Solutions to problems in worksheet T1

PART 1

Problem 1:

$$P_1 = P_2$$
$$N_1 k T_1 / V_1 = N_2 k T_2 / V_2$$
$$V_1 = A L_1$$
$$\frac{L_2}{L_1} = \frac{N_2}{N_1} = 2/3$$
$$L_1 + L_2 = 1\ m$$
$$L_1 = \frac{1}{3} m, L_2 = \frac{2}{3} m$$

Problem 2

$$T_1 = 25 + 273\ K = 298\ K$$
$$T_2 = -10 + 273\ K = 263\ K$$
$$\frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{263}{298} = 0.883$$

The volume shrank by 11.7%.

The path on the P-V diagram is a straight line at constant P, starting at point P1 V1 at the right, going to P2V2 on the left, where V2 is less than V1. This diagram has P on the y-axis and V on the x-axis.

Problem 3

PV is a constant if T and N are constant, as they are in this problem. If the volume is halved, then the pressure doubles. The P-V diagram has an isothermal curve from P1V1 to P2V2, which is to the upper left of the starting point.

PART 2

Question 4:

(a) If the particles have the same mass, then they have the same average velocity.
(b) The diatomic particles have more kinetic energy by an extra factor NkT from the two rotational degrees of freedom.

Question 5: $\Delta E_{int} = 0$ since T does not change.

Question 6: Sample B has more kinetic energy by an extra factor of ½ kT from one vibrational degree of freedom.

Problem 2

(a) $p_1 = p_2, V_2 = 7V_1, V_3 = V_2, p_3 = \frac{1}{4} p_1$

(b) $T_1 = \frac{p_1 V_1}{Nk},\ T_2 = \frac{7 p_1 V_1}{Nk}, T_3 = \frac{7}{4}\frac{p_1 V_1}{Nk}$

(c) $\Delta E_i = \frac{5}{2} Nk\ (T_2 - T_1) = 15 p_1 V_1$

$$\Delta E_{ii} = \frac{5}{2} Nk\ (T_3 - T_2) = -\frac{105}{8} p_1 V_1$$

$$\Delta E_{iii} = \frac{5}{2} Nk (T_1 - T_3) = -\frac{15}{8} p_1 V_1$$

(d) 0