13.7: Exercises

Exercise 13.7.1

Consider a system of two objects in contact, one initially hotter than the other, so they may directly exchange thermal energy, in isolation from the rest of the world. According to the laws of thermodynamics, what must happen to the system's total energy and entropy? (Do they change, increase, decrease, stay constant...?)

Exercise 13.7.2

Consider the same two objects in Problem 1 and suppose the heat capacity of the colder object is much greater than the heat capacity of the hotter one. When the system reaches thermal equilibrium, will its final temperature will be closer to the initial temperature of the hot object, the colder object, or exactly halfway between the two initial temperatures? Why?

Exercise 13.7.3

Which of the following is *not* a valid formulation of the second law of thermodynamics?

a. For any system in thermal equilibrium, there exists a state variable, called entropy, with the property that it can never decrease for a closed system.
b. No process is possible whose sole result is the transfer of heat from a cooler to a hotter body.
c. It is impossible for an engine that operates in a cycle, taking in heat from a hot reservoir at temperature T_h and exhausting heat to a cold reservoir at temperature T_c, to do work with an efficiency greater than $1-T_c/T_h$.
d. The entropy of any system goes to zero as T (the absolute, or Kelvin) temperature goes to zero.

Exercise 13.7.4

Which of the following statements is true?

a. Once the entropy of a system increases, it is impossible to bring it back down.
b. Once some amount of mechanical energy is converted to thermal energy, it is impossible to turn any of it back into mechanical energy.
c. It is always possible to reduce the entropy of a system, for instance, by cooling it.
d. All of the above statements are true.
e. None of the above statements are true.

Other Questions

- Can you tell the temperature of a gas by measuring the translational kinetic energy of a single molecule?
- Does a shuffled deck of cards have more or less entropy (in the thermodynamic sense) than an identical, ordered set of cards? Assume they are at the same temperature.
- A diatomic gas molecule, such as O_2, can store kinetic energy in the form of vibrations and rotations, in addition to just translation of the center of mass. By contrast, a monoatomic gas molecule such as C has virtually no kinetic energy (at normal temperatures) other than translational kinetic energy. Which kind of gas do you expect to have a larger molar heat capacity (heat capacity per molecule)?