

Hadrons

- Hadrons are particles that can feel the **strong nuclear force**. (force that holds the protons together)
- Hadrons are made up of smaller particles called **quarks**. (hence hadrons are not fundamental particles)
- There are two types of hadrons — **baryons and mesons**.
- Baryons and mesons are classified according to the number of quarks that make them.

Baryons

baryons: 3 quarks
mesons: 2 quarks

What are baryons? (3 quark composition)

- **Protons and neutrons** (nucleons) are both baryons
- There are also other baryons that you don't get in normal matter like sigmas (Σ).
- All baryons except a free proton (i.e. not in a nucleus) can be unstable.
- This means that all baryons apart from protons decay to become other particles. (eventually a proton)
- Baryons must contain **3 quarks** in its composition.

Antiprotons and antineutrons are antibaryons

- Antiparticles are annihilated when they meet the corresponding particle — which means that you don't find antibaryons in ordinary matter.

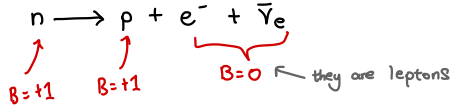
Conservation of baryon number

- Baryon number is basically nucleon number (if you ignore unusuals like Σ)

Protons/Neutrons/ Σ : $B = +1$
Antiprotons/Antineutrons: $B = -1$
Non-baryons (mesons/leptons): $B = 0$

The total baryon number in any particle interaction never changes.

- Using beta-minus decay as an example, we can see the conservation of baryon number come into play here:



Mesons

What are mesons? (2 quark composition)

- All mesons are **unstable**.
- Mesons are not observable in day-to-day life. However, large amounts are observable in high-energy particle collisions like in the CERN particle accelerator.

Examples of mesons

- **Pions** (π^+ , π^0 , π^-) are the **exchange particle of the strong nuclear force**.
- π^+ and π^- are particle - antiparticle pairs.
- **Kaons** (K^+ , K^- , K^0) are **heavier** and more **unstable** than pions.
- Kaons have a very short lifetime