

Engagement and Learning through Chemistry Demonstrations

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Agenda

- ▶ Why do demonstrations?
- ▶ Safety
- ▶ Examples
- ▶ Resources

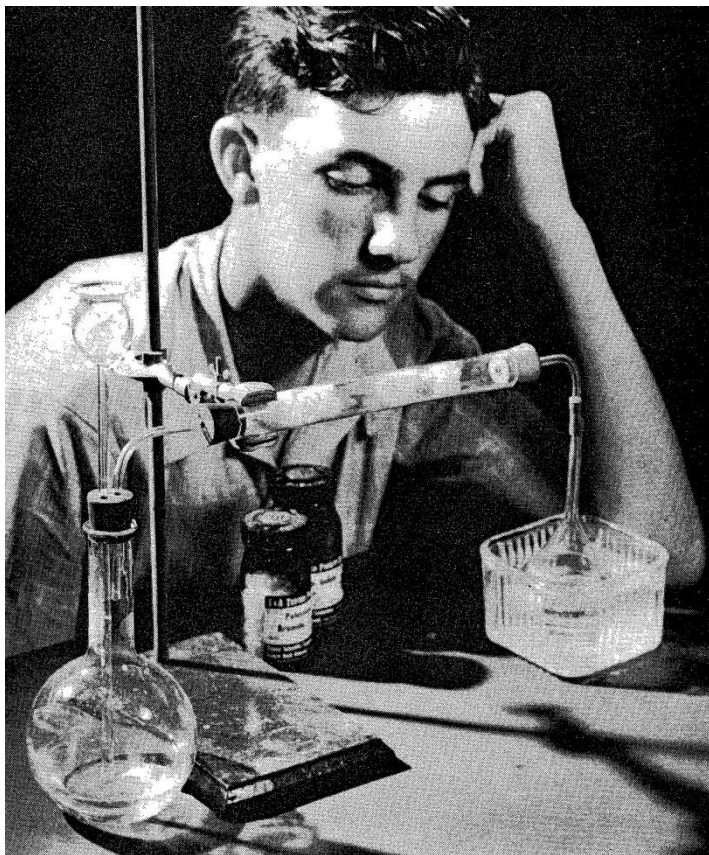


The best chemistry demonstrations...

- ▶ Illustrate chemical principles
- ▶ Must be experienced
- ▶ Relevant to our world



Safety: Don't try this at home (or anywhere!)



Chemistry Magic, Kenneth M. Swezey,
McGraw-Hill, New York, 1956



Safety

- ▶ **Model good science!**
 - ▶ Use of protective equipment
 - ▶ Concern for the environment
 - ▶ Respect for the law

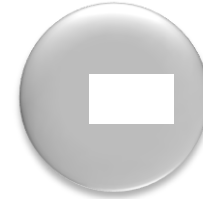


DEMO #1

Delayed Detonation of an
Explosive Mixture

a.k.a. Exploding Pringle's Can

- ▶ Prepare can: one small hole on metal end. Cover with tape.
- ▶ Fill can with H_2 gas immediately before use and cover with lid.
- ▶ Replace lid with thrust nozzle and position above table top.
- ▶ Remove tape from hole and *carefully* ignite.
- ▶ Listen for hum: pitch will go up, then down, then...
- ▶ KABOOM!



Exploding Pringle's Can

[Video](http://www.youtube.com/watch?v=v6XZETa0xOk&) <http://www.youtube.com/watch?v=v6XZETa0xOk&>

Big Idea:

- ▶ Flammable hydrogen gas becomes an explosive mixture with air that can be set off by a flame
- ▶ Rate of reaction accelerated by higher air/fuel ratio

Directions

- ▶ Detailed instructions given at the URL on the handout
- ▶ No H₂ tank? Make some!

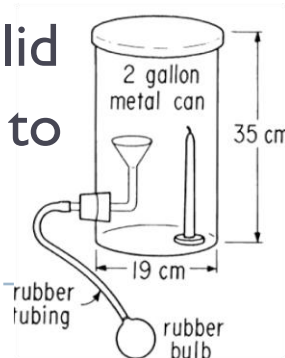
Variations

Good

- ▶ Fill can with chips still in it
- ▶ Candle in a tube
 - ▶ Sift dry flour, coffee creamer, or lycopodium powder from above
 - ▶ Do outdoors!
- ▶ Candle in a can
 - ▶ Load combustible powder in funnel
 - ▶ Light candle, replace lid
 - ▶ Blow through tubing to suspend powder

Bad

- ▶ Handheld demo
- ▶ Impure H₂ (delayed demo)



Real World Applications

Other substances can form explosive mixtures if combustible substance is finely dispersed in air

- ▶ Dust from : sugar, coal, grain, metal, polymers
- ▶ Gasoline vapor at Speedway
- ▶ Chemistry in the news

Imperial Sugar Refinery 2-7-08

Port Wentworth, GA

13 dead, 60 injured

\$5M OSHA fine



West Pharmaceutical Services *Kinston, NC* 1-29-03





Hayes Lemmerz Int'l *Huntington, IN* 10-29-03



Integration opportunities

- ▶ Ethics—Who is responsible for worker safety?



U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

INVESTIGATION REPORT

COMBUSTIBLE DUST HAZARD STUDY



- ▶ Civics—How do laws get made?

110TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
2d Session } 110-601

COMBUSTIBLE DUST EXPLOSION AND FIRE PREVENTION
ACT OF 2008

- ▶ Others?

DEMO #2

Sudden Release of
Supersaturated Gaseous Solute

a.k.a. Diet Cola & Mints

- ▶ Saturated solution of CO_2
- ▶ Release of CO_2 overpressure makes solution supersaturated
- ▶ Mints provide nucleation sites and surfactants to break up bubbles

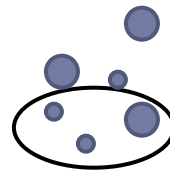
Important Principles

Henry's Law $S_g \propto P_{\text{gas}}$

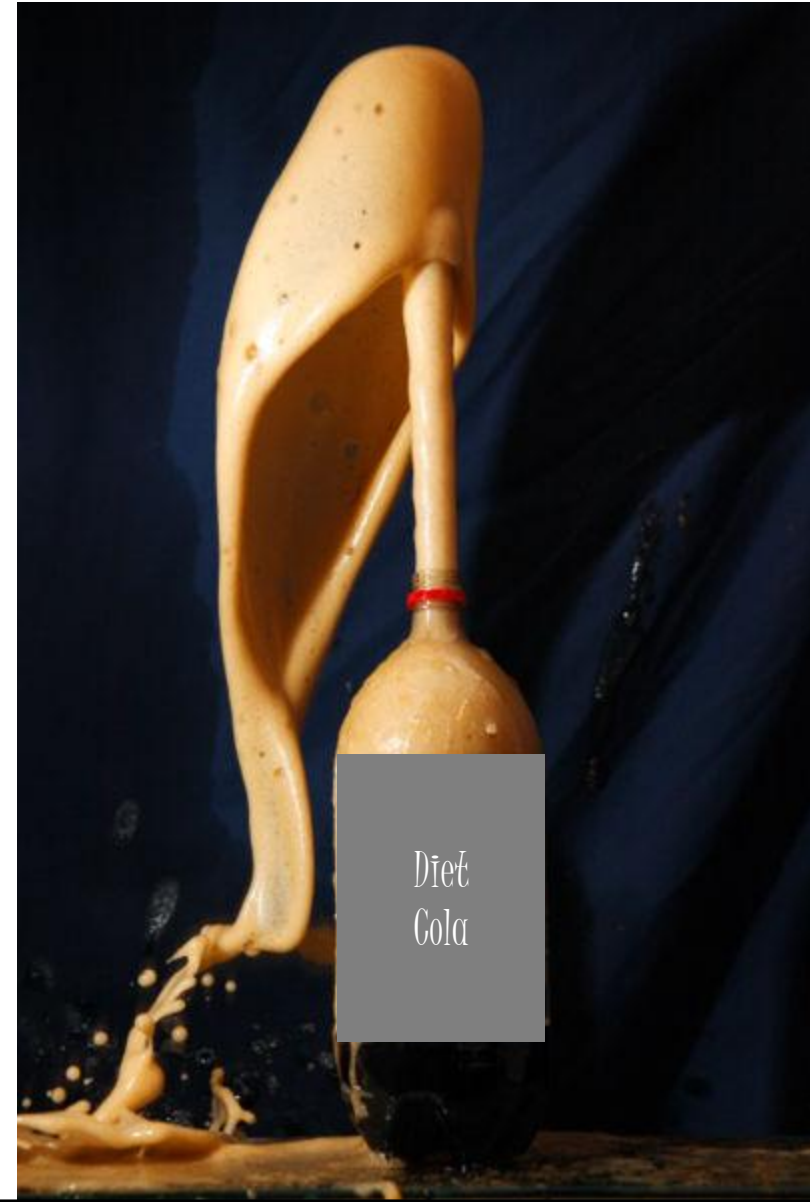
Thermodynamics vs. Kinetics

Surface tension

$\Delta H_{\text{solution}} < 0 \text{ kJ/mol}$



Am. J. Phys. **2008**, 76 (6), 551-557.



Directions

- ▶ Obtain diet cola (off-brand works fine)
- ▶ Unload roll of Mentos into clean, dry 20 mm test tube
- ▶ Uncap cola
- ▶ Invert test tube onto index card
- ▶ Place over bottle top
- ▶ Pull out the card and remove test tube as soon as last mint drops in
- ▶ Enjoy the 2 seconds of effervescence (best to contain the spray)

Variations

Good

- ▶ Drop in mints, enjoy the spray
 - ▶ Best outdoors
 - ▶ Can “catch” spray indoors
- ▶ Flattening a Coke

Bad

- ▶ Prime and smash
 - ▶ Mints added, bottle recapped
 - ▶ Bottle ruptured on hard surface to create uncontrolled rocket
- ▶ Ingest and regurgitate



Application: Lake Nyos, Cameroon

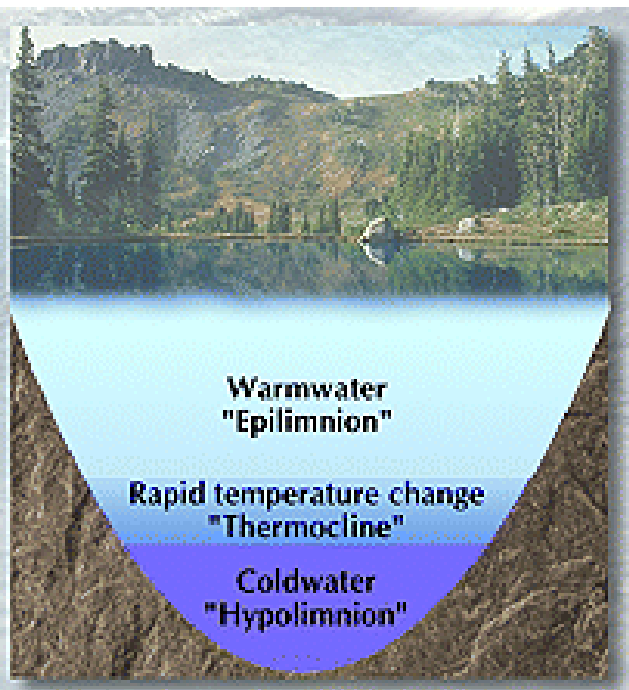
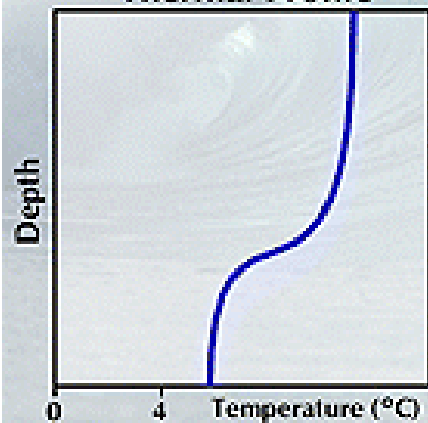
Used by permission <http://perso.wanadoo.fr/nyos/>





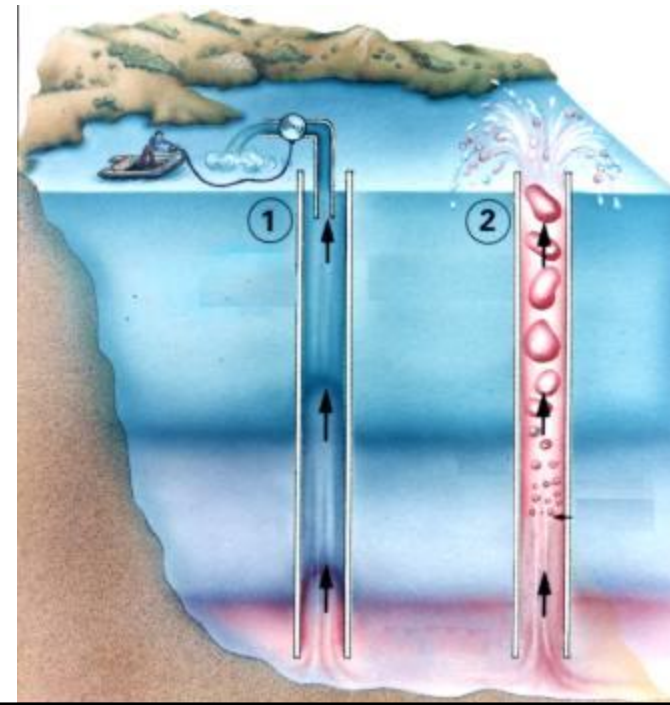
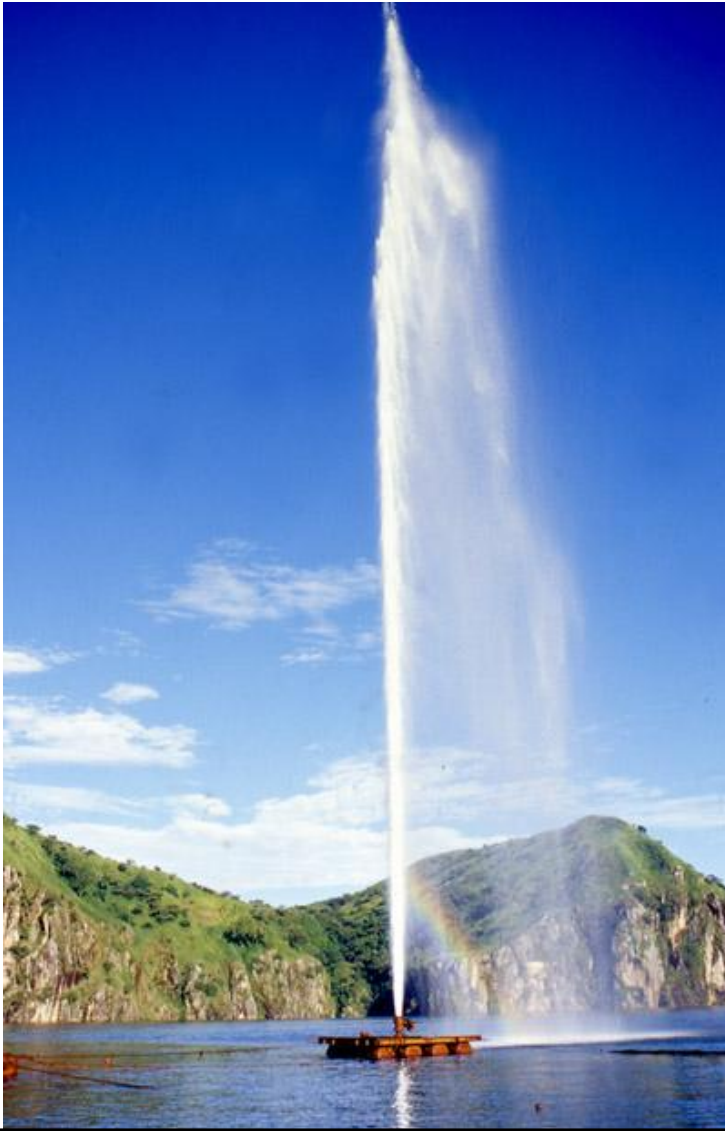
Stratification = Layers

Thermal Profile



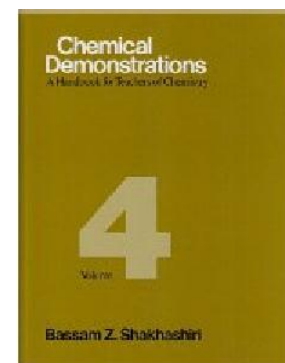
Averting Another Tragedy

- ▶ Webcam: <http://pagesperso-orange.fr/mhalb/nyos/webcam.htm>

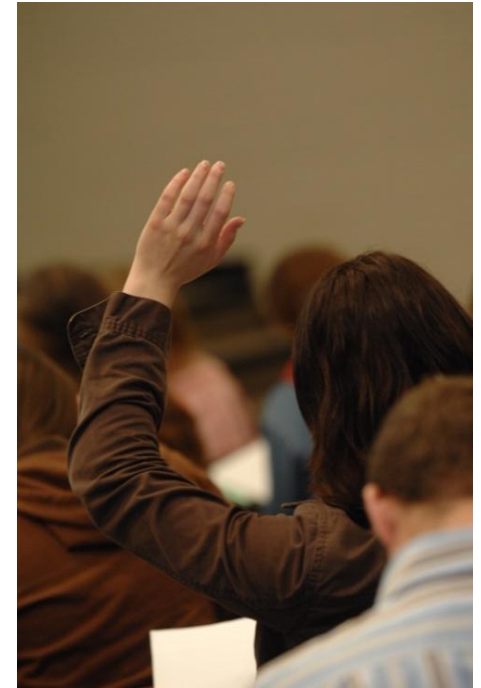


Other goodies

- ▶ Anything liquid N_2
 - ▶ Burning steel wool
 - ▶ Slime in a bag
 - ▶ Turning $\text{Cu} \rightarrow \text{Ag} \rightarrow \text{Au}$
 - ▶ Plastic sulfur
 - ▶ Elephant toothpaste
-
- ▶ Your favorite?



Questions?



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http://www.cedarville.edu/academics/sciencemath/mcclain/mdm_www.htm