Name: SOLUTIONS
Hour: ________ Date: ____________

Chem B Unit 8, Day 2: The Nature of Gases
Multimodal learning

Today's task: Investigate additional resources which support the information presented in "The Nature of Gases" section of your textbook (13.1).

Purpose: To help you visualize kinetic theory of gases by allowing you to manipulate variables and observe the resulting effect on gas molecules' motion and kinetic energy.

a. In-class discussion
   1) Postulates (or "assumptions") of the Kinetic Theory of Gases:
      i. Gases consist of very small particles that are ~~relatively~~ far apart relative to their size.
      ii. Gases are in constant random motion. They constantly collide w/ each other and the walls of the container). ← Gas pressure!
      iii. Collisions between molecules are elastic (no net loss of E)
      iv. There are no forces of attraction/repulsion between gas molecules (no IMFs!)
      v. The temperature of the gas is dependent on the average KE of the gas particles.
   2) Speed and Kinetic Energy: How are these concepts related?

      1) How are kinetic energy and temperature related?

         KE is directly proportional to the temperature of the system. In fact T is a measure of the system's KE.

      2) What is the equation that relates kinetic energy and velocity of an object?

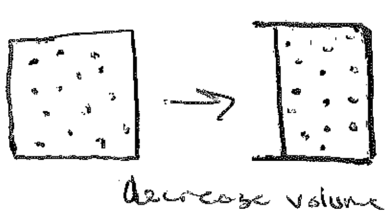
         $KE = \frac{1}{2}mv^2$ (m = mass of molecule; v = velocity of molecule)

b. In the library/computer lab: Go to http://www.padlet.com/wall/chemb_gases.
c. Follow the directions listed on the Chemb_gases Wall for Parts A-C.
d. Part B:

   If the van and Smart car have same KE, then $speed_{smart}$ must be GREATER than $speed_{van}$ due to their difference in mass.

   3) What are the units used in this simulation?
      i. Pressure: atm
      ii. Temperature: K
   4) Manipulate the system to demonstrate the following. Draw a picture of each scenario.

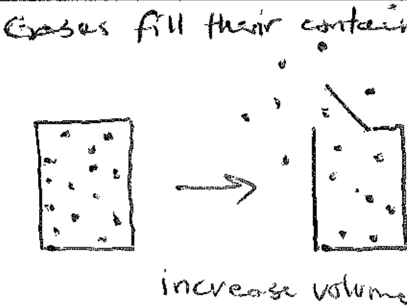
Gases fill their container!



decrease volume

i. Gas compressibility

Gases fill their container!



increase volume

ii. Gas expandability

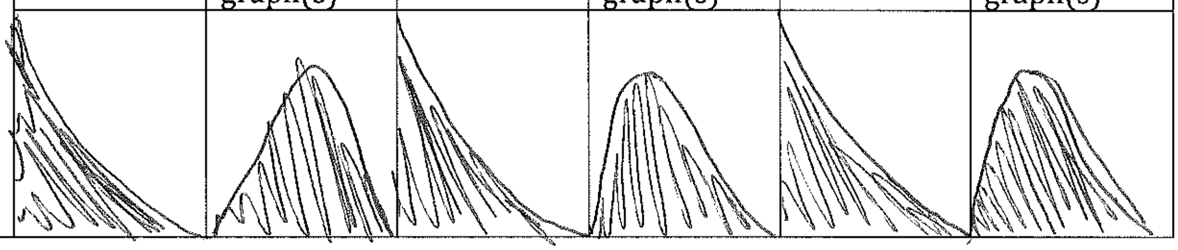
e. Part D:

5) Reset the system by pressing the "Reset" button (bottom right of screen).
6) Under the "Measurement tools, open the "Species Information" and the "Energy histograms." You will need the data presented in these graphs to help answer following questions.

Scenario 1: Fill the container with 200 molecules of the *lighter gas species* and 0 molecules of the *heavier gas species.* Record data in table below.
Scenario 2: Reset fill the container with 200 molecules of the *heavier gas species* and 0 molecules of the *lighter gas species.* Record data in table below.
Scenario3: Finally, reset and fill the container with 100 molecules of the *heavier gas species* and 100 molecules of the *lighter gas species.* Record data in table below.

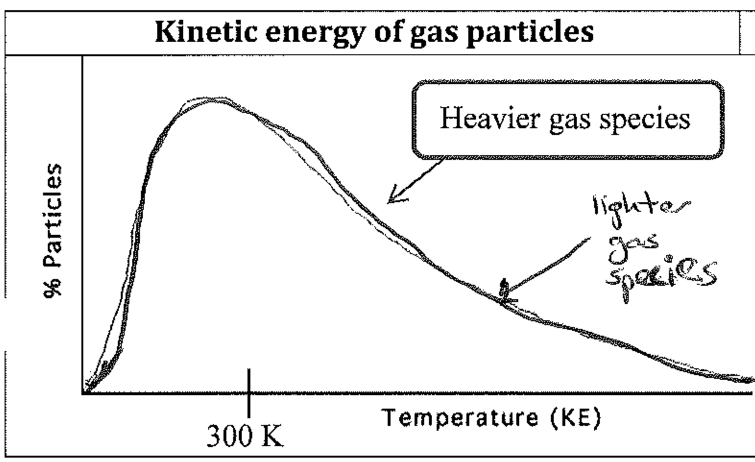
Table 1: Speed and kinetic energy of gas particles

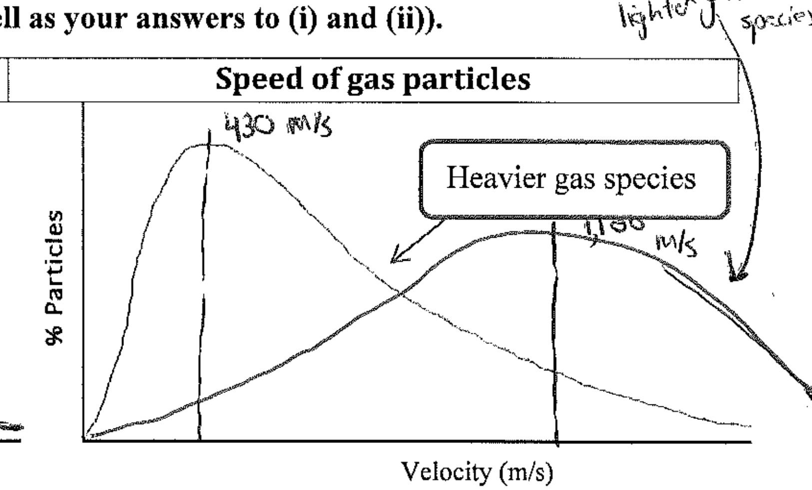
	Scenario 1		Scenario 2		Scenario 3	
	200 light	0 heavy	0 light	200 heavy	100 light	100 heavy
Average speed of particles (m/s)	1,110 m/s		420 m/s			
What qualitative changes to you observed in the Energy Histograms as you move from one scenario to the next? (i.e. How do the graphs shift? Be descriptive or draw pictures!)	Kinetic E of system graph	Average Speed of participles graph(s)	Kinetic E of system graph	Average Speed of participles graph(s)	Kinetic E of system graph	Average Speed of participles graph(s)



3) Using your data from Table 1, consider the scenario in which you have 100 of each species in the container (Scenario 3). If the heavier gas species have a KE distribution as represented to the left, how do you expect the KE distribution of the *lighter gas species* to look? Draw a second distribution curve onto the graph and label it appropriately to represent the Average kinetic energy of the lighter species in this container. **(Your observations from Table 1 should help answer this question, as well as your answers to (i) and (ii)).**

4) Scenario 2 has a velocity distribution as represented to the right. What velocity does the apex of the curve represent? How do you expect the velocity distribution of the *lighter gas species* (Scenario 1) to look? Draw a second distribution curve onto the graph and label it appropriately to represent the Average speed of the lighter species in this container. **(Your data from Table 1 should help answer this question, as well as your answers to (i) and (ii)).**





Distribution of Molecular Kinetic Energy

Distribution of Molecular Speed

v. Using the relationships determined in (i) and (ii), explain why these two graphs look different. (Use your text and the "Energy Histograms" for support).

Because the 2 systems are at the same temp, they have the same ave KE and thus their KE curves should be identical. However, because these gases have different molar masses, in order to have same KE, the lighter particles must have a higher average velocity (thus we see the speed curve shifted to the right).

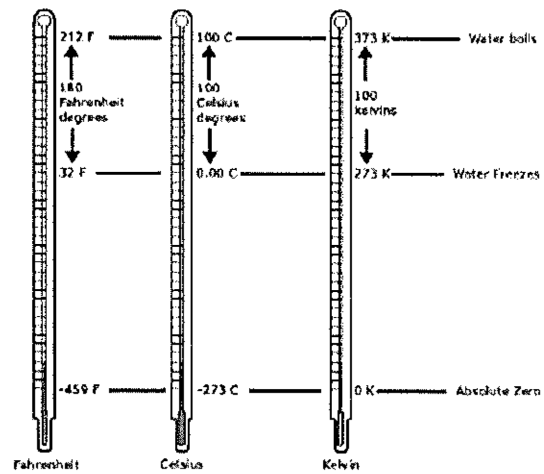
f. **Review and synthesis of KMT**: Your books states that:

Measurements indicate that the average speed of oxygen molecules in air at 20°C is an amazing 1700 km/hr! At these speeds, the odor from a hot cheese pizza in Washington, D.C., should reach Mexico City in about 115 minutes. That does not happen, however, because... (pg. 420).

7) What is air temperature in the above scenario in Kelvin (Hint: You book states that Absolute zero, 0 °C is measured to be 273.15 K and these temperature measurements have the same scale, i.e. a shift of 1 °C will result in a shift of 1 K)?

20 °C → K ?

20 + 273.15 = **293.15 K**



8) What is the average speed of these molecules when measured in units of meters per second (m/s) (There are 1000 m in a kilometer)?

$$\frac{1700\ \text{km}}{1\ \text{hr}} \times \frac{1000\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{hr}}{60\ \text{minutes}} \times \frac{1\ \text{minute}}{60\ \text{seconds}} = 472\ \text{m/s}$$

9) Do either species in the simulation have an average speed close to that of oxygen molecules in air (Hint: Review your data from Table 1)?

The heavier species had a similar average speed, so assuming same P and T conditions, this heavier species could be O_2 gas.

10) In your own words, explain why an adult walking in Mexico City won't smell the D.C. pizza *ever* (Use the definition of the kinetic theory).

According to the assumptions of KMT, gases move randomly and collide elastically (and often) with other gas molecules and with objects. Gas molecules don't have a directed "flight path", so it is much more likely for gas molecules in D.C. to collide and be moving in random directions, thus minimizing the likelihood that even 1 molecule would get to Mexico.