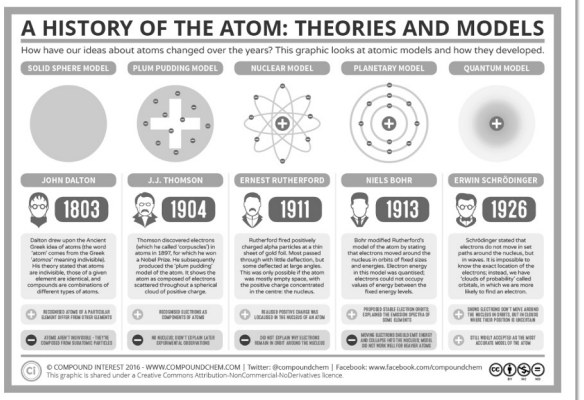
## Studying Matter…

All materials on earth and the universe are made of matter. In this unit we will study the basic underpinning of matter…

**The ATOM**




2

## Role of Subatomic Particles

The modern atomic model contains protons, electrons, and neutrons *(+, -, and neutral*)

### Protons

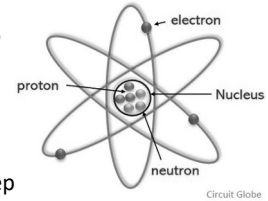
In nucleus (*center of atom*), identifies atom, keep electrons within the outer portion of the atom

### Electrons

Atomic communication, connection to other atoms, balancing protons in the atom

### Neutrons

Barrier between protons/electrons, sheilding




**Basic Structure of the Atom**

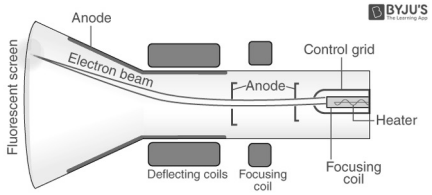
Includes electrons ($e^-$), protons (p+), and neutrons ($n^o$)

3

## Subatomic Particles

### Thomson's Cathode Ray Experiments

Thomson worked with Cathode "Canal" Rays in a vacuum to determine the energy and charge of $e^-$




Cathode Ray Tube Experiment

**Joseph John Thomson**

*English Chemist*

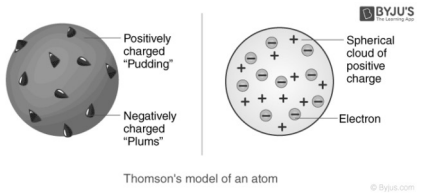
*1856 - 1940AD*

4

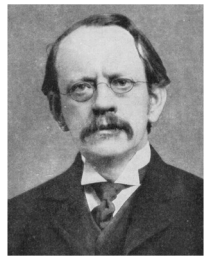
## Subatomic Particles

### Thomson's Plum Pudding Model

Thomson's discovery of the electron ($e^-$) lead to the *plum pudding model,* $e^-$ in an atom surrounded by a positive *matrix*




Thomson's model of an atom



**Joseph John Thomson**

*English Chemist*

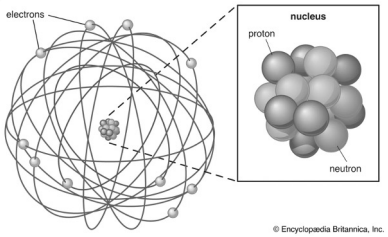
*1856 - 1940AD*

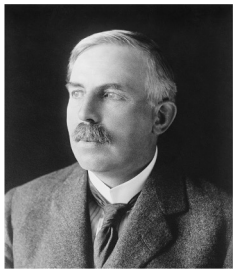
5

## Subatomic Particles

### Rutherford's Atomic Model

Strong positive center to the atom (*nucleus*) surrounded by negatively charged electrons ($e^-$)



**Earnest Rutherford**

*New Zealand Chemist*

*1871 - 1931AD*

6

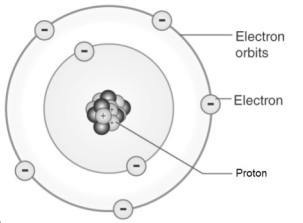
## Subatomic Particles

### Bohr's Atomic Model

$e^-$ travel in orbits around the center of the atom

**Atomic Orbits**

Pathways around nucleus $e^-$ travel in to maintain distance between other $e^-$ and keep $e^-$ and $p^+$ from colliding (*nucleus*)




Bohr atomic model of a Nitrogen atom

**Neil Bohr**

*Polish Chemist*

*1885 - 1962AD*

7

## Subatomic Particles

### Inner and Valence Electrons ($e^-$)

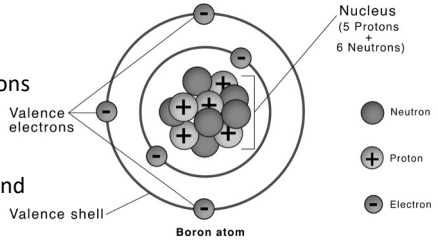
Electrons contain different roles within the atom

**Inner (*Shell*) Electrons**

Provide repulsive force (- to -) helping protect valence electrons

**Valence (*Outer*) Electrons**

Electrons that communicate (*transferred or shared*) and bond (*connect*) with other atoms



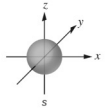

8

## Subatomic Particles

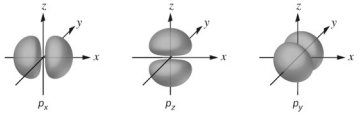
### Atomic Orbitals and Electron Filling

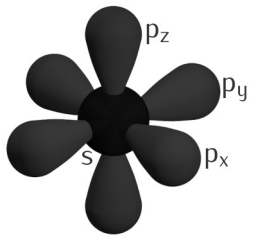
Orbitals are predicted electron locations around the atom to minimize electron repulsion in the orbitals.

0, 1 or 2 $e^-$ allowed per orbital




Electrons always fill one per suborbital before pairing together




**Overall Orbital Set**

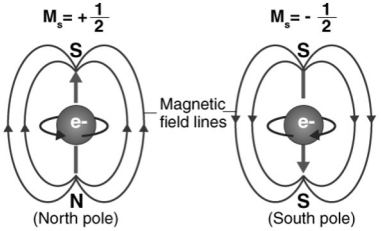
8 electrons fit within 4 orbitals in the s, $p_x$, $p_y$, $p_z$ orbital set

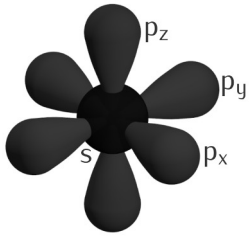
9

## Subatomic Particles

### Atomic Orbital Electron Spin

Within an orbital electrons spin in opposite directions (+1/2 and -1/2) to min. replusion




### Overall Orbital Set

8 electrons fit within 4 orbitals in the s, $p_x$, $p_y$, $p_z$ orbital set

10

## Subatomic Particles

### Counting Valence Electrons ($e^-$) [*Representative Groups*]

Valence Electrons are based on group on the table

| Group | Name | Val $e^-$ | Group | | Val $e^-$ |
|---|---|---|---|---|---|
| 1A (1) | Alkali Metals | 1 | 5A (15) | Pnictogens | 5 |
| 2A (2) | Alkali Earth Metals | 2 | 6A (16) | Chalcogens | 6 |
| 3A (13) | Earth Metals | 3 | 7A (17) | Halogens | 7 |
| 4A (14) | Carbon Group | 4 | 8A (18) | Noble Gases | 8 |

11

## Subatomic Particles

### Counting Valence Electrons ($e^-$) [*Transition Metals*]

Valence Electrons are based on group on the table

Transition Metals can have 1 – 7 valence electrons (*base 2*)

| Group | 3B (3) | 4B (4) | 5B (5) | 6B (6) | 7B (7) | 8B (8) | 8B (9) | 8B (10) | 1B (11) | 2B (12) |
|---|---|---|---|---|---|---|---|---|---|---|
| Element | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn |
| Possible Valence electron | 3 | 3<br>4 | 2<br>3<br>4<br>5 | 2<br>3<br>4<br>6 | 2<br>3<br>4<br>5<br>7 | 2<br>3<br>6 | 2<br>3 | 2<br>3 | 1<br>2<br>3 | 2 |

12