Early Models of the Atom

D\_\_\_\_\_

* Greek philosopher (460 – 370 BC) Coined the term “Atom”
* “Matter consists of discrete, \_\_\_\_\_ particles”.
* Democritus held a very general theory with \_\_\_\_\_ experimental evidence.
* Democritus’ ideas were rejected by Plato & Aristotle (*fathers of philosophy and ancient “scientific thinking”*) … & therefore, set aside.

D\_\_\_\_\_’s Atomic Theory (1808)

1. All \_\_\_\_\_ are composed of extremely small, \_\_\_\_\_ particles called "\_\_\_\_\_."

2. All atoms of the same element have the same \_\_\_\_\_ properties. Atoms of different elements have different properties.

3. In the course of an ordinary chemical reaction, no atom of one element disappears or is changed into an atom of another element.

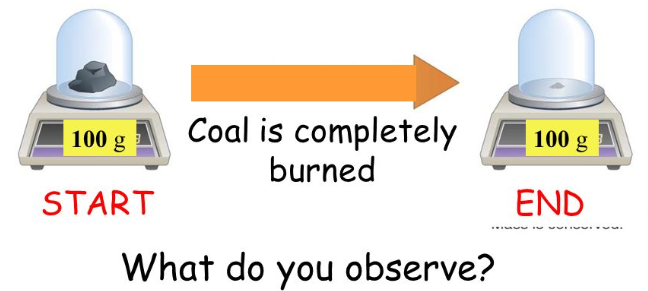
4. \_\_\_\_\_ are formed when atoms are joined together in simple, \_\_\_\_\_ -number \_\_\_\_\_ (*Law of “Multiple Proportions”)*.

Dalton’s Work - Forming Tin oxides

* Discovered that tin reacts with a \_\_\_\_\_ \_\_\_\_\_ of oxygen
* 100 g tin reacts with 27 g (SnO) or 13.5 g oxygen (SnO2) … [definite proportions]
* Oxygen is always consumed in a 1:2 ratio \_\_\_\_\_ the compounds (multiple proportions).
* Each tin atom can combine with one or two oxygen atoms. The atoms \_\_\_\_\_ combine in any other ratios.

The Law of \_\_\_\_\_ Of \_\_\_\_\_

* \_\_\_\_\_ cannot be created nor destroyed.
* There is \_\_\_\_\_ detectable change in \_\_\_\_\_ in an ordinary chemical reaction.
* All compounds/elements that react are just \_\_\_\_\_ their atoms.



Acrylic Tape (2 charges exist)

* In the first case you should have noticed “\_\_\_\_\_”
* In the second case, “\_\_\_\_\_”

Historical Overview

Benjamin Franklin

* Learned from experiments with thunderstorms, that lightning is a flow of \_\_\_\_\_ energy through the atmosphere.
* He arbitrarily decided that there must be “\_\_\_\_\_” … and called them charge “A” and charge “B”

E\_\_\_\_\_

* A \_\_\_\_\_ ray can also be deflected by a magnet.
* In 1897, JJ Thomson got the same result as \_\_\_\_\_ with any gas he used, which \_\_\_\_\_ Dalton’s assumption that all atoms are indivisible.
* He theorized the existence of a particle common to all atoms 🡪 using the charged plates on either side of the tube, he showed the particle was \_\_\_\_\_ charged.

The \_\_\_\_\_ \_\_\_\_\_ Model

* Thomson's \_\_\_\_\_ led to the proposal of a new atomic model, the plum pudding model.
* \_\_\_\_\_ floating in a \_\_\_\_\_ of positive charges
* Modification of Dalton’s model of a solid, \_\_\_\_\_ sphere
* Recognition of the existence of \_\_\_\_\_ and the \_\_\_\_\_ of the whole atom

\_\_\_\_\_’s Oil Drop Experiment

* Millikan repeatedly measured \_\_\_\_\_ between the \_\_\_\_\_ and \_\_\_\_\_ charged plates and found that they were always a multiple of 1.60 x 10-19 coulomb.
* Millikan called this the \_\_\_\_\_ on the electron.

Millikan’s Oil Drop Experiment

* Measured rate of fall of charged oil droplets
* Determined the \_\_\_\_\_ on an \_\_\_\_\_

Thomson’s experiment: mass-to-charge ratio for an electron

Together, Millikan’s and Thomson’s results allowed for the determination of the \_\_\_\_\_ and \_\_\_\_\_ of the \_\_\_\_\_.

Testing the Plum Pudding Model

* Ernest \_\_\_\_\_ developed an experiment to test the plum pudding model of JJ Thomson.
  + He shot \_\_\_\_\_ particles (+) at a thin sheet of gold foil.
  + \_\_\_\_\_ particles are detected at various angles.
* Rutherford’s Results: Discovery of the \_\_\_\_\_
  + \_\_\_\_\_ particles pass straight through gold foil (99%)
  + A \_\_\_\_\_ particles \_\_\_\_\_ at very large angles ???

Conclusions:

* Atom: mostly \_\_\_\_\_ space
* \_\_\_\_\_ charge is concentrated in small, \_\_\_\_\_ region (\_\_\_\_\_)
* Volume of nucleus: \_\_\_\_\_; mass: l\_\_\_\_\_ arge

Led to the Initial *Planetary* Model of the Atom 🡪 Dense, \_\_\_\_\_ nucleus of atom \_\_\_\_\_ by \_\_\_\_\_.

P\_\_\_\_\_

* In 1886, Eugen \_\_\_\_\_ (1850–1930) observed a cathode-ray tube to discover a new particle.
* Protons were originally called “\_\_\_\_\_ rays” in the CRT, electrons were called “cathode rays”
* “Canal Rays” responded \_\_\_\_\_ to the “cathode rays” (electrons) indicating an opposite \_\_\_\_\_.

N\_\_\_\_\_

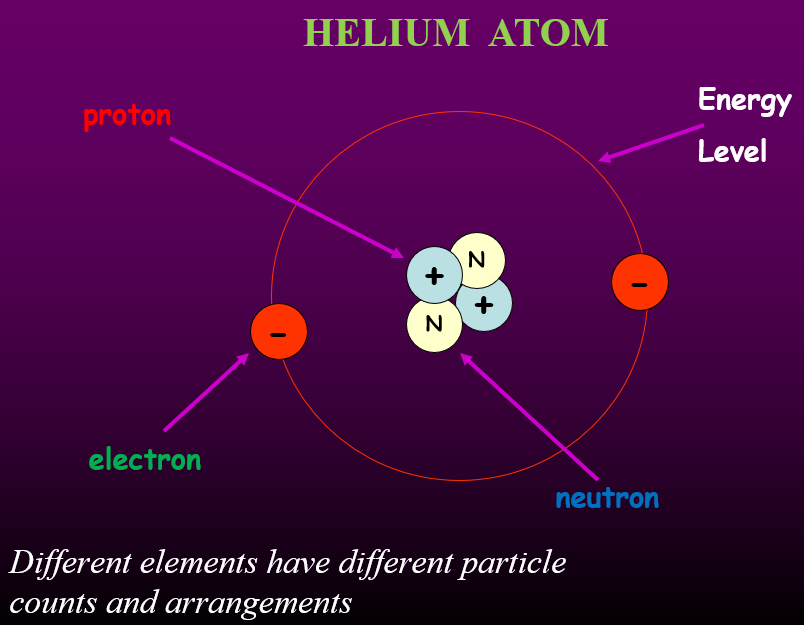
* Physicist James \_\_\_\_\_ (1891–1974) confirmed the existence of yet another subatomic particle: the neutron.
  + Chadwick bombarded Beryllium with alpha particles and found a new particle was released
  + \_\_\_\_\_ charge (*did not deflect under electric or magnetic field influence*)
  + Essentially the same \_\_\_\_\_ as the \_\_\_\_\_
  + Highly penetrable particle (*could penetrate 10-20 cm into lead*)

A\_\_\_\_\_ M\_\_\_\_\_ Unit

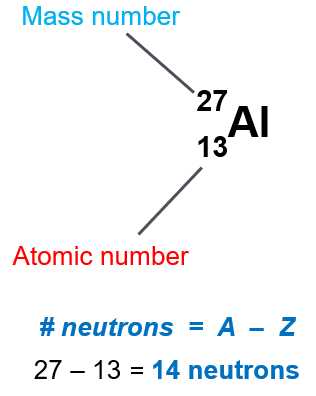
* The atomic mass unit is the unit used to express the \_\_\_\_\_ of an \_\_\_\_\_.
* One-twelfth the mass of a \_\_\_\_\_ atom
* Corresponds to 1.660538921 × 10−24 g

The Atom

* Atom is the \_\_\_\_\_ particle of an \_\_\_\_\_ that has the same \_\_\_\_\_ as the element.
* The atom can be divided into two parts:
  + \_\_\_\_\_: \_\_\_\_\_ portion of the atom
  + \_\_\_\_\_: Regions \_\_\_\_\_ the nucleus
* The atom is made of \_\_\_\_\_ particles: \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
  + Protons are \_\_\_\_\_ charged.
  + Electrons are \_\_\_\_\_ charged.
  + Neutrons are \_\_\_\_\_ charged.



What is the structure of the atom?



Atomic \_\_\_\_\_ (*Z*)

* Number of \_\_\_\_\_ in an atom
* \_\_\_\_\_ for each element
* Every atom of a given element has the \_\_\_\_\_ atomic number, and atomic number can be used to \_\_\_\_\_ an element.

\_\_\_\_\_ number (A)

* Total number of \_\_\_\_\_ + \_\_\_\_\_
* Usually varies from atom to atom
* Aluminum-27

Al-27

27Al

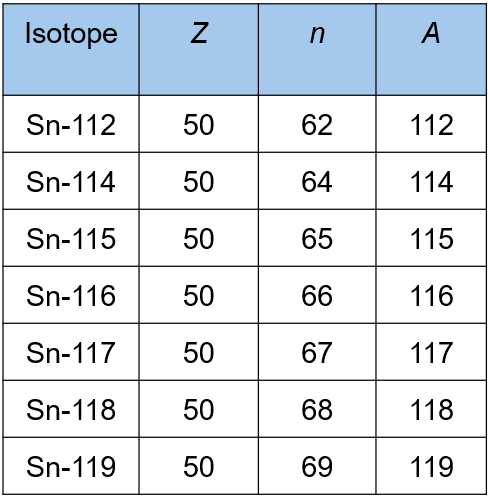
* All atoms of an element have the \_\_\_\_\_ atomic number, but atoms of the same element can have \_\_\_\_\_ mass numbers.

N\_\_\_\_\_ Symbols  


In a neutral atom, the number of \_\_\_\_\_ = the number of \_\_\_\_\_.

Isotopes

* \_\_\_\_\_ are atoms that have the same number of \_\_\_\_\_ but different numbers of \_\_\_\_\_. Therefore, they have the same \_\_\_\_\_ properties.



* Neon-20, neon-21, and neon 22 are \_\_\_\_\_ of neon.

Isotopes of Neutral Atoms

* Atoms of the same \_\_\_\_\_ with different \_\_\_\_\_ numbers.
  + Number of \_\_\_\_\_ are the same
  + Number of \_\_\_\_\_ are the same
  + Number of \_\_\_\_\_ are different

Atomic Mass

* An atomic mass unit (\_\_\_\_\_) is defined as one-twelfth of the mass of a \_\_\_\_\_ -12 atom.
* The \_\_\_\_\_ of carbon has been assigned a mass of exactly \_\_\_ atomic mass units: 6C12.
* In nature, most elements occur as a \_\_\_\_\_ of two or more isotopes.
* Each isotope of an element has a fixed \_\_\_\_\_ and a natural \_\_\_\_\_ abundance.
* Chlorine exists as chlorine-35 and chlorine-37.
  + Chlorine’s atomic mass on the Periodic Table is 35.453 amu. (*Notice is it not exactly in-between.*)
  + Which isotope is more abundant?
  + In nature there is \_\_\_\_\_ Cl-35 than \_\_\_\_\_ Cl-37, therefore, the atomic mass of chlorine, \_\_\_\_\_ amu, is closer to \_\_\_\_\_ than to 37.

Calculating Average Atomic Mass

* The average atomic mass is the weighted \_\_\_\_\_ mass of all \_\_\_\_\_ of an \_\_\_\_\_.

Average Atomic Mass

* Abundance of silicon isotopes:
* 92.2297% is from Si-28
* 4.6832% is from Si-29
* 3.0872% is from Si-30
* How do you arrive at a mass of 28.09?
* The weighted average mass reflects both the \_\_\_\_\_ and the \_\_\_\_\_ \_\_\_\_\_ **(%)** of the \_\_\_\_\_ as they occur in nature.
* \_\_\_\_\_ the mass of each isotope by its natural abundance and \_\_\_\_\_ the products.

\_\_\_\_\_ % (\_\_\_) + \_\_\_\_\_ % (\_\_\_) + \_\_\_\_\_ % (\_\_\_) = \_\_\_\_\_ amu

OR

\_\_\_\_\_ (\_\_\_) + \_\_\_\_\_ (\_\_\_) + \_\_\_\_\_ (\_\_\_) = 28.09 amu

25.82 + 1.36 + 0.93