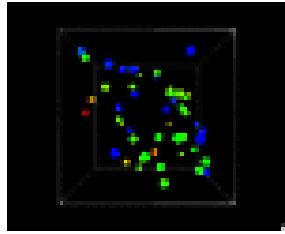


# SEEING TEMPERATURE, KINETIC ENERGY, COLOR AND BLOWING BUBBLES TO ACIDIFY WATER



We read that temperature is the average kinetic energy of a substance but you can (especially if you're a visual learner) nicely internalize this from simple videos or animations. UCAR has a little animation with their definition of temperature. I however, adapted an interactive, 3d animation that I think does a nice job, and also introduces a couple of other interesting concepts too.

I've also used this model, at different times, to show:

- The relationship between temperature and color emitted by objects. The main way we know the temperature of stars is because blue stars are hotter than red stars. Blue light has a shorter wavelength than red light, and things that are at higher temperatures emit shorter wavelengths.
- Absolute zero (0 Kelvin) – where (almost) all motion stops and the objects stop emitting light.

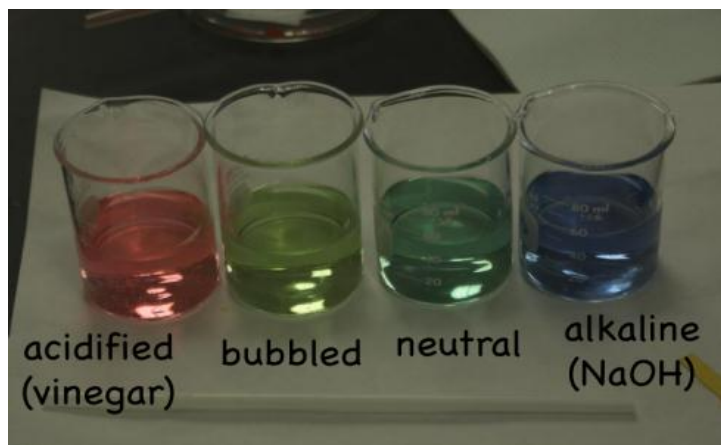
- Pressure in a gas – you really get a feel for the force exerted by the particles on the side of the box (although it might be even more interesting once I figure out how to add sound).

It is an interactive model, but it's pretty simple because the only control is a slider that lets you set the temperature.

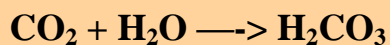
Finally, in the age of 3d movies, like Avatar, the models can be easily shown in 3d if you have the glasses (redcyan).

The model is easy to install and run on Windows, but you have to install the programming language VPython separately on a Mac (but that isn't very hard).

## Blowing Bubbles to Acidify Water



Changing colors of universal indicator show how blowing bubbles acidifies water (light green-second beaker) from neutral pH (dark green-third beaker) standard. For comparison, the first beaker (red) is acidified while the last beaker (blue) is made alkaline.



This useful little reaction, where carbon dioxide reacts with water to produce carbonic acid, came up in my middle school class when we talked about respiration, it'll come up soon in environmental science with the effects of carbon dioxide on the oceans (acidification), and it offers the opportunity to discuss pH and balancing chemical reactions in chemistry.

The middle school class did the neat little experiment where students blow bubbles in water (through a straw), and the carbon dioxide in their breath reacts with the water to slightly acidify it. A little universal pH indicator in the water (or even cabbage juice indicator) shows the acidification pretty well if you make sure to keep a standard nearby so students can see the change in color.

The fact that the CO<sub>2</sub> in your breath is enough to acidify water begs the question — which was asked — how much of the air you exhale is carbon dioxide? According to the Oak Ridge Carbon Dioxide Information Analysis Center's FAQ page, it's concentration is about 3.7% by volume. Which is a lot more than the 0.04% average of the atmosphere.

Of course if you really want to talk about the pH you need to get into the acid equilibrium and the dissociation of the carbonic acid to produce H<sup>+</sup> ions.

Source: <http://montessorimuddle.org/2010/01/24/seeing-temperature-kinetic-energy-and-color/>