1-1-2016

10.0.A Daily Outline

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Chem 444A, Fire & Ice, Day 10, Feb 24 cfb DAY OUTLINE

Purpose:
- Discuss mini-experiment results in light of readings on latent heat
- Discuss challenge questions (about gas behavior and KMT)
- About the test

Set groups into same locations – so video can follow same group in follow up discussion

C E D
B A

Board

Sit with group from last class – when all present, look in folder for instructions to get started
Make a stick-on name tag with first name.

No notes to show today: Check-in is just presence today – checkmark your name

Materials

Name tags (4 per table)
Premade name cards (set on tables)
White board markers
Post their composite posters and heating/cooling posters around the room

Returns
- Recorder reports for Feb 19

Distributions
- Organized Q bank for Feb 19

Starting Comments 2 minutes max

- Very good observational notes and thoughtful suggested explanations
- Fabulous set of Questions for Q bank – this will guide part of today's discussion

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Once your whole group has arrived [this page into folder]

Figure out who is what role:

Manager:	was Reflector last class
Recorder:	was Manager last class
Spokesperson:	was Recorder last class
Reflector:	was Spokesperson last class

Manager: three initial tasks

1) distribute the Q bank questions
2) You were the Reflector last time. One goal of the procedures was to encourage everyone to have hands on the experimental materials. Share with your group how well that goal was achieved. Whether it was or was not, discuss how you might, as a group, achieve that goal in future situations.
3) Recorder should summarize this discussion on Recorder Report for today.

Task One [10 min or less, Manager let me know when you've completed discussion]

- Some groups would like a little more time to complete the description/explanation part of the mini-experiments. Give you 10 minutes.
- If you are satisfied with your discussion or finish early, I will give you one or more of the Alternate tasks.

Alternate A

Find a piece of board. Put up a summary table using the Wikipedia data of the substances we studied.

Alternate B

There are three primary factors that determine what the mp and bp will be for a substance. Our experiments include sufficient clues to suggest what those factors are (not enough to be definitive, but suggestive). Suggest what they are and find some evidence to support that. There is a point where I will introduce this question – be ready to respond.

Alternate C

Discuss old challenge problem B: components of the atmosphere, put graph of speeds up on board. Prepare to give rest of class a tutorial on that.

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<u>Task One</u> [10 min max]

- Some groups would like a little more time to complete the description/explanation part of the mini-experiments. Give you 10 minutes. [Add this to 2/19 Recorder Report]
- If you are satisfied with your discussion, I will give you one or more alternate tasks.

<u>Alternate A</u>

Find a piece of board. Put up a summary table using the Wikipedia data of the substances we studied.

<u>Alternate B</u>

There are three primary factors that determine what the mp and bp will be for a substance. Our experiments include sufficient clues to suggest what those factors are (not enough to be definitive, but suggestive). Suggest what they are and find some evidence to support that. There is a point where I will introduce this question – be ready to respond.

<u>Alternate C</u>

Discuss old challenge problem B: components of the atmosphere, put graph of speeds up on board. Prepare to give rest of class a tutorial on that.

<u>Task Two</u> Discussion of readings [7 min talk; 10 min debrief]

In your table groups:

The readings all had something in common conceptually, AND connected with our experimental work. Describe what you think this is and how it plays out in the readings and experiments. Use the Recorder Report you started for today. Spokesperson will be reporting out on behalf of group. Welcome other groups to comment or refine.

See if there is any back and forth to refine the ideas.

Notes:

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<u>Task Three</u>

You're ready to tie some ideas together and may have already done so. It's possible that you could accomplish this entirely on your own with focused attention, but I'd like to move our class agenda ahead, so I'm going to use your Question Bank questions as a framework for a Socratic dialogue.

I am going to lead with stepwise questions that encourage you to review and integrate what you have experienced and learned. Each question will be asked, and then I'll choose someone to suggest a response. Ok to stop process to clarify. Give everyone a chance to take the lead.

A) Address questions about flat part of heating/cooling curves.

1) When heat is added to a collection of molecules (in absence of phase change), what happens?

- Causes increase in T
- Causes increase in motion of molecules
- Goes to increasing Kinetic Energy

2) That is true in gases. Is it also true in liquids and solids?

3) In any of these cases, what does a graph of temperature vs "heat added" look like? Point to any of our data that confirms this. By the way, our data is pretty reasonable.

4) If T stops changing, several things are possible:
   a) the heat energy being supplied is not being absorbed and goes elsewhere
   b) the heat energy is being directed to some process other than increasing motion
   Which is more reasonable suggestion?

5) What other process is the heat energy going into? Phase change
   Does it make sense that it takes energy to separate molecules from each other?

- Added heat energy causes increasing motion (increase kinetic energy)
- Added heat energy causes new "more free" structure (new phase) – increases potential energy – molecules can do things couldn't do before

6) Consider opposite situation: cooling a liquid at constant rate by removing heat energy
- When heat is removed from liquid (in absence of phase change), what happens?
- What does graph of temperature vs "heat removed" look like?
- If T stops changing, possibilities:
- Heat is no longer coming from liquid but from somewhere else
- Heat is being released by the liquid as it becomes a solid, preventing T from decreasing until totally solid
- So, when molecules become "less free" – decreases potential energy (by releasing that energy)

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B) Address questions about structure

1) Dry ice sublimes in syringe. Tiny chunk to about 10 mL. About 1000 x more volume. Options?

- Something else entered syringe to take up space
- Molecules got larger
- Molecules spread out, moving faster

2) Did we read anything that addressed whether "something else" could be entering the system?

Benjamin Thompson (Rumford): no mass change on heating/cooling

3) In solid, are the molecules attached or just adjacent? In liquid? In gas?

Talk about bonds between atoms in molecule, and between atoms in different molecules. Use I_2 as example. Talk about representations of bonding within a molecule. Show space filling model.

4) Think of gas molecules flying around.

To become liquid, what happens to their position? Get closer together

What would cause molecules to "get together"? an attractive force

Do you have any evidence that such attractive forces exist?

Balloon charge effect; water on wax paper

Do you have any evidence that degree of attractive force varies with type of substance?

Water vs oil on wax paper; heating/cooling data and phase change T

So, consider the mp of two substances. One has higher mp.

One reason could be that those molecules stick to each other more?

So the T has to be raised higher in order for there to be enough KE to shake them loose.

Another related factor: how much energy per gram does it take to make the phase change happen (how long is the plateau) – magnitude of the "latent heat"

- Formal term "enthalpy of fusion" or "enthalpy of vaporization"

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5) Where does the stickiness come from?

a) clue: balloon and electrical charge

atoms have e and p; simple bond shown as, can be equally shared e.g. N2

If unequal, could lead to permanently charged ends (polar)

Water is very polar. Oil is a little bit. N2 not at all.

b) other factors

compare: stearic (mp 69 C) and oleic (mp 13 C)

How do they differ structurally?

2 H atoms and double bond; Kink and packing in solid

Packing is a specific factor in solid/liquid phase change

Stearic is saturated fat (saturated with H atoms) butter, lard, wax

Oleic is unsaturated fat (2 fewer H because of double bond); MONO for One

Olive oil, corn oil

What would you expect to see in a polyunsaturated fat? More dbl bonds

Someone may ask about trans fats.

c) phase change affected by:

mass of molecule (bigger is harder to get moving),

stickiness/polarity (more sticky is harder to loosen up)

shape (sol/liq maximization of intermolecular interations)

C) Things we are delaying on

1) Fundamental nature of heat and energy
2) Rate of heating/cooling
3) Experimental technical issues, mostly which related to #2.

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		mp ^oC	
stearic acid	$C_{18}H_{36}O_2$	69	
lauric acid	$C_{12}H_{24}O_2$	44	
oleic acid	$C_{18}H_{34}O_2$	13	
methyl salicylate	$C_8H_8O_3$	-9	
ethylene glycol	$C_2H_6O_2$	-13	
water	H_2O	0	

Task Four Those past challenge questions

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_2 and He, whereas the outer planets are rich in them. [name the inner and outer planets] You can use the PhET to test this.

Who thinks they have a good handle on a response to ….

2) May be up on wall

See where the discussion goes.

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Intern Quide Feb 24   Fire & Ice

We're starting where we left off on Thursday with the same groups. So, you can continue to sit in with them.

You are welcome to facilitate helping them to talk about the experimental results or alternative tasks (I've given you a handout), and about the readings.   Don't force ideas on them, but help them articulate what they might be thinking.

When we kick into the Socratic dialogue, I've never done this before in this way – I've given them a set of questions – an outline – and I'm going to ask them to respond to each question with something, but shift that responsibility to different person each time. (I've given you that handout.)   You can think about whether this is valuable. My intention is to bring closure to ideas and answer questions – continued exploration on their part may have diminishing returns, and we have other topics I'd like to get to this semester.

I hope to have 20-30 min to take them into lab to see Odyssey molecular dynamics program – I have a script they can follow.   At that time, pick a lab bench (one that is not on the close-in camera) and watch how the two pairs there talk with each other about what they see and what they take away from the experience.

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Synthesis of last several days

You're ready to tie some ideas together and may have already done so. It's possible that you could accomplish this entirely on your own with focused attention, but I'd like to move our class agenda ahead, so I'm going to use your Question Bank questions as a framework for a Socratic dialogue.

I am going to lead with stepwise questions that encourage you to review and integrate what you have experienced and learned. Each question will be asked, and then I'll choose someone to suggest a response. Ok to stop process to clarify. Everyone will get a chance to take the lead. Your input will help build the argument, so I'm not expecting right answers as much as helpful answers.

A) Address questions about flat part of heating/cooling curves.

1) When heat is added to a collection of molecules (in absence of phase change), what happens?

2) Is it also true in liquids and solids?

3) In any of these cases, what does a graph of temperature vs "heat added" look like?

4) If T stops changing, several things are possible:
   a) the heat energy being supplied is not being absorbed and goes elsewhere
   b) the heat energy is being directed to some process other than increasing motion
   Which is more reasonable suggestion?

5) What other process is the heat energy going into?

6) Consider opposite: cooling a liquid at constant rate by removing heat energy
   - When heat is removed from liquid (in absence of phase change), what happens?
   - What does graph of temperature vs "heat removed" look like?
   - If T stops changing, is heat is no longer coming from liquid but from somewhere else
   - Or is heat being released by the liquid as it becomes a solid, preventing T from decreasing until totally solid

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B) Address questions about structure

1) Dry ice sublimes in syringe. Tiny chunk to about 10 mL. About 1000 x more volume. Options?
   - Something else entered syringe to take up space?
   - Molecules got larger?
   - Molecules spread out, moving faster?

2) Did we read anything that addressed whether "something else" could be entering the system?

3) In solid, are the molecules attached or just adjacent? In liquid? In gas?
What do "bonds" look like?

4) Think of gas molecules flying around.
To become liquid, what happens to their position?
What would cause that?
Do you have any evidence that such a cause exists?
Is this the same for every substance?
So, consider the mp of two substances. One has higher mp.
Could one reason for this be that the molecules for substance with high mp stick to each other more strongly?
How does that relate to temperature?
Can the stickiness of molecules affect the amount energy per gram to make the phase change happen? What feature of our data graphs would this relate to?

5) Where does the stickiness come from?

a) if necessary, I'll give you a clue
b) another factor: compare stearic and oleic How do their structures differ?

c) phase change affected by what factors

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