CHEMISTRY

De-carbonating Soda Water

❖ *Aim*

To investigate the amount of carbon dioxide lost when a carbonated beverage is degassed.

❖ *Hypothesis*

There will be no mass change in the soda water, and there will therefore be no carbon dioxide lost.

❖ *Method*

1) Whilst wearing safety glasses, an unopened bottle of soda water was weighed on an electronic balance. A dry, 500mL beaker with a glass rod inside was also weighed.
2) The soda water bottle was opened and its contents transferred to the beaker. The filled beaker, empty bottle, lid and glass rod were then all weighed together.
3) The pH of the soda was measured and recorded with a pH probe.
4) 6.0g of salt was weighed out on a clean clock glass, and subsequently added to the soda water. The mixture was stirred with the glass rod continually for 10 minutes, while the pH probe monitored any pH changes. The equipment was thus assembled as shown:
5) After the 10 minutes, the beaker, its contents and the empty soda water bottle plus lid were all reweighed.
6) Another 5 minutes was spent stirring the mixture with the glass rod as the pH was monitored. The relevant materials were then reweighed once again.

❖ *Results*

	Before the addition of salt	***15 minutes after the addition of 6.0 salt***	***Total change***
Mass (soda water, bottle, bottle lid, beaker, glass rod) (g)	657.8	662.0	-1.8
pH	5.49	6.22	0.73
Carbon dioxide lost	0 mols 0L	0.04 mols 1.014L	0.04 mols 1.014L

❖ *Discussion*

The soda water had lost of a mass of 1.8g 15 minutes after the addition of salt, which indicates that the dissolved carbon dioxide gas was released from the solution. This is further implicated by the reduced acidity of the soda water, as the pH increased from 5.49 to 6.22 as a result of the experiment. The mass loss is equivalent to 0.04 mols of $CO_{2(g)}$, or alternatively, 1.014L in volume.

The soda water initially registered as acidic because carbon dioxide is an acidic oxide. It dissolves in water to produce a solution of carbonic acid, as shown in the equation below:

$$CO_{2(aq)} + H_2O_{(l)} \leftrightarrow H_2CO_{3(aq)}$$

Soda water is produced through the dissolving of carbon dioxide in water under pressure until it is supersaturated, an exothermic reaction. When the cap of the bottle was unscrewed in the experiment, the high gas pressure in the space under the cap was lost, causing a shift in the equilibrium. According to Le Chatelier's principle, the decrease in concentration of the reactant molecule CO_2 resulted in the decrease of the product acid, H_2CO_3, due to the loss of available ions. Thus, the reduction in the acidity of the soda water as a consequence of this experiment resulted from the release of CO_2. This escape of CO_2 from the system further explains the reduction in mass.

The addition of salt to the soda water also produced what is known as the diverse ion effect, which further accelerated the release of CO_2 from the system. The diverse ion effect results from the addition of any soluble compound to a saturated aqueous solution of a soluble gas, which causes a small change in the solubility of that gas. This is because the chemical activity of the solute ions interferes with the other ion's motions and reactions. In this case, the addition of the soluble salt NaCl introduced new ions to the solution, which interfered with the equilibrium system of the soda water. The dissolved CO_2 thus became less soluble, and evaporated into the atmosphere.

The exact percentage of CO_2 lost cannot be ascertained from the results, however, it is definite that 100% of the CO_2 could not have been lost to the atmosphere. Aside from the fact that 15 minutes of stirring would not have been long enough to achieve such results, an equilibrium reaction would have been established between the soda water and the atmosphere. Thus, some CO_2 molecules would always have been present within the soda water at any given time.

There are numerous improvements which can be made to this experiment. Firstly, an impetuous opening of the bottle resulted in an overflow (unfortunately, on the textbook!) which contributed to a loss of mass and CO_2, an inaccuracy in measurements - and thus unreliable results. Further, at least 30minutes is required to maximize CO_2 loss, therefore rendering the 15 minute duration of the experiment an inadequate length of time. The experiment could also have been repeated to ensure the consistency of its results.

❖ *Conclusion*

The soda water lost mass and experienced a reduction in acidity, both of which indicate that there was indeed carbon dioxide released from the system.