the name of element 2, replacing “ine” with “ic acid”.
1. If **Z = one more**, then the name is: ***per*** + insert the name of element 2, replacing “ine” with “ic acid”.

# Naming Oxyacids



In other words, you use “*hypo*” for the formula with the fewest oxygen atoms and “*per*” for the formula with the most oxygen atoms:

|          |                   |                   |                   |                   |
|----------|-------------------|-------------------|-------------------|-------------------|
| Formula: | HClO              | HClO <sub>2</sub> | HClO <sub>3</sub> | HClO <sub>4</sub> |
| Name:    | Hypochlorous acid | Chlorous acid     | Chloric acid      | Perchloric acid   |

# Naming Oxyacids



In other words, you use “*hypo*” for the formula with the fewest oxygen atoms and “*per*” for the formula with the most oxygen atoms:

|          |                   |                   |                   |                   |
|----------|-------------------|-------------------|-------------------|-------------------|
| Formula: | HClO              | HClO <sub>2</sub> | HClO <sub>3</sub> | HClO <sub>4</sub> |
| Name:    | hypochlorous acid | chlorous acid     | chloric acid      | perchloric acid   |

# Naming Oxyacids



## EXAMPLES:

|          |                         |                         |                         |                         |
|----------|-------------------------|-------------------------|-------------------------|-------------------------|
| Formula: | $\text{H}_3\text{PO}_2$ | $\text{H}_3\text{PO}_3$ | $\text{H}_3\text{PO}_4$ | $\text{H}_3\text{PO}_5$ |
| Name:    | hypophosphorous acid    | phosphorous acid        | phosphoric acid         | perphosphoric acid      |

|          |                         |                         |                         |                         |
|----------|-------------------------|-------------------------|-------------------------|-------------------------|
| Formula: | $\text{H}_3\text{PO}_2$ | $\text{H}_3\text{PO}_3$ | $\text{H}_3\text{PO}_4$ | $\text{H}_3\text{PO}_5$ |
| Name:    | hypophosphorous acid    | phosphorous acid        | phosphoric acid         | perphosphoric acid      |

# Naming Oxyacids



## EXAMPLES:

|          |                         |                         |                         |                         |
|----------|-------------------------|-------------------------|-------------------------|-------------------------|
| Formula: | $\text{H}_3\text{PO}_2$ | $\text{H}_3\text{PO}_3$ | $\text{H}_3\text{PO}_4$ | $\text{H}_3\text{PO}_5$ |
| Name:    | hypophosphorous acid    | phosphorous acid        | phosphoric acid         | perphosphoric acid      |

|          |                         |                         |                         |                         |
|----------|-------------------------|-------------------------|-------------------------|-------------------------|
| Formula: | $\text{H}_2\text{SO}_2$ | $\text{H}_2\text{SO}_3$ | $\text{H}_2\text{SO}_4$ | $\text{H}_2\text{SO}_5$ |
| Name:    | hyposulfurous acid      | sulfurous acid          | sulfuric acid           | persulfuric acid        |

# Seven Strong Acids You Should Know

There are seven strong acids whose names and formulas I require my students to memorize. They are:

| Binary Acids:                                                          | Oxyacids:                                                                                                                                               |
|------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hydrochloric acid, HCl<br>Hydrobromic acid, HBr<br>Hydroiodic acid, HI | Chloric acid, HClO <sub>3</sub><br>Perchloric acid, HClO <sub>4</sub><br>Nitric acid, HNO <sub>3</sub><br>Sulfuric acid, H <sub>2</sub> SO <sub>4</sub> |

# Question

Please give the name or chemical formula (whichever one isn't provided) for each of the following molecular compounds:

- Tetraphosphorus hexasulfide
- $\text{PCl}_3$
- Dinitrogen tetroxide
- $\text{Cl}_2\text{O}_3$
- $\text{SF}_6$

# Question

Please give the name or chemical formula (whichever one isn't provided) for each of the following molecular acids:

- HCN
- $\text{H}_2\text{SO}_3$
- $\text{HClO}_4$
- $\text{H}_2\text{SO}_4$
- Hydroiodic acid
- $\text{HClO}_3$

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

# Question

Please give the name or chemical formula (whichever one isn't provided) for each of the following molecular acids:

- $\text{H}_3\text{PO}_4$
- $\text{HNO}_3$
- $\text{H}_2\text{CO}_3$
- $\text{HI}$
- $\text{H}_3\text{PO}_3$
- $\text{HNO}_2$
- Hydrobromic acid

## Cations

Ammonium:  $\text{NH}_4^+$

## Anions

Acetate:  $\text{CH}_3\text{COO}^-$

Cyanide:  $\text{CN}^-$

Nitrate:  $\text{NO}_3^-$

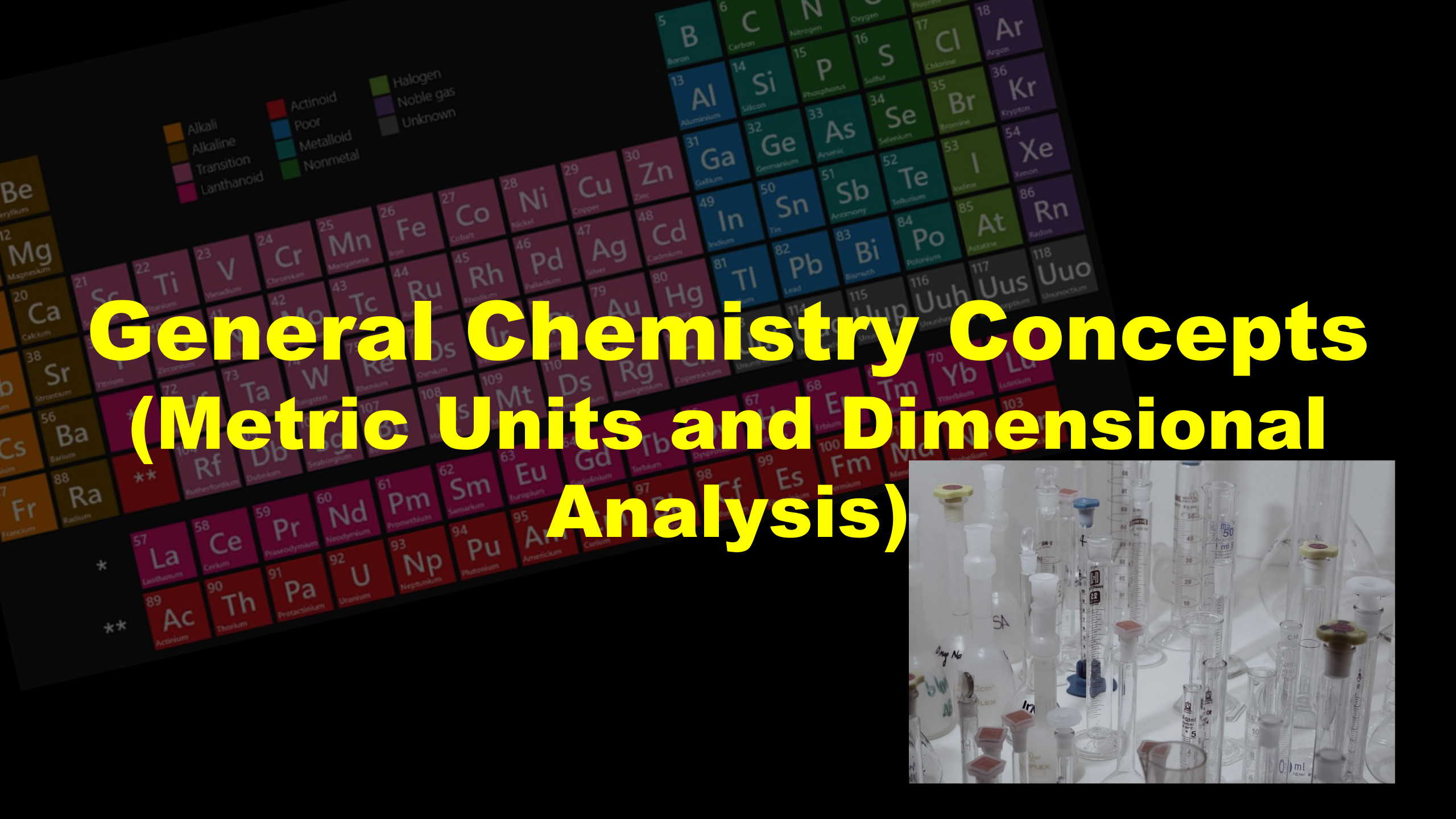
Phosphate:  $\text{PO}_4^{3-}$

Sulfate:  $\text{SO}_4^{2-}$

Carbonate:  $\text{CO}_3^{2-}$

Hydroxide:  $\text{HO}^-$

Permanganate:  $\text{MnO}_4^-$

A periodic table of elements is shown in the background, tilted at an angle. It is color-coded by groups: Alkali (orange), Alkaline (yellow), Transition (pink), Lanthanoid (purple), Actinoid (red), Poor (blue), Metalloid (teal), Nonmetal (green), Halogen (dark green), Noble gas (light green), and Unknown (grey).

# General Chemistry Concepts (Metric Units and Dimensional Analysis)



# SI (Système International) Units

We scientists typically use and publish our findings in international units of measurement, called **SI** (for “Système International”) units. Each physical quantity uses a different base as its **SI unit**:

| Physical Quantity  | Name of Base Unit | Abbreviation |
|--------------------|-------------------|--------------|
| Length             | Meter             | m            |
| Time               | Second            | s or sec     |
| Temperature        | Kelvin            | K            |
| Substance amount   | Mole              | Mol          |
| Electric current   | Ampere            | A or amp     |
| Luminous intensity | Candela           | Cd           |
| Mass               | kilogram          | kg           |

I also strongly advise you to memorize that **1 cm<sup>3</sup> = 1 mL**.

# SI (Système International) Units

Unfortunately, for the EXAM, you need to memorize the following *SI unit prefixes* and their amounts:

- Terra –  $10^{12}$
- Giga –  $10^9$
- Mega –  $10^6$
- Kilo –  $10^3$
- Centi –  $10^{-2}$
- Milli –  $10^{-3}$
- Micro –  $10^{-6}$
- Nano –  $10^{-9}$

# Unit Conversion/Dimensional Analysis

With these prefix values in mind, we can now interconvert from one set of units to another. This process is called ***unit conversion*** or ***dimensional analysis***. Here are the steps:

**Step 1:** Write down the value, from your problem, that you want to convert (this is usually the value that has no units in its denominator).

**Step 2:** Draw a set of parentheses to the right of it, with a horizontal line in the middle.

# Unit Conversion/Dimensional Analysis

With these prefix values in mind, we can now interconvert from one set of units to another. This process is called ***unit conversion*** or ***dimensional analysis***. Here are the steps:

**Step 1:** Write down the value, from your problem, that you want to convert (this is usually the value that has no units in its denominator).

**Step 2:** Draw a set of parentheses to the right of it, with a horizontal line in the middle.

**Step 3:** Write units (no numbers yet!) that relate to each other on the top and bottom of the horizontal line. These should cancel out the units you started with and take you to the units where you want to go. Be sure to focus on units. (Units!!!!) Multiple sets of parentheses may be necessary.

# Unit Conversion/Dimensional Analysis

With these prefix values in mind, we can now interconvert from one set of units to another. This process is called ***unit conversion*** or ***dimensional analysis***. Here are the steps:

**Step 4:** Put numbers on the top and the bottom of the horizontal line in your parentheses. As you do this, make sure that each set of parentheses (with numbers and units) conveys a true statement.

**Step 5:** Multiply out all the numbers. This should cancel out the units you started with and take you to the units where you want to go. If applicable, express your answer with the correct number of significant figures. (We'll talk about this later on.)

# Example Problem

A modern advertising blimp balloon has a volume of about  $8.41 \times 10^6$  L. Convert this to gallons. (Note: 1 gal = 3.785 L)

**Step 1:** Write down the value, from your problem, that you want to convert:

$$8.41 \times 10^6 \text{ L}$$

**Step 2:** Draw a set of parentheses to the right of it, with a horizontal line in the middle.

$$8.41 \times 10^6 \text{ L} \left( \text{—————} \right)$$

# Example Problem

**Step 3:** Write units (no numbers yet!) that relate to each other on the top and bottom of the horizontal line. These should cancel out the units you started with and take you to the units where you want to go. Be sure to focus on units. (Units!!!!) Multiple sets of parentheses may be necessary.

In this case, put **L** on the bottom of the fraction to cancel out the **L** you start with. Then put **gal** (the value we want to get to) on top:

$$8.41 \times 10^6 \text{ L} \left( \frac{\text{gal}}{\text{L}} \right)$$

# Example Problem

**Step 4:** Put numbers on the top and bottom of each set of parentheses that go with the units in that set of parentheses. As you do so, make sure that each set of parentheses (with numbers and units) conveys a true statement.

In this case, we know that **1 gal = 3.785 L**, so put **3.785** on the bottom (with the **L**) and **1** on top (with the **gal**).

$$8.41 \times 10^6 \text{ L} \left( \frac{1 \text{ gal}}{3.785 \text{ L}} \right)$$

# Example Problem

Now that I've written in the numbers, I ask myself: did I put my numbers in the correct place? In this case, are there really 3.785 L in 1 gal? If so, then my parentheses are written correctly. If not, then I need to rewrite them until I have a true statement inside the parentheses.

$$8.41 \times 10^6 \text{ L} \left( \frac{1 \text{ gal}}{3.785 \text{ L}} \right)$$

# Example Problem

**Step 5:** Multiply out all the numbers. This should cancel out the units you started with and take you to the units where you want to go. If applicable, express your answer with the correct number of significant figures. (We'll talk about this later on.)

You cannot use a calculator on the EXAM, so all the questions they give you will either involve simple arithmetic you can do without a calculator, OR they will be left as an un-simplified expression. In this case, for example, the correct multiple-choice answer might look like:

$$8.41 \times 10^6 \cancel{\text{L}} \left( \frac{1 \text{ gal}}{3.785 \cancel{\text{L}}} \right) = \text{gal}$$

# Example Problem

**Step 5:** Multiply out all the numbers. This should cancel out the units you started with and take you to the units where you want to go. If applicable, express your answer with the correct number of significant figures. (We'll talk about this later on.)

You cannot use a calculator on the EXAM, so all the questions they give you will either involve simple arithmetic you can do without a calculator, OR they will be left as an un-simplified expression. In this case, for example, the correct multiple-choice answer might look like:

$$8.41 \times 10^6 / 3.785$$

# Converting Between Mass and Volume

Just so you know, to convert between *mass* and *volume*, we use *density*:

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

# Questions

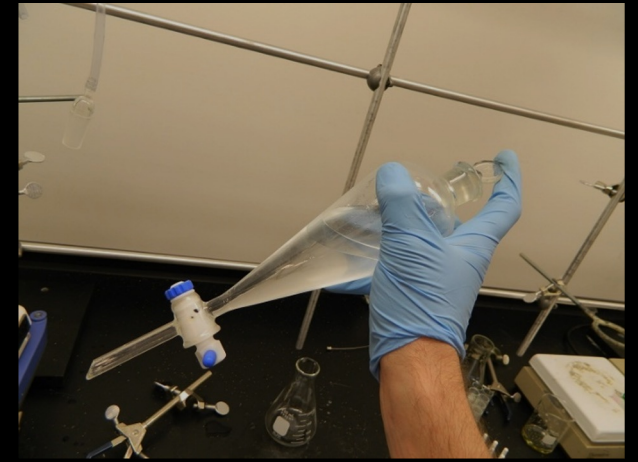
- How many seconds are in a day?
- How many hours are in a year?
- How many kg are there in  $7 \times 10^{25} \mu\text{g}$ ?
- How many sec are there in  $5.2 \times 10^{18} \text{ ns}$ ?
- Please convert 20 km to cm.
- If you're going 50 miles/hour, how many feet/second are you traveling?

# Questions

- On average, hummingbirds fly at 30 miles/hour. Convert this speed to m/s. (Note: 1 m = 3.28 feet and 1 mile = 1.61 km.)
- The Brooklyn Bridge is 277 feet tall. Convert this to meters. (Note: 1 m = 3.28 feet.)
- In a vacuum, light travels at a speed of  $2.998 \times 10^8$  m/s. Convert this to miles per hour. (Note: 1 mile = 1.61 km.)

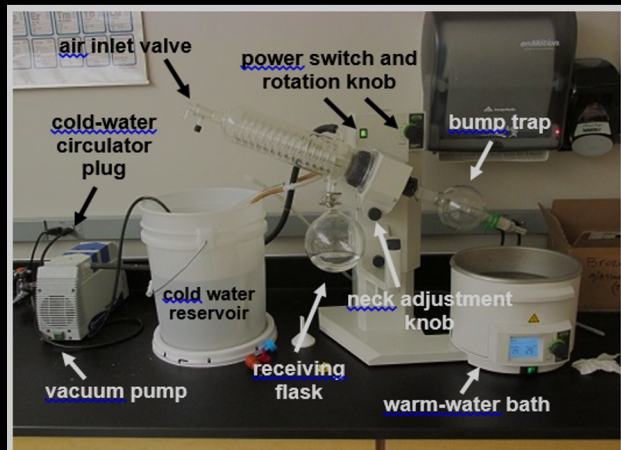
# Questions

- What is the mass in kilograms of 18.5 gallons of gasoline? (Note: the density of gasoline is 0.70 g/mL.)
- What is the density, in g/cm<sup>3</sup>, of a 1.5 kg cube whose edges are each 5 cm?
- The density of aluminum is 2.7 g/mL. What volume (in L) would a 50.2 g sample of aluminum occupy?



# Lab Concepts

## (Significant Figures and % Error)



# Significant Figures

There's always some uncertainty in the last integer of any measured value. When we take values that we've measured and then multiply, divide, add, or subtract them with each other, the uncertainties of each value compound together to make the final answer even more uncertain. To avoid this increased uncertainty, we follow special rules called *significant figure* rules.

# Significant Figures

To determine the number of significant figures in a value, read the number from left-to-right, starting with the first digit that's not zero. Then remember:

1. Zeroes between nonzero digits are always significant: 1005 kg (four sig-figs); 7.03 cm (three sig-figs).
1. Zeroes at the start of a number are never significant: 0.02 g (one sig-fig); 0.0026 cm (two sig-figs).
1. Zeroes at the end of a number are significant **only if** the zeroes are AFTER a decimal point: 0.0200 g (three sig-figs); 3.0 cm (two sig-figs).

# Significant Figures

When adding or subtracting values, your answer should have the same number of decimal places as the value that has the fewest decimal places. When the answer contains more than the correct number of significant figures, it must be rounded off.

When multiplying or dividing values, your answer should have the same number of significant figures as the value with the fewest significant figures. When the answer contains more than the correct number of significant figures, it has to be rounded off.

# Precision Versus Accuracy

**Precision** is how close a series of measurements are to each other. The closer they are, the “more precise” they are. The ***precision*** of a measurement is not the same as its ***accuracy***.

**Accuracy** is how close a measurement is to reality.



This archer is precise  
but not accurate.



This archer is precise  
*and* accurate.



This archer is imprecise  
and inaccurate.

# Percent Error Calculations

When conducting experiments, the values that we calculate usually differ slightly from the values we actually obtain or measure in the lab. The difference between calculation (theory) and reality is called ***percent error***. Similar to ***percent yield***, this is calculated as follows:

$$\% \text{ error} = \frac{(\text{actual} - \text{theoretical})}{\text{theoretical}} \times 100$$

# Questions

After carrying out the following operation, the reported value should have how many significant figures?

$$(6.943 \text{ cm} - 5.81 \text{ cm}) \times 3.23 \text{ cm}$$

A. 2

B. 3

C. 4

D. 5

E. 6

# Questions

Which measurement below contain 3 significant figures?

- I. 0.02 cm
- II. 1.32 mL
- III. 0.000500 kg

- A. I and II
- B. I and III
- C. II and III**
- D. II only
- E. I, II, and III

# Questions

Which of the following has the same number of significant figures as the number 1.00310?

A.  $5 \times 10^6$

B. 299.782

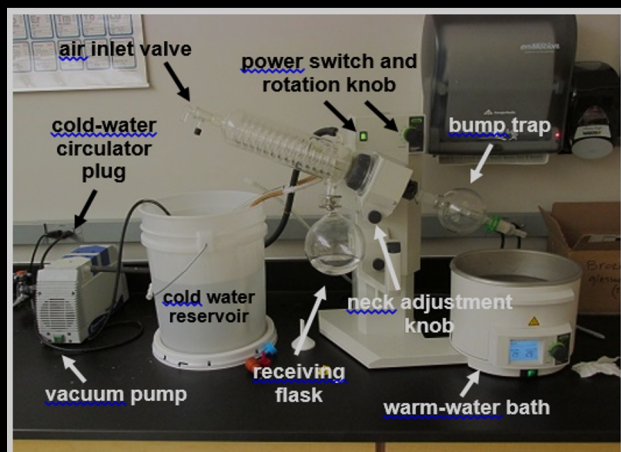
C. 7.92

D. 9.234

E. 300



# Lab Concepts (Basic Lab Safety)



# The Basics

If you encounter any safety questions on the EXAM, the best strategy is to just use common sense. In the lab:

- Always wear proper personal protective equipment (ppe): a lab coat, safety glasses or goggles, and lab gloves.
- Don't run around naked.
- Don't hide things.
- Don't endanger other people

# How to Properly Heat a Test Tube

To safely heat a test tube:

- Use a test tube holder, not your hand.
- Heat the test tube using a water bath, not an open flame

# How to Properly Heat a Test Tube

Insert footage of:

- Heating a test tube using holder
- Heating a test tube using my hand
- Heating a test tube using a water bath
- Heating a test tube using an open flame

# How to Properly Dilute a Strong Acid

To safely dilute a strong acid:

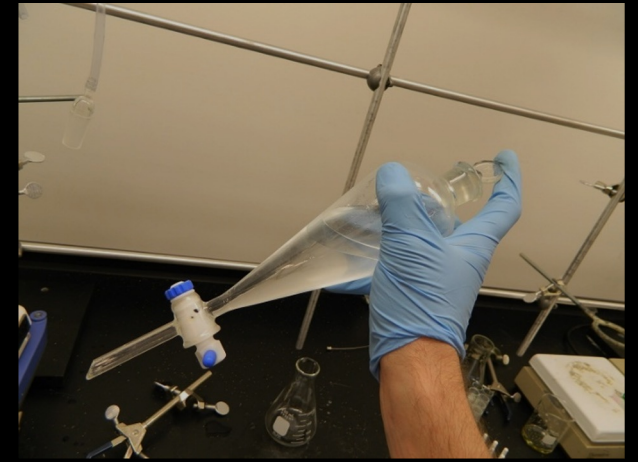
- Always ADD THE ACID TO WATER, not the other way around.

The reason is because when a strong acid dissolves in water, the process is very **exothermic**, so it produces a lot of heat. If you add acid to the water, the water can help disperse this heat. If you add water to the acid, the acid spatters everywhere.

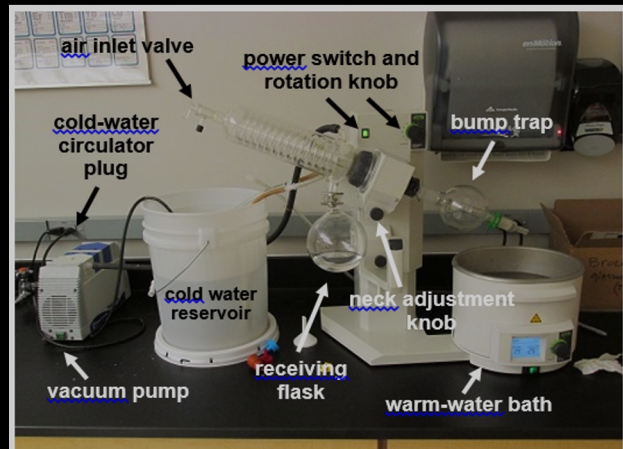
# How to Properly Heat a Test Tube

Insert footage of:

- Adding acid to water
- Adding water to acid (with spattering)



# Lab Concepts (Weights, Measures, and pH)



# Weighing or Measuring Dry Reagents

When weighing things using a lab balance or scale, be sure to weigh your sample on a weigh paper. (Tip: you need to first **tare**, or pre-weigh separately, the weigh paper in order to get an accurate measurement.)

How do you properly transfer a powdered reagent from its bottle to your weigh paper?

**Answer:** To avoid contamination, never stick your measuring spoon into the bottle! Instead, pour some of the reagent onto a separate weigh paper and then transfer it in portions, as needed. Also, to avoid contamination, do NOT pour the excess reagent back into the bottle.

# **Weighing or Measuring Dry Reagents**

Get footage of:

- Taring a weigh paper
- Sticking a measuring spoon into a bottle
- Pouring some of the reagent onto a separate weigh paper
- Transferring it in portions onto the weigh paper on the balance
- Pouring the excess reagent back into the bottle

# Measuring Liquid Reagents

Certain liquids –especially water– form a curved bottom along their upper surface when poured into a graduated cylinder. This curved bottom is called a ***meniscus***.

Thus, when measuring liquid reagents like water by pouring them into a graduated cylinder, we must read the graduated cylinder correctly by reading the center-bottom of the curved ***meniscus*** as the true reading, not the raised sides.

Errors in misreading your liquid's volume, when caused by looking at the liquid from an indirect angle, are called ***parallax errors***.

# Using a pH Meter

When using a *pH meter*, or *pH probe* (same thing):

- Calibrate the probe by using calibrated buffers. We usually use a calibrated buffer of pH 4 and pH 10.
- Rinse the pH probe with deionized water in-between samples.
- Also, be sure to dab the probe dry so you don't throw off the measurement.