

A few more math with significant figures examples:

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

~~16~~

$$160000$$

$$1.6 \times 10^5$$

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

Addition:

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

2692

DENSITY
CALCULATION

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

$$= 5.446962963 \text{ g/mL}$$

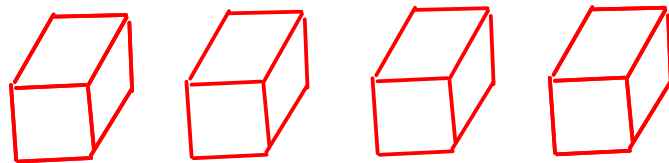
5.4 g/mL

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 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 $\underline{2.54 \text{ cm} = 1 \text{ in}}$

EXACT!

$$2.54 \text{ cm} = 1 \text{ in} \quad 1 \text{ cm} = 10^{-2} \text{ m}$$

$$4.45 \text{ m} \times \frac{1 \text{ cm}}{10^{-2} \text{ m}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} = 175.1968504 \text{ in}$$

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

Significant figures analysis:
 - 4.45 m: 3 significant figures (indicated by an upward arrow and the number 3)
 - 10⁻² m: ∞ significant figures (indicated by an upward arrow and ∞)
 - 2.54 cm: ∞ significant figures (indicated by an upward arrow and ∞)

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 ADDITION (different rule!)

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

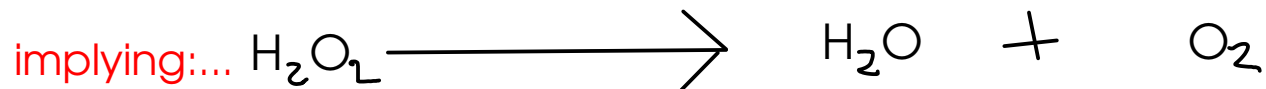
- ① Matter is composed of small, chemically indivisible ATOMS
- ② ELEMENTS are kinds of matter that contain only a single kind of atom. All the atoms of an element have identical chemical properties.
- ③ COMPOUNDS are kinds of matter that are composed of atoms of two or more ELEMENTS which are combined 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!

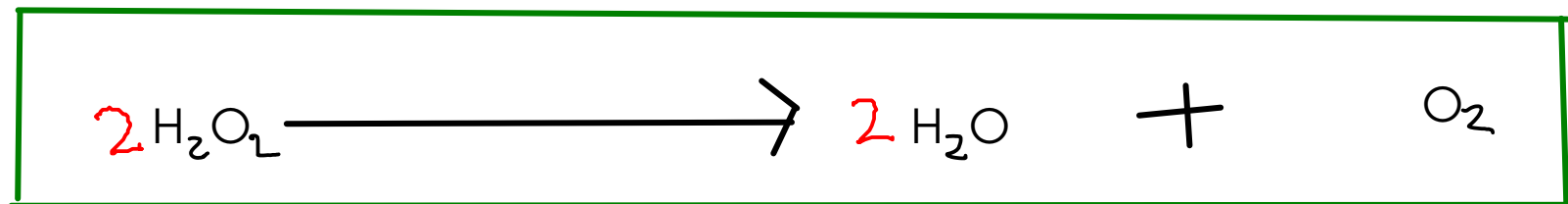
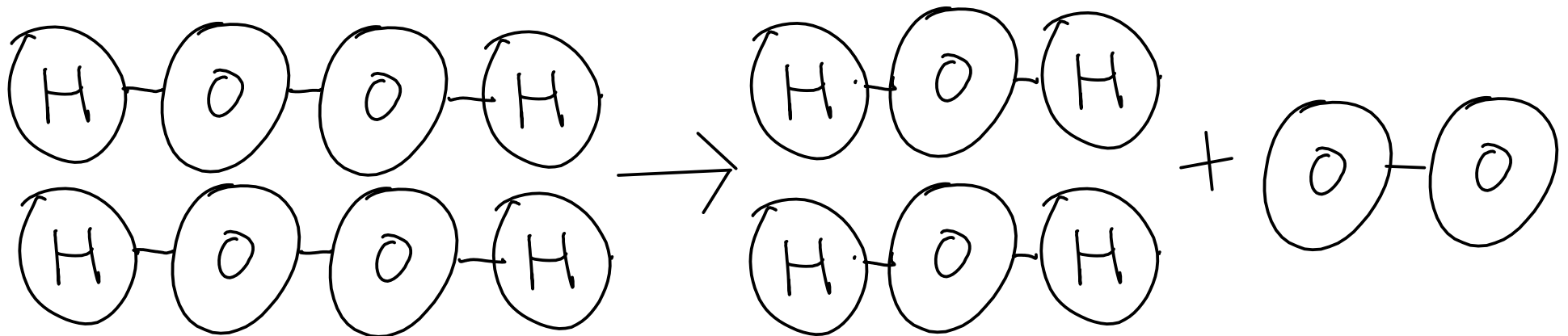
Another look at chemical reactions

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



... 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:



- 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 carries an overall unit POSITIVE CHARGE

NEUTRON

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

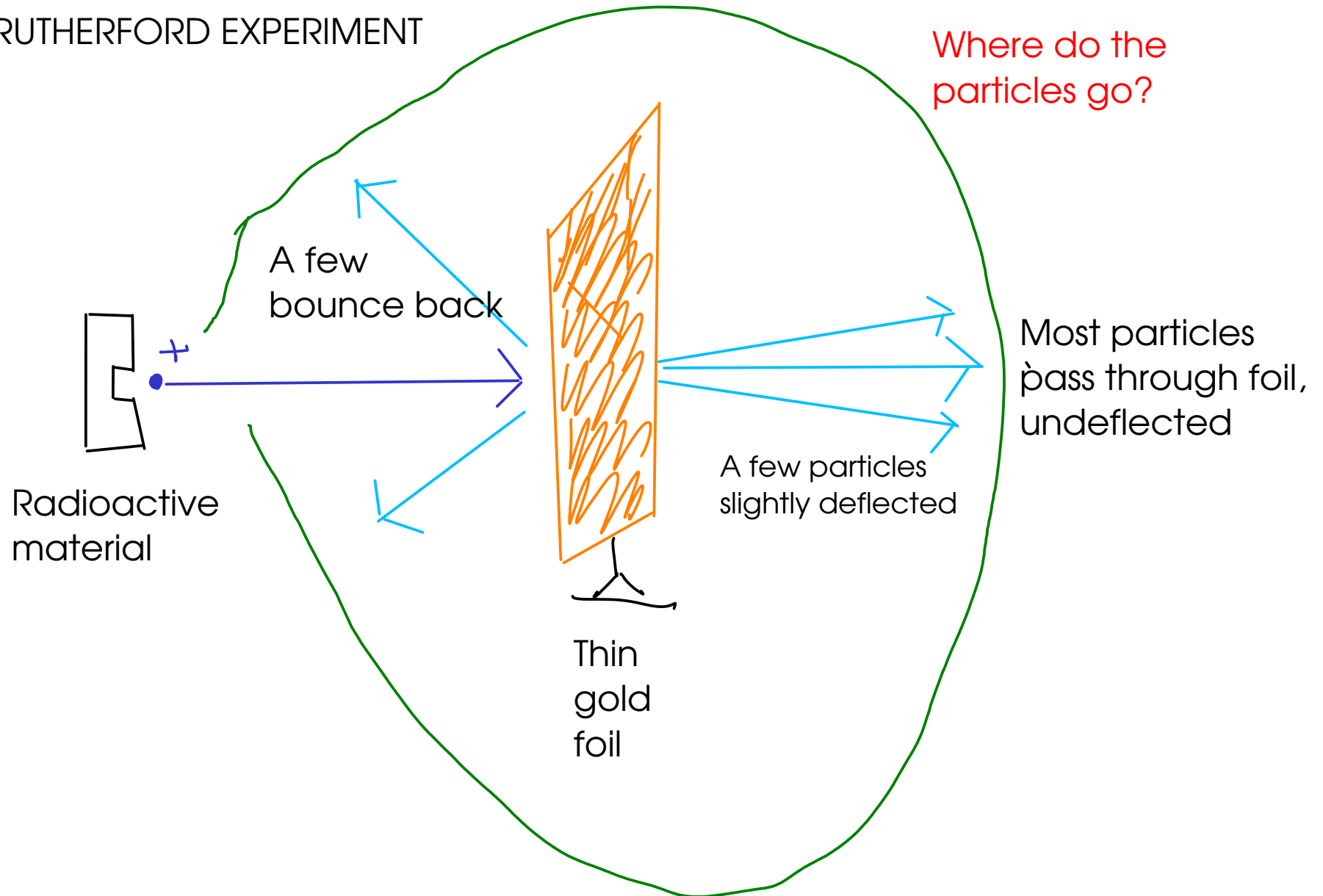
ELECTRON

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

Putting it together...

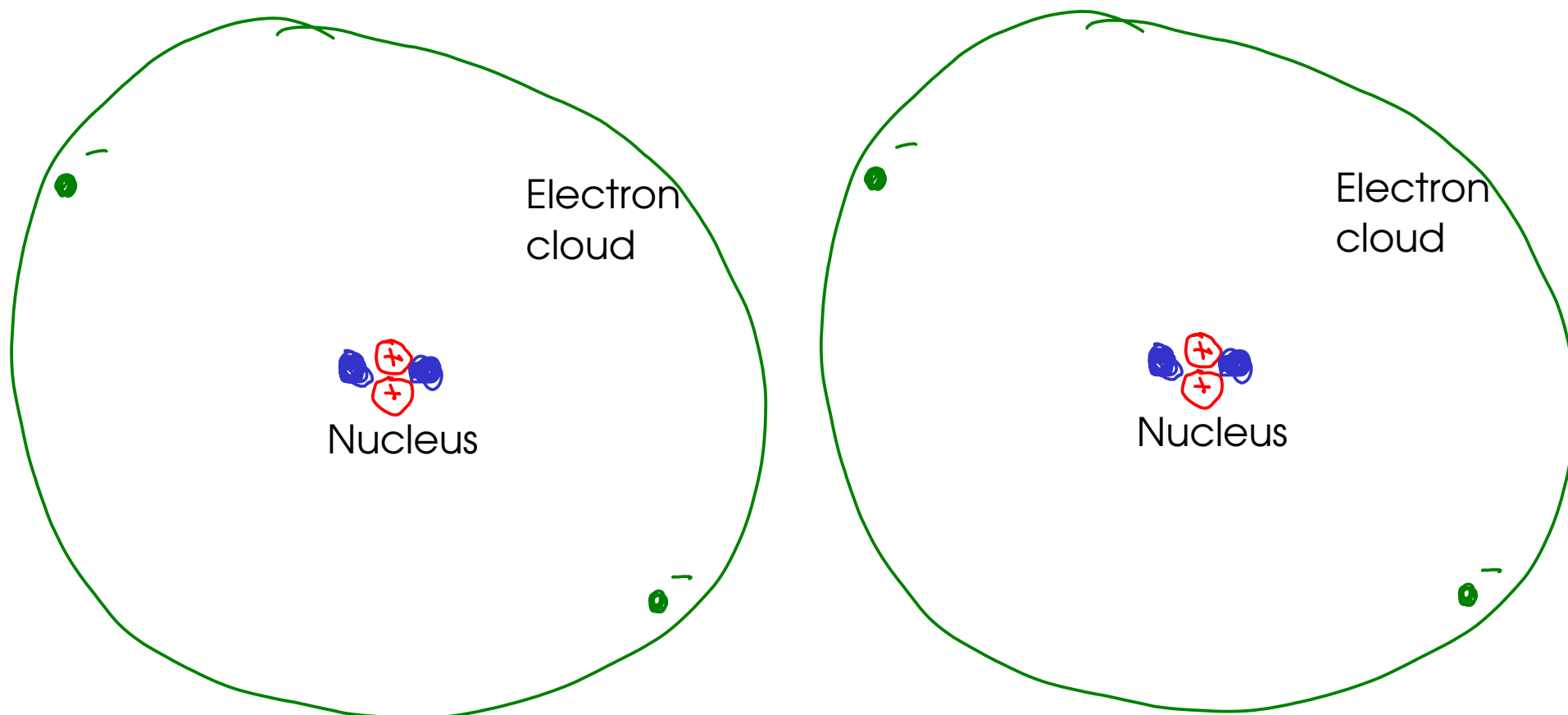
- In the early 20th century, there was a debate on how the newly discovered subatomic particles actually made an atom.

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



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!