HW-5. Ch. 7 material: What is the advantage of the 4-level laser relative to the 3-level one and why? Draw an energy level diagram and refer to it.

- Answer using the concept of population inversion.
- Hint: the ground state is one of the two levels involved in the lasing transition of the 3-level laser.

In order to amplify light by stimulated emission, a material containing the chemical species that will emit laser light must be excited (pumped) such that the upper of the two states involved in the lasing transition is more populous than the lower. When the upper of the two states is more populous (i.e. in higher concentration) it is said to be in a state of population inversion. In order to establish a population inversion, the upper state must be populated by pump energy, and the lower state must be depopulated. In the case of the 3-level laser – the lower state is the ground state, so in order to depopulate it, a large amount of pump energy must be put in so that the ground state is actually in lower concentration than excited state 3. The only way to depopulate the ground state is to put in more and more pump energy. In the case of the 4-level laser, only a modest pump energy may be sufficient to establish a population inversion between states 3 and 4 if state 3 is relatively long lived (metastable) and state 4 is relatively short lived (unstable).