5 Thermodynamics

8/23:

1) Young and Freedman (2019): Problem 36.21.

   An interference pattern is produced by light of wavelength 580 nm from a distant source incident on two identical parallel slits separated by a distance (between centers) of 0.530 mm.

   (a) If the slits are very narrow, what would be the angular positions of the first-order and second-order, two-slit interference maxima?

   (b) Let the slits have width 0.320 mm. In terms of the intensity I_0 at the center of the central maximum, what is the intensity at each of the angular positions in part (a)?

2) Young and Freedman (2019): Problem 36.44.

   Observing Jupiter. You are asked to design a space telescope for Earth orbit. When Jupiter is 5.93×10^8 km away (its closest approach to Earth), the telescope is to resolve, by Rayleigh's criterion, features on Jupiter that are 250 km apart. What minimum-diameter mirror is required? Assume a wavelength of 500 nm.

3) Young and Freedman (2019): Problem 18.6.

   You have several identical balloons. You experimentally determine that a balloon will break if its volume exceeds 0.900 L. The pressure of the gas inside the balloon equals air pressure (1.00 atm).

   (a) If the air inside the balloon is at a constant 22.0 °C and behaves as an ideal gas, what mass of air can you blow into one of the balloons before it bursts?

   (b) Repeat part (a) if the gas is helium rather than air.

4) Young and Freedman (2019): Problem 18.21.

   Modern vacuum pumps make it easy to attain pressures of the order of 1×10^{-13} atm in the laboratory. Consider a volume of air and treat the air as an ideal gas.

   (a) At a pressure of 9.00×10^{-14} atm and an ordinary temperature of 300.0 K, how many molecules are present in a volume of 1.00 cm^3?

   (b) How many molecules would be present at the same temperature but at 1.00 atm instead?

5) Young and Freedman (2019): Problem 18.38.

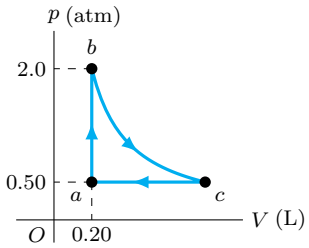
   Perfectly rigid containers each hold n moles of an ideal gas, one being hydrogen (H_2) and the other being neon (Ne). If it takes 300 J of heat to increase the temperature of the hydrogen by 2.50 °C, by how many degrees will the same amount of heat raise the temperature of the neon?

6) Young and Freedman (2019): Problem 19.10.

   Five moles of an ideal monatomic gas with an initial temperature of 127 °C expand and, in the process, absorb 1 500 J of heat and do 2 100 J of work. What is the final temperature of the gas?

7) Young and Freedman (2019): Problem 19.43.

   The following figure shows a pV-diagram for 0.004 0 mol of *ideal* H_2 gas. The temperature of the gas does not change during segment *bc*.



(a) What volume does this gas occupy at point c?

(b) Find the temperature of the gas at points a, b, and c.

(c) How much heat went into or out of the gas during segments ab, ca, and bc? Indicate whether the heat has gone into or out of the gas.

(d) Find the change in the internal energy of this hydrogen during segments ab, bc, and ca. Indicate whether the internal energy increased or decreased during each segment.

8) You hear the weather report on the radio. However, the announcer forgets to say what scale is being used: Celsius or Fahrenheit. If it doesn't matter, how cold is it outside?

9) A pinhole camera can produce a surprisingly sharp image. The key is using a small hole so only a narrow bundle of rays is allowed through. However, if the pinhole is too small, then diffraction will limit the sharpness of the image. The optimum pinhole size is one that makes the fuzziness due to bundle size comparable to the fuzziness due to diffraction. Assume the distance from pinhole to screen is 1 foot, and the wavelength of the light is 5 500 Å. What is the optimum size of the pinhole?