HADRONS **- made of quarks**

BARYONS **- made of three quarks or three anti-quarks**

NUCLEONS **- contain no strange quarks**

|  |  |  |
| --- | --- | --- |
|  PARTICLE | CHARGE | MASS(MeV) |
|  proton |  +1 |  938.27231 |
|  anti-proton |  -1 |  938.27231 |
|  neutron |  0 |  939.56563 |
|  anti-neutron |  0 |  939.56563 |

HYPERONS **- contain one or more strange quarks**

|  |  |  |
| --- | --- | --- |
|  PARTICLE |  CHARGE |  MASS(MeV) |
|  lambda |  0 |  1115.684 |
|  anti-lambda |  0 |  1115.684 |
|  positive sigma |  +1 |  1189.37 |
|  anti-positive sigma |  -1 |  1189.37 |
|  neutral sigma |  0 |  1192.55 |
|  anti-neutral sigma |  0 |  1192.55 |
|  negative sigma |  -1 |  1197.436 |
|  anti-negative sigma |  +1 |  1197.436 |
|  neutral xi |  0 |  1314.9 |
|  anti-neutral xi |  0 |  1314.9 |
|  negative xi |  -1 |  1321.32 |
|  anti-negative xi |  +1 |  1321.32 |
|  negative omega |  -1 |  1672.45 |
|  positive omega |  +1 |  1672.45 |

MESONS **- made of one quark and one anti-quark**

|  |  |  |
| --- | --- | --- |
|  PARTICLE |  CHARGE |  MASS(MeV) |
|  positive pion |  +1 |  139.56995 |
|  negative pion |  -1 |  139.56995 |
|  neutral pion |  0 |  134.9764 |
|  positive kaon |  +1 |  493.677 |
| negative kaon | -1 | 493.677 |
|  neutral kaon |  0 |  497.672 |
|  anti-neutral kaon |  0 |  497.672 |
|  eta |  0 |  547.45 |

 LEPTONS **- elementary particles not made of quarks**

|  |  |  |
| --- | --- | --- |
|  PARTICLE |  CHARGE |  MASS(MeV) |
|  positron |  +1 |  0.51099907 |
|  electron |  -1 |  0.51099907 |
|  electron neutrino |  0 |  0 |
|  electron anti-neutrino |  0 |  0 |
|  positive muon |  +1 |  105.658389 |
|  negative muon |  -1 |  105.658389 |
|  muon neutrino |  0 |  0 |
|  muon anti-neutrino |  0 |  0 |
|  positive tau |  +1 |  1777.0 |
|  negative tau |  -1 |  1777.0 |
|  tau neutrino |  0 |  0 |
|  tau anti-neutrino |  0 |  0 |

 GAUGE BOSON **- carries force**

|  |  |  |
| --- | --- | --- |
|  PARTICLE |  CHARGE |  MASS(MeV) |
|  gamma |  0 |  0 |

Use this website to ‘watch’ the particle

decays.

<http://ed.fnal.gov/students/hwtools/dcypages/decay/decay3.html>

Questions on Conservation Laws

1. Refer to the charges on the [particle table](http://ed.fnal.gov/students/hwtools/dcypages/decay/partab.html). How much total charge exists in the neutron's decay products? Is charge conserved?
2. Are the decay products of the antineutron related to those of the neutron? If so, how? If not, how not?
3. Are the decay products of the positive sigma and the anti-negative sigma related? If so, how? If not, how not?
4. Keep track (on some paper or on a board if necessary) of all the particles into which the negative omega EVENTUALLY decays. (If a particle just seems to decay into itself, that branch is done.) Sum the charges in the FINAL decay products. What do they equal? Is charge conserved?
5. Find all of the stable particles on this page. They are the ones that just seem to decay into themselves. Which ones are they?
6. Find at least five examples of a specific particle in the first two rows that never seems to decay into another specific particle in the first two rows.
7. Look at the masses on the [particle table](http://ed.fnal.gov/students/hwtools/dcypages/decay/partab.html) and compare values for the pairs of particles you found in answer to the previous question. What seems true about the relative masses of each pair of particles? Is mass conserved? Is energy?
8. The proton's charge is +1. It is stable. If it could decay into two new particles, what two particles might it produce, yet still conserve charge and energy?
9. The antiproton's charge is -1. It is stable. If it could decay into two new particles, what two particles might it produce, yet still conserve charge and energy?