

Solutions

Problem 1:

(D) The Stefan-Boltzmann law

Problem 2:

(C) A reversible process does not change the entropy of the system.

Problem 3:

(C) Boltzmann statistics

$$\langle E \rangle = [\varepsilon \exp(-\varepsilon/kT) + 3\varepsilon \exp(-3\varepsilon/kT)] / [\exp(-0/kT) + \exp(-\varepsilon/kT) + \exp(-3\varepsilon/kT)]$$

$\sim 4\varepsilon/3$ since $\varepsilon \ll kT$.

Problem 1:

(E) Vibrational modes are excited at higher temperature than rotational modes.

Problem 9:

(D) Specific heat, energy conservation

The final temperature is 50°C , so $\Delta T = 50\text{ K}$.

The initially hotter block loses $\Delta Q = 0.1\text{ kcal}/(\text{kg K}) * 1\text{ kg} * 50\text{ K} = 5\text{ kcal}$.

This amount of energy is transferred to the initially cooler block

Problem 6:

(D) The average energy associated with each vibrational mode is kT of the oscillator is kT . [The average kinetic energy of an oscillator mode is $\frac{1}{2} kT$ (from the definition of the temperature T) and the average potential energy is equal to the average kinetic energy.]

The 3D oscillator has 3 vibrational modes.

Problem 7:

(C) Divide the volume into 10^6 subunits. Each single atom is equally likely to be in any of the subunits. Pick a particular subunit. The probability that a particular atom is not in this subunit is $1-10^{-6}$. The probability that none of the atoms is in this subunit is $(1-10^{-6})^N$.