COMPILATION: phase changes but temperature does not

Oct. 28, 2018
From: Elizabeth Pate, a modeler in North Carolina

Hello colleagues! I have been using the chemistry modeling materials for quite a while and LOVE the story that it presents. However, I have a TERRIBLE time getting my students to let go of the misconception that temperature changes during a phase change. Here's what I typically do:

- Icy hot lab and Lauric acid so they have evidence that proves temperature is constant during a phase change.
- Energy bar charts, heating/cooling curves (circle the applicable segments), particle diagrams of initial and final conditions, and a written statement describing if the system is increased or decreasing in total energy AND the impact that has on the particles. (Are they becoming more or less organized OR increasing or decreasing in speed?)
- All 4 of these representations should be in agreement and I require the students to do all 4 for each scenario.
- All of this is done FAR before I even think of introducing energy calculations.

I would love to hear if anyone has a solution to help their kids let go of this major misconception. Any help is welcome!

Oct. 29, 2018
From: Pete Langr

Elizabeth asked how to help students let go of the misconception that temperature changes during a phase change. I haven't noticed this as too much of a problem (but may not be paying enough attention to it.) However, perhaps it is that during much of the winter I have a partially frozen Lake Superior outside my school, and it does not seem difficult to convince students that the Lake in this situation is at roughly 32 degrees Fahrenheit, even on a -20 degree day. And it is also pretty easy to convince students, I think, that the Lake is still roughly 32 degrees in April, as long as ice chunks are floating around. So the temperature only changes after the phase change is complete, and it takes March and April and May warm days to get the job done. These observations complement the labs, I think.

A similar observation is that a glass of cold water stays cold as long as the ice cubes are in there, and mainly warms after. (Of course, all of this would have to be extensively discussed while whiteboarding.)

(A related observation is that dogs dislike walking through salty, slushy wet snow during cold days in winter, like 5 degrees Fahrenheit. Some have said to me that this is due to the road salt that is in the slush, but I suspect not. I suspect that it is the fact that the water is at 5 degrees. If 32 degree water can make one's hand/paw hurt from the cold, how much worse will 5 degree water hurt? So examination of this example may help with an extension of that thought process.)

Oct. 31, 2018
From: Colleen Cozad
Actually water temperature as a solid can be less than 32 degrees Fahrenheit or 0 degrees Celsius. This link explains it better than I can.
http://www.quora.com/Why-is-pure-frozen-water-always-32-degrees-even-if-the-environmental-temperature-is-colder

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Oct. 31, 2018
From: Brenda Royce, Modeling Workshop leader & co-developer of chemistry Modeling resources.

I've battled the same problem raised by Elizabeth, and accidentally found a solution by using an alternative sequence that separates the concepts of Eth and Eph in the model development during the unit. Building on the Eth idea introduced in Unit 2, I use an energy exchange lab in an isolated system first which shows (semi-quantitatively) the inverse relationship between m and dT when dE is the same for two objects put into contact (hot or cold water in a test tube placed in an styrofoam cup of water with the opposite temp; these then are allowed to go to thermal equilibrium.) We conceptually develop the equation for dEth from these observations, define specific heat capacity, and then apply T-t graphs, LOL graphs, and the equation from our analysis and model-development to a handful of situations.

Then we ask if this energy model can be extended to phase change, using the dE = c *(m*dT) as our hypothesis (testing the existing model). This focuses the attention on m, dT, and dE as the pertinent variables. The results show the model only works when a single phase is present. When the system is going through phase change, no significant temperature change is seen. This leads to a need to update the model for phase changes only, and really points to the fact that it is phase change that breaks the previous model's predictions. As a result, I find students are far more likely to change their minds about phase change being associated with a temperature change.

Feel free to email me if you would like additional information about my sequence. I'm happy to share more about the Eth lab I described above (pix, LoggerPro file examples, etc.); I just can't attach files here. BTW - I gain back most (all?) the time spent on the Eth lab (which can also be done as a demo) when we are working on the qualitative and quantitativeproblems after the second lab. The kids just get it better with fewer practice problems.

Nov. 1, 2018
From: Justin Worboys

I also adjusted my sequence and supported more energy flow earlier in the year.

One thing I added that specifically helped them understand phase energy: I took a squirt bottle with ethanol and capped it. I had someone in class hold the bottle close to their body for a while during class. Effectively having them agree that it has reached body temperature. Then sprayed a little onto their hands. Their hands still feel cold and they smell it in the air. **The energy doesn't go into heating the liquid, it goes into evaporating the liquid.**

Even if there is some inaccuracy to this, it seemed to register to them how energy can purely go into the phase change itself.