

Unit 1 Atomic Structure and Properties

-answering question of what “stuff is made out of”

Development of Atomic Theory

1. Democritus (about 440 BC)

- thought experiment: atomos, uncuttable particle
- also that this particle came in different kinds

Proving the first Democritus' first postulate:

2. Robert Boyle 1660

- first real experimental evidence that stuff is made of tiny grains rather than being continuous.
- behaviour of gas such as steam could be explained if it were made of tiny angry bees.

Expanding on Democritus' second idea:

3. Ancient civilizations were aware of many elements around them.

- examples: gold, silver, copper
- used them for tools or jewels.
- why were some elements so easy to spot?
- elements that don't interact with other elements are easy to pin-point.
- had no idea that these easy to distinguish types of stuff were the examples of the building blocks of the universe

4. Hennig Brandt (late 1600s) - tried to isolate gold from his urine. Instead isolated the element P. First person to isolate an element even though he had no idea what an element was.

5. Antoine Lavoisier (1789)

1. Defined what an element was: a substance that cannot be broken down by existing chemical means.
2. Made a list of the known elements. Got to 23 before he lost his head.
3. Ordered them into gases or metals. First attempt at periodic table?

Today we know of 92 naturally occurring elements. Hydrogen is the lightest, uranium is the heaviest.

Why are there so many? Idea: atoms are not the ultimate building block but themselves made up of smaller things.

Scientists that used weights of the elements

6. William Prout (1800) - compared the weights of the different elements and found a striking pattern.

e.g. Take the number 8787878787878787

What is the simplest building block from which this number is made?

-87

87878787 is 4 87s glued together

Prout found all the elements weight in exact multiples of the weight of hydrogen. As an example, He is two hydrogens glued together. Lithium is three hydrogens glued together. Prout thought that hydrogen was the basic building block of matter and all the heavier atoms were simply different numbers of hydrogen atoms stuck together.

-not true, but evidence that atoms themselves are made of something smaller.

7. John Dalton (1808) Common substances are made of combinations of atoms of different elements that cannot be created nor destroyed. -atoms of varying elements are different, atoms of the same element are identical.

8. Dmitri Mendeleev arranged elements into a table based on increasing atomic weight. Made the periodic table. Discovery, on his chart he found that the vertical columns made groups of elements with lots in common. -more evidence that they are made of something smaller.

Finding the things that make up atoms

9. JJ Thomson (1897) -used high voltage to rip a part of the atom away from the rest. This particle is the carrier of electricity, and is attracted to positives. Really tiny. 1/2000th the mass of hydrogen. Too small to be Prout's building block.

Nobody really knows what charge is, we just know our universe has two of them, we've termed one of them positive and the other negative. We know that the two different charges attract each other and like charges repel. And since in our daily lives we don't experience this electric force tugging this way that all matter must be neutral.

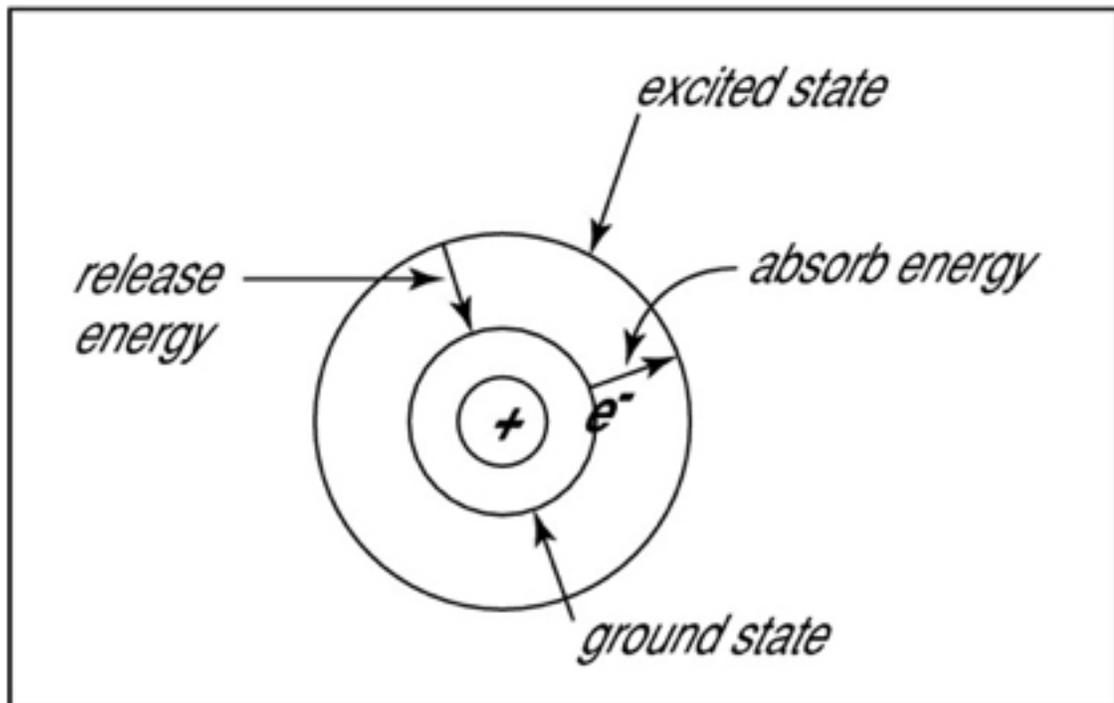
So if atoms have negatives it must be perfectly balanced by something else. Despite not knowing what this something else was, Thomson made a model of the atom.

10. Rutherford (1909)

- studied radioactivity, found there are three different types of radiation
- discovered the nucleus

11. Bohr (1913)

Electrons orbit the nucleus at fixed energies/distances. they are able to jump from one level to another but cannot exist in the states in-between.



Ground and excited states in the Bohr model.

Bohr found that the closer an electron is to the nucleus, the less energy it needs, but the farther away it is, the more energy it needs. So Bohr numbered the electron's energy levels. The higher the energy-level number, the farther away the electron is from the nucleus — and the higher the energy.

Bohr also found that the various energy levels can hold differing numbers of electrons: energy level 1 may hold up to 2 electrons, energy level 2 may hold up to 8 electrons, and so on.

-this planetary model soon became challenged:

Quantum Model of Atom

Experiments: electrons are not just discrete particles but also behave as waves.

-not confined to a particular point in space.



-Heisenberg: formulated the uncert. principle. showed it is impossible to determine both exact position and speed of electrons as move around atom.

the idea that we cannot pinpoint electrons but exist within a range of possible locations gave rise to our current quantum model of the atom.

Mathematician named Erwin Schrodinger made equations to define these possible locations that we can find an electron or probability densities. These densities we refer to as orbitals.

-it is like drawing a shape around the nucleus such that we are 95 percent sure of finding a given electron in that shape.

what an orbital looks like depends on how much energy it has - more energy it has the further its density is from the nucleus.