

Name of the Student: _____

Max. Marks : 20 Marks

Time : 20 Minutes

Q1.

Helium is the second most abundant element in the universe. The most common isotope of helium is ${}^4_2\text{He}$ and a nucleus of this isotope has a rest energy of 3728 MeV.

In 2011, at the Relativistic Heavy Ion Collider, anti-helium nuclei were produced. Nuclei of anti-helium are made up of antiprotons and antineutrons. It is suggested that an antineutron can decay to form an antiproton in a process similar to β^- decay.

In one particular collision between an anti-helium nucleus and a helium nucleus, the nuclei are annihilated and two photons are formed.

- (a) State what is meant by isotopes.

(2)

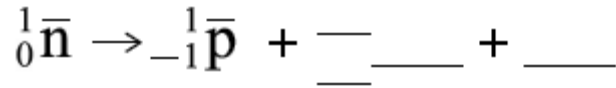
- (b) Explain why two photons are formed instead of a single photon when a helium nucleus annihilates with the anti-helium nucleus.

(2)

- (c) Calculate, using data from the passage, the maximum frequency of the photons produced in this annihilation of a ${}^4_2\text{He}$ nucleus.

frequency = _____ Hz (4)

(d) Complete this equation for the possible decay of an antineutron.



(2)

(e) What interaction would be responsible for the decay in **part (d)**? Tick (✓) the correct answer in the right-hand column.

	✓ if correct
electromagnetic	
gravitational	
strong nuclear	
weak nuclear	

(1)

(Total 11 marks)

Q2.

The element uranium has an isotope ${}^{237}_{92}\text{U}$.

(a) Explain what is meant by an isotope.

(2)

(b) Determine the charge in coulomb of the ${}^{237}_{92}\text{U}$ nucleus.

charge = _____ C (2)

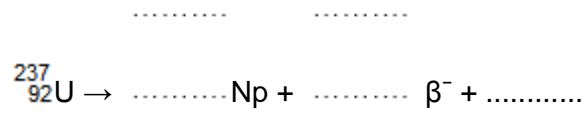
(c) A positive ion of ${}^{237}_{92}\text{U}$ has a charge of $+4.80 \times 10^{-19}$ C.
Determine the number of electrons in the ion.

number of electrons = _____

(2)

- (d) ${}^{237}_{92}\text{U}$ decays by β^- emission to form an isotope of neptunium (Np).

Complete the equation for this decay.



(3)

(Total 9 marks)