Unit 1
Particles, Quantum Phenomena and Electricity

2.5 Conserv-ation Rules

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Particles and properties

- Particles, as we have seen, possess properties such as charge, momentum, energy, spin, baryon number, lepton number, strangeness and others.
- In all interactions and decays, particles must obey conservation rules involving some or all of these properties.
- Total energy and charge must be conserved in **all** interactions and decays. These are laws of physics.
- Conservation rules are simply based on which interactions are observed and which ones never happen. We use only a limited number of these in your course:

Conservation of Lepton Number

In any interaction or decay, the total lepton number must be conserved. This means the total electron lepton number **and** the total muon lepton number must not change.

Conservation of Strangeness Number

In any **strong** interaction, the total strangeness number must stay the same. Strangeness is **not** conserved in weak interactions. Strange particles decay via the weak interaction so strangeness is not conserved when strange particles decay.

Conservation of Baryon Number

All baryons have a baryon number of +1.
All antibaryons have a baryon number of -1.
All mesons and leptons have a baryon number of 0.

In all interactions and decays, the total baryon number is conserved.

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What lies beyond?

Although the limits of your course do not permit further study, as accelerators grew more and more powerful, they revealed the existence of more massive quarks. In fact the quarks form three generations:

First generation:	up quark	down quark
Second generation:	strange quark	charmed quark
Third generation:	top quark	bottom quark

Quarks also have a property known as colour or colour charge. This restricts the ways they can combine to form particles. (Quarks are never found separately).

There are even some tantalising hints that there may be further structure inside quarks.

The problem of mass

One of the next big questions for particle physicists to answer is “what is mass?”
Peter Higgs, emeritus professor at the University of Edinburgh and leading theoretical physicist, has proposed that mass measures how strongly a particle interacts with a field that permeates the whole Universe, known now as the Higgs Field. The greater the interaction, the greater the mass. The particle which mediates this interaction is known as the **Higgs Boson**. If it exists, the Large Hadron Collider should have the energy to reveal it. The world of particle physics is waiting for the next big step.

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