Perturbation expansion for classical liquids ; Wang-Landau algorithm

- **Perturbation expansion for classical liquids**
  Consider a classical liquid subject to inter-molecular two-body interactions.

  1. Clearly explain all steps in the derivation of the *high-temperature expansion of the free energy*. In that context, clearly discuss the role of the disconnected, reducible and irreducible diagrams.

  2. Clearly explain all steps in the derivation of the *density expansion of the free energy*. How do effective interactions emerge from the perturbation expansion?

  3. Clearly explain all steps in the derivation of the equation-of-state for a system of hard spheres.

- **Wang-Landau algorithm**

  1. Discuss in great detail the principles underlying the Wang-Landau algorithm for evaluating the density of states for a particular system of interacting particles.

  2. Discuss how the Wang-Landau algorithm can be applied to the two-dimensional Ising model. For this particular system, what is the advantage/disadvantage of the Wang-Landau algorithm compared to the Metropolis-Hastings algorithm (Monte Carlo algorithm)?