1. **Engel and Reid, P31.12.**

2. **Engel and Reid, P31.13.**

3. **Engel and Reid, P31.19.**

4. **Engel and Reid, P31.20.**

5. **Engel and Reid, P33.3.**

6. A system of a molecule in a magnetic field has a simple energy-level diagram illustrated below.  Two energy levels are available that have equal energies of $-D$ (D is a constant).

$$\overline{\qquad\qquad}$$
$$\varepsilon_3 = 0$$

$$\overline{\qquad\qquad} \qquad \overline{\qquad\qquad}$$
$$\varepsilon_1 = -D \qquad \varepsilon_2 = -D$$
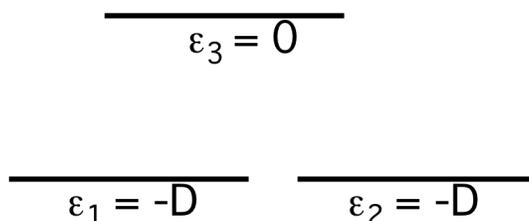
   a.   Write an expression for the partition function of the system.  Your answer should be given in terms of D, T (absolute temperature), and universal constants.

   b.  Write an expression for the average energy of the system in terms of D, T, and universal constants.

   c.  Calculate the average energy in the limit of high temperatures.

   d.  Calculate the average energy in the limit of very low temperature.

   e.  Write an expression for the ratio of the probabilities of finding the particle in the excited state 3 vs. *either* one of the ground states 1, 2.

   f.  Calculate the entropy of the molecule in the high-temperature limit.

(Modified slightly from Tinoco et al. *Physical Chemistry: Principles and Applications in Biological Sciences*, 4th Ed. Prentice Hall, 2002; problem 11.13)