Constituents of the Atom

Checklist statement	✓
I can describe a simple model of the atom, including protons, neutrons and electrons.	☐
I can state the charge and mass of the proton, neutron and electron in SI units and relative units.	☐
I can apply the idea of specific charge for protons, electrons, nuclei and ions.	☐
I can define proton number (Z) and nucleon number (A).	☐
I can use and interpret nuclide notation ${}^{A}_{Z}X$.	☐
I can explain what isotopes are.	☐
I can use isotopic data appropriately.	☐

Stable and Unstable Nuclei

Checklist statement	✓
I can explain the role of the strong nuclear force in keeping the nucleus stable.	☐
I can describe the short-range attraction (up to about 3 fm) and very short-range repulsion (below about 0.5 fm) of the strong nuclear force.	☐
I can distinguish between stable and unstable nuclei.	☐
I can describe alpha decay and beta decay.	☐
I can write and interpret equations for alpha decay and β^- decay, including the need for the neutrino.	☐
I can explain why the neutrino was proposed to account for conservation of energy in beta decay.	☐

Antiparticles, Annihilation and Photons

Checklist statement	✓
I know that every particle has a corresponding antiparticle.	☐
I can compare particles and antiparticles in terms of mass, charge and rest energy (MeV).	☐
I can identify the antiparticles of the electron, proton, neutron and neutrino.	☐
I can describe the photon model of electromagnetic radiation.	☐
I can apply $E = hf$, define all terms and know their standard units.	☐
I can apply $E = \frac{hc}{\lambda}$, define all terms and know their standard units.	☐
I can explain annihilation and pair production, including the energies involved.	☐

Particle Interactions

Checklist statement	✓
I can name the four fundamental interactions: gravitational, electromagnetic, strong nuclear and weak nuclear.	☐
I can explain the idea of exchange particles to describe forces between particles.	☐
I can explain the electromagnetic interaction in terms of virtual photons.	☐
I can describe the weak interaction in β^- decay, β^+ decay, electron capture and electron–proton collisions.	☐
I know that W^+ and W^- bosons are the exchange particles for the weak interaction.	☐
I can draw simple particle diagrams showing incoming particles, outgoing particles and exchange particles.	☐

Classification of Particles

Checklist statement	✓
I know that hadrons are particles that experience the strong interaction.	☐
I can distinguish between baryons, antibaryons and mesons.	☐
I can explain baryon number as a quantum number.	☐
I can apply conservation of baryon number.	☐
I know that the proton is the only stable baryon.	☐
I can describe the pion as the exchange particle of the strong nuclear force.	☐
I can describe the kaon as a particle that can decay into pions.	☐
I can identify leptons (electron, muon and neutrinos) and their antiparticles.	☐
I can explain lepton number as a quantum number and apply its conservation for electron and muon leptons.	☐
I can describe the decay of a muon into an electron.	☐

Strange Particles

Checklist statement	✓
I can explain what is meant by a strange particle.	☐
I know that strange particles are produced by the strong interaction and decay through the weak interaction.	☐
I can explain strangeness (S) as a quantum number.	☐
I know that strange particles are always created in pairs.	☐
I can apply conservation of strangeness in strong interactions.	☐
I know that strangeness can change by 0, +1 or −1 in weak interactions.	☐

Quarks and Antiquarks

Checklist statement	✓
I can describe the properties of quarks and antiquarks, including charge, baryon number and strangeness.	☐
I can describe how baryons, antibaryons and mesons are formed from quarks and antiquarks.	☐
I know that only up (u), down (d) and strange (s) quarks (and their antiquarks) are required.	☐
I can describe the quark structure of the proton and neutron.	☐
I can describe the decay of a neutron in terms of quark changes.	☐

Applications of Conservation Laws

Checklist statement	✓
I can describe changes of quark flavour in β^- and β^+ decay.	☐
I can apply conservation of charge, baryon number, lepton number and strangeness to particle interactions.	☐
I recognise that energy and momentum are conserved in particle interactions.	☐