

# Chemistry of Alcohol

Developed by  
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For the  
*My Environment, My Health, My Choices* project



University of Rochester  
Rochester, NY

## Abstract:

Methanol and ethanol are both metabolized (oxidized) into an aldehyde and then an organic acid. Why then is methanol more toxic than ethanol? Should a Breathalyzer be used to screen for drinkers at school events? Using a Web Quest (or alternatively using a directed study), a molecular model building activity and making a class presentation for a Board of Education meeting are all part of this organic chemistry environmental health science four day lesson.

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***Teachers, we would appreciate your feedback. Please complete our brief, online Environmental Health Science Activity Evaluation Survey after you implement these lessons in your classroom.***

***The survey is available online at: [www.surveymonkey.com/s.asp?u=502132677711](http://www.surveymonkey.com/s.asp?u=502132677711)***

## Pre/Post Test

Name \_\_\_\_\_

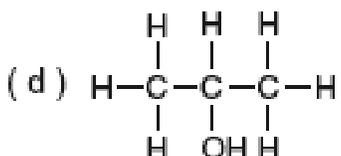
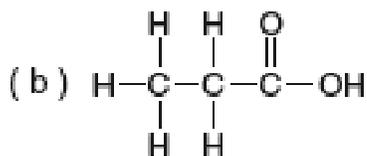
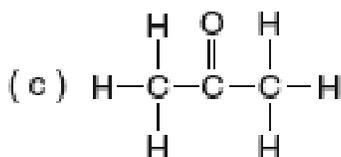
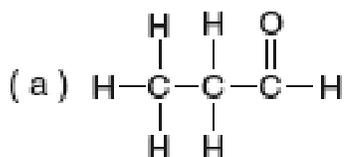
1. What is the common name for ethanoic acid?
  1. acetic acid
  2. ascorbic acid
  3. lactic acid
  4. salicylic acid
2. What is the IUPAC name of the compound that has the condensed structural formula  $\text{H}_2\text{CO}$ ?
  1. methanal
  2. methanol
  3. hydrogen carbon (II) oxide
  4. dihydrogen carbon monoxide
3. Which compound has chemical properties most similar to the chemical properties of ethanoic acid?
  1.  $\text{C}_2\text{H}_5\text{OH}$
  2.  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
  3.  $\text{C}_3\text{H}_7\text{COOH}$
  4.  $\text{C}_2\text{H}_5\text{COOC}_2\text{H}_5$
4. Given the balanced equation for the mild oxidation of  $\text{CH}_3\text{OH}$  :



What is the functional group of the organic product produced?

1. acid
  2. alcohol
  3. aldehyde
  4. ketone
5. When considering toxic substances,  $\text{LD}_{50}$  is a term that often appears. What do the letters, "LD" represent in the term  $\text{LD}_{50}$ ?
    1. legally dead
    2. learning disabled
    3. lethal dose
    4. limited degree

6. Given the structural formulas of four organic compounds



Which pair contains an alcohol and an acid?

1. a and b
  2. a and c
  3. b and d
  4. c and d
7. When applied to measurements, what is the meaning of the statement, "Your precision is good but not your accuracy?"
1. Your values are close to the true value and are close to each other.
  2. Your values are close to the true value but are not close to each other.
  3. Your values are not close to the true value but are close to each other.
  4. Your values are not close to the true value and are not close to each other.
8. When ethanal is converted into ethanoic acid, which statement describes what happens in the reaction?
1. Ethanal loses one oxygen atom to become ethanoic acid.
  2. Ethanal gains one oxygen atom to become ethanoic acid.
  3. Ethanal gains two hydrogen atoms to become ethanoic acid.
  4. Ethanal loses two hydrogen atoms to become ethanoic acid.
9. What human activity is most closely associated with ethanol poisoning?
1. binge drinking
  2. competitive eating
  3. drug using
  4. practical joking
10. If someone is in danger of ethanol poisoning, what step should be taken to reduce the chance of death?
1. keep them awake
  2. call 911 for emergency help
  3. have them take a cold bath or shower
  4. turn them on their side and let them sleep it off

## Pre/Post Test – Teacher Answer Key

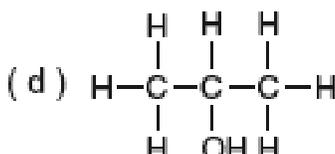
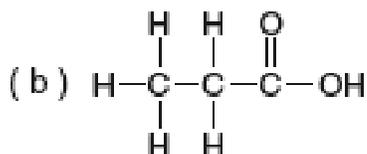
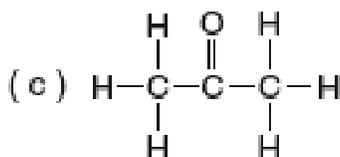
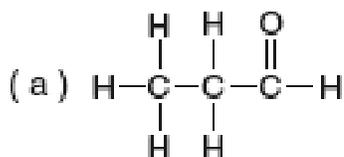
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  2. ascorbic acid
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2. What is the IUPAC name of the compound that has the condensed structural formula  $\text{H}_2\text{CO}$ ?
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  2. methanol
  3. hydrogen carbon (II) oxide
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3. Which compound has chemical properties most similar to the chemical properties of ethanoic acid?
  1.  $\text{C}_2\text{H}_5\text{OH}$
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  3.  **$\text{C}_3\text{H}_7\text{COOH}$**
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4. Given the balanced equation for the mild oxidation of  $\text{CH}_3\text{OH}$  :



What is the functional group of the organic product produced?

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  3. **aldehyde**
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    2. learning disabled
    3. **lethal dose**
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6. Given the structural formulas of four organic compounds



Which pair contains an alcohol and an acid?

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  2. a and c
  3. **b and d**
  4. c and d
7. When applied to measurements, what is the meaning of the statement, "Your precision is good but not your accuracy?"
1. Your values are close to the true value and are close to each other.
  2. Your values are close to the true value but are not close to each other.
  3. **Your values are not close to the true value but are close to each other.**
  4. Your values are not close to the true value and are not close to each other.
8. When ethanal is converted into ethanoic acid, which statement describes what happens in the reaction?
1. Ethanal loses one oxygen atom to become ethanoic acid.
  2. **Ethanal gains one oxygen atom to become ethanoic acid.**
  3. Ethanal gains two hydrogen atoms to become ethanoic acid.
  4. Ethanal loses two hydrogen atoms to become ethanoic acid.
9. What human activity is most closely associated with ethanol poisoning?
1. **binge drinking**
  2. competitive eating
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  4. practical joking
10. If someone is in danger of ethanol poisoning, what step should be taken to reduce the chance of death?
1. keep them awake
  2. **call 911 for emergency help**
  3. have them take a cold bath or shower
  4. turn them on their side and let them sleep it off

## Teacher Information

### Learning Context:

- This learning experience is designed for high school students taking a chemistry course.
- Students should be familiar with using the Internet and have access at the school unless doing this as a directed study.
- Students should know how to name alkanes minimally knowing the prefixes meth- and eth-.

### Overall Purpose:

- The overall purpose of the learning experience is to learn more about alcohols, aldehydes and organic acids as well as to become aware of alcohol poisoning and the limitations of a Breathalyzer.

### Student Learning Objectives:

- Students will be able to recognize important functional groups, in particular, alcohols, aldehydes and organic acids.
- Students will be able to name simple aldehydes, organic acids and monohydroxy alcohols using IUPAC nomenclature or common names.
- Students will be able to identify organic oxidation reactions that either add oxygen or remove hydrogen.
- Students will know the mild oxidation of an aldehyde produces an organic acid.
- Students will know the mild oxidation of methanol or ethanol produces an aldehyde as the organic product.
- Students will be able to classify an organic compound based on its structural or condensed structural formula.
- Students will be able to draw a structural formula with the functional group(s) on a straight chain hydrocarbon backbone, when given the IUPAC name for the compound.
- Students will be able to create and use molecular models of organic molecules to illustrate their shape and simulate mild oxidation reactions of alcohols and aldehydes.
- Students will be able to create and use molecular models of organic molecules to show they differ in their structures.
- Students will be able to define and use the terms precision and accuracy when applied to a Breathalyzer.
- Students will be able to define toxic and explain the term LD<sub>50</sub>.
- Students will be able to identify what to do if someone shows signs of alcohol poisoning.

## Procedure:

### Classroom Timeline:

Day 1	Part 1 Part 2	15 minutes 30 minutes	Read article Web Quest
Day 2		45 minutes	Molecular modeling activity
Day 3		45 minutes	Prepare for presentation
Day 4		45 minutes	Presentations

## **Day 1 - Part 1: Read Article (15 minutes)**

The students should be given a copy of the article on the next page, “Bizarre Fatality in the Suburbs.” The article is fiction but it is a compilation based on real cases.

Allow them to read the article and when everyone finishes ask students to think about the article they have just read. They are then paired up with a classmate to share their opinion about the article. Some students may then briefly share their thoughts with the whole class.

## **Bizarre Fatality in the Suburbs**

By Joshua Good

Jason Drake, 17, a senior at Borders High School, died an unusual death Friday night. Police sources stated Jason had attended a party with friends and classmates at the home of Thomas and Julie Contrary who were out of town.

The party started around 9:00 PM but young Drake did not arrive until approximately one hour later. The teenagers reported drinking a mixture of concentrated juice, vodka, and beer placed in a punch bowl, a drink called “jungle-juice” by the teenagers. After the first bowl of the beverage was consumed Will Contrary, 16, son of Thomas and Julie, went to get more vodka for the second batch. It was about this time that Jason Drake arrived.

Will’s father admitted he would illegally bring vodka back from Canada. He would fill empty bottles of windshield-wash with vodka and then add blue food coloring to make it seem like windshield-washer fluid to avoid the tariff for importing alcohol that is imposed at the border. Will took what he thought was one of his father’s illegal imports from the basement. Unfortunately, the bottle that he took was in fact windshield-washer fluid that contained methyl alcohol as the main ingredient. Will Contrary then proceeded to make another bowl of the drink using the bottle of windshield-washer fluid.

Students at the party said that Jason had then tried to “catch up” by drinking two large glasses of the punch immediately. Jason seemed to be having no difficulties but sometime later he passed out. Two of his friends decided that since this was a fairly common occurrence at this sort of party the best thing to do would be to take him across the street to his house and put him to bed.

Jason’s friend and fellow senior Mark Townsend, 17, who was one of those who carried him, had this to say, “Well, he just passed out. I mean, lots of people pass out at

parties. Since his house was right across the street and no one was home we didn’t think there’d be a problem leaving him there. We turned him on his side and made sure he had a bucket and everything. We didn’t think there was anything wrong. It’s just one of those things, you know? We thought we were helping him out by getting him home so no one knew he’d been at a party.”

The next evening when Jason’s mother, who had recently returned from a business trip, decided to awaken him for dinner, found that she could not rouse him. She called 911 and he was rushed to St. Joseph’s Hospital. He was declared dead upon arrival. Toxicity tests later showed that he had died of methanol poisoning.

The people in this tight-knit community are doing more than just talking about how to address the issue of teenage alcohol abuse. Board of Education President Dr. Herman Melville proposes a solution. He favors breathalyzers be used at all school functions. This is a policy adopted at a growing number of schools to deter drinking at after-school events. Dr. Melville supports a one-strike and your out, zero-tolerance policy. Students who test positive for alcohol will be ineligible for all extracurricular activities, including sports, and performances in plays or concerts, for one full year.

William Pratt, a 16-year-old junior at the school, said he would “refuse to be tested even if he did not have any alcohol as a matter of privacy.” In an attempt to be less disruptive, officials at the school said they would “only use alcohol testing on students they suspect have been drinking.” “It really won’t change the problem; if kids want to drink they will,” says Susie Kerr, a 17-year-old senior.

According to senior Timothy Dayton, 17, each year since he can remember there has been an incident in which someone “almost” died from drinking too much. “It’s totally out of control,” said another senior, Jared Hall, 18.

## **Day 1 – Part 2: Web Quest (30 minutes)**

Students will now do a “Web Quest” and use Internet resources to prepare for a presentation to the Board of Education. Have the students read the “**Board of Education Presentation**” (see following page). Students should then be given time to seek answers to questions five different questions that you assign to each pair using the matrix provided. This will ensure that each of the ten questions have been answered by several groups. Note that each group will be answering question 6 and question 10 which are deemed to be most important for all students to address.

See the teacher reference guide for suggested search words and Internet addresses.

This activity will take approximately thirty minutes although some students may require longer. You could have students finish their assigned questions for homework, but is not required so long as several pairs of students have answers to each of the questions.

**Important Note:** The questions are provided in three alternative formats.

1. An open internet inquiry format where students search for their own sites.
2. A directed internet inquiry format where sites for student research are suggested.
3. An inquiry format that does not require the use of computers.

**Select the question format that best suits your classroom constraints and teaching goals.**

## Board of Education Presentation

The board of education is debating a policy to deter drinking at after-school events. They want to randomly test students who enter school dances, night football games, school plays and any after-hour event with Breathalyzers.

The president of the Board of Education believes this will address the widespread problem of student drinking. The chemistry class has been asked to prepare a presentation on the "Chemistry of Alcohol, Breathalyzers and School Policy to Deter Drinking" for the next Board of Education meeting.

The class presentation should answer the ten questions that follow, express their opinion on the use of Breathalyzers, and provide a rationale for their opinion. You should suggest actions the Board of Education should take to curb the student-drinking problem.

Research the answers to the questions for your presentation using Internet resources, working in pairs on assigned questions. Be sure to include Internet references with your answers. If you have trouble finding the answer to a question, raise your hand and ask your teacher for assistance. If you complete all of your assigned questions, you can continue to work on the rest of the ten questions.

## Questions for Internet Inquiry:

- Can someone die of water intoxication (drinking too much water)?
  - Find an example of someone who died due to water intoxication.
- What makes something toxic?
- Scientists often report toxicity using the term  $LD_{50}$ . What is  $LD_{50}$ ?
- How toxic is methanol (methyl alcohol)?
- How toxic is ethanol (ethyl alcohol)?
- Methanol and ethanol are both metabolized into an aldehyde and then an organic acid. Why then is methanol more toxic than ethanol?
- Why does the treatment for methanol poisoning involve giving the patient ethanol?
- If someone is in danger of ethanol poisoning, what steps should be taken to reduce the chance of death?
- What is a Breathalyzer?
  - How does a Breathalyzer work?
- Reliability is reproducibility of multiple measurements free from random error which in this case would mean if the test were repeated several times with the same subject, would the readings be the same?

Accuracy is how close a measurement comes to the true value, which in this case is the blood alcohol concentration (BAC).

How reliable is a Breathalyzer? How accurate is a Breathalyzer?

Please answer the following questions in the order listed. If you finish early, then look up the answers to some of the other ten questions. Be sure to not only answer the question, but to include the web site where you found the answer.

Ask you teacher if you are having trouble with any particular question.

Student Names	Assigned Questions
_____	Pair #1: 1, 2, 3, 6, 10
_____	Pair #2: 4, 5, 6, 7, 10
_____	Pair #3: 6, 8, 9, 10, 1
_____	Pair #4: 10, 9, 8, 7, 6
_____	Pair #5: 1, 2, 3, 6, 10
_____	Pair #6: 4, 5, 6, 7, 10
_____	Pair #7: 6, 8, 9, 10, 1
_____	Pair #8: 10, 9, 8, 7, 6
_____	Pair #9: 1, 2, 3, 6, 10
_____	Pair #10: 4, 5, 6, 7, 10
_____	Pair #11: 6, 8, 9, 10, 1
_____	Pair #12: 10, 9, 8, 7, 6
_____	Pair #13: 1, 2, 3, 6, 10
_____	Pair #14: 10, 9, 8, 7, 6

## Questions for Directed Internet Inquiry:

- (a) Can someone die of water intoxication (drinking too much water)?  
Suggested web sites:  
<http://chemistry.about.com/cs/5/f/blwaterintox.htm>  
<http://www.fbnewsleader.com/articles/2006/07/29/sports/03greg.txt>  
Search Tip: use quotation marks and search "water intoxication"

(b) Find an example of someone who died due to water intoxication.  
Suggested web sites:  
<http://www.npr.org/templates/story/story.php?storyId=5012154>  
Search Tip: use quotation marks and search "water intoxication" and death
- What makes something toxic?  
Suggested web sites:  
[http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution\\_seeds.pdf](http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution_seeds.pdf)  
<http://en.wikipedia.org/wiki/Toxicology>  
Search Tip: use toxicology and/or poison in your search string
- Scientists often report toxicity using the term LD<sub>50</sub>. What is LD<sub>50</sub>?  
Suggested web sites:  
<http://en.wikipedia.org/wiki/LD50>  
Search Tip: use LD<sub>50</sub>
- How toxic is methanol (methyl alcohol)?  
Suggested web sites:  
<http://www.nlm.nih.gov/medlineplus/ency/article/002680.htm>  
[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)  
Search Tip: using some combination of search words that include LD<sub>50</sub> or toxicity and methanol or methyl alcohol
- How toxic is ethanol (ethyl alcohol)?  
Suggested web sites:  
[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)  
Search Tip: using some combination of search words that include LD<sub>50</sub> or toxicity and ethanol or ethyl alcohol
- Methanol and ethanol are both metabolized into an aldehyde and then an organic acid. Why then is methanol more toxic than ethanol?  
Suggested web sites:  
[http://en.wikipedia.org/wiki/Alcohol\\_-\\_Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)  
[http://chemmovies.unl.edu/chem\\_source\\_pdf/ChemSource.html](http://chemmovies.unl.edu/chem_source_pdf/ChemSource.html) (Organic)  
Search Tip: use the words alcohol metabolism

7. Why does the treatment for methanol poisoning involve giving the patient ethanol?  
Suggested web sites:  
[http://en.wikipedia.org/wiki/Alcohol - Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)  
<http://www.emedicine.com/NEURO/topic217.htm>  
Search Tip: treatment methanol poisoning
8. If someone is in danger of ethanol poisoning, what steps should be taken to reduce the chance of death?  
Suggested web sites:  
[http://www.collegedrinkingprevention.gov/media/NIAAA\\_Grad\\_Flyer\\_NEW.pdf](http://www.collegedrinkingprevention.gov/media/NIAAA_Grad_Flyer_NEW.pdf)  
<http://www.collegedrinkingprevention.gov/OtherAlcoholInformation/factsAboutAlcoholPoisoning.aspx>  
Search Tip: search "alcohol poisoning"
9. (a) What is a Breathalyzer?  
Suggested web sites:  
<http://en.wikipedia.org/wiki/Breathalyzer>  
Search Tip: Breathalyzer
- (b) How does a Breathalyzer work?  
Suggested web sites:  
<http://science.howstuffworks.com/breathalyzer2.htm>  
<http://science.howstuffworks.com/breathalyzer3.htm>  
Search Tip: Breathalyzer works
10. Reliability is reproducibility of multiple measurements free from random error which in this case would mean if the test were repeated several times with the same subject, would the readings be the same?  
Accuracy is how close a measurement comes to the true value which in this case is the blood alcohol concentration (BAC). How reliable is a Breathalyzer? How accurate is a Breathalyzer?  
Suggested web sites:  
[http://www.ncdd.com/dsp\\_articleDetails.cfm?article=2](http://www.ncdd.com/dsp_articleDetails.cfm?article=2)  
<http://www.bookrags.com/other/drugs/breathalyzer-dat-01.html>  
Search Tip: Breathalyzer reliability

## Questions for use if Internet is Not Available

1. (a) Can someone die of water intoxication (drinking too much water)?

<http://chemistry.about.com/cs/5/f/blwaterintox.htm>

### Can You Really Drink Too Much Water?

In a word, yes. Drinking too much water can lead to a condition known as water intoxication and to a related problem resulting from the dilution of sodium in the body, hyponatremia. Water intoxication is most commonly seen in infants under six months of age and sometimes in athletes. A baby can get water intoxication as a result of drinking several bottles of water a day or from drinking infant formula that has been diluted too much. Athletes can also suffer from water intoxication. Athletes sweat heavily, losing both water and electrolytes.

Water intoxication and hyponatremia result when a dehydrated person drinks too much water without the accompanying electrolytes.

### What Happens During Water Intoxication?

When too much water enters the body's cells, the tissues swell with the excess fluid. Your cells maintain a specific concentration gradient, so excess water outside the cells (the serum) draws sodium from within the cells out into the serum in an attempt to re-establish the necessary concentration. As more water accumulates, the serum sodium concentration drops -- a condition known as hyponatremia. The other way cells try to regain the electrolyte balance is for water outside the cells to rush into the cells via osmosis. The movement of water across a semipermeable membrane from higher to lower concentration is called osmosis. Although electrolytes are more concentrated inside the cells than outside, the water outside the cells is 'more concentrated' or 'less dilute' since it contains fewer electrolytes. Both electrolytes and water move across the cell membrane in an effort to balance concentration. Theoretically, cells could swell to the point of bursting.

From the cell's point of view, water intoxication produces the same effects as would result from drowning in fresh water. Electrolyte imbalance and tissue swelling can cause an irregular heartbeat, allow fluid to enter the lungs, and may cause fluttering eyelids. Swelling puts pressure on the brain and nerves, which can cause behaviors resembling alcohol intoxication. Swelling of brain tissues can cause seizures, coma and ultimately death unless water intake is restricted and a hypertonic saline (salt) solution is administered. If treatment is given before tissue swelling causes too much cellular damage, then a complete recovery can be expected within a few days.

### It's Not How Much You Drink, It's How Fast You Drink It!

The kidneys of a healthy adult can process fifteen liters of water a day! You are unlikely to suffer from water intoxication, even if you drink a lot of water, as long as you drink over time as opposed to intaking an enormous volume at one time. As a general guideline, most adults need about three quarts of fluid each day. Much of that water comes from food, so 8-12 eight ounce glasses a day is a common recommended intake. You may need more water if the weather is very warm or very dry, if you are exercising, or if you are taking certain medications. The bottom

line is this: it's possible to drink too much water, but unless you are running a marathon or an infant, water intoxication is a very uncommon condition.

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<http://www.fbnewsleader.com/articles/2006/07/29/sports/03greg.txt>

### **Too Much Water Can Be Deadly**

Q: What is water intoxication?

A: For years doctors have told athletes to drink water in order to avoid dehydration and to combat the potential of heat related illness. However, too much of anything can be detrimental, and water is no different. Drinking too much water can have very serious and even deadly effects.

The body's regular mechanism for cooling during exercise is to sweat. Sweating leads to not only the loss of water, but also the loss of salt from your system. When you replace only the water through oral intake, you further lower your relative salt concentration in your body, a condition called hyponatremia, but also known as water intoxication.

Initial symptoms of this include overt sweating, dizziness and fainting. Many often mistake these early symptoms for dehydration, when, in fact, it is just the opposite, over-hydration. Many physicians now recommend that you drink only when you are thirsty, while others suggest no more than eight ounces of fluid every 20 minutes.

Water intoxication can become life threatening because as the salt concentration continues to drop in the blood system, water moves from the small arteries and veins into the surrounding tissues, causing those cells to swell. Certain areas are not able to handle this local swelling, especially the brain. When the brain swells, referred to as cerebral edema, symptoms may include headache, confusion, nausea, vomiting and then seizures, and ultimately even death.

Some experts have noted that a marathoner who drinks a single cup of water at every mile of the race risks hyponatremia by mile 17. A study from The New England Journal of Medicine reported on nearly 500 runners during the Boston Marathon and found that 13 percent suffered from various forms of hyponatremia after the race.

Hyponatremia in athletics is not something that is widely known, and the first reported case was not until 1985 in ultra-marathoners who compete in 100-mile races. Since then there have been nine reported deaths from water intoxication in athletics.

Unfortunately, not only do many athletes fail to recognize this, but medical providers often can be fooled by the condition. If one is suffering from hyponatremia but treated for dehydration, the condition will only worsen. The difficult part is again that the symptoms closely resemble each other and initially they can look almost identical. One significant difference however may be related to the mental status, because athletes suffering from dehydration are typically conversant and aware of their surroundings, while those with hyponatremia often are relatively non-conversant, extremely confused and disoriented.

The number of cases of water intoxication in athletics has increased in frequency as the number of people taking place in marathons has increased as well. More people are running marathons than ever before, and many people are running their first marathon in their 40s, 50s and even

later stages of life. Over-hydration is most commonly seen in those first-time marathon runners or those very new to the sport. A higher incidence is also noted in women.

It is believed that first timers are more susceptible because they often take longer to complete the race, and therefore have more time to drink more during the course of the race. Correct treatment involves water restriction and electrolyte replenishment and, if needed, the infusion of hypertonic saline through intravenous administration, while monitoring blood chemistry levels.

This column is written to discuss issues regarding sports, medicine and safety. It is not intended to serve as a replacement for treatment by your regular doctor. It is only designed to offer guidelines on the prevention, recognition and care of injuries and illness. Specific concerns should be discussed with your physician. Mail your questions to Gregory Smith, M.D., Sports Medicine, 1250 S. 18th Street, Suite 204, Fernandina Beach, FL 32034. For appointments, call 261-8787 or visit [www.gsmithmd.com](http://www.gsmithmd.com).

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1 (b) Find an example of someone who died due to water intoxication.

<http://www.npr.org/templates/story/story.php?storyId=5012154>

### **A Fraternity Hazing Gone Wrong**

by Elaine Korry, NPR

All Things Considered, November 14, 2005

It's a parent's nightmare and a nagging fear for the people who run colleges and universities: A young fraternity pledge dies when hazing gets out of control. It's happened at least once each year for more than three decades. Nine months ago it happened at Chico State University in California, and this time prosecutors did something unusual: They filed felony criminal charges against the fraternity brothers involved.

But that's not much comfort to the family of Matthew Carrington, who died during the Feb. 2, 2005, hazing accident.

In his 22 years, Gabriel Maestretti has often been a role model: an altar boy, high school homecoming king and a volunteer coach. But in the past year he's also been called a "tormentor" and "a mean drunk." And earlier this month, he became something worse: a felon.

The Butte County courtroom of Judge Stephen Benson was awash in red, the color worn by family and friends of Matthew Carrington to honor him. Gabriel Maestretti, deeply religious as a boy, had never been in trouble before. Yet, according to the district attorney, he was the most culpable in Carrington's death. He stood before the judge, baby-faced, with the physique of a linebacker, choking back tears.

"I did what I did out of a misguided sense of building brotherhood, and instead I lost a brother. I will live with the consequences of hazing for the rest of my life," Maestretti told the court. "My actions killed a good person, and I will be a felon for the rest of my life, and I'll have to live with that disability, but I'm alive and Matt's not. "

Moments later, Maestretti and three of his fraternity brothers -- John Fickes, 20, Carlos Abrille, 22, and Jerry Lim, 25 -- were handcuffed and led off to jail.

Matthew Carrington would have turned 22 this month. He grew up with his younger brother in a small ranch-style house in Pleasant Hill, east of San Francisco. Debbie Smith has a giant portrait of her son on the fireplace mantle. Dozens of snapshots fill the coffee table and bookshelves.

"We did everything together as a family, so we have tons of pictures, and I have to have them out," she said. "I have this need to just be surrounded by him. I can't put him away."

Like a lot of moms, Debbie Smith says her son was destined for great things. But Carrington's plans weren't grandiose at all. He just wanted to graduate and get a good job, marry and have kids, his mother says. Now, she mourns the wedding she'll never attend, the grandchildren she'll never hold.

Boarded-up on the edge of campus is the Chi Tau fraternity house. From the outside, the white building doesn't look like a crime scene. The basement, says Chico Police detective Greg Keeney, the lead investigator on the case, is another story.

"It's kind of like the medieval castle dungeon," says Keeney. In February, at the time of Carrington's death, the dark and dirty basement would have been very cold, says Keeney. Repeatedly scribbled on the walls was the phrase, "In the basement, no one can hear you scream."

Carrington died during Chi Tau's "Hell Week." Junior fraternity brothers were in charge and were told to be tough on the pledges. Carrington was at the Chi Tau, located in Chico, Calif., north of Sacramento to support his friend, Mike Quintana. Both were sober, according to police reports.

The two pledges were ordered downstairs and told to do calisthenics in raw sewage that had leaked on the floor. For hours, according to district attorney Mike Ramsey, they were interrogated and taunted.

There were forced pushups and trivia quizzes. Through it all, the Carrington and Quintana were ordered to drink from a five-gallon jug of water, which was filled over and over. Fans blasted icy air on their wet bodies. They urinated and vomited on themselves. Then, according to DA Ramsey, something went terribly wrong.

Carrington collapsed and started a seizure. Fraternity members didn't initially call an ambulance. By the time they did, it was too late. Carrington was taken to Enloe Medical Center, where his heart stopped. At about 5 a.m. he was pronounced dead from water intoxication, which caused the swelling of his brain and lungs. Not a single fraternity brother was there, a fact that still haunts his mother.

"All I could think of was, 'Matt's alone. Nobody is with him... why is that?'" she said. Hours passed from the hospital's first call to Carrington's parents before they learned how he died.

Hazing is illegal in the majority of states, including California. But usually it's a misdemeanor offense that brings a slap on the wrist. Most colleges have banned hazing, and rogue Greek chapters have been suspended. But sometimes the strategy backfires. Hazing expert Hank Nuwer says once they're decertified, these chapters are accountable to no one.

"It's kind of like having unregulated gangs on campus, and yet it's a hidden problem that doesn't get discussed on the news a lot," says Nuwer.

It was a problem at Chico State. Chi Tau was among a handful of suspended fraternities that had been in trouble before. For now, the school has shut down all Greek recruitment. A task force is overhauling all the rules for student conduct. And University President Paul Zingg has threatened the ultimate punishment -- an outright ban on fraternities and sororities.

"They talk about integrity and scholarship and holy friendship forever," says Zingg. "And I basically said, if that's really what you believe in, you've got a respected place on this campus. But if you're nothing but drinking clubs masquerading as fraternities, you don't."

Fraternity members pass the now-defunct Chi Tau house everyday on their way to classes. It's a vivid reminder of Carrington's death.

"We're still dealing with it. Everybody's still kind of haunted by it," says Adam Cherry, a Chico State junior and a member of Sigma Pi, a fraternity which he says doesn't haze. He thinks it's only right that the defendants are in jail. But he resents being lumped together with the young men implicated in Carrington's death.

"This fraternity, Chi Tau, was not recognized by the school, not recognized by anybody. So basically they were just a bunch of guys with letters on their house," says Cherry.

There's a growing movement to toughen the penalties for hazing. Two states, New York and Florida, have done it already, and Carrington's parents say now it should be California's turn. They want hazing out of the education code and charged under the penal code, like other violent crimes. But even that's not enough, says Debbie Smith. Something else has to change: the mindset that considers hazing just part of college life.

"I understand that they didn't intend to kill Matt," she says. "My hope is that they learned something, that we all learned something, and that they can teach others from their experience so that we don't have to have this keep happening to our children."

It may be too late for Gabriel Maestretti, who will serve one year in jail. But he, too, wants to get the message out.

"I accept my punishment, with the hope that it will serve as a warning to others not to follow the path I did," he said during his sentencing. "Hazing isn't funny, it's not cute. It's stupid, dangerous. It's not about brotherhood, it's about power and control."

For other students, the message hasn't sunk in yet. Despite the trauma of Carrington's death, two more Greek organizations at Chico State have already been suspended for misconduct this semester.

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## 2 What makes something toxic?

[http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution\\_seeds.pdf](http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution_seeds.pdf)

One of the fundamental concepts of toxicology was stated by a 16th century Swiss physician and alchemist named Paracelsus (pronounced “para-SELL-suss”; his original name was Theophrastus Bombastus von Hohenheim) who basically said “The dose makes the poison.” In toxicology, dose is the amount of exposure to a potentially toxic substance, and depends upon the concentration of the substance, the duration of the exposure, and the size of the organism being exposed to the substance. The key implication of Paracelsus’ statement is that everything is poisonous if the dose is high enough. How an organism responds to a potentially toxic substance also depends upon the sensitivity of the organism to the substance (all substances are not equally toxic to all organisms) and the route of exposure (whether the substance is inhaled, absorbed through the skin, eaten, injected, etc.)

<http://en.wikipedia.org/wiki/Toxicology>

Toxicology (from the Greek words *toxicon* and *logos*) is the study of the adverse effects of chemicals on living organisms. It is the study of symptoms, mechanisms, treatments and detection of poisoning, especially the poisoning of people. The chief criterion regarding the toxicity of a chemical is the dose, i.e. the amount of exposure to the substance. Almost all substances are toxic under the right conditions. As Paracelsus, the father of modern toxicology said, “Sola dosis facit venenum” (only dose determines the poison). Paracelsus, who lived in the 16th century was the first person to explain the dose-response relationship of toxic substances.

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## 3 Scientists often report toxicity using the term LD<sub>50</sub>. What is LD<sub>50</sub>?

<http://en.wikipedia.org/wiki/LD50>

In toxicology, the LD<sub>50</sub> (abbreviation for "Lethal Dose, 50%") or median lethal dose of a poison or radiation is the dose required to kill half the members of a tested population. LD<sub>50</sub> figures are frequently used as a general indicator of a substance's toxicity. The test was created by J.W. Trevan in 1927.[1]

The term semilethal dose is occasionally used with the same meaning, particularly in translations from non-English-language texts, but can also refer to a sublethal dose; because of this ambiguity, it should generally be avoided.

MeSH (ID D007928) defines LD<sub>50</sub> as:

The dose amount of poisonous or toxic substance or dose of ionizing radiation required to kill 50% of the tested population.

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## 4 How toxic is methanol (methyl alcohol)?

<http://www.nlm.nih.gov/medlineplus/ency/article/002680.htm>

Methanol is highly toxic, and you must seek medical care at your nearest emergency room for any ingestion. As little as 2 tablespoonsful can be fatal to a child, and 2 to 8 oz. can be fatal for an adult. The ultimate outcome depends on how much was swallowed and how soon appropriate care was given.

[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)

Toxicological Information from Material Safety Data Sheet (MSDS):

Methyl Alcohol

- Acute effects: Poison, irritant, GI disturbances
  - Chronic effects: N.A. = Not available, not all health aspects of this substance have been fully investigated.
  - Target organs: Eyes, kidneys
  - ORL-RAT LD<sub>50</sub>: 5628 mg/kg
  - IHL-RAT LC<sub>50</sub>: 64000 ppm/4H
  - SKN-RBT LD<sub>50</sub>: 15800 mg/kg
- 

5 How toxic is ethanol (ethyl alcohol)?

[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)

Toxicological Information from Material Safety Data Sheet (MSDS)

Ethyl Alcohol

- Acute effects: Poison, irritant, nausea, dizziness and headache
- Chronic effects: N.A. = Not available, not all health aspects of this substance have been fully investigated.
- Target organs: Eyes, liver, kidneys, nerves
- ORL-RAT LD<sub>50</sub>: 7060 mg/Kg
- IHL-RAT LC<sub>50</sub>: 20000 ppm/10H
- SKN-RBT LD<sub>50</sub>: N.A. = Not available, not all health aspects of this substance have been fully investigated.

- 6 Methanol and ethanol are both metabolized into an aldehyde and then an organic acid. Why then is methanol more toxic than ethanol?

[http://en.wikipedia.org/wiki/Alcohol - Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)

Other alcohols are substantially more poisonous than ethanol, partly because they take much longer to be metabolized, and often their metabolism produces even more toxic substances. Methanol, or wood alcohol, for instance, is oxidized by alcohol dehydrogenase enzymes in the liver to the poisonous formaldehyde, which can cause blindness or death.

An effective treatment to prevent formaldehyde toxicity after methanol ingestion is to administer ethanol. Alcohol dehydrogenase has a higher affinity for ethanol, thus preventing methanol from binding and acting as a substrate. Any remaining methanol will then have time to be excreted through the kidneys. Remaining formaldehyde will be converted to formic acid and excreted.

[http://chemmovies.unl.edu/chem\\_source\\_pdf/ChemSource.html](http://chemmovies.unl.edu/chem_source_pdf/ChemSource.html)

Aldehydes are very easy to oxidize. The human body oxidizes acetaldehyde to acetic acid. If large quantities of alcohol are ingested, enough may be converted to acetaldehyde which is then oxidized to acetic acid to cause a drop in blood pH. If the pH drops far enough, enzymes necessary for vital functioning begin to precipitate and the individual dies of alcohol poisoning. One of the medical treatments for alcohol poisoning is to add sodium bicarbonate solution to the patient's bloodstream, helping to raise the pH back to normal levels because the bicarbonate anion is the conjugate base of a weak Brønsted-Lowry acid.

A similar reaction series occurs when methanol (wood alcohol) is ingested because alcohol dehydrogenase can also work on methanol. In this case, formaldehyde is produced by the dehydrogenation of methanol. Formaldehyde is quite reactive and reacts with just about any biomolecule that happens to be in the neighborhood when it is formed. For example, it is known to be a carcinogen, indicating that it can disrupt the cell's genetic machinery. Methanol ingestion, even in fairly small quantities, can lead to blindness, paralysis, and death. Patients who have ingested methanol are treated with ethanol because alcohol dehydrogenase reacts preferentially with ethanol. Maintaining a relatively high concentration of ethanol in the body pushes the equilibrium of the reaction in which enzyme-ethanol complex is formed to the right, effectively preventing oxidation of methanol into formaldehyde. Once analysis of the patient's urine indicates that methanol is no longer being excreted, then the ethanol treatment is removed.

(Page 34 Organic Chemistry (ORGN) ChemSource Version 1.0 1994)

- 7 Why does the treatment for methanol poisoning involve giving the patient ethanol?

[http://en.wikipedia.org/wiki/Alcohol - Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)

An effective treatment to prevent formaldehyde toxicity after methanol ingestion is to administer ethanol. Alcohol dehydrogenase (ADH) has a higher affinity for ethanol, thus preventing methanol from binding and acting as a substrate. Any remaining methanol will then have time to be excreted through the kidneys. Remaining formaldehyde will be converted to formic acid and excreted.

<http://www.emedicine.com/NEURO/topic217.htm>

Ethanol inhibits the toxic effects of methanol. Ethanol is believed to compete with methanol for ADH, thus preventing metabolism of methanol to its toxic by-products. By slowing degradation, it is assumed this prevents accumulation of high levels of formic acid.

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- 8 If someone is in danger of ethanol poisoning, what steps should be taken to reduce the chance of death?

[http://www.collegedrinkingprevention.gov/media/NI\\_AAA\\_Grad\\_Flyer\\_NEW.pdf](http://www.collegedrinkingprevention.gov/media/NI_AAA_Grad_Flyer_NEW.pdf)

### **A WORD ABOUT ALCOHOL POISONING...**

#### **What Should I Do?**

Know the danger signals. If you suspect someone has alcohol poisoning, don't wait for all the critical signs to be present. If you suspect an alcohol overdose, call 911 immediately for help.

<http://www.collegedrinkingprevention.gov/OtherAlcoholInformation/factsAboutAlcoholPoisoning.aspx>

#### **Critical Signs for Alcohol Poisoning**

- Mental confusion, stupor, coma, or person cannot be roused.
- Vomiting.
- Seizures.
- Slow breathing (fewer than eight breaths per minute).
- Irregular breathing (10 seconds or more between breaths).
- Hypothermia (low body temperature), bluish skin color, paleness.

#### **What Should I Do If I Suspect Someone Has Alcohol Poisoning?**

- Know the danger signals.
- Do not wait for all symptoms to be present.
- Be aware that a person who has passed out may die.

- If there is any suspicion of an alcohol overdose, call 911 for help. Don't try to guess the level of drunkenness.

### **What Can Happen to Someone With Alcohol Poisoning That Goes Untreated?**

- Victim chokes on his or her own vomit.
- Breathing slows, becomes irregular, or stops.
- Heart beats irregularly or stops.
- Hypothermia (low body temperature).
- Hypoglycemia (too little blood sugar) leads to seizures.
- Untreated severe dehydration from vomiting can cause seizures, permanent brain damage, or death.

Even if the victim survives, an alcohol overdose can lead to irreversible brain damage. Rapid binge drinking (which often happens on a bet or a dare) is especially dangerous because the victim can ingest a fatal dose before becoming unconscious.

Don't be afraid to seek medical help for a friend who has had too much to drink. Don't worry that your friend may become angry or embarrassed-remember, you cared enough to help. Always be safe, not sorry.

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9 (a) What is a Breathalyzer?

<http://en.wikipedia.org/wiki/Breathalyzer>

A breathalyzer (or breathalyser) is a device for estimating blood alcohol content (BAC) from a breath sample. "Breathalyzer" is the brand name of a model made by one manufacturer of these instruments (originally Smith and Wesson, later National Draeger), but has become a genericized trademark for all such instruments. Intoxilyzer, Intoximeter, Alcotest, Alcosensor and Datamaster are the other most common brand names in use today.

Though technologies for detecting alcohol vary, it's widely accepted that Dr. Robert Borkenstein (1912-2002), a captain with the Indiana State Police and later a professor of Indiana University at Bloomington, is regarded as the first to create a device that measures a subject's alcohol level based on a breath sample. In 1954, Borkenstein invented his breathalyzer, which used chemical oxidation and photometry to determine alcohol concentration. The invention of the breathalyzer provided law enforcement with a non-invasive test with immediate result reporting that can be used to determine an individual's level of intoxication. The various versions of the Breathalyzer were made by Smith and Wesson, the gun manufacturer, until the sale of the line to the German company National Draeger.

Breath analyzers don't directly measure blood alcohol content or concentration, which requires the analysis of a blood sample. Instead, they estimate BAC indirectly by measuring the amount of alcohol in one's breath. Three technologies are in use: evidentiary machines, used by police forces, which generally utilize infrared spectrophotometer technology; less accurate hand-held electrochemical fuel cell-based instruments, used by officers in the field

and commonly called PBT (preliminary breath test) or PAS (preliminary alcohol screening); and semiconductor oxide based testers, cheapest and least reliable but becoming increasingly popular for personal and professional testing applications.

9 (b) How does a Breathalyzer work?

<http://science.howstuffworks.com/breathalyzer2.htm>

### Principle of Testing

Alcohol that a person drinks shows up in the breath because it gets absorbed from the mouth, throat, stomach and intestines into the bloodstream.

Alcohol is not digested upon absorption, nor chemically changed in the bloodstream. As the blood goes through the lungs, some of the alcohol moves across the membranes of the lung's air sacs (alveoli) into the air, because alcohol will evaporate from a solution -- that is, it is volatile. The concentration of the alcohol in the alveolar air is related to the concentration of the alcohol in the blood. As the alcohol in the alveolar air is exhaled, it can be detected by the breath alcohol-testing device. Instead of having to draw a driver's blood to test his alcohol level, an officer can test the driver's breath on the spot and instantly know if there is a reason to arrest the driver.

Because the alcohol concentration in the breath is related to that in the blood, you can figure the BAC by measuring alcohol on the breath. The ratio of breath alcohol to blood alcohol is 2,100:1. This means that 2,100 milliliters (ml) of alveolar air will contain the same amount of alcohol as 1 ml of blood.

<http://science.howstuffworks.com/breathalyzer3.htm>

### How Breathalyzers Work

by Craig C. Freudenrich, Ph.D.

There are three major types of breath alcohol testing devices, and they're based on different principles:

- Breathalyzer - Uses a chemical reaction involving alcohol that produces a color change
- Intoxilyzer - Detects alcohol by infrared (IR) spectroscopy
- Alcosensor III or IV - Detects a chemical reaction of alcohol in a fuel cell

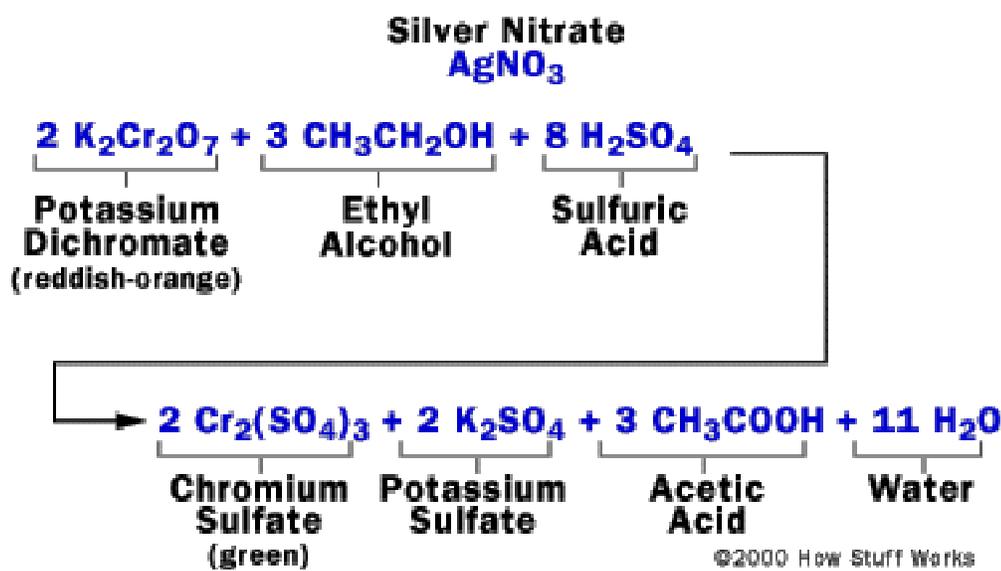
Regardless of the type, each device has a mouthpiece, a tube through which the suspect blows air, and a sample chamber where the air goes. The rest of the device varies with the type.

The Breathalyzer device contains:

- A system to sample the breath of the suspect
- Two glass vials containing the chemical reaction mixture
- A system of photocells connected to a meter to measure the color change associated with the chemical reaction

To measure alcohol, a suspect breathes into the device. The breath sample is bubbled in one vial through a mixture of sulfuric acid, potassium dichromate, silver nitrate and water.

The principle of the measurement is based on the following chemical reaction:



In this reaction:

1. The sulfuric acid removes the alcohol from the air into a liquid solution.
2. The alcohol reacts with potassium dichromate to produce:
  - chromium sulfate
  - potassium sulfate
  - acetic acid
  - water

The silver nitrate is a catalyst, a substance that makes a reaction go faster without participating in it. The sulfuric acid, in addition to removing the alcohol from the air, also might provide the acidic condition needed for this reaction.

During this reaction, the reddish-orange dichromate ion changes color to the green chromium ion when it reacts with the alcohol; the degree of the color change is directly related to the level of alcohol in the expelled air. To determine the amount of alcohol in that air, the reacted mixture is compared to a vial of unreacted mixture in the photocell system, which produces an electric current that causes the needle in the meter to move from its resting place. The operator then rotates a knob to bring the needle back to the resting place and reads the level of alcohol from the knob.

- 10 Reliability is reproducibility of multiple measurements free from random error which in this case would mean if the test were repeated several times with the same subject, would the readings be the same?

Accuracy is how close a measurement comes to the true value which in this case is the blood alcohol concentration (BAC).

How reliable is a Breathalyzer? How accurate is a Breathalyzer?

<http://en.wikipedia.org/wiki/Breathalyzer>

A major problem with some machines is that they not only identify the ethyl alcohol (or ethanol) found in alcohol beverages, but also other substances similar in molecular structure. Those machines identify any compound containing the methyl group structure. Over one hundred compounds can be found in the human breath at any one time and 70 to 80 percent of them contain methyl group structure and will be incorrectly detected as ethyl alcohol. Importantly, the more different ethyl group substances the machine detects, the higher the false BAC estimate will be.

The National Highway Traffic Safety Administration (NHTSA) has found that dieters and diabetics can have acetone levels hundreds and even thousand of times higher than those in others. Acetone is one of the many substances that can be falsely identified as ethyl alcohol by some breath machines.

Substances in the environment can also lead to false BAC readings. For example, an alcohol-free subject was asked to apply a pint of contact cement to a piece of plywood and then to apply a gallon of oil-base paint to a wall. The total activity lasted about an hour. Twenty minutes later the subject was tested on an Intoxilyzer, which registered a BAC of .12 percent. This level is 50% higher than a BAC of .08, which constitutes legal intoxication.

Any number of other products found in the environment can cause erroneous BAC results. These include compounds found in lacquers, paint removers, celluloid, gasoline, and cleaning fluids. Other common things that can cause false BAC levels are alcohol, blood or vomit in the subject's mouth, electrical interference from cell phones and police radios, tobacco smoke, dirt, and moisture.

Breath testers can be very sensitive to temperature and will give false readings if not adjusted or recalibrated to account for ambient or surrounding air temperatures. The temperature of the subject is also very important. Each one Fahrenheit degree of body temperature above normal will cause a substantial elevation (about 8%) in apparent BAC.

On the other hand, products such as mouthwash or breath spray can "fool" breath machines by significantly raising test results. Listerine, for example, contains 27% alcohol; because the breath machine will assume the alcohol is coming from alcohol in the blood diffusing into the lung rather than directly from the mouth, it will apply a "partition ratio" of 2100:1 in computing blood alcohol concentration -- resulting in a false high test reading.

This was clearly illustrated in a study conducted with Listerine mouthwash on a breath machine and reported in an article entitled "Field Sobriety Testing: Intoxilyzers and Listerine Antiseptic", published in the July 1985 issue of The Police Chief (page 70). Seven individuals were tested at a police station, with readings of .00%. Each then rinsed his mouth with 20 milliliters of Listerine mouthwash for 30 seconds in accordance with directions on the label. All seven were then tested on the machine at intervals of one, three, five and ten minutes.

The results indicated an average reading of .43% blood-alcohol concentration -- indicating a level that, if accurate, approaches lethal proportions. After three minutes, the average level was

still .20%, despite the absence of any alcohol in the system. Even after five minutes, the average level was .11% -- well over the legal limit.

In another study, reported in 8(22) Drinking/Driving Law Letter 1, a scientist tested the effects of Binaca breath spray on an Intoxilyzer 5000. He performed 23 tests with subjects who sprayed their throats, and obtained readings as high as .81% -- far beyond lethal levels. The scientist also noted that the effects of the spray did not fall below detectable levels until after 18 minutes.

[http://www.ncdd.com/dsp\\_article\\_details.cfm?article=2](http://www.ncdd.com/dsp_article_details.cfm?article=2)

At least one court has even reversed DUI convictions on the grounds that breath tests are inherently unreliable. In *State v. McGinley*, 550 A.2d 1305 (N.J. Super. 1988), the New Jersey Superior court, Law Division, considered the consolidated appeals of four defendants whose convictions involved Breathalyzer tests. Although noting that the New Jersey Superior Court had essentially taken judicial notice that the Breathalyzer models "900 and 900A are scientifically reliable," the court nevertheless felt free to consider new scientific evidence not previously available — evidence based in large part on the work of Dr. Kurt Dubowski:

The scientific evidence upon which the defendants rely shows the following:

1. The breathalyzer is designed to test persons having a 2100/1 blood-breath ratio. Such ratios in fact vary from 1100/1 to 3200/1 and the variance can produce erroneous test results. High readings are produced in 14% of the population.
2. The temperature of the machine itself varies, affecting test results.
3. Body temperatures vary, affecting test results.
4. Hematocrit (the solid particles in whole blood) levels vary, particularly between males and females, affecting test results. These sources of error make breathalyzer test results suspect and, to insure reliability, require the substantial reduction of blood-alcohol percentages based on a translation of those results. The leading expert in the field, recognized as such by both State and defense, is of the opinion that the reduction should be .055. [1350 A.2d at 1306.]

Dr. Dubowski has long advocated strict procedures for minimizing the many sources of error in breath testing. In a recent article entitled *Quality Assurance in Breath-Alcohol Analysis*, 18 *Journals of Analytical Toxicology* 306 (October 1994), he identified four "necessary safeguards" for breath testing:

1. A pre-test deprivation-observation period of at least 15 minutes (set the discussion of mouth alcohol in 8.1.4);
2. Blank tests immediately preceding each breath specimen collection step;
3. Analysis of at least two separate consecutive breath specimens, taken two to ten minutes apart (different results from duplicate analysis may indicate such problems as ratio frequency interference; see 8.1.9);
4. An appropriate control test accompanying every subject test (see 8.1.9 for a discussion of calibration using a simulator).

Due largely to the inherent unreliability of breath analysis, the National Safety Council Committee on Alcohol and Other Drugs has recommended that at least two separate breath samples be collected and analyzed individually. As reported in a letter from Dr. Dubowski published in 9 *American Journal of Forensic Medical Pathology* 272 (1988), the Committee further recommended that the breath samples be collected at intervals of at least two and not

more than ten minutes. This process of duplicate analysis has been widely advocated by experts in the past, most notably (and vociferously) by Dr. Richard Jensen.

<http://www.bookrags.com/other/drugs/breathalyzer-dat-01.html>

Because Breathalyzer test results serve as powerful evidence, defendants and their lawyers often obtain experts who question the way the test was administered and the reliability of the Breathalyzer machine itself. If the Breathalyzer machine has not received proper and timely maintenance, this information can be used to cause a jury to have a reasonable doubt about the accuracy of the results. This failure has led to an acquittal (failure to convict) in a number of trials.

In recent years, schools have begun to use the Breathalyzer breath-test machine as well. Some schools now use Breathalyzers at school functions such as proms to bar entrance to students whose test results show that they have blood alcohol levels above the legal limit. Such use of the Breathalyzer is controversial. Some students and others see this use as an infringement on students' rights; others see it as a way to save lives and to discourage the use of alcohol among minors.

Published: June 29, 2006 ROCKFORD REGISTER STAR Local News: Rockford

## **Civil Suit Filed For Alcohol Death**

**By Mike Wiser**

ROCKFORD — The family of a 13-year-old boy who died of alcohol poisoning two summers ago filed a civil suit Wednesday afternoon against the boy's cousin and two of the cousin's friends.

The lawsuit, which seeks more than \$50,000 in damages, claims Todd Trosper, Jared Hooks and David Dwyer were negligent and caused the death of 13-year-old Blake Barrone on July 4, 2003.

Barrone died after drinking beer and rum with Trosper, then 19, and Trosper's friends, Hook, then 18, and Dwyer, then 19, at Trosper's home while Barrone's parents were camping for the holiday weekend. Rodney Kimes, a Beloit attorney who filed the suit on behalf of the family, said the decision to file the suit was difficult.

He read a statement provided to him by the family which they said "The family of Blake Barrone wants the defendants, Todd Trosper, David Dwyer and Jared Hook, to be held accountable."

The suit claims that Trosper, Dwyer and Hook took an unconscious Barrone to Barrone's home even though they knew no one was there, and they "negligently and carelessly delayed seeking medical attention" for the boy.

The suit is also seeking funeral and hospitalization costs.

The Winnebago County State's Attorney's office brought endangering the life or health of a child and providing alcohol to a minor charges against Trosper, Hook and Dwyer in 2004.

A fourth man, Chase Kennedy, who bought the alcohol, also was charged with providing alcohol to minors. Kennedy pleaded guilty in May 2005. He received a 90-day suspended sentence, 60 hours of community service, had to pay court costs and agreed to testify in the cases of Trosper, Hook and Dwyer. He is not named in the civil suit.

Dwyer pleaded guilty in September 2005 to giving or selling alcohol to a minor, a Class 4 felony. In exchange for the plea, his other charges were dropped. He was sentenced to 30 months of probation and 40 hours of community service.

His agreement also stipulated that he had to make an apology to Barrone's parents, and participate in a public-service announcement regarding binge drinking.

Trosper's case went to a Winnebago County jury in December, when he was found not guilty. He faced up to 10 years in prison.

The statute of limitations on a wrongful-death civil suit is two years, which is why the family filed this week even though Hook's case has yet to go to trial, Kimes said. "Only time will tell whether we go to a jury," Kimes said. "There is a jury demand, and we are prepared to do that if need be."

## Sample Answers To Questions With References

- 1 (a) Can someone die of water intoxication (drinking too much water)?

<http://chemistry.about.com/cs/5/f/blwaterintox.htm>

<http://www.fbnewsleader.com/articles/2006/07/29/sports/03greg.txt>

**Yes, due to electrolyte imbalance and tissue swelling of the brain, which can result in seizures, coma and ultimately death unless water intake is restricted and a hypertonic saline solution is administered.**

**Search Tip:** use quotation marks and search “water intoxication”

- (b) Find an example of someone who died due to water intoxication.

<http://www.npr.org/templates/story/story.php?storyId=5012154>

**Student Matthew Carrington, 21, died from water intoxication, which caused the swelling of his brain and lungs on Feb. 2, 2005 after a night of hazing.**

**Search Tip:** use quotation marks and search “water intoxication” and death

- 2 What makes something toxic?

[http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution\\_seeds.pdf](http://www.oceanservice.noaa.gov/education/kits/pollution/lessons/pollution_seeds.pdf)

<http://en.wikipedia.org/wiki/Toxicology>

**All substances are poisons;  
there is none that is not a poison.  
The right dose  
differentiates a poison and a remedy.**

**Paracelsus (1493-1541)**

**The dose makes the poison. Any chemical can cause poisoning if a sufficient dose is taken into the body. Dose is usually measured as milligrams of toxicant per kilogram of body weight = mg/kg**

**Search Tip:** use toxicology and/or poison in your search string

- 3 Scientists often report toxicity using the term LD<sub>50</sub>. What is LD<sub>50</sub>?  
<http://en.wikipedia.org/wiki/LD50>

**LD refers to "Lethal Dose" and the 50 refers to the dose of toxicant, given all at once, which is deadly to 50% of the population.**

**Search Tip:** use LD<sub>50</sub>

- 4 How toxic is methanol (methyl alcohol)?  
<http://www.nlm.nih.gov/medlineplus/ency/article/002680.htm>  
[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)

**“Methanol is extremely toxic. As little as 2 tablespoonfuls can be fatal to a child, and 2 to 8 oz. can be fatal for an adult.”**

**ORL-RAT LD<sub>50</sub>: 5628 mg/kg**

**Search Tip:** using some combination of search words that include LD<sub>50</sub> or toxicity and methanol or methyl alcohol

- 5 How toxic is ethanol (ethyl alcohol)?  
[http://www.flinnsci.com/search\\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp)

**Ethanol has a relatively low toxicity and is often used as a solvent for medical drugs.**

**ORL-RAT LD<sub>50</sub>: 7060 mg/Kg**

**Search Tip:** using some combination of search words that include LD<sub>50</sub> or toxicity and ethanol or ethyl alcohol

**EXTRA:** If ethanol is so much less toxic than methanol, why don't the LD<sub>50</sub> values show this? Answer: Rat physiology is different than human physiology.

- 6 Methanol and ethanol are both metabolized into an aldehyde and then an organic acid. Why then is methanol more toxic than ethanol?

[http://en.wikipedia.org/wiki/Alcohol - Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)  
[http://chemmovies.unl.edu/chem\\_source\\_pdf/ChemSource.html](http://chemmovies.unl.edu/chem_source_pdf/ChemSource.html) (Organic)

**The answer is partly because ethanol takes longer to metabolize than methanol and partly because the aldehyde and organic acid formed from methanol are more toxic substances than those formed from ethanol.**

**Search Tip:** use the words alcohol metabolism

- 7 Why does the treatment for methanol poisoning involve giving the patient ethanol?

[http://en.wikipedia.org/wiki/Alcohol - Toxicity](http://en.wikipedia.org/wiki/Alcohol_-_Toxicity)  
<http://www.emedicine.com/NEURO/topic217.htm>

**Ethanol is administered when methanol poisoning occurs because alcohol dehydrogenase has a higher affinity for ethanol and preferentially reacts with the enzyme allowing the methanol time to be excreted through the kidneys without being metabolized into formaldehyde and formic acid. Once the urine is methanol free, then ethanol no longer needs to be administered.**

**Search Tip:** treatment methanol poisoning

- 8 If someone is in danger of ethanol poisoning, what steps should be taken to reduce the chance of death?

[http://www.collegedrinkprevention.gov/media/NI\\_AAA\\_Grad\\_Flyer\\_NEW.pdf](http://www.collegedrinkprevention.gov/media/NI_AAA_Grad_Flyer_NEW.pdf)  
<http://www.collegedrinkprevention.gov/OtherAlcoholInformation/factsAboutAlcoholPoisoning.aspx>

**If you suspect someone has alcohol poisoning, don't wait for all the critical signs to be present. Put them in the recovery position\* and, call 911 immediately for help. Don't try to guess the level of drunkenness.**

**\* Recovery Position:**

- **Turn victim onto their side.**
- **Lift chin forward in open airway position and adjust hand under the cheek as necessary.**
- **Check that victim cannot roll forwards or backwards.**
- **Monitor breathing and pulse continuously.**
- **If injuries allow, turn the victim to the other side after 30 minutes.**

**Search Tip:** search "alcohol poisoning"

- 9 (a) What is a Breathalyzer?

<http://en.wikipedia.org/wiki/Breathalyzer>

**A breathalyzer is a generic name for a device used to estimate blood alcohol content (BAC) levels by taking a sample of breath.**

**Search Tip:** Breathalyzer

- 9 (b) How does a Breathalyzer work?

<http://science.howstuffworks.com/breathalyzer2.htm>

<http://science.howstuffworks.com/breathalyzer3.htm>

**The alcohol concentration in the breath is related to that in the blood. The alcohol concentration in blood is 2100 times greater than the alcohol concentration in the breath. The breathalyzer uses a chemical reaction with the chromium ion and alcohol that produces a color change. The color change is then read by a spectrophotometer and used to estimate the blood alcohol level.**

**Search Tip:** Breathalyzer works

- 10 Reliability is reproducibility of multiple measurements free from random error which in this case would mean if the test were repeated several times with the same subject, would the readings be the same?  
Accuracy is how close a measurement comes to the true value which in this case is the blood alcohol concentration (BAC).

How reliable is a Breathalyzer? How accurate is a Breathalyzer?

[http://www.ncdd.com/dsp\\_article\\_details.cfm?article=2](http://www.ncdd.com/dsp_article_details.cfm?article=2)

<http://www.bookrags.com/other/drugs/breathalyzer-dat-01.html>

**If the breathalyzer is properly maintained and calibrated, and the operator is using proper protocols, it does seem to be reliable but there are many reasonable doubts concerning the accuracy of the machine. Research has shown that breath tests can vary 15% from actual blood alcohol concentration and even more in some populations such as diabetics.**

**Reliability is reproducibility of multiple measurements free from random error which in this case would mean if the test were repeated several times with the same subject, would the readings be the same.**

**Accuracy is how close a measurement comes to the true value which in this case is the blood alcohol concentration (BAC).**

**Search Tip:** Breathalyzer reliability

## Day 2: Molecular Modeling Activity (40 minutes)

Students will be doing a molecular modeling activity, **Alcohols, Aldehydes and Organic Acids in 3-D**. You should spend about 20 minutes of class time on the “introduction” to make sure that everyone understands, and then spend 25 minutes constructing the models.

Be sure to have students build the alcohol model first and then either remove hydrogen or add oxygen to form each of the oxidized products. Allow time for students to compare their answers with those of their neighbors and ask you for help if they are having trouble.

The curricular ties related to this activity are shown below.

- Functional groups are groups of a few atoms that impart distinctive physical and chemical properties to organic compounds. Students should learn to recognize and name a few important functional groups and the focus should be placed on the chemical similarity that functional groups show.
- Alcohols, aldehydes and organic acids have common names and IUPAC names. Monohydroxy alcohols have the hydroxyl functional group (-OH) in place of a hydrogen and are named as an alkane except the final “e” is replaced with “ol”. Aldehydes are named as an alkane except the final “e” is replaced with “al”. Organic acids are named as an alkane except the final “e” is replaced with “oic” and the separate word acid is also added.

- Aldehydes have the functional group  $\begin{array}{c} \text{O} \\ || \\ -\text{C}-\text{H} \end{array}$

- Organic acids have the functional group  $\begin{array}{c} \text{O} \\ || \\ -\text{C}-\text{OH} \end{array}$

- Organic oxidation reactions involve either adding oxygen or removing hydrogen. Mild oxidation of a primary alcohol produces an aldehyde as the organic product. Mild oxidation of an aldehyde produces an acid as the organic product.
- Students should be able to classify certain organic compounds based on structural or condensed structural formula.
- Students should be able to draw a structural formula with the functional group(s) on a straight chain hydrocarbon backbone, when given the IUPAC name for the compound.
- Students should be able to use molecular models to identify and explain common organic reactions.

## Alcohols, Aldehydes and Organic Acids in 3-D

### Introduction:

Molecules of alcohols, aldehydes and organic acids all have characteristic functional groups. Functional groups are groups of a few atoms that impart distinctive physical and chemical properties to organic compounds.

Alcohols, aldehydes and organic acids have common names and International Union of Pure and Applied Chemistry (IUPAC) names. Chemists prefer the IUPAC name for compounds because it is systematic as well as easily adaptable to new compounds.

Monohydroxy alcohols have the alcohol functional group (-OH) in place of a hydrogen and are named as an alkane except the final "e" is replaced with "ol".

Aldehydes are named as an alkane except the final "e" is replaced with "al". Organic acids are named as an alkane except the final "e" is replaced with "oic" and the separate word acid is also added. IUPAC names are shown on worksheet along with a common name.

Atoms, bonds and molecules can be represented in various ways. Each method has its advantages and drawbacks. Molecules can be represented by condensed structural formulas and structural formulas but these two dimensional models have their limits. Ball-and-stick models show the three dimensional structure and geometry of the molecule. In ball-and-stick models, a ball represents an atom while a stick represents a covalent bond between two atoms. Since physical, biological and chemical properties of molecules are often determined by their structure or geometry, building these models makes it easier to visualize molecule's shapes.

Purpose:

To construct and compare three-dimensional models with structural formulas of simple alcohols and their metabolized (oxidized) aldehyde and further metabolized (oxidized) organic acid.

Materials:

safety goggles (if activity is being done in the laboratory)

ball-and-stick molecular model kits

Procedure:

Build the models, show a structural formula of the three-dimensional ball-and-stick molecules and a sketch and then answer the questions.

Condensed Structural Formula	CH <sub>3</sub> OH	H <sub>2</sub> CO	HCOOH
Structural Formula			
Sketch of 3-D Model			
IUPAC Name	methanol	methanal	methanoic acid
Common Name	methyl alcohol	formaldehyde	formic acid

The Table on this page shows the metabolized (oxidized) methanol and aldehyde and the further metabolized (oxidized) organic acid it forms in the body.

CH <sub>3</sub> CO			ethanoic
			acetic

<p>The Table on this page shows ethanol and the metabolized (oxidized) aldehyde and the further metabolized (oxidized) organic acid it forms in the body.</p>				
Condensed Structural Formula	$\text{CH}_3\text{CH}_2\text{OH}$	$\text{CH}_3\text{CHO}$		
Structural Formula				
Sketch of 3-D Model				
IUPAC Name	ethanol	ethanal		
Common Name	ethyl alcohol	acetaldehyde		

1. Identify the functional group in each of the following molecules:

- |                                   |  |
|-----------------------------------|--|
| A) $\text{CH}_3\text{OH}$ _____   | D) $\text{CH}_3\text{CH}_2\text{OH}$ _____ |
| B) $\text{CH}_3\text{CHO}$ _____  | E) $\text{H}_2\text{CO}$ _____             |
| C) $\text{CH}_3\text{COOH}$ _____ | F) $\text{HCOOH}$ _____                    |

2. Write the IUPAC name for each of the following molecules:

- |                                   |  |
|-----------------------------------|--|
| A) $\text{CH}_3\text{OH}$ _____   | D) $\text{CH}_3\text{CH}_2\text{OH}$ _____ |
| B) $\text{CH}_3\text{CHO}$ _____  | E) $\text{HCHO}$ _____                     |
| C) $\text{CH}_3\text{COOH}$ _____ | F) $\text{HCOOH}$ _____                    |

3. One way to recognize organic oxidation is to compare the carbon containing compound before oxidation to the carbon containing compound that results from the oxidation. If there is a loss of hydrogen or the addition of oxygen to the product, then oxidation has occurred.

A) When ethanol is metabolized to ethanal, oxidation occurs. Provide evidence to verify this statement.

\_\_\_\_\_

B) When ethanal is metabolized to ethanoic acid, does oxidation occur? \_\_\_\_\_

Provide evidence to support your answer.

\_\_\_\_\_

\_\_\_\_\_

## Sample Answer Key for Teacher Reference:

1. Identify the functional group in each of the following molecules:

- |    |                      |                       |    |                                    |                       |
|----|----------------------|-----------------------|----|------------------------------------|-----------------------|
| A) | CH <sub>3</sub> OH   | <u>alcohol</u>        | D) | CH <sub>3</sub> CH <sub>2</sub> OH | <u>alcohol</u>        |
| B) | CH <sub>3</sub> CHO  | <u>aldehyde</u>       | E) | H <sub>2</sub> CO                  | <u>aldehyde</u>       |
| C) | CH <sub>3</sub> COOH | <u>(organic) acid</u> | F) | HCOOH                              | <u>(organic) acid</u> |

2. Write the IUPAC name for each of the following molecules:

- |    |                      |                      |    |                                    |                       |
|----|----------------------|----------------------|----|------------------------------------|-----------------------|
| A) | CH <sub>3</sub> OH   | <u>methanol</u>      | D) | CH <sub>3</sub> CH <sub>2</sub> OH | <u>ethanol</u>        |
| B) | CH <sub>3</sub> CHO  | <u>ethanal</u>       | E) | HCHO                               | <u>methanal</u>       |
| C) | CH <sub>3</sub> COOH | <u>ethanoic acid</u> | F) | HCOOH                              | <u>methanoic acid</u> |

3. One way to recognize organic oxidation is to compare the carbon containing compound before oxidation to the carbon containing compound that results from the oxidation. If there is a loss of hydrogen or the addition of oxygen to the product, then oxidation has occurred.

A) When ethanol is metabolized to ethanal, oxidation occurs. Provide evidence to verify this statement.

**CH<sub>3</sub>CHO has lost two hydrogen from the CH<sub>3</sub>CH<sub>2</sub>OH.**

B) When ethanal is metabolized to ethanoic acid, does oxidation occur? Yes

Provide evidence to support your answer.

**CH<sub>3</sub>COOH has an added oxygen from CH<sub>3</sub>CHO.**

## **Day 3: Preparing for Presentation (45 minutes)**

### **1. Assign students to new groups to share information (15 minutes)**

1. Use the information below to assign students to new cooperative learning groups of four students (paired students from the Web Quest activity are not to be in the same group). (See <http://edtech.kennesaw.edu/intech/cooperativelearning.htm> for information on cooperative learning)

The assigned groups would be similar to the following:

Group A: one student from Pair #1, #2, #3, and #4  
Group B: one student from Pair #5, #6, #7, and #8  
Group C: one student from Pair #1, #6, #3, and #8  
Group D: one student from Pair #5, #2, #7, and #4  
Group E: one student from Pair #9, #10, #11, and #12  
Group F: one student from Pair #9, #10, #11, and #12

2. During the Web Quest, each student pair answered only 5 of the 10 questions. This new grouping allows groups of four students to share information from their Web Quest research and to seek information needed to answer all of these questions.
3. Students should work in their groups to:
  - Compare and reach consensus on the correct answer for each question on the Web Quest.
  - Be certain that each student has recorded answers to all of the Web Quest questions.

### **2. Web Quest pairs prepare for Board of Education presentation (30 min)**

1. Class members need to prepare a Board of Education presentation. Ask students to return to work with their Web Quest partner to prepare for their part in the Board of Education presentation.
2. Assign each pair of students to prepare a **2 minute** presentation on **one** of these possible topics:
  - The answer to one or two assigned questions from the Web Quest.
  - Support the Board's proposed use of Breathalyzers and provide rationale for this position.
  - Disagree with the Board's proposed use of Breathalyzers and provide rationale for this position.
  - Suggest other actions the Board of Education could take to curb the student drinking problem.
3. Encourage students to make their presentation more interesting and effective by preparing a PowerPoint, a poster, or a role-play scenario.

#### **Day 4: Presentations (45 minutes)**

Student pairs should make their presentation to the class. After doing this activity, it is hoped that students will learn some organic chemistry and become aware of the danger of drinking anything to excess especially the problem of binge drinking. It is also hoped that the terms precision and accuracy will be more meaningful to students.

## Scoring Rubrics

### Rubric For Answers to Internet Research Questions:

- 4 points Complete and addresses all the questions assigned
- 3 points Complete but either fails to address the question or contains an error
- 2 points Incomplete because Internet reference is missing
- 1 points Incomplete because not all assigned questions were answered
- 0 points Most questions were not addressed or question were left blank

### Presentation Rubric:

- 4 points Completely true
- 3 points Generally true
- 2 points True some of the time
- 1 point Not true most of the time
- 0 points Not true at all

\_\_\_\_\_ Position is well explained.

\_\_\_\_\_ Evidence supports the position.

\_\_\_\_\_ Presentation appeared well prepared.

\_\_\_\_\_ Presentation is concise.

\_\_\_\_\_ Evidence technology was used to support their position.

\_\_\_\_\_ Evidence that both members of the team contributed to the presentation.

# New York State Learning Standards

## STANDARD 1 - Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

### Key Idea 1:

The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

S1.1 Elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent thinking.

- use theories and/or models to represent and explain observations
- use theories and/or principles to make predictions about natural phenomena
- develop models to explain observations
- 

S1.2 Hone ideas through reasoning, library research, and discussion with others, including experts.

- locate data from published sources to support/defend/explain patterns observed in natural phenomena
- 

S1.3 Work towards reconciling competing explanations, clarifying points of agreement and disagreement.

- evaluate the merits of various scientific theories and indicate why one theory was accepted over another

### Key Idea 2:

Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

S2.2 Refine research ideas through library investigations, including information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.

## STANDARD 2 - Information Systems

Students will access, generate, process, and transfer information using appropriate technologies.

### Key Idea 1:

Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

Examples include:

- use the Internet as a source to retrieve information for classroom use

**Key Idea 2:**

Knowledge of the impacts and limitations of information systems is essential to its effectiveness and ethical use.

Examples include:

- critically assess the value of information with or without benefit of scientific backing and supporting data, and evaluate the effect such information could have on public judgment or opinion, e.g., environmental issues

**STANDARD 7 - Interdisciplinary Problem Solving**

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

**Key Idea 1:**

The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision-making, design, and inquiry into phenomena.

1.1 Analyze science/technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action.

- carry out a remedial course of action by communicating the plan to others, e.g., writing and sending “a letter to the editor”

**Key Idea 2:**

Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

If students are asked to do a project, then the project would require students to:

- work effectively
- gather and process information
- generate and analyze ideas
- observe common themes
- realize ideas
- present results

**Process Skills****Key Idea 3:**

Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

**3.1** Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.

xvii classify an organic compound based on its structural or condensed structural formula

xx draw a structural formula with the functional group(s) on a straight chain hydrocarbon backbone, when given the IUPAC name for the compound

- 3.2 Use atomic and molecular models to explain common chemical reactions.
  - ii identify types of chemical reactions
  - iv identify organic reactions
- 3.3 Apply the principle of conservation of mass to chemical reactions.
  - iii create and use models of particles to demonstrate balanced equations

## **Chemistry Core Topics - Appendix A**

### **VII. Organic Chemistry**

- VII.1** Organic compounds contain carbon atoms which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system. (3.1ff)
- VII.3** Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic molecules that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds. (3.1hh)