English for specific purpose

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Week 1

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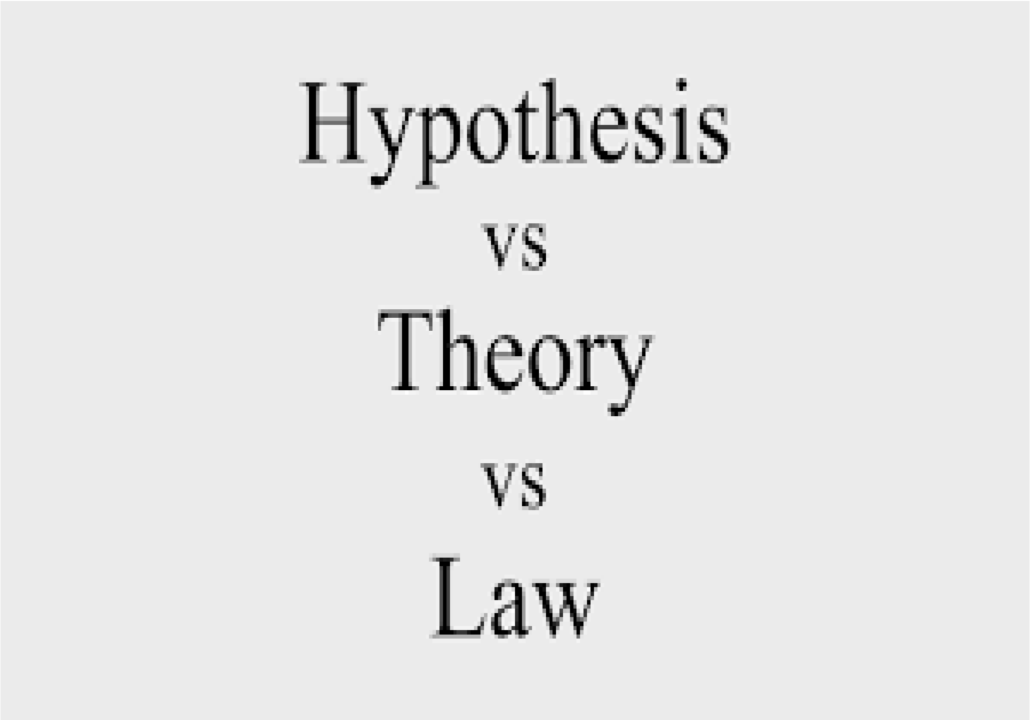
The difference between Hypothesis, Theory and Low



Hypotheses ,Theories and Laws گریمانە ، بیردۆزەکان و یاساکان

- When we find that an **idea** helps us **understand** or connect a lot of different things, we call this idea a **hypothesis**. There are **more tests** we can do to see if our **assumptions are correct**. You can call it a **theory** if it **keeps working** with what you **learned from the experiment**, or you can call it a **law**.

- کاتێک بیرۆکەیەک دەبینین یارمەتیمان دەدا کە کۆمەڵێک شتی جیاواز بەیەکەوە ببەستینەوە یان لێی تێبگەین ، بەو بیرۆکەیە دەگوترێت **گریمانە**. زۆر لە پشکنین هەیە دەتوانین ئەنجامی بدەین بۆ ئەوەی بزانین گریمانەکانمان ڕاستن. دەتوانی ئەمە بە **بیردۆزە** دابنێیی ئەگەر بەردەوام بی لە کارکردن لەوەی کە فێری بووی لە پشکنینەکان، یان دەتوانی بە **یاسا** ناوی بنێیت

A Theory, like the **atomic theory**, usually has some idea about the nature of some part of the Universe.

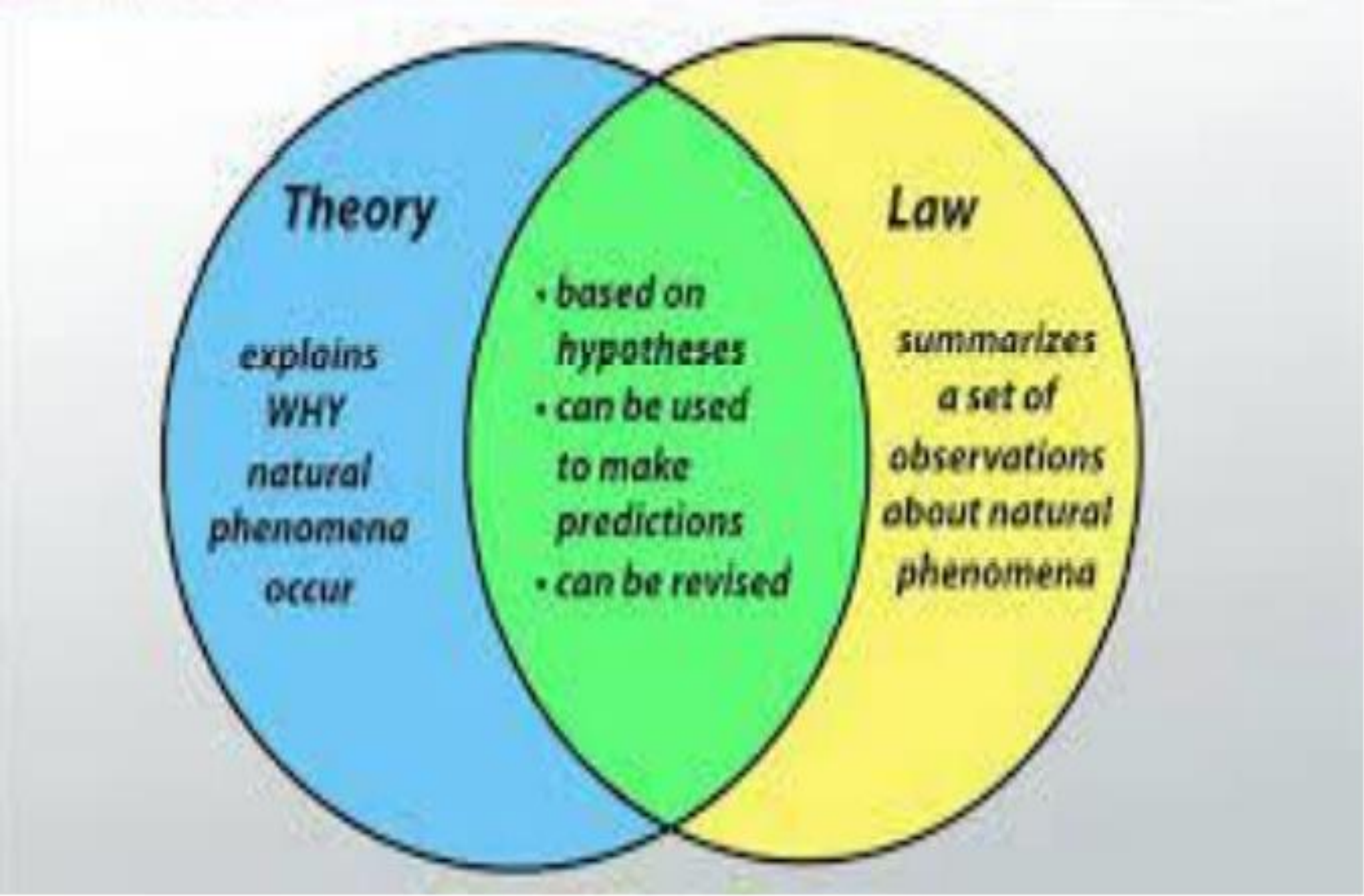
In chemistry and other fields of study, the word “**Theory**" is used in two very different ways.

The **first** meaning of the word is the one above, which is a hypothesis that has been proven true. This is the second time the word "theory" has been used. It **refers** to a **well-organized body** of **knowledge** that is made up of **facts**, **laws**, **theories**, **deductive arguments**, and so on.

لە کیمیا و بوارەکانی تری خوێندن دا ، ووشەی " بیردۆزە" بە دوو شێوازی تەواو جیاواز بەکاردێت. مانای یەکەم ئەوەی کە لەسەرەوە باسمان کرد ، ئەویش گریمانەیە کە ڕاستیەکەی سەلمێنرا . ئەمە دووەم جارە ووشەی "بیردۆزە "بەکاربێت . دەستنیشان کردنە بۆ کۆمەڵێک ناوەڕۆکی زانراو لە زانیاری کە پێکهاتووە لە ڕاستیەکان و یاساکان و بیردۆزەکان و هەڵێنجاندنی بەڵگەیی و شتی تر.

Thus, when we talk about the **atomic theory**, we don't just mean the idea that substances are made up of atoms. We also mean all of the facts about substances that can be explained or interpreted in terms of atoms and the arguments that explain the properties of substances in terms of their atomic structure.

کەواتە ، کاتێ باسی بیردۆزەی گەردیلەیی دەکەین ، واتای تەنها ئەوە نیە کەوا ماددەکان لە گەردیلە پێکدێن . بەڵکو واتای **ڕاستیەکانی** پەیوەست بە هەموو **ماددەکان** کە دەتوانرێ **لێکدانەوە** یان **ڕوونکردنەوەیان** بۆ بکرێت کە باسی سیفەتەکانی ماددە دەکات لە ڕووی پێکهاتەی گەردیلەیی.


Theory
explains WHY natural phenomena occur
• based on hypotheses
• can be used to make predictions
• can be revised
Law
summarizes a set of observations about natural phenomena

Summary: A set of observations can be used to make a hypothesis, which is a possible explanation for the observations made, but note a hypothesis is just a possible explanation. Sometimes, we get new evidence from an experiment or new observations that contradict our hypothesis. An experiment is a procedure carefully done to examine the validity of a hypothesis.

In fact, scientists seek to test their hypotheses by making extensive observations or conducting many experiments. The idea is to prove a hypothesis by trying to disprove it first. A hypothesis can be changed or reformulated over a series of observations or experiments. Once a hypothesis holds true, it is accepted as fact.

Over the course of time, a collection of hypotheses can be used to generate either a scientific law or theory.

A scientific law is a statement that summarizes a collection of observations or results from experiments.

Scientific laws are always true under the same conditions and therefore can be used to make predictions.

In fact, our cartoon friend here could use some of the Laws of Inheritance to better understand why some cats are gray, while other cats are orange, black, white, or even calico!

In case you've never heard of them, the Laws of Inheritance were developed by the Austrian **monk Gregor Mendel** to explain inheritance patterns initially observed in pea plants.

Collectively, the laws explain how genes are passed from parents to their offspring.

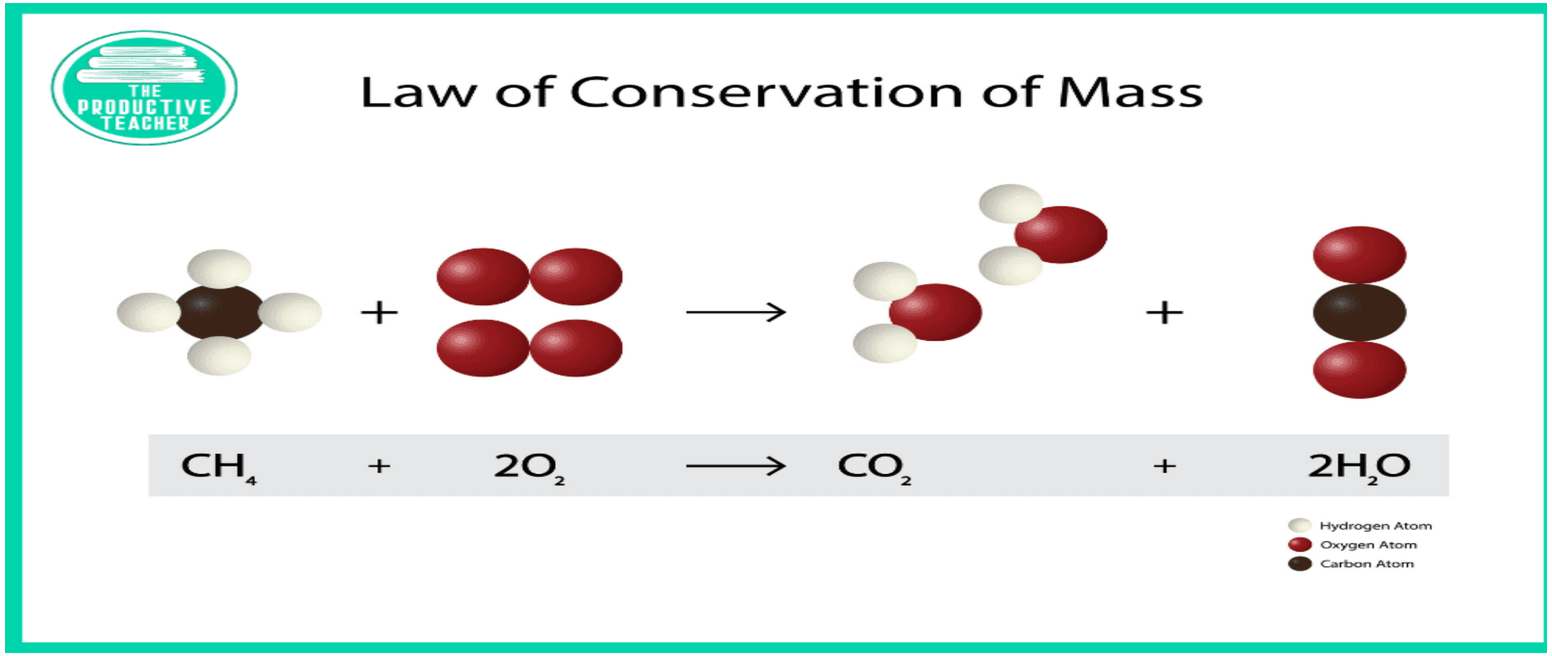
Because Mendel's explanations were true for a variety of organisms, they became a set of laws.

A scientific law may also be referred to as a principle.

Other examples of scientific laws or principles include:

1. The Law of Conservation of Mass
2. Coulomb's Law
3. Newton's Law of Universal Gravitation
4. The Ideal Gas Law
5. Bernoulli's Principle

The Law of Conservation of Mass dates from Antoine Lavoisier's 1789 discovery that **mass is neither created nor destroyed in chemical reactions**. In other words, the mass of any one element at the beginning of a reaction will equal the mass of that element at the end of the reaction. If we account for all reactants and products in a chemical reaction, the total mass will be the same at any point in time in any closed system.



https://youtu.be/JCyjLPYXl1I

Laws of conversation of mass

- In this video we examine the historical and present days significance of the law of conversation of mass. In the 18th century scientists thought that when things burn a substance called phlogiston came out of them, then experiments in closed vessels where substances could be accurately weighted began to help early scientists such as Antoine Lavoisier understand that when things burn oxygen is added. He realized that matter can be changed but not destroyed. In 1789 he established the law of conservation of mass. In chemical reactions no matter is lost or gained. Theses experiments on combining weights also showed that elements always combined in fixed ratios the law of definite proportion and constant composition and they led John Dalton to publish his atomic theory in 1808.

- Modern chemistry had started by mid 19th century only half the elements had been discovered but enough to enable **Dimitri Mendeleeve** to produce his famous periodic table that was in 1869. chemical equations began to be written as we know them from about this time for example: $2Mg + O_2 \longrightarrow 2MgO$
- The burning of magnesium, this need balancing when we **balance an equation we simply obeying the law of conservation of mass** (**all the atoms in the reactants must be accounted for in the products**). It is easy to see this if we draw out the atoms rearranging themselves to form the products you can see clearly that no atoms are gained or lost during a reaction so the mass is conserved. Here is another example :
- A reaction you will see every time you use a gas cooker which uses natural gas

$$CH_4 + O_2 \longrightarrow CO_2 + H_2O$$

- But is this reaction is balanced? Count carbon, hydrogen and oxygen on each side
- It is easy to count if we draw out the molecules as models, carbon one on each side, oxygen two to start with but now three hydrogen four to start with but now only two to balance the hydrogens we need to add two more hydrogens on the right. To do this we add another water molecule and count again. Is it balanced now?

$$CH_4 + O_2 \longrightarrow CO_2 + \mathbf{2}H_2O$$

- Well the carbon and the hydrogen balance but we have four oxygens in the product but only two in the reactants so we add another oxygen molecule to the reactants. **Now we have conserved mass.**

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

- In summary, the law of conservation of mass is simply saying that during chemical change there is no loss or gain of atoms it is for this reason that we always balance chemical equations until you are really familiar with using formulae. It is easier to draw out the molecules as models to enable you to account for all the atoms.

A theory, or model, is also based on a set of hypotheses. Unlike a law, however, a theory describes and explains why a natural phenomenon occurs.

In science, theories explain reality well and are generally accepted as truth. Theories are based on **information** from many different areas of study.

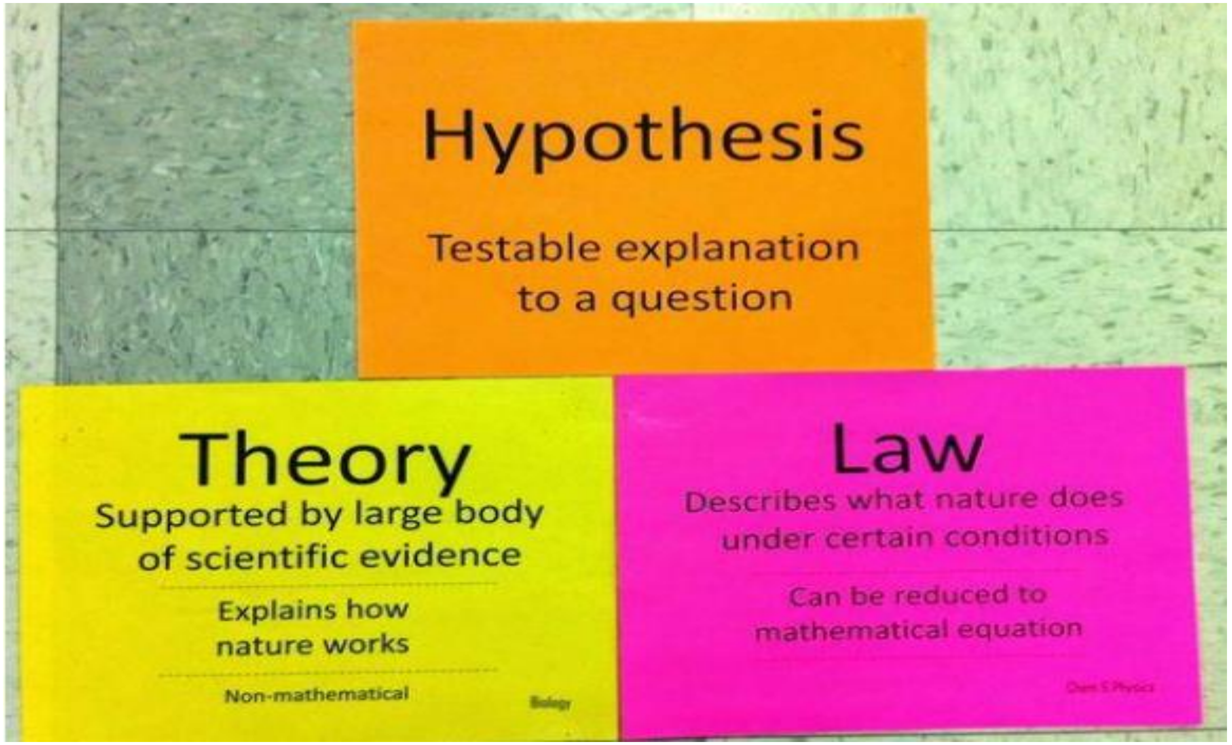
Our cartoon friend might find the theory of evolution quite helpful when trying to understand where cats came from or why different colored fur might be beneficial in helping cats to survive.

To briefly summarize, the **theory of evolution** explains that organisms slowly change over time due to genetic mutations. Organisms that have beneficial mutations, like the ability to camouflage well, are more likely to survive and pass their traits on to their offspring.

Theories can also be **changed** or **modified** if new evidence is found!

Examples of theories include:

- Cell Theory
- Theory of Relativity
- Atomic Theory
- Plate Tectonics Theory



Hypotheses vs Theories vs Laws

Hypothesis

- An educated guess based on observations
- A rational explanation of a single event
- Usually can be supported or refuted by continued experimentation or observation

Theory

- What one or more hypotheses become when they have been verified and accepted to be true
- It explains a set of related observation or proven events
- Verified multiple times by separate groups of researchers

Law

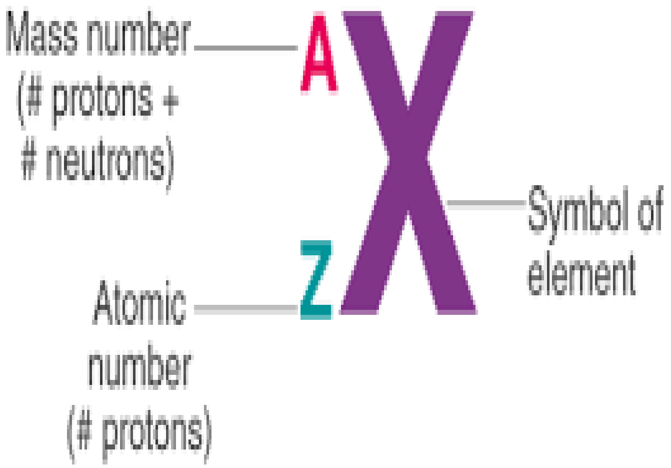
- Describes a single action (usually a mathematical relationship)
- Accepted to be true by the scientific community
- Much less complex compared to a theory

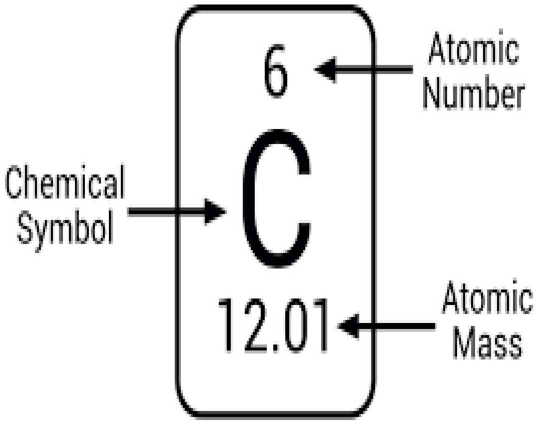
- **Discovery of Neutron, Isotopes, Isobars, Isotones and isoelectronics**

❖Introduction:

- It is a remarkable fact the existence of neutron was not discovered until 1932. The general atomic imagination of the time was protons and electrons

- scattering experiments, it was found out that the Atomic mass number A of an element is **a bit more** than twice the atomic number Z for most atoms and that essentially all the mass of an atom was concentrated in a very tiny space at the center of the atom. The alpha particles that took a 180-degree turn stand as proof of this.





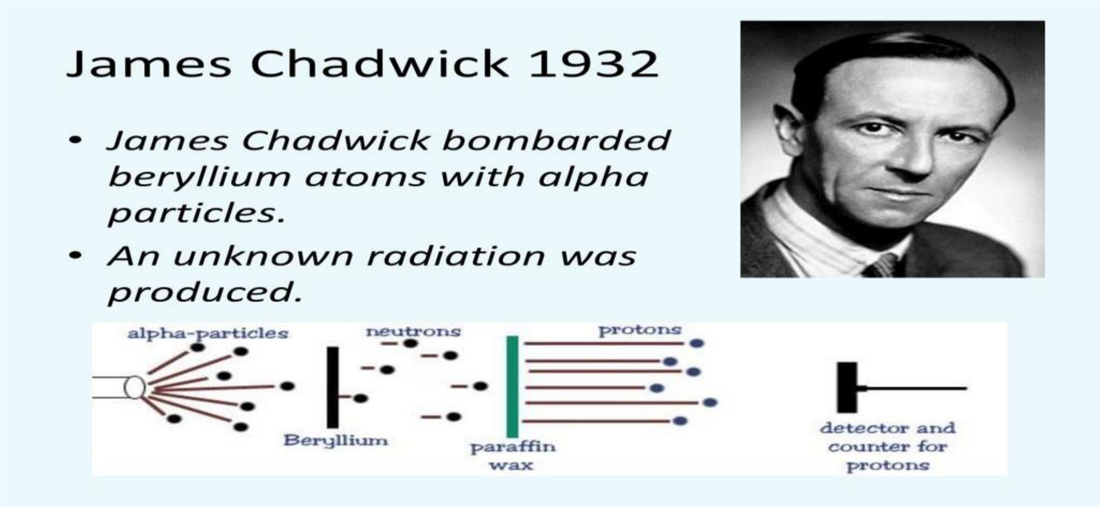
- Until 1930, a few electrons were thought to coexist with the protons in the dense nucleus but the immense amount of energy required to sustain such a system was way beyond the atomic energies.
- If we take the size of a Hydrogen atom as 0.2 nanometers, then the electron confinement energy is 38eV which is the correct magnitude for atomic electrons. But if the electron were to coexist with the protons in the nucleus, the electron confinement energy is approximately 250Mev! Many magnitudes huger than the 38eV.

- Who discovered the Neutron?

- A breakthrough came when it was shown that the bombardment of Beryllium with alpha particles from a radioactive source yielded penetrating but non-ionizing radiation.

- Such neutral radiation confounded the scientists since the only known neutral radiation than were photos.

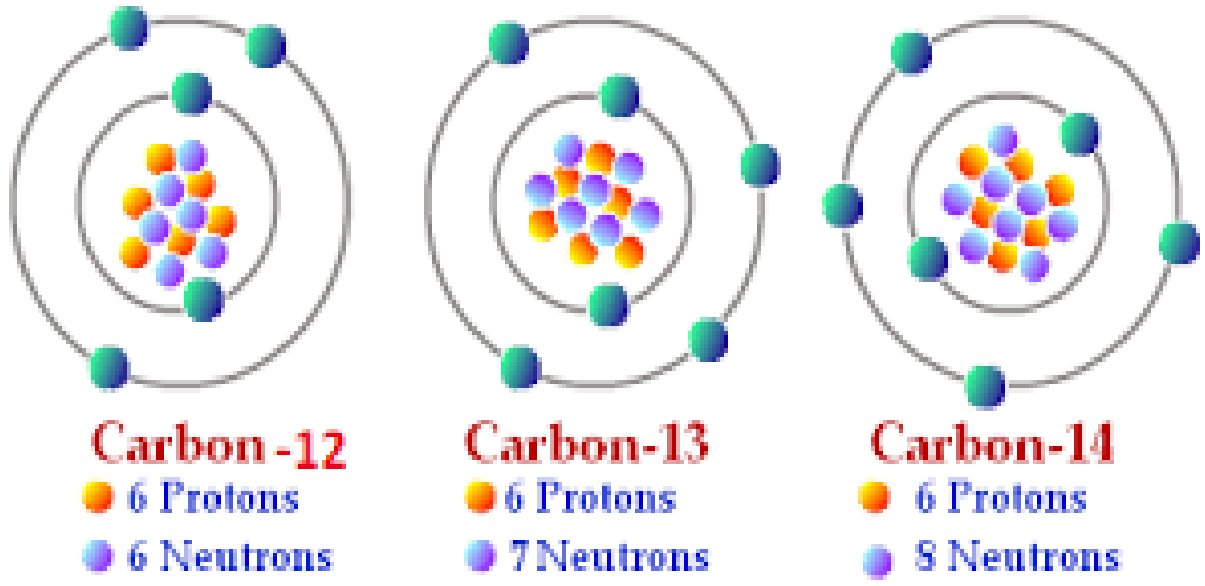
- The neutral radiation had it been a photon would exit the beryllium atom with far more energy than it actually does.



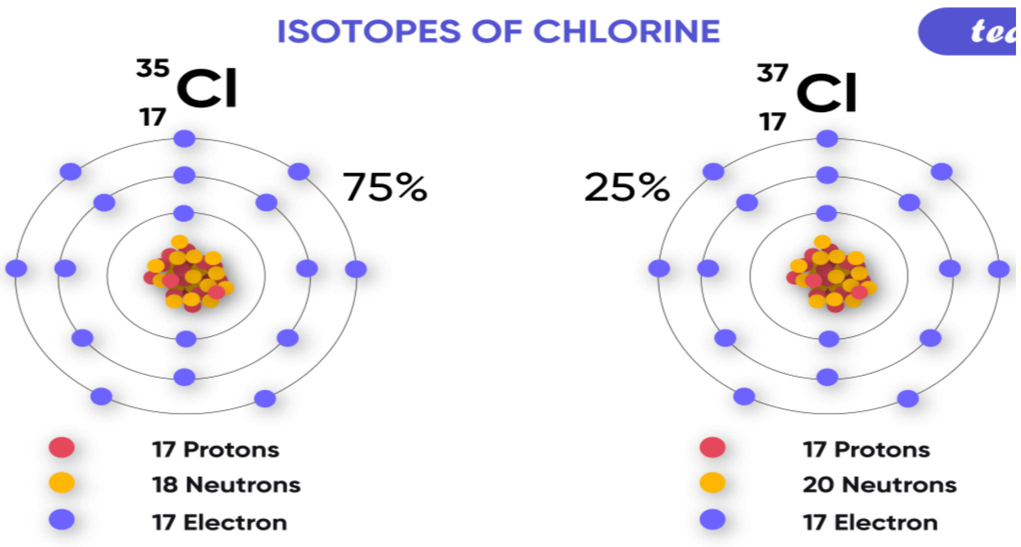
❖What is a Neutron?

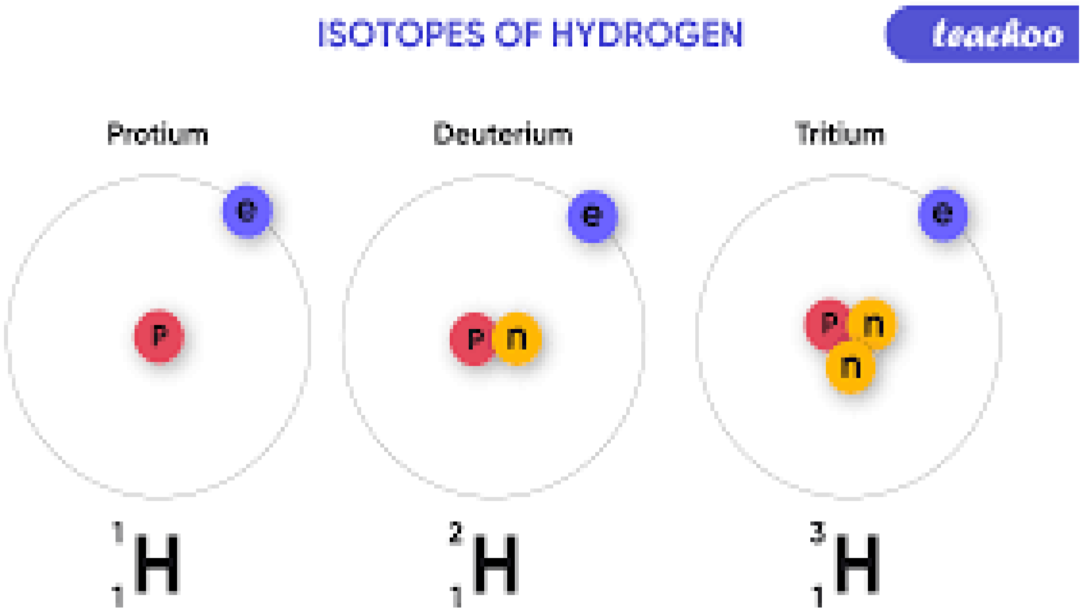
- The answer to this puzzle was provided by James Chadwick who boldly stated that this was a new type of fundamental particle that is neutral, and he called them Neutrons.
- From the conservation of energy and momentum, he was able to derive with considerable accuracy the mass of this new particle. He found that the mass of a neutron was very close to that of a proton.
- MN = 1.00866 u = 1.6749 X 10^{-27} kg
- So now the nucleus had another resident, and the proton-neutron pair was called a Nucleon.
- The discovery of Neutron led to a better understanding of atomic mass and atomic number also with isotopes which is what radioactivity is based on!
- Z – Atomic Number = number of protons/ electrons
- N – Neutron Number = Number of Neutron
- A – Atomic Mass Number = Z + N = Total number of protons and neutrons

- **What are Isotopes?**
- **Isotopes are variants of a particular element with different number of neutrons.**
- For example, the two isotopes of Uranium are, $_{235}U^{92}$ and $_{239}U^{92}$.
- You will see here that the number of protons is the same in both the isotopes, but they contain **143 and 147** neutrons respectively.
- The presence of an extra neutron significantly changes the behavior of that particular atom.
- There are two different types of isotopes, stable and radioactive. **Stable isotopes are one that can exist in its free state without breaking down spontaneously.**
- **Radioactive isotopes are ones that are too unstable to sustain itself, and they spontaneously break down into two lighter daughter elements with the emission of particles such as alpha, beta, and gamma rays**



Isotopes of Carbon

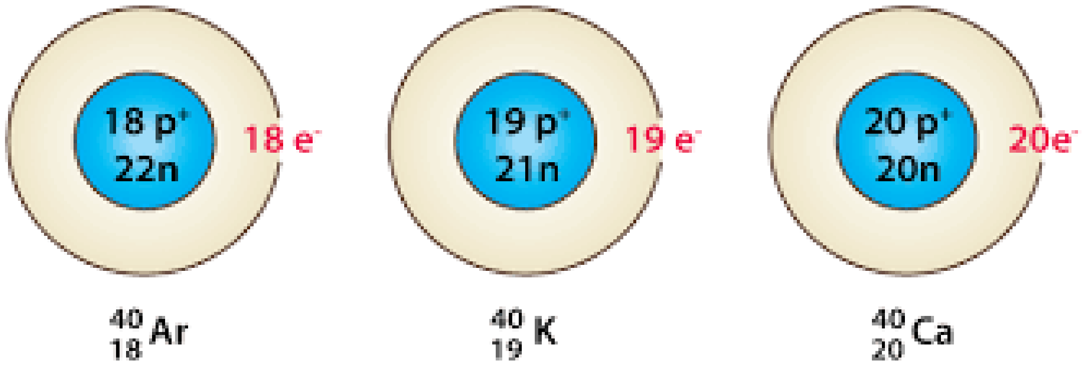




- **What are Isobars?**

- **Isobars are elements that have the same number of nucleons (sum of protons and neutrons).** The series of elements with **40 Mass numbers** serve as a good example; $_{40}S^{16}$, $_{40}Cl^{17}$, $_{40}Ar^{18}$, $_{40}K^{19}$, and $_{40}Ca^{20}$.

- The nucleus of all the above-mentioned elements contain the same number of particles in the nucleus but contain varying numbers of protons and neutrons.



Isobars: atoms of different elements with same atomic mass (40)

Isobar

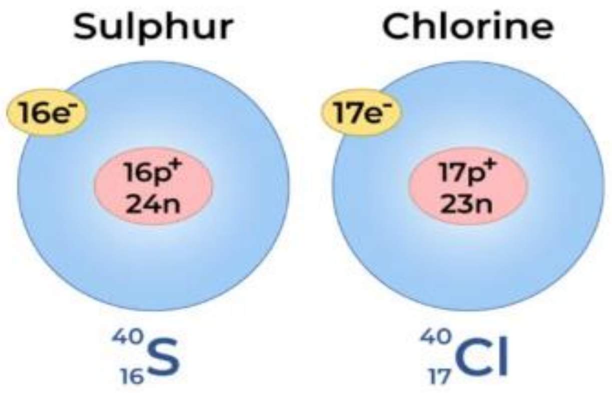
- Same atomic mass
- Different elements

$^{22}_{10}Ne$ $^{22}_{11}Na$

$^{40}_{18}Ar$ $^{40}_{19}K$

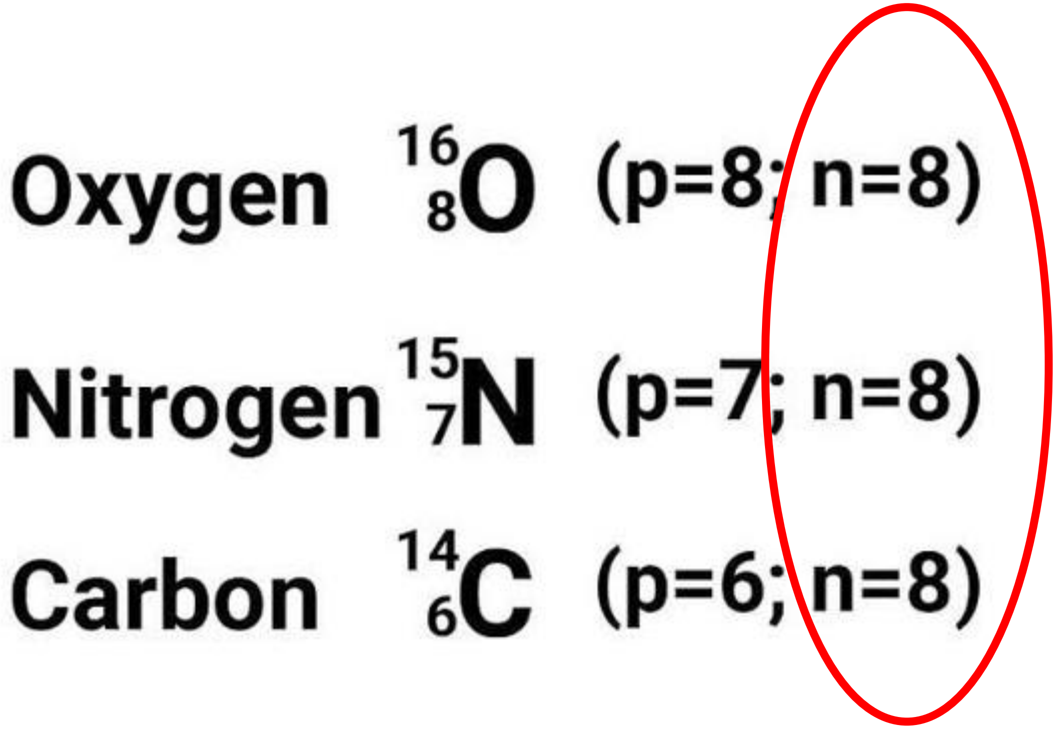
$^{14}_{7}N$ and $^{14}_{6}C$

$^{24}_{11}Na$ and $^{24}_{12}Mg$



- **What are Isotones?**

- **Isotones are atoms that have the same <u>neutron number but different proton number</u>.** For example, ${}_{36}S^{16}$, ${}_{37}Cl^{17}$, ${}_{38}Ar^{18}$, ${}_{39}K^{19}$, and ${}_{40}Ca^{20}$ are all isotones of **20 since they all contain 20 neutrons**.



What are Isoelectronics?

Isoelectronic Series

- Isoelectronic: having the same number of electrons

- N^{3-}, O^{2-}, F^{-}, Ne, Na^{+}, Mg^{2+}, and Al^{3+} form an isoelectronic series.
  - A group of atoms or ions that all contain the same number of electrons

Isoelectronic

Species with the same electron configuration.

These species all have the electron configuration of

$$1s^2\ 2s^2\ 2p^6$$

Ne, N^{3-}, O^{2-}, F^{-}, Na^{+}, Mg^{2+}, Al^{3+}

Example :

Isoelectronic ions	Mg^{2+}	Na^{+}	F^{-}	O^{2-}
No. of electrons	10	10	10	10
No. of protons	12	11	9	8

List of Some Isoelectronic Species

1. N^{3-}, O^{2-}, F^{-}, Ne, Na^{+}, Mg^{2+}, Al^{3+}, CH_4, NH_3, H_2O, HF
2. P^{3-}, S^{2-}, Cl^{-}, Ar, K^{+}, Ca^{2+}
3. H^{-}, He, Li^{+}, Be^{2+}
4. CO, CN^{-}, N_2
5. N_2O, CO_2, CNO^{-}

ChemistNotes.com

ISOELECTRONIC

ATOM/ION/ MOLECULE	NO OF ELECTRONS
N^{3-}	7+3=10
O^{2-}	8+2= 10
F^{-}	9+1= 10
Ne	10
Na^{+}	11-1= 10
Mg^{2+}	12-2= 10
Al^{3+}	13-3= 10
Si^{4+}	14-4=10

Which of the following pairs is correctly matched

A) Isotopes $^{40}_{20}Ca, ^{40}_{19}K$ ✗

B) Isotones $^{30}_{14}Si, ^{31}_{15}P, ^{32}_{16}S$ ✓

C) Isobars $^{16}_{8}O, ^{17}_{8}O, ^{18}_{8}O$ ✗

D) Isoelectronic N^{-3}, O^{-2}, Cr^{+3} ✗

Which of the following species are isoelectronic with Ne?

Choose one or more:

- ☐ Li
- ☐ Li^{+}
- ☐ F^{-}
- ☐ Al^{3+}
- ☐ Na^{+}
- ☐ Ca
- ☐ Mg^{2+}

Which of the following are a pair of isotopes?

- ○ ${}^{40}_{20}Ca$ and ${}^{40}_{19}K$
- ○ ${}^{40}_{20}Ca$ and ${}^{39}_{19}K$
- ○ ${}^{40}_{18}Ar$ and ${}^{40}_{19}K$
- ○ ${}^{40}_{20}Ca$ and ${}^{42}_{20}Ca$
- ○ ${}^{40}_{18}Ar$ and ${}^{80}_{36}Kr$

The set which represents the isotopes, isobars and isotones respectively is

- ($_1H^2$, $_1H^3$), ($_{79}Au^{197}$, $_{80}Hg^{198}$) & ($_2He^3$, $_1H^2$)
- ($_1H^2$, $_1H^3$), ($_2He^3$, $_1H^3$) & ($_{79}Au^{197}$, $_{80}Hg^{198}$)
- ($_2He^3$, $_1H^1$), ($_1H^2$, $_1H^3$) & ($_{79}Au^{197}$, $_{80}Hg^{198}$)
- ($_2He^3$, $_1H^1$), ($_{79}Au^{197}$, $_{80}Hg^{198}$) & ($_1H^1$, $_1H^3$)

What is the meaning of these terms?

- Science
- Scientific
- Scientist
- Difference
- Different