PHY240 Thermodynamics and Modern Physics

Fall 2012 Exam I (Chapters 1 – 3) September 30 2012

Total 50 points

Due October 3, 2012

Chp 1: First Law of Thermodynamics (5 points)

Question 1(a) A 5-gallon container of water (approximately 20 kg) having a temperature of 212°F is added to a 50-gallon tub (approximately 200 kg) of water having a temperature of 50°F. What is the final equilibrium temperature (in °C) of the mixture?

a. 54
b. 36
c. 18
d. 66
e. 14

ANS: C

Question 1(b) (15 points)

30. A gas is taken through the cyclic process described in Figure P20.30. (a) Find the net energy transferred to the system by heat during one complete cycle. (b) **What If?** If the cycle is reversed—that is, the process follows the path *ACBA*—what is the net energy input per cycle by heat?

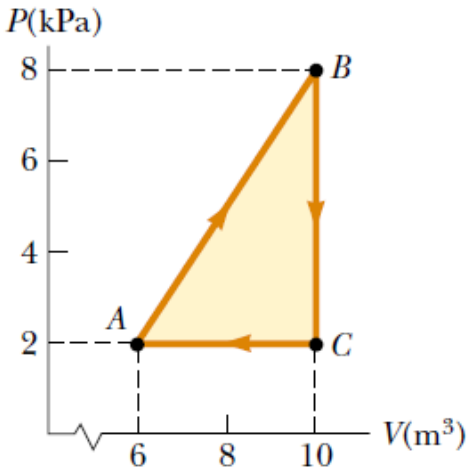

Figure P20.30 Problems 30 and 31.

Chp 2: Kinetic Theory of Gases (15 points)

34. A certain molecule has f degrees of freedom. Show that an ideal gas consisting of such molecules has the following properties: (1) its total internal energy is $fnRT/2$; (2) its molar specific heat at constant volume is $fR/2$; (3) its molar specific heat at constant pressure is $(f+2)R/2$; (4) its specific heat ratio is $= C_P/C_V = (f+2)/f$.

35. In a crude model (Fig. P21.35) of a rotating diatomic molecule of chlorine (Cl_2), the two Cl atoms are 2.00×10^{-10} m apart and rotate about their center of mass with angular speed $w = 2.00 \times 10^{12}$ rad/s. What is the rotational kinetic energy of one molecule of Cl_2, which has a molar mass of 70.0 g/mol?

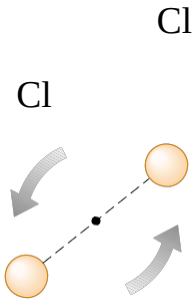

Figure P21.35

Chp 3: Entropy and Second Law of Thermodynamics (15 points)

20. A 20.0%-efficient real engine is used to speed up a train from rest to 5.00 m/s. It is known that an ideal (Carnot) engine using the same cold and hot reservoirs would accelerate the same train from rest to a speed of 6.50 m/s using the same amount of fuel. The engines use air at 300 K as a cold reservoir. Find the temperature of the steam serving as the hot reservoir.