1-1-2016

14.0.B Discussion Thermal Equilibrium

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RECORDER REPORT, Chem 444A "Fire & Ice"

Group Member Name	Role
Tim Closson	~~Reflec~~ Recorder
Emmaddison	Manager
Kaleigh Z	Spokesperson
Mandy Graves	Encourager

Date: 3/10/15

3 nice job very clear + on the mark

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1) The hot line has a steep downward slope and it curves off and then the slope becomes horizontal. The cold line has a steep upward slope and it curves off then its slope also becomes horizontal. The lines become parellel to each other but don't intersect. ✓

2) When two materials at different temperatures are mixed together, the temperature of the mixture moves toward equilibrium. This point is called thermal-equilibrium. ✓

3) This hypothesis ✓ is not supported by the data because when we measured the temperature's seperatley, they still moved towards the same temperature.

4) Yes they are ✓ consistent. The result of the mixture in the direct mixing experiment was 18.4°c and the temp. of the hot and cold water in the second experiment was very close to that. Hot = 19.6°c Cold = 18.5°c

Correct + very clear.

5) We believe ✓ that the best way to explain this phemomena is that the hot water is giving energy to the cold water. However, there is ~~own~~ nothing with mass being given to the cold water. We also believe that the cold water isn't giving anything to the hot water. It is just reciering energy.

6) Yes, the data supports the notion of conservation of energy. We say this because the hot water is transferring energy to the cold water as we can see in the graph. The energy isn't just disappearing from the hot water.

7) If you know the starting temperatures, and the ending temp of the mixture, you can predict ~~the~~ whether there was more hot or cold water and therefore how much kinetic energy was involved. OK leads to

8. skipped to do experiment — we'll do this together.

xperiment

Copper: 142.11 g

)mL water at 4.7° C

ubstance at 48° C

ubstance 1: 12.9

Brass: 135.60 g

).mL water at 4.7° C

ubstance at 46° C

ubstance 2:

See instructions for graph

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Samantha Colaw	Spokesperson
Becky Pettig	Manager
Miriam Arsenault	Encourager

Date: 3/10/15

3 well stated complete nice job

Task 2

1) The curve that started at the hot temperature starts with a steep downward slope then gradually levels off and plateaus about halfway between the two initial temperatures. The curve that started cold is a mirror image of this, starting with a steep upward slope and leveling off at the same region. However the two curves do not reach the same temperature, never touching. (will at long time)

this is important - true at all points in time

2.) when two materials at different temperatures are put in contact with one another thermal energy is transferred from the hot to the cold causing the temp. of the cold to rise and the hot to fall until they reach a thermal equillibrium

3) No, because they both approach a thermal equillibrium.

4.) Yes they are, because in the experiment where we mixed equal volumes of hot (45°) and cold (7°) it reached a thermal equillibrium of 25.3°, which is right in the middle. This result is also evident when we didn't mix them, because they reached a temperature range of 26-21° starting from 44° and 9°. This was also consistent with unequal volumes as one group tested; the temperature just ends up closer to the one with the larger volume.

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5) No, neither of these occur. A better way to explain it is that through collisions on the molecular level, the hot water molecules increase the kinetic energy of whatever they are in contact with. So, in the cup scenario, the hot water ~~molecules~~ molecules collide with the plastic cup molecules, increasing their K.E., and then the plastic cup molecules colliding with the cold water molecules increases their KE. In the mixing, this happened directly between the molecules.

good

) Yes, because the particular collisions are energy transfers from one molecule to another. The thermal equilibrium is our evidence of this, because no energy is lost, it is simply transferred until they are at an equal temperature.

what shows you this from the graph

) From the graph, we can conclude that the initial quantities of energy are equal to the final quantity of energy, and that the change in KE of the hot is equal to the change in KE of the cold.

good - we'll talk about this

) $|\Delta KE_{hot}| = |\Delta KE_{cold}|$, $n_C T_C + n_H T_H = n_F T_F$ where n is the number of moles and T is temperature.

: Task 3

set up: ① 2 plastic cups 40 mL Hot in cup, 40 mL cold in other cup

② 3 plastic cups " same "

- taped around brims to prevent hot air from escaping. placed nametags under outer cups.

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Group Member Name	Role
Nick Bouchard	Reflector
Eliza	Manager
Amanda	Encourager
Calé	Spokesperson

Date: 3/10/15

3 Good detail.

Nice job.

Task 2.

1.) There are two curves connected to the y axis. One (the hot) starts high up on the axis and the other (cold) starts at a low point on the y axis. The "hot" curve decrease <u>at a similar rate</u> that the "cold" curve increases as time (x-axis) progresses. The y-axis is temperature so the would be in terms of increase/decrease temperature. The curves will eventually intersect after each curve gradually increases/decreases ✓ the first two-three minutes.

this is a critical observation - parallel change rates

2.) When two materials ✓ at different temperatures are in contact with ✓ one another they will eventually meet at the same temperature, because of heat transfer causing the temperature to be somewhere between the two extremes depending on the present volumes. (Coming to Thermal Equilibrium)
→ Move to intermediate temperature (0th law of thermodynamics)

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=) Principle of Thermal Equilibrium ... all substances in contact ...

3.) The hypothesis is not supported by the data, as the graphs show that each substance (hot and cold) is changing temperatures.

1.) The results of the 2nd experiment are consistent with the direct mixing experiment. Each set of graphs of the data shows that the temperatures of each will meet at a point relative to the volumes.

For the second set of experiments we used 2 volumes of 80mL of water, one at 6.8°C and the other at 42.4°C. Eventually both volumes came to a temperature of about 22.35°C. This is similar to the direct mixing experiment #2 since the volumes were both the same as well and meet at about the average. Exp #2 60mL each. meet at 23.8°C (42°C − 7.2°C)

5.) The "hot" is losing heat energy to the "cold". The cold isn't losing energy it's just recieving heat energy. (frigorific corpuscles) Therefore the hot is decreasing temperature because it's losing heat energy to the cold and the cold is increasing temperature because it is acquire from the hot. Therefore the heat energy is hot water is "giving caloric corpuscles to the cold water."

The intent was to get rid of the corpuscle idea because molecular collision explains data.

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Group Member Name	Role
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Eliza	Manager
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Cole	Spokesperson

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6.) The experiments do support the notion of conservation of energy since the energy is neither created nor destroyed, but transferred from one substance to the other. ✓

7.) The graph shows us that the quantity of the energy transfer is affected by the present volumes. The Quantity of energy transfer will remain the same. The temperature is affected by the volumes since the transferred energy will impact a lesser volume more significantly than a greater volume. OK

What aspect of graph gives the quantity of lost heat + gained heat

8.) $\mathcal{E}$ = hot lost = ✓ cold gained

Cold 6.8 → 22.35 15.55

Hot 28.35 ← 42.4 20.05

$\mathcal{E} = \frac{V_1 + V_2}{2}$

Hot Initial Temp − Avg
Avg − Cold Initial Temp
= Energy Transfer

This is a start. We'll discuss all together.

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Marisa Butler	Manager	
Taylor Witkiewicz	Recorder	
Charles Cappetta	Encourager	
Emily Koester	Spokesperson	

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① The heat line starts at a high temp. and has a negative slope. The cold line starts at a low temp. and has a slight positive slope. The two lines approach each other and level off. ✓

② When two materials at different temperatures are mixed together, their temperatures will change until they reach a midpoint between the two initial temperatures. The midpoint they reach is the thermal equilibrium. (Zeroth Law of Thermodynamics) ✓

③ No because the hot water and cold water were not touching but their temperatures changed. Hot water got colder and cold water got warmer because energy was being transferred. The molecules are transferring the energy. ✓

④ On experiment 2 in the direct mixing, the results were consistent with our experiment using the mug and can. Both experiments used equal volumes for hot and cold water. In both experiments a thermal equilibrium was reached. For example, in the direct mixing experiment the hot was 44.8°C cold was 6.4°C. The thermal equilibrium was 21.7°C. In the second exp. we saw the same pattern in the results. ✓ ✓

⑤ No, the hot water is giving energy to the cold. The cold water is not giving anything to the hot it is just receiving energy from the hot. ✓ ✓ Good

⑥ Yes because the hot and cold water are just transferring energy, not losing it. ✓

⑦ The hot water has a lot of energy because it is at a higher temperature. The hot has a steeper slope because it is losing energy faster than the cold is receiving it (less steep slope).

(artifact of experiment) otherwise energy is not conserved

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Group Member Name	Role
Heather Price	Manager
Jon Tamposi	Encourager
Jacob Sidney	Recorder
Emily Dwyer	Spokesperson

Date: 3/10/15

3 Good detail. Well expressed.

Task 2:

1. The hot and cold lines curve towards each other, converging on a middle temperature. The hot and cold increase/decrease quickly and then gradually as time goes on. ✓

2. When two materials of different temperatures are combined, the temperature of the product is an average of the initial temperatures. ✓
   - Formal name: Thermal equilibrium
     Zero-eth law of thermodynamics

3. No it is not. Although we isolated the "hot molecules" and "cold molecules", their temperatures still changed when in contact w/ each other. ✓

4. Yes. When equal parts of hot and cold were mixed, the final temperature was in the middle, as it was in the middle trial of the first experiment. ✓
   1. 60 mL of 44°C w/ 60 mL of 7°C ⟶ 25.5°C
   2. 60mL of 40°C w/ 60 mL of 8.8°C ⟶ ≈21°C

5. A better way to explain it is that energy is passing from the hot to cold molecules. ✓

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6. Yes it does conserve energy. If the hot molecules "lose" energy, it is "gained" in the cold molecules, so it is never really lost. ✓

1. 7. If exposure to air is ignored, energy in the system can be quantified by adding the temperatures of the hot and cold water. ✓

8. $E_T = \frac{E_H V_H + E_c V_c}{V_T}$ ✓

heat lost = heat gained

$-\Delta T_1 V_1 = \Delta T_2 V_2$

$-(T_F - T_{1,1})V_1 = (T_F - T_{2,1})V_2$

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Keep the same role structure today as you had last class (manager, recorder, spokesperson, encourager – if you are in 5-person group, let the encourager be the person who did not have a role last time)

Task 1:

Complete the graphs of your data, and post it up on the wall. If you have completed that, proceed to Task 2. Please get this done as efficiently as you can.

In review, it seems that all experimental conditions have been tested, so we are ready for a conference after the graphs are posted.

Task 2:

Once you have prepared your graph, start considering these questions. Use a new recorder report form.

1) Look at the shape of the graphs from the second set of experiments. Describe the shape of the graphs so that someone who can't see the graphs can image what they look like (and could reproduce the shape).

2) The shape you see illustrates an important principle of all matter. See if you can state it by starting a sentence with "When two materials at different temperatures are ……" Ask CB to listen to your statement, and he'll tell you the formal name (s).

3) Is the hypothesis of hot-stays-hot-and-cold-stays-cold supported by the data?

4) Are the results of this second set of experiments consistent with the results of the direct mixing experiments? Cite specific data.

5) Does the hot water give caloric corpuscles to the cold water?
Does the cold water give frigorific corpuscles to the hot water?
Is there a better way to explain the process?

6) Do our experiments support the notion of conservation of energy? How so?

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7) Assuming you like the energy idea, how can you use the graph to tell you something about the quantities of energy involved?

8) Try to write a little mathematical equation that expresses this energy idea in terms of the information on the graph. [It may be easier to figure this out by using the direct mixing experimental data. And to look at the equal-volume condition first. Then consider the non-equal volume condition.] Your equation should make sense in terms of your model that you described in #5.

9) We may have a general conference at this point, or we may proceed to more experiments.

Task 3: Extensions of the ideas

Choose one of the research questions below.
I will also entertain alternative suggestions from your group.

Design an experiment that will help you investigate the question. I will have materials available that may spark your thinking. Clear your intended procedure with an instructor. Gather the data, review, perform additional confirmatory experiments if necessary, and assemble information for presentation (e.g. graph of data).

<u>Research Questions</u>

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?

4) Develop proof that latent heat of phase change actually involves heat transfer.

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