Chemistry titration lab

Science, Chemistry

Table 1: Data Collection Table – Contains all of the primary data directly obtained from the lab. Indicator | Initial volume of NaOH in burette (ml) ±0. 05| Final Volume of NaOH in burette (ml) ±0. 05| Final – initial Burette Reading (Volume of NaOH used) (ml) ±0. 1| Qualitative Observations | Phenolphthalein | 0. 00 | 0. 90| 0. 9| At first when the base was being dropped into the vinegar there wasn’t a color change, however when the solutions came close to full titration, the solution would turn pink and once mixed would turn clear again| | 0. 90| 2. 30| 1. 4| | | 2. 30| 3. 20| 0. 9| | | 3. 20| 4. 0| 0. 9| | Bromothymol Blue | 8. 00| 9. 50| 1. 5| Solution turned from yellow to light green | | 9. 50| 11. 10| 1. 6| Solution turned from a bright yellow to bright blue rather than a light green indicating over-titration had occurred| | 11. 10| 12. 90| 1. 8| | | 12. 90| 14. 40| 1. 5| | | 14. 40| 15. 90| 1. 5| | Methyl Orange | 15. 90| 16. 90| 1. 0| Reaction occurred quick, over-titration occurred and solution turned from red to orange | | 16. 90| 17. 20| 0. 3| | | 17. 20| 17. 40| 0. 2| | | 17. 40| 17. 60| 0. 2| | | 17. 60| 17. 80| 0. 2| | Methyl Red | 0. 00| 5. 00| 5. 0| | | 5. 00| 7. 80| 2. | Solution turned from red to a light orange/yellow color| | 7. 80| 10. 70| 2. 9| | | 10. 70| 13. 60| 2. 9| | | 13. 60| 16. 50| 2. 9| | Bromocresol Green| 20. 80| 21. 20| 0. 4| Solution turned from yellow to light green | | 21. 20| 21. 60| 0. 4| | | 21. 60| 22. 00| 0. 4| | Table 2: Data Processing Table displaying the volume of NaOH required to titrate 10ml of vinegar and their corresponding concentration of acetic acid Indicator | Volume of NaOH required to titrate 10mL of Vinegar (ml) (±0. 1)| Concentration of Acetic Acid ±0. 5 (mol/l) | Percent Uncertainty (%)| Percent Error (%) | Phenolphthalein| 0. | 0. 9mol/dm3| 11. 1| 3. 4| Bromothymol Blue | 1. 5 | 1. 5mol/dm3| 6. 7| 72. 0| Methyl Orange| 0. 2| 0. 2mol/dm3| 50. 0| -77.

0| Methyl Red | 2. 9| 2. 9mol/dm3| 3. 5| 233. 0| Bromocresol Green| 0. 4| 0. 4mol/dm3| 25. 0| -54. 0| Sample Calculations: Ex. The calculation of the concentration of acetic acid for phenolphthalein NaOH Volume: 0. 9ml NaOH Concentration: 1. 00mol/dm3 1. Convert Volume to Litres 0. 9 = 0. 0009L 1000 1. Calculate the moles of NaOH (n= CV) n= (1. 00mol/dm3) (0. 0009L) = 0. 0009mol 2. Calculate the concentration of the diluted acetic acid.

Because acetic acid and sodium hydroxide have a 1: 1 ratio, they have the same number of moles. C = 0. 0009mol = 0. 09 0. 01L 3. Calculate the initial concentration of acetic acid pre-dilution C1V1 = C2V2 C1(0. 01L) = (0. 09mol/L)(0. 1) Concentration of Acetic Acid = 0. 9mol/L Sample Calculations Continued 4. Calculating percent uncertainty = absolute uncertainty x 100 Measurement 1 Example: Calculating the percent uncertainty for the volume of NaOH required when methyl red is used = 0. 1 x 100 2. 9 1 = 3. 5% Therefore, the volume of NaOH required when methyl red is used as the indicator is 2. 9ml ± 3. % 5. Uncertainty propagation for the volume of NaOH required for each indicator (0. 9 ± 0. 1) + (1. 5 ± 0. 1) + (0. 2 ± 0. 1) + (2. 9 ± 0. 1) + (0. 4 ± 0. 1) = 5. 9ml ± 0. 5 6. Calculating percent error Percent error = Actual – accepted x 100 accepted Example: Calculating percent error for phenolphthalein Percent error = 0. 9 – 0. 87 x 100 0. 87 = 3. 4% Methyl Red Methyl Red Bromothymol Blue Bromothymol Blue Bromocresol Green Bromocresol Green Methyl Orange Methyl Orange Phenolphthalein Phenolphthalein Graph 1: Titration curve representing the effect of the volume of NaOH on the pH of the titration solution at end point

Conclusion This lab tested the effect of the use of different indicators on the volume of NaOH required to reach the end point of the titration with acetic

acid in vinegar. The equation for this reaction is: CH3COOH(aq) + NaOH(aq) NaCH3COO(aq) + H2O(l) The As one can see from graph 1 the results of this lab demonstrated that the indicators that required different volumes of sodium hydroxide to reach end point from least amount of volume required to most was with the use of; methyl orange, bromocresol green, phenolphthalein, bromothymol blue and lastly methyl red.

Therefore, the highest volume of NaOH that was required to change the color of the vinegar occurred when using methyl red, and the smallest volume of NaOH that was required to change the color of the vinegar occurred when using methyl orange. Different indicators were tested as if the indicator is chosen well, then the endpoint will represent the equivalence point of the titration reaction; the point when the volume of titrant is equal to the amount of analyte (the acetic acid in the vinegar). An important factor to consider is hat indicators don’t change color at a specific pH.

However, they do change color over a narrow range of pH values. Because vinegar has a pH of around 2. 4 the equilibrium was firmly to the left before the sodium hydroxide was added. Adding the sodium hydroxide will begin to shift the equilibrium to the right. As more and more base was added, for example with phenolphthalein, the pink eventually became so dominant that it could no longer be turned clear by swirling the beaker. If the light pink was achieved, then end point was perfectly reached and if the solution became bright pink then over-titration occurred.

Although the majority of this lab occurred according to plan, there were a few minor anomalous results that occurred. For instance, the amount of NaOH used in the titration when the methyl red indicator was used was 2.

9ml. However, for one of these tests when using methyl red, the volume of NaOH required to reach the end point of the reaction was 5. 0ml. This was a clear anomalous result as it was very different from the consistent 2. 9ml of NaOH from the other trials. This anomalous result can be explained due to several systematic and/or random that will be discussed further on with their potential improvements.

There were no error bars included in this lab. This is due to the fact that they would be non-existent as each titration was repeated until the exact same volume of NaOH was required to reach the end point for each different indicator at least 3 times. Figure 1: Representation of the various indicators used throughout the conduction of this lab and their pH levels. It also demonstrates their colors in acids and colors in bases as well as the color when end point is reached. This lab evidently demonstrated that phenolphthalein would be the best indicator to use.

The justification for this is that every indicator has their own individual range of pH for the end points. When the end point occurs, it means there is slightly excess base. For phenolphthalein, the end point would be when the color of the solution changed into a very light pink color. As one can see from figure 2 the indicator phenolphthalein only changes color in basic solutions. This is a reason why it would be considered the best indicator for this experiment. This is because the end point for this experiment ranges in between a pH of 8. 2 and 10. , which as one can see is very similar to the pH ranges of phenolphthalein. This would cause the phenolphthalein to give the most accurate reading of the volume of NaOH required to reach the end point of its reaction with acetic acid. The reason the other indicators may not

give the most accurate readings can be seen from the diagram below: Graph 2: This graph represents a simple visual of the effect of different indicators on the volume of base required to reach end point with an acid. The green block above represents the phenolphthalein in this lab as it has its pH ranges on the break of the curve.

This means that the color change will be accurate in terms of changing color at the break point of the reaction Evaluation There are a variety of ways this lab could be furthered. This lab was done using a strong base (NaOH) and a weak acid (acetic acid). A way that this lab could be furthered would be to do the exact same lab using a weak base and a strong acid such as NH4OH (ammonium hydroxide which is a weak base) the same weak acid (acetic acid). This would skew the results in that a much higher volume of base would be required to reach end point with the acid. This is because it would be much more difficult to shift equilibrium o the right. For example, the phenolphthalein indicator only turns the solution pink in basic solutions. Because a weak base is what will be used, it would take much more base in order to reach end point of the reaction. There were a few errors that could have been improved throughout the conduction of this lab. One of the major errors occurred prior to the actual titration itself. This error occurred when the sodium hydroxide solution was being created. When the sodium hydroxide was being created, 1g of solid sodium hydroxide pellets had to be weighed using an electronic balance and then put in a volumetric flask.

After this water was added to the sodium hydroxide pellets and diluted to the 150ml mark. The pellets were left in a dish in the open while we were getting other materials set up. This was definitely an error as the sodium hydroxide

pellets absorb moisture from the air. This means that the sodium hydroxide was actually becoming heavier than 1g as it began absorbing his moisture. This affected results as there was a higher concentration of sodium hydroxide in the water than recorded. This could have affected the results in that less sodium hydroxide would have been required to reach the end point of the reaction.

This would be considered a systematic error as the slightly increased mass of the NaOH would have been used for every trial as the same source of NaOH was used throughout. An improvement to this error would be to not put the sodium hydroxide pellets into the volumetric flask until the very last second. Also, the sodium hydroxide was put into the volumetric flask and then the water was added, however adding the water first could minimize the time that the solid sodium hydroxide is left in the air.

This step in the procedure could also be improved if it were possible to purchase this solid sodium hydroxide already measured out in grams so that they would only be in the open for a matter of seconds as they were being transferred into the volumetric flask. A systematic error that occurred throughout the process of this lab was over-titration. Over titration is when too much of the base is added to the solution and the reaction passes end point. For example, the color that one would attempt to achieve when perfectly titrating using phenolphthalein is a light pink color.

However, for all of our trials the solution turned a bright fuchsia color when using phenolphthalein implying it had over-titrated. This error could definitely have been improved. The improvement for this error would be to use a burette with a smaller opening. This would allow decreased room for

the error of over-titration. This is because one would have more control over the volume of base released by the burette allowing for more control. Another systematic error that occurred repeatedly throughout the conduction of this lab was that the temperature of the room did not stay constant.

Therefore, the temperature of the solutions including the indicators was not constant. Temperature changes could have occurred in the lab without being noted. This is a problem as it slightly changes the color change pH range of indicators. As one can see below, these are the effects on various common indicators' color change ranges with an increase in temperature: Table 3: Table representing common indicators and the effect of changing temperature drastically on the color change range. Although the temperature would not have fluctuated drastically in the classroom there were still potential fluctuations that were not accounted for.

This would have caused the end point to appear to be occurring at different times than expected for that indicator. The way this error could be improved would be to conduct the lab in an area where the temperature is closely and easily monitored. Conducting this lab in a classroom with the door frequently opening and shutting let in a draft therefore this lab should be conducted in an area with no interruptions that may effect temperature. Also, temperature can be monitored so that it can be at least accounted for in one's results and the changes in temperature can be used as an explanation for the behaviour of the indicators in each test.

Another section of the procedure of this lab that requires improvement relates to the indicators used. The indicators used throughout the process of

this lab had pH ranges of around 2-3 increments. For example, phenolphthalein changes color over a pH range of around 8-10. This means that one would not be able to tell exactly what pH the final solution was when it reached end point from the indicator. This could be improved if indicators were produced that did not have a range of pH values in which they change color but one specific pH range where it changes the color of the solution.

This would improve the lab as it would allow scientists to know exactly at which pH the end point of the reaction was reached exactly when it happens. For example, this specific experiment is supposed to reach end point between pH values 8-10, however having an indicator that changes color at pH 8, one that changes color at pH 9 and one at 10 would allow for a more accurate result. An additional random error that occurred throughout the process of this lab was that rarely a drop of NaOH wouldn’t come out of the burette completely straight and would end up getting stuck to the side of the beaker.

This would have caused the volume of NaOH required to reach end point of the reaction to appear greater than it actually was. This is because NaOH was leaving the burette but not going into the beaker containing the vinegar and indicator. Although one cannot control the behaviour of the burette with the NaOH other than potentially using a burette with a thinner opening allowing for less room for the NaOH to fall from obscure angles, one can control beaker size.

By increasing the size of the beaker containing the vinegar and the indicator, one is able to reduce the likelihood of the NaOH not going directly into that

beaker. This would mean that there wouldn’t be as much NaOH lost from the burette that isn’t accounted for. Often in the real world, titration experiments are performed regularly. This is because titration is a process of determining the concentration of a substance in an unknown solution, in which a known reagent is added to that unknown solution in order to produce a known reaction such as a color change.

A real world example of this is biodiesel production. Acid-base titrations are used in the production of biodiesel in order to determine the acidity of waste vegetable oil (one of the main ingredients in biodiesel production). pH paper is used to test a small sample in order to represent the pH of the entire batch. This allows one to determine how much base is required to achieve the desired pH. Bibliography Websites: " Chemical Analysis by Acid-Base Titration. " AcidBaseTitration. N. p. , n. d. Web. 12 Nov. 2012. . " ChemTeacher. ChemTeacher. N. p. , n. d. Web. 12 Nov. 2012. . " Sample Lab Report. " Sample Lab Report. N. p. , n. d. Web. 12 Nov. 2012. . " Titration Lab Report. " Titration Lab Report. N. p. , n. d. Web. 12 Nov. 2012. . Books: Textbook: Talbot, Chris. Chemistry for the IB Diploma. London: Hodder Murray, 2009. Print.