

Conceptual Questions

14. A bomb calorimeter is placed in a water bath, and a mixture of fuel and oxygen is burned inside it. The temperature of the water is observed to rise during the combustion reaction. The calorimeter and the water remain at constant volume.
- If the reaction products are the system, which thermodynamic quantities— ΔU , Q , or W —are positive and which are negative?
 - If the water bath is the system, which thermodynamic quantities— ΔU , Q , or W —are positive and which are negative?
15. Which of the thermodynamic values (ΔU , Q , or W) would be negative for the following systems?
- a steel rail (system) undergoing slow thermal expansion on a hot day displaces the spikes and ties that hold the rail in place
 - the interior of a closed refrigerator (system)
 - the helium in a thermally insulated weather balloon (system) expands during inflation

Practice Problems

For problems 16–17, see Sample Problem B.

16. Heat is added to an open pan of water at 100.0°C , vaporizing the water. The expanding steam that results does 43.0 kJ of work, and the internal energy of the system increases by 604 kJ . How much energy is transferred to the system as heat?
17. A 150 kg steel rod in a building under construction supports a load of 6050 kg . During the day, the rod's temperature increases from 22°C to 47°C . This temperature increase causes the rod to thermally expand and raise the load 5.5 mm .
- Find the energy transferred as heat to or from the rod. (Hint: Assume the specific heat capacity of steel is the same as for iron.)
 - Find the work done in this process. Is work done on or by the rod?
 - How great is the change in the rod's internal energy? Does the rod's internal energy increase or decrease?

EFFICIENCY AND ENTROPY

Review Questions

18. The first law of thermodynamics states that you cannot obtain more energy from a process than you originally put in. The second law states that you cannot obtain as much usable energy from a system as you put into it. Explain why these two statements do not contradict each other.
19. What conditions are necessary for a heat engine to have an efficiency of 1.0 ?
20. In which of the following systems is entropy increasing? (Do not include the surroundings as part of the system.)
- An egg is broken and scrambled.
 - A cluttered room is cleaned and organized.
 - A thin stick is placed in a glass of sugar-saturated water, and sugar crystals form on the stick.
21. Why is it not possible for all of the energy transferred as heat from a high-temperature source to be expelled from an engine by work?

Conceptual Questions

22. If a cup of very hot water is used as an energy source and a cup of cold water is used as an energy “sink,” the cups can, in principle, be used to do work, as shown below. If the contents are mixed together and the resulting lukewarm contents are separated into two cups, no work can be done. Use the second law of thermodynamics to explain this. Has the first law of thermodynamics been violated by mixing and separating the contents of the two cups?

