A few more math with significant figures examples:

$\overset{5}{15047} \times \overset{2}{11} \times \overset{4}{0.9876} = 163464.5892$ $\boxed{160000}$

~~16~~

1.6×10^5

Placeholder zeros, even though they aren't SIGNIFICANT, still need to be included, so we know how big the number is!

Addition:

$$\begin{array}{r} 147.3 \\ 2432 \\ 0.97 \\ +\ 111.6 \\ \hline 2691.87 \end{array}$$

$\boxed{2692}$

DENSITY CALCULATION

$$\frac{14.7068\ g}{2.7\ mL}$$

6

2

$= 5.44962963\ g/mL$

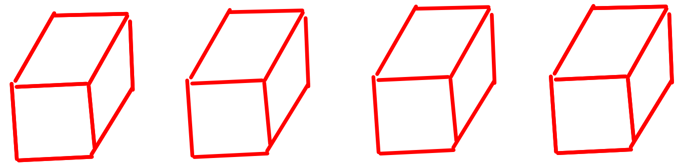
$\boxed{5.4\ g/mL}$

To improve (make more precise) this calculated density, we must improve the poorest measurement. We must use a more precise device to measure the VOLUME (which only has two significant figures in this example)!

Exact Numbers

- Some numbers do not have any uncertainty. In other words, they weren't measured!

1) Numbers that were determined by COUNTING!



How many blocks are to the left?

exactly $\underline{\underline{4}}$

2) Numbers that arise from DEFINITIONS, often involving relationships between units

$12 \text{ in} = 1 \text{ ft}$

$\text{Km} = 10^3 \text{ m}$

* All metric prefixes are exact!

- Treat exact numbers as if they have INFINITE significant figures or decimal places!

Example

You'll need to round the answer to the right number of significant figures!

Convert 4.45 m to in, assuming that 2.54 cm = 1 in

EXACT!

$2.54\ \text{cm} = \text{in} \qquad \text{cm} = 10^{-2}\ \text{m}$

$$\underset{3}{4.45\ \cancel{\text{m}}} \times \frac{\cancel{\text{cm}}}{\underset{\infty}{10^{-2}\ \cancel{\text{m}}}} \times \frac{\text{in}}{\underset{\infty}{2.54\ \cancel{\text{cm}}}} = 175.1968504\ \text{in}$$

$$= \boxed{175\ \text{in}}$$

Usually, in unit conversions the answer will have the same number of significant figures as the original measurement did.

EXCEPTION: Temperature conversions, since these often involve ADDTION (different rule!)

A note on rounding: If possible, try to round only at the END of a multiple-step calculations. Avoid rounding intermediate numbers if possible, since extra rounding introduces ERROR into your calculations.

DALTON'S ATOMIC THEORY

- 1808: Publication of Dalton's "A New System of Chemical Philosophy", which contained the atomic theory

- Dalton's theory attempted to explain two things:

1 CONSERVATION OF MASS

- The total amount of mass remains constant in any process, chemical or physical!

2 LAW OF DEFINITE PROPORTIONS (also called the LAW OF CONSTANT COMPOSITION): All pure samples of a given compound contain the same proportion of elements by mass

The parts of Dalton's theory

1 Matter is composed of small, chemically indivisible ATOMS

2 ELEMENTS are kinds of matter that contain only a single kind of atom. All the atoms 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

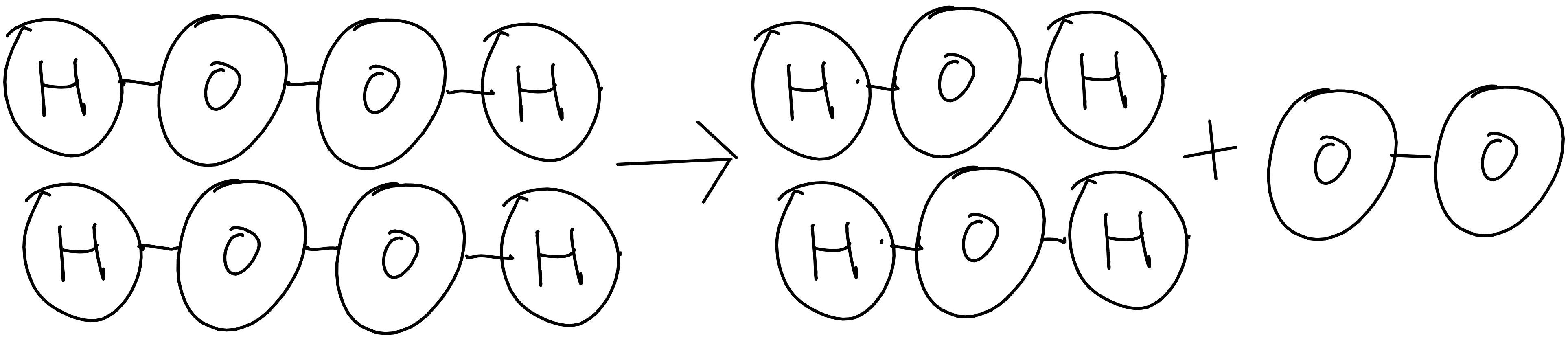
The decomposition of hydrogen peroxide over time (or when poured over a cut) works like this:

HYDROGEN PEROXIDE $\longrightarrow$ WATER + OXYGEN GAS

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

... 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:



$$\boxed{\color{red}{2}\ H_2O_2 \longrightarrow \color{red}{2}\ H_2O + O_2}$$

- 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

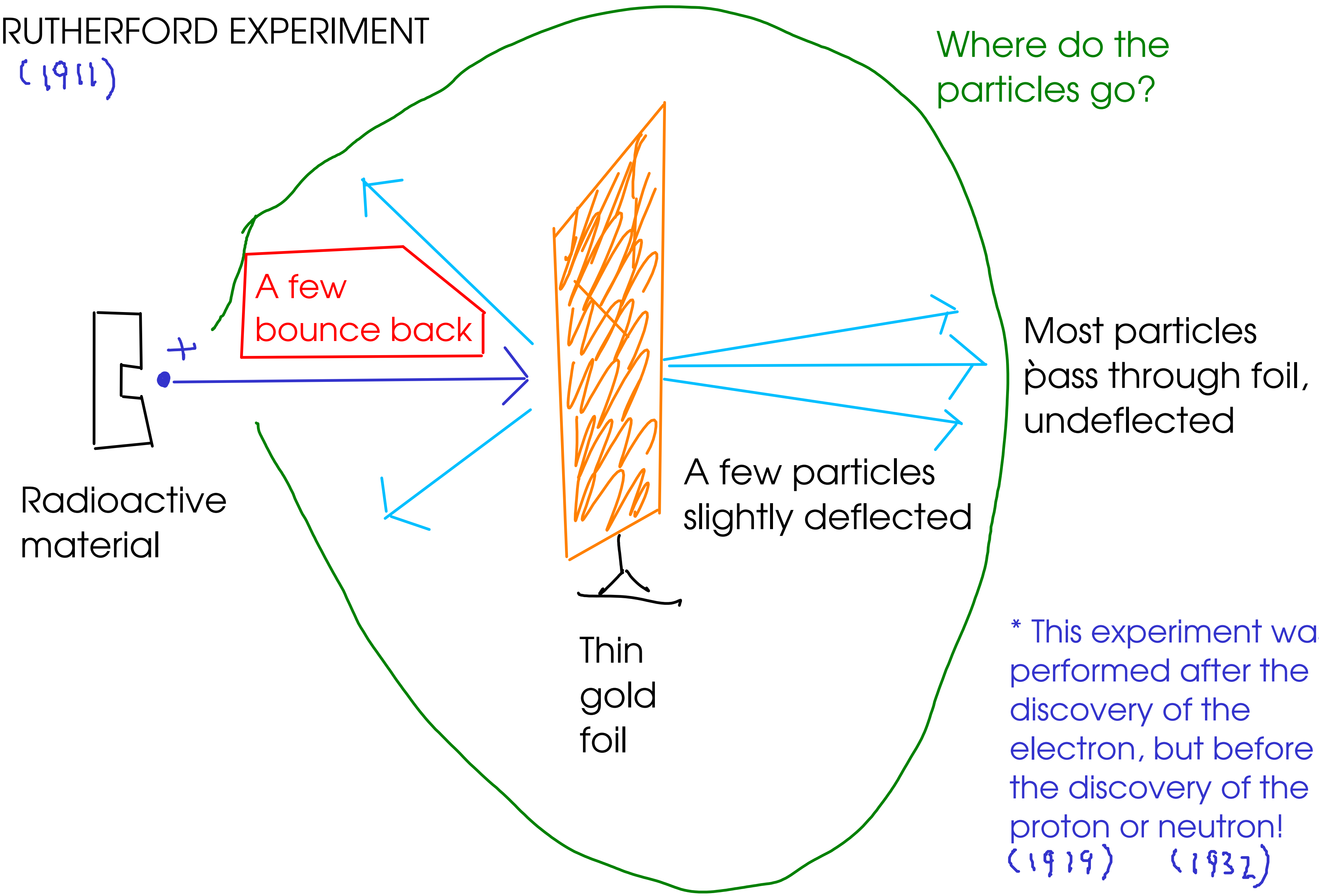
ELECTRON

- 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 the structure of the atom.

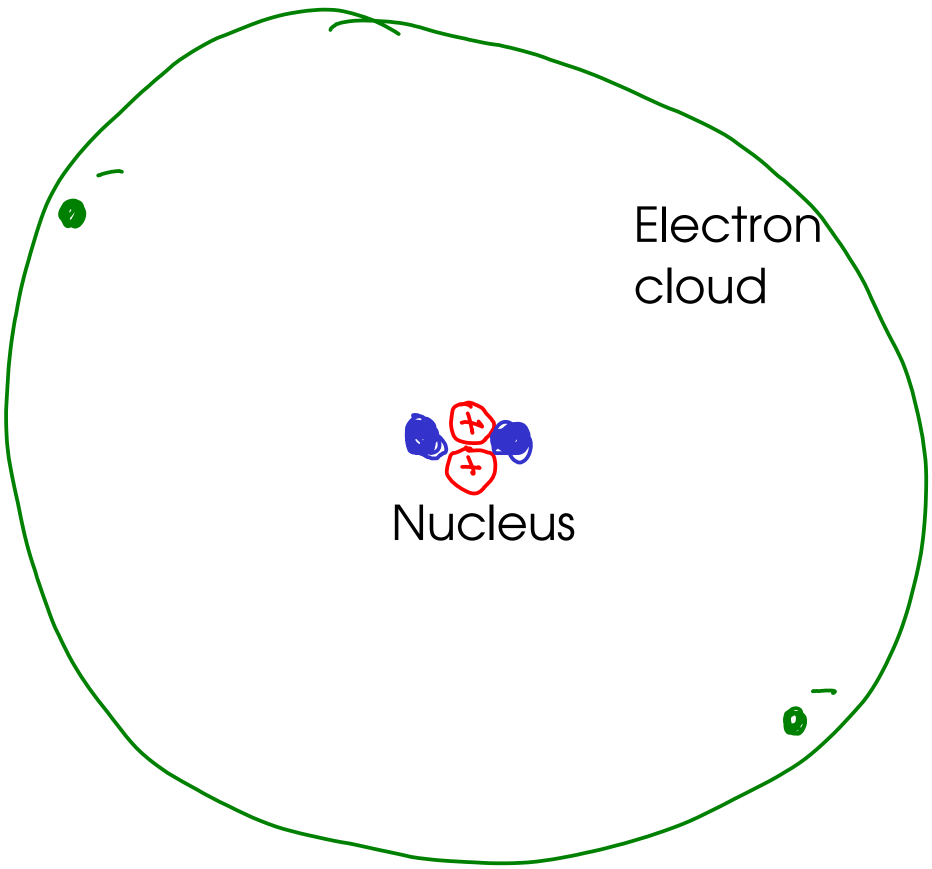
RUTHERFORD EXPERIMENT
(1911)

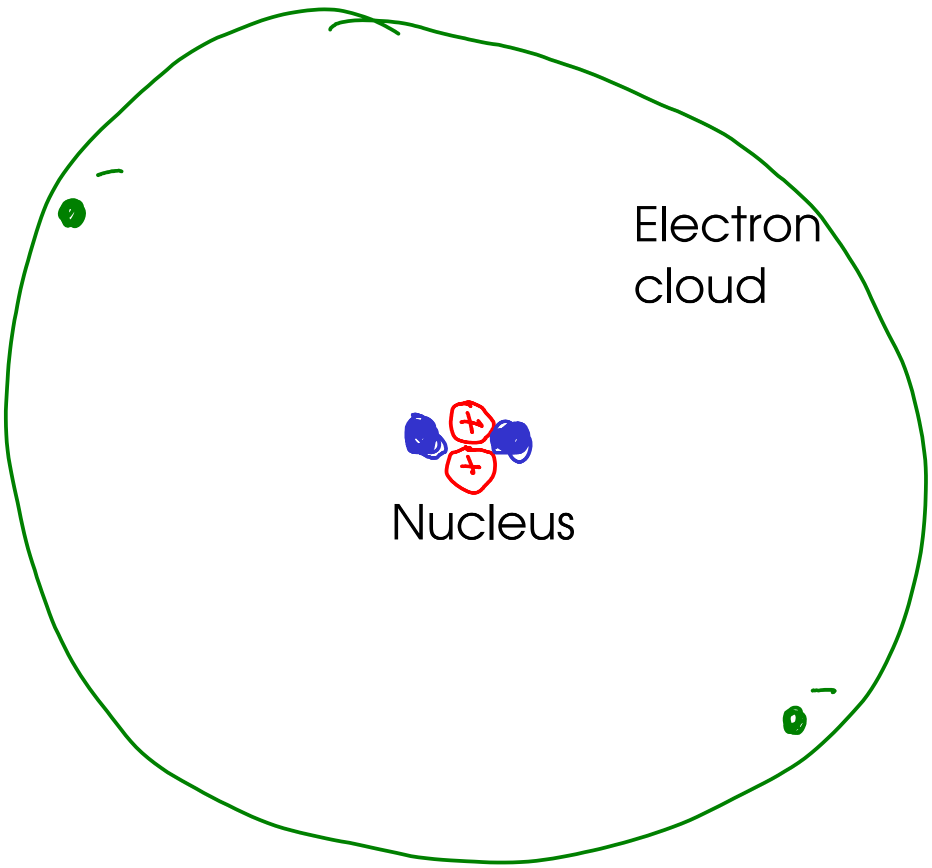


* This experiment was performed after the discovery of the electron, but before the discovery of the proton or neutron!
(1919) (1932)

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





Why are atoms stable (why don't they change identity) during a reaction? The nucleus of an atom is not involved in chemical reactions, and the nucleus controls what kind of atom you have!