

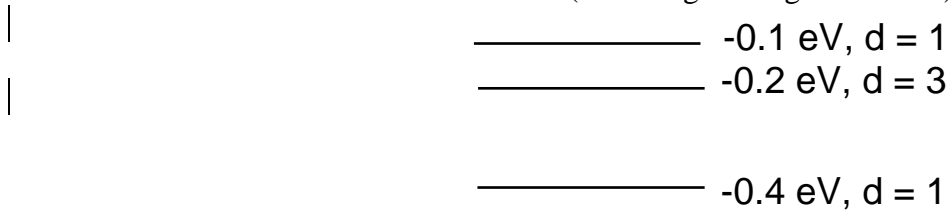
1. Sammy wants to make a chemical insect 'net', by creating a mist of droplets containing insecticide. The problem is that if the droplets are too heavy, they only float close to the ground; and if they are too light, they all float away. What should be the mass of a given droplet, if the density of droplets should vary ~50% from the floor to the ceiling (2 m)? (You may assume $T = 300 \text{ K}$).

- a. $1.5 \times 10^{-19} \text{ g}$
- b. $7.2 \times 10^{-13} \text{ g}$
- c. $2.1 \times 10^{-12} \text{ g}$

[Note: These are really all too small for reasonably sized droplets – we rely on air currents to keep 'mist' in the air.]

The next two questions pertain to the following situation.

A molecule has the level structure shown (including the degeneracies d):



2. At $T = 300 \text{ K}$, what is the probability that the molecule will not be in the lowest energy state?

- a. 0
- b. 5.3×10^{-5}
- c. 4.3×10^{-4}
- d. 1.3×10^{-3}
- e. 2.3×10^{-2}

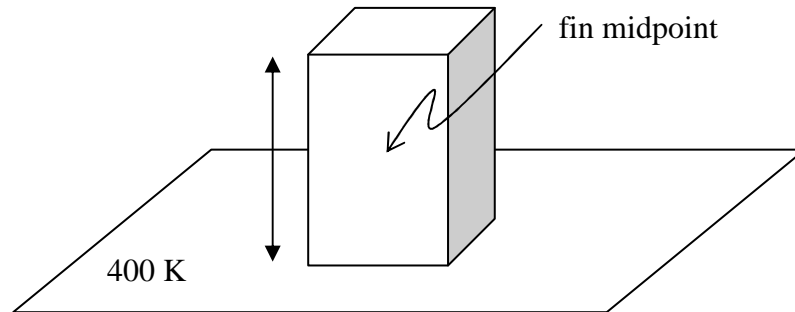
3. What is the entropy S (associated with the internal energies) of a collection of N such molecules, as the temperature \rightarrow infinity?

- a. 0
- b. Nk
- c. $Nk \ln(3)$
- d. $3Nk$
- e. $Nk \ln(5)$

The next two questions pertain to the following situation.

4. An aluminum fin (with cross-sectional area 8 cm^2 and height 5 cm) initially at room temperature (280 K) is attached at its base to a heat load at 400 K . It is determined experimentally to take 2 seconds for the midpoint of the fin (at distance 2.5 cm from the heat load) to reach 350 K . Now we repeat the experiment with a fin that is three times as high (15 cm). Approximately how long does it take the midpoint (7.5 cm from the heat load) of the new fin to reach 350 K ?

- a. 3.5 s
- b. 5 s
- c. 6 s
- d. 12 s
- e. 18 s



5. Returning to the original-height fin (5 cm), if we double the thickness of the fin, thereby doubling the cross-sectional area, what will happen to the time required for the midpoint of the fin to reach 350 K ?

- a. halve (i.e., 1 s)
- b. double (i.e., 4 s)
- c. stay the same