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Day 05 Feb 05 Simulation of Particulate model  
for gases. Kinetic Molecular Theory

Fire and Ice

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2016

### 5.0.A Daily Outline

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Purpose:

Continue building understanding of particulate nature of matter and how heat and temp fit with that

- Confirm homework finishing the paired simulation work from Tuesday
- Link with liquid nitrogen experiments (motion, volume, flexibility)
- Conduct Charles law experiment and establish idea of absolute zero
- Hands-on tests of compressibility of solids, liquids, gases

Address some extensions and applications

Reading assignment that reinforces these things

[holding off on bank of hands-on experiments that have to do with phase change]

Board

~~Find your partner from Tuesday~~ Sit with your working group from Tuesday. Pick up your Recorder Reports and name card.

Make a stick-on name tag with first name

I'll come around to check your notes

Materials

- Name tags
- Premade name cards
- Poster paper
- Poster markers
- White board markers
- Tape
- Graph paper
- Computer set up with PhET running

Returns

- Recorder reports from the working pairs from Tuesday

Distributions

Starting Comments \_\_\_\_\_ 3 minutes max

- During today's activities, will come around to take a picture. Posting on BB.

Activity Two (cont'd from Tues)

Extend exploration of gas behavior and temperature using PhET (est 40 min)

Pick up where you were last time.

You and your partner should share what you found in completing Question 3.  
Then present to each other what you did, and what you found, regarding Questions 4 and 5.

Circulate to check in on progress and on answers to key questions. See my annotated copy of activity.  
Don't over-explain in response to their developing answers regarding the particulate model.  
Hold back and let this emerge over time.

Get tables to report out on 1g, 2e, 2f, 3d, 3f, then 4 and 5 – goal is to develop idea we can agree on

- One table show graph of V vs T. Get confirmation from others.
- One table show graph of P vs T. Get confirmation from others.

Final comments based on what's been heard. Bring in the name Kinetic Molecular Theory

Notes for me:

Link anything observed to playing with liquid nitrogen. V vs T balloon, flexibility/rigidity

See my debriefing/answers.

I elicited the term Absolute Zero (which needs a reading backup)

[simulation allows for removing energy AT ABSOLUTE ZERO – which is not correct]

Most people found linear V vs T and P vs T. A few people on the V/T controlled Volume not Temp and got the opposite results. This does WORK on system. Others acknowledged doing this too. This let to me talking about two ways to change internal energy of a system (pushing and heat). Did not extend the work idea at this time.

Student comments suggest they may not have good idea for how pressure relates to motion.

Activity Three – hands-on extensions

Each table will be given a set of materials and some instructions for exploration. See that handout for procedures.

A) Charles Law at 5 temp points. Draw graph. Confirm V/T proportionality vs simulation.

Use my computer and excel to plot and graph and draw extrapolation line for absolute zero.

B) Determine volume of sublimated piece of dry ice. Est about 20 mg gives 15 mL. There are more accurate ways to do this measurement, but this should give a quick sense that a tiny amount of solid can become a huge volume of gas, and then the question is how did that happen? Did the molecules expand their size, or that? Can talk about the simulation and that it oversized the particles relative to the real particle size/volume ratio.

C) Compressibility of gases. This again confirms that there is space between the molecules in gases, but not so in liquids or solids.

Debriefing: **NO TIME FOR THIS**

At your tables, discuss the results from each of the experiments. We have been developing a model for gases and gas behavior as conditions change. You will need one of the recorders to continue. You will be needing a spokesperson.

1. To what extent do these experiments confirm or contradict each other or the simulations you investigated?
2. What insights or additional questions occur to you as a result of these discussion or experiments?

If time, discuss these thing. If not, they are things to consider for homework. **I indicated that these are what “tests” could be like. Handed out as homework.**

Challenge Questions (attempt without consulting other sources of info):

- 1) Things we did apply to the deflate-gate controversy. What and explain how it applies? Does this confirm or dispute the claim that the Patriots let air out of the balls?
- 2) What are the major components of air? Predict (graph) their relative average speeds. (dinitrogen, dioxygen, carbon dioxide, water, argon) – how to calculate mass of a substance
- 3) Apply any relationship we’ve discussed to explaining why the inner planets are devoid of H<sub>2</sub> and He, whereas the outer planets are rich in them. [name the inner and outer planets]  
You can use the PhET to test this.

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