

Review of KMT

PhET sims: Friction, States of Matter and Gas Properties

This is for College Chemistry for students who have already taken Physics and completed the KMT inquiry lesson

<http://phet.colorado.edu/en/contributions/view/2816>

Or this activity can be used as an introduction to the particle nature of matter. The learning goals are lesson

Also uses Molecules 360 by Chem Ed DL

Have *Friction, States of Matter* and *Gas Properties* and Molecules 360 all running before class starts

Learning Goals:

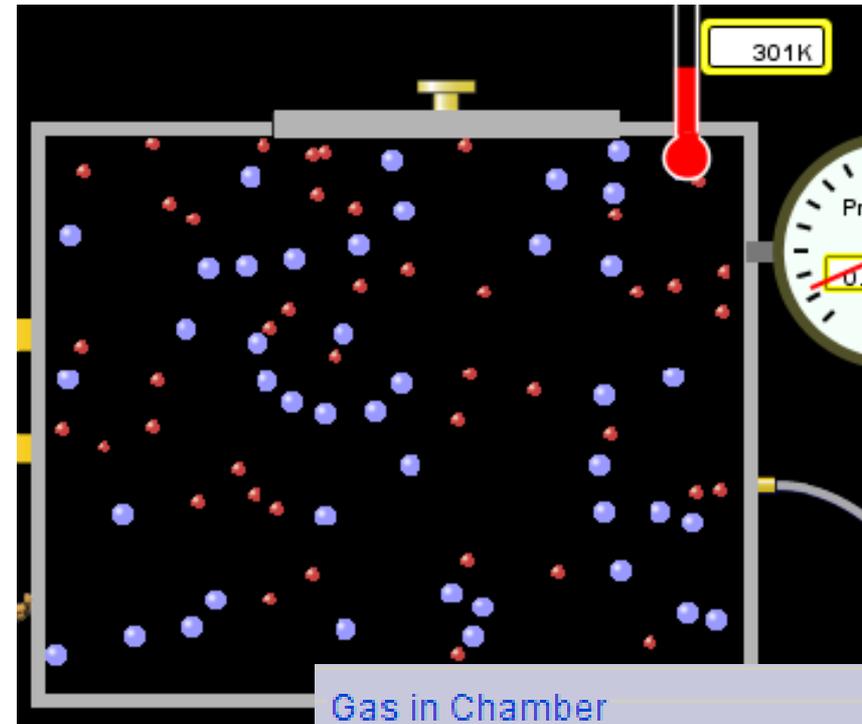
- **Students will be able to describe matter in terms of molecular motion. The description should include**
- **Diagrams to support the description.**
- **How the particle mass and temperature affect the image.**
- **What are the differences and similarities between solid, liquid and gas particle motion**
- **How the size and speed of gas molecules relate to everyday objects**

Rub your hands together. What does friction do to molecules?

- Draw your ideas

If you have a bottle with Helium & Nitrogen at room temperature, how do the speed of the particles compare?

- A. All have same speed
- B. The average speeds are the same
- C. Helium particles have greater average speed
- D. Nitrogen particles have greater average speed



Gas in Chamber

Heavy Species 43

Light Species 43

Gravity



0

Lots

Light and heavy gas at same temperature 300K

Gas Properties

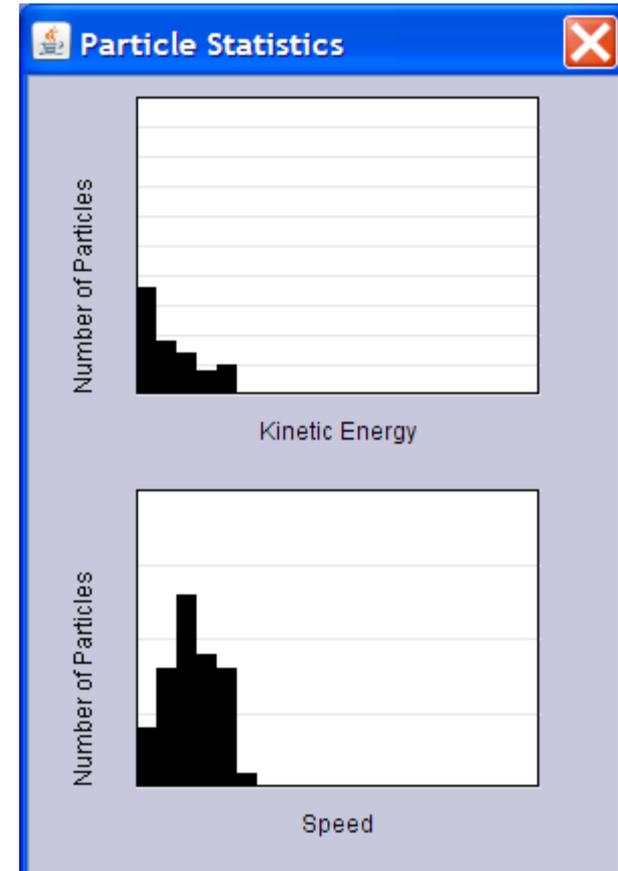
Heavy species

Number of Gas Molecules: 43 Ave. Speed: 425.21 m/sec

Light species

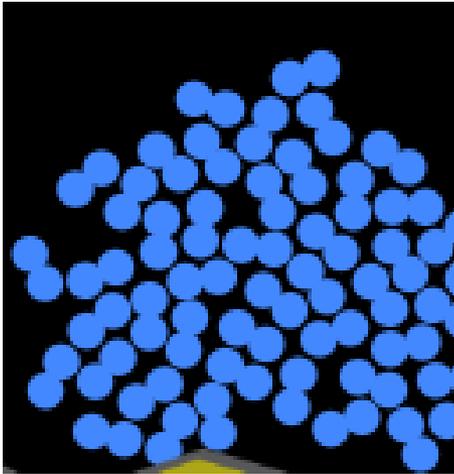
Number of Gas Molecules: 43 Ave. Speed: 1,172.71 m/sec

Java Application Window

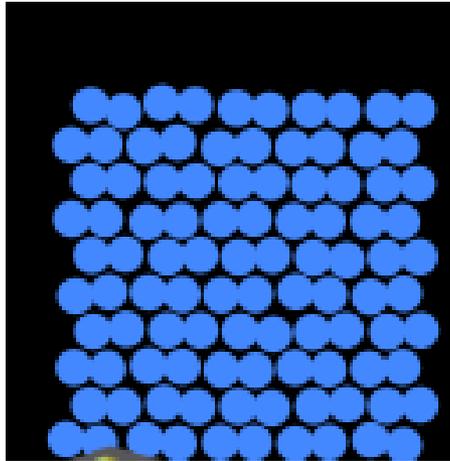


Speed of each particle varies!!

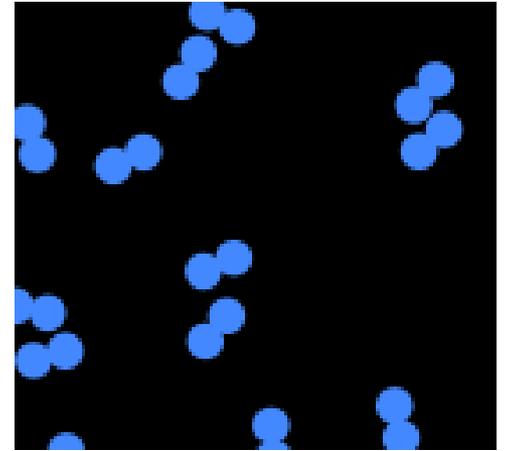
Which is most likely oxygen gas?



A

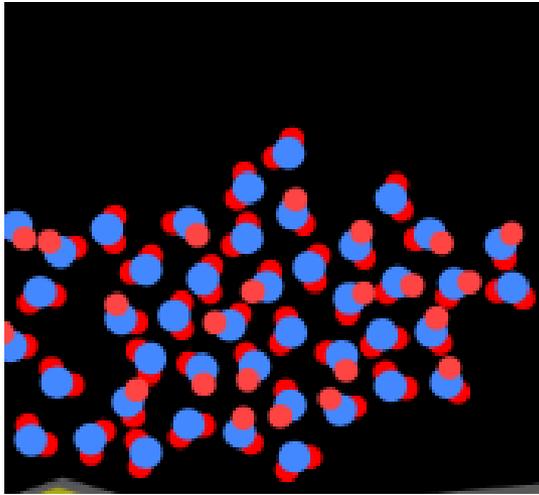


B

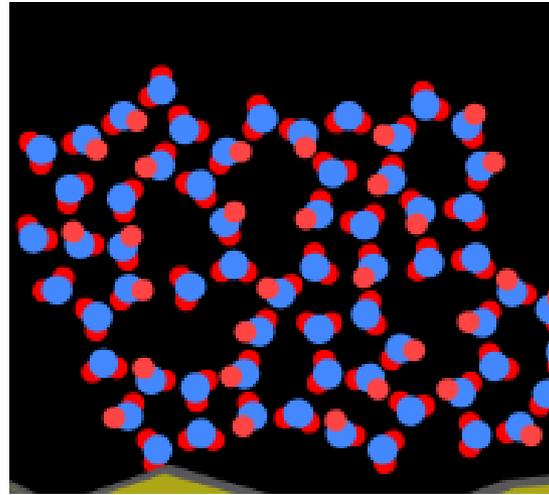


C

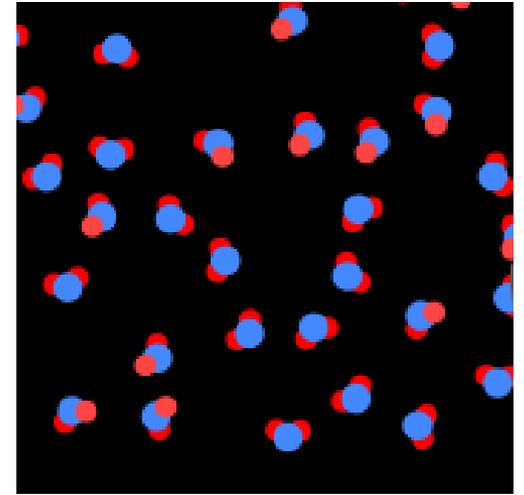
Which is most likely liquid water?



A

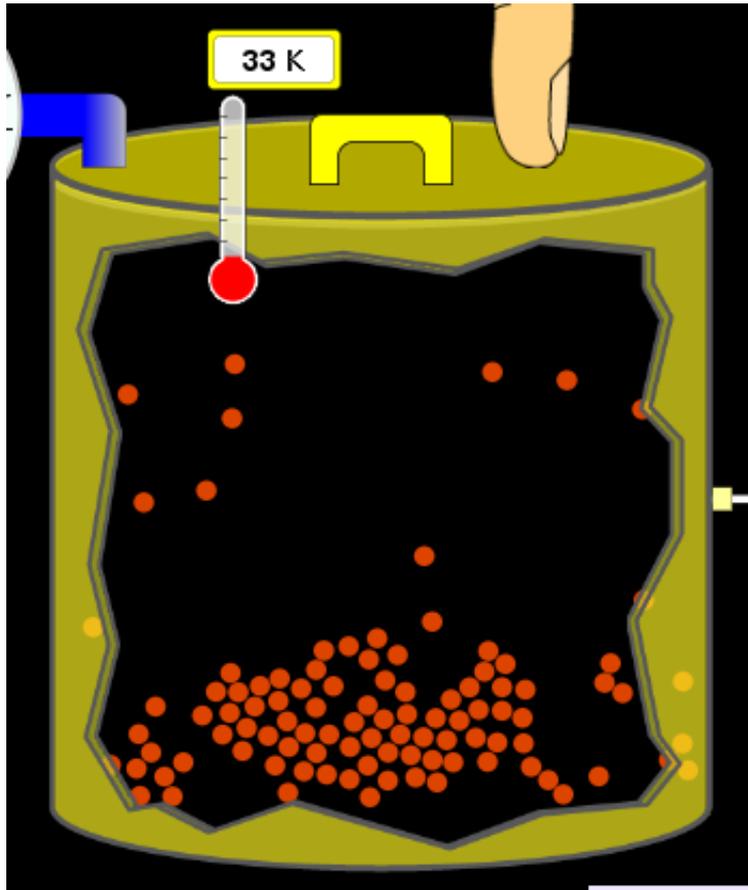


B



C

How could material be the same temperature and yet have different Phase?



Neon

Liquid-Gas

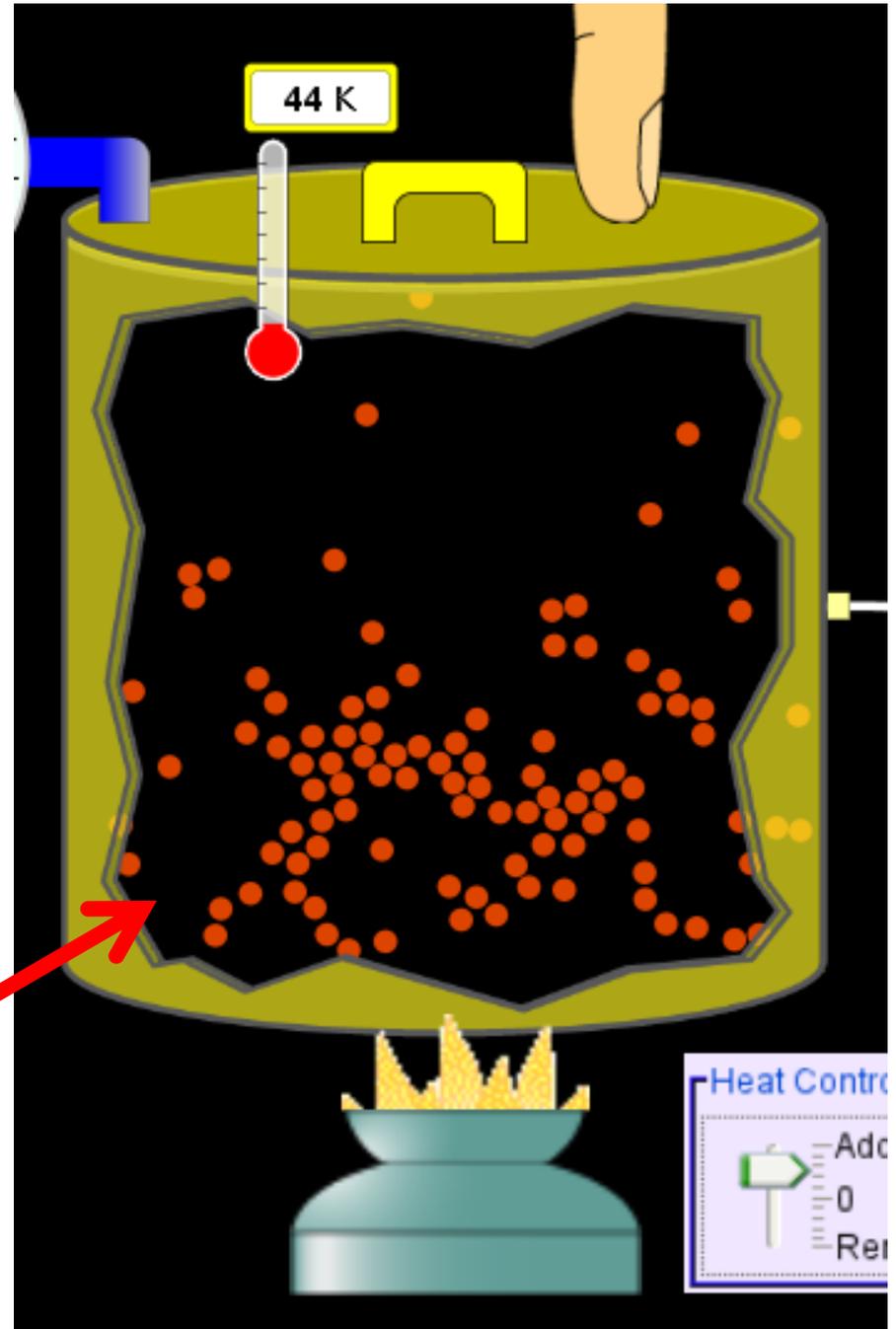
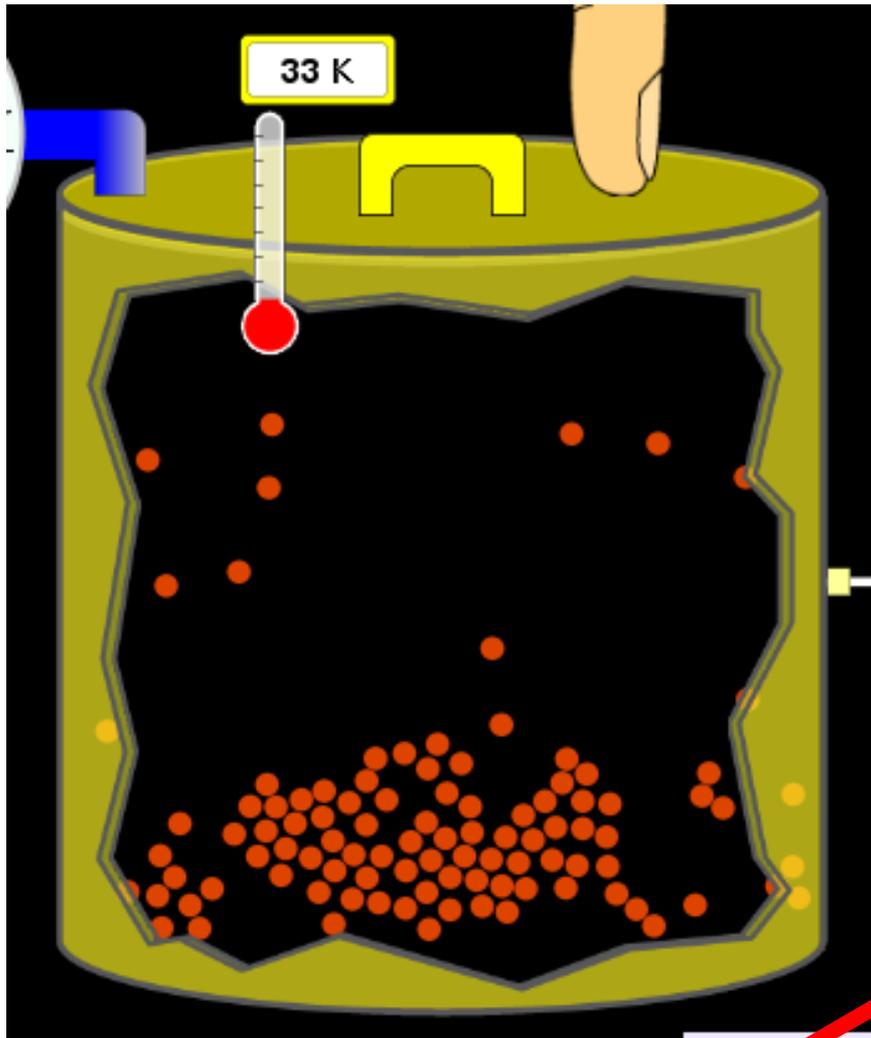
Like water-
water vapor in
a water bottle



What happens if you add energy using the heater?



- A. No change other than all atoms speed up
- B. More atoms would condense
- C. More atoms would evaporate



More are gaseous

KMT summary:

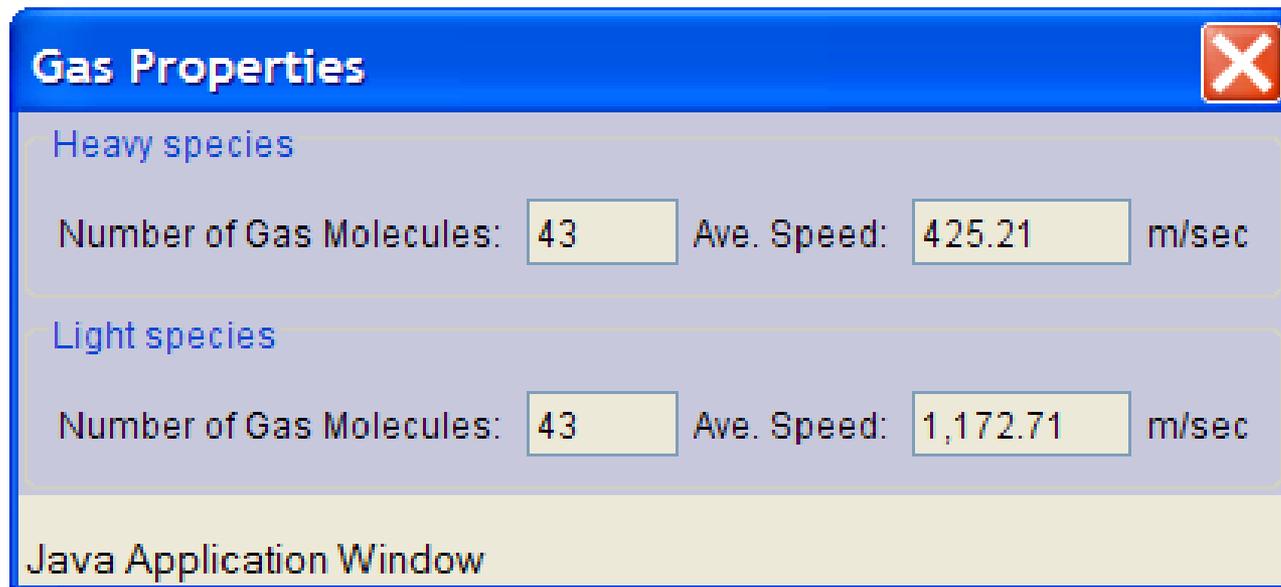
- Matter is made up of particles having negligible mass are in constant random motion (vibrate, rotate, translate)
- The particles are separated by great distances
- The particles collide perfectly elastically (there are no forces acting except during the collision)
- The temperature of a substance is related to the molecular velocity.

To show vibration

- <http://chemeddl.org/collections/molecules/index.php>
- Check **Spin Molecule** to see 3D rotation
- Show vibration under **Normal modes of vibration** (toggle down to see bond length changing)

An air particle travels about _____
as fast as a car on the highway.

60 mph is about 26m/s



The screenshot shows a Java Application Window titled "Gas Properties" with a close button (X) in the top right corner. The window is divided into two sections: "Heavy species" and "Light species". Each section displays the number of gas molecules and the average speed in m/sec.

Species	Number of Gas Molecules	Ave. Speed (m/sec)
Heavy species	43	425.21
Light species	43	1,172.71

Java Application Window

How many water molecules are
in a raindrop(.5 cm diameter).
The molecules are about .1nm

**If we just look at how
many are across**

**.05m/.1E-9m = 5E7 or
50 million.**