- Avogadro's hypothesis: $235\ gram\ of\ U-235 = 6.023\times10^{23} atoms$

$$6.023\times10^{23} atoms\ of\ U-235 = 235\ grams$$

** $\mathbf{1eV = 1.6\times10^{-19}J}$ $\mathbf{1MeV = 1.6\times10^{-13}J}$ $\mathbf{1MW = 10^{6}W}$ **

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1. The energy liberated in the fission of a single Uranium -235 atom is 3.2×10^{-11}J. Calculate the power production corresponding to the fission of 1Kg of Uranium per day. Assume Avogadro's constant as $6.02\times10^{23}mole^{-1}$. []

Hint: $Power = \frac{Total\ energy}{time}$ $Total\ energy = Number\ of\ atoms\ \times energy\ due\ to\ single\ atom$

2. The energy liberated in the fission of a single Uranium -235 atom is 3.2×10^{-11}J. Calculate the power production corresponding to the fission of 1.5Kg of Uranium per day. []
3. Assuming that about 200MeV energy is released per fission of $_{92}U^{235}$ nuclei. What would be the mass of U^{235} consumed per day in the fission reactor of power 1MW approximately? []

Hint: $Total\ energy = Power\ \times time$ $Number\ of\ atoms = \frac{Total\ energy}{energy\ due\ to\ single\ atom}$

4. A city requires 10^7Watts of electrical power on the average. If this is to be supplied by a nuclear reactor of efficiency 20%. Using $_{92}U^{235}$ as the fuel source, calculate the amount of fuel required per day. (Energy released per fission $_{92}U^{235}$=200MeV).

Solution:

Given,

Efficiency (η) = 20%= $\frac{20}{100}$

Output Power (P_{out}) = 10^7 watt

Time(t) = 1 day =86400 seconds

Energy liberated (Q) = 200 MeV

= $200 \times (10^6) \times (1.6 \times 10^{-19}$ J)

= 3.2×10^{-11} J

We Know, $\eta = \frac{P_{out}}{P_{in}}$

or, $P_{in} = \frac{P_{out}}{\eta}$

or, $P_{in} = \frac{10^7}{(\frac{20}{100})}$

or, $P_{in} = 5 \times 10^7$ watt … … … … … … (1)

Also, $P_{in} = \frac{total\ nergy\ released\ (E)}{time\ taken(t)}$

or, $P_{in} = \frac{Number\ of\ atoms(N)\times liberated\ energy(Q)}{time\ taken(T)}$

or, $5\times10^7 = \frac{N\times3.2\times10^{-11}}{86400}$

or, $N = 1.35\times10^{23}$ atoms

Now, 6.023×10^{23} atoms of U^{235} = 235 gm

or, 1 atom of $U^{235} = \frac{235}{6.023\times10^{23}}$ gm

∴ 1.35×10^{23} atoms of $U^{235} = \frac{235}{6.023\times10^{23}}\times1.35\times10^{23}$ gm

= 52.67 gm

= 0.05267 Kg