Name: _____ Date: _____

Student Exploration: Diffusion

Vocabulary: absolute zero, controlled experiment, diffusion, dynamic equilibrium, Kelvin scale, kinetic energy

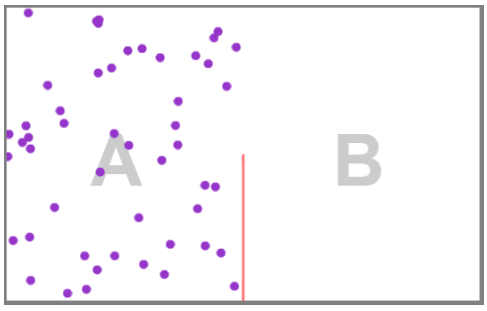
Prior Knowledge Question (Do this BEFORE using the Gizmo.)
Have you ever smelled microwave popcorn? The oddly enticing scent can fill a whole house.

How do you think the smell of popcorn spreads through the air? _____

_____

_____

Gizmo Warm-up
Smells are carried by tiny particles that move through the air. The *Diffusion* Gizmo shows gas particles in a chamber that is divided into two regions by a partial wall. Click **Play** ( ) and observe.



1. Describe the motion of the gas particles. _____

   _____

2. Over time, what is happening? _____

   This process, in which particles move from an area of high concentration (region **A**) to an area of low concentration (region **B**), is called **diffusion**.

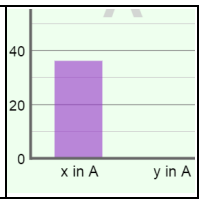
3. Select the BAR CHART tab, and observe the chart for a few minutes. After the first 30 seconds or so, how much do the numbers of particles in each region change?

   _____

   When the numbers don't change much, the particles are said to be in **dynamic equilibrium**.

4. Click **Pause** ( ), and select the GRAPH tab. What does the graph tell you about the number of particles in region A? _____

   _____

Activity A: **Temperature and diffusion**	Get the Gizmo ready: • Click **Reset** ( ). • Set the **Wall** to 100%.	

Introduction: In this Gizmo, temperature is measured on the **Kelvin scale**. On this scale, 0 K represents **absolute zero**, the coldest possible temperature. Water freezes at 273.15 K (0 °C), and water boils at 373.15 K (100 °C).

Question: How does temperature affect the rate of diffusion?

1. Observe: Set the temperature (**Temp.**) to 100 K, and press **Play**. Observe the motion of particles. Click **Reset**. Then set the temperature to 600 K, click **Play**, and observe.

   How does the temperature of the gas relate to the motion of the particles? _____

   _____

   The temperature of a gas is a measure of the average **kinetic energy** of a set of particles. Kinetic energy (KE) depends on the velocity and mass of the particles (KE = mv^2 / 2).

2. Form hypothesis: How do you think temperature will affect the rate of diffusion? _____

   _____

3. Experiment: Click **Reset**. Set the **Wall** to 50%, **x in A** to 100, **y in B** to 0, **Temp.** to 100 K, and **Particle mass** to 15 amu (atomic mass units). Select the TABLE tab. Press **Play**.

   Click **Pause** when **x in A** first reaches 55% or below. Record this **Time to reach equilibrium** in the left table below.

   Repeat four more times at 100 K, and then run five trials with the temperature set to 600 K.

Temp = 100 K experiment

Trial	Time to reach equilibrium
1	
2	
3	
4	
5	

Temp = 600 K experiment

Trial	Time to reach equilibrium
1	
2	
3	
4	
5	

(Activity A continued on next page)

Activity A (continued from previous page)

4. Calculate: Find the average time to reach equilibrium for each experiment:

    A. Average time to reach equilibrium at 100 K: _____

    B. Average time to reach equilibrium at 600 K: _____

5. Draw conclusions: Compare the average times to reach equilibrium for each temperature.

    A. How did temperature affect the rate of diffusion? _____

    _____

    _____

    B. Why do you think this was the case? _____

    _____

    _____

6. Extend your thinking: Why do you think the experimental results were different for each trial?

    _____

    _____

    _____

    _____

7. On your own: In our lives, we rarely experience temperatures that are above 373 K (100 °C) or below 273 K (0 °C). Investigate how much diffusion rates differ between these two temperatures. Describe the results of your experiments below.

    _____

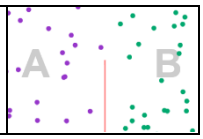
    _____

    _____

    _____

    _____

    _____

Activity B: **Rates of diffusion**	Get the Gizmo ready: • Click **Reset**.	

Introduction: The *Diffusion* Gizmo allows you to manipulate five variables: the **Wall**, the number of **x** particles in region **A**, the number of **y** particles in region **B**, the temperature, and the **Particle mass**.

Question: How do factors other than temperature affect the rate of diffusion?

1. Choose a variable: Pick a variable to investigate. Which one did you choose? _____

2. Form hypothesis: How do you think this variable will affect rates of diffusion? _____

   _____

   _____

3. Set up experiment: In a **controlled experiment**, only one variable is manipulated, or changed. Set up your experiment so that there is just one difference between set-up A and set-up B. List the Gizmo settings you will use for each set-up below.

	Set-up A		**Set-up B**
Wall	_____	**Wall**	_____
x in A	_____	**x in A**	_____
y in B	_____	**y in B**	_____
Temp.	_____	**Temp.**	_____
Particle mass	_____	**Particle mass**	_____

4. Gather data: Use the Gizmo to fill in each table. As before, the "time to reach equilibrium" is the time it takes for the number of **x** particles in region A to reach 55% or lower.

Set-up A

Trial	Time to reach equilibrium
1	
2	
3	
4	
5	

Set-up B

Trial	Time to reach equilibrium
1	
2	
3	
4	
5	

(Activity B continued on next page)

Activity B (continued from previous page)

5. Calculate: Find the average time to reach equilibrium for each experiment:

    A. Average time to reach equilibrium for set-up A: _____

    B. Average time to reach equilibrium for set-up B: _____

6. Draw conclusions: Compare the average times to reach equilibrium for each set-up.

    A. How did the variable you investigated affect the rate of diffusion? _____

    _____

    _____

    B. Why do you think this was the case? _____

    _____

    _____

    _____

7. On your own: Investigate the remaining variables. Record all experimental results in your notes. Summarize your findings in the space below.

    _____

    _____

    _____

    _____

    _____

    _____

    _____