

# Analysing the chemistry of coke chemistry essay



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Coke is the most popular carbonated soft drink. Generally there is Phosphoric acid in all fizzy drinks including cokes. The Phosphoric acid is infused as an active ingredient in coke to provide the tangy flavour. There is variety of different types of cokes. For example diet coke which contains less sugar and calories than original coke, vanilla coke which has vanilla flavour and zero coke which contains no sugar at all. Nowadays it is getting issued that phosphoric acid can damage human's teeth or bone health even with minimal exposure. Investigation of finding out the amount of phosphoric acid in each three different cokes; original, zero and vanilla coke by titration is done for consumers to let them know that amount of phosphoric acid is not changed depends the types of the cokes.

## Introduction

Phosphoric acid ( $H_3PO_4$ ) is an active ingredient that contributes the tangy taste in the coke. The acid is fairly weak but, more drinks, the more acid human body has to neutralize. For that the body uses calcium from the bones which reduce the bone strength. (AdlersbergJay, 2010) To analyse the phosphoric acid in cokes, the acid/base titration method has been brought. Acid/bas titration is required to determine the unknown concentration of a known reactant. It is performed by dropping the known solution in the burette into the unknown solution in the beaker which has been added a few drops of the indicator or simply using the pH Meter. (KennanMark) The indicator is a liquid that makes the colour change of the solution when it is neutralized. Different indicators are used for different pH levels and they have different colour changes. (Acid-Base Chemistry)

Indicator

pH Range

Color Change

Thymol blue

1.2 - 2.8

red → yellow

Methyl red

4.4 - 6.2

red → yellow

Litmus

5 - 8

red → blue

Bromothymol blue

6.2 - 7.6

yellow → blue

Phenolphthalein

8.0 - 10.0

colorless to pink

The experiment is performed based on the hypothesis, the amount of phosphoric acid in each different types of cokes are different as they are not the same type of the coke.

## **Main Body**

### **Aim**

The aim of the experiment is to analyse a commercial sample of three different types of cokes and determine the mass of phosphoric acid in the samples using volumetric analysis; acid/base titration.

### **Hypothesis**

If the types of the coke are different then the quantity of phosphoric acid in cokes will differ to each other because each types of coke contain variety of ingredients in different amounts.

### **Materials**

Balance

50ml beaker

20ml pipette

25ml pipette

50ml burette

250ml volumetric flask

100ml volumetric flask

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250ml conical flask

Spatula

Label sticker

Small glass funnel

Burette stand and clamp

White tile

Distilled water

Phenolphthalein indicator

KHSO<sub>4</sub>

Approx 0. 1M NaOH solution

Coca-Cola (original, zero, vanilla)

## **Method**

### **Standard KHSO<sub>4</sub> Solution**

Approximately 3g of KHSO<sub>4</sub> was measured and put into a clean 50ml beaker. For dissolving the KHSO<sub>4</sub>, Transferred KHSO<sub>4</sub> and distilled water to 250ml volumetric flask and filled the flask with distilled water. Put the stopper and mixed the contents of the flask well. Then calculated number of moles and concentration of KHSO<sub>4</sub> and recorded them.

## **Standardising the NaOH solution**

Pour the 0.1M of NaOH into the burette and made sure that the initial volume exactly 0.00ml. Next, poured the standard KHSO<sub>4</sub> solution measured with 20ml pipette into conical flask and added 3 drops of phenolphthalein indicator. Then, the NaOH was slowly dropped into the flask until the KHSO<sub>4</sub> solution turned slightly pale pink which tells its end-point and recorded the NaOH volume used. Repeated standardising twice and recorded them as well. After that, calculation of the molarity of NaOH was done by using the average of the three volume measurements.

## **Analysis of Coke**

Before starting the analysis of the cokes, original coke, zero coke and vanilla coke had been left for approximately 32 hours in the beakers with no lids on, to make sure there was no carbonic acid in them. This was because that coke doesn't only contain phosphoric acid but carbonic acid which makes the drinks fizzy. Put cokes measured by Pipette 20ml in to 100ml volumetric flasks. Then made 20% diluted coke by filling the flask to the 100ml mark with distilled water. Put the stoppers on them and shake the each solution. Labelled the each flask. Pipette 25ml of each three 20% diluted coke solution to clean 250ml conical flasks and added 3 drops of phenolphthalein indicator to each samples in flasks. After that, titrating NaOH solution was performed into the coke samples and recorded the required NaOH volumes for the samples. Again, the steps were repeated twice for each sample. Lastly, the molarity of phosphoric acid in the 20% coke solutions and the mass of phosphoric acid present in commercial undiluted cokes were calculated.

## Results

### Standard KHSO<sub>4</sub> solution

Mass of KHSO<sub>4</sub> used: 3. 2g

### Standardising the NaOH solution

V(KHSO<sub>4</sub>) = 20ml

#### Trial 1

#### Trial 2

#### Trial 3

### NaOH

#### Volume used

20. 4ml

19. 8ml

19. 8ml

Average volume:  $(20. 4+19. 8+19. 8)/3 = 20\text{ml}$

### Analysis of Coke

Volume of 20% original/zero/vanilla coke used = 25ml

#### Trial 1

#### Trial 2

### Original

0. 7ml

0. 8ml

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**Zero**

0. 8ml

0. 8ml

**Vanilla**

0. 7ml

0. 9ml

Average volume:

Original:  $(0. 7+0. 8)/2 = 0. 75\text{ml}$ Zero:  $(0. 8+0. 8)/2 = 0. 8\text{ml}$ Vanilla:  $(0. 7+0. 9)/2 = 0. 8\text{ml}$ **Discussion& Analysis of results**

The experiment was performed in three parts to titrate the cokes.

The first part was for making standard KHSO<sub>4</sub> solution. 3. 2g of KHSO<sub>4</sub> was used to make the solution and that made the concentration of KHSO<sub>4</sub> solution 0. 0938M which is nearly 0. 1 M.

Molar mass of KHSO<sub>4</sub>:  $39. 1+1+32. 1+(16\times 1) = 136. 2\text{g/mol}$

Moles of KHSO<sub>4</sub>:  $m/M = 3. 2/136. 2 = 0. 0235 \text{ moles}$

Concentration of KHSO<sub>4</sub>:  $n/V = 0. 0235/0. 250 = 0. 0938\text{M} (\hat{\%}^{\wedge}0. 1\text{M})$



The second part was for standardising the 0.1 M NaOH solutions. It was performed three times and the average volume of NaOH used was applied in the calculation of concentration of NaOH by using the concentration formula,  $C_1V_1 = C_2V_2$ . The calculation below shows the concentration of NaOH was 0.0938 M.

Concentration of NaOH:  $(CKHSO_4VKHSO_4)/V_{NaOH} = (0.0938 \times 20)/20 = 0.0938M$

Lastly the third part was for analysis of cokes. Titrating three different types of coke by NaOH solution was performed in this part. The result showed that NaOH solution has been used 0.75ml for original coke and 0.8ml for zero and vanilla coke. The volume used differences between the three cokes were not that big. However these little differences affected the final result.

Concentration calculation was brought to determine the concentration of 20% coke solutions and undiluted coke. After the molarity of undiluted coke (phosphoric acid), it was able to calculate the mass of phosphoric acid in 1L of undiluted coke solutions.

Concentration of 20% coke solutions (phosphoric acid):

$(C_{NaOH}V_{NaOH})/V_{coke}$

Original:  $(0.0938 \times 0.75)/25 = 0.002814M$

Zero:  $(0.0938 \times 0.8)/25 = 0.003002M$

Vanilla:  $(0.0938 \times 0.8)/25 = 0.003002M$

Concentration of the undiluted coke (phosphoric acid)

Original:  $0.001814 \times 5 = 0.00912M$

Zero:  $0.003002 \times 5 = 0.01501M$

Vanilla:  $0.003002 \times 5 = 0.01501M$

Mass of phosphoric acid in 1L of undiluted coke solutions

(Molar mass of phosphoric acid ( $H_3PO_4$ ):  $(1 \times 3) + 31 + (16 \times 4) = 98g/mol$ )

Original:  $0.00912 \times 98 = 0.89376g/1000ml$

Zero:  $0.01501 \times 98 = 1.47098g/1000ml$

Vanilla:  $0.01501 \times 98 = 1.47098g/1000ml$

Throughout the titration in third part of experiment, the amount of phosphoric acid in 1L of undiluted original coke, zero coke and vanilla coke have been calculated. The result came out fairly different to the hypothesis of this experiment. Contrary to the expectation, titration results of three cokes were not that different. According to the result, there is approximately 0.89376g of phosphoric acid in original coke and 1.47098g of phosphoric acid in zero and vanilla coke. The original coke has 0.57722g less phosphoric acid than others. Therefore the original coke has less phosphoric acid and zero and vanilla coke contain 0.57722g more phosphoric acid.

## **Error analysis**

The major error was occurred during the titration. Because the colour of the cokes was too dark to see the colour change to pink, it was needed to be diluted so the coke solutions were 20% diluted with distilled water. However,

even if it was able to see the colour change, the colour of the diluted coke was still dark that it was hardly seen the solutions changing of pale pink, end-point. The result was supposed to show their phosphoric acid contents were same but it was not. It is assumed that the titration was not accurate enough because of the dark colour of cokes and that is because there was 0.05ml of NaOH less volume used in original coke.

## **Conclusion**

The purpose of the experiment was to find out the most phosphoric acid contained coke since it was guessed that different types of coke would contain unlike quantity of acid to each other. So the method of acid/base titration has been invited to figure out the amount of phosphoric acid in each different types of coke; original coke, zero coke and vanilla coke. For the titration, standard  $\text{KHSO}_4$  solution and standardising the NaOH solution were required. Throughout all the records and calculation, it was able to determine the quantity of phosphoric acid in each types of coke. Different to the prediction, fairly similar amounts of phosphoric acid were contained in the cokes. It is shown through that original coke is bit healthier than other two types of coke as it has 0.57722g less phosphoric acid it but as the difference is not that outstand, it is determined that generally constant amount of phosphoric acid are irrespective of the types of the coke.