

Problem set 6**Due April 21, 2026**

1. Based on the relationship of the entropy differential (dS) and elementary heat change under reversibility conditions (Q_{el}^{rev})

$$dS = \frac{Q_{el}^{rev}}{T}$$

where T is the absolute temperature, prove that, for a system that is at contact with a thermal bath, the Helmholtz free energy (F) attains a minimum subject to constant volume and the Gibbs free energy (G) attains a minimum subject to constant pressure.

Hint: Express F and S in terms of energy (U), entropy, and the state variables (p , V , and T) and consider the infinitesimal energy change due to elementary heat and elementary work in both regimes.

2. Estimate the decrease of entropy of the brain of the reader due to absorbing the information by reading a 400-page book, each page having 50 lines of 70 characters each, the Latin alphabet having approximately 2^5 different characters including space and punctuation marks. Then estimate the increase of the entropy due to lighting the book while reading by a 100 Watt light bulb. Assume room temperature (25°C) and that the reading takes summarily 24 hours.
3. Methane is a gas at normal conditions but the energy of the interactions between two methane molecules *in vacuo* amounts to about 0.3 kcal/mol. In the molecular-modeling community, the statement that any system tends to reach the global energy minimum tends to be a common knowledge. Why, then, methane apparently is not at the global energy minimum?