

27. (a) We use $\epsilon = L_V/N$, where L_V is the heat of vaporization and N is the number of molecules per gram. The molar mass of atomic hydrogen is 1 g/mol and the molar mass of atomic oxygen is 16 g/mol so the molar mass of H_2O is $1+1+16 = 18$ g/mol. There are $N_A = 6.02 \times 10^{23}$ molecules in a mole so the number of molecules in a gram of water is $(6.02 \times 10^{23} \text{ mol}^{-1})/(18 \text{ g/mol}) = 3.34 \times 10^{22}$ molecules/g. Thus $\epsilon = (539 \text{ cal/g})/(3.34 \times 10^{22}/\text{g}) = 1.61 \times 10^{-20} \text{ cal}$. This is $(1.61 \times 10^{-20} \text{ cal})(4.186 \text{ J/cal}) = 6.76 \times 10^{-20} \text{ J}$.

- (b) The average translational kinetic energy is

$$K_{\text{avg}} = \frac{3}{2}kT = \frac{3}{2}(1.38 \times 10^{-23} \text{ J/K}) [(32.0 + 273.15) \text{ K}] = 6.32 \times 10^{-21} \text{ J} .$$

The ratio ϵ/K_{avg} is $(6.76 \times 10^{-20} \text{ J})/(6.32 \times 10^{-21} \text{ J}) = 10.7$.