

Gas solubility -What type of fish will you catch in warm water?



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Spring Lake High School

- Spring Lake, Michigan
- Public High School – 850 students
- Inquiry driven chemistry classroom
- All students take chemistry





Spring Lake



Activity development

- Concept
 - gas solubility
- Lab components
 - write experiment
 - discuss results
 - use information

“Constructivism: The Implications for Laboratory Work”, Thomas Shiland (1999) suggested that:

- (1) mental activity
- (2) social component
- (3) application

Background-What does CO₂ do to the water?

- New York Times article
- Included information
 - What is the effect?
 - How can we measure a pH?
 - What colors indicator scale would Puget Sound be?



What Type of Your Student Book

11	Simple water
12	Weakly acidic water
14	Strongly acidic water

Use the numerical scale to identify the color of water of:

- a. tap water
- b. distilled water
- c. sea water
- d. orange juice
- e. acid

Teacher Check _____

• **SAFETY:** There are no specific safety hazards. Wear goggles and follow standard laboratory procedures.

• **MATERIALS**

Diphenylpicrylhydrazyl, 1
Sodium hydroxide, 1
100 mL beakers, 3
Blue glass
Eye safety
Thermometer
Universal indicator solution and color scale

Use and follow Student Book pages

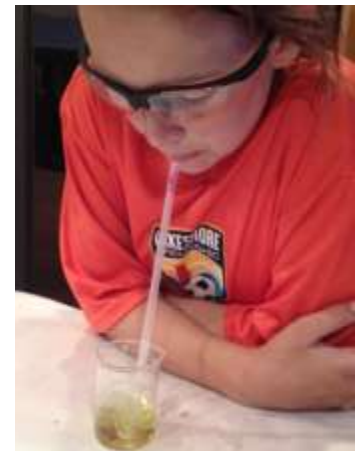
• **BACKGROUND INFORMATION**

In this activity, we are going to measure how changing the temperature of a water solution affects the amount of dissolved CO₂ and the pH of the system. The pH is a measure of H⁺ ions in solution. The pH of pure water is 7, but this value can change depending on temperature and ions dissolved in the water. For example, when carbon dioxide is dissolved in water, carbonic acid (H₂CO₃) forms. Carbonic acid produces H⁺ ions, so the pH of the solution is lowered. Studies show that larger quantities of dissolved CO₂ have a bigger effect on the pH. We can measure this change in pH with a pH sensor or an indicator solution. Please read the following article about CO₂ absorption and acidity: [CO₂ Absorption and Nutrient Runoffs Increase Acidity of Puget Sound](#)

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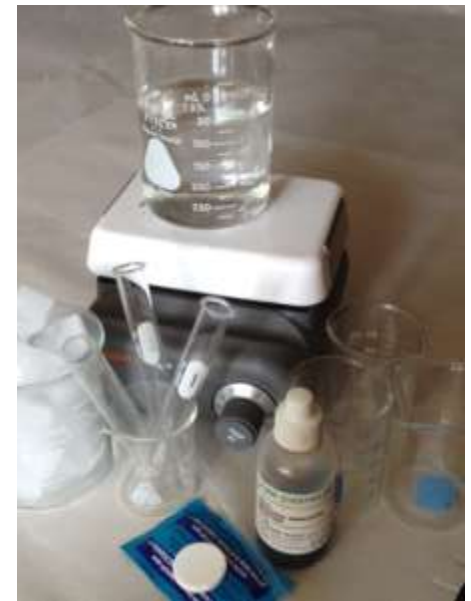
Explore the reaction

- $\text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3$
- Try it
 - Universal indicator, water, straw
 - Alka-Seltzer, Universal indicator



How does temperature affect the amount of dissolved CO₂?

- Materials: Alka-Seltzer, water, hot plate, ice, universal indicator, thermometer.
- In small lab groups, students design their own procedures and make predictions



Sample student procedure

Materials: ^{for each trial} 100 mL tap water, Alka-Seltzer (1/4 tab) 15 drops universal indicator, thermometer, hot water, ice, test tubes

$$\text{H}_2\text{O} + \text{CO}_2 \rightleftharpoons \text{H}_2\text{CO}_3$$

Procedure: Add 1/4 tab Alka-Seltzer to 100 mL of water and 15 drops indicator. Record results. Try with hot and cold water. Repeat. Warm a sample of the cold solution in a hot water bath.

Trial	Temp °C	Observations
Trial 1	Tap water	
	Cold water	
	hot water	
Trial 2	Tap	
	cold	
	hot	
heated sample 1		
sample 2		

white tablet plus water = bubbles and color
Get materials, do reaction with different temps of water.

Teacher check

Repeatable?

Number of trials?

What will you record?

Use the results?

Reaction at different temperatures

4 - Pink



5 - Orange



6 - Yellow



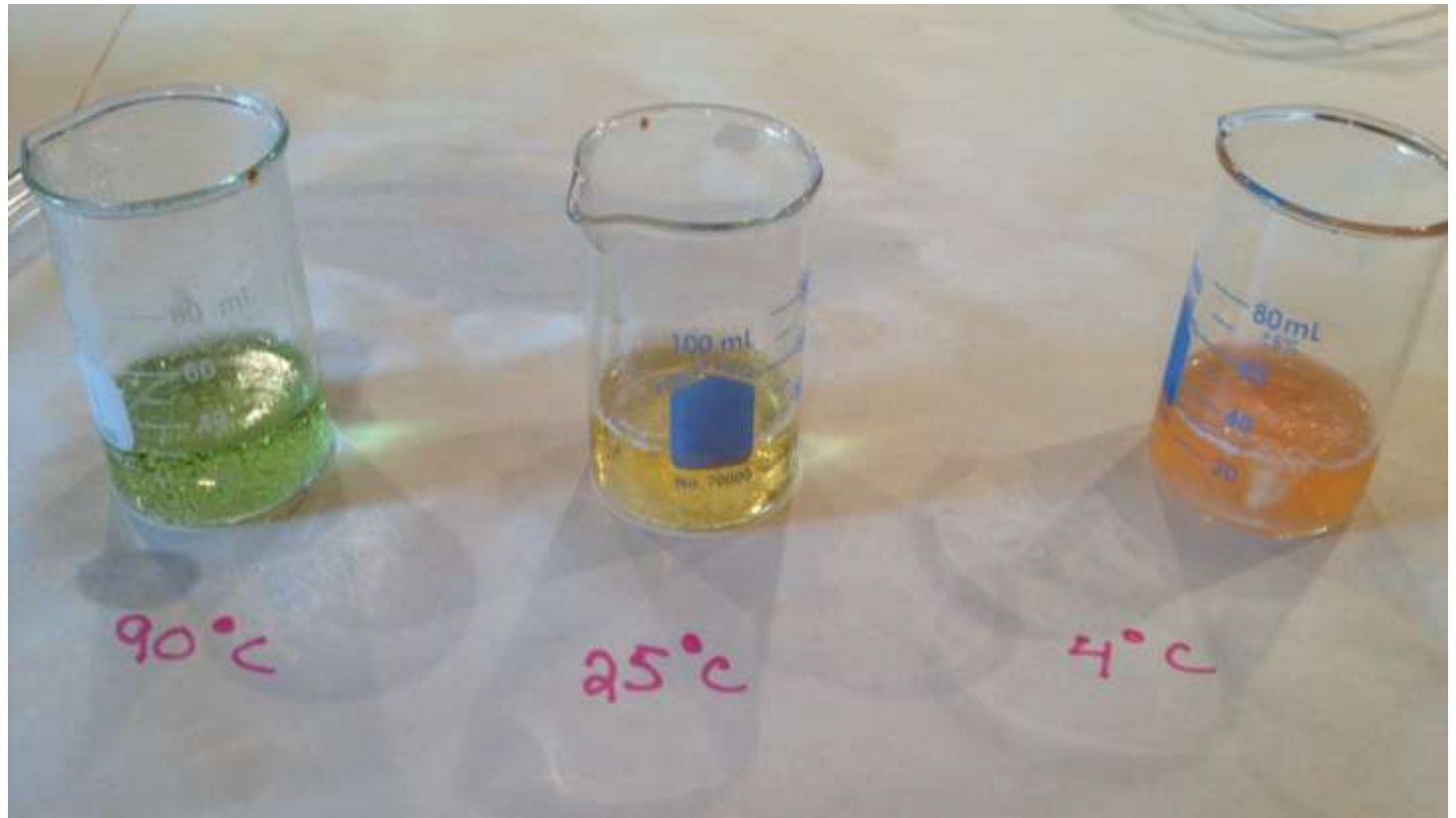
7 - Yellow-green



8 - Blue Green






9 - Blue



How does temperature affect the amount of dissolved CO_2 ?

Heat a sample of the cold water reaction

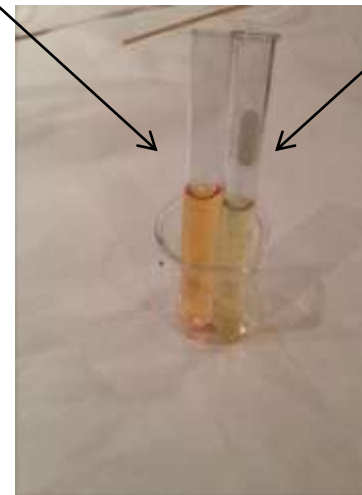


- 5 - Orange 
- 6 - Yellow 
- 7 - Yellow-green 

Compare

Original sample

Heated sample



Discussion Questions

- Small groups and class discussion
 - How did the color of the cold CO₂ solution compare to the warm CO₂ solution?



- What does this tell you about the amount of CO₂ dissolved in each solution?
 - *Green = pH 7. Less acidic, therefore less CO₂ dissolved*
 - *Orange = pH 5. More acidic, therefore more CO₂ dissolved.*

Modeling

- Develop a solubility trend and apply to other gases.
 - *As the temperature of the water increased the solubility of the gas decreased.*
- Explain the observed effect of temperature on gas solubility using kinetic molecular theory.
 - *An increased temperature of the liquid means increased molecular motion for the gas. This provides the energy necessary for the gas to escape the liquid*

Scoring

- Students are expected to share their data and discuss their conclusions as a group and the teacher.
- Each group member must record everything; the procedure, data and results and be prepared to answer teacher questions.

Real World Connections

- How do fish breathe?
- How does oxygen dissolve in water?
- Water temp for these fish?
- Respiration rates?

Effect of dissolved oxygen level on fish	
Fish species	Lowest DO level for 24 hr survival
Northern Pike	6.0 ppm
Trout	5.1
Salmon	5.1
Bass	5
Sunfish	4.2
Perch	4.2
Catfish	2
Carp	1.2



Real World Connections

- 2012 heat wave and fish kills

More Michigan fish kills expected until scorching summer weather changes, DNR says

By Tim martin

LANSING, MI - Michigan's hot, dry summer is resulting in tough times for some types of fish - especially northern pike -- in unusually warm waters.

The Michigan Department of Natural Resources says Monday there have been "numerous" fish kills reported recently from around the state. And more could be on the way.

"We expect to see more of these fish kills until there are major changes in this summer's weather," said Gary Whelan, a DNR fish production manager.

State officials say water reached nearly 90 degrees in the lower Shiawassee River last week, killing off some northern pike.

Northern pike also died in recent weeks in Kent County's Dean Lake. Portions of the River Raisin in Monroe County, the Kawkawlin River in Bay County and the lower Kalamazoo River are among the other places that have had fish deaths, according to the DNR. The fish killed typically range from the dozens to the hundreds.



Mlive.com file photo
A steelhead floats on the display pond at Wolf Lake State Fish Hatchery.



Eric Sharp: Alarms raised over summer fish kills

If you see fish struggling at the surface of a lake or canal early in the morning, it's because oxygen levels in the water reach their low point then.

The low oxygen levels sometimes combine with high water temperatures to cause a fish kill that has people convinced their lake has been poisoned.

"Everything dies at dawn," said Jim Baker, a fisheries biologist and Lake Huron unit

against the shoreline."

"They looked like they'd been dead for a while, because they were all kind of bleached out, and I didn't see any that looked fresh," she said, adding, "When I stepped into the water, it felt like a warm bath on my feet. I don't think I've ever felt that pond get that warm in the 20 years we've been going there."

Dave Barton from Trenton said he saw large numbers of dead carp in the shallow water of Brest Bay on Lake Erie in July, "and I figured it had to be some kind of pollution, because those things can take about anything."

But even hardy species like carp succumb to water temperatures above 90 degrees, especially fish that have spawned recently and are still recovering from the stress

Connections

- Student stories
 - Utility discharge



Man catches 18-inch piranha in Muskegon Lake

MUSKEGON, Mich. (AP) — The Amazon River basin of South America, not the inland waters of Michigan, is the usual home of the piranha.

But this week, a longtime fisherman from this western Michigan city pulled in what is believed to be a piranha from Muskegon Lake.

John Quincy Allen Jr. says he pulled in the 5-pound, nearly 18-inch fish Tuesday morning at the east end of Muskegon Lake, near a hot-water discharge from an industrial plant.

The fish are well known for their razor-sharp teeth and feeding frenzies.

"At first I thought I'd hooked a catfish but then it splashed to the top and ran like a sheepshead," Allen told the



Going Further

- Solubility of polar versus nonpolar
- Excess dissolved oxygen
- Lake Nyos disaster of 1986

Assessment Questions

- Construct a graph relating solubility of a gas to the temperature of water.
- Use the Kinetic Molecular theory to explain why cold pop has more fizz than warm pop.



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<http://www.gvsu.edu/targetinquiry>

- Password required to obtain materials
(data collection only)
- Free teacher and student guides
 - Facilitation notes
 - Student misconceptions
 - Teacher set-up
 - Assessment questions