Name: _____ Date: _____ Class: _____

Diffusion worksheet

Vocabulary list

Helium: A type of gas. It is a very light gas and when you inhale it, your voice changes pitch.

Argon: A type of gas. It is a heavy gas.

Neon: A type of gas. It is heavier than helium, but lighter than argon.

amu: This stands for atomic mass unit. It is the unit for the mass of atoms.

Read: The Case of the Punk and the Popcorn

What is the name of Gabriella's brother?

_____

How did Gabriella know that he was making a snack?

_____

Listen to the tutorial on using the Diffusion simulation and answer the questions below.

What 2 variables affect diffusion? _____ and _____

What are we trying to figure out by using this program?

_____

_____

What are the units for temperature? (What do we measure temperature in?)

_____

What is atomic mass measured in? (What are the units of atomic mass)?

_____

What are the 2 gases we can inject into the chamber? _____ and _____

Which gas is heavier? _____

How do you inject atoms (particles) into the chamber? (What button do you have to click?)

_____

_____

Question: How does temperature affect the diffusion of a gas?

Use the simulation by collecting data to answer this question (20 min)

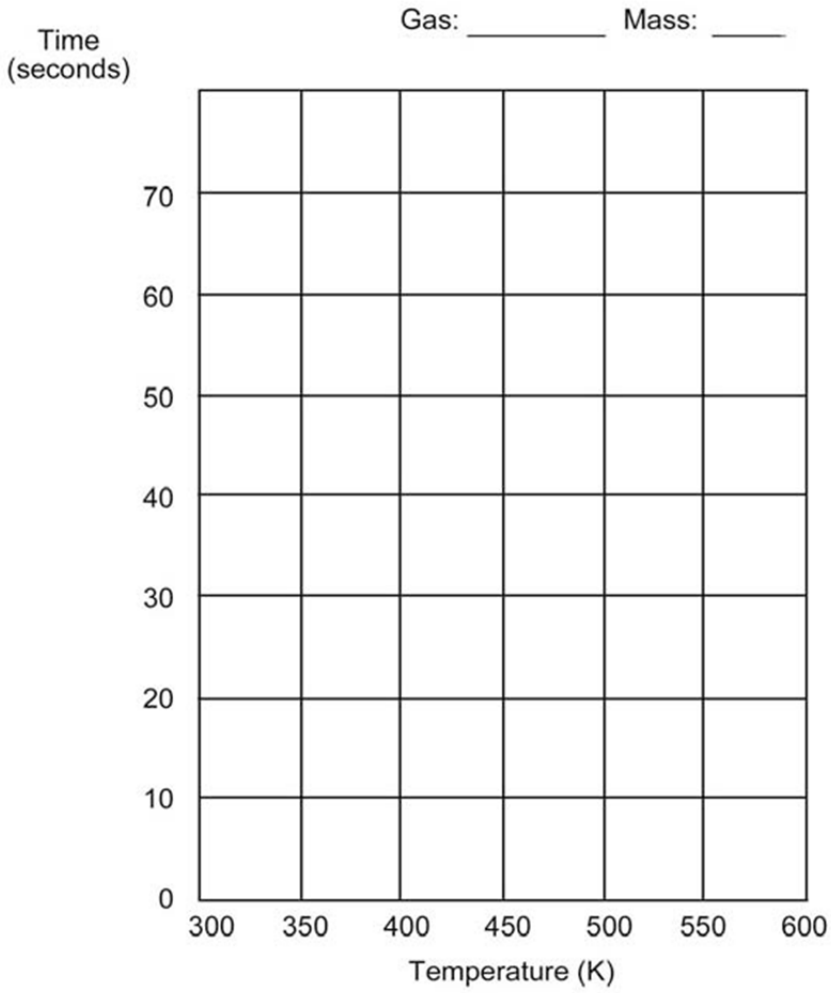
What color are:

the helium particles? _____ the argon particles? _____ the neon particles? _____

Start answering your main question by selecting a gas.
Gas: Helium or Argon (circle the one you have chosen to test)

Temperature (K)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
350				
550				

Before you go on, please copy the graph from the computer program onto this worksheet.



Repeat the process for the other gas.

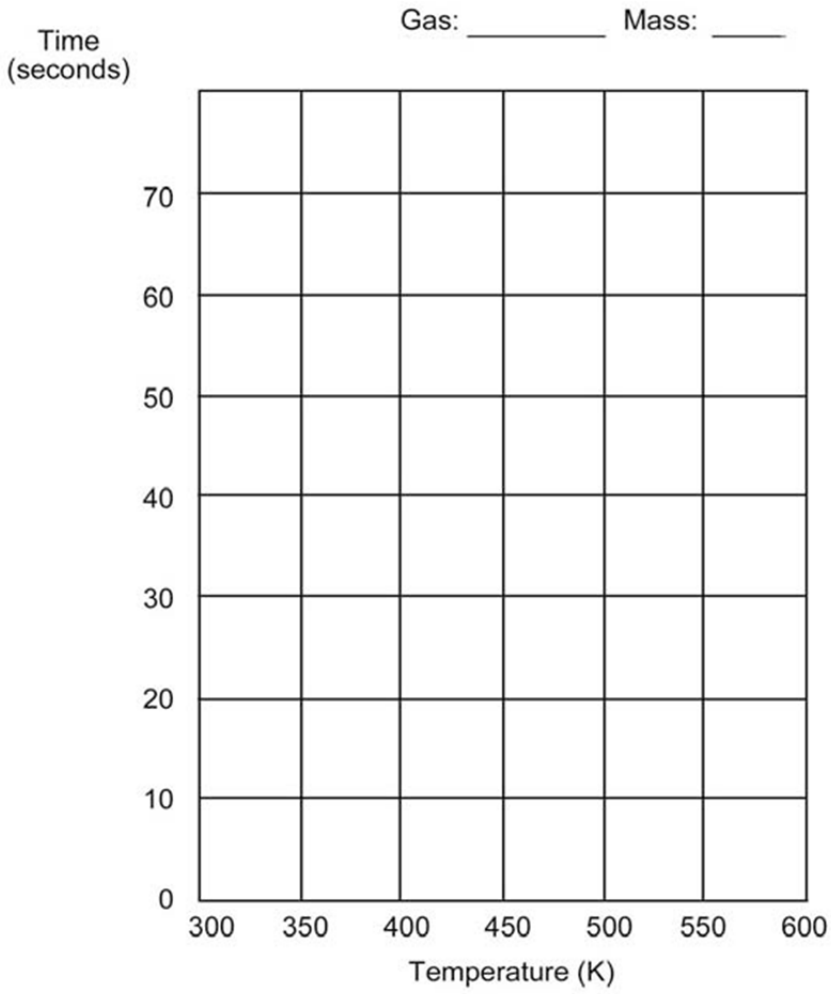
Why would it be useful to test another gas? _____

_____

Gas: Helium or Argon (circle one)

Temperature (K)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
350				
550				

Before you go on, please copy the graph from the computer program onto this worksheet.



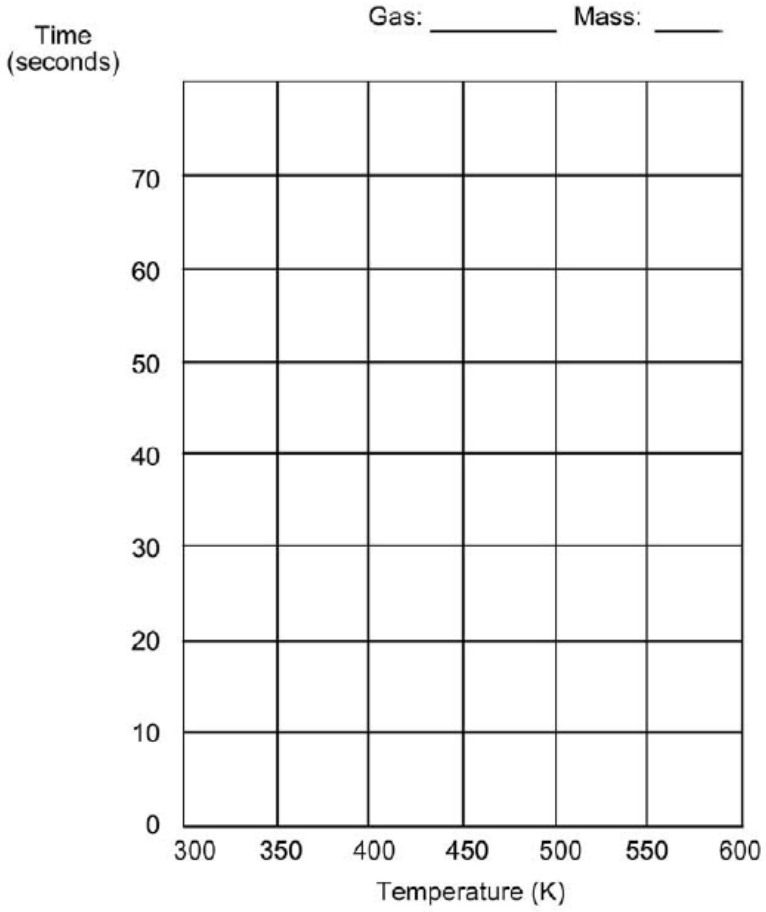
Question: How does the mass of atoms/molecules in a gas affect diffusion?

please complete the following graph by plotting the averages you calculated for Helium and Argon from your table.

Use 2 different symbols for the helium and for the argon gas. You should have 2 dots for each Temperature.

Argon ☐

Helium ☐



Analyzing the Data

Report what the data tells you about the question that we began with for this study.

Bringing it all together

How is the popcorn odor Gabriella could smell as she entered the apartment like the atoms you injected into the container in the program?

_____

_____

How is Gabriella's apartment like the container in the program?

_____

_____

_____

How is the air in the apartment like the neon gas in the program?

_____

_____

_____

Diffusion summary (5 min)

Circle one of the words in parentheses:

As the temperature increased, it took the molecules (less / more) time to reach the detector.
As the temperature increased, the gas particles moved (faster / slower).
As the mass of the gas increased, it took the molecules (less / more) time to reach the detector.
As the mass of the gas increased, the gas particles moved (faster / slower).
Why do you think we took 3 measurements for each gas and then used the average? Why weren't the times always the same if the settings (temperature and type of gas) were the same? (We learned this yesterday…it has to do with the KMT).

_____

_____

_____

_____

Lesson Plan: Diffusion

Aim: What is diffusion and what are some of the conditions where we can observe it?

Agenda:

Do Now –10 min
Diffusion: Definition, lecture/notes – 15 minutes
Connection to the simulation, calculation – 15 minutes
Demo: Diffusion of food coloring in hot and cold water – 10 minutes
Homework: Write me a story/comic

Diffusion: describes how one gas or liquid spreads through another gas or liquid.
It depends on the mass (or size) of the particles and the temperature.
If the particles are small, they travel fast. If the particles are big, they travel slowly.
If the temperature is hot, they travel fast. If the temperature is cold, they travel slowly

It is important to note that movement of gas by gas convection is often a more significant factor in the movement of gas, especially in open areas.

Question: How is the diffusion we studied similar and different from the diffusion we learned in living environment (biology)?
Similar: traveling through another solution
Different: Energy requirements

Simulation Question:
How come each gas didn't always take the same amount of time to reach the detector?
Calculation: Graham's law of diffusion
The heavier the particle, the slower it traveled
Graham worked out that the rate at which the particles spread out is inversely proportional to the square root of the molecular weight. We can write his law as a mathematical equation that should "fit" with the results you got from the simulation:
$Rate_{He}/Rate_{Ar} = \sqrt{39}$(mass of Argon)/$\sqrt{4}$ (mass of Helium)
So what might we predict about the rate of Argon when compared with the rate of Helium? How do the results you recorded from the simulation compare with your prediction? Students can check their results.

How do we know the simulation is a good model?
One way we can address this question is the way we did in 3 – seeing whether it can be used to make a prediction. But we can also see how it works with our experiences in our lives.
You see diffusion everyday but perhaps not in the same form as the gases you studied in the simulation. We can describe a gas as a **fluid**. Are there any other fluids you use that also show diffusion?

Student feedback about where they might observe diffusion e.g. tea, coffee, cocoa, sugar

Demonstration/Student Activity: Diffusion in liquid (another fluid) and the effect of temperature

Heat beaker of water on hotplate

Also get the same amount of cold water in another beaker of the same size

Have a couple of student volunteers (one for hot and one for cold) with stopwatches to record the rate of diffusion

Have a couple of students (one for the hot water and one for the cold) add one drop of food coloring

The student recorders should record how long it takes for the food coloring to diffuse throughout the water. (When this was done the first time the hot beaker was left on the hot plate and was boiling and one of the students suggested that it was the boiling which was helping the color to diffuse in the hot water. So then I took a second beaker of boiling water off the hot plate and repeated the test in hot water that was still rather than moving [A teachable moment!])

Discussion about gases and liquids and diffusion and the effect of temperature and mass on the rate (Would Gabriella and her friends be able to smell the bathroom more quickly on a hot summer's day than a cold winter's day?)

You might also want to acknowledge with students that, in this case, diffusion is not the only scientific concept that is working on those molecules.

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Do Now: Diffusion

What 3 gases did we mess with (use) in the diffusion simulation? _____ _____

_____

Which one was already in the container before you injected the other gas?

_____

Which gas moved the fastest? _____

Why did that gas move faster than the others? _____

What is the definition of diffusion?

_____

_____

_____

Do you have any feedback about the diffusion simulation? (you have to write something!)

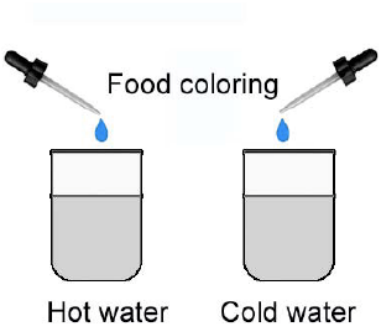
_____

_____

_____

_____

Diagram of Diffusion Demonstration Set-up



Homework: Diffusion

Write me a story or a comic book
You are going to pretend that you are a gas particle that has been injected into a closed box. I want you to describe your thoughts as a particle inside this box. To complete this task you need the following terms:

Straight, random motion
Elastic collisions
Attraction toward other gas particles
Your speed compared to other particles
Your mass/size
What happens when the temperature increases.

Your story needs to be at least 1 page long; if you choose to do a comic book it needs to be 15-20 frames long!