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:

$$U^{235} + {}_0n^1 \to Y^{89} + Nd^{144} + 3 \cdot {}_0n^1$$

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

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

For the right part of the reaction:

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

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

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).

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

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

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

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

Answer:

$1.09 \cdot 10^4\ kWh$