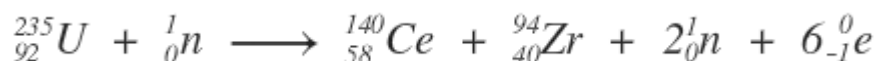


# Particles and Waves

## Nuclear Reactions

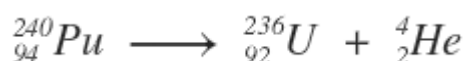


- 1) A uranium - 235 nucleus undergoes induced fission. The equation for the reaction is shown below:

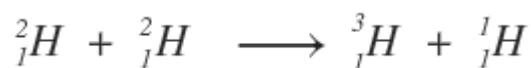


The total mass of the particles on the LHS is  $391.848 \times 10^{-27}$  kg and the total mass of the particles on the RHS is  $391.476 \times 10^{-27}$  kg.

- Determine the mass defect.
  - Calculate the energy released in this nuclear reaction.
- 2) A nuclear reaction is represented by the equation below:

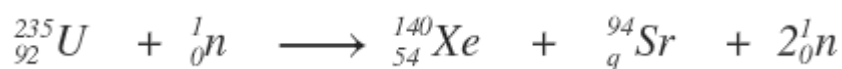


- Pu has a mass of  $398.626 \times 10^{-27}$  kg. The total mass of the particles on the RHS of the nuclear equation is  $398.615 \times 10^{-27}$  kg. Determine the mass defect.
  - Calculate the energy released in this nuclear reaction.
  - How many of the above reactions would have to take place each second to produce a power of 1kW.
- 3) A nuclear reaction is represented below:



- State the type of nuclear reaction shown above.
- The mass of the nuclei on the LHS amounts to  $6.689 \times 10^{-27}$  kg and the mass of the nuclei on the RHS amounts to  $6.682 \times 10^{-27}$  kg. Determine the mass defect and calculate the energy released in the nuclear reaction.

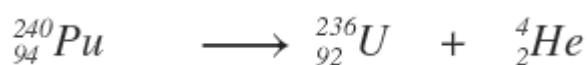
4) A nuclear reaction is shown below:



- a) Determine the value of q
- b) Physicists use the value of the *atomic mass unit (amu)* to stand for nuclear masses.  $1 \text{ amu} = 1.660\,539 \times 10^{-27} \text{ kg}$ .  
Use the table below to determine the mass defect of the above nuclear reaction. The numbers represent the masses of the nuclei in amu.

${}_{92}^{235}\text{U}$	${}_0^1\text{n}$	${}_{54}^{140}\text{Xe}$	${}_q^{94}\text{Sr}$	${}_0^1\text{n}$
235.043 923	1.008 665	139.921 647	93.915 361	1.008 665

- c) Calculate the energy released by this nuclear reaction.
  - d) Determine the number of the above reactions that must take place each second to provide a power of 800 MW
- 5) Which of the following statements correctly describes nuclear fission
- i) Two nuclei combine to form a large nucleus releasing several neutrons
  - ii) A large nucleus splits into two smaller nuclei releasing three electrons
  - iii) A large nucleus splits into two smaller nuclei releasing several protons
  - iv) A large nucleus splits into two smaller nuclei releasing several neutrons.
- 6) The nuclear reaction represented below gives off  $9.9 \times 10^{-13} \text{ J}$ .  
Determine the total mass of the product nuclei given that the mass of the Pu - 240 is  $398.626 \times 10^{-27} \text{ kg}$



Answers and solutions.

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- 1) a) mass defect =  $0.372 \times 10^{-27} \text{ kg}$   
b) Energy =  $3.348 \times 10^{-11} \text{ J}$
- 2) a) mass defect =  $1.1 \times 10^{-29} \text{ kg}$   
b) Energy =  $9.9 \times 10^{-13} \text{ J}$   
c)  $1.01 \times 10^{15}$  reactions per second.
- 3) a) Fusion reaction  
b) mass defect =  $7.0 \times 10^{-30} \text{ kg}$   
Energy =  $6.3 \times 10^{-13} \text{ J}$
- 4) a)  $q = 38$   
b) mass defect =  $3.29 \times 10^{-28} \text{ kg}$   
c) Energy =  $2.96 \times 10^{-11} \text{ J}$   
d)  $2.7 \times 10^{19}$  reactions per second
- 5) Statement iv is correct
- 6) Total mass of products =  $3.98615 \times 10^{-25} \text{ kg}$