Problem Set #4

1. See Problem Set # 4, 1977, question # 1.

2. See Problem Set # 4, 1977, question # 2.

3. See Problem Set # 4, 1977, question # 3.
   (a) See Problem Set # 4, 1977, question # 3a.
   (b) See Problem Set # 4, 1977, question # 3b.
   (c) The ground electronic state of C₃O₂ is nondegenerate. What is the degeneracy of \( \psi_{\text{mol}} \) when C₃O₂ is in its ground electronic state with \( v_1 = v_2 = v_3 = v_4 = v_5 = v_6 = 0, v_7 = 1 \), and the rotational quantum number \( J = 5 \)? The normal coordinate \( Q_7 \) is antisymmetric with respect to simultaneous interchange of all pairs of equivalent nuclei. What is the degeneracy of \( \psi_{\text{mol}} \) for the above state with \( J = 6 \) instead of 5?


5. \(^{16}\text{O}^{12}\text{C}^{32}\text{S} \) is a linear molecule. The bond lengths are
   \[ r_{\text{CO}} = 1.16\text{Å} \]
   \[ r_{\text{CS}} = 1.56\text{Å} \]
   and the observed fundamental vibrational frequencies are
   \[ \nu_1 = 858.9 \text{ cm}^{-1} \text{ stretch} \]
   \[ \nu_2 = 520.4 \text{ cm}^{-1} \text{ bend} \]
   \[ \nu_3 = 2062.2 \text{ cm}^{-1} \text{ stretch}. \]
   (a) Obtain \( k_{\text{CS}}, k_{\text{CO}}, \) and \( k_0[r_{\text{CO}}r_{\text{CS}}]^{-1} \) in dynes/cm.
   (b) What are the amplitudes for C-O and C-S stretch in \( \nu_1 \)?
   (c) What are the vibrational frequencies for \(^{18}\text{O}^{12}\text{C}^{32}\text{S} \)?