**'A' Level questions on the structure of the atom**

**Q1.** A neutral atom of carbon is represented by ${}^{14}_{6}C$.

(i) Name the constituents of this atom and state how many of each are present.

(ii) Which constituent of an atom has the largest charge-to-mass ratio?

(iii) Carbon has several isotopes. Explain the term *isotope*.

**(Total 6 marks)**

**Q2.** (a) ${}^{232}_{90}$Th is a neutral atom of thorium. How many protons, neutrons and electrons does it contain?

**(2)**

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

**(3)**

**(Total 5 marks)**

**Q3.** (a) The most abundant isotope of cobalt is represented by ${}^{59}_{27}\mathrm{Co}$.

How many protons, neutrons and orbital electrons are there in a neutral atom of this element?

**(2)**

(b) How is the nuclide that has one less proton than the nickel nuclide, ${}^{61}_{28}\mathrm{Ni}$, represented?

**(2)**

(c) (i) The heaviest isotope of hydrogen, whose nucleon number is 3, is called tritium. How is tritium represented?

(ii) Calculate the charge per unit mass, in C $kg^{-1}$, for a tritium nucleus.

**(3)**

**(Total 7 marks)**

**Q4.** An atom of argon ${}^{37}_{18}\mathrm{Ar}$ is ionised by the removal of two orbiting electrons.

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

**(2)**

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

**(2)**

(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)**

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

**(3)**
**(Total 9 marks)**

**Q5.** A radioactive isotope of carbon is represented by $^{14}_{6}C$.

(a) Using the same notation, give the isotope of carbon that has two fewer neutrons.

**(1)**

(b) Calculate the charge on the ion formed when **two** electrons are removed from an atom of $^{14}_{6}C$.

**(2)**

(c) Calculate the value of $\frac{\text{charge}}{\text{mass}}$ for the nucleus of an atom of $^{14}_{6}C$.

**(2)**
**(Total 5 marks)**

**Q6.** (a) How many protons, neutrons and electrons are there in an atom of $^{14}_{6}\text{C}$?

**(2)**

(b) The $^{14}_{6}\text{C}$ atom loses two electrons.
For the ion formed;

(i) calculate its charge in C,

(ii) state the number of nucleons it contains,

(iii) calculate the ratio $\frac{\text{charge}}{\text{mass}}$ in C $kg^{-1}$.

**(4)**
**(Total 6 marks)**

**Q7.** (a) An ion of plutonium $^{239}_{94}\text{Pu}$ has an overall charge of $+1.6 \times 10^{-19}$ C.

For this ion state the number of

(i) protons (ii) neutrons (iii) electrons

**(3)**

(b) Plutonium has several *isotopes*.

Explain the meaning of the word isotopes.

**(2)**
**(Total 5 marks)**

**Q8.** (a) Name the constituent of an atom which

(i) has zero charge,

(ii) has the largest charge to mass ratio,

(iii) when removed leaves a different isotope of the element.

**(3)**

(b) An $\alpha$ 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 thorium by the emission of an $\alpha$ particle.

Determine

(i) the values of X and Y, shown in the equation,

(ii) the ratio $\dfrac{\text{mass of } {}^{X}_{Y}\text{Ra nucleus}}{\text{mass of } \alpha \text{ particle}}$

**(3)**
**(Total 6 marks)**

**Q9.** (a) A stable atom contains 28 nucleons.

Write down a possible number of protons, neutrons and electrons contained in the atom.

**(2)**

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

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

(i) Explain what is meant by isotopes.

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

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

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

**(6)**
**(Total 8 marks)**

**Q10.** (a) Give the number of nucleons and the number of electrons in an atom of $^{22}_{11}$Na.

**(2)**

(b) The isotope $^{22}_{11}$Na is a positron emitter. In positron emission an up quark undergoes the following change,

$$u \rightarrow d + \beta^{+} + \nu_e.$$

Show that charge, lepton number and baryon number are conserved in this decay.

**(3)**

(c) Describe what happens when a positron collides with an electron.

**(2)**

**(Total 7 marks)**

**Q11.** (a) (i) Determine the charge, in C, of a $^{239}_{92}U$ nucleus.

(ii) A positive ion with a $^{239}_{92}U$ nucleus has a charge of $4.80 \times 10^{-19}$ C. Determine how many electrons are in this ion.

**(4)**

(b) A $^{239}_{92}U$ nucleus may decay by emitting **two** $\beta^{-}$ particles to form a plutonium nucleus $^{X}_{Y}Pu$. State what X and Y represent and give the numerical value of each.

**(4)**

**(Total 8 marks)**