THERMODYNAMICS OF HIKING

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Reference: Daniel V. Schroeder, *An Introduction to Thermal Physics*, (Addison-Wesley, 2000) - Problem 1.54.

Suppose a 60 kg hiker wishes to climb a 1500 m tall mountain. If she wants to provide the energy for the climb by eating only corn flakes, how much would she need to eat? We'll make a lot of oversimplifying assumptions to get an estimate. First, suppose that the only work expended on the hike is the energy required to climb 1500 m. The work is equal to the potential energy gained, so

$$\begin{aligned} W &= mgh && (1)\\ &= 60 \times 9.8 \times 1500 && (2)\\ &= 8.82 \times 10^5 \text{ J} && (3)\\ &= 211 \text{ kcal} && (4) \end{aligned}$$

Assuming that she can convert 25% of the food's energy to work, she will therefore need to consume 844 kcal in corn flakes. The enthalpy change in 'burning' corn flakes is 100 kcal per 28 g, so she will need to eat

$$\frac{844}{100} \times 28 = 236 \text{ g} \tag{5}$$

If the remaining 75% of the energy is retained as heat within the hiker's body, this will cause her temperature to rise. Taking the body to be water (which it is, mostly), 1 kcal of heat will raise 1 kg of water by 1 K, so from retaining the $844 - 211 = 633$ kcal of heat, her body temperature will rise by

$$\Delta T = \frac{633}{60} = 10.55^\circ \text{ C} \tag{6}$$

That would give her quite a fever, so it's not surprising that most of the heat is lost through the skin by evaporating sweat. Given that the latent heat of vaporization of water at 25° C is 580 cal g^{-1}, this excess heat will evaporate an amount of water given by

$$\frac{633 \times 10^3}{580} = 1091 \text{ g} \tag{7}$$

To replace this, she'd need to drink just over a litre of water.