

O-LAB 12: States of matter

Purpose: Investigate the basic thermal properties of matter.

Introduction

Matter can be in a solid, liquid, or gas form depending on its temperature and pressure. Noble gases typically have low gas→liquid and liquid→solid transition temperatures due to their low interaction potentials. Diatomic molecules have a preferred polarization associated with them which decreased the bottom of their interaction potential well. Molecules with permanent dipoles and polarizabilities such as water have large interaction potentials. Thus, the phase transition in water occurs at much higher temperatures than the phase transition of a noble gas at the same pressure. This laboratory assignment investigates phase transitions of well-known materials and investigates the effect of the interaction potential on the phase transition temperature.

Laboratory assignment

Part 1: phases of atoms and small molecules

1. View the simulation for states of matter.
2. Choose the “States” button.



3. Choose neon.



4. Click on the “Solid” button.



5. Describe what you see at temperature $T = 14$ K.

6. Slowly heat the neon by adding some heat (not full blast) using the toggle at the bottom of the screen until the temperature reaches $T = 28$ K. Describe what you see.

7. Select the “Solid” button again so the system is in equilibrium in its solid state. This time rapidly heat the neon by adding the full amount of heat until the temperature reaches $T = 28$ K. Describe what you see and any differences between this step and the previous step.

8. Click on the “liquid” button
9. Slowly heat (lowest heat setting) the neon to $T = 32$ K. Wait a 3 minutes and then describe what you see.

10. Select the “Gas” button. Describe what you see.

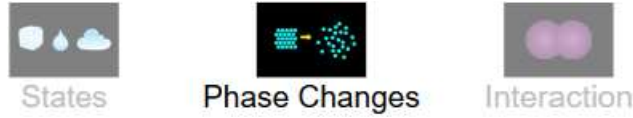
11. Now choose the “Water” molecules.
12. Click on the “liquid” button.
13. Describe what you see at temperature $T = 286$ K.

14. Use the heat toggle to quickly heat the water to $T = 400$ K. Make your observations immediately after the temperature is increased and describe them.

15. Wait three minutes while the temperature is static at $T = 400$ K and then describe what you see.

Part 2: phases and the interaction potential

16. Select the “Phase Changes” tab at the bottom of the screen.



17. Select the “Adjustable” molecule.

18. Set the interaction to the weakest setting.



19. Write down your observations.

20. Rapidly increase the temperature to $T = 540$ K. Describe what you see.

21. Change the interaction potential to the strongest setting.



22. Wait 5 minutes and then describe what happens (is it a gas, liquid, or solid and explain why).

23. Write a short conclusion to this laboratory assignment.
