Chemistry Education and Career Day

April 12, 2016

Miami University – Middletown campus

Schedule

9:00 - 9:15 a.m.	Welcome and Check-in (142 Johnston Hall)
9:15 - 10:45 a.m.	Experiment #1 (Levey Hall)
10:45 - 11:00 a.m.	Snack (100 Levey Hall)
11:00 a.m. - 12:30 p.m.	Experiment #2 (Levey Hall)
12:30 - 2:00 p.m.	Lunch and Speaker Panel (142 Johnston Hall)

Experiments and Instructors

Water Stoichiometry: The Big Bang Theory
(213 Levey with Dr. Chuck Degenhardt and Ms. Carol Durrough)

Chemistry of Blue Jeans: Indigo Synthesis and Dyeing
(214 Levey with Dr. George Rizzi and Ms. Jackie Webster)

Investigating the Process of Electroplating
(209 Levey with Mr. Howard Vail and Mr. Kody Day)

The Delicious Chemistry of Food and iPad Bingo
(100 Levey with Dr. Janet Marshall and Ms. Ashley Cundiff)

HPLC Analysis of Caffeine in Beverages
(215 Levey with Dr. Susan Marine and Ms. Angela French)

High School Chemistry Students and Faculty

Edgewood High School	Mrs. Corrina Centers
Fenwick High School	Mr. Fred Reuter and Dr. Jay Kirchner
Madison High School	Ms. Cindy Malott
Mariemont High School	Mr. Ed Kuhn

Guest Speakers

Mr. Kody Day – HPLC Chemist at Patheon Inc.
B.A. Chemistry – Miami University

Ms. Carol Durrough – Medical Technologist at Medpace Reference Laboratories and Medical Technologist (microbiology) at Mercy Health West Hospital
A.A.S. Chemical Technology – Miami University Middletown
B.S. Clinical Lab Science and B.A. Chemistry – Miami University

Ms. Angela French – Operations Chemist at Pilot Chemical Co.
B.A. Chemistry – Miami University

Ms. Melanie Rybar – Product Safety Analyst at Pilot Chemical Co.
B.S. Biochemistry – Miami University

Ms. Cassandra Sandvick – Chemistry Education Student at Miami University

Ms. Jackie Webster – Quality Control Manager at Quaker Chemical Co.
B.S. Chemistry – Wright State University and M.S. Chemistry - Miami University

Miami University Faculty and Staff

Ms. Ashley Cundiff	Admission Counselor (Middletown campus)
Dr. Chuck Degenhardt	Visiting Faculty in Chemistry (Middletown campus)
Dr. Scott Hartley	Professor of Chemistry (Oxford campus)
Dr. Susan Marine	Professor of Chemistry (Middletown campus)
Dr. Janet Marshall	Lecturer in Chemistry (Middletown campus)
Dr. George Rizzi	Visiting Faculty in Chemistry (Middletown campus)
Ms. Mandy Stewart	Chemistry Lab Coordinator (Middletown campus)
Mr. Howard Vail	Lecturer in Chemistry (Middletown campus)

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WATER STOICHIOMETRY: THE BIG BANG THEORY

Introduction

Hydrogen gas and oxygen gas react with one another in a very quick and exothermic manner. The explosive nature of this reaction is greatest when the hydrogen and oxygen are mixed in the proper ratio. In this experiment, you will generate both gases and test their explosiveness in mixtures of varying proportions. Your goal is to find the most "powerful" mixture of gases, then use it to launch a "rocket" across the room!

Procedure

Safety: Because the experiment is carried out on a microscopic scale, the explosions, though potentially loud, are completely safe. However, the two solutions used for gas generation, hydrochloric acid (HCl) and hydrogen peroxide (H_2O_2), can cause serious damage to the eyes and skin. Wear goggles and disposable gloves and avoid contact.

Waste: *When you are finished with your oxygen and hydrogen generators, please pour the contents into the appropriate waste beaker in the hood. Then rinse any residual solid material with deionized water and add the rinse water to the waste container in the hood.*

I. Generating O_2 and H_2

1. $2\ H_2O_2\ (l) \xrightarrow{Mn} 2\ H_2O\ (l) + O_2\ (g)$

   The micro oxygen generator has manganese metal (Mn) in it. Remove the top and add 3% hydrogen peroxide solution (H_2O_2). Fill the generator to within 2 cm of the top. Replace the lid and set the generator in your Petri dish.

2. $Zn\ (s) + 2\ HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$

   The micro hydrogen generator has zinc (Zn) metal in it. Remove the cap and add 3 M hydrochloric acid solution (HCl). Fill the generator to within 2 cm of the top. Replace the lid and set the generator in the Petri dish beside the oxygen generator.

II. Testing the spark

You will be using a piezoelectric igniter as the source of sparks for your "rocket" launch. Check to be sure the igniter is working by pressing the button and looking for a spark at the exposed ends of the wires.

III. Collecting gas by water displacement

1. Carefully fill a collection bulb with water from a squeeze bottle. The water should completely fill the bulb and neck so that, when inverted, no air bubbles are visible inside the bulb.

2. Place the water-filled collection bulb mouth downward over the nozzle of the appropriate generator. Allow the volume of gas to be used for the test to bubble in and displace the water out of the bulb. The bulb is marked with six graduations. Use these to estimate the proportions of gas collected in the bulb.

3. Move the collection bulb to the other generator by lifting the bulb off the nozzle and quickly placing your index finger under it to prevent water from leaking out. Continue filling the bulb with the proper amount of the second gas. There should be no water remaining in the bulb when gas collection is complete. Vary the amounts of H_2 and O_2 for each trial according to the list in Figure 1.

   Note: As long as the bulb remains upside down with water in the lower portion and neck, no air should enter the bulb and mix with your pure gases. Once all the water is displaced, the gas will quickly escape from the bulb, so the next step must be done quickly. If a delay is necessary, keep the bulb inverted or the open end of the bulb dipped in water or tightly covered with your index finger.

IV. Pop-tests

1. Working as a team, you and your partner will place the gas-filled collection bulb over the igniter wires. You will need to work very quickly (see note above) to prevent loss of your gas mixture. Place the wires of the igniter inside the collection bulb so that they extend about half-way into the bulb.

2. **Hold onto the bulb** and push the button of the igniter.

3. Rate the loudness of the pop using a scale of 0 - 10 to indicate relative loudness. Develop your scale as you perform each trial, and finalize it after hearing the pops for all of the mixtures listed in Figure 1. Record your data in Table 1.

Figure 1. Gas mixtures to be tested

Parts O_2	6	5	4	3	2	1	0
Parts H_2	0	1	2	3	4	5	6

V. Launch

Your instructor will show you where the launch area will be. DO NOT launch the bulb in any other place.

Use the loudness of the pop tests to narrow down your choices for the optimum gas mixture. You and your partner can use the distance the bulb travels when launched from the igniter to determine which mixture should be reported as the optimum gas mixture, if necessary.

Fill your collection bulb with the chosen gas mixture. Record the composition below Table 1. Quickly move to the launch area and put the collection bulb on your launcher. Without holding the bulb, aim the launcher away from any people around you and push the button. Determine the distance the bulb traveled. Repeat this process with any other gas mixture which you suspect to be near optimum. The bulb should fly the farthest when launched with the optimum mixture of gases.

VI. Reporting

Report your measured optimum ratio of hydrogen and oxygen to your friendly instructor. Your ratio will be put on the board along with the results from the rest of the class. Record the class results.

Name **Partner** **Date**

WATER STOICHIOMETRY

Table 1. Relative loudness of pop-tests

Parts O_2	6	5	4	3	2	1	0
Parts H_2	0	1	2	3	4	5	6
Relative Loudness (0-10)							

Results

Composition of optimum mixture (your results):

Distance in meters traveled by the bulb using that mixture:

Composition of optimum mixture (class results):

Questions

Q 1: Write the balanced equation to represent the reaction of oxygen and hydrogen to form water.

Q 2: How do the optimum gas mixture results on the board compare to yours? What might cause a variance in the results reported by other class members?

Q 3: What proportions produced the least explosive mixture? How do you explain this observation?

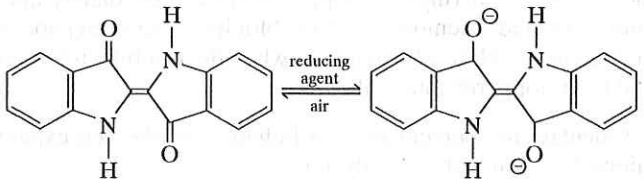
Q 4: Avogadro suggested a hypothesis that two samples of gas of identical volume at the same temperature and pressure contain the same number of molecules. This implies that if you measure the **volumes** of two gases as you did in this experiment, you can assume that you are measuring the **number of molecules** of the gases. In what way(s) does your data confirm or refute this hypothesis?
(*Note: As you think about this question, consider the equation you wrote for the reaction of oxygen with hydrogen (Q1.).*

MINILAB

Dyeing with Indigo

Before You Begin: Read or review the operations as necessary.

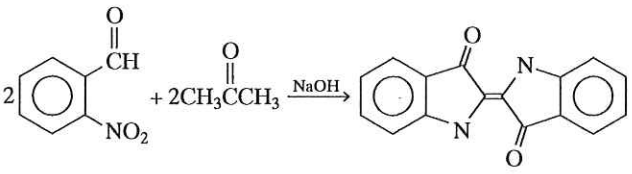
The indigo plant, *Indigofera tinctoria*, is a shrub of the legume family that has been used to dye cloth since ancient times. Egyptian mummies were sometimes wrapped in cloth dyed blue with indigo. The leaves of the indigo plant contain a colorless natural product called indican, which is converted to indigo by a process that involves fermentation and oxidation. Indigo is an indole derivative that, in the presence of a reducing agent, changes to the colorless base-soluble compound leucoindigo.



indigo (blue) leucoindigo (colorless)

When a piece of cloth is dipped into a solution of leucoindigo and exposed to air, indigo is regenerated, dyeing the cloth the color of blue jeans. Indigo fades with time, but the popularity of faded blue jeans has turned this apparent deficiency into an advantage.

In this minilab you will prepare synthetic indigo by a condensation reaction of 2-nitrobenzaldehyde with acetone in an alkaline solution, then use it to dye a piece of cloth.



2-nitrobenzaldehyde + $2CH_3COOH + 2H_2O$

Directions

Safety Notes

Indigo is a mild irritant and will turn the skin blue; wear gloves while working with indigo and its solutions.
2-Nitrobenzaldehyde is a mutagen (a substance that may cause genetic mutations), so avoid contact.

Chemistry of Blue Jeans: Indigo Synthesis and Dyeing

Procedure:

1. Dissolve 0.50 g of 2-nitrobenzaldehyde in 2.0 mL of acetone in a test tube.

2. Add water drop-by-drop until the solution becomes cloudy, then add a drop or so of acetone to clear it up.

3. Slowly add 20 drops of 1 M aqueous sodium hydroxide, with stirring. The solution should warm up and turn dark brown. Let the mixture stand at room temperature for 15 minutes to complete the synthesis and separation of indigo.

4. Cool the solution in an ice bath. Using a glass stirring rod, mix the solution to facilitate the transfer (step 5).

5. Collect the solid indigo by vacuum filtration using a Hirsch funnel. Wash the indigo dye with a small amount of 95% ethanol and then let it air dry.

6. Transfer the indigo to a clean test tube, add 0.15 g of sodium dithionite (also known as sodium hydrosulfite, $Na_2S_2O_4$), and grind the solids together using a glass stirring rod until they are well mixed. Leave the stirring rod in the test tube.

7. Add 10 mL of 1 M aqueous sodium hydroxide and heat the mixture in a hot water bath with stirring. Be sure to immerse the test tube in the hot water bath to insure complete heating of the solution.

8. When the indigo has dissolved, stopper and carefully shake the tube until the indigo-blue color disappears.

9. Immerse a small piece of cotton fabric in the solution with a stir rod, stopper the tube immediately, and shake it for about 30 seconds.

10. Remove the cloth, blot it dry between paper towels, and let it dry. What do you observe?

11. Note what happens with the test tube when the remaining solution is left open to the atmosphere and then stoppered and shaken.

Discussion Questions:

1. What is the function of sodium dithionite (also known as sodium hydrosulfite) in the conversion of indigo to leucoindigo? What is the function of air, and specifically which component of air, in the reverse reaction?

2. In the presence of an alkaline solution of sodium dithionite, indigo is converted to the colorless compound leucoindigo. What about the structure of leucoindigo makes it soluble in aqueous base?

3. Describe and explain your observations during and after the dyeing step. What happens when the test tube is left open for a time and then stoppered and shaken? Correlate these observations.

INVESTIGATING the PROCESS of ELECTROPLATING

Scenario

You have decided to build a deck in your backyard. At the hardware store (the only one around for 200 miles – you live in the middle of nowhere and are a very impatient person), the only nails you could find were iron nails. From experience, you know that iron rusts easily, especially in the high-humidity area where you live. Since you want the deck to last a long time and require little maintenance, you would like to prevent the nails from rusting. You have noticed that the iron fence in your backyard is coated with a protective layer of zinc that prevents rusting of the iron fence. Aha! Could a coating of zinc on the nails be the answer? Since you love chemistry and are an amateur chemist (with a mini-lab in the garage – isn't that convenient?), you decide to try and coat the iron nails with zinc yourself. Oh no – there is a quality control issue … read on.

Background

Pure metals can often be produced by electrolysis (using electricity to cause a nonspontaneous reaction to occur). This electrolytic method is referred to as *electroplating* when plating a thin metal coating onto a metal surface. The process is important in industry because metal coatings are commonly used as protective or ornamental coatings. Some examples include copper-plated jewelry, galvanized fencing (zinc coated onto steel), and chrome-plated bumpers. An electrolytic cell is the apparatus used in the electroplating process. Two electrodes (often different metals) are placed in a solution. The electrodes are connected to each other through a wire to a battery or other energy source. One metal is connected to the positive terminal; the other metal is connected to the negative terminal.

Objective

You should produce an iron nail that is coated uniformly and sturdily with zinc. An example of the desired product will be available in lab as a reference. The coating must adhere to the nail and not rub off or be flaky. In addition, the coating should be smooth and uniform in color. The instructor will act as a quality control analyst and give final approval. Remember that you will need to hammer these nails into wood, so a sturdy zinc coating will withstand the impact of being impelled into wood.

Procedure

I. Initial Testing

1. Pour about 30 mL of 10% $CuSO_4$ solution into a 50-mL beaker. Clean a 2-inch iron nail with steel wool and place it in the beaker. After 2 minutes, remove the nail and record your observations.

_____

_____

_____

2. Obtain 25 mL of 10% $ZnSO_4$ solution and 25 mL of 10% $FeCl_3$ solution in separate 30-mL medicine cups.

3. Clean one strip each of iron and zinc using steel wool. Remove any steel wool residue from the strip surfaces using a paper towel.

4. Place the zinc strip in the $FeCl_3$ solution and the iron strip in the $ZnSO_4$ solution. Allow them to react for at least 20 minutes and record any observations. The change may be subtle.

_____

_____

_____

Which strip showed evidence of being plated by the other metal? _____

Based on your observations above, is the process of plating an iron nail with zinc a spontaneous process (i.e. one that occurs on its own)? If so, the chemical reaction would be

$$Zn^{2+}(aq) + Fe(s) \rightarrow Zn(s) + Fe^{2+}(aq).$$

II. Construction of Plating Apparatus

Since the above reaction will not take place on its own, we use a source of electrical energy (a 6-volt battery) to force the plating reaction to occur.

$$Zn^{2+}(aq) + 2e^{-} \rightarrow Zn(s)$$

Because the electrons are supplied by the battery, the iron strip does not itself participate in the reaction; it acts as only a surface on which the plating takes place. In the procedure below, you will construct the apparatus for plating iron nails with zinc.

1. Clean a 2″ iron nail and a zinc strip using steel wool.

2. Using an insulated wire connector with alligator clips on both ends, connect the tip of the nail to one of the alligator clips. Connect the other alligator clip to the negative terminal on a 6-volt battery.

Note: If the alligator clips show any sign of corrosion, clean them using steel wool before continuing.

3. Suspend the nail into a 250-mL beaker until it just touches the bottom. Secure the alligator clip/wire to the side of the beaker using a clothes pin or tape. Add enough 10% $ZnSO_4$ solution to cover the bottom 1½ inches of the nail. Be certain that the alligator clip does not contact the solution.

4. Using another insulated wire connector with alligator clips, connect a zinc strip to one of the clips. Suspend the Zn strip into the beaker on the opposite side from the nail. Secure the strip to the side of the beaker using a clothespin.

5. Connect the other alligator clip to the positive terminal of the 6-volt battery and watch the contents of the beaker for about 2 minutes.

6. If the nail shows evidence of a zinc coating (light grey, not dark) on the nail, the system is ready to refine the parameters for plating the nail. If not, see your lab instructor.

III. Refining the Electroplating Process

1. Vary the plating parameters (e.g. plating time, acidity/alkalinity of the solution, method of cleaning nail, etc.) until you obtain a nail that has a uniform coating that will not flake off when rubbed with a paper towel. Always weigh the nail before and after the coating procedure to see how much zinc was deposited. Inspect the nail closely by using a magnifying glass. Keep a careful record of all the trials that were performed including those that produced an inferior product.

   Note: Should you decide to plate the nail from an alkaline pH, add about 10 mL of 10% $ZnSO_4$ solution and 90 mL of water in Part II, Step 3, prior to making the solution alkaline (test with a pH strip). Make sure to add enough NaOH solution to dissolve any white solid that appears in the solution.

2. Hammer the nail about ½ to ¾ inches deep into a wooden block. Remove the nail and inspect the coating for signs of chipping or flaking. If the coating falls off, go back to step 1 and find new parameters that result in a more sturdy coating.

3. Be sure that your method is reproducible (i.e., you can make as many nails as you wish). Coat three nails to be submitted with your lab report.

4. Now that you have a viable plating scheme, determine how much zinc you can coat on a nail in 30 seconds, 1 minute, 2 minutes, and 4 minutes, using the same nail. Record your results in the following table.

Elapsed time	Mass of nail (g)	Mass of Zn

(min)		coating (g)
0		0.000
0.50		
1.0		
2.0		
4.0		

Is there a linear relationship between the time and mass of coating? That is, does the mass of the zinc coating double when the plating time is doubled?

_____

Draw and label a diagram of the electrochemical cell you designed. Identify the cathode (the electrode where plating occurs), the anode (the electrode where plating does not occur), and the direction in which the current (or electrons) moves, as well as anything else you feel is important.

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How is Flavor Perceived?

Lifesavers Taste Test

Purpose and Background: The purpose of this exercise is to get you thinking about the factors that affect our perception of flavor. Appearance is typically our first contact with food, but flavor is often what is remembered. To a scientist, flavor includes the basics tastes (salty, sour, sweet, bitter, and umami), smell, and trigeminal effects (chemical feeling factors).

Interestingly, smell is often considered the most important of the three flavor factors. Humans can smell thousands of distinctly different aromas and most of them are quite complex. For example, the aromas of chocolate and coffee are comprised of hundreds of separate chemicals. Compounds that we can smell are usually volatile, in order for them to evaporate from a food and enter our nasal cavity. They are then sensed by our olfactory cells, or smell receptors, that reside on the olfactory bulb located at the top of the nasal cavity. Aroma molecules enter our nasal cavity directly through the orthonasal pathway (via our nose) or through the retronasal pathway (from the back of our throat). Smell is such an important component of flavor that for many foods, over 80% of our perception of flavor is related to smell. And as you probably know, when people have colds they often complain that food "tastes" bland, even though our ability to smell is what's most affected.

Procedure: In this exercise, we'll examine how much of our sense of flavor is determined by smell using Lifesavers candy. You will work with a partner. First, one of you should close your eyes and pinch your nose to close off the orthonasal pathway. Your partner will feed you a Lifesaver without letting you see the color or know the flavor. You should try to guess the flavor of the Lifesaver while keeping your nose closed. You'll have to breathe through your mouth. Be sure to have your nose pinched shut the whole time.

Record your initial observation from the first 5-to-10 seconds. After having the candy in your mouth for at least 30 seconds, guess the flavor again. Do you notice any change in the flavor of the Lifesaver from the beginning (your very initial impression) to the end (after 1-2 minutes)? Repeat this exercise by doing the same for your partner.

Next, both you (and your partner) should repeat this exercise with your eyes closed but do not pinch your nose shut. See if you can tell a difference in how quickly you can determine the flavor of the Lifesaver.

Trial	Lifesaver – Actual Flavor	Initial Flavor Perception	Final Flavor Perception
#1 – nose shut			
#2 – nose open			

References:

Chapter 3 "Taste and Structure" from Malapati, S. 2011. *Food and Chemistry*. Dubuque, IA: River 2 River Publications.

Figoni, P. 2011. *How Baking Works*, 3rd ed. Hoboken, NJ: Wiley.

Exploratorium. 2014. Your Sense of Taste. http://www.exploratorium.edu/snacks/your_sense_of_taste/index.html (Accessed July 18, 2014).

Questions for Discussion

1. Salt and sugar both affect the perception of smell, in part by changing the rate at which molecules evaporate. In general the more salt or sugar added to a food, the slower the release of aroma molecules. How does this affect the flavor?

2. Many flavor molecules readily dissolve in fat, so when fat is eliminated from a recipe, there is often a change in how quickly these molecules reach the taste buds, olfactory cells, and nerve endings beneath the skin. When there is no fat in a food product, flavor is sometimes described as lacking "staying power." Explain.

3. Why does warm food typically have a stronger flavor than cold food?

4. Sometimes the smell of a chili pepper is sufficient to trigger an irritation or "hot" sensation in the nose. Explain why.

5. How successful were you at correctly identifying the Lifesavers flavors? Did your success rate improve the longer the Lifesaver was in your mouth? If so, explain why this might occur.

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Tricking the Taste Buds with Miracle Berries

Purpose: The purpose of this experiment is to explore the ability of miracle berries and its bioactive compound miraculin to make sour foods taste sweet. The effect will be observed by taste testing several different types of foods, including lemons, limes, strawberries, and/or dill pickles.

Background: The fruit known as a miracle berry is harvested from the West African shrub *Richadella dulcifica*. The red berry itself is low in sugar content and has a mildly sweet tang. It contains a glycoprotein called miraculin. Miraculin has been shown to bind strongly to the sweet taste receptors on our tongues; however, it does not activate the receptors (taste sweet) at neutral pH. When a sour or acidic food is eaten, miraculin binds the hydrogen ions (protons) released from the sour food. At that point, it is able to activate the sweet receptors. The net result is sour foods taste sweet! The effect can last until the miraculin protein is washed away by saliva (up to about an hour).

The human sense of taste allows us to recognize structurally different sweeteners, including saccharides (sugars), D-amino acids, peptides, and sweet proteins. The glycoprotein miraculin is a protein that structurally has saccharide (sugar) chains attached to polypeptide side-chains. As noted, miraculin itself is not sweet. However, when it binds protons from acidic or sour foods, its conformation changes so that it activates the sweet taste receptors. Interestingly, at neutral pH, miraculin inhibits the taste of sweeteners such as aspartame by blocking the activation of the sweet receptor.

Miraculin has not been approved for use as a sweetener by the U.S. Food and Drug Administration (FDA), despite attempts by the Miralin Company to have it approved as such. In the 1970's, the company petitioned the FDA for approval to bring miraculin to market. The expectation was the product would be approved as "generally recognized as safe" (GRAS) since the berries have been used for centuries in Africa to sweeten the taste of sour foods. However, just before the product was ready to go to market, the FDA rejected the company's petition claiming miraculin would be considered a food additive and require extensive testing for approval. Some speculate that pressure from the U.S. sugar industry influenced the FDA decision.

Taste Test Procedure:
Dissolve a miracle berry tablet in your mouth, being sure to let it coat your tongue. These tablets each contain the freeze-dried extract of three berries. Since the shelf life of the fresh berries is very limited (1-2 days), the tablets are an easier way to deliver the active compound miraculin.

Taste several of the provided foods, choosing from lemons, limes, strawberries, and dill pickles. Record your observations.

Observations and Questions for Discussion:

1. List at least two of the sour foods you tasted and your perceptions of each after eating the miracle berry tablet. Comment on whether you could still taste sour and/or if you only tasted sweet after coating your tongue with the miracle berry tablet.

Food	**Taste after Miracle Berry Tablet**	

2. Would you expect miraculin to alter the taste of bitter foods? Why or why not?

References:

A Molecular Mechanism for Flavor Tripping. 2011. *Proceedings of the National Academy of Sciences* 108: 16483.

Koizumi, A. et al. 2011. Human Sweet Taste Receptor Mediates Acid-induced Sweetness of Miraculin. *Proceedings of the National Academy of Sciences* 108: 16819-16824.

Gollner, A.L. 2008. *The Fruit Hunters: A Story of Nature, Adventure, Commerce and Obsession.* New York: Schribner.

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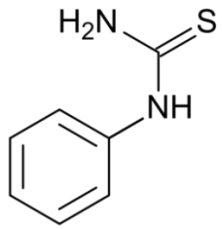
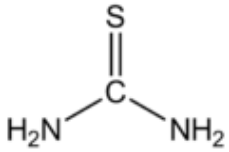
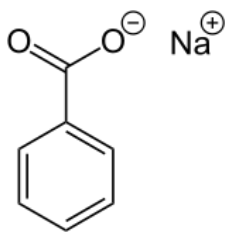
Exploring Genetic Differences: PTC Taste Strips

Purpose: The purpose of this exercise is to determine your personal taste sensitivity and genetic response to phenylthiocarbamide, PTC, and thiourea (perceived as bitter substances, if you can taste them) and sodium benzoate, commonly used as a preservative in processed foods (perceived as salty, bitter, sour, or sweet, if you can taste it).

Background: PTC tasting is largely determined by a single gene, TAS2R38, with two common alleles. The allele for tasting is mostly dominate over the allele for non-tasting. However, additional genetic studies have shown that other genes and environmental factors can influence PTC tasting. As a result, there is a continuous range of PTC tasting vs. absolute separation into tasters and non-tasters. Despite this, virtually all homozygous non-tasters (tt) cannot taste PTC and most homozygous tasters (TT) report the taste to be quite bitter. The heterozygous genotype (Tt) has the "leakiest" phenotype, with weakly bitter or non-tasting being somewhat common.

Procedure: Place the control taste test strip on your tongue and leave it there for about 30 seconds. You may find it helpful to chew (but not swallow) the strip. Remove the strip and record the taste in the table given below. Repeat this procedure with each of the other test strips. Compare your results to those of your classmates.

Test Strip Compound	Observations
#1 Control (none)	
#2 Phenylthiocarbamide (PTC) (also known as phenylthiourea) 	
#3 Thiourea 	
#4 Sodium benzoate 	

References:

Hundley, L.R. 1960. Taste Test Papers. http://www.indigo.com/documents/File/VMI-Taste-Test-Papers.pdf (Accessed July 13, 2014).

McDonald, J.H. 2011. Myths of Human Genetics. http://udel.edu/~mcdonald/mythptc.html (Accessed July 13, 2014).

Micklos, D. 2014. Coming into the Genome Age Part III: The Molecular Genetic Basis of PTC Tasting. http://www.carolina.com/teacher-resources/Interactive/molecular-genetic-basis-of-ptc-tasting/tr10687.tr (Accessed July 13, 2014).

Wooding, S. 2014. PTC: Genes and Bitter Taste. http://learn.genetics.utah.edu/content/inheritance/ptc/ (Accessed July 13, 2014).

Questions for Discussion

1. The ability to taste phenylthiourea (phenylthiocarbamide, PTC) and thiourea are genetically linked. This is not surprising, since they are similar in molecular structure. However, they are not identical compounds. Some individuals will not be able to taste either (category 1), some will perceive both as bitter (category 2), and others will be able to taste one but not the other (category 3). Which category do you fall into to?

2. Define the terms genotype and phenotype.

3. In 1931, a chemist named Arthur Fox was running an experiment with PTC, phenylthiocarbamide. He transferred some of the powdered compound into a bottle. A colleague who was also in the room noticed that the dust in the air tasted bitter. Fox tasted nothing. Fox later had his family and friends taste PTC and observed that some perceived the compound to taste bitter and others could not taste it. Based on this information, what was the genotype of Arthur Fox? Would his parents have been able to taste PTC? Explain your answer.

Chemistry Education and Career Day **April 12, 2016**
Miami University - Middletown campus **Dr. Janet Marshall**

Clues for iPad Bingo – Nutritionally Relevant Elements Based on Theodore Gray's "The Elements" App

K, Potassium

Bananas and grapes are rich in this important nutrient.

The table salt substitute "No Salt" contains the +1 ion of this element.

The +1 ion of this element is an essential nutrient and is critical to nerve transmission. If its level is too low, fingers start to freeze in place. A deficiency in the heart leads to death.

This element is a component of "sulfate of potash," a common fertilizer.

Co, Cobalt

This nutritionally important transition metal is found in most animal products, including meat, milk, and eggs.

A single atom of this transition metal element is found in every molecule of vitamin B_{12}.

This transition metal is used in artist pigments for its rich blue-purple color.

This transition metal element is used in alloys to make magnets and heat-resistant tools.

N, Nitrogen

All amino acids contain this element. The major gas in our atmosphere is this in its elemental form.

Certain plants such as beans and alfalfa "fix" this element from the atmosphere so that it becomes bioavailable.

In its liquid form, this element is the least expensive and most readily available cryogenic cooling liquid. It is occasionally used to make ice cream.

This non-metal element, when combined with silicon, gives a compound that is so hard it can be used to make cutting tools.

Na, Sodium

This is one of the most explosive metals in its elemental form and one of the best tasting in its ionic form.

The vapor of this alkali metal is used in lamps to give a yellowish glow.

The ion of this element is the dominate cation outside our cells and helps keep the water content of the intracellular and extracellular fluids in healthy balance.

Ions of this alkali metal play a critical role in the transmission of nerve signals within the body.

Mo, Molybdenum

This group VIB element is an essential trace mineral. It serves as a cofactor for certain enzymes that are involved in eliminating toxic substances. Beans and peas are a good source of this element.

This transition metal is used to generate the ^{99}Tc isotope for medical imaging. The device containing this element, used to generate radioactive technetium, is called a "moly cow."

This transition metal is naturally found in the mineral wulfenite.

The metal is a "metal of industry." Tools made of steel strengthened with this element are sometimes marked with an "M."

C, Carbon

This element is the most important element of life. It defines organic chemistry.

This is an element found in pencils; it is sometimes described as the "lead."

Diamonds are an allotrope of this element.

This element can form spheres knowns as "buckyballs" that have the appearance of geodesic domes. Geodesic domes were invented by Buckminster Fuller, hence the name "buckyball."

Fe, Iron

This element is the only one that has an "Age" named after it.

This metal is essential to the function of hemoglobin and myoglobin.

A nutritional deficiency of this element leads to anemia.

This element combines with sulfur to form the mineral pyrite, commonly known as Fool's Gold.

I, Iodine

This element was once widely used as a disinfectant and was often sold as a tincture.

A nutritional deficiency of this halogen element causes goiter. Chewing gum fortified with the ion of this element was once sold to prevent a deficiency.

This Group VIIA element is used in veterinary medicine to treat hoof fungus in horses.

This nonmetal is important to the proper development and operation of the thyroid gland.

V, Vanadium

This transition metal, found in Group VB, is needed in the formation of bones and teeth.

The steel in some hand tools is strengthened by the addition of this element. Such tools often have the name of the element stamped into the steel.

A complex of this transition metal colors some emeralds green.

A beautiful orange-red mineral containing this transition metal element also contains lead, oxygen, and chlorine.

S, Sulfur

The smell of rotten eggs is due to a simple compound formed from this element and hydrogen.

This nonmetal is one of the three basic components of gunpowder.

The characteristic smells of onions and garlic come from compounds containing this element.

The historical name of this element is brimstone, as in the expression "fire and brimstone."

Se, Selenium

This semiconductor element is found in relatively high concentration in Brazil nuts.

This essential micronutrient is toxic in larger amounts. Nutritionally, it is commonly obtained from plants grown in soils containing this metalloid element.

This element plays an important role in xerography because of its semiconductor properties.

Pastures and fields that contain large amounts of locoweed often have high levels of this element in the soil. Animals that ingest locoweed can suffer poisoning from both a neurotoxin found in the plant and high levels of this element.

Hg, Mercury

This element is one of two elements found in the liquid phase at standard temperature and pressure conditions.

This metal is highly poisonous. It damages the central nervous system and leads to "madness." Mad hatters used it to felt hats and often suffered the neurological consequences.

This metal accumulates in large, fatty marine mammals such as tuna, leading to _____ poisoning.

This metal was once used in dental fillings as an amalgam with silver.

F, Fluorine

The ion of this element is added to toothpaste to strengthen tooth enamel in young children.

In its elemental form, this element is highly reactive. In contrast, compounds of this element, such as Teflon, are very stable.

Ionic compounds of this element are often added to municipal drinking water to help protect the teeth of children from developing cavities.

This halogen is one of the most reactive elements in its elemental form and one of the most stable in its ionic form.

Bi, Bismuth

The active ingredient in Pepto-Bismol contains this element.

This heavy metal chemically resembles arsenic and antimony but has an unusually low toxicity.

The consumption of too much of this Group VA element can cause gums to turn black.

This Group VA element is often sold as 30-lb ingots. It is highly crystalline in the pure form.

Ca, Calcium

This metal is a major component of bone mineralization.

The ion of this Group IIA element plays a major role in cellular function and helps mediate the action of nerves and muscles.

This element is nutritionally required in substantial quantities. It is readily obtained from dairy products.

Eggshells and seashells are made from the carbonate salt of this alkaline earth metal.

Mg, Magnesium

This element is found in the tips of sparklers and gives a characteristic silvery glow upon burning.

The carbonates of calcium and this metal are the primary components of limestone.

The antacid Milk of Magnesia contains the hydroxide of this element.

The ion of this metal is found in chlorophyll.

Cr, Chromium

This Group VIB element plays an important role in the metabolism of glucose.

This shiny transition metal is used in electroplating. It was especially popular for plating the bumpers of cars in the 1950's and 1960's.

This metal is found in high concentration (about 20%) in common stainless steel.

An oxide of this metal is a common green pigment used in paints and glazes.

Ba, Barium

The sulfate salt of this element is commonly used as a contrast agent for x-ray imaging of the digestive tract.

Compounds of this alkaline earth metal are used in fireworks to impart a green color.

The name of this Group IIA element comes from the Greek word for heavy.

This alkaline earth element reacts readily with oxygen. This property has been used to create "_____ getters" to scrub oxygen from old-style vacuum tubes.

Mn, Manganese

Nutritionally this transition metal is essential for healthy bones, a well-functioning nervous system, and reproduction.

Oxides of this transition metal were used as a black pigment by early cave dwellers.

This element is found in high concentration in nodules collected from the floor of deep oceans.

The mineral rhodochrosite is the carbonate compound of this transition metal element.

P, Phosphorus

Red-tipped, strike-anywhere matches use this element as an ignitor.

This nutritionally important element is found chemically bound to oxygen in ATP and ADP.

This element is found in several allotropic forms including black, white, and red. The white form is especially dangerous due to its toxic and pyrophoric nature.

Fertilizers containing this non-metal are made from rocks that are rich in it.

Si, Silicon

This metalloid is needed for the growth and maintenance of bones and teeth.

The oxide of this element is commonly referred to as sand.

Crystals of this element are semiconducting which makes it especially valuable for computers.

A compound of this element is often used in surgical implants.

Cl, Chlorine

This element is one of the least expensive and most effective disinfectants.

This element is found in common table salt as an ion.

This element is a component of the major acid present in the stomach.

The ion of this nutritionally important element plays many roles in living organisms, especially with regards to nerve function and digestion.

H, Hydrogen

This element is naturally found as a gas and is lighter than helium.

This nonmetal is commonly found bound to carbon and/or oxygen.

The sun works by turning this element into helium.

This element was once used to "float" hot air balloons and zeppelins but its flammability resulted in a historic tragedy known as the Hindenberg disaster.

O, Oxygen

This element is considered the "fuel" for life.

This element is the most abundant element on earth, comprising almost 50% of the Earth's crust, atmosphere, and surface water.

Ozone is a common allotrope of this element.

This element is one of the two major gases found in our atmosphere.

Zn, Zinc

This metal has been used as the core of pennies minted since 1982.

Nutritionally, this is a trace mineral that promotes growth and the healing of wounds.

This transition metal is used to galvanize iron. It is commonly used to plate iron nails to prevent rusting.

An oxide of this element is sold as a white cream that is used to prevent sunburn.

Cu, Copper

This metal has antimicrobial properties that make it useful in hospitals for doorknobs and other surfaces.

This is one of the few metals that is not grey in color.

A deficiency of this Group IB element can lead to anemia and bone disease and may impair the immune system.

This metal is a component of brass when alloyed with zinc.

B, Boron

This metalloid element is used in Silly Putty.

This element is found in boric acid powder – a commercial product once recommended for washing eyes as well as poisoning ants.

This element is believed to play a regulatory role in the metabolism of minerals such as calcium. Its atomic number is 5.

This element is the lightest of the series of elements known as the metalloids.

Ni, Nickel

This element is used to make coins. The name of the element is also the name of a coin in U.S. currency.

This transition metal is used to make bumpers for automobiles, providing rust protection. In this application, it is often plated with chromium.

This element is a common trace nutrient found in multiple vitamins. It is believed to play a role in increasing iron absorption and preventing anemia. It is found in the same period as iron.

This element is commonly used to plate iron and brass. When plated properly, it imparts a beautiful silver sheen to an object.

Name: _____ School: _____

Lab Partner: _____ School: _____

HPLC Determination of Caffeine in Beverages

Since the introduction of reliable pumps and sensitive detectors for high performance liquid chromatography (HPLC) in the early 1970's, HPLC has become one of the most widely used instrumental methods. For substances with low volatility or thermal instability, HPLC offers the advantages of simultaneous separation and quantitation. Advances in column technology have been remarkable, and the resolution of extremely complex mixtures is now possible.

In this experiment, we will perform a relatively simple separation to demonstrate the capabilities of the technique. Caffeine is an ingredient in most popular soft drinks. We will determine the caffeine concentration in a few of these products.

Part I. Instrument Set-up

The instrument to be used is a ThermoScientific UltiMate 3000 HPLC by Dionex and the Chromeleon software system. Select sequence "CHM 364 Caffeine Analysis". Select the “Data” tab to access the Sample Injection Table which lists the injection order and rack location of each vial. The Method listed for each sample provides a predefined set of instrument parameters including the following conditions:

Column	Acclaim 120 C-18; 150mm x 3mm; 3 µm particles
Flow rate	0.3 mL/min
Eluent composition	50% methanol / 50% water (HPLC grade)
Flow Profile	Isocratic
Detector	UV-Vis
Detector wavelength	270nm
Run time	5.0 minutes
Sample size	5.0 microliters

Part 2. Calibration Curve (has been made for you)

1. Prepare a 500 ppm solution of caffeine in water using a 1-L volumetric flask.
2. From the stock solution, prepare six standards with concentration covering the range 0 to 150 ppm using 100-mL volumetric flasks.
3. Filter the standards into 2-mL sample vials for injection.
4. Make injections of the standards and determine the retention time and area response characteristics of caffeine under these analytical conditions.

5. From the calibration data, plot the calibration curve.

Part 3. Determination of Caffeine in Beverages

1. Samples must be degassed and filtered prior to injection!

2. Prepare the samples by diluting quantitatively with methanol (HPLC grade) so the expected concentration is within the range of your standards. For cola drinks, dilute 1:3 with methanol as directed below while filtering the samples.

3. To do this, remove the plunger from a plastic 10-mL syringe. Attach a clean 0.20-µm disposable filter. Hold the syringe over the beaker labeled "Waste" and add methanol to the syringe barrel, filling the "Methanol" pipette 3 times to the line. Use the beral pipette labeled "Sample" to deliver your sample (measured ONCE to the line) into the syringe barrel. Use this pipette to mix the methanol and sample together well. Do not splash the liquid out of the syringe.

6. Slowly insert the plunger into the syringe barrel; liquid will begin to drip from the filter into the "Waste" beaker. Apply gentle pressure to the plunger to filter the diluted sample drop-wise into the "Waste" beaker until the liquid level is at 2.0-2.5 mL in the syringe. Filter the sample into a 2-mL sample vial until the liquid is just over the 1.5 mL line on the vial. Samples may contain solid material that will clog the filter. Do not filter too quickly (less than 1 drop/sec) or you may puncture the filter.

4. Cap the vial; label it; and place it in the sample rack. Enter the vial's name and location in the Sample Table in Chromeleon for analysis.

5. Remove the filter from the plastic syringe and allow any remaining liquid to drip into the "Waste" beaker. Lay the used filter neatly on your work space; do not discard it. Remove the plunger from the plastic syringe. Rinse the syringe and plunger with deionized water into the "Waste" beaker. Dry the syringe parts and lay them out for the next students.

6. Ensure that the caffeine peak for your sample has an area count within the calibration range. If not, it may be necessary to make additional dilutions to match sample and standard concentrations.

7. Calculate the concentration of caffeine in your beverage, taking into account the dilution of the sample. Include a chromatogram of a standard and of your sample in your report.