

Discovery of the Atom – Notes

Early Greek philosophers such as Plato and Aristotle taught that matter could be indefinitely divided into smaller pieces. The earliest known written record that talks about atoms is by Democritus. Democritus and Leucippus believed that matter consisted of tiny particles that couldn't be divided into smaller pieces and that the spaces between the particles consisted of nothing. These ideas were based off beliefs and philosophies rather than scientific observations.

The Law of Conservation of Mass: "In a chemical reaction **the total mass of the products formed equals the total mass of the reactants consumed**".

Democritus based his ideas on atoms on beliefs and philosophies rather than experimental observations and so **he didn't provide observational evidence to support his claims**.

Lavoisier conducted many experiments and collected data that supported his proposal of the Law of Conservation of Mass.

*To prove the Law of Conservation of Mass, you must **take all the reactants and products into account**. The mass of both sides should remain equal. Missing mass from the product(s) is often the gas produced.

Although Joseph Proust's Law of Definite Proportions (or Law of Constant Composition) wasn't a new idea, **he was the first to experimentally show the law**. He provided compelling evidence that the previously assumed law was in fact consistent. Thus, he was credited with the law since he was the first to experimentally demonstrate it.

Although the cathode rays themselves are invisible, **they cause a low-pressure gas inside the CRT to glow**. The rays could also be detected as **they cause phosphors (such as ZnS) to glow**.

The cathode rays are deflected **towards a positively charged plate and away from a negatively charged plate**, leading Thompson to believe cathode rays possessed a negative charge.

Q: How was Thompson able to produce a beam of cathode rays?

The cathode rays stream away from the high voltage negative plate of the CRT as a wide beam. **These rays are attracted towards a positive plate that has a narrow slit in it**. The rays passing through the slit **form a narrow beam** that's attracted to a more distant positive plate.

Q: How was Thompson able to see the cathode rays?

Thompson used a **phosphor-coated screen that glowed when struck with cathode rays**. This **produced a trace that showed the path of the cathode rays**.

With his modified CRT, Thompson was able to **determine the charge to mass ratio of a cathode ray particle** (now known to be an electron). He **estimated the mass of a cathode ray particle** to be less than $\frac{1}{1000}$ the mass of the lightest known element.

Alpha particles are produced by some naturally occurring or artificial **radioisotopes** (Rutherford used radium). They're fast-moving helium nuclei with a +2 charge.

Gold was able to be made so thin because as a metal it's **malleable** and can therefore be made into very thin sheets.

Based on Thompson's model of the atom with a **uniformly spread mass and charge**, Rutherford hypothesized that the alpha particles should essentially **pass through the gold sheet undeflected**.

Rutherford used a **zinc sulfide coated screen and a microscope** to count the flashes produced by the alpha particles striking the fluorescent screen.

Some alpha particles were considerably deflected. Rutherford interpreted this as to mean that there must be a **very small, high mass and high charge central nucleus in an atom** and that it takes up a **very small percentage of the atom's volume**. This nucleus was causing the occasional alpha particle to be deflected.

Rutherford suggested that the missing mass was due to an **undetected neutral particle**. It was difficult to detect because it had **no charge** and the detectors used at the time relied on charged plates to identify particles. Sir James Chadwick was credited with its discovery, which he later called neutrons.

Rutherford's idea of electrons orbiting the nucleus meant that such orbiting electrons would, according to classical physics principles, **continuously emit radiation, causing the electron to lose energy and speed and presumably spiral into the nucleus**, hence being "inherently unstable".

Bohr proposed that the electrons in an atom **could only orbit at specific radii that were associated with fixed amounts of quanta energy**, and so they couldn't just lose energy and spiral into the nucleus.

Q: What instrument can be used to observe the spectrum produced by a discharge tube?

A **spectroscope**.

The visible part of the emission spectrum of hydrogen gas consists of 4 lines of light:

- **Red.** (Ron)
- **Cyan.** (Came)
- **Violet.** (Very)
- **Blue.** (Blue)

There's **no light between the colours**.

Once a hydrogen electron is excited, it's in a higher energy level than normal. When it falls back to a lower energy level, it **emits a photon of light of a specific wavelength** or colour of light. There are several different visible colours possible for hydrogen depending on the specific electron transitions involved. **Only certain quanta of allowable electron energy are possible and hence only certain specific energy photons (colours) can be produced.**