

Physics 237 Problem Set #12

In preparation for the quiz on Thursday, 23 April 2026

- E. Deuterium - D, also known as ${}^2\text{H}$, or heavy hydrogen - has a nucleus consisting of a proton and a neutron. Its atomic mass is $m_D = 3.345 \times 10^{-24}$ gm. Its nucleus has charge $+e$ and spin 1. The deuterium molecule D_2 , which we assume to be a rigid rotor, has interatomic distance very close to the same as H_2 , $r = 0.074$ nm.
- Using your experience in calculation of Clebsch-Gordan coefficients ([Problem Set #11](#)), with help from G&S Table 4.8, find all the states of total spin which are possible in D_2 , with quantum numbers s and m , given the spin quantum numbers $s_1, m_1, s_2,$ and m_2 of the D atoms.
 - Find the symmetry of each state total spin state $|sm\rangle$; that is, calculate $\hat{P}|sm\rangle$. How many symmetric states are there, and how many antisymmetric states?
 - Which states of orbital angular momentum, with quantum numbers J and M , can be combined with the spin states $|sm\rangle$, under the rules of spin and statistics?
 - The **statistical weight, g** , of a set of states is the number of states in the set: for example, the statistical weight of a spin triplet is 3, and that of a singlet is 1. What is the statistical weight g_J of each rotational state J of a rigid rotor, not counting the spin parts of the states?
 - For H_2 ([Lecture 23](#)) and D_2 , list the total statistical weight g of each complete state of orbital and spin angular momentum, for $J = 0 - 5$ in each case.

From chapter 5 of Griffiths & Schroeter:

5.10

5.12

5.19

5.20

5.21

5.22