

Chemistry of Cleaning: Collaborative Research Projects

Based on California State Standards in Chemistry

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Context for Learning

- General Chemistry 9th and 10th grade
- Class size: 17-30
- ELL students in class: 3%
- Students with IEPs: 5%
- College-bound students
- Non-science majors

Surfactant Research

- Patrick Stenger in Joe Zasadzinski's lab (Chemical Engineering)
- Studied effects of albumin concentration on lung surfactant ability to modify surface pressure
- Every day use of surfactants to give students context for learning principles of chemistry
- Three collaborative research projects on cleaning agents (most are surfactants) resulting in a board game, website, and a documentary

Translating research into classroom

- Using surfactant research knowledge, creating a collaborative curriculum project that has a real-life context
- Fundamentals of chemistry can be learned by studying everyday products such as toothpaste and shampoo
- Combines hands-on activities, DRTA, and collaboration

Overview

- Part I: Board game
 - Atomic and molecular structure
 - Chemical bonds
- Part II: Website and On-line Trivia
 - Include information learned in Part I
 - Conservation of Matter and Stoichiometry
 - Acids and Bases
- Part III: Scientific Documentary
 - Include information learned in Part I and II
 - Solutions
 - Organic Chemistry and Biochemistry

Research: websites

Chemi	Descriptio	Websites
General Surfactant Informatio n	Surfactants are surface acting agents that reduce surface tension in water and other liquids	<p>http://www.ukrnarinesac.org.uk/activities/water-quality/wq8_46.htm</p> <p>http://hwb.unl.edu/Teacher/NSF/CO1/CO1Links/www.tigerchem.com/surf.html#SURF</p> <p>http://www.chemistry.co.nz/surfactants.htm</p> <p>FIRP Booklet #E300-A: Surfactants Types and Uses Journal of Chemical Education Vol.79 No.3 March 2002 JChemEd.wisc.edu</p> <p>http://en.wikipedia.org/wiki/Surfactant</p> <p>http://en.wikipedia.org/wiki/Benzalkonium_chloride</p> <p>http://en.wikipedia.org/wiki/Bronidox</p> <p>http://en.wikipedia.org/wiki/Cetyl_alcohol</p> <p>http://en.wikipedia.org/wiki/Cocamide_DEA</p> <p>http://en.wikipedia.org/wiki/Cocamide_MEA</p> <p>http://en.wikipedia.org/wiki/Cocamide_TEA</p> <p>http://en.wikipedia.org/wiki/Cocamidopropyl_betaine</p> <p>http://en.wikipedia.org/wiki/Dimethyldioctadecylammonium_chloride</p> <p>http://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=chem&id=1000</p> <p>http://en.wikipedia.org/wiki/Hexadecyltrimethylammonium_bromide</p> <p>http://en.wikipedia.org/wiki/hydroxysultaine</p> <p>http://en.wikipedia.org/wiki/Nonoxynol-9 (spermicide)</p> <p>http://en.wikipedia.org/wiki/Oleyl_alcohol (used in mascara)</p> <p>http://www.cleaning101.com/house/fact/houseclean5.cfm</p>

Research websites continued

Chemi	Descriptio	Websites
Laundry Detergent	A type of detergent used to get laundry cleaner	<p> http://en.wikipedia.org/wiki/Laundry_detergent http://sci-toys.com/ingredients/detergents.html http://www.chemistry.co.nz/detergentshistory.htm http://www.chemistry.co.nz/deterginfo.htm http://inventors.about.com/library/inventors/blsoap.htm http://www.cleaning101.com/sdalatest/html/soapchemistry1.htm http://www.cleaning101.com/ http://www.care2.com/channels/solutions/home/118 http://hotproducts.alibaba.com/manufacturers-exporters/Detergent.html Journal of Chemical Education Vol.81 No.10 October 2004 www.JCE.DivCHED.org Journal of Chemical Education Vol.74 No.5 May 1997 http://www.chemistryquestion.com/English/Questions/ChemistryInDailyLife/27C_n_ionicsurfactant.html http://www.aocs.org/news/archive_story.asp?arch=1&id=74 </p>
Shampoo	Product that removes dirt and oil from hair	<p> http://www.herballuxuries.com/res4.htm http://www.herballuxuries.com/res3.htm http://www.herballuxuries.com/shampoo1.htm http://en.wikipedia.org/wiki/Shampoo http://sci-toys.com/ingredients/shampoo.html http://sci-toys.com/ingredients/introduction.html http://pubs.acs.org/cen/whatstuff/stuff/8015sci3.html http://www.snopes.com/inboxer/household/shampoo.asp http://www.mansfieldking.com/hair-cosmetics-contract.html Journal of Chemical Education Vol.54 No.9 September 1977 </p>

Research websites cont'd

Chemi	Descriptio	Websites
Soap		<p>Journal of Chemical Education Vol.82 No.2 February 2005 Journal of Chemical Education Vol.80 No.9 September 2003 http://inventors.about.com/library/inventors/blsoap.htm http://chemistry.about.com/library/weekly/aa081301a.htm http://chemistry.about.com/library/weekly/blsapon.htm http://www.cleaning101.com/cleaning/chemistry/ http://www.cleaning101.com/sdalatest/html/soapchemistry1.htm http://www.chandlerssoaps.com/chemistry-of-soap.html http://en.wikipedia.org/wiki/Soap http://www.sdahq.org/cleaning/history/ http://www.butser.org.uk/iafsoap_hcc.html http://www.cetrangle.com/history_soap.htm http://www.pharmj.com/Editorial/19991218/articles/soap.html http://www.alcasoft.com/soapfact/historycontent.html http://soapnaturally.org/soaphistory.html http://www.executive-shaving.co.uk/shaving-soaps-shave-soap.php Journal of Chemical Education Vol.79 no.10 October 2002 Journal of Chemical Education Vol.82 no.10 October 2005</p>

Research websites cont'd

Chemicals	Description	Websites
Wetting agents		http://www.global-garden.com.au/burnley/dec02jan03dte.htm http://www.cop.ufl.edu/safezone/prokai/pha5100/Eagents.htm http://www.aquatrols.com/MixerGrowerProducts/MGPMixer.HTM http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-25/ http://www.alconox.com/wetting_agent.htm http://en.wikipedia.org/wiki/Ox_gall (used in art work)
Emulsifiers	A type of surfactant used to stabilize food and other immiscibles	http://www.rikenvitamin.jp/int/emulsifier/index.html http://www.rikenvitamin.jp/int/emulsifier/basic/index.html http://www.rikenvitamin.jp/int/emulsifier/basic/kind.html http://en.wikipedia.org/wiki/Emulsifier http://www.soapnaturally.org/naturalskincare/emulsions.html http://pharmlabs.unc.edu/emulsions/text.htm http://en.wikipedia.org/wiki/Lecithin http://en.wikipedia.org/wiki/Polyglycerol_Polyricinoleate (replaces cocoa butter in low grade candy bars) http://en.wikipedia.org/wiki/Stearyl_alcohol

Research websites cont'd

Chemicals	Description	Websites
Detergents – general		http://en.wikipedia.org/wiki/Sodium_dodecyl_sulfate http://www.chemicaland21.com/arokorhi/specialtychem/perchem/SODIUM%20LAURYL%20SULFATE.htm http://en.wikipedia.org/wiki/Ammonium_lauryl_sulfate http://en.wikipedia.org/wiki/Sodium_laureth_sulfate http://en.wikipedia.org/wiki/Sodium_myreth_sulfate http://en.wikipedia.org/wiki/Sodium-pareth_sulfate http://en.wikipedia.org/wiki/Triton_X-100 http://en.wikipedia.org/wiki/Tween_20
Dispersing agents	Increases fluidity of substances by decreasing intra-particle attraction	http://www.specialchem4coatings.com/tc/dispersion/index.aspx http://www.epa.gov/oilspill/disperse.htm http://www.specialchem4polymers.com/tc/silanes-dispersing/ http://www.answers.com/topic/limonene

Research websites cont'd

Chemi	Descriptio	Websites
Toothpaste		http://en.wikipedia.org/wiki/Toothpaste http://www.fluoride-history.de/p-dentifrice.htm http://inventors.about.com/library/inventors/blidental.htm http://www.colgate.com/app/Colgate/US/OC/Information/OralHealthBasics/GoodOralHygiene/BrushingandFlossing/HistoryToothbrushesToothpastes.cvsp http://www.chemistry.nus.edu.sg/2500/toothpaste.htm http://www.therabreath.com/art_cankersores.asp
Carpet cleaners		http://www.checnet.org/HealththeHouse/education/articles-detail.asp?Main_ID=442 http://www.scotlabs.com/main.asp?zone=4&detail=1 http://www.banecleane.com/catalog/chemistry.html Http://www.madsci.org/posts/archives/oct98/907212366.Ch.r.html http://en.wikipedia.org/wiki/Perfluorooctane_sulfonate (stain repellent)
Dispersing agents	Increases fluidity of substances by decreasing intra-particle attraction	http://www.specialchem4coatings.com/tc/dispersion/index.aspx http://www.epa.gov/oilspill/disperse.htm http://www.specialchem4polymers.com/tc/silanes-dispersing/ http://www.answers.com/topic/limonene

Research websites cont'd

Chemic	Descripti	Websites
Lung surfactants	A complex mixture of lipid and protein that reduces the work of	http://ising.phys.cwru.edu/surfactants/surfactants.html http://en.wikipedia.org/wiki/Pulmonary_surfactant http://en.wikipedia.org/wiki/Acute_respiratory_distress_syndrome http://en.wikipedia.org/wiki/Surface_tension
Controversial information about detergents	Not everyone agrees that cleaning ingredients are all good!	http://www.tomsomaine.com/faq/#OCT12 http://www.jasoncosmetics.com/sodium_lauryl_sulfate.html http://www.health-report.co.uk/sodium_lauryl_sulphate.html http://www.natural-health-information-centre.com/sodium-lauryl-sulfate.html http://www.greenpeople.co.uk/Organics_Features_SLS.htm

Lesson Plan for Board Game

Day	Activity	Assessmen	Length
1	<ul style="list-style-type: none">✓ Introduction✓ Each student numbers off 1, 2, or a 3✓ Students assemble into groups of 3✓ Each student chooses a cleaning agent/surfactant	Surfactant Topic Sheet	30 minutes
2	<ul style="list-style-type: none">✓ Research in computer lab using websites provided	Chemistry of Cleaning Research Sheets: Part I	55 minutes

Lesson Plan for Board Game

Day	Activity	Assessment	Length
3	<ul style="list-style-type: none">✓ Hand out Chemistry of Cleaning Job Worksheet: Part I✓ Meet with partners, use computer lab using websites provided	Chemistry of Cleaning Research Sheets: Part I	55 minutes
4	<ul style="list-style-type: none">✓ Instruction on board game & brainstorm board game ideas in collaborative groups	Board Game Exit Slip #1	30 minutes

Lesson Plan for Board Game

Day	Activity	Assessmen t	Length
5	✓ Meet with collaborative group to share facts	Board Game Exit Slip #2	20 minutes
6	✓ Meet with collaborative group to dissect article ✓ Work on board game	DRTA Board Game Exit Slip #3	55 minutes
7	✓ Meet in groups & show board games to teacher	NONE	20 minutes

Lesson Plan for Board Game

Day	Activity	Assessmen t	Length
8	✓ Finalize board games	Board game checklist	20 minutes
9	✓ Play board games	Board game peer review	55 minutes
10	✓ Play board games	Board game peer review	55 minutes

Part I Grading Rubric: Board Game

Presentation requirements	Earned points	Possible Points	Comments
<p>Introduction</p> <ul style="list-style-type: none"> ✓ Define surfactant/use/structure ✓ What is its history? Is it controversial? 		20	
<p>Atomic and molecular info</p> <ul style="list-style-type: none"> ✓ What is the chemical formula? ✓ What elements are present? ✓ What are their atomic #s and masses? ✓ Locations on the periodic table? ✓ Identities (metals, etc) ✓ Valence electrons? 		35	
<p>Chemical Bonds</p> <ul style="list-style-type: none"> ✓ Ionization energy, e-negativity, sizes? ✓ Using e-negativity values, what kind of bonds are found in your surfactant? How do you know? ✓ Draw a picture of how the surfactant behaves in water ✓ Draw Lewis Dot structures for each atom found in your molecule 		25	

Part I Grading Rubric: Board Game cont'd

Presentation requirements	Earned points	Possible Points	Comments
Game Board ✓ Aesthetically pleasing ✓ Board game instructions included ✓ All presentation requirements fulfilled in the form of questions ✓ Board game is comprehensible ✓ Board game, instructions, and playing cards are typed ✓ All guidelines from checklist followed		30	
Total Points Earned		110	

Learning Objectives

- Students have real-world application
- Students work collaboratively (3/group)
- Students use art/creativity to teach other students
- Student research supports the academic content and standards taught in the class

Chemistry 9-12 standards

- Atomic and Molecular Structure: a, d, e
- Chemical Bonds: a, b, c, d,
- Conservation of Matter and Stoichiometry:
b, c, d, e
- Acids and Bases: a, b, c, d
- Solutions: a, b, d
- Organic Chemistry and Biochemistry: a, b,
c

References

- Claire Carey UCSB RET II, '05
- CA state standards
- Journal of Chemical Education
- Websites listed
- Kim Goto
- DRTA from Leila Jirari UCSB RET '06