

AQA A-Level Physics

2.1 Particles

Flashcards

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What are the main constituents of an atom?



What are the main constituents of an atom?

- Proton
- Neutron
- Electron



What is meant by specific charge?



What is meant by specific charge?

The charge to mass ratio:

$$\textit{Specific charge} = \textit{charge} / \textit{mass}$$

Units C/kg.



What is the specific charge of a proton?



What is the specific charge of a proton?

Protons have charge $+1.6 \times 10^{-19}$ and mass 1.67×10^{-27} kg

$$\begin{aligned}\text{Specific charge} &= 1.6 \times 10^{-19} / 1.67 \times 10^{-27} \\ &= 9.58 \times 10^7 \text{ C/kg}\end{aligned}$$



What is the letter associated with a proton number?



What is the letter associated with a proton number?

Z.



What is a nucleon?



What is a nucleon?

A constituent of the nucleus: a proton or a neutron.



What letter represents nucleon number?

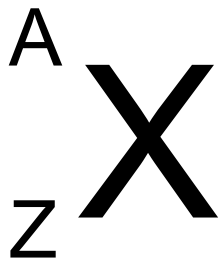


What letter represents nucleon number?

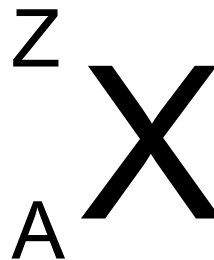
A.



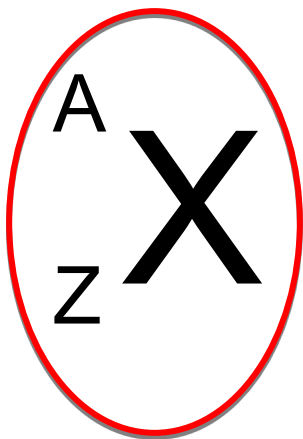
Which is the correct notation?



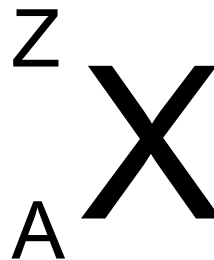
OR



Which is the correct notation?



OR



What is an isotope?



What is an isotope?

A version of an element with the same number of protons but a different number of neutrons.



State a use of radioactive isotopes.



State a use of radioactive isotopes.

Carbon dating - the proportion of carbon-14 in a material can be used to estimate its age.



What is the strong nuclear force?



What is the strong nuclear force?

The fundamental force that keeps the nucleus stable by counteracting the electrostatic force of repulsion between protons.



Describe the range of the strong force?



Describe the range of the strong force?

- Repulsive up to 0.5fm
- Attractive from 0.5-3fm
- Negligible past 3fm



What makes a nucleus unstable?



What makes a nucleus unstable?

Nuclei which have too many of either protons or neutrons or both.



How do nuclei with too many nucleons decay?



How do nuclei with too many nucleons decay?

Alpha decay (emission of a helium nucleus formed of 2 protons and 2 neutrons).



How do nuclei with too many neutrons decay?



How do nuclei with too many neutrons decay?

Beta minus decay in which a neutron decays to a proton by the weak interaction (quark character has changed from udd to uud).



How was the existence of the neutrino hypothesised?



How was the existence of the neutrino hypothesised?

The energy of particles **after** beta decay was lower than before, a particle with 0 charge (to conserve charge) and negligible mass must carry away this excess energy, this particle is the neutrino.



What is meant by beta minus decay?



What is meant by beta minus decay?

When a neutron turns into a proton, the atom releases an electron and an anti-electron neutrino.



What is an alpha particle?



What is an alpha particle?

A particle contains two protons and two neutrons, the same as a helium nucleus.



What is an antiparticle?



What is an antiparticle?

For each particle there is an antiparticle with the same rest energy and mass but all other properties are the opposite of its respective particle.



True or false:
'Every particle has a antiparticle'



True or false: 'Every particle has a antiparticle'

True.



What is the name of the antiparticle of an electron?



What is the name of the antiparticle of an electron?

Positron.



What is the antiparticle of π^0 (pion with 0 charge) ?



What is the antiparticle of π^0 (pion with 0 charge) ?

π^0 , its antiparticle is itself.



What occurs when a particle and antiparticle meet?



What occurs when a particle and antiparticle meet?

Annihilation:

The mass of the particle and antiparticle is converted back to energy in the form of 2 gamma ray photons which go in opposite directions to conserve momentum.



What is pair production?



What is pair production?

A gamma ray photon is converted into a particle-antiparticle pair.



What is the minimum energy of a photon required to make a proton-antiproton pair?



What is the minimum energy of a photon required to make a proton-antiproton pair?

2 x proton rest energy

$$2 \times 938.257 = 1876.514 \text{ MeV}$$



Name the 4 fundamental forces?



Name the 4 fundamental forces?

- Gravity
- Electromagnetic
- Weak nuclear
- Strong nuclear



The virtual photon is the exchange particle of which force?



The virtual photon is the exchange particle of which force?

The electromagnetic force.



What type of particles are affected by the strong nuclear force?



What type of particles are affected by the strong nuclear force?

Hadrons.



What is the exchange particle of the weak nuclear force?



What is the exchange particle of the weak nuclear force?

The W boson (W^+ or W^-).



What does the electromagnetic force act on?



What does the electromagnetic force act on?

It acts on charged objects, for example when a positively charged ball repels another positively charged ball.



When does weak nuclear interaction occur?



When does weak nuclear interaction occur?

When quark character changes (a quark changes into another quark), it affects all types of particles.



Which properties must be conserved in particle interactions?



Which properties must be conserved in particle interactions?

- Energy
- Charge
- Baryon number
- Lepton number
- Momentum
- Strangeness (only for strong interactions)



What is a hadron?



What is a hadron?

Both baryons and mesons are hadrons, hadrons are made of 2 or more quarks held together by the strong nuclear force.



What are the classes of hadrons?



What are the classes of hadrons?

- Baryons (three quarks)
- Mesons (1 quark, 1 antiquark)



The pion and kaon are both examples of which class of particle?



Pion and kaon are both examples of which class of particle?

Mesons.



The pion can be an exchange particle for
which force?



The pion can be an exchange particle for which force?

The strong nuclear force.



What particle does a kaon decay into?



What particle does a kaon decay into?

A kaon decays into a pion.



Give some examples of baryons?



Give some examples of baryons?

- Proton - uud
- Neutron - ddu



What is significant about a proton?



What is significant about a proton?

- It is the only stable baryon
- All baryons will eventually decay into protons



What are some example of leptons?



What are some examples of leptons?

- Electron
- Muon
- Neutrino
- (the antiparticles of the above)



What does a muon decay into?



What does a muon decay into?

An electron and two types of neutrino.



What is the strangeness value of a strange quark?



What is the strangeness value of a strange quark?

-1



True or false:
'Strangeness is always conserved in a
weak interaction'



True or false: 'Strangeness is always conserved in the weak interaction'

False.

Strangeness is only conserved in the strong interaction, in weak interactions it can change by 0, -1 and +1.



Complete the sentence:
Strange particles are produced through the
_____ and decay through the _____.



Strange particles as particles that are produced through the **strong interaction** and decay through the **weak interaction**.

