



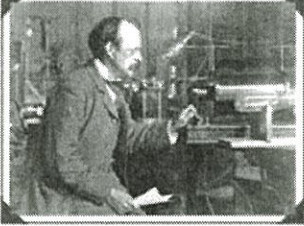
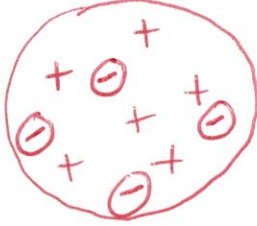

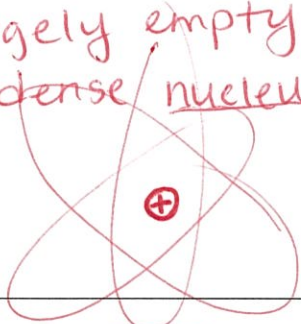

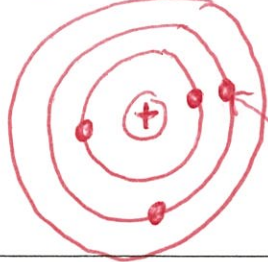

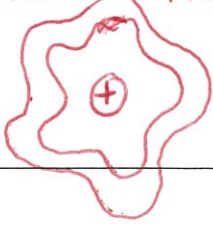


UNIT  
3.1

# History of the Atom

How has our understanding of the atom changed over time?

Scientist	Observations or experimental evidence for atomic model	Atomic Model Diagram
 Democritus ~ 440 B.C.	<p>n/a</p>	
 John Dalton ~ 1808	<p><math>H_2O \rightarrow O + H + H</math></p>	
 JJ Thomson ~ 1897	<p>Cathode ray tube experiment</p>	
 Ernest Rutherford ~ 1910	<p>Gold Foil Experiment</p>	<p>① largely empty space            ② ⊕ dense nucleus</p> 
 Niels Bohr ~ 1913	<p>atoms emitted specific amounts of energy</p>	 <p>planetary model            electrons move in orbits</p>
 Erwin Schrödinger ~ 1926	<p>electrons acted like waves &amp; particles</p>	<p>quantum model</p> 

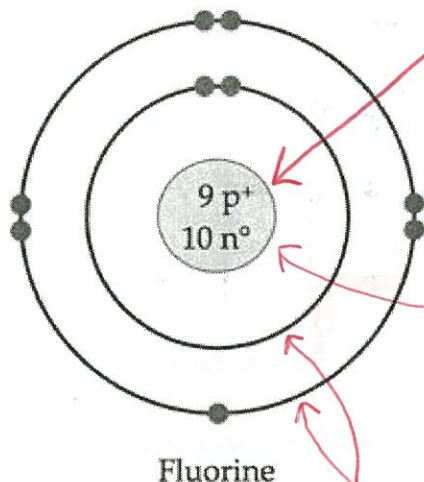


UNIT  
3.2

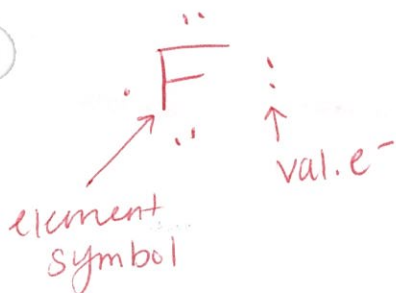
# Subatomic Particles

How are elements organized on the Periodic Table?

Bohr Model:



Lewis Dot Diagram:



### Key Information

Nucleus:

- contains protons & neutrons
- Responsible for the mass and radioactivity of the atom.

Atomic mass:

- The sum of protons + neutrons  
ex:  $10 + 9 = 19$

Atomic number:

- The number of protons in the nucleus.  
ex: 9
- Identifies the element.

Electron Shells:

2-7 (e<sup>-</sup> configuration)

- Orbit the nucleus; where electrons are found.
- Electrons in last shell:

VALENCE electrons

- Responsible for the chemical properties of an element

Subatomic Particle	Charge	Mass amu	Location	How to determine the # of this subatomic particle for a given atom
Proton	+1	1	nucleus	atomic #
Neutron	0	1	nucleus	atomic mass - atomic #
Electron	-1	0	orbiting nucleus	equal to the # of protons

Atoms on the Periodic Table are arranged in order of increasing

atomic number.



**Key**

- 11 — Atomic number
- Na — Element symbol
- Sodium — Element name
- 22.99 — Average atomic mass\*

\* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.

1 1A H Hydrogen 1.01	2 2A He Helium 4.00											13 3A B Boron 10.81	14 4A C Carbon 12.01	15 5A N Nitrogen 14.01	16 6A O Oxygen 16.00	17 7A F Fluorine 19.00	18 8A Ne Neon 20.18																											
3 Li Lithium 6.94	4 Be Beryllium 9.01											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95																											
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 9B	10 10B	11 11B	12 2B	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80																											
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29																											
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)																											
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59																																	
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)																																				
<table border="1"> <tr> <td>58 Ce Cerium 140.12</td> <td>59 Pr Praseodymium 140.91</td> <td>60 Nd Neodymium 144.24</td> <td>61 Pm Promethium (145)</td> <td>62 Sm Samarium 150.36</td> <td>63 Eu Europium 151.96</td> <td>64 Gd Gadolinium 157.25</td> <td>65 Tb Terbium 158.93</td> <td>66 Dy Dysprosium 162.50</td> <td>67 Ho Holmium 164.93</td> <td>68 Er Erbium 167.26</td> <td>69 Tm Thulium 168.93</td> <td>70 Yb Ytterbium 173.04</td> <td>71 Lu Lutetium 174.97</td> </tr> <tr> <td>90 Th Thorium 232.04</td> <td>91 Pa Protactinium 231.04</td> <td>92 U Uranium 238.03</td> <td>93 Np Neptunium (237)</td> <td>94 Pu Plutonium (244)</td> <td>95 Am Americium (243)</td> <td>96 Cm Curium (247)</td> <td>97 Bk Berkelium (247)</td> <td>98 Cf Californium (251)</td> <td>99 Es Einsteinium (252)</td> <td>100 Fm Fermium (257)</td> <td>101 Md Mendelevium (258)</td> <td>102 No Nobelium (259)</td> <td>103 Lr Lawrencium (262)</td> </tr> </table>																	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)
58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97																															
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)																															

Property	Metals	Nonmetals
Physical appearance <ul style="list-style-type: none"> <li>Shiny (Luster)</li> <li>Dull</li> </ul>	shiny	dull
Conductivity <ul style="list-style-type: none"> <li>Poor</li> <li>Good</li> </ul>	good	poor
Malleability <ul style="list-style-type: none"> <li>Malleable (can bend or flatten)</li> <li>Brittle (breaks easily)</li> </ul>	malleable	brittle
Reaction with acid <ul style="list-style-type: none"> <li>Does react</li> <li>Does not react</li> </ul>	does react	does NOT react

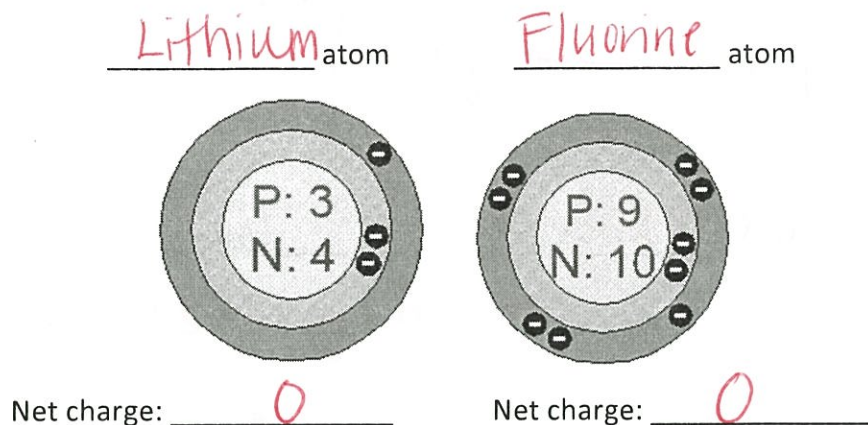
An element with characteristics of *both* metals and nonmetals is called a metalloid.

## Atoms and Ions

What happens to net charge when atoms gain or lose electrons?

Recall that the charge of a proton is +1 and the charge of an electron is -1.

The **net charge** represents the overall charge of the atom. It can be determined by subtracting the number of electrons from the number of protons.



Atoms are always NEUTRAL!

In your reflection from 3.2, you learned that atoms with 8 valence electrons are stable, and those who aren't will either gain or lose electrons to become stable. Let's use Lewis Dot Diagrams to demonstrate these changes.

When electrons are lost or gained, **net charge** changes, and the atom becomes an ion!

ATOM	Gain/lose electrons	ION
$\text{Li}$ #p: <u>3</u> #e: <u>3</u> Net charge: <u>0</u>	$\xrightarrow{\text{loses } 1 e^-}$	$[\text{Li}]^{+1}$ #p: <u>3</u> #e: <u>2</u> Net charge: <u>+1</u>
$\text{F}$ #p: <u>9</u> #e: <u>9</u> Net charge: <u>0</u>	$\xrightarrow{\text{gains } 1 e^-}$	$[\text{F}]^{-1}$ #p: <u>9</u> #e: <u>10</u> Net charge: <u>-1</u>



## Oxidation and Reduction

What happens to net charge when atoms gain or lose electrons?

To get from Al to  $\text{Al}^{3+}$ , what has to happen? the atom loses 3  $e^-$  to become an ion

- Draw a diagram:



- This is called: oxidation (charge goes up)

To get from  $\text{Cu}^{2+}$  to Cu, what has to happen? the ion gains 2  $e^-$  to become an atom

- Draw a diagram:



- This is called: reduction (charge goes down)

## SUMMARIZE:

Process	Change in Electrons	Change in Charge
Oxidation (oxidized)	losing	up
Reduction (reduced)	gaining	down



Losing electrons = Oxidation

Gaining electrons = Reduction

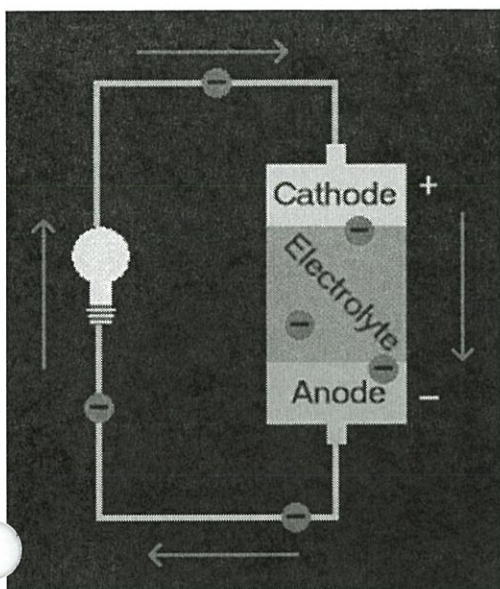
UNIT  
3.6

## Batteries

How do oxidation and reduction reactions power your cellphone?

Electricity is the flow of electrons through a conductive path like a wire. This path is called a *circuit*.

Batteries have three parts: (1) cathode (2) anode (3) electrolyte



The chemical reactions in the battery are a result of oxidation and reduction (aka redox):

Reduction occurs at the cathode

Oxidation occurs at the anode

Electrons travel through the wire from the anode to the cathode. The electrolyte prevents the electrons from going directly from anode to cathode.

The electrical current through the wire can power a variety of objects, such as a light bulb, cell phone, or laptop!

