Ideal Gas, pV=NkT or pV=nRT

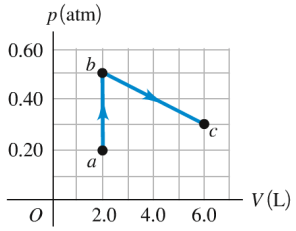
18.26 •• In a gas at standard conditions, what is the length of the side of a cube that contains a number of molecules equal to the population of the earth (about 6×10^9 people)?

First Law of Thermodynamics, $\Delta U = Q - W$

19.6 •• A gas undergoes two processes. In the first, the volume remains constant at 0.200 m^3 and the pressure increases from 2.00×10^5 Pa to 5.00×10^5 Pa. The second process is a compression to a volume of 0.120 m^3 at a constant pressure of 5.00×10^5 Pa. (a) In a *pV*-diagram, show both processes. (b) Find the total work done by the gas during both processes.

19.11 •• The process *abc* shown in the *pV*-diagram in Fig. E19.11 involves 0.0175 mole of an ideal gas. (a) What was the lowest temperature the gas reached in this process? Where did it occur? (b) How much work was done by or on the gas from *a* to *b*? From *b* to *c*? (c) If 215 J of heat was put into the gas during *abc*, how many of those joules went into internal energy?

Figure **E19.11**



19.29 • A monatomic ideal gas that is initially at a pressure of 1.50×10^5 Pa and has a volume of 0.0800 m^3 is compressed adiabatically to a volume of 0.0400 m^3. (a) What is the final pressure? (b) How much work is done by the gas? (c) What is the ratio of the final temperature of the gas to its initial temperature? Is the gas heated or cooled by this compression?

Second Law of Thermodynamics, $\Delta S \geq 0$

20.16 •• An ice-making machine operates in a Carnot cycle. It takes heat from water at 0.0°C and rejects heat to a room at 24.0°C. Suppose that 85.0 kg of water at 0.0°C are converted to ice at 0.0°C. (a) How much heat is discharged into the room? (b) How much energy must be supplied to the device?

20.41 •• **CALC** You build a heat engine that takes 1.00 mol of an ideal diatomic gas through the cycle shown in Fig. P20.41. (a) Show that segment *ab* is an isothermal compression. (b) During which segment(s) of the cycle is heat absorbed by the gas? During which segment(s) is heat rejected? How do you know? (c) Calculate the temperature at points *a*, *b*, and *c*. (d) Calculate the net heat exchanged with the surroundings and the net work done by the engine in one cycle. (e) Calculate the thermal efficiency of the engine.

Figure **P20.41**