First Law of Thermodynamics

1. A sealed container is filled with an ideal gas. The internal energy of the gas is 688J. The gas performs 241J work on its surroundings while absorbing 68.0J of heat from the surroundings. What is the internal energy of the gas afterward?

2. A sealed container of gas is at 321K. The container loses 630J of thermal energy and maintains its temperature. How much work is done? Is the work done to the gas or by the gas?

3.

A C

3.00x105 Pa

1.00x105Pa B

0.500m3 0.800m3

Consider the PV graph shown.

a. What type of process is CA?

b. What type of process is BC?

c. Find Q in BC.

d. Find Q in CA.

e. If the temperature at A is 422K, find the number of molecules in the container.

4. A gas, in a container with a floating lid, expands. In doing so it lifts the lid, m=650g, r=5.00cm a distance of 12.0cm in 0.68s. Find the change in internal energy of the gas.

5. A gas has volume V0 and pressure P0 and is at 420K. The pressure is increased to 4V0 while the temperature is dropped to 210K.

a. What is the final pressure in terms of P0.

b. What is the ratio of U/U0

c. Did the energy of the gas increase or decrease?

6. Consider the following PV diagram for a sealed container containing 6.0mols of ideal gas.

PA TA=620K

A

0.20PA B

VA 3VA

a. Find TB.

b. Find QAB.

7. A container undergoes an adiabatic compression. a. Is work done by the gas or to the gas?

b. Does internal energy increase or decrease?

c. Does temperature increase or deacrese?

d. Do the molecules of the gas speed up or slow down on

average?

e. Does heat flow into or out of the gas?

8. A container undergoes an isobaric expansion. a. Is work done by the gas or to the gas?

b. Does internal energy increase or decrease?

c. Does temperature increase or deacrese?

d. Do the molecules of the gas speed up or slow down on

average?

e. Does heat flow into or out of the gas?

Thermodynamics: The 2nd Law, Heat Engines, Heat Pumps and Refrigerators.

1. A heat engine absorbs 56000J of thermal energy while performing 34000J of work. How much thermal energy is discarded?

2. A heat engine performs 4.0J of work for every 3.0J of thermal energy discarded. How much thermal energy must be absorbed to perform 400J of work?

3. What is the thermal efficiency of a heat engine that discards 5.0J of thermal energy for every 3.0J of work performed?

4. A heat engine is 42% efficient. How much work is performed for every 1.00x104J of thermal energy absorbed?

5. A heat engine is 42% efficient. How much work is performed for every 1.00x104J of thermal energy discarded?

6. A heat pump absorbs 650J of thermal energy, and discards 1650J of thermal energy. How much work was done to the system?

7. A heat pump absorbs 250J of heat for every 450J of work done. How much thermal energy is discarded as 750J of thermal energy is absorbed?

8. A heat pump has a C.O.P. of 2.0. How much work is done to absorb 1200J of thermal energy?

9. What is the maximum efficiency of a heat engine operating between a hot reservoir at 1200K and a cold reservoir at 650K?

10. A heat engine is 43.0% efficient. The engine operates at 6500W (that means the work output is 6500J/s)

a. At what rate is heat output from the engine?

b. The waste heat is used to heat a tank of water. How long will it take the engine to raise a tank containing 100.0L of water from 20.0oC to 30.0oC?

11. How much electrical energy must be input to a heat pump with a COP=2.0 in order for it to provide 125kJ of heat to the interior of a house?

12. How much electrical energy must be input to a refrigerator with a COP=2.0 in order for it to provide 125kJ of heat to the interior of a house?

13. A Carnot engine operates between a hot reservoir at 600.0K and a cold reservoir at 200.0K. During a cycle the engine takes in 8000.0J of heat from the hot reservoir.

a. How much heat is exhausted to the cold reservoir per cycle?

b. How much work is performed by the engine per cycle?

14. A heat engine takes in 24kJ of heat and performs 16kJ of work. The discarded heat is deposited into a sealed container of ideal gas. The container has a fixed volume of 2.0x10-2m3 and is initially at 1.00atm and 26.0oC. What is the final pressure of the gas?

15. A Carnot refrigerator is in a kitchen at 20.0oC. The interior of the freezer is -12.0oC. 1.00kg of liquid water at 0oC is placed in the freezer and allowed to freeze completely, and reach the same temperature of the interior of the freezer. If electricity is $0.180 per kilowatt hour, what does it cost to make the ice?