# Particles

#### 1 Constituents of the atom

Specific charge - The charge to mass ratio

Isotope - An atom with the same number of protons as an element but a different number of neutrons

#### 2 Stable and unstable nuclei

## 2.1 The strong nuclear force

0fm - 0.5fm - Repulsion 0.5fm - 3fm - Attraction 3fm+ - No force

## 2.2 Alpha decay

An atom emits an alpha particle (Helium Nucleus/2 protons and 2 neutrons) Reduces  $Mass\ Number$  by 4 and  $proton\ number$  by 2

## 2.3 Beta decay

Neutron→Proton+Electron+Neutrino
The neutrino was hypothesised to conserve energy

## 3 Particles, antiparticles and photons

For every particle there is a corresponding antiparticle (can be itself)

Property	Particle	Antiparticle
Mass	x	x
Charge	x	-x
Rest Energy	x	x
Baryon Number	x	-x
Lepton Number	x	-x
Strangeness	x	-X

When a particle and antiparticle collide they annihilate each other

A particle-antiparticle pair can be produced from energy

#### 4 Particle interactions

Fundamental interactions:

Force	Affects	Gauge Boson	Range
Gravitational	Mass	Graviton	Infinite
Electromagnetic	Charge	Photon	Infinite
Nuclear Strong	Quarks	Gluon(Pion)	$10^{-15}$ m
Nuclear Weak	Leptons+Quarks	$W^{+}, W^{-}, Z^{0}$	$10^{-18}$ m

The exchange particles provide the forces between elementary particles Virtual photons are the exchange particle of the electromagnetic force Examples of the weak interaction:

- $\beta^+$  Decay
- $\beta^-$  Decay
- Electron capture
- Electron-proton collisions

# 5 Classification of particles

#### 5.1 Hadrons

Hadrons are subject to the strong interaction There are two types of hadrons:

- Baryon(3 Quarks)
- Meson (Quark-Antiquark pair)

The baryon number is conserved in an interaction All baryons will eventually decay into protons Kaons can decay into pions

## 5.2 Leptons

Types of lepton(All have a lepton number of 1):

- Electron
- Muon
- Electron Neutrino (Approximated to massless)
- Muon Neutrino (Approximated to massless)

Lepton number is conserved during an interaction Muons decay into electrons

#### 5.3 Strange particles

Produced through the strong interaction Decay through the weak interaction

# 6 Quarks and antiquarks

# 6.1 Baryons

Proton	UUD
Neutron	DUD

## 6.2 Mesons

## 6.2.1 Pions(All 0 Strangeness)

$\pi^0$	$U\bar{U}$ or $D\bar{D}$
$\pi^+$	$U\bar{D}$
$\pi^-$	$Dar{U}$

## 6.2.2 Kaons (All strange)

$K^+$	$Uar{S}$
K <sup>-</sup>	$ar{U}S$
$K^0$	$Dar{S}$
$ar{K^0}$	$\bar{D}S$