Author:

Title: **An investigation into the effect of pH on Methyl Orange and Phenolphthalein colour in solution.**

Introduction:

**The purpose of this investigation is to confirm the indicative properties of Methyl Orange and Phenolphthalein by observing the effect of a range of pH solutions on the colour of each.**

**This is of interest because indicators are useful for determining the products of chemical reactions and whether they’re an acid or base (alkaline). Knowing the colour changing intervals of phenolphthalein and methyl orange will allow them to be used for this purpose.**

Independent Variable:

**A series of pH solutions ranging from pH 1 through to pH 14 will be prepared in order to ascertain the colour intervals for Methyl Orange and Phenolphthalein. This series of pH solutions will be prepared using methodology published by the** [**Royal Society of Chemistry**](https://edu.rsc.org/experiments/testing-the-ph-of-different-solutions/395.article)**.**

Dependent Variable:

**Both Methyl Orange and Phenolphthalein are known to change colour at different pH. Using solutions with known pH it is possible to find out the colour of each over a range of pH. Hence, we will ascertain the colour interval range for each by adding drops of each to the colourless pH solutions.**

Controlled Variables:

**In order to maintain the reliability of our data it will be important to control the following variables;**

* **The temperature of the solutions.**
* **The batch of reactants being used (Methyl Orange, Phenolphthalein, 0.1M HCl, and 0.1M NaOH)**
* **Reactant volumes**
* **The deionised water used to dilute the acid and base solutions.**

Hypothesis:

**If there is a relationship between pH and the colours of these two indicators, then it is expected that when placed in colourless pH solutions less than pH 4, the originally orange coloured Methyl Orange solution will change to red. Likewise, when Phenolphthalein is placed in colourless pH solutions greater than pH 8, it is expected that the phenolphthalein will change to pink.**

**Science Direct (2024) states that Methyl Orange is red when in an acidic solution and yellow in neutral to basic solution. The colour change occurs between pH 3.2 to 4.4. This makes it useful for identifying acidic solutions. Phenolphthalein is stated to remain clear in acidic solutions and change to pink when the solution becomes basic. The colour change occurs between pH 8.2 to 10.0.**

Materials:

* **Eye protection**
* **13 x 100mL beakers**
* **2 x 200mL beaker**
* **2 x 10mL measuring cylinder**
* **Pipettes**
* **pH meter**

Procedure:

1. **Number the test tubes 1–7.**
2. **Half-fill test tube 1 with the hydrochloric acid solution.**
3. **Transfer 1 cm3 of the hydrochloric acid into the measuring cylinder. Add distilled or deionised water to the measuring cylinder, up to the 10 cm3 mark.**
4. **Pour some of the resulting diluted solution from the measuring cylinder into test tube 2, enough to come to a similar height as the solution in test tube 1.**
5. **Carefully, pour away all but 1 cm3 of the solution remaining in the measuring cylinder. Now add distilled or deionised water to the measuring cylinder up to the 10 cm3 mark. Pour the resulting solution into test tube 3. Continue in this way until you have solutions in test tubes 1 to 6. Put only distilled or deionised water into test tube 7.**
6. **Repeat instructions 1–5 using the sodium hydroxide solution instead of hydrochloric acid. Number the test tubes 8–13.**
7. **Put the two racks of test tubes together so that the solutions are in order 1 to 13. The test tubes now have solutions in them with pH 1 (test tube 1) to pH 13 (test tube 13).**
8. **Add a drop of universal indicator to each test tube. Rock each test tube from side to side to mix the contents. Add more universal indicator solution to each test tube if needed to allow the colours to be seen more clearly. Be sure to add the same number of drops of indicator to each test tube.**
9. **Compare the colours of the solutions with the pH indicator chart**

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| **Method** or **Procedure**  Describe what you did. It must be in:  𝤿 Use past tense, e.g.,’ Measured in 10ml of water’ or ‘10ml of water was measured’  𝤿 Passive voice (what was done rather than what you did). e.g., ‘The circuit was set up’ rather than ‘I set up the circuit’  𝤿 Give step by step instructions, like a recipe, with enough detail for another person to repeat your experiment and get the same results.  𝤿 Use dot points or numbered steps.  𝤿 Make sure that you give safety warnings and emphasize how to control variables.  𝤿 State how many times the procedures should be repeated. For example;   1. *Set up the apparatus as shown in Figure 1.* 2. *Prepare solutions by \_\_\_\_.* 3. *Place the beaker for Solution 1 on the metal mesh, 5cms above the tip of a blue flame. When handling \_\_\_\_ be sure to \_\_\_\_\_(safety consideration).*   *9) Repeat this procedure three times to allow for three sets of data to be collected.*  𝤿 Provide a diagram of the experiment design.  𝤿 Name and number the diagram, below the diagram. E.g. Figure 1: Experiment Setup  𝤿 Label or annotate the different parts in the diagram.  𝤿 The diagram must be neat and mostly just 2D lines. See class slides for an example.    Figure 1: Experiment Setup |

Results:

Table 1: Effect of different pH solutions on indicators.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test Tube Number  (pH) | Indicator | | | |
| Universal Indicator | Methyl Orange | Phenolphthalein | pH Meter |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |
| 9 |  |  |  |  |
| 10 |  |  |  |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Results**  𝤿 Descriptive title written in past tense. Title above the table  Table 1: Time taken for a cube of ice to melt under differing conditions | | | | |
| 𝤿 IV in this column | 𝤿 DV (with units for measurements)  Time taken to completely melt (sec) | | | |
| Colour of underlying paper | Trial 1 | Trial 2 | Trial 3 | Mean |
| White | 268 | 275 | 238 | 260 |
| Matte Black | 217 | 193 | 185 | 198 |
| Aluminium Foil | 305 | 332 | 290 | 309 |

|  |
| --- |
| Chart |
| 𝤿 Descriptive title written in past tense. Charts or figures are labelled underneath. |

Figure 2:

Discussion:

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| **Discussion**  **First paragraph - discuss results.**  𝤿 Use past tense.  𝤿 Use words to explain what the data shows. Describe how the variables are related.  𝤿 Indicate which data points do not fit the pattern. State whether or not they are likely to be ‘outliers’ and unreliable and why.  𝤿 State whether or not the data supports your hypothesis. Try not to write ‘proves’, ‘correct’, ‘wrong’, or ‘right’.  *The data shows an increase in \_\_\_ as \_\_\_.*  *This suggests that \_\_\_.*  *\_\_\_\_\_\_supports the hypothesis.*  *This data supports/does not support/partially supports \_\_\_*  **Next paragraph - discuss the hypothesis and any conclusions that can be made.**  𝤿 If your data supports your hypothesis, write about what happened at a molecular level. This should be similar to what you wrote in the hypothesis but with extra evidence.  𝤿 Use definitions or text from reputable sources to back up your statements (provide citations).  𝤿 Write about any other possible explanations. If your data does not, or only partially supports your hypothesis, provide alternative explanations using scientific reasoning. Provide research, including quotes, supporting your explanation of what happened at a molecular level.  𝤿 Write a concluding sentence that states whether or not your research question has been answered.  *It was predicted that there would be a \_\_\_\_\_ relationship between \_\_\_\_\_\_.*  *This might be because \_\_\_.*  *Another source that supports this reasoning is \_\_\_.*  *\_\_\_\_ accounts for the relationship that was observed in the data.*  *It can be concluded that \_\_\_.*  **Next paragraph - discuss the validity and reliability of your experiment design and method.**  𝤿 Was your experiment a true test of your hypothesis? Write about the strengths and weaknesses of your methodology.  𝤿 Did you produce valid and reliable data that answered your research question? Write about the improvements that you would make if you were to do the experiment again.  *The methodology used allowed/did not allow for \_\_\_\_.*  *This is because \_\_\_.*  *Some strengths in the method were \_\_\_.*  *A weakness in the method was \_\_\_.*  *One difficulty was \_\_\_.*  *The data can be seen as being in/valid because \_\_\_.*  *The data can be seen as being un/reliable because \_\_\_.*  **Last paragraph - restate findings, discuss ‘next steps’.**  𝤿 Summarize findings in one sentence.  𝤿 Suggest ways to significantly improve the procedure you used, or come up with a completely new procedure which addresses the problems that you just wrote about.  𝤿 If your research question was successfully answered, introduce a new research question and possible methodology which extends on from what you have learnt.  *The method could be improved by \_\_\_.*  *Another option would be to \_\_\_.*  *This would be an improvement because \_\_\_.*  *A logical next step from this experiment would be to \_\_\_.*  *This could be tested by \_\_\_.*  *It would be worthwhile to investigate what effect \_\_\_.* |

Bibliography:

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| **Bibliography**  𝤿 Use in-text citation when quoting.  𝤿 List any sources that you used for ideas or quoted in your text.  List websites and videos:  “Title of Article/Work.” URL.  For images:  Description of image. *Title of Website*, URL. |