

'A' Level questions on the structure of the atom

Q1. A neutral atom of carbon is represented by ${}^{14}_6\text{C}$.

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

(2)

- (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)

(Total 5 marks)

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

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, ${}^{61}_{28}\text{Ni}$, 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 ${}^{37}_{18}\text{Ar}$ 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)

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- (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 ${}^{14}_6\text{C}$.

- (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 ${}^{14}_6\text{C}$.

(2)

- (c) Calculate the value of $\frac{\text{charge}}{\text{mass}}$ for the nucleus of an atom of ${}^{14}_6\text{C}$.

(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 $+1.6 \times 10^{-19}\text{C}$.

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,

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

(3)

- (b) An α particle is the same as a nucleus of helium, ${}^4_2\text{He}$.
The equation



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

Determine

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

- (ii) the ratio $\frac{\text{mass of } {}^X_Y\text{Ra nucleus}}{\text{mass of } \alpha \text{ particle}}$

(3)

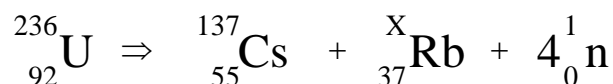
(Total 6 marks)

- 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.



- (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.

(6)

(Total 8 marks)

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

(2)

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

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$$u \rightarrow d + \bar{\nu} + \nu_e.$$

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 ${}_{92}^{239}\text{U}$ nucleus.

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

(4)

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

(4)

(Total 8 marks)



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