TERRIFIC SCIENCE
EMPOWERING TEACHERS THROUGH INNOVATION

Experimentell kemi - Gävle 2017
Part 2

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What do whoopee cushions, potato guns, and exploding straws have in common?

Straws: Science Tools

Work in pairs.
One partner hold a straw.
The other prepare to flick.
Then

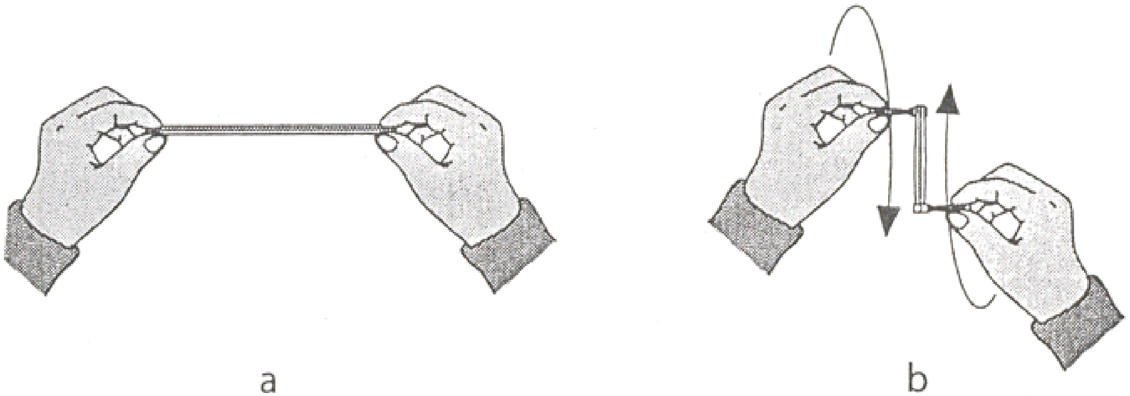


Figure 3: After (a) grasping the straw with both hands, (b) twist one hand over another until about two inches of unrolled straw are left in the middle.

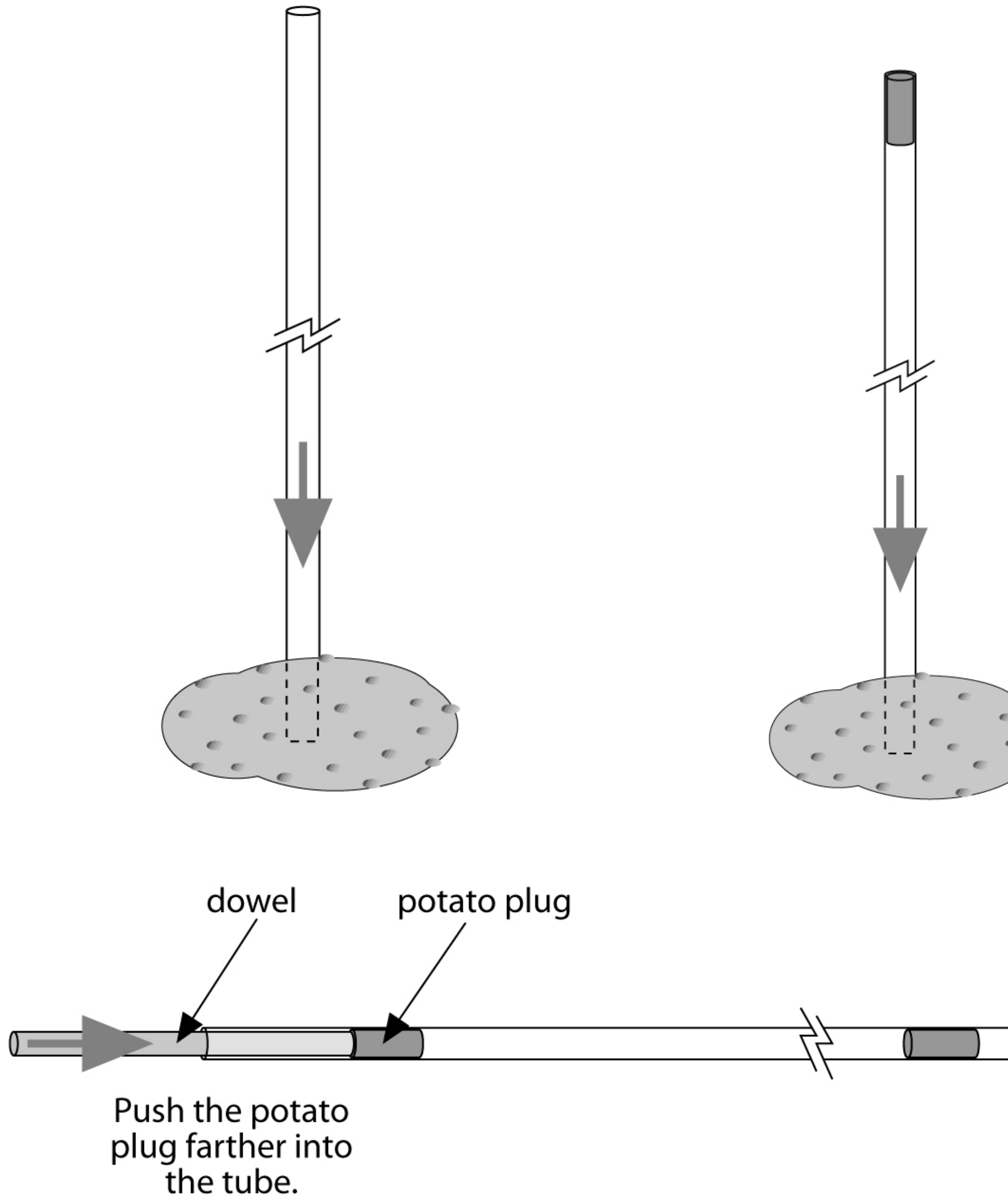
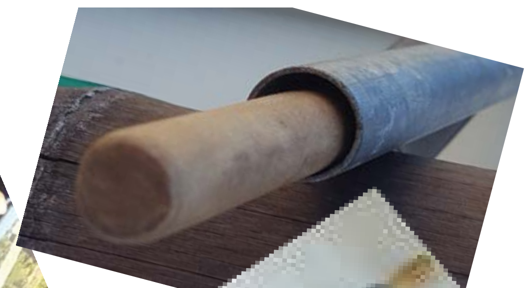


Figure 4: Push the plug 5–6 cm (about 2 inches) into the tube with the dowel.

Home-made potato shooter

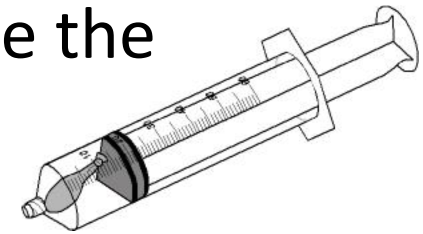
wooden dowel rod (1cm diameter at least 60cm long)



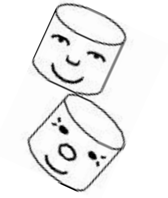
From phenomena to student generated models…

- Trap air inside a syringe. Observe as you increase and decrease the pressure.

- Put a small, tied-off balloon into the syringe. Close the system. What happens if you decrease the pressure in the syringe?

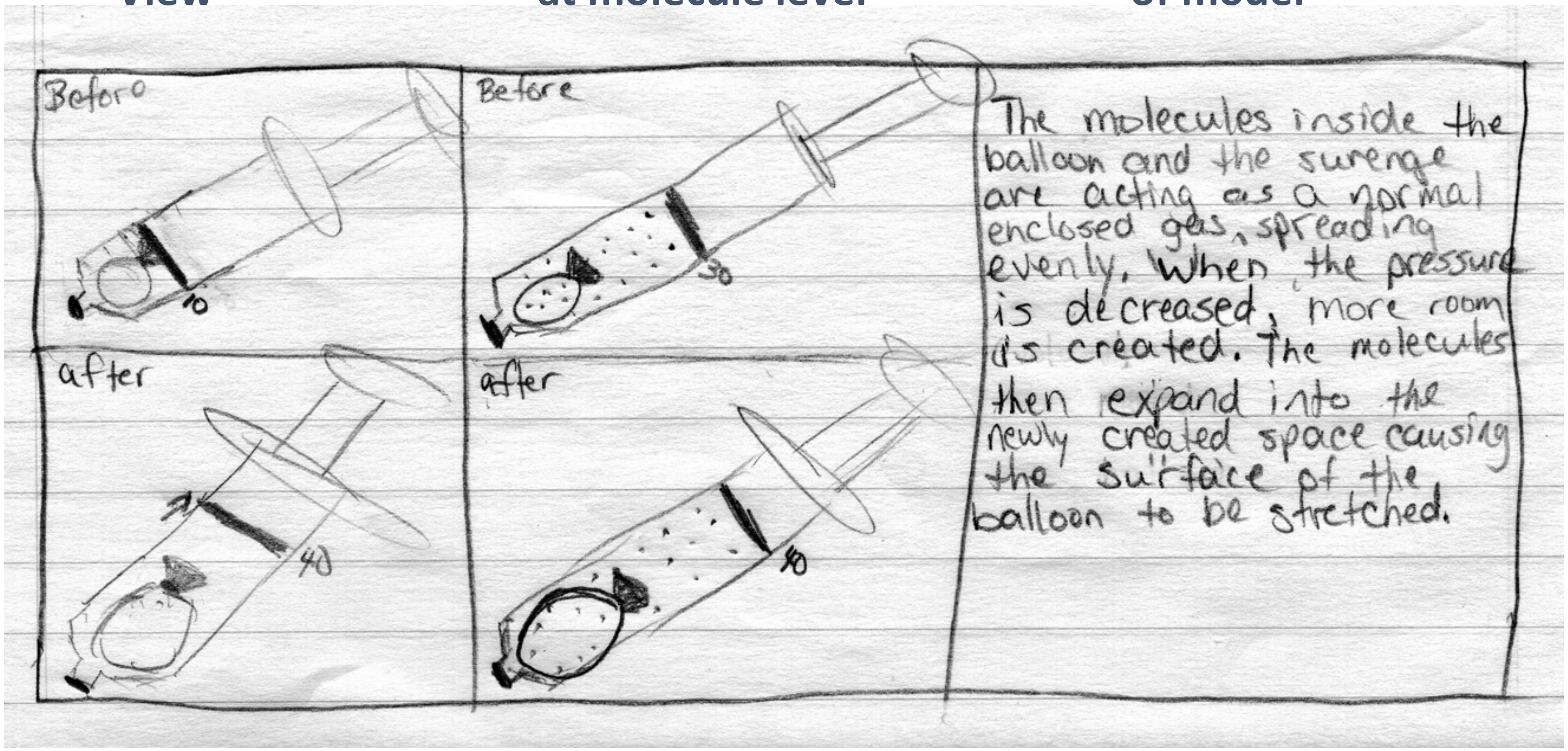


- Repeat the experiment with a marshmallow. What happens?



HS Student's Visualization & Storyboarding

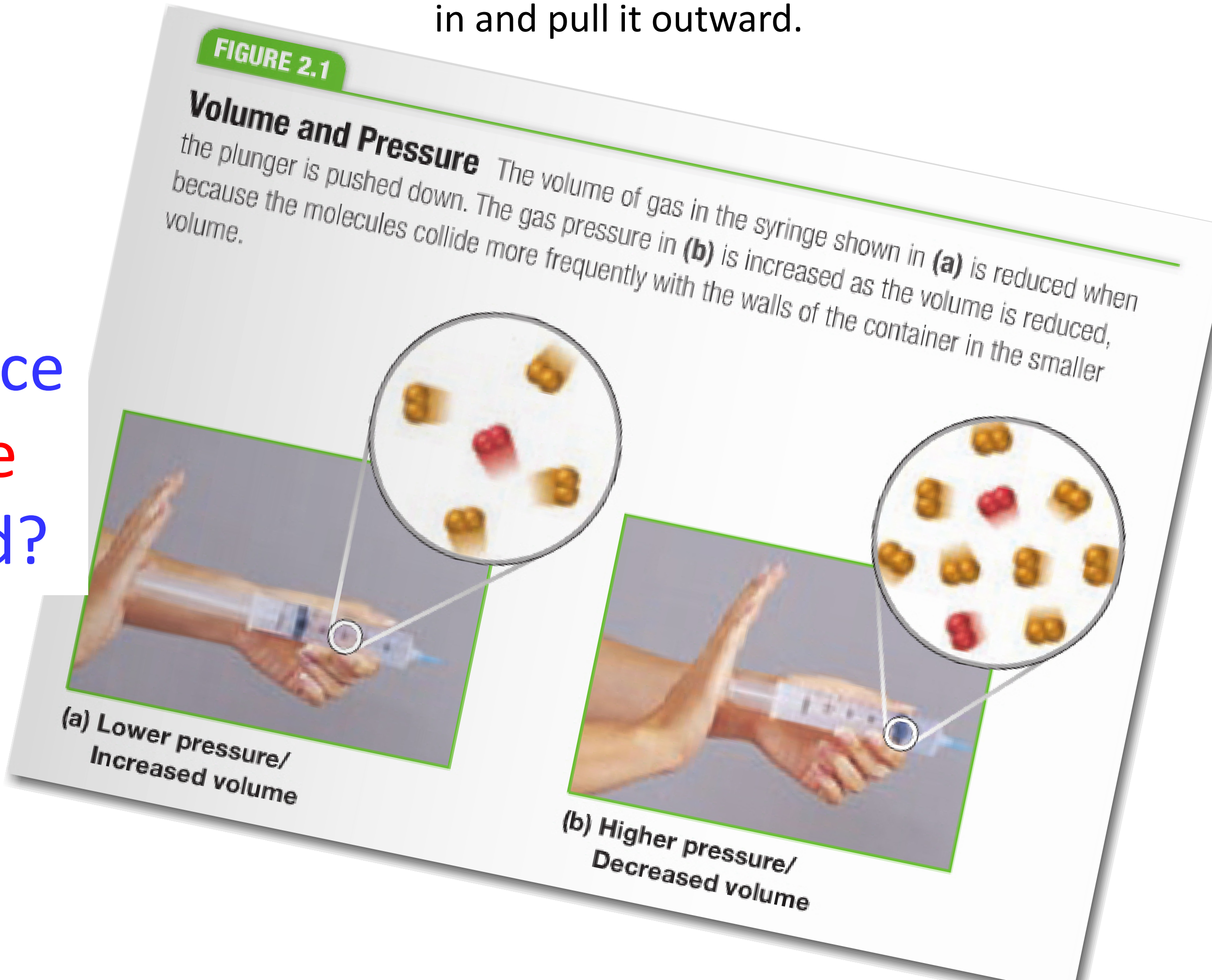
Macroscopic View | **Visualization at molecule level** | **Explanation of model**



Thank you Robert William Boyle (1627-1691)

Trap air inside a syringe.

Observe as you push the plunger in and pull it outward.



What's the evidence that the pressure inside is increased?

Charles Law meets the bubble film

Simple… yet surprising
&
they are doing it!

Placement in your curriculum

- gas laws ($V \alpha T$)

Can you get a hardboiled egg into the bottle?

Ok.. Do it without pushing it with your hands!

What pushed the egg in?

atmospheric pressure

Can you use a raw egg in its shell?

Collecting evidence to understand the system

The System

Procedure:

- Light the candle
- Invert jar or other container
- Quickly lower the mouth of the jar over the candle & into the water
- Observe

Students observe:

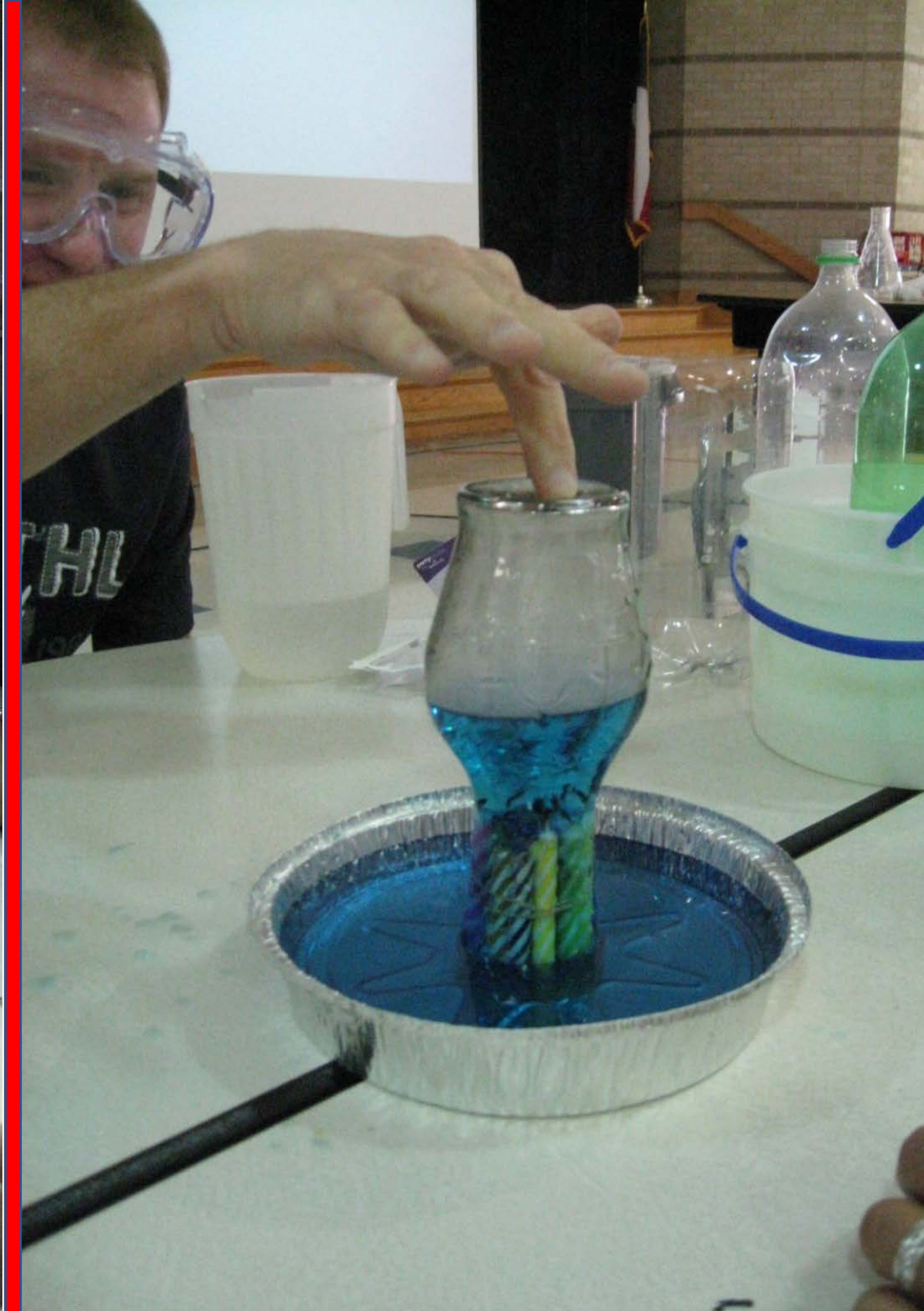
- A few bubbles at the very beginning (~40% of the time)
- Water rises into the jar
- The flame goes out
- Water continues to rise even after flame is out

What *testable* questions can you ask?

What *variable would you change* that could allow you to collect information to answer your question?

Group 1

Does increasing the amount of heat affect the results ?



Group 2: testable question

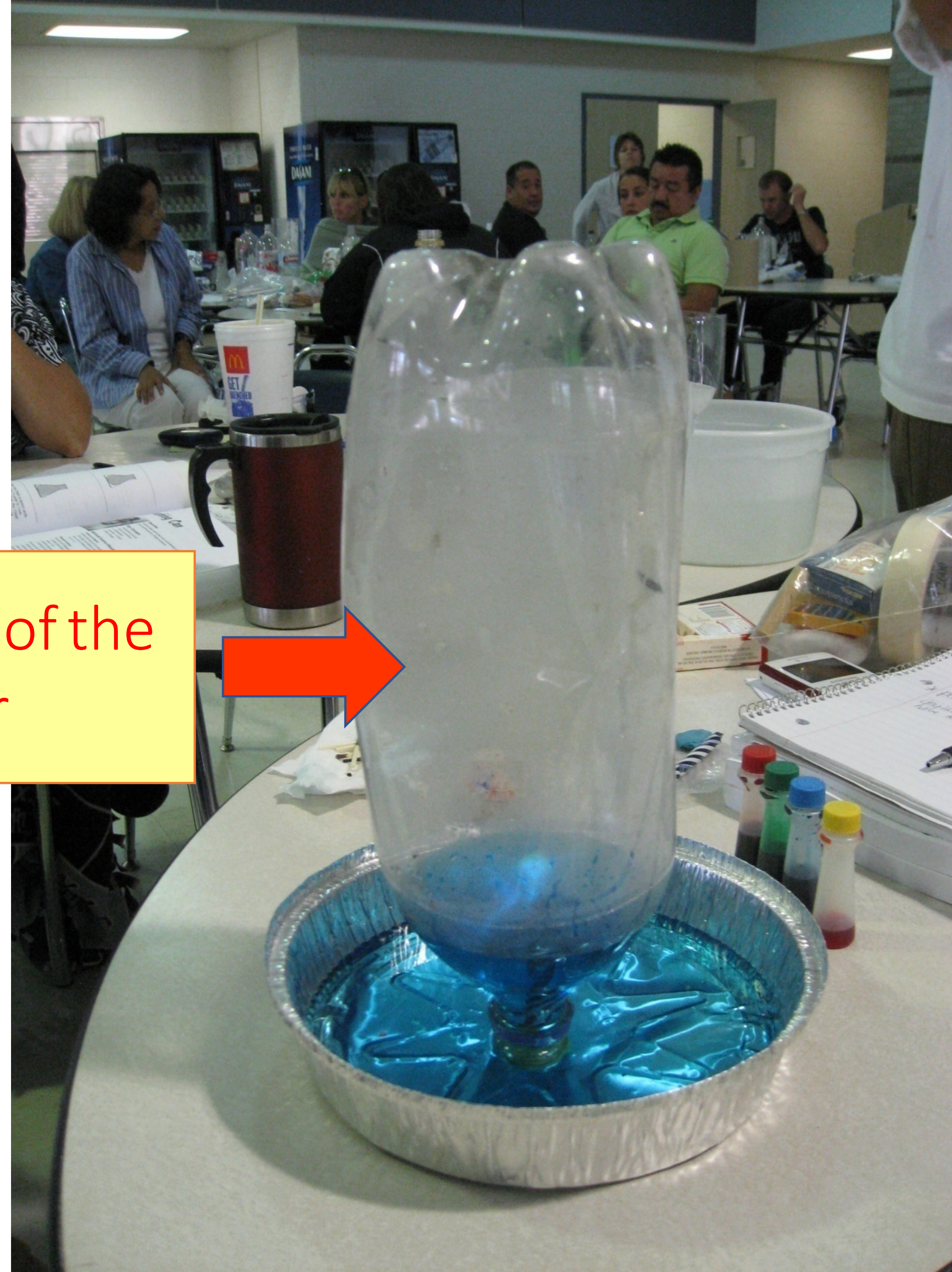
Does the height of the candle change the results?


TEXAS
2006


Group 3

Does a larger bottle affect the results ?


Group 4



Note the sides of the container

other views

Group 5

Another group tries a similar test

What happens when the warm jar is NOT placed over the candle?

What if the jar is held over the candle for a VERY long time?

Pooling results…
The Sum is Greater than the Parts

- As groups share their claims and evidence with the class, the knowledge base of the class increases.

- As a class, they negotiate meaning from the various studies that were undertaken.

- Formulate more advanced claims as the discussion progresses.

What would most kids say was responsible for the water rising into the container?

the Oxygen was used up…

… but is that the whole story?

MAIN IDEA

Combustion reactions involve oxygen.

In a **combustion reaction,** a substance combines with oxygen, releasing a large amount of energy in the form of light and heat. The burning of natural gas, propane, gasoline, and wood are also examples of combustion reactions. For example, the propane, C_3H_8, combustion results in the production of carbon dioxide and water vapor.

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$$

Resource search reveals

Charles' Law: $V \propto T$

accounts in part for

- the bubbles observed initially T↑V↑
- water moves into jar T↓V↓

BUT wait.. There is MORE to search…

Yet more….

Gay-Lussac's Law: $P \propto T$

accounts in part for

- the bubbles observed initially T↑P↑
- water moves into jar T↓P↓

BUT wait.. There is MORE to search…

And more…

$$n \propto P$$

BUT wait.. There is MORE to search…

And more …

Avogadro's Law: $V \propto n$

But is “n” changing?

Combustion of wax

Candle wax is typically paraffin C_nH_{2n+2}

$$C_{17}H_{36}(g) + 26\ O_2(g) \rightarrow 17\ CO_2(g) + 18\ H_2O(g)$$

Moles of gas as reaction occurs:

1 (g) + 26(g) → 17(g) + 18(g)

27 moles (g) reactants   35 moles (g) products

n↑V↑

When the system cools: $18\ H_2O(g) \rightarrow 18H_2O(l)$

Moles of gas once cooled:

1 (g) + 26(g) → 17(g) + ~~18 (l)~~

27 moles (g) reactants   17 moles (g) products

n↓V↓

n↓P↓

Phases changes make a difference !

1 gram of $H_2O(g)$ occupies about

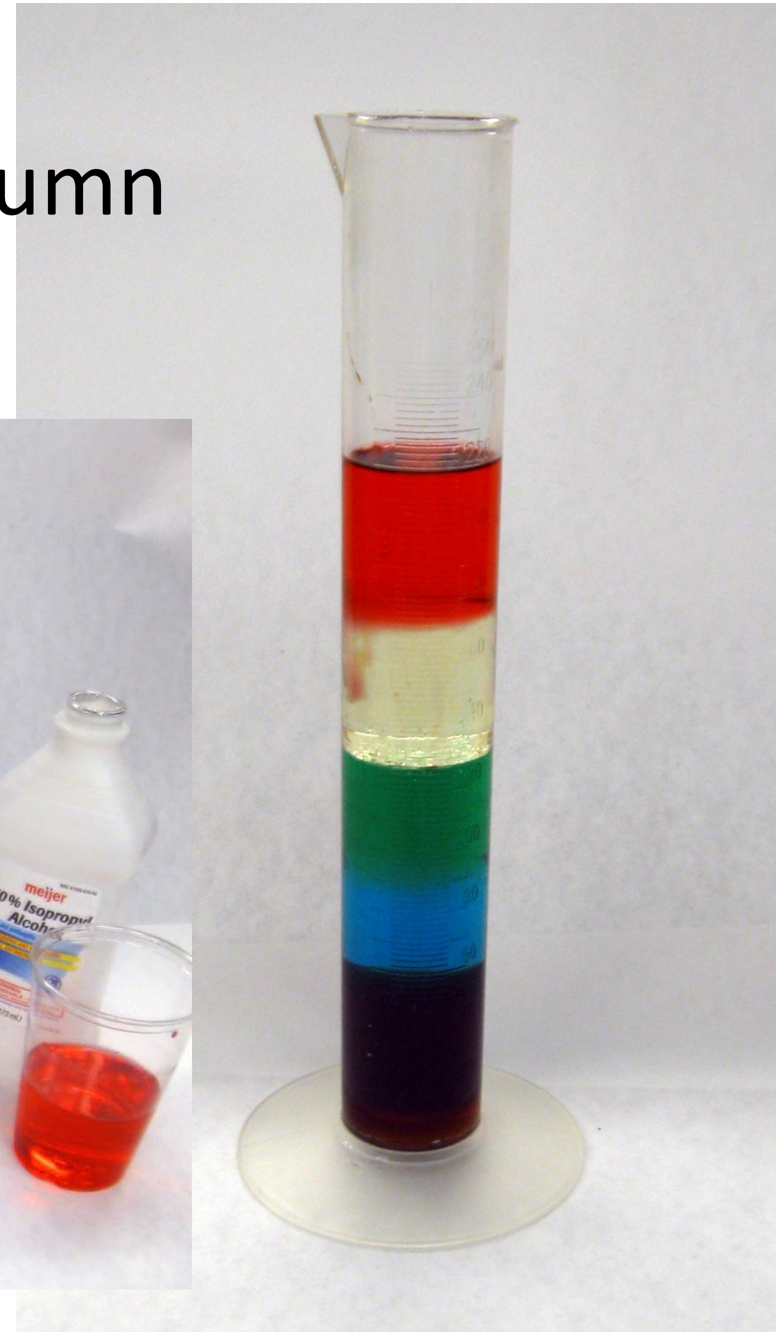
1300 times

the volume of the same mass of $H_2O(l)$! ! ! !

Using chemistry to crush an Al can

A used soda can

Household Density Column

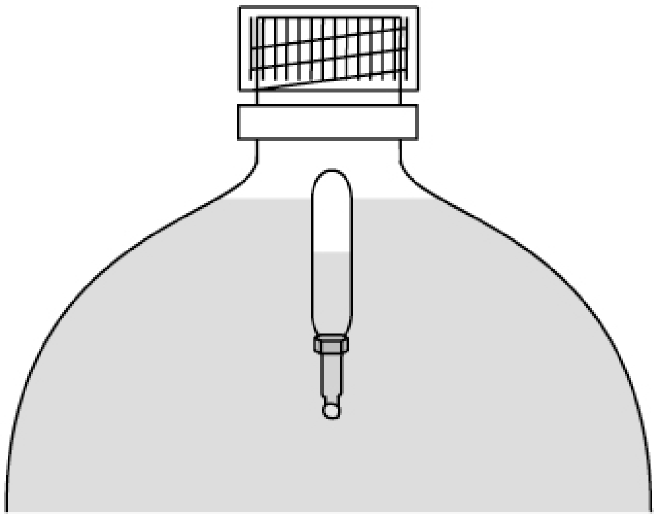


What's happening here?

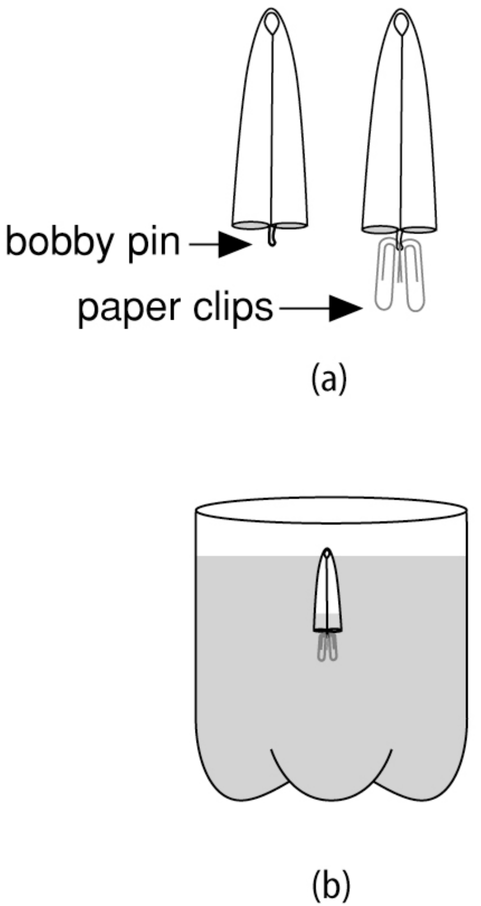
water with red food-coloring

water with blue food-coloring

Cartesian Divers



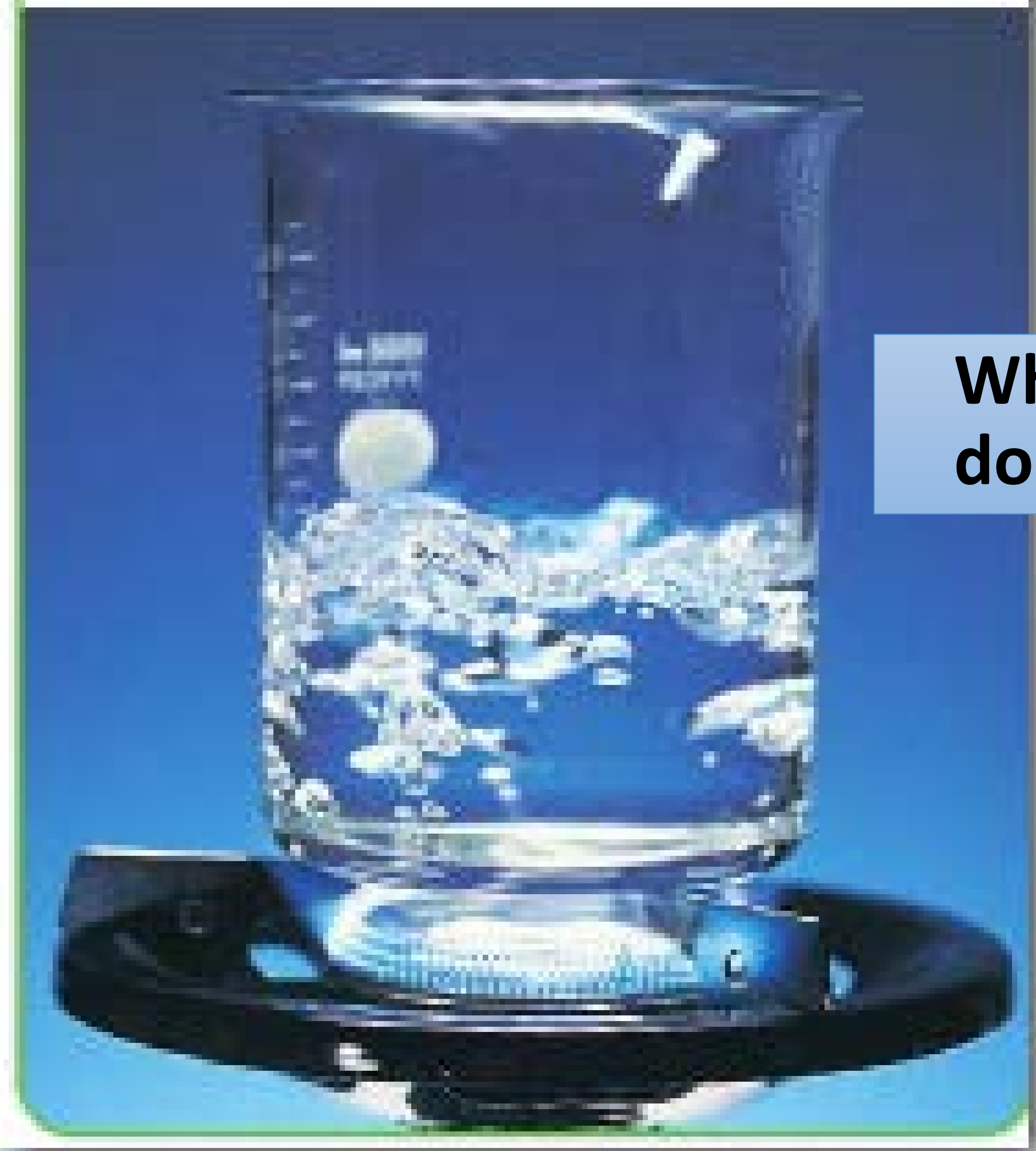
Beral Pipet



Folded straw

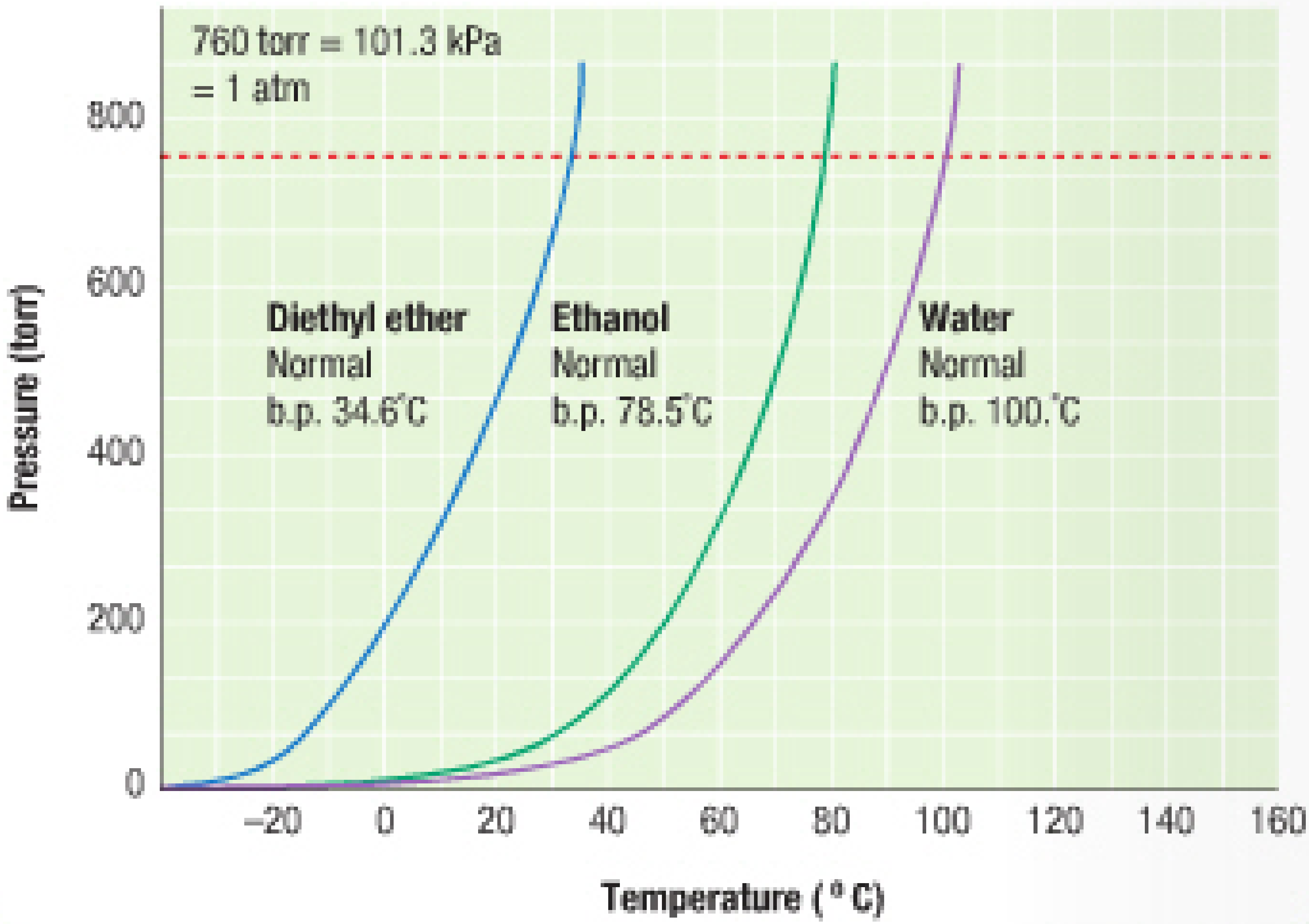
Can you pour a gas?

What's happening to the water?

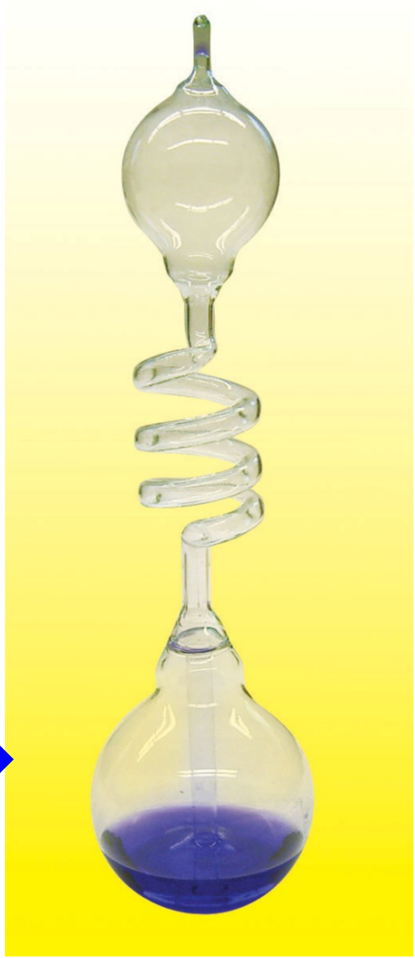


What temperature does water boil at?

Vapor Pressures of Diethyl Ether, Ethanol, and Water at Various Temperatures



Hand boiler (love meter)



base chamber→

How does it work?

Is this boiling?

Useful, engaging, & fun chemistry tools!

Hand boiler (love meter)

Challenge students to figure out

- the engineering/design of the toy
- the science of the system

Placement in your curriculum

- how gases make pressure
- gas laws ($P \alpha T$)
- what is boiling & what isn't

carefully invert …

keeping ALL of the colored liquid in the base chamber..

What does the top chamber feel like?

Ice-salt bath

Research Question:
Will an ice cube melt faster in salt water or tap water?

Equipment:
- 2 Styrofoam cups
- Salt water (160 g NaCl / 1 L)
- Thermometers
- Room temperature tap water
- 20 mL ice cubes (made in plastic soufflé cups)

Authentic Research Within the Grasp of High School Students
Annis Hapkiewicz, Okemos High School, Okemos, MI
Journal of Chemistry Education, Vol 76, No. 9, Sept 1999

Speculation:

Ice cube floats higher in salt water which causes the difference in melting rate.

Experiment:

Holding the ice cubes under the surface of the water

Results:

No difference from the initial experiment

Speculation:

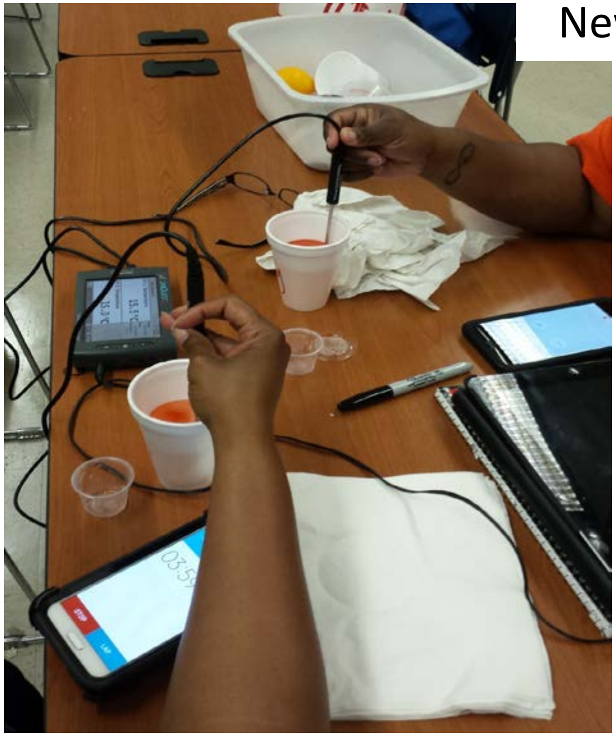
Salt water does not transfer heat as well as tap water.

Experiment:

Measure temperature vs time for ice in salt water and ice in tap water

Old School

New School



Results:

Temperature changed more slowly in salt water

Speculation:

Ions in salt causes the ice cube to melt slower

Experiment:

Compare ice cube melting rate in a sugar solution vs tap water

Results: ice cube melted slower in sugar solution

Question: Would stirring the tap water and the salt water during the experiment change the melting rate of the ice cube?

Results: the ice cubes melted at the same rate

Question: Does the size of the container make a difference?

Question: Is there a difference in density of melted ice in salt water vs melted ice room temperature tap water?

Our Questions:
Will an ice cube melt faster in salt water or tap water?

RESULTS
????????????

Tap Water