**States Of Matter**

**I. Introduction**

 The kinetic theory describes matter as a large number of small particles (atoms or [molecules](http://en.wikipedia.org/wiki/Molecule)), all of which are in constant, random [motion](http://en.wikipedia.org/wiki/Motion_%28physics%29). The rapidly moving particles constantly collide with each other and/or with the walls of the container. Kinetic theory explains properties such as pressure, temperature, viscosity, thermal conductivity, and volume.

 Specifically with gases, two molecular laws are significant : Boyle’s Law and Charles’ Law. Boyle’s Law states that pressure is inversely proportional to volume (P1V1 = P2V2), i.e., a decrease in volume results in an increase in pressure. Charles’ Law states that volume is directly proportional to temperature (V1/T1 = V2/T2), i.e., an increase in temperature results in an increase in volume.

 In this activity, you will demonstrate the properties of various types of matter. The demonstration will allow you to change forms of matter, amounts of matter, temperature, and pressure.

**II. Procedure**

 1. Go to the following website : <https://phet.colorado.edu/en/simulation/states-of-matter> .

 2. Click on “Run Now!”. Then open the JNLP file.

 3. Click on the tab that is labeled “Solid, Liquid, Gas”.

 4. Using Neon, choose a solid state of matter, record the temperature, and describe the

 nature of the solid neon in the container.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 5. Using solid Neon, increase the temperature, record the temperature, and describe the

 nature of the solid neon.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 6. Using solid Neon, decrease the temperature, record the temperature, and describe the

 nature of the solid neon.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 7. Using Argon, choose a liquid state of matter, record the temperature, and describe the

 nature of the liquid argon in the container.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 8. Using liquid Argon, increase the temperature, record the temperature, and describe the

 nature of the liquid argon.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 9. Using liquid Argon, decrease the temperature, record the temperature, and describe the

 nature of the liquid argon.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 10. Using Water, choose a gaseous state of matter, record the temperature, and describe the

 nature of the gaseous water in the container.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 11. Using gaseous Water, increase the temperature, record the temperature, and describe the

 nature of the gaseous water.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 12. Using gaseous Water, decrease the temperature, record the temperature, and describe the

 nature of the gaseous water.

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Nature of Molecules : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 13. Click on the tab that is labeled “Phase Changes”.

 14. Using Oxygen, record the initial pressure. Then, push the finger down on the

 container until the oxygen becomes distorted. If you go too far with the finger, the

 click on reset and try again. Record the pressure that stabilizes after reducing the volume.

 Initial Pressure : \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ATM

 Reduced Volume Pressure : \_\_\_\_\_\_\_\_\_\_\_\_\_\_ ATM

 15. Click on Reset.

 16. Using Oxygen, heat up the container and record the stabilizing temperature and pressure

 without changing the container size. Click on Reset. Using Oxygen, cool down the

 container and record the stabilizing temperature and pressure without changing the container

 size.

 Heat

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Pressure : \_\_\_\_\_\_\_\_\_\_ ATM

 Cool

 Temperature : \_\_\_\_\_\_\_\_\_\_ K

 Pressure : \_\_\_\_\_\_\_\_\_\_ ATM

 17. Click on Reset. Choose any type of atom or molecule (Neon, Argon, Oxygen, Water).

 Create an experiment on your own using the PhET simulation. Describe the experiment

 below by altering the number of particles (pump), temperature (bucket), or volume (finger).

 Determine a conclusion regarding your experiment. Record the following below.

 **Experiment Description** : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **Type Of Atom or Molecule** : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **Final Temperature** : \_\_\_\_\_\_\_\_\_\_ K

 **Final Pressure** : \_\_\_\_\_\_\_\_\_\_ ATM

 **Experiment Conclusion** : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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