Matter and radiation

Specification reference	Checklist questions	
3.2.1.1	Can you represent a simple model of the atom, including the proton, neutron, and electron?	☐
3.2.1.1	Can you describe charge and mass of the proton, neutron, and electron in SI units and relative units?	☐
3.2.1.1	Can you explain the specific charge of the proton and the electron, and of nuclei and ions?	☐
3.2.1.1	Can you define and use 'proton number Z, nucleon number A' nuclide notation?	☐
3.2.1.1	Can you recognise and use the ${}^{A}_{Z}\mathrm{X}$ notation?	☐
3.2.1.1	Can you define isotopes and use isotopic data?	☐
3.2.1.2	Can you explain the strong nuclear force and its role in keeping the nucleus stable?	☐
3.2.1.2	Can you describe short-range attraction up to approximately 3 fm and very-short range repulsion closer than approximately 0.5 fm?	☐
3.2.1.2	Can you describe unstable nuclei; alpha and beta decay?	☐
3.2.1.2	Can you use equations for alpha decay and β^- decay, including the need for the neutrino?	☐
3.2.1.2	Can you explain how the existence of the neutrino was hypothesised to account for conservation of energy in beta decay?	☐
3.2.1.3	Can you explain that, for every type of particle, there is a corresponding antiparticle?	☐

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Specification reference	Checklist questions	
3.2.1.3	Can you compare particle and antiparticle mass, charge, and rest energy in MeV?	☐
3.2.1.3	Can you explain that the positron, antiproton, antineutron, and antineutrino are the antiparticles of the electron, proton, neutron, and neutrino respectively?	☐
3.2.1.3	Can you use the photon model of electromagnetic radiation and the Planck constant?	☐
3.2.1.3	Can you explain annihilation and pair production, and the energies involved?	☐
3.2.1.4	Can you explain the four fundamental interactions: gravity, electromagnetic, weak nuclear, and strong nuclear?	☐
3.2.1.4	Can you describe the concept of exchange particles to explain forces between elementary particles?	☐
3.2.1.4	Can you explain the electromagnetic force and virtual photons as the exchange particle?	☐
3.2.1.4	Can you describe the weak interaction limited to β^- and β^+ decay, electron capture, and electron–proton collisions?	☐
3.2.1.4	Can you describe W^+ and W^- as exchange particles?	☐
3.2.1.4	Can you draw simple diagrams to represent reactions or interactions in terms of incoming and outgoing particles, and exchange particles?	☐
3.2.1.5	Can you explain that hadrons are subject to the strong interaction?	☐

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Specification reference	Checklist questions	
3.2.1.5	Can you define the two classes of hadrons: • baryons (proton and neutron) and antibaryons (antiproton and antineutron) • mesons (pion and kaon)?	☐
3.2.1.5	Can you define the baryon number as a quantum number?	☐
3.2.1.5	Can you explain conservation of baryon number?	☐
3.2.1.5	Can you explain that the proton is the only stable baryon into which other baryons eventually decay?	☐
3.2.1.5	Can you describe the pion as the exchange particle of the strong nuclear force?	☐
3.2.1.5	Can you describe kaons as particles that can decay into pions?	☐
3.2.1.5	Can you explain that leptons are subject to the weak interaction?	☐
3.2.1.5	Can you describe leptons: electrons, muons, neutrinos (electron and muon types only), and their antiparticles?	☐
3.2.1.5	Can you describe lepton number as a quantum number?	☐
3.2.1.5	Can you explain conservation of lepton number for muon leptons and for electron leptons?	☐
3.2.1.5	Can you describe the muon as a particle that decays into an electron?	☐
3.2.1.5	Can you describe strange particles?	☐
3.2.1.5	Can you describe strange particles as particles that are produced through the strong interaction and decay through the weak interaction (e.g., kaons)?	☐

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Specification reference	Checklist questions	
3.2.1.5	Can you describe strangeness (symbol s) as a quantum number to reflect the fact that strange particles are always created in pairs?	☐
3.2.1.5	Can you explain conservation of strangeness in strong interactions?	☐
3.2.1.5	Can you explain that strangeness can change by 0, +1, or –1 in weak interactions?	☐
3.2.1.5	Can you explain that particle physics relies on the collaborative efforts of large teams of scientists and engineers to validate new knowledge?	☐