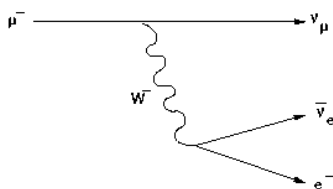


Fundamental Particles

In the current model, all matter is made out of three types of elementary particles: leptons, quarks and exchange particles.

Leptons

The LEPTONS are the electron, muon, tauon and their associated neutrinos. They all have a -1 charge. There are also six antileptons with a charge of +1. Leptons have a lepton number of +1 and the antileptons have a lepton number of -1. Lepton number is always conserved. Leptons do not encounter the strong force.

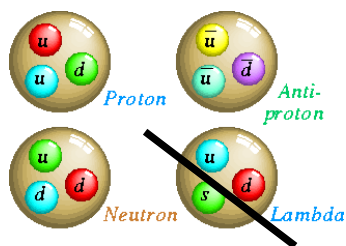


Particle interaction diagram of muon decay.

Quarks

QUARKS come in three flavours – up, down and strange. Particles made up of quarks are subject to the strong force (ie. hadrons).

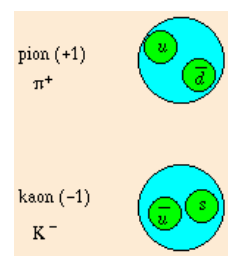
| Quark / Antiquark | Symbol | | Charge/e | | Baryon number, B | | Strangeness, S | |
|-------------------|--------|-----------|----------|------|------------------|------|----------------|---|
| | u | \bar{u} | +2/3 | -2/3 | 1/3 | -1/3 | 0 | 0 |
| down | d | \bar{d} | -1/3 | +1/3 | 1/3 | -1/3 | 0 | 0 |
| charm | c | \bar{c} | +2/3 | -2/3 | 1/3 | -1/3 | 0 | 0 |
| strange | s | \bar{s} | -1/3 | +1/3 | 1/3 | -1/3 | -1 | 1 |



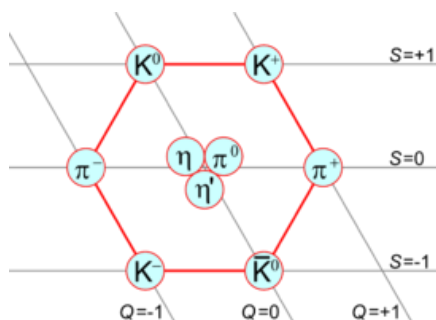
BARYONS are composed of three quarks (and every antibaryon is composed of three antiquarks). You will need to know the combination of quarks and antiquarks for protons, neutrons, antiprotons and antineutrons.

The only stable baryon is the proton.

MESONS are composed of a quark and an antiquark. You need to know the quark composition for pions and kaons.



The π^0 meson is its own antiparticle eg. An up-antiup becomes an antiup-up, which are the same.



The other mesons are positioned *opposite* to their antiparticles eg. K^+ has up-antistrange quarks and the K^- has strange-antiup quarks. Hence the antiparticles of mesons are *still mesons*, but they do have different charge and strangeness.

The meson octet.

EXCHANGE PARTICLES are responsible for forces between elementary particles. They are the *virtual photon* (electromagnetic), W^+ and W^- bosons (weak) and the *gluon* (strong).

Questions**The atom**

1. Sketch the atomic model of the atom and label the following particles; electron, proton and neutron.
2. What are the relative masses of the different particles in the atom?
3. What are the relative charges of the particles in the atom?
4. Which two particles are found in the nucleus?
5. Using the information on the page above which particle in the atom is a fundamental particle?

Classification of particles

1. Give one example of a lepton.
2. Which force do leptons **not** encounter?
3. Give one example of a baryon.
4. What fundamental particles are baryons made from? How many of these particles are needed to make a baryon?
5. What particle is the only stable baryon?
6. Give one example of a meson.
7. What fundamental particles are mesons made from? How many of these particles are needed to make a meson?
8. What are exchange particles?
9. What is the exchange particle for the strong nuclear force?

Application

1. Particle A contains 3 quarks what type of particle is particle A?
2. Particle X does not encounter the strong force what type of fundamental particle is particle X?
3. Particle Y contains an up quark and an anti-down quark what type of particle is particle Y?