

53. Since 1.00 L of water has a mass of 1.00 kg, the mass of the heavy water in 1.00 L is $0.0150 \times 10^{-2} \text{ kg} = 1.50 \times 10^{-4} \text{ kg}$. Since a heavy water molecule contains one oxygen atom, one hydrogen atom and one deuterium atom, its mass is $(16.0 \text{ u} + 1.00 \text{ u} + 2.00 \text{ u}) = 19.0 \text{ u}$ or $(19.0 \text{ u})(1.661 \times 10^{-27} \text{ kg/u}) = 3.16 \times 10^{-26} \text{ kg}$. The number of heavy water molecules in a liter of water is $(1.50 \times 10^{-4} \text{ kg})/(3.16 \times 10^{-26} \text{ kg}) = 4.75 \times 10^{21}$. Since each fusion event requires two deuterium nuclei, the number of fusion events that can occur is $N = 4.75 \times 10^{21}/2 = 2.38 \times 10^{21}$. Each event releases energy $Q = (3.27 \times 10^6 \text{ eV})(1.60 \times 10^{-19} \text{ J/eV}) = 5.23 \times 10^{-13} \text{ J}$. Since all events take place in a day, which is $8.64 \times 10^4 \text{ s}$, the power output is

$$P = \frac{NQ}{t} = \frac{(2.38 \times 10^{21})(5.23 \times 10^{-13} \text{ J})}{8.64 \times 10^4 \text{ s}} = 1.44 \times 10^4 \text{ W} = 14.4 \text{ kW} .$$