AS Physics Test: Particles (§1.1–1.5) Open Book Exam

Bishop Heber High School

For your reference: Use pp. 245–246 from the Nelson Thornes AS textbook for data and formulae.

1. Draw a Feynman diagram for two electrons interacting, identifying the exchange particle and the type of interaction of the two electrons [4]

2. (a) Draw a Feynman diagram for a proton and an electron interacting, identifying the exchange particle and the type of the interaction between the two particles [4]

    (b) The exchange particle in this interaction was discovered by experiment with a rest mass that had been predicted. Why is it important to test by experiment the prediction of a scientific theory? [2]   [Jan09]

3. (a) An unstable nucleus, $_Z^A X$, can decay by emitting a β particle. What part of the atom is the same as a β particle? [1]

    (b) State the changes, if any, in A and Z when X decays. [1]

    (c) Write a general nuclear equation for beta decay. [1]   [Jan10]

4. (a) A neutral atom of a radium isotope may be represented by $_{88}^{228} Ra$. Name the constituents of this atom and state how many of each are present. [3]

    (b) Which constituent of an atom has the largest specific charge? [1]

    (c) $_Z^A Ra$ is a neutral atom of a different isotope of radium. State a possible value for A and for Z. [2]

5. (a) Under certain circumstances, a photon moving through a material can interact with the nucleus of an atom of the material to produce an electron and a positron. What is the name of this process? [1]

    (b) Give one reason why the photon could not produce a single electron instead of an electron and a positron. [2]

    (c) Show that the minimum energy of the photon required for this process is $1.02\,MeV$. [1]

    (d) Photons whose wavelength exceeds a certain value will not cause this process. Calculate the maximum wavelength for the process to occur stating your answer to an appropriate number of significant figures and prefix with unit. [5]

    (e) Explain what will happen to the positron produced by the interaction. [2]   [Jan11]

6. (a) Explain what is meant by an isotope. [2]

(b) Copy the table and fill in missing gaps. [2]

	protons	neutrons	Specific charge of nucleus / ...
First isotope	92	143	X
Second isotope	...	Y	3.7×10^7

(c) Calculate the specific charge, X, for the first isotope. [3]

(d) Calculate the number of neutrons, Y, for the second isotope. [3]

(e) Convert the energy of $9.0\,\text{eV}$ into Joules. [2]   [Jun09]

7. (a) Describe how the strong nuclear force between two nucleons varies with the separation of the nucleons quoting suitable values for separation. [3]

(b) $^{238}_{92}\text{U}$ decays by alpha emission. Write the nuclear equation for this decay. [2]

(c) If there are eight alpha decays in the sequence of decays from $^{238}_{92}\text{U} \longrightarrow {}^{206}_{82}\text{Pb}$ deduce how many β decays are involved. [3]   [Jun10]

TOTAL SCORE = 50