SCIENCE DETECTIVE'S NOTEBOOK #2:

KINETIC MOLECULAR THEORY

Produced by:

MOLECULES & MINDS
Simulations for Chemistry Learning

Create
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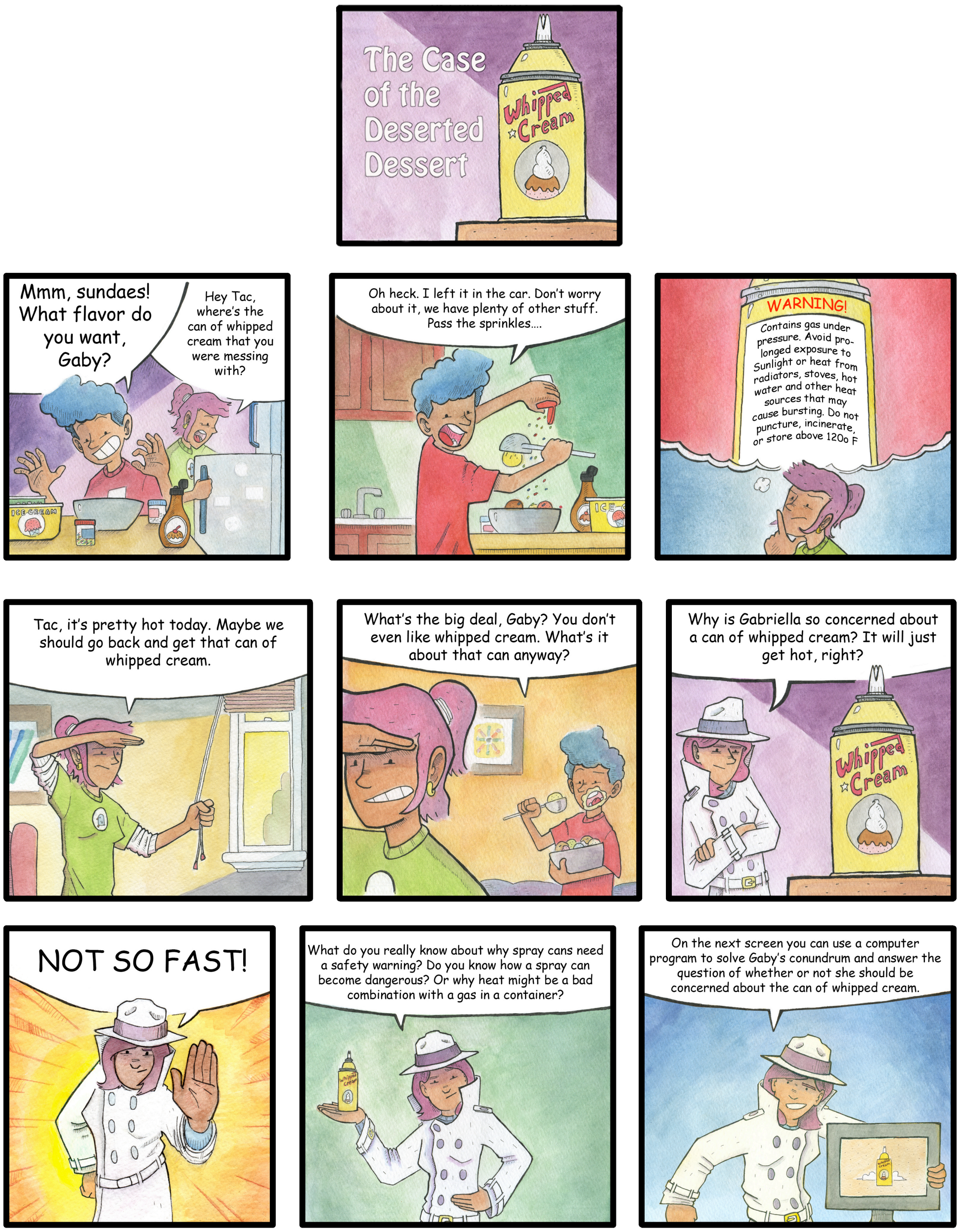
ENTRY 1: MAKE OBSERVATIONS AND PROPOSE A HYPOTHESIS

The Case of the Deserted Dessert



Entry 1A: Gaby was worried about the can of whipped cream Tac had left in the car. At what temperature could the can become dangerous?

Entry 1B: Use clues (observations) from the story to propose what conditions outside might allow the can to reach such a temperature.

Entry 1C: Using information from this case, hypothesize why Gaby was concerned about Tac leaving the can of whipped cream in the hot car.

ENTRY 2: EXPLORE LANGUAGE

Here is some information that can help you understand KMT:

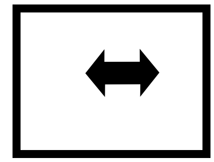
Theory: an accepted statement that explains why observations are the way they are. Theories can be used to make predictions and have been tested and reviewed many times.

Kinetic: KINETIC means *movement* in Greek. Kinetic energy has to do with things moving and is stored in objects.

Particles: All matter is made up of tiny particles we call atoms or *molecules*. KMT uses the movement of particles to explain things we observe in the world. For example, it can help us to understand *pressure*.

Pressure: The amount of force per area. If you are pushing against a wall, you are putting pressure on the wall.

Internal Pressure: The amount of pressure inside a container. Gas molecules inside a container collide with the walls of the container, exerting pressure.



External Pressure: The amount of pressure put on the outside of a container. If you sit on a box, you put pressure on the box. Atmospheric pressure is external pressure that presses down all over you.

Independent Variable: A variable you change (graphed on x-axis)

Dependent Variable: A variable that changes because of the independent variable (graphed on y-axis)

Atmosphere: This is a unit of pressure represented by ‘atm’. In New York state, found on Table A in the reference tables.

Temperature: measure of the average kinetic energy of particles in a sample; measured in a scale such as Kelvin, Celsius, or Fahrenheit.

Kelvin: This is a unit of temperature that scientist use represented by ‘K’. 298 K is about room temperature (= 25 degrees C). Found on reference tables [Table A and Table T].

ENTRY 3: EXPLORE A MODEL TO TEST YOUR HYPOTHESIS

Read the instructions for the Kinetic Molecular Theory simulation. What variables can you explore with this simulation? Complete the table:

Entry 3A:

	Variable	Unit of Measurement
1.		
2.		
3.		

Thinking about your hypothesis in Entry 1C, what are the two variables you need to test that hypothesis?

Entry 3B:
The two variables to explore are:

____________________ and ___________________ .

Entry 3C:
In order to test your hypothesis, which variable will be kept constant?

____

Entry 3D: Why can you only change one variable at a time?

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Before you use the simulation to test your hypothesis, carefully observe the behavior of the gas molecules in the container. Actual gas molecules are very small and cannot be observed directly but the simulation helps us to *visualize* the molecules.

Entry 3E: Click on the 'Trail' and 'Color' buttons and observe the one molecule closely. How would you describe its motion? Choose one:

a. circular

b. zig-zag

c. straight line

Entry 3F: What happens when paricles bump into each other?

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Entry 3G: Watch one molecule until it collides with one of the walls of the container. Observe the movement of the molecule before and after the collision with the wall. Complete the table:

	Molecule motion before and after *colliding with the wall* of the container
Compare (How is molecule motion the same?)	
Contrast (How is molecule motion different?)	

Entry 3H: Describe how a molecule colliding with the wall of the container is different from a tennis ball hitting a wall.

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Entry 3I: Based on your observations of the simulations you've completed, write 3 rules about how gas molecules behave:

Rule 1:

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Rule 2:

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Rule 3:

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Entry 3J: Explain why these rules are important.

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ENTRY 4: COLLECT YOUR DATA

Look back at your hypothesis in Entry 1C. Now you will use the model to test your hypothesis by collecting data.

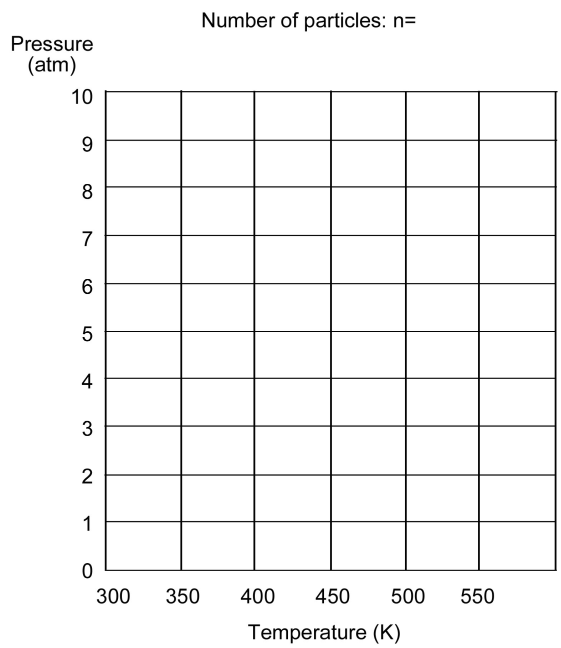
Entry 4A:

- Collect 10 data points
- This should only take a few minutes!
- Lock the number of particles at any number you want. Record that number here: ______.
- Record the temperature and the internal pressure on the table below

Temperature (Kelvin)	Internal Pressure (atmospheres)

Entry 4B:

Copy the graph you made onto this worksheet.



Entry 4C: Summarize the relationship between the two variables you explored. Was your hypothesis supported or not?

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Entry 4D: Exploring another set of variables.

You just explored the effect of one variable on another. Write another question that you could investigate using the variables in this model.

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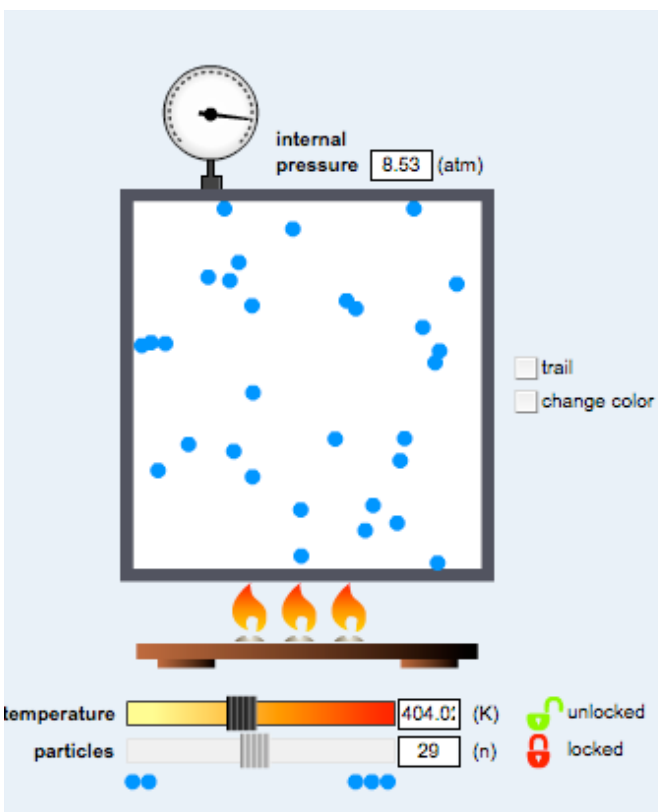
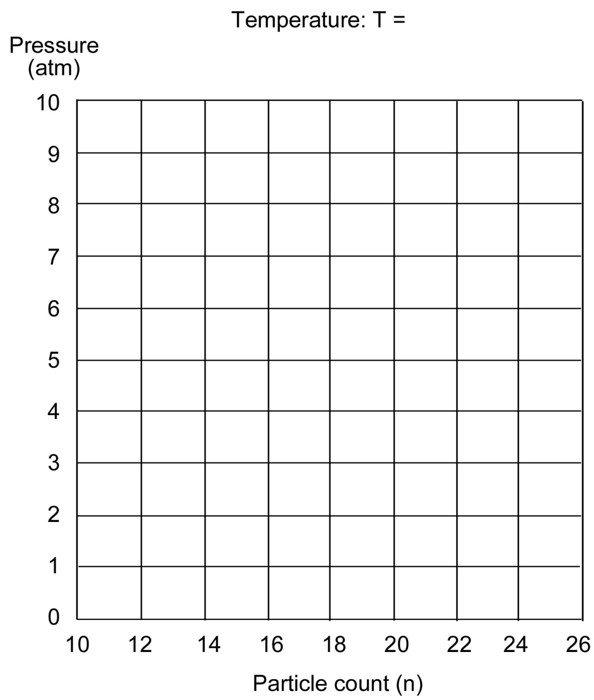


Entry 4E: Investigating a second hypothesis

- Collect 10 data points
- This should only take a few minutes!
- Lock the temperature at any value you want. Record that number here: ______ K.
- Record the number of particles and the internal pressure on the table below

Number of Particles (n)	Internal Pressure (atmospheres)

Entry 4F:
Copy the graph you made onto this worksheet.



Entry 4G: Summarize the relationship between the two variables you explored:

ENTRY 5: GENERALIZE CONCLUSIONS

Entry 5A:
When the temperature increases, the internal pressure

____________________.
(increases/decreases)

Entry 5B:
This means the gas molecules pushed

________________ against the walls of the
(harder/softer)

container.

Entry 5C:
When the number of molecules in the container increases,

the internal pressure _____________________.
(increases/decreases)

Entry 5D:

This is ___________________ relationship.
(a direct/an indirect)

ENTRY 6: SYNTHESIZE WHAT YOU LEARNED

Apply your understanding to "The Case of the Deserted Dessert."

Entry 6A: Compare and contrast the *spray can* in the story and the *container* in the model.

	The *spray can* in the story and the *container* in the model
Compare (How are they the same?)	
Contrast (How are they different?)	

Entry 6B: Compare and contrast the *particles* inside the spray can of whipped cream that Tac left in the car and the *moving particles* in the model?

	The *particles in the spray can* and the *moving particles in the model*
Compare (How are they the same?)	
Contrast (How are they different?)	

Entry 6C: Would Gaby have been as worried if the air temperature was lower? Why or why not?

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ENTRY 7: SOMETHING EXTRA – CONDUCT RESEARCH!

Entry 7A: Think of another everyday example of particles inside a container that could be explained using Kinetic Molecular Theory.

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ENTRY 1: DO IT NOW!

Kinetic Molecular Theory describes the behavior of gases. The variables involved are pressure, volume, temperature, number of molecules, and size of molecules.

Gases contain molecules that move randomly and in straight paths.

When gas molecules collide with each other or with the walls of a container they do not lose energy.

Gas particles spread out to fill whatever space is available.

Gas molecules are not attracted to each other.

Entry 1A: Compare and contrast the 3 rules you wrote about the behavior of gases [Science Detective Notebook Entry 3I] to the actual parts of Kinetic Molecular Theory presented above. What parts are different? What parts are the same?

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Entry 1B: Do you think that all gases behave this way all of the time? Why or why not?

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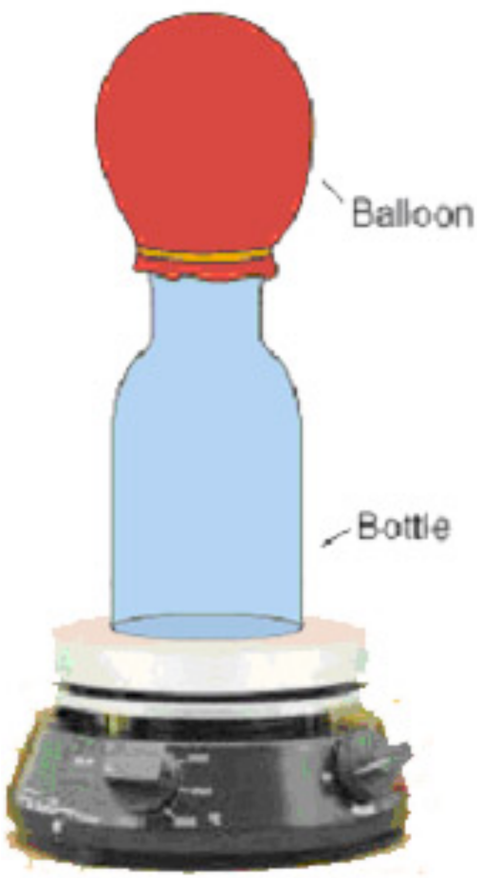
ENTRY 2: LAB/DEMO

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

Demonstration/Lab*: Balloon and flask on hot plate*



Entry 2A: *Predict*
What do you predict will happen if we heat the air in a bottle with a balloon attached over the open top of the bottle?

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Entry 2B: *Confidence*
What did you learn from the simulation that makes you confident about your prediction?

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Entry 2C: *Collect* your equipment:

- Balloon
- Bottle
- Hotplate

Entry 2D: *Perform* your experiment

- Secure a balloon over the opening of a bottle
- Place the bottle on a hot plate
- Heat the bottle.

Entry 2E: *Observe* what happens

Entry 2F: *Explain* your observations using Kinetic Molecular Theory.

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ENTRY 3: EXTENSION ACTIVITIES

Entry 3A:

A student investigated heat transfer using a bottle of water. The student placed the bottle in a room at 20.5 °C. The student measured the temperature of the water in the bottle at 7 a.m. and again at 3 p.m. The data from the investigation are shown in the table below.

Water Bottle Investigation Data

7 a.m.		3 p.m.	
Mass of Water (g)	Temperature (°C)	Mass of Water (g)	Temperature (°C)
800.	12.5	800.	20.5

Compare the average kinetic energy of the water molecules in the bottle at 7a.m. to the average kinetic energy of the water molecules in the bottle at 3 p.m.

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Entry 3B: Based on the simulations and the demonstrations from today, when is a gas most likely to behave ideally?