AQA Examination-style questions

1 (a) Copy and complete the table below: *(3 marks)*

	particle or antiparticle	$\frac{\textbf{charge}}{\textbf{proton charge}}$
antiproton	antiparticle	
neutrino		
neutron		0
positron		

(b) **Figure 4** in Topic 1.4 shows the spiral tracks of a positron and an electron created by pair production in a magnetic field.

(i) Why do they curve in opposite directions?

(ii) Both particles spiral inwards. What can you deduce from this observation about their kinetic energy?

(iii) In **Figure 4** of Topic 1.4, the track is a typical beta track. Explain how Carl Anderson deduced from the photograph that the track was created by a positron rather than an electron travelling in the opposite direction. *(5 marks)*

2 (a) ${}^{229}_{90}\text{Th}$ is a neutral atom of thorium. How many protons, neutrons and electrons does it contain? *(2 marks)*

(b) ${}^{Y}_{X}\text{Th}$ is a neutral atom of a different isotope of thorium which contains Z electrons. Give possible values for X, Y and Z. *(3 marks)*

AQA, 2001

3 An atom of argon ${}^{37}_{18}\text{Ar}$ is ionised by the removal of two orbiting electrons.

(a) How many protons and neutrons are there in this ion? *(2 marks)*

(b) What is the charge, in C, of this ion? *(2 marks)*

(c) Which constituent particle of this ion has

(i) a zero charge per unit mass ratio?

(ii) the largest charge per unit mass ratio? *(2 marks)*

(d) Calculate the percentage of the total mass of this ion that is accounted for by the mass of its electrons. *(3 marks)*

AQA, 2002

4 (a) A stable atom contains 28 nucleons.

Write down a possible number of protons, neutrons and electrons contained in the atom. *(2 marks)*

(b) An unstable isotope of uranium may split into a caesium nucleus, a rubidium nucleus and four neutrons in the following process.

$${}^{236}_{92}\text{U} \longrightarrow {}^{137}_{55}\text{Cs} + {}^{X}_{37}\text{Rb} + 4\,{}^{1}_{0}\text{n}$$

(i) Explain what is meant by isotopes.

(ii) How many neutrons are there in the ${}^{137}_{55}\text{Cs}$ nucleus?

(iii) Calculate the ratio $\frac{\text{charge}}{\text{mass}}$, in C kg^{-1}, for the ${}^{236}_{92}\text{U}$ nucleus.

(iv) Determine the value of X for the rubidium nucleus. *(4 marks)*

AQA, 2003

5 An α particle is the same as a nucleus of helium, ${}^{4}_{2}\text{He}$.

The equation ${}^{229}_{90}\text{Th} \longrightarrow {}^{X}_{Y}\text{Ra} + \alpha$

represents the decay of a thorium isotope by the emission of an α particle.

Determine:

(a) the values of X and Y, shown in the equation, *(2 marks)*

(b) the ratio $\frac{\text{mass of } {}^{X}_{Y}\text{Ra nucleus}}{\text{mass of } \alpha \text{ particle}}$ *(1 mark)*

AQA, 2005

6 (a) (i) Describe an α particle and state its properties.

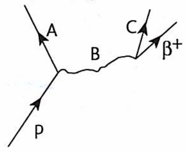
(ii) ${}^{215}_{85}$At is an isotope of the element astatine (At) which decays into an isotope of bismuth (Bi) by emitting an α particle. Write down the equation to represent this reaction. *(5 marks)*

(b) (i) State what happens when an unstable nucleus decays by emitting a β^- particle.

(ii) Write down and complete the following equation, showing how an isotope of molybdenum decays into an isotope of technetium.

$${}^{\dots}_{42}\text{Mo} \longrightarrow {}^{99}_{\dots}\text{Tc} + \beta- + \dots$$ *(5 marks)*

7 In a radioactive decay of a nucleus, a β^+ particle is emitted followed by a γ photon of wavelength 8.30×10^{-13} m.



(a) (i) State the rest mass, in kg, of the β^+ particle.

(ii) Calculate the energy of the γ photon.

(iii) Determine the energy of the γ photon in MeV. *(6 marks)*

(b) Name the fundamental interaction or force responsible for β^+ decay. *(1 mark)*

(c) β^+ decay may be represented by the Feynman diagram.

Name the particles represented by A, B and C. *(3 marks)*

AQA, 2004

8 (a) (i) State the name of the antiparticle of a positron.

(ii) Describe what happens when a positron and its antiparticle meet. *(3 marks)*

(b) Calculate the minimum amount of energy, in J, released as radiation energy when a particle of rest energy 0.51 MeV meets its corresponding antiparticle. *(2 marks)*

AQA, 2005

9 In a particle accelerator a proton and an antiproton, travelling at the same speed, undergo a head-on collision and produce subatomic particles.

(a) The total kinetic energy of the two particles just before the collision is 3.2×10^{-10} J.

(i) What happens to the proton and antiproton during the collision?

(ii) State why the total energy after the collision is more than 3.2×10^{-10} J. *(2 marks)*

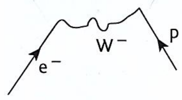
(b) In a second experiment the total kinetic energy of the colliding proton and antiproton is greater than 3.2×10^{-10} J.

State **two** possible differences this could make to the subatomic particles produced. *(2 marks)*

AQA, 2001

10 An electron may interact with a proton in the following way

$$e^- + p \longrightarrow n + \nu_e.$$



(a) Name the fundamental force responsible for this interaction. *(1 mark)*

(b) Complete the Feynman diagram for this interaction and label all the particles involved. *(2 marks)*

AQA, 2003

11 (a) Give an example of an exchange particle other than a W^+ or W^- particle, and state the fundamental force involved when it is produced. *(2 marks)*

(b) State what roles exchange particles can play in an interaction. *(2 marks)*

AQA, 2006

12 Describe what happens in pair production and give **one** example of this process. *(3 marks)*

AQA, 2005