Atomic and Molecular Physics course, Week-09 Assignment-09

The due date for submitting this assignment has passed.

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1. The mass of helium is 4.00x10^{-3} kg/m^3. Calculate the angular velocity of a solid sphere to spin around a central axis.

   \[ \frac{I}{2mR^2} \]  
   \[ \frac{1}{2} \times 4.00 \times 10^{-3} \times \frac{1}{(0.100 \text{ m})^2} \]  
   \[ 0.002 \text{ rad/second} \]  
   \[ 0.1\text{ rad/second} \]  
   \[ 0.1\text{ rad/second} \]  
   \[ 0.1\text{ rad/second} \]  

   **Answer:** Correct

2. The number of atoms of O in a solid is 1.40x10^{22} kg/m^3. Calculate the angular velocity of O atoms in its lowest rotational energy level.

   \[ I = \frac{1}{2} mR^2 \]  
   \[ 0.140 \times 10^{22} \times \frac{1}{(0.100 \text{ m})^2} \]  
   \[ 0.003 \text{ rad/second} \]  
   \[ 0.003 \text{ rad/second} \]  
   \[ 0.003 \text{ rad/second} \]  
   \[ 0.003 \text{ rad/second} \]  

   **Answer:** Correct

3. The OH radical has a moment of inertia of 1.49x10^{-22} kg.m^2. Calculate its internal molecular distance.

   \[ I = \frac{1}{2} mR^2 \]  
   \[ 1.49 \times 10^{-22} \times \frac{1}{(0.100 \text{ m})^2} \]  
   \[ 0.0005 \text{ m} \]  
   \[ 0.0005 \text{ m} \]  
   \[ 0.0005 \text{ m} \]  
   \[ 0.0005 \text{ m} \]  

   **Answer:** Correct

4. The energy of the first excited state of a hydrogen atom in its ground state is 1.49x10^{-22} electron-volts (eV). Calculate the energy level of the hydrogen atom.

   \[ E_n = -\frac{13.6}{n^2} \text{ eV} \]  
   \[ -\frac{13.6}{4^2} \text{ eV} \]  
   \[ -0.34 \text{ eV} \]  
   \[ -0.34 \text{ eV} \]  
   \[ -0.34 \text{ eV} \]  
   \[ -0.34 \text{ eV} \]  

   **Answer:** Correct

5. The rotational energy of a diatomic molecule is 1.49x10^{-22} J. Calculate the angular momentum of the molecule.

   \[ E = \frac{1}{2} I \omega^2 \]  
   \[ 1.49 \times 10^{-22} = \frac{1}{2} I \omega^2 \]  
   \[ \omega = 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  

   **Answer:** Correct

6. The rotational energy of a diatomic molecule is 1.49x10^{-22} J. Calculate the angular momentum of the molecule.

   \[ E = \frac{1}{2} I \omega^2 \]  
   \[ 1.49 \times 10^{-22} = \frac{1}{2} I \omega^2 \]  
   \[ \omega = 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  
   \[ 0.1 \text{ rad/second} \]  

   **Answer:** Correct

7. The bond length of NO is 1.17 A. Calculate the moment of inertia of NO.

   \[ I = \frac{1}{2} mR^2 \]  
   \[ \frac{1}{2} \times 1.17 ^2 \]  
   \[ 0.73 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.73 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.73 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.73 \times 10^{-22} \text{ kg.m}^2 \]  

   **Answer:** Correct

8. The bond length of H₂O is 0.96 A. Calculate the moment of inertia of H₂O.

   \[ I = \frac{1}{2} mR^2 \]  
   \[ \frac{1}{2} \times 0.96 ^2 \]  
   \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  

   **Answer:** Correct

9. The bond length of H₂S is 1.35 A. Calculate the moment of inertia of H₂S.

   \[ I = \frac{1}{2} mR^2 \]  
   \[ \frac{1}{2} \times 1.35 ^2 \]  
   \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
   \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  

   **Answer:** Correct

10. The bond length of H₂O is 0.96 A. Calculate the moment of inertia of H₂O.

    \[ I = \frac{1}{2} mR^2 \]  
    \[ \frac{1}{2} \times 0.96 ^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  

    **Answer:** Correct

11. The bond length of H₂S is 1.35 A. Calculate the moment of inertia of H₂S.

    \[ I = \frac{1}{2} mR^2 \]  
    \[ \frac{1}{2} \times 1.35 ^2 \]  
    \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.52 \times 10^{-22} \text{ kg.m}^2 \]  

    **Answer:** Correct

12. The bond length of H₂O is 0.96 A. Calculate the moment of inertia of H₂O.

    \[ I = \frac{1}{2} mR^2 \]  
    \[ \frac{1}{2} \times 0.96 ^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  
    \[ 0.46 \times 10^{-22} \text{ kg.m}^2 \]  

    **Answer:** Correct