The parts of Dalton's theory

1. Matter is composed of small, chemically indivisible ATOMS

2. ELEMENTS are kinds of matter that contan only a single kind of atom. All the stoms of an element have identical chemical properties.

3. COMPOUNDS are kinds of matter that are composed of atoms of two or more ELEMENTS which are combined in simple, whole number ratios.

Most importantly,

4. CHEMICAL REACTIONS are REARRANGEMENTS of atoms to form new compounds.

   - Atoms are not gained or lost during a chemical reaction.

   - Atoms do not change their identity during a chemical reaction.

   - All the atoms that go into a chemical reaction must go out again!

Another look at chemical reactions

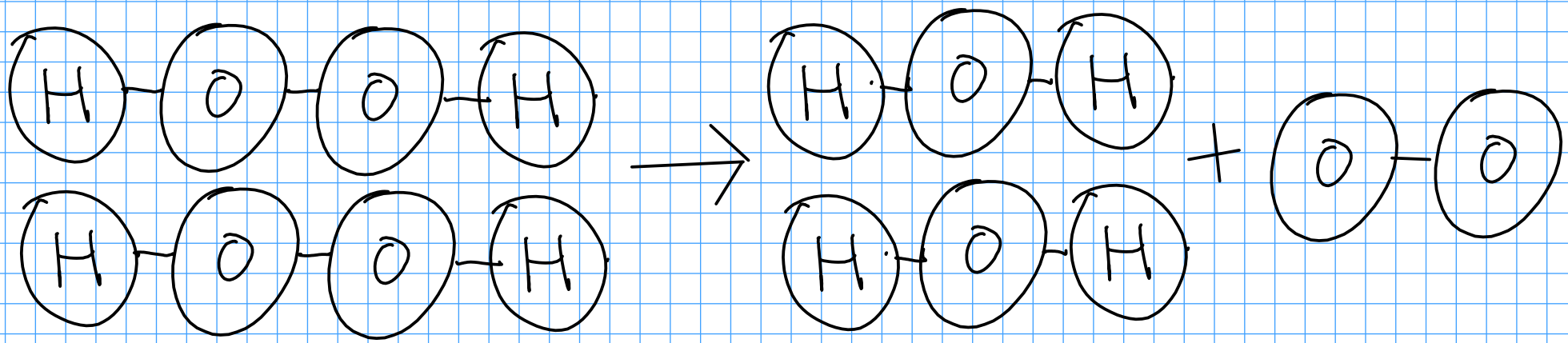
The decomposition of hydrogen peroxide over time works like this:

HYDROGEN PEROXIDE → WATER + OXYGEN GAS

implying:... $H_2O_2 \rightarrow H_2O + O_2$

... but wouldn't this mean that somehow an extra oxygen atom would form?

Not according to Dalton's theory. Dalton's theory would predict a different RATIO of water and oxygen would form:



$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$

- Dalton's theory sets LIMITS on what can be done with chemistry. For example:

1. Chemistry can't convert lead (an element) into gold (another element). Sorry, alchemists!

2. You can't have a compound form in a chemical reaction that contains an element that was not in your starting materials.

3. You can only make a certain amount of desired product from a fixed amount of starting material.

Atomic structure

- Until the early 20th century, chemists considered atoms to be indivisible particles.
- The discovery of SUBATOMIC PARTICLES changed the way we view atoms!

The subatomic particles

PROTON

- a small, but relatively massive particle that carres an overall unit POSITIVE CHARGE

NEUTRON

- a small, but relatively massive, particle that carries NO CHARGE
- slightly more massive than the proton

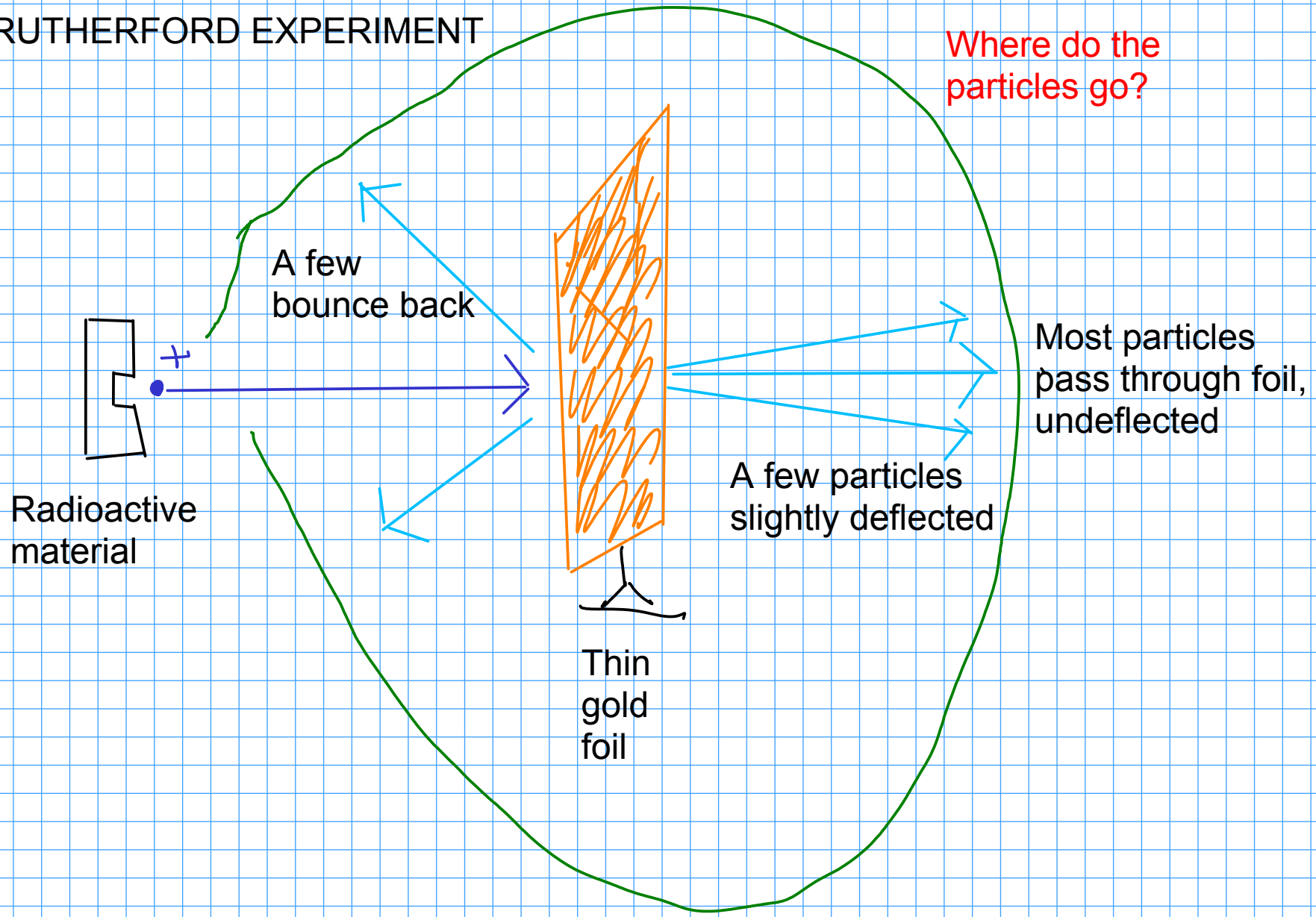
ELECTRON

- a small particle that carries an overall unit NEGATIVE CHARGE
- about 2000 times LESS massive than either protons or neutrons

Putting it together...

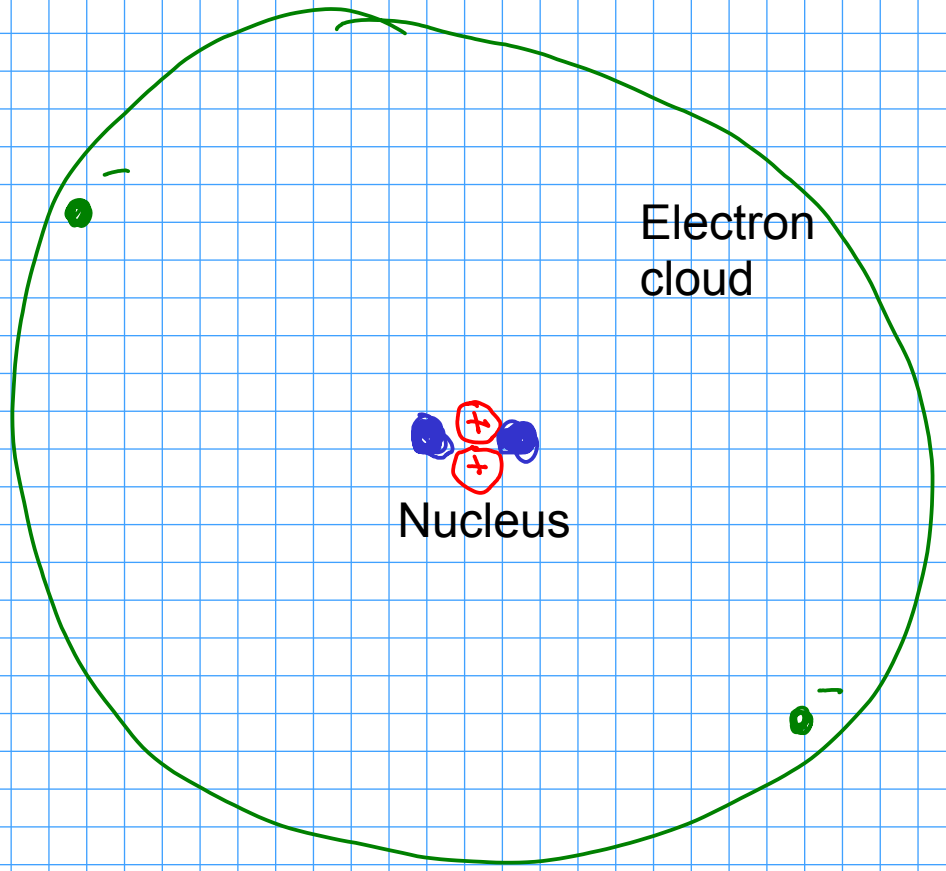
- In the early 20th century, there was a debate on how the newly discovered subatomic particles actually made an atom.

RUTHERFORD EXPERIMENT



NUCLEAR MODEL

- Atoms are mostly empty space
- NUCLEUS, at the center of the atom, contains protons and neutrons. This accounts for almost all the mass of an atom
- Electrons are located in a diffuse ELECTRON CLOUD surrounding the nucleus



Atomic terms

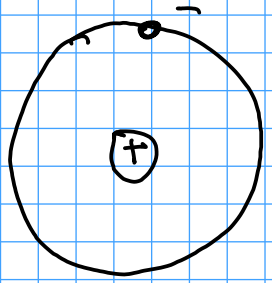
- ATOMIC NUMBER: The number of protons in the atomic nucleus. Each ELEMENT has the SAME NUMBER OF PROTONS in every nucleus. In neutral atoms, the number of ELECTRONS is also equal to the atomic number.

Example: Helium has an atomic number of 2. Every helium atom has two protons in its nucleus.

- MASS NUMBER: The number of protons PLUS the number of neutrons in the atomic nucleus, Atoms of the same element may have DIFFERENT mass numbers.

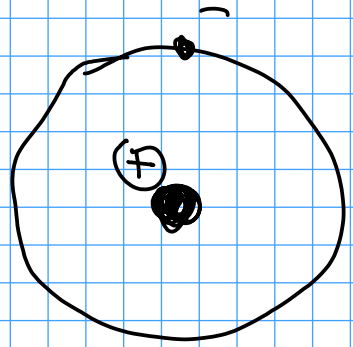
- ISOTOPES: are atoms of the same element with different mass numbers. In other words, they have the same number of protons but different numbers of neutrons.

A few isotopes



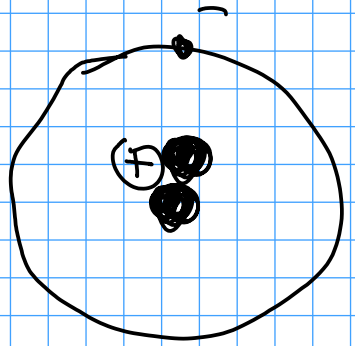
Hydrogen-1

$^{1}_{1}H$



Hydrogen-2
"Deuterium"

$^{2}_{1}H$



Hydrogen-3
"Tritium"

mass # — 3

atomic # — 1

$^{3}_{1}H$

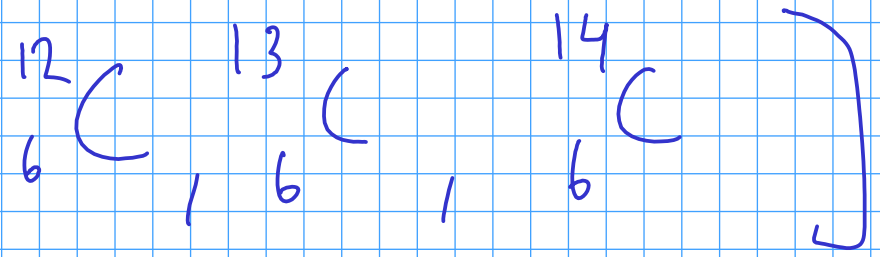
Isotopes

- Have identical CHEMICAL properties
- Differ in MASS
- May differ in stability. Elements may have some isotopes that are RADIOACTIVE

Atomic weight

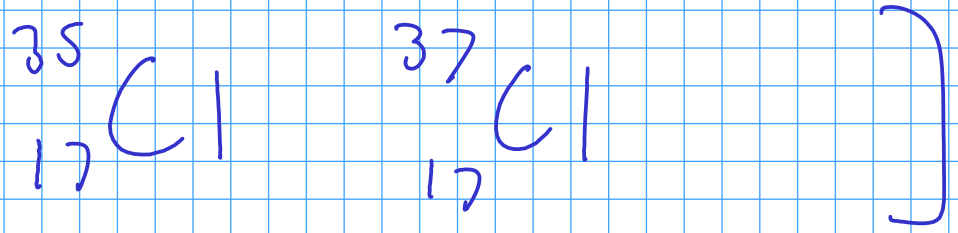
- The AVERAGE MASS of all naturally occurring isotopes of an element.

Example: Hydrogen has an atomic weight of 1.008 "atomic mass units"
(Naturally-occurring hydrogen is almost all Hydrogen-1!)



atomic weight of C:
12.01 amu

(Natural carbon is mostly carbon-12)



atomic weight of Cl:
35.45 amu

(Natural chlorine is mostly chlorine-35)