Background concepts

- Classical (Greek!) Letters Primer
- Typing symbols on the Edge forum

Energy, Temperature, Heat

Cooking is the transformation of foods into edible form; this is often done using heat. Heat is a form of energy, generated from fuels. Equivalent weights of different fuels can produce different amounts of heat; e.g. propane has a higher energy density than wood.

Adding heat results in increased molecular motion, catalyzing the transformations of food. The relationship between the amount of heat Q that is added and the temperature rise of a food from initial temperature $T_{initial}$ to final temperature T_{final} is

$$\mathrm{Q} \quad = \quad mc_p\left(T_{final} - T_{initial}\right), \tag{1}$$

Here m is the mass of the food, and c_p is its specific heat.

Different food materials have different specific heats. Water has an unusually high specific heat of 4.18 J/g^{o}K, whereas oil has a specific heat of $\sim$ 2 J/g^{o}K – this has great consequence for cooking. Heat capacities can be looked up online[1]. Precise changes in temperature of foods < 1^{o}C can lead to dramatic changes in foods (Dave Arnold's Eggs).

Latent Heat

Extra energy (heat) must be supplied for a material to undergo a change in phase. The absorbed heat is used to break bonds during the phase transition, as we'll discuss next week.

For water, the latent heat of fusion [extra energy to turn ice into water] is 335 J/g, whereas the latent heat of evaporation [extra energy to turn water into steam] is 2, 260 J/g. This is an extraordinary amount of energy, widely important in cooking, including our ability to cook food steam as well as the remarkable cooling power of ice.

Specific heat and the calorie content of foods

The specific heat of water is intimately related to the definition of the dietary Calorie, the energy it takes to heat 1 liter water by 1^{o}C. A simple rule of thumb can be used to calculate the Calorie content of a food, the 4-4-9 rule.

$$\text{Calorie Content} \quad = \quad \mathrm{m_{Carb}} \times 4 \text{ Cal/g} + \mathrm{m_{Protein}} \times 4 \text{ Cal/g} + \mathrm{m_{Fat}} \times 9 \text{ Cal/g}, \tag{2}$$

where $\mathrm{m_{Carb}}$,$\mathrm{m_{Protein}}$,$\mathrm{m_{Fat}}$ are the masses of Carbohydrates, Proteins and Fats, respectively (in grams). Deviations from this rule occur because proteins, carbohydrates, and fats are not the only sources of Calories in foods. For example, the acetate in distilled vinegar and ethanol in alcoholic beverages contribute significantly to the caloric content.

Advanced materials available online

- Perfect eggs through science
- Calculating heat released by combustion
- Develop a theory to explain the 4-4-9 rule

[1] Try searching http://www.wolframalpha.com/ or http://www.wikipedia.org.