Quark structure of baryons

A.C. Norman
anorman@bishopheber.cheshire.sch.uk

1. (a) A baryon is formed from three quarks. There are ten possible combinations of the up, down and strange (u, d, and s) which will make baryons. List these ten combinations.
   u u u, u u d, u u s, u d s, u s s, d d d, d d u, d d s, d s s, s s s.

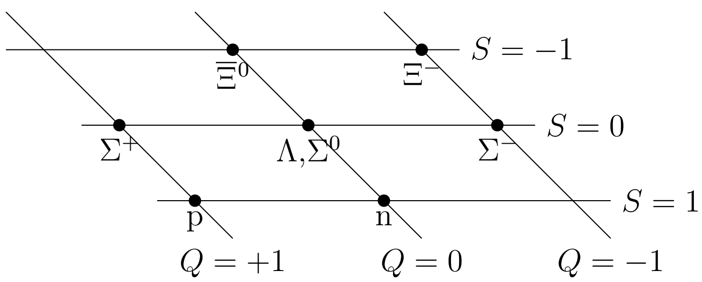
   (b) The table below shows eleven baryons. Using your list from 1a identify the quark structure in each of the baryons.

particle	Charge (Q) / e	Baryon number	Strangeness	Quark Structure
p	+1	1	0	u u d
n	0	1	0	d d u
Λ	0	1	−1	u d s
Σ^+	+1	1	−1	u u s
Σ^0	0	1	−1	u d s
Σ^-	−1	1	−1	d d s
Δ^-	−1	1	0	d d d
Δ^{++}	+2	1	0	u u u
Ξ^0	0	1	−2	u s s
Ξ^-	−1	1	−2	d s s
Ω^-	−1	1	−3	s s s

   (c) Which two baryons have the same quark structure?
   Λ and Σ^0

   (d) How may they be different to each other?
   Difference in rest energy, due to the quarks being in differing energy states.

   (e) The diagram below is often called the *Baryon Octet*. Copy the diagram, and add on the eight particles at the intersections of the lines. (Don't put any Δs on this diagram.)



   (f) Why is there no particle with a strangeness of −2 and a charge of +1?
   For a baryon to have strangness of −2, it must contain two strange quarks, which would (together) have $Q = -\frac{2}{3}$. There exists no quark with the required properties ($Q = +\frac{5}{3}$, $B = +\frac{1}{3}$, $S = 0$) to make the particle described in the question.