

# The Chemistry Side

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## The Basics

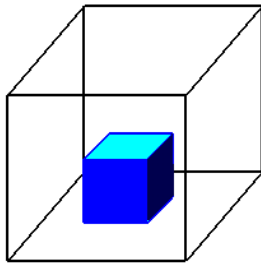
- ▶ **Matter** is anything that occupies space and has mass.
- ▶ Matter has physical properties and chemical properties.
- ▶ The physical properties of matter are:
  - ▶ Volume, mass, melting point, Color, electrical conductivity, magnetic ,density
- ▶ The chemical properties – any of chemical reaction that is possible with the substance.
- ▶ A chemical property is observed through a change of the substance.
- ▶ A physical property is observed with no change of the substance.
- ▶ **Mass** is the quantity of matter an object has.

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# States of Matter

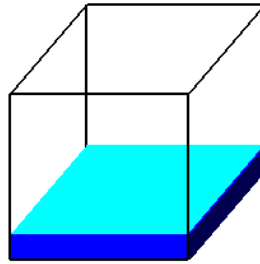
Glenn  
Research  
Center



## Solid

Holds Shape

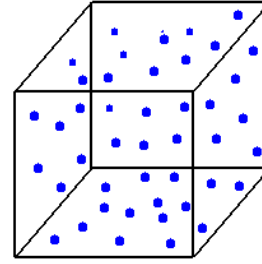
Fixed Volume



## Liquid

Shape of Container  
Free Surface

Fixed Volume



## Gas

Shape of Container

Volume of Container

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## Pure Groups

- ▶ **Elements** are made of a single kind of **atom** and cannot be broken down by chemical means into simpler substances.
- ▶ Atoms are composed of protons, neutrons, and electrons.
  - Protons = Positive; In the Nucleus
  - Neutrons = Neutral; In the Nucleus
  - Electrons = Negative; Orbitals outside the Nucleus

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# The Center

- ▶ **The Nucleus**
  - Protons and neutrons make up the **nucleus** of the atom. element pocesses
- ▶ The Atomic Number refers to the number of protons an element has (always remember # Protons= # of Electrons)
- ▶ The protons and Neutrons compose the mass of an atom. Atomic Mass is determined by the following equation=
  - ▶ Protons + Neutrons = Atomic Mass

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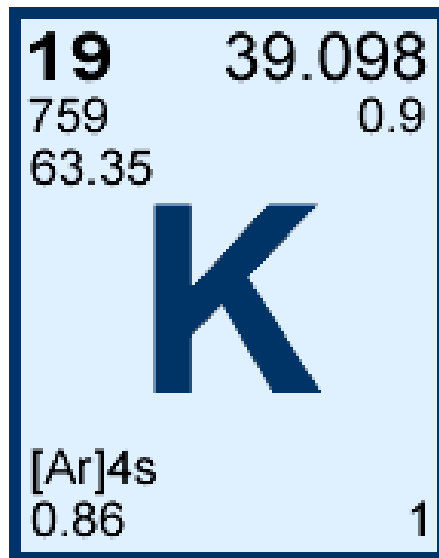
## PERIODIC TABLE OF THE ELEMENTS

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|  |                                       |  |  |   |   |   |  |   |   |  |  |   |                                       |  |  |   |  |                                    |
|--|---------------------------------------|--|--|---|---|---|--|---|---|--|--|---|---------------------------------------|--|--|---|--|------------------------------------|
| 1A<br>1                                |                                       |  |  |   |   |   |  |   |   |  |  |   |                                       |  |  |   | 8A<br>18                               |                                    |
| 1<br><b>H</b><br>Hydrogen<br>1.00794   |                                       |  |  |   |   |   |  |   |   |  |  |   |                                       |  |  |   | 2<br><b>He</b><br>Helium<br>4.002602   |                                    |
| 2A<br>2                                | 3<br><b>Li</b><br>Lithium<br>6.941    | 4<br><b>Be</b><br>Beryllium<br>9.01218   |  |   |   |   |  |   |   |  |  |   | 5<br><b>B</b><br>Boron<br>10.811      | 6<br><b>C</b><br>Carbon<br>12.011        | 7<br><b>N</b><br>Nitrogen<br>14.0067   | 8<br><b>O</b><br>Oxygen<br>15.9994      | 9<br><b>F</b><br>Fluorine<br>18.998403 | 10<br><b>Ne</b><br>Neon<br>20.1797 |
| 3<br><b>Na</b><br>Sodium<br>22.98977   | 4<br><b>Mg</b><br>Magnesium<br>24.305 |  |  |   |   |   |  |   |   |  |  | 13<br><b>Al</b><br>Aluminum<br>26.98154 | 14<br><b>Si</b><br>Silicon<br>28.0855 | 15<br><b>P</b><br>Phosphorus<br>30.97376 | 16<br><b>S</b><br>Sulfur<br>32.066     | 17<br><b>Cl</b><br>Chlorine<br>35.453   | 18<br><b>Ar</b><br>Argon<br>39.948     |                                    |
| 3B                                     | 4B                                    | 5B                                       | 6B   | 7B  | 8B                                      |   |  |   |   |  | 1B                                       | 2B                                      | 3A                                    | 4A                                       | 5A                                     | 6A                                      | 7A                                     |                                    |
| 11<br><b>K</b><br>Potassium<br>39.0983 | 12<br><b>Ca</b><br>Calcium<br>40.078  | 21<br><b>Sc</b><br>Scandium<br>44.9559   | 22<br><b>Ti</b><br>Titanium<br>47.88       | 23<br><b>V</b><br>Vanadium<br>50.9415       | 24<br><b>Cr</b><br>Chromium<br>51.9961  | 25<br><b>Mn</b><br>Manganese<br>54.9380 | 26<br><b>Fe</b><br>Iron<br>55.847      | 27<br><b>Co</b><br>Cobalt<br>58.9332    | 28<br><b>Ni</b><br>Nickel<br>58.9334      | 29<br><b>Cu</b><br>Copper<br>63.546      | 30<br><b>Zn</b><br>Zinc<br>65.39         | 31<br><b>Ga</b><br>Gallium<br>69.723    | 32<br><b>Ge</b><br>Germanium<br>72.63 | 33<br><b>As</b><br>Arsenic<br>74.9216    | 34<br><b>Se</b><br>Selenium<br>78.96   | 35<br><b>Br</b><br>Bromine<br>79.904    | 36<br><b>Kr</b><br>Krypton<br>83.80    |                                    |
| 37<br><b>Rb</b><br>Rubidium<br>85.4678 | 38<br><b>Sr</b><br>Strontium<br>87.62 | 39<br><b>Y</b><br>Yttrium<br>88.9059     | 40<br><b>Zr</b><br>Zirconium<br>91.224     | 41<br><b>Nb</b><br>Niobium<br>92.9064       | 42<br><b>Mo</b><br>Molybdenum<br>95.94  | 43<br><b>Tc</b><br>Technetium<br>[98]   | 44<br><b>Ru</b><br>Ruthenium<br>101.07 | 45<br><b>Rh</b><br>Rhodium<br>102.9055  | 46<br><b>Pd</b><br>Palladium<br>106.42    | 47<br><b>Ag</b><br>Silver<br>107.8682    | 48<br><b>Cd</b><br>Cadmium<br>112.411    | 49<br><b>In</b><br>Indium<br>114.82     | 50<br><b>Sn</b><br>Tin<br>118.710     | 51<br><b>Sb</b><br>Antimony<br>121.757   | 52<br><b>Te</b><br>Tellurium<br>127.60 | 53<br><b>I</b><br>Iodine<br>126.9054    | 54<br><b>Xe</b><br>Xenon<br>131.29     |                                    |
| 55<br><b>Cs</b><br>Cesium<br>132.9054  | 56<br><b>Ba</b><br>Barium<br>137.327  | 57<br><b>La</b><br>Lanthanum<br>138.9055 | 71<br><b>Hf</b><br>Hafnium<br>178.49       | 72<br><b>Ta</b><br>Tantalum<br>180.9479     | 73<br><b>W</b><br>Tungsten<br>183.85    | 74<br><b>Re</b><br>Rhenium<br>186.207   | 75<br><b>Os</b><br>Osmium<br>190.2     | 76<br><b>Ir</b><br>Iridium<br>192.22    | 77<br><b>Pt</b><br>Platinum<br>195.08     | 78<br><b>Au</b><br>Gold<br>196.9665      | 79<br><b>Hg</b><br>Mercury<br>200.59     | 81<br><b>Tl</b><br>Thallium<br>204.3833 | 82<br><b>Pb</b><br>Lead<br>207.2      | 83<br><b>Bi</b><br>Bismuth<br>208.9804   | 84<br><b>Po</b><br>Polonium<br>[209]   | 85<br><b>At</b><br>Astatine<br>[210]    | 86<br><b>Rn</b><br>Radon<br>[222]      |                                    |
| 87<br><b>Fr</b><br>Francium<br>[223]   | 88<br><b>Ra</b><br>Radium<br>226.0254 | 89<br><b>Ac</b><br>Actinium<br>227.0278  | 104<br><b>Rf</b><br>Rutherfordium<br>[261] | 105<br><b>Db</b><br>Dubnium<br>[262]        | 106<br><b>Sg</b><br>Seaborgium<br>[263] | 107<br><b>Bh</b><br>Bohrium<br>[264]    | 108<br><b>Hs</b><br>Hassium<br>[265]   | 109<br><b>Mt</b><br>Meitnerium<br>[266] | 110<br><b>Ds</b><br>Darmstadtium<br>[269] | 111<br><b>Rg</b><br>Roentgenium<br>[271] | 112<br><b>Cn</b><br>Copernicium<br>[277] |   |                                       |  |  |   |  |                                    |
| *Lanthanide Series                     |                                       |  | 58<br><b>Ce</b><br>Cerium<br>140.115       | 59<br><b>Pr</b><br>Praseodymium<br>140.9077 | 60<br><b>Nd</b><br>Neodymium<br>144.24  | 61<br><b>Pm</b><br>Promethium<br>[145]  | 62<br><b>Sm</b><br>Samarium<br>150.36  | 63<br><b>Eu</b><br>Europium<br>151.965  | 64<br><b>Gd</b><br>Gadolinium<br>157.25   | 65<br><b>Tb</b><br>Terbium<br>158.9254   | 66<br><b>Dy</b><br>Dysprosium<br>162.50  | 67<br><b>Ho</b><br>Holmium<br>164.9303  | 68<br><b>Er</b><br>Erbium<br>167.26   | 69<br><b>Tm</b><br>Thulium<br>168.9342   | 70<br><b>Yb</b><br>Ytterbium<br>173.04 | 71<br><b>Lu</b><br>Lutetium<br>174.967  |  |                                    |
| † Actinide Series                      |                                       |  | 90<br><b>Th</b><br>Thorium<br>232.0381     | 91<br><b>Pa</b><br>Protactinium<br>231.0369 | 92<br><b>U</b><br>Uranium<br>238.02891  | 93<br><b>Np</b><br>Neptunium<br>237.048 | 94<br><b>Pu</b><br>Plutonium<br>[244]  | 95<br><b>Am</b><br>Americium<br>[243]   | 96<br><b>Cm</b><br>Curium<br>[247]        | 97<br><b>Bk</b><br>Berkelium<br>[247]    | 98<br><b>Cf</b><br>Californium<br>[251]  | 99<br><b>Es</b><br>Einsteinium<br>[252] | 100<br><b>Fm</b><br>Fermium<br>[257]  | 101<br><b>Md</b><br>Mendelevium<br>[258] | 102<br><b>No</b><br>Nobelium<br>[259]  | 103<br><b>Lr</b><br>Lawrencium<br>[260] |  |                                    |

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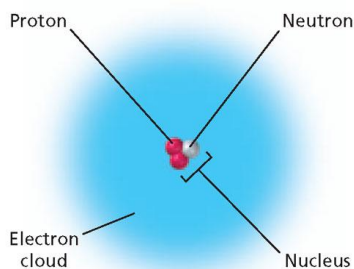
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## Outside

- **Electrons** move about the nucleus in orbitals.
- An **orbital** is a three-dimensional region around a nucleus that indicates the probable location of an electron.

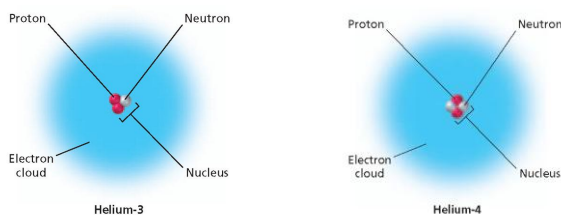


**Helium-3**  
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# Neutral Variation

## ▶ Isotopes

- Atoms of the same element that have a different number of neutrons are called **isotopes**.



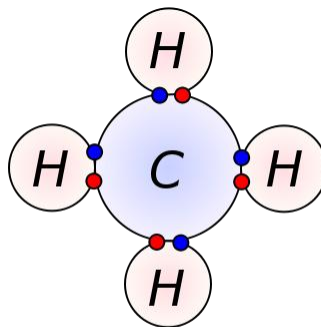
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- ▶ **Compounds** consist of atoms of two or more elements that are joined by chemical bonds in a fixed proportion.
  - Types of Bonds
    - Ionic
    - Covalent

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## Sharing

- A **covalent bond** is formed when two atoms share electrons.

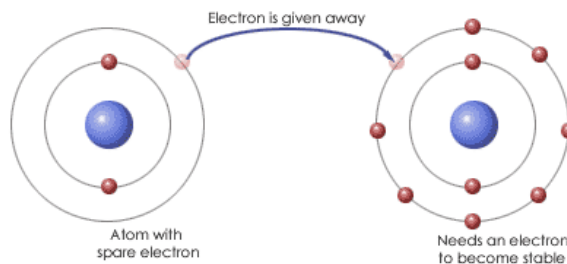


- Electron from hydrogen
- Electron from carbon

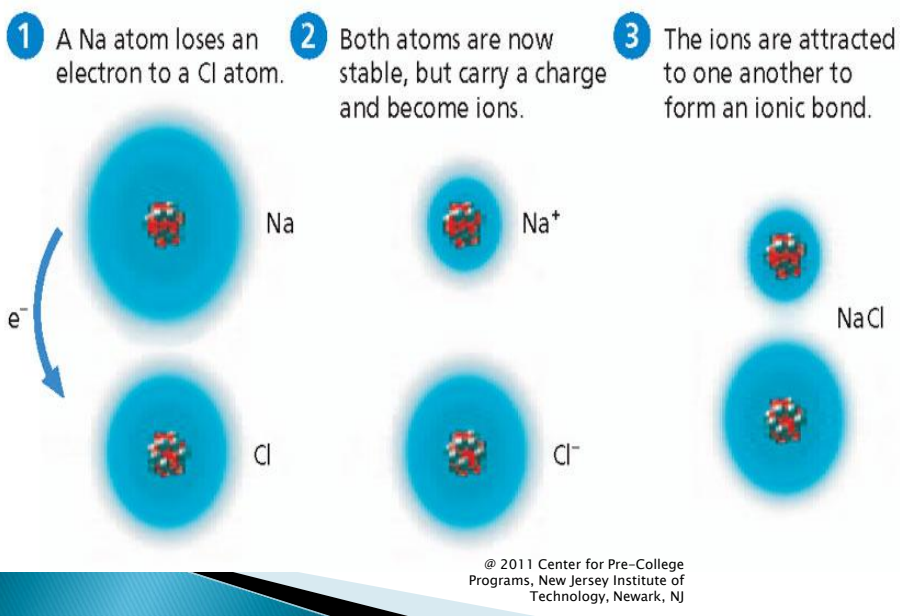
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## Stealing

- An **ionic bond** is formed when one atom gives up an electron to another. The positive ion is then attracted to a negative ion to form the ionic bond.



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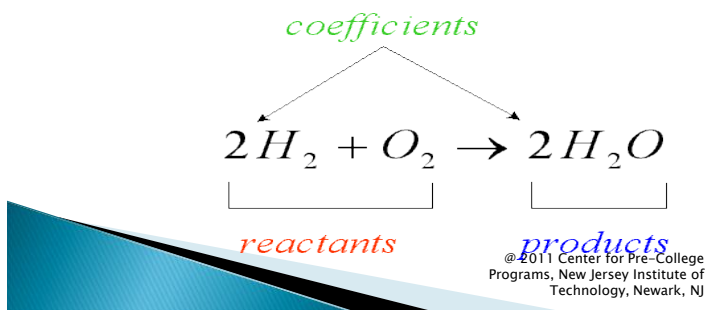


## Energy

- ▶ Energy comes in many forms
  - Potential
  - Kinetic
  - Chemical
  - Heat
  - Light
  - Sound

# Chemical Reactions

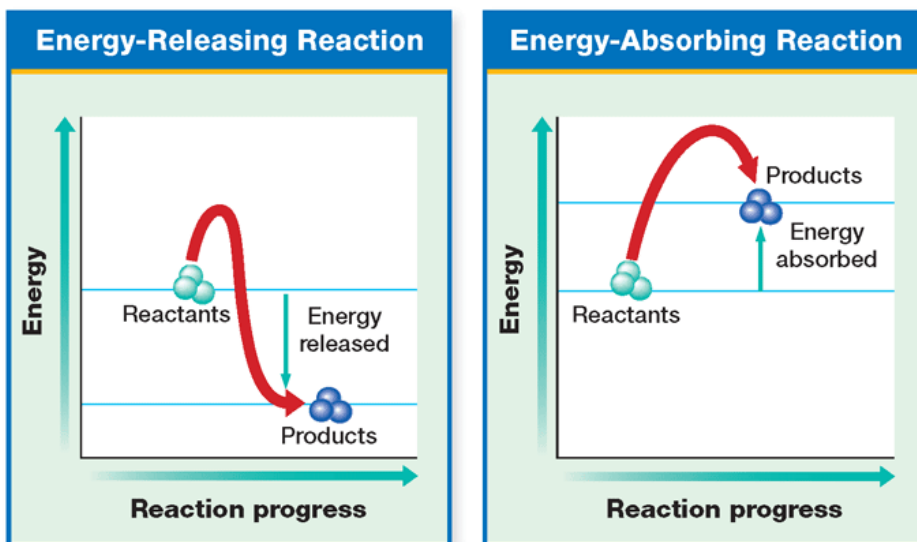
- **Reactants** are substances that enter chemical reactions.
- **Products** are substances produced by chemical reactions.



# Activation Energy

- ▶ Activation energy is the energy needed to start a reaction
- ▶ Once activated, energy can either be released or used
- ▶ This is illustrated through the use of an energy diagram





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## Water

- Water is considered to be a **polar** molecule due to an uneven distribution of charge.
- The electrons in a water molecule are shared unevenly between hydrogen and oxygen.

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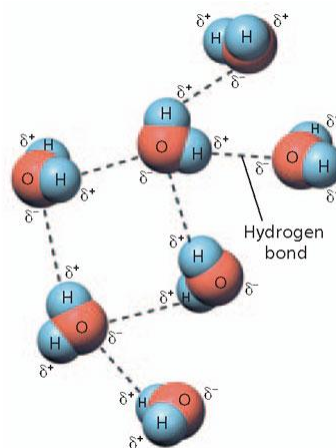
# Mixing

- **Solubility of Water**
  - The polarity of water makes it effective at dissolving other polar substances such as sugars, ionic compounds, and some proteins.

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# More Bonds


- A **hydrogen bond** is the force of attraction between a hydrogen molecule with a partial positive charge and another atom or molecule with a partial or full negative charge.



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# You To Me?


- **Cohesion and Adhesion**
  - **Cohesion** is an attractive force that holds molecules of a single substance together, such as water molecules.
  - **Adhesion** is the attractive force between two particles of different substances, such as water molecules and glass molecules.



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## Acids and Bases

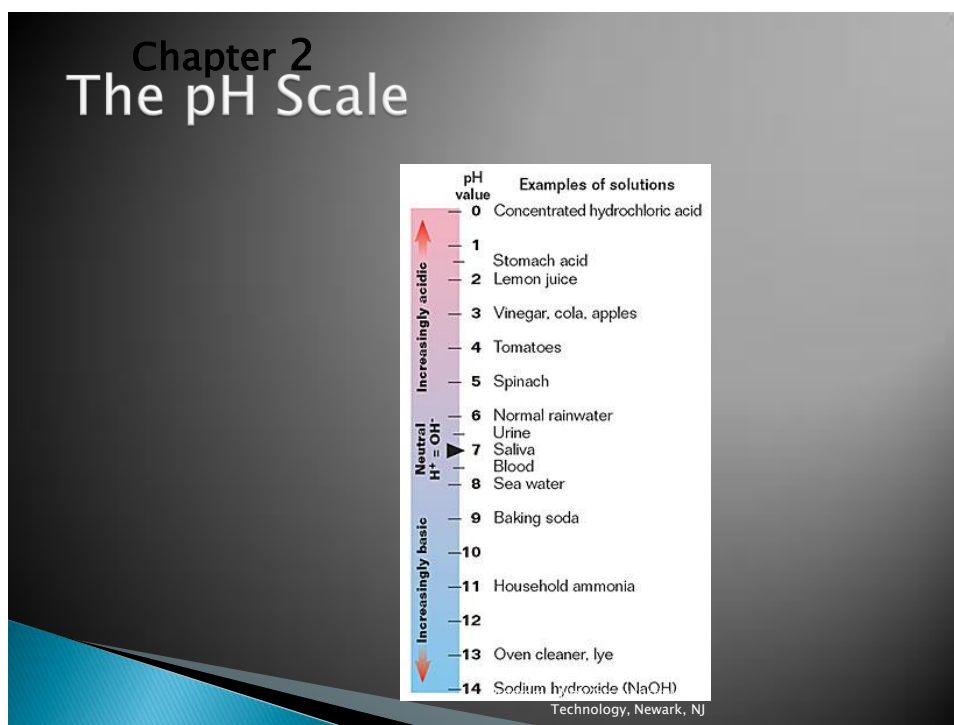
- **Ionization of Water**
  - Water ionizes into **hydronium ions** ( $\text{H}_3\text{O}^+$ ) and **hydroxide ions** ( $\text{OH}^-$ ).
- **Acids**
  - **Acidic solutions** contain more hydronium ions than hydroxide ions.
- **Bases**
  - **Basic solutions** contain more hydroxide ions than hydronium ions.




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- pH
  - Scientists have developed a scale for comparing the relative concentrations of hydronium ions and hydroxide ions in a solution. This scale is called the pH scale, and it ranges from 0 to 14.

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- **Buffers**
  - **Buffers** are chemicals that neutralize the effects of adding small amounts of either an acid or a base to a solution.



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