

Name: _____

Period: _____

Seat#: _____

Club soda (carbonated water) is a solution of CO₂ in water.

The equilibria involved are:

$$\text{CO}_2(\text{aq}) + \text{heat} \leftrightarrow \text{CO}_2(\text{g})$$
$$\text{H}_2\text{CO}_3(\text{aq}) \leftrightarrow \text{CO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$$

carbonic acid

Universal indicator is greenish close to pH 7, is yellow/orange near pH 5-6, and is reddish near pH 4.

Steps

1. Fill two beakers with water and place them on a white piece of paper (to help see the colors).
2. Add a big squirt of universal indicator to each beaker.
3. Collect a few bits of dry ice from the front of the classroom and place some in each of the aforementioned. Use enough dry ice to keep the it vigorously bubbling for at least 1 to 2 minutes.

Question #1 - *Why do the solutions change color?*

- Be specific and mention the exact color it changes to and why this makes sense.
- Be sure to discuss Le Chatelier's principal.
- You must mention BOTH equilibria above to explain this.

Steps

1. Remove any pieces of dry ice from the beaker.
2. Heat (*DO NOT boil*) one beaker containing solution on a hot plate for 2 to 3 minutes.

Question #2 - *Why does the solution change color?*

- Be specific and mention the color it changes to.
- You must mention BOTH equilibria above to explain this.

Steps

1. Draw about 15ml of cool (*unheated*) solution from the **larger** beaker into the syringe. One beaker should still be empty for the end of the lab!
2. Place a syringe cap over the end of the syringe, pull the plunger out until you can lock it with a nail.
3. Hold the locked syringe upside down (pointy end facing up). Bubbles of carbon dioxide should be seen out-gassing. You can shake the syringe to speed this up.
4. After about 30 sec remove the syringe cap and push the plunger to expel the gas but not the solution.
5. Stopper the syringe again and repeat the above cycle one or two more times.
6. Empty the solution into an **empty** beaker and note its color.



Question #3 - Did the solution become more or less acidic as the pressure was reduced? How do you know?

Circle your answer

more acidic or **less acidic**

Question #4 - Fill in the statements below based on your observations.

- The two statements should not be the same, but should express the same idea.

Circle your answer

Higher or **Lower**

pressures favor

Circle your answer

More or **Fewer**

moles of a gas.

Or another way to express this would be:

Circle your answer

Higher or **Lower**

pressures favor

Circle your answer

More or **Fewer**

moles of a gas.

Question #5 - Why is it a good idea to keep club soda cold? Explain.

- Be sure to discuss Le Chatelier's principal.

Question #6 – What would the equilibrium expression for the decomposition of carbonic acid be?

Question #7 – If $K_{eq} = 2 \times 10^{-3}$ for the decomposition of H_2CO_3 at $25^\circ C$, which direction should the equilibrium shift if you started with $[H_2CO_3] = 3.1 \times 10^{-3} M$ and $[CO_2] = 1.2 \times 10^{-5} M$? Justify by showing a calculation.

Question #8 – Which color would you expect the solution to lie closer to if using Universal Indicator – the green side or the red side of the range? Explain your answer.