The rest energy of a particle is given by:

$$E = mc^2$$

All particles have an antiparticle with the same rest energy but another opposite property eg charge, spin. When a particle and an antiparticle meet they 'annihilate' and their mass goes to energy, governed by $E=mc^2$ relationship. The opposite can occur is energy can create matter.

Conservation Laws:

In any interaction
- charge
- lepton number
- baryon number
- spin etc

must be conserved

Fundamental Forces	Range/m	Boson
Strong	$\sim 10^{-15}$	Gluon
Electromagnetic	∞	Photon
Weak	$\sim 10^{-17}$	W^+, W^-, Z^0
Gravitational	∞	

Bosons are exchanged and cause a force. However they are considered virtual.

Chapter 17
Probing Deep into Matter

Collisions

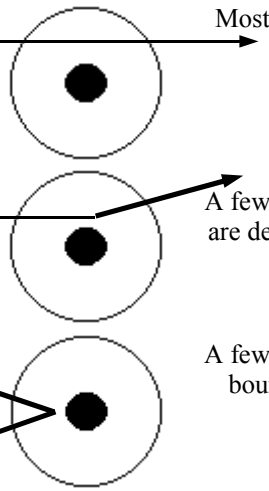
In an elastic collision all KE is conserved
eg e^- bouncing off an atom
KE is not conserved in an inelastic collision
eg ionisation -some energy required to remove e^-
excitation -some energy required to excite an e^- from the ground state to a higher energy level.
The loss of KE in such a collision corresponds to the discrete energy levels in an atom.
Electrons can make quantum jumps between allowed energy levels, emitting a photon whose energy is given by:

$$E = hf = E_{initial} - E_{final}$$

For Hydrogen the energy spacings are given by:

$$E_n = \frac{13.6eV}{n^2}$$

Rutherford Scattering Experiment



Rutherford concluded that the atom must contain a heavy positively charged nucleus at the centre, with lighter, negatively charged electrons in orbit around it.

Classification of Particles

Affected by the strong force	**Hadrons**	Baryons eg proton, neutron, sigma plus Spin 1/2, 3/2 etc Mesons eg pion-zero, kaon zero Spin 0, 1 etc
Not affected by the strong force	**Leptons**	eg electrons, muons, tau Spin1/2

Quarks have fractional Charges: +2/3 or –1/3. Three quarks make up a hadron.