Particle Forces

force	affects	exchange particles	range
strong nuclear	hadrons	pion/gluon	none- >4fm, attrac 0.5<x<4fm, repul <0.5fm
em	charged particles	photons	infinite
weak nuclear	all	$W^{+/-}$	10^{-18}
gravity	all	graviton	infinite

the strong nuclear force holds nucleons together in a nucleus. the repulsion at <0.5fm stops the nucleus imploding.

specific charge

specific charge:
charge to mass ratio
for an atom, is the charge (typically proton number unless an ion then the charge eg 2+ only) over the overall mass (proton and neutron number)

nuclear decay equations

unstable nuclei decay to become more stable emitting radiation. these can ionise other atoms/molecules which can be dangerous
Alpha decay (larger nuclei):
4 on the top, 2 on the bottom
Beta decay (smaller nuclei):
+ - p>n
- - n>p
*make sure lepton numbers are balenced
eg. beta- decay has anti electron neutrino
gamma radiation:
is a high energy EM wave that can be emitted but this isnt due to decay but due to nucleus being in an metastable state (excess energy)
in a decay equation you would write the product number at the top with a small m
in a separate equation you take the element with the m and write it out with the product being without the m and the gamma ray

conservation

charge, energy and momentum, baryon/lepton number must all be conserved in any interaction.
strangeness doesnt need to be conserved, only in *strong* interaction
rules:
- particle decay > strangeness is not always conserved
- pair production > strangeness is always conserved
strangeness:
- strange particles are produced by strong interaction
- to conserve strangeness they are always created in pairs
eg. p + p = $us\bar{s}$
- they decay via weak interaction but don't need to be created in pairs (don't have to be conserved)
proving conservation: (Relating to particle interactions)
$B^{+/-}$ --> occurs in a neutron (decay) - B^{+} = p>n
electron scatter --> come close and repel due to charge
P-N bond --> occurs in nuecleus due to strong force (also em however em is weaker than strong)
electron capture --> electron captured by a proton, therefore exchange particle is always from the proton (W^{+})
E-P collision --> electron collides with proton so exchange particle comes from the electron (w^{-})

Annihilation and pair production

these are possible due to the fact that **mass can be converted ubti energy and vice versa**
Annihilation:
particle and antiparticle collide- mass is converted to two photons
minimum energy/frequency:
$2mc^2 = 2hf$
if the particles have kinetic energy this is added to the photons energy
Pair production:
a photon of sufficient energy is converted into a particle and its antiparticle
minimum freq photon for this:
$hf = 2mc^2$
if photon has more than minimum needed, it is converted into Ek