A Level Physics Online

AQA Physics - 7407/7408

Module 2: Particles and Radiation

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
2.1 Particles				
2.1.1 Constituents of the Atom				
Simple model of the atom, including the proton, neutron and electron. Charge and mass of the proton, neutron and electron in SI units and relative units.				
The atomic mass unit (amu) is included in the A-level Nuclear physics section.				
Specific charge of the proton and the electron, and of nuclei and ions.				
Proton number Z, nucleon number A, nuclide notation.				
Students should be familiar with the $^{A}_{Z}X$ notation.				
Meaning of isotopes and the use of isotopic data.				
2.1.2 Stable and Unstable Nuclei				
The strong nuclear force; its role in keeping the nucleus stable; short-range attraction up to approximately 3 fm, very-short range repulsion closer than approximately 0.5 fm.				
Unstable nuclei; alpha and beta decay.				
Equations for alpha decay, β^- decay including the need for the neutrino.				
The existence of the neutrino was hypothesised to account for conservation of energy in beta decay.				
1.3 Particles, Antiparticles and Photons				
For every type of particle, there is a corresponding antiparticle.				
Comparison of particle and antiparticle masses, charge and rest energy in MeV.				

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Students should know that the positron, antiproton, antineutron and antineutrino are the antiparticles of the electron, proton, neutron and neutrino respectively.				
Photon model of electromagnetic radiation, the Planck constant. $E = h f = hc / \lambda$				
Knowledge of annihilation and pair production and the energies involved.				
The use of $E = mc^2$ is not required in calculations.				
1.4 Particle Interactions				
Four fundamental interactions: gravity, electromagnetic, weak nuclear, strong nuclear. (The strong nuclear force may be referred to as the strong interaction.)				
The concept of exchange particles to explain forces between elementary particles.				
Knowledge of the gluon, Z^0 and graviton will not be tested.				
The electromagnetic force; virtual photons as the exchange particle.				
The weak interaction limited to β^- and β^+ decay, electron capture and electron–proton collisions; W^+ and W^- as the exchange particles.				
Simple diagrams to represent the above reactions or interactions in terms of incoming and outgoing particles and exchange particles.				
1.5 Classification of Particles				
Hadrons are subject to the strong interaction.				
The two classes of hadrons: • baryons (proton, neutron) and antibaryons (antiproton and antineutron) • mesons (pion, kaon)				
Baryon number as a quantum number.				
Conservation of baryon number.				
The proton is the only stable baryon into which other baryons eventually decay.				
The pion as the exchange particle of the strong nuclear force.				

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The kaon as a particle that can decay into pions.				
Leptons: electron, muon, neutrino (electron and muon types only) and their antiparticles.				
Lepton number as a quantum number; conservation of lepton number for muon leptons and for electron leptons.				
The muon as a particle that decays into an electron.				
Strange particles.				
Strange particles as particles that are produced through the strong interaction and decay through the weak interaction (eg kaons).				
Strangeness (symbol s) as a quantum number to reflect the fact that strange particles are always created in pairs.				
Conservation of strangeness in strong interactions.				
Strangeness can change by 0, +1 or -1 in weak interactions.				
Appreciation that particle physics relies on the collaborative efforts of large teams of scientists and engineers to validate new knowledge.				
1.6 Quarks and Antiquarks				
Properties of quarks and antiquarks: charge, baryon number and strangeness.				
Combinations of quarks and antiquarks required for baryons (proton and neutron only), antibaryons (antiproton and antineutron only) and mesons (pion and kaon only).				
Only knowledge of up (u), down (d) and strange (s) quarks and their antiquarks will be tested.				
The decay of the neutron should be known.				
1.7 Applications of Conservation Laws				
Change of quark character in β^- and in β^+ decay.				
Application of the conservation laws for charge, baryon number, lepton number and strangeness to particle interactions. The necessary data will be provided in questions for particles outside those specified.				

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Students should recognise that energy and momentum are conserved in interactions				
2.2 Electromagnetic Radiation and Quantum Phenomena				
2.1 The Photoelectric Effect				
Threshold frequency; photon explanation of threshold frequency.				
Work function ϕ, stopping potential.				
Photoelectric equation: $hf = \phi + E_{k(max)}$				
$E_{k(max)}$ is the maximum kinetic energy of the photoelectrons.				
The experimental determination of stopping potential is not required.				
2.2 Collisions of Electrons with atoms				
Ionisation and excitation; understanding of ionisation and excitation in the fluorescent tube.				
The electron volt.				
Students will be expected to be able to convert eV into J and vice versa.				
2.3 Energy levels and photon emissions				
Line spectra (eg of atomic hydrogen) as evidence for transitions between discrete energy levels in atoms.				
$hf = E_1 - E_2$				
In questions, energy levels may be quoted in J or eV.				
2.4 Wave Particle Duality				
Students should know that electron diffraction suggests that particles possess wave properties and the photoelectric effect suggests that electromagnetic waves have a particulate nature.				
Details of particular methods of particle diffraction are not expected.				
de Broglie wavelength $\lambda = \frac{h}{mv}$ where mv is the momentum.				
Students should be able to explain how and why the amount of diffraction changes when the momentum of the particle is changed.				

You should be able to demonstrate and show your understanding of:	**Progress and understanding:**			
	1	**2**	**3**	**4**
Appreciation of how knowledge and understanding of the nature of matter changes over time.				
Appreciation that such changes need to be evaluated through peer review and validated by the scientific community.				