1-1-2016

13.0.A Daily Outline

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Chem 444A, Fire & Ice, Day 12, Mar 5 cfb DAY OUTLINE

Purpose:

- Visualization of heat transfer by conduction
- Further development of the concept of heat, linking to energy and molecular motion

Board

Find your group (same as pre-test)
Make a stick-on name tag with first name.
Get your eye protection
Look in folder for: Instructions for your organization and initial task today.
Once your entire table is present, you can start.

DON'T FORGET TO CLAP

Materials

Name tags (4 per table)
Premade name cards (set on tables) – shuffle the table locations A C B
D E
White board markers
Dark, Blue, Red markers at each table

Returns

Distributions

- Group organization instructions
- Task 1 Instructions

Starting Comments 2 minutes max

- Select someone to clap
- I sent you a long message. No info about exam tili next wek.
- Starting a new set of explorations with experimental work

Christopher F. Bauer, Principal Investigator.
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GROUP ORGANIZATION FOR MAR 5

Manager: Person at the table with the least manager experience

Efficiency of time use is particularly important today.

Recorder: Of remaining people, person with least recorder experience

Recording data and conditions are particularly important to have on the Recorder Report.

Spokesperson: Of remaining people, person with the least spokesperson experience

Being prepared to explain how experiments are done and what the group thinks the results mean are particularly important today.

Encourager: If there are two people left, do rock/paper/scissors. Winner gets to the role.

This is a new role. Person is responsible for encouraging group members to express their ideas, particularly if any member has been silent or not had a chance to say anything. Encouragement can also take the form of asking someone to rephrase or restate what someone else is saying. Don't overdo it.

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Task 1 Temperature Mixing [20 min]

Put 4 copies of procedure into each folder. It is self explanatory from there.

The idea is to mix two cups of water at various temperatures, predicting the final temp beforehand, and then visualizing the results graphically. The graph is arranged vertically as a temperature line, and instructions highlight in color the initial temps and final temp and arrows moving to the final temp. This anticipates the next set of data, temp vs time, also laid out with T on vertical axis.

The arrows subtly suggest something moving.

At the end, there are several questions intended to get the group to think about molecular motion, heat, and the role of volume.

Task 2 With frequent facilitator contact [40 min]

The key challenge delivered by facilitator is to design an experiment to investigate this question.

"In the mixture, do the hot water molecules stay hot and the cold stay cold, with the thermometer just measuring the average? Or do all the water molecules come to the same temperature?"

The only option is to separate the two bodies of water but still allow heat transfer.

Once they have the notion of wanting to do this, they will be presented with materials that "might help them" accomplish their goal. In past, presenting a coffee mug, thermometers, and an aluminum can is sufficient to direct their thinking.

Their volume choices should be restricted (volume enough to measure T well, not so much as to overflow containers):

When ready, claim one experiment. On Board,

Conditions		Group Claiming
40 in hot	40 out cold	
80 in cold	80 out hot	
40 in hot	80 out cold	
40 in cold	80 out hot	
80 in hot	40 out cold	
60 in hot	60 out hot (not a mistake)	For group that finishes first

Monitor to get graphs produced and up on board. -- MUST GET TO AT LEAST THIS POINT

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Discussion [15 min]

Look at your graph of temperature vs time, and look at those of the other groups.

All of the data have common features.

Each person ON HIS/HER OWN: write down an explanation for what is going on, attempting to explain the temperatures, the changes, and the role of volume.

Then, go around the group and read your explanation to the others. Discuss to try to come to a consensus explanation. Write that down and be ready to report that to the class.

Ask each group to report out their consensus idea.

---------- potential stop

Time Dependent, challenge them as follows

a) You've probably heard of conservation of energy. How does your data support the notion of conservation of energy? Let group chat for a minute or two, then listen to comments.

So, one way to interpret what is going on is to say, the hot water delivers energy to the cold water, until they are equivalent.

Another way to interpret what is going on is to say, the total energy in the hot water and the total energy of the cold water is distributed equally around to all molecules.

b) Lets turn the energy idea into a mathematical relationship.

Energy lost by hot water = energy gained by cold water

In equal volume case, what aspect of graph indicates energy lost by hot water?

What aspect indicates energy gained by cold water?

So energy lost (-) by hot = energy gained (+) by cold

$$| T_{hot} - T_{final} | = | T_{cold} - T_{final} |$$

Add direction: $$- \Delta T_{hot} = \Delta T_{cold}$$

If this is true, it should match our data: pick any of the equal volume cases, and calculate the final temperature from the initial temperatures using this equation. Do it as a group.

How do you handle the volume? What contains more energy, larger V or smaller V?

So energy lost by hot = energy gained by cold

$$- V_{hot} \Delta T_{hot} = V_{cold} \Delta T_{cold}$$

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Homework:

Write a molecular level story that describes the before and after of putting 20 mL hot water inside and 100 mL cold water outside. Story must describe exactly how gets from starting condition to end condition. No standing assignment this weekend.

Give some thinking to this experimental challenge.

Your group will choose one of the three research questions below.

I will also entertain alternative suggestions from you (email me).

Design an experiment that will help you investigate the question.

I will have materials available that will allow you to explore the question, so you won't be able to get specific about details until you see what's available.

Clear your intended procedure with an instructor

Gather the data, review, perform additional experiment confirmatory experiments, assemble information for presentation (e.g. graph of data).

Research Questions

1) Can the movement of heat be controlled?

2) Do cold things have heat?

3) Do different substances have the same ability to provide heat?

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Intern Instructions for Mar 5

I'm sending along your instructions for Thursday. The first two pages are an experiment groups will do in the first 30 minutes. Then the "challenge" will be the remaining time.

You role will be to choose a group, and be the facilitator for that group. This is the initial exploration of a new set of ideas (thermal equilibrium, thermal conductivity) and more development of the nature of heat.

The first activity is a set up for the second (page 3). With your chosen group, you will lead them through page 3 -- page 3 is your agenda -- they will not have any written procedure for this. They have to develop it. You have to channel them to the correct procedure, to develop a graph that illustrates thermal equilibrium, and then use the data to label the phenomena and concept, and push the boundaries. It is critical to let them develop their own thinking, and then you help them to closure once they are invested.

This is brining to a head the fundamental nature of heat as "change in molecular motion" which is distinct from temperature which is the "amount of motion", and that the former is an extensive variable (depends on quantity) and the latter an intensive variable (doesn't).

This should be fun. I think Sara said she woudl be absent, but there will be future fun for her.

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