Chemistry Demonstrations

All of the following demonstrations were carried out in class. If you missed them, either because you were away in either body or spirit, here is your chance to catch up. Of course, nothing beats the live event, not even a Madonna concert. A chemical demo both entertains *and* enlightens.

<table>
<tr><th>DEMONSTRATION 1</th><th>QUESTIONS/ANSWERS</th></tr>
<tr><td>
1) Equip a round flat-bottom flask with a one-holed stopper.
2) Insert a glass stem through the stopper.
3) Fill about 4/5 of the flask with water and a few drops of indicator that will change colour with a small amount of NaOH. I used universal indicator.
4) Place a small amount of 0.1 M NaOH in a small beaker, not enough to potentially cause an overflow in the flask.
5) Attach polyvinyl (clear) tubing to the glass stem of the flask and place the other end of the tubing in the beaker of sodium hydroxide.
6) Using a hot plate, gently heat the flask until it boils for about 15 seconds.
7) Turn off the heat, and wait for it to cool. Or assist the cooling.

OBSERVATIONS

Water moves from the beaker into the flask and turns the flask purple.
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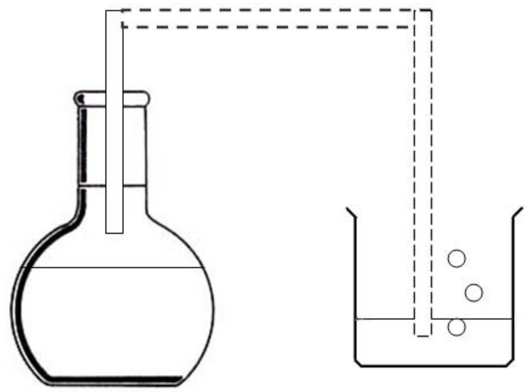
1. How does the water get sucked in?

The steam pushes the air out of the flask and out of the tubing. Upon cooling, condensation lowers the pressure inside the flask, allowing atmospheric pressure to push the sodium hydroxide up the tubing, back into the flask containing the water and indicator. As a result the solution turns from green to purple.
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<tr><th>DEMONSTRATION 2</th><th>QUESTIONS/ANSWERS</th></tr>
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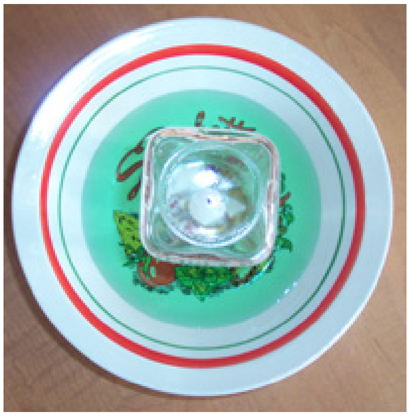

A pasta bowl is filled with water and green food colouring, an unlit candle is placed standing in the middle of the water. The candle is then covered with a jar.

The candle is lifted temporarily; the candle is lit and covered again. As the flame goes out, something unexpected occurs.
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1. Initially, why is there no water in the jar. The pressure of the air inside the jar is still equal to the atmospheric pressure pushing down on the water. With equal forces per unit area, nothing happens yet.

2. Why does water eventually move into the jar after the candle is lit?

While the flame appears, oxygen inside the jar is consumed. This in itself does not reduce the number of gas molecules inside the jar because the combustion of hydrocarbons (such as wax) produces both carbon dioxide and water. But the water condenses against the cold glass jar, and the hot expanding CO_2 slips under the jar's lips and dissolves in the water. (Some may even bubble out, but you don't always see bubbles if you repeat the experiment) Suddenly there is less pressure inside the jar. The external pressure remains unchanged, and its weight is able to push some of the water into the jar. There is still water remaining outside because of the lingering inert nitrogen from the air within the jar.

3. Why does the water occupy $1/5^{th}$ of the jar's volume after the oxygen is consume.?

The height of the liquid inside the jar divided by the jar's total height approximately equals the percent of oxygen in the air.
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OBSERVATIONS

Initially there is practically no water in the jar. But after the flame is extinguished, water moves into the jar, approximately filling about one fifth of its volume.
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DEMONSTRATION 3	**QUESTIONS/ANSWERS**

A disk of potassium is added to water in a beaker. (must be dome in the fumehood!)

OBSERVATIONS

After a few seconds, we see orange and violet flames. Sparks result. An explosion is heard. There is a white residue on the glass door of the fume hood. We also notice a small silvery streak on the glass.

1. There are actually three exothermic reactions involved in this demonstration. Identify all three and provide evidence for each one.

The reaction between potassium and water to create potassium hydroxide (a base) and hydrogen gas must release, otherwise the fuels would never ignite in the first place.

The heat released by the first reaction then ignites two different fuels, hydrogen and the oil that potassium was stored in.
How do we know?
There were two different colours observed.

2. *How can one provide evidence for the hypothesis that the explosion sent some melted, unreacted potassium flying onto the glass?*

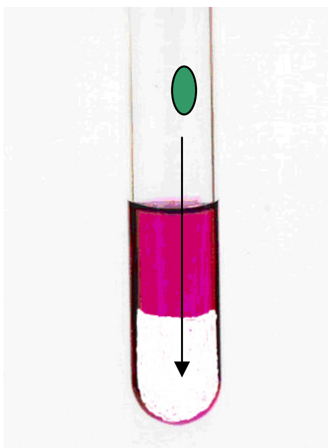
Add water to the silvery streak on the glass. It should fizz and create white coloured base.

DEMONSTRATION 4	**QUESTIONS/ANSWERS**

Turpentine($C_{10}H_{16}$) is added to a few crystals of iodine in a graduated cylinder or large test tube. The purple solution is then added to water.
Drops of food colouring(water-based) arethen added

OBSERVATIONS

The purple layer sits on top of the watery layer and resists mixing. The food colouring goes right through the purple layer without affecting it and colours the watery layer below.



Sorry the image is" photoshopped". No camera was available when we saw the real thing.

1. Why does the iodine-turpentine layer sit on top of the water?

Not only is it less dense than water, but there are stronger intermolecular attractions between iodine and turpentine molecules than there are between water and turpentine molecules. The strongest attractions in the mixture are between water molecules themselves.
Why?

Water is a polar molecule: there is a positive and negative part to it due to both the bonding angle formed at the oxygen-vertex of the water molecule and by the electronegativity difference between oxygen and the two hydrogen atoms. The hydrogen atoms of one water molecule are attracted to oxygen atoms of neighbouring molecules.
In turpentine there is only a small difference in greediness between C and H. The molecule is considered to be non-polar, and so it has a weak attraction for water.

2. *What would happen of you added food colouring, which is water-based with, to the test tube?*
The food colouring drops right through the purple layer and dissolves in the watery layer.
3. Why do the food colouring molecules pass right through the turpentine layer?
Because it is water-based, the food colouring forms weak attractions with the turpentine that cannot be overcome by gravity. Once in the watery layer much stronger attractions between the green pigment and the water cause it to dissolve there.

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<u>Mayonnaise Recipe</u>

1. First show that oil and vinegar do not mix.
2. Mix the following with a hand blender for several minutes.

Use a container slightly larger than the diameter of the blender's end.
125 ml of corn oil
15 ml of white vinegar or lemon juice
1 teaspoon of salt
1 egg yolk
3. Show that the emulsion (mayo) is now homogeneous.
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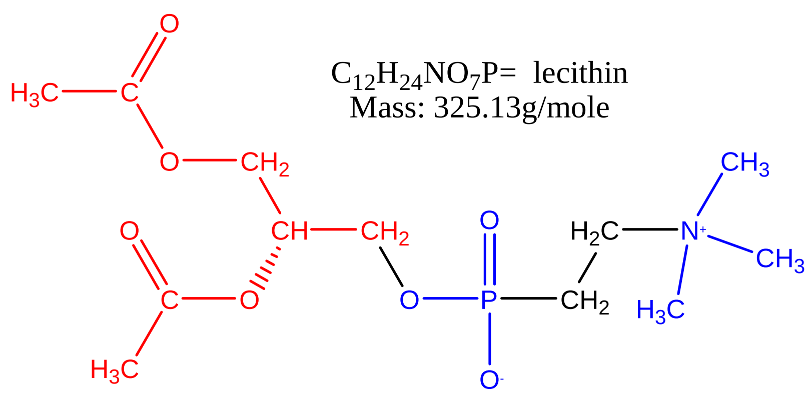
1. Why don't vinegar and oil mix?
Two of mayonnaise's main ingredients--- vinegar and oil--- do not mix. Vinegar consists of polar molecules, namely water and acetic acid. The intermolecular attractions between these are strong because there is an attraction between the negative acetate ion and water's hydrogen atoms and also between the oxygen atom in water and the positive H^+ ions in acid.

Oil molecules are attracted to themselves. In fact there could be <u>intermolecular</u> attractions between water and oil, but compared to the previously mentioned bonds, the water-oil ones are very weak. For this reason the oil and vinegar stick with their own kind.

Water or polar like attractions > oil-oil attractions > oil-water attractions

2. Why does lecithin help them mix and create mayonnaise?
Well, lecithin is a molecule that could get along with everyone and form strong bonds---something that grabs the watery, vinegary molecules with "one hand" and the oil with the other. And that molecule is lecithin found in the egg yolks. The ionic part (in blue)on the right is the part that interacts with the vinegary portion, and the part in red strongly attracts oil.



$C_{12}H_{24}NO_7P$= lecithin
Mass: 325.13g/mole
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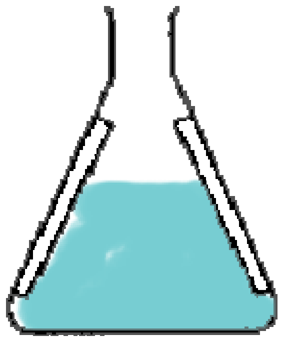
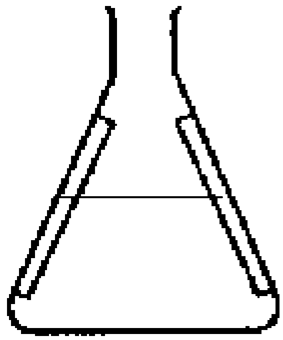
DEMONSTRATION

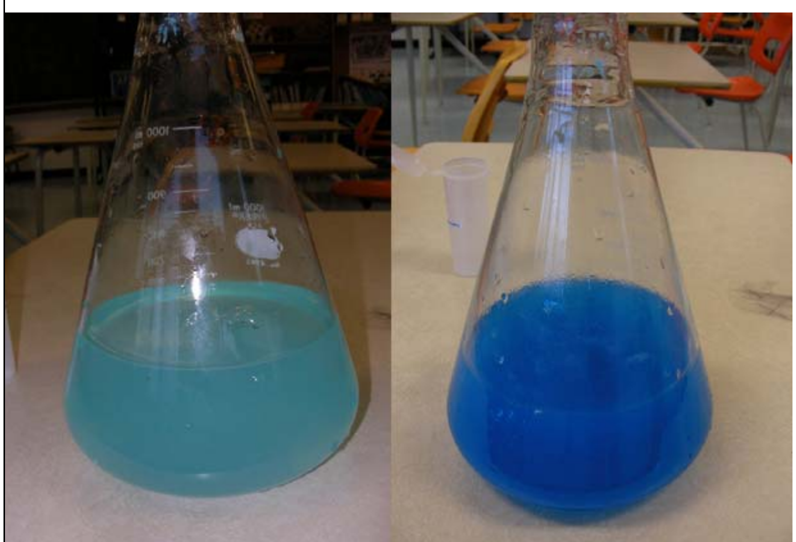
(6) To Precipitate or Not? And the Rates Perspective

	
$CuSO_{4(aq)}$	**$NaOH_{(aq)}$**

We have two solutions. The copper solution is light blue in colour. The sodium hydroxide solution is clear. The solutions are mixed.

OBSERVATIONS

Strangely, adding a clear solution actually creates a deeper blue mixture. Eventually the deep blue substance settles to the bottom, leaving an almost clear layer above it.



If allowed to stand for several hours, the deep blue colour becomes dull and then a dark grey.

QUESTIONS/ANSWERS

1. *When we mix two ionic solutions: at least two possible things could happen:*

   - *The ions could remain in solution.*
   - *Or at least one pair of ions could form a new compound?*

In each possible scenario, what would you observe? Which scenario applies to our demo?

- If the ions had remained in solution, there would be a paint-effect: a clear solution + light blue would have resulted in an even lighter blue solution.
- If a new compound would have formed, it would have precipitated. This is what we observed. The dark blue colour was the result of a precipitate.

2. What precipitate could have formed?

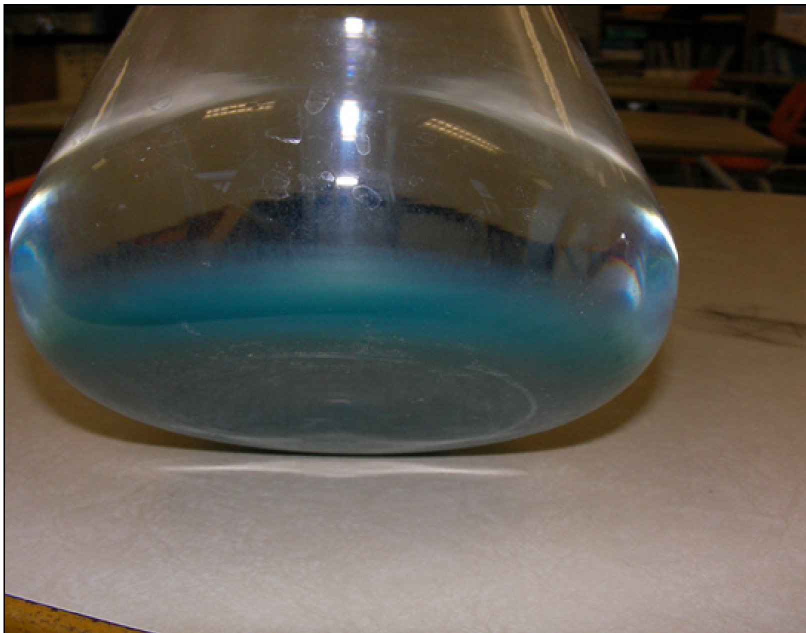
Either $Cu(OH)_2$ or Na_2SO_4

3.How do we know which one was responsible for the colour?

Obtain Na_2SO_4, dissolve it in water, and it will produce a clear solution. So we could conclude that copper(II) hydroxide was responsible for the relatively deeper shade of blue.

4. *The reaction occurs fairly quickly. Why?*

Reactions involving only

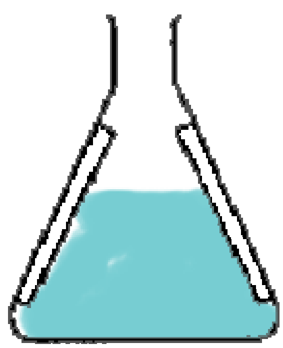
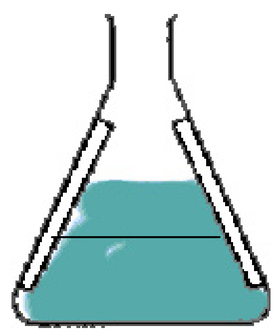


ions such as precipitation reactions occur very quickly.

5. Why is the discolouring reaction in which the blue becomes grey so much slower?

The second reaction involves CO_2, a covalent compound, which combines with $Cu(OH)_2$. The mechanism of this reaction is no longer the simple ionic exchange of a precipitation reaction.

(7)The Oxidation of Aluminum

 **$CuSO_{4(aq)}$**	 **$CuCl_{2(aq)}$**

A piece of aluminum foil is placed into two different solutions of Cu^{+2}, as shown above. Cu^{+2} is known to attack aluminum metal. The solution on the right seems to be a darker shade of blue. After a few seconds, the solution on the right($CuCl_2$) eats up the aluminum. Heat is released, and a brown substance collects at the bottom of the flask.
The $CuSO_4$ solution eventually reacts with the aluminum, but it takes a lot longer.

1. ***Form 2 hypotheses to explain why the $CuCl_2$ solution reacts faster.***

(1)The $CuCl_2$ solution had a higher concentration of Cu^{+2}.
(2) The Cl^- ion helps Cu^{+2} eat through the aluminum. The chloride acts as a catalyst.

2. ***How could we check if the presence of chloride was the main factor?***

Repeat the experiment but using the same concentrations of $CuCl_2$ and $CuSO_4$

(8)Ammonia and LeChatelier

Ammonium chloride(NH_4Cl) is dissolved in a test tube of water. A pH measurement reveals the solution to be slightly *acidic*. You are also told that, in theory, there should be a small amount of ammonia(NH_3) in solution, but that the basic properties do not express themselves in

1. **How do you get the ammonia out of the solution?**

Add NaOH, which will eat up H_3O^+. This will discourage the reverse reaction in the following

the presence of H_3O^+.	**and create enough ammonia to drive it out of solution:** **NH_4+ $H_2O = NH_3 + H_3O^+$** **2. How do test to see if adding base really drives out the ammonia?** **You can smell the ammonia(carefully) or insert a wet piece of red litmus above the test tube, without making it touch the liquid. In a few seconds, the paper will turn blue.**