

Chapter 3: Chemical Compounds

Sept 7, 2022

Chemistry Department, Cypress College

Class Announcements

- Inputted grades for up to the quiz
- When uploading assignments, be certain that the file is in a readable format e.g. docx, png, jpeg, and pdf
- Everyone performed pretty well on the quiz; average 4.1 and standard deviation 0.84
- This week only, any late assignments will not be penalized 50%; submit late assignments by the Sept 7th at 11:59pm

Lecture and Lab Weekly Agenda

Lab Section

- Finish Exp 1 - Laboratory Techniques
- There is no need to cut glassware and fire polishing
- Be familiarize with evaporation and filtration techniques
- Submit the lab worksheet due Sept 14 at 11:59pm; 50% late penalty

Lecture Section

- Go over homework assignment; present your work for 1pt EC
- Review Ch 2 - Atoms, Ions, and the Periodic Table
- Begin lecture on Ch 3 - Chemical Compounds and Ch 8.1 - 8.2 - Types of Bonding

Review: Chapter 2 Highlights

Ionic and Molecular Compounds

Monatomic and Polyatomic Ions

Formulas for Ionic Compounds

Naming and Writing Formulas

Ionic Compounds

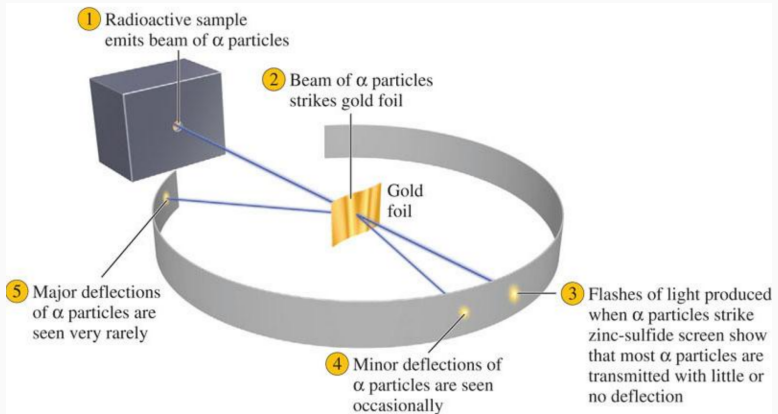
Molecular Compounds

Acids and Bases

Atoms and Ions

- Conservation of mass and conservation of energy
- Anions (gain electron) and cations (lose electron)
- Made up of protons, neutrons, and electrons

J.J. Thompson's Plum Pudding Model



Review: Modern Period Table

<div> <div>32</div> <div>Ge</div> <div>Germanium</div> <div>72.630</div> </div> <div> <div>Series</div> <div>Write-up</div> <div>State at</div> <div>Weight</div> <div>Energy levels</div> <div>Electronegativity</div> <div>Melting point</div> <div>Boiling point</div> <div>Electron affinity</div> <div>Ionization, 1st</div> <div>Radius, calculated</div> <div>Hardness, Brinell</div> <div>Modulus, bulk</div> <div>Density, STP</div> <div>Conductivity, thermal</div> </div> <div> <div>Metalloids</div> <div>Germanium</div> <div>Wikipedia</div> <div>0 °C</div> <div>°C</div> <div>Solid</div> <div>72.63 u</div> <div>2, 8, 18, 4</div> <div>2.01</div> <div>938.25 °C</div> <div>2,820 °C</div> <div>119 kJ/mol</div> <div>762 kJ/mol</div> <div>125 pm</div> <div>N/A MPA</div> <div>N/A GPa</div> <div>5,323 kg/m³</div> <div>60 W/(m·K)</div> </div>		<div>Temperature</div> <div> <div>—</div> <div></div> <div>+</div> </div> <div>0 °C</div> <div>32 °F</div> <div>273 °K</div>																	
		<div>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18</div> <div> <div>1 H Hydrogen 1.008</div> <div>2 He Helium 4.0026</div> <div>3 Li Lithium 6.94</div> <div>4 Be Beryllium 9.0122</div> <div>5 B Boron 10.81</div> <div>6 C Carbon 12.011</div> <div>7 N Nitrogen 14.007</div> <div>8 O Oxygen 15.999</div> <div>9 F Fluorine 18.998</div> <div>10 Ne Neon 20.180</div> <div>11 Na Sodium 22.990</div> <div>12 Mg Magnesium 24.305</div> <div>13 Al Aluminum 26.982</div> <div>14 Si Silicon 28.085</div> <div>15 P Phosphorus 30.974</div> <div>16 S Sulfur 32.06</div> <div>17 Cl Chlorine 35.45</div> <div>18 Ar Argon 39.948</div> <div>19 K Potassium 39.098</div> <div>20 Ca Calcium 40.078</div> <div>21 Sc Scandium 44.956</div> <div>22 Ti Titanium 47.867</div> <div>23 V Vanadium 50.942</div> <div>24 Cr Chromium 51.996</div> <div>25 Mn Manganese 54.938</div> <div>26 Fe Iron 55.845</div> <div>27 Co Cobalt 58.933</div> <div>28 Ni Nickel 58.693</div> <div>29 Cu Copper 63.546</div> <div>30 Zn Zinc 65.38</div> <div>31 Ga Gallium 69.723</div> <div>32 Ge Germanium 72.630</div> <div>33 As Arsenic 74.922</div> <div>34 Se Selenium 78.971</div> <div>35 Br Bromine 79.904</div> <div>36 Kr Krypton 83.798</div> <div>37 Rb Rubidium 85.468</div> <div>38 Sr Strontium 87.62</div> <div>39 Y Yttrium 88.906</div> <div>40 Zr Zirconium 91.224</div> <div>41 Nb Niobium 92.906</div> <div>42 Mo Molybdenum 95.94</div> <div>43 Tc Technetium 98</div> <div>44 Ru Ruthenium 101.07</div> <div>45 Rh Rhodium 106.42</div> <div>46 Pd Palladium 106.42</div> <div>47 Ag Silver 107.87</div> <div>48 Cd Cadmium 112.41</div> <div>49 In Indium 114.82</div> <div>50 Sn Tin 118.71</div> <div>51 Sb Antimony 121.76</div> <div>52 Te Tellurium 127.60</div> <div>53 I Iodine 126.90</div> <div>54 Xe Xenon 131.29</div> <div>55 Cs Cesium 132.91</div> <div>56 Ba Barium 137.33</div> <div>57-71 Lanthanides</div> <div>72 Hf Hafnium 178.49</div> <div>73 Ta Tantalum 180.95</div> <div>74 W Tungsten 183.84</div> <div>75 Re Rhenium 186.21</div> <div>76 Os Osmium 190.23</div> <div>77 Ir Iridium 192.22</div> <div>78 Pt Platinum 195.08</div> <div>79 Au Gold 196.97</div> <div>80 Hg Mercury 200.59</div> <div>81 Tl Thallium 204.38</div> <div>82 Pb Lead 207.2</div> <div>83 Bi Bismuth 208.98</div> <div>84 Po Polonium (209)</div> <div>85 At Astatine (210)</div> <div>86 Rn Radon (222)</div> <div>87 Fr Francium (223)</div> <div>88 Ra Radium (226)</div> <div>89-103 Actinides</div> <div>104 Db Dubnium (261)</div> <div>105 Ds Darmstadtium (265)</div> <div>106 Sg Seaborgium (266)</div> <div>107 Bh Bohrium (264)</div> <div>108 Hs Hassium (277)</div> <div>109 Mt Meitnerium (268)</div> <div>110 Ds Darmstadtium (271)</div> <div>111 Rg Roentgenium (272)</div> <div>112 Cn Copernicium (285)</div> <div>113 Nh Nihonium (284)</div> <div>114 Fl Flerovium (289)</div> <div>115 Mc Moscovium (288)</div> <div>116 Lv Livermorium (293)</div> <div>117 Ts Tennessine (294)</div> <div>118 Og Oganesson (294)</div> <div>57 La Lanthanum 138.91</div> <div>58 Ce Cerium 140.12</div> <div>59 Pr Praseodymium 140.91</div> <div>60 Nd Neodymium 144.24</div> <div>61 Pm Promethium (145)</div> <div>62 Sm Samarium 150.36</div> <div>63 Eu Europium 151.96</div> <div>64 Gd Gadolinium 157.25</div> <div>65 Tb Terbium 158.93</div> <div>66 Dy Dysprosium 162.50</div> <div>67 Ho Holmium 164.93</div> <div>68 Er Erbium 167.26</div> <div>69 Tm Thulium 168.93</div> <div>70 Yb Ytterbium 173.05</div> <div>71 Lu Lutetium 174.97</div> <div>89 Ac Actinium (227)</div> <div>90 Th Thorium 232.04</div> <div>91 Pa Protactinium 231.04</div> <div>92 U Uranium 238.03</div> <div>93 Np Neptunium (237)</div> <div>94 Pu Plutonium (244)</div> <div>95 Am Americium (243)</div> <div>96 Cm Curium (247)</div> <div>97 Bk Berkeleium (247)</div> <div>98 Cf Californium (251)</div> <div>99 Es Einsteinium (252)</div> <div>100 Fm Fermium (257)</div> <div>101 Md Mendelevium (258)</div> <div>102 No Nobelium (259)</div> <div>103 Lr Lawrencium (260)</div> </div>																	
		<div> <div>Atomic Symbol</div> <div>Solid</div> <div>Liquid</div> <div>Gas</div> <div>Unknown</div> <div>Metals</div> <div>Alkali metals</div> <div>Alkaline earth metals</div> <div>Actinoids</div> <div>Lanthanoids</div> <div>Transition metals</div> <div>Post-transition metals</div> <div>Metalloids</div> <div>Nonmetals</div> <div>Reactive nonmetals</div> <div>Noble gases</div> </div>																	
		<div>For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.</div>																	

Relative Atomic Mass

$$\text{Relative Atomic Mass} = (I_1 \times A_1) + (I_2 \times A_2) + \dots \quad (1)$$

where I is the mass of the isotope, and A is the relative abundance between 0 and 1

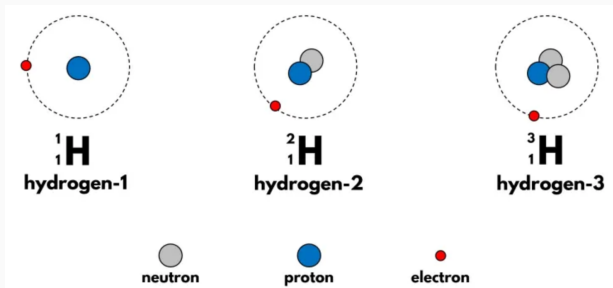
Defining Atomic Number and Mass



where A is the atomic mass, Z is the atomic number, X is atomic symbol, and C is the overall charge

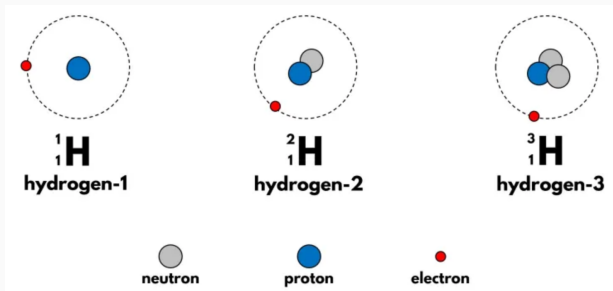
Isotopes - chemically same atom (same number of protons) but physically different (different number of neutrons)

Hydrogen Isotopes and Applications



- Hydrogen (${}^1_1\text{H}$), deuterium (${}^2_1\text{D}$), and tritium (${}^3_1\text{T}$)
- **Q:** Which hydrogen isotope is the highest in abundance?

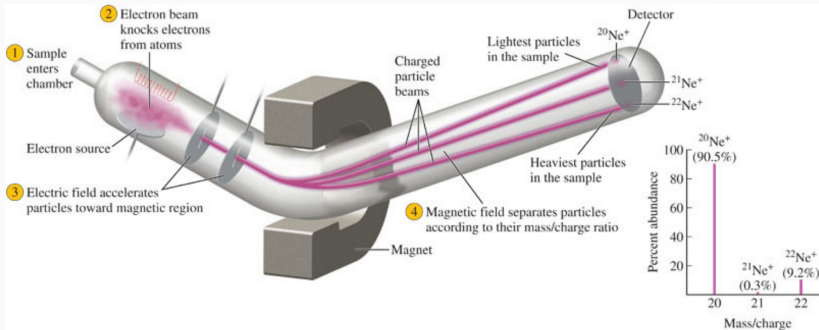
Hydrogen Isotopes and Applications



Applications

- Semiconductor production enhancing Si-H bond by preventing chemical erosion and Hot Carrier Effect
- Chemical labeling to track chemical reactions
- Medicinal chemistry - FDA approved the first deuterium-labeled drug (reference)

Experiment: Mass Spectroscopy



- Ionizes the atom and electric field accelerates atoms
- Time of flight - heavier atoms will travel slower than lighter ones
- Weighted average of atomic masses

Outline

Review: Chapter 2 Highlights

Ionic and Molecular Compounds

Monatomic and Polyatomic Ions

Formulas for Ionic Compounds

Naming and Writing Formulas

Ionic Compounds

Molecular Compounds

Acids and Bases

Ionic and Molecular Compounds

Ionic Compounds

- Consists of oppositely charged cations and anions such that the overall charge is neutral e.g $\text{CaCl}_2(\text{s})$, $\text{BaF}(\text{s})$, and $\text{Fe}_2\text{O}_3(\text{s})$
- Electrolyte - substances that separate into the ions e.g. $\text{NaCl}(\text{aq})$ dissociates into Na^+ and Cl^-
- Forms ionic bonds (purely electrostatic interactions)

Molecular Compounds

- Composed of atoms from two or more nonmetals
- Forms covalent bonds (sharing of electrons)

Properties of Ionic and Molecular Compounds

Introduction to Bonding

Ionic Bonding

- Electrons transferred from metal to nonmetal
- Ionized atoms and electrostatic interactions

Covalent Bonding (CB)

- Sharing of electrons between atoms (usually look at as pairs)
- Generally occurs between nonmetals in molecular elements, molecular compounds, and polyatomic ions

CB: Consideration of Electronegativity

Monatomic and Polyatomic Ions

Molecular Formulas for Ionic Compounds

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Formulas for Ionic Compounds

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Molecular Compounds

Acids and Bases

Naming Ionic Compounds

Naming Molecular Compounds

Definition of an Acid

Naming Acids and Bases