

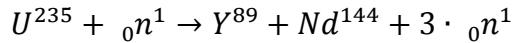
Answer on Question #63137, Physics / Quantum Mechanics

Question:

In the fission of a part of uranium there is loss in mass of 0.5g. How many kilo-watt hour energy will be obtained ?

Solution:

Let's consider one of the possible ways of uranium's fission:



At first we calculate the energy released in the fission of one nucleus. Einstein's formula for mass-energy equivalence looks like this: $E = mc^2$. For the left part of the reaction we obtain

$$E_{in} = (235.117 + 1.00866) \cdot 931.5 \text{ MeV} = 219951 \text{ MeV}.$$

For the right part of the reaction:

$$E_{out} = (88.937 + 143.956 + 3 \cdot 1.00866) \cdot 931.5 \text{ MeV} = 219758.5 \text{ MeV}.$$

$$\text{So, for one nucleus } E_0 = E_{out} - E_{in} = 192.5 \text{ MeV} = 192.5 \cdot 10^6 \text{ eV} = 192.5 \cdot 10^6 \cdot 1.6 \cdot 10^{-19} \text{ J} = 3.08 \cdot 10^{-11} \text{ J}.$$

Now we must calculate the number (N) of nuclei in 0.5g of uranium.

$$N = \frac{m}{m_{nucleus}} \cong \frac{m}{u \cdot A}$$

where

m is the loss of mass (0.5g or $5 \cdot 10^{-4}$ kg),

u — unified atomic mass unit ($1.66 \cdot 10^{-27}$ kg),

A — total number of nucleons (235).

$$\text{Then } N \cong \frac{m}{u \cdot A} = \frac{5 \cdot 10^{-4}}{1.66 \cdot 10^{-27} \cdot 235} = 1.28 \cdot 10^{21}.$$

$$\text{And total energy: } E = E_0 \cdot N = 3.08 \cdot 10^{-11} \text{ J} \cdot 1.28 \cdot 10^{21} = 3.94 \cdot 10^{10} \text{ J}$$

$$\text{One kilo-watt hour } 1 \text{ kWh} = 1000 \text{ W} \cdot 3600 \text{ s} = 3.6 \cdot 10^6 \text{ J}$$

$$\text{So } E (\text{kWh}) = \frac{3.94 \cdot 10^{10} \text{ J}}{3.6 \cdot 10^6 \text{ J}} = 1.09 \cdot 10^4 \text{ kWh}$$

Answer:

$$1.09 \cdot 10^4 \text{ kWh}$$