SCIENCE DETECTIVE'S NOTEBOOK #1:

DIFFUSION

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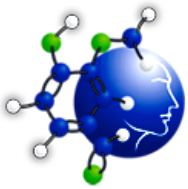

MOLECULES & MINDS

Simulations for Chemistry Learning

create

Consortium for Research and Evaluation of Advanced Technologies in Education

NYU Steinhardt

Steinhardt School of Culture, Education, and Human Development

With support from:

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ENTRY 1: MAKE OBSERVATIONS AND PROPOSE A HYPOTHESIS

"The Case of the Punk and the Popcorn"

Entry 1A: Gaby could still smell the popcorn an hour after Tac made it. Suggest an explanation for this observation.

_____

_____

(An *explanation* can also be called a *hypothesis*)

ENTRY 2: EXPLORE A MODEL TO TEST YOUR HYPOTHESIS

- You will use a computer simulation to learn more about how Gaby could tell that Tac made the popcorn she had been saving.
- A simulation is a computer model that helps you understand how something works.
- Watch the *TUTORIAL* about how to use the *diffusion simulation*.
- After you have completed the tutorial, go ahead and make the following entries:

Entry 2A: According to the tutorial, the two *variables* that affect diffusion are:

_____ and _____

Entry 2B: What can you learn about diffusion using this simulation?

_____

_____

Entry 2C: The temperature scale used in this model is called

_____

Entry 2D: What units are used to measure the mass of atoms?

_____

Entry 2E: The two gases that you can inject into the chamber are:

_____ and _____

Entry 2F: Which gas is heavier? _____

ENTRY 3: COLLECT YOUR DATA

Start exploring!

- Select a gas
- Choose a temperature
- Inject the gas into the diffusion chamber

Entry 3A: Observe what's happening

Describe how the particles move in the container.

_____

_____

_____

_____

_____

_____

Entry 3B: Collect your data: Gas #1

- Complete the table by running three separate tests before changing the temperature.
- Calculate the averages of your results for each temperature

Gas #1: _____

Temperature: (K)	Trial 1: (seconds)	Trial 2: (seconds)	Trial 3: (seconds)	Average Time (seconds)
250				
500				

Entry 3C: Collect your data: Gas #2

- Repeat the process for the second gas

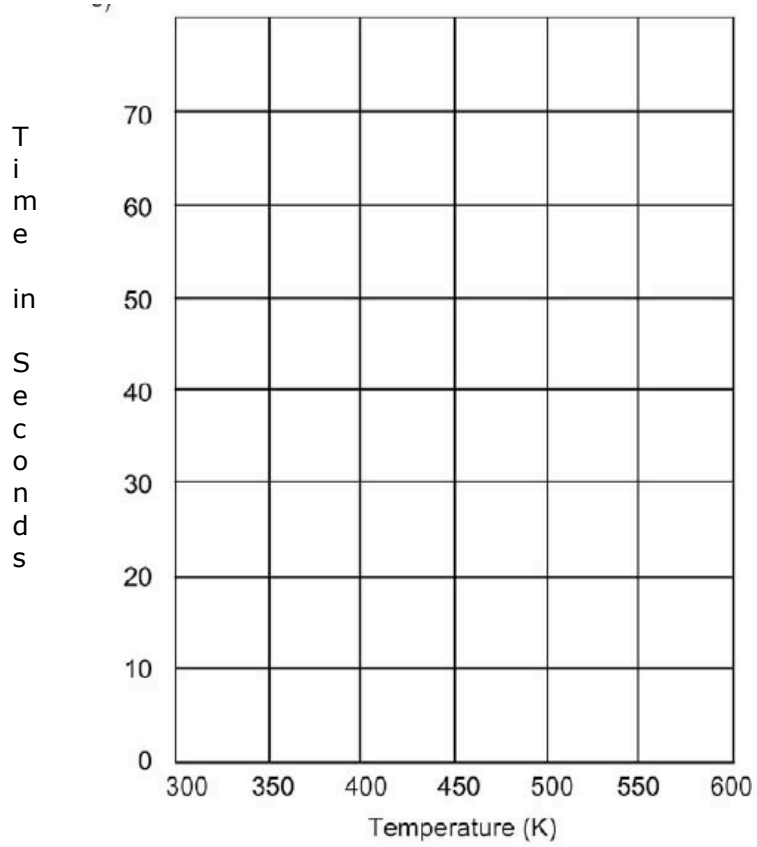
Gas #2: _____

Temperature: (K)	Trial 1: (seconds)	Trial 2: (seconds)	Trial 3: (seconds)	Average Time (seconds)
250				
500				

Entry 3D: Complete the graph using the averages you calculated in the tables for Entries 3B and 3C.

Use the following symbols to plot your averages:

- ● Gas 1 _____
- ▲ Gas 2 _____



Entry 3E: Explain why it is useful to test a second gas.

_____

_____

_____

Entry 3F: Explain why it is useful to test several temperatures.

Now we can use our data to answer two main questions:

Entry 3G:

> Main Question #1: What role does temperature play in diffusion?

Entry 3H:

Main Question #2: How does the mass of a gas affect the rate of diffusion?

Entry 3I:

If you injected a gas made up of particles (molecules) with an amu of 20, where would you predict the average rate of detection would fall? Add your prediction to your graph in Entry 3D using a ■ for these plot points.

ENTRY 4: SYNTHESIZE WHAT YOU LEARNED

Apply your understanding to "The Case of the Punk and the Popcorn."

Entry 4A: How is Gaby and Tac's apartment like the gas container in the simulation?

_____

_____

_____

Entry 4B: How is the popcorn smell that Gaby detected like the atoms you injected into the gas container?

_____

_____

_____

Entry 4C: How is the air in the apartment like the neon gas in the gas container?

_____

_____

_____

ENTRY 5: GENERALIZE CONCLUSIONS

Entry 5A: A Claim

Circle one:

When molecules are injected into the container at a specific temperature, each molecule will take (**the same / a different**) amount of time to reach the detector.

Entry 5B: Evidence

What evidence did you find by using the simulation that allows you to make the claim in Entry 5A?

_____

_____

_____

_____

Entry 5C:

As the temperature increased, it took the molecules (**less / more**) time to reach the detector.

Entry 5D:

As the temperature increased, the gas molecules moved (**faster / slower**).

Entry 5E:

As the mass of the gas increased, it took the molecules (**less / more**) time to reach the detector.

Entry 5F:

As the mass of the gas increased, the gas particles moved (**faster / slower**).

Entry 5G:

Kinetic energy is energy due to motion. Why can we say that temperature is a measure of the average kinetic energy of the molecules?

_____

_____

_____

_____

ENTRY 6: SOMETHING EXTRA – CONDUCT RESEARCH!

Entry 6A:

As you were exploring diffusion with the simulation, you may have thought that diffusion was the only concept involved in the motion of gas molecules. Actually, there is another concept called ***convection*** that is often more important for the movement of smells and other molecules. Find out how *diffusion* and *convection* are different at the molecular level.

DIFFUSION LAB NOTEBOOK

ENTRY 1: DO IT NOW!

Use your experience with the diffusion simulation to answer the following questions.

Entry 1A:
What 3 gases were in the diffusion simulation?

_____

_____

_____

Entry 1B:
Which gas was already in the container before you injected the other gas?

_____

Entry 1C:
Which gas moved the fastest?

_____

Entry 1D:
Why did that gas move faster than the others?

_____

_____

Entry 1E:
What is your definition of diffusion?

_____

_____

_____

_____

_____

_____

ENTRY 2: DISCUSSION QUESTIONS

Entry 2A:
How many of these concepts did your definition include?

1. Diffusion describes how particles of one gas or liquid spread through another gas or liquid
2. Diffusion depends on the mass (or size) of the particles and the temperature
3. Smaller particles travel more quickly than bigger particles
4. The colder the temperature, the more slowly the particles travel

Entry 2B: How is the diffusion we studied similar and different from the diffusion we learned about in living environment (biology)?

Entry 2C: How come each gas didn't always take the same amount of time to reach the detector?

Entry 2D: So what might we predict about the rate of Argon when compared with the rate of Helium?

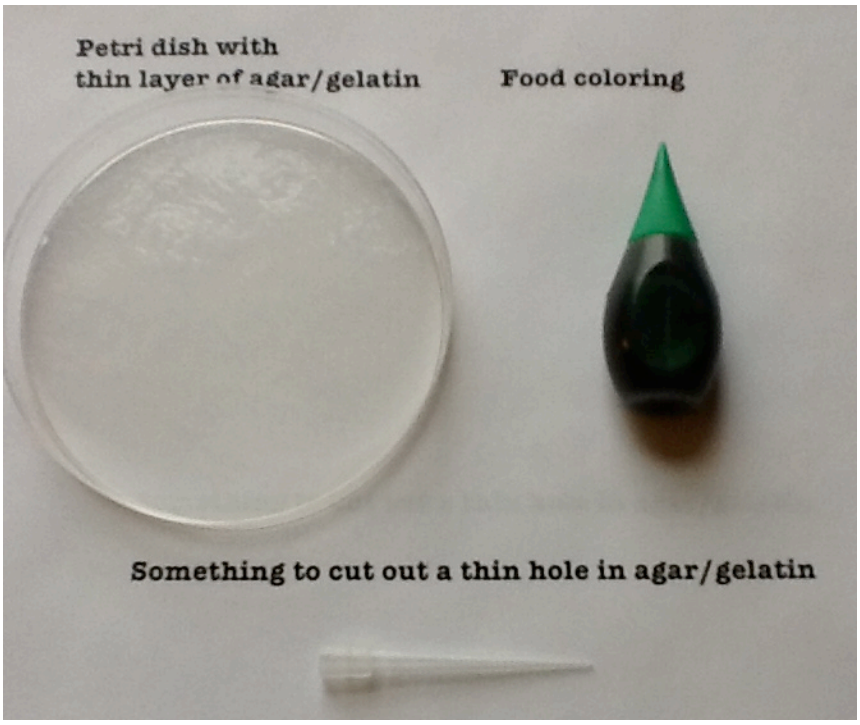
Entry 2E: How do the results you recorded from the simulation compare with your prediction?

ENTRY 3: LAB/DEMO

How do we know if the simulation is a good model?

You see diffusion every day but perhaps not in the same form as the gases you studied in the simulation. In this demonstration/lab you can observe diffusion in a different state of matter.

Demonstration/Lab: Agar and Food Coloring



Entry 3A: *Predict* what will happen if we cut a hole in the middle of the agar/gelatin and put a drop of food coloring in it.

_____

_____

_____

Entry 3B: *Confidence*
What did you learn from the simulation that makes you confident about your prediction?

_____

_____

_____

Entry 3C: *Collect* your equipment:

- A Petri dish with agar/gelatin
- A pipette tip or cork borer or something that can be used to make a small hole in the agar
- Food coloring.

Entry 3D: *Perform* your experiment:

- Remove a small circle of agar from the center of the plate using the cork borer
- Place a small drop of food coloring in the circle.

Entry 3E: *Observe* the rate of diffusion

Entry 3G: *Explain* your observations using the principles of diffusion.

ENTRY 4: EXTENSION ACTIVITIES

Entry 4A:

- Write a story or a comic strip.
- Pretend that you are a gas particle that has been injected into a closed box. Describe your thoughts as a particle inside this box.
- Incorporate the following concepts/terms/facts into your narrative:
    1. Straight, random motion
    2. Elastic collisions
    3. Attraction toward other gas particles
    4. Your speed compared to other particles
    5. Your mass/size
    6. What happens when the temperature increases?

Your story needs to be at least 1 page long; if you choose to do a comic strip, it needs to be 15-20 frames long! Use the next few pages for this activity.

Entry 4A:

Entry 4A: