**O3.2\_Lesson plan\_Chemistry\_pH Indicators**

**Age group/class:** 14-15 years old / 8th grade

**Lesson title:** pH Indicators

**School Discipline:** Chemistry

**Key concepts:** pH, pH indicator, phenolphthalein, acid, base

**Aims:**

- understanding how phenolphthalein indicates pH

- pH analysis of various substances using phenolphthalein

**Skills developed**: observation, description, analysis, research and collaboration

**Materials/Equipment needed**:

- periodic table

- notebook

- worksheets

- chemical compounds - sodium hydroxide solution (pH>7, alkaline), HCl solution (pH<7, acid), phenolphthalein

- laboratory tools and utensils - two Erlenmeyer glasses

- VR Headset

- VR resource <https://eloquent-ramanujan-887aa5.netlify.app/chemistry-4.html>

**Lesson plan:**

|  |  |  |
| --- | --- | --- |
| **Stages** | **Description of activity** | **Time** |
| **Preparation before the lesson** | Students will already have learned about the periodic table and the various categories of substances and their properties. This lesson focuses on the reaction of the phenolphthalein indicator with various acids and bases.  If this is the first VR experience for students, go through the safety rules:  - Students should sit down while using VR glasses and not hold anything in their hands unless the experience is such that it requires them to stand, in which case make sure there is enough space around all students.  - Students will be told to expect a feeling of vertigo. If it gets worse, students should remove their VR glasses.  - Students need to know how to adjust the focus of the view before using the glasses.  - Students should not use headphones when they are: tired, need sleep, emotional stress or anxiety, when they suffer from colds, headaches, migraines, as this can worsen their susceptibility to side effects.  - Students must have the opportunity to opt out of using VR. | - |
| **Introduction** | The teacher recaps, together with the students, the pH indicators already studied and announces that the theme of the day is the pH indicator phenolphthalein. | 10’ |
| **Initial Immersive Experience** | Students watch the VR material <https://eloquent-ramanujan-887aa5.netlify.app/chemistry-4.html> and observe the process of use, then discuss with the teacher the inferred meaning of phenolphthalein’s colours in various media. | 10’ |
| **Guided Immersive Experience** | The teacher presents the theoretical part of the lesson:  Phenolphthalein is a chemical compound with the formula C20H14O4, with uses in education, entertainment and medicine. It is easily soluble in water and is usually dissolved in alcohols for use in experiments. It is a weak acid, which can lose H+ ions in the solution. The molecule of nonionized phenolphthalein is colourless, Fen phenolphthalein protonate is orange, and Fen phenolphthalein deprotonate is fuchsia. When a base is added to a solution containing phenolphthalein, the balance between the non-ionized and deprotonated States changes in favour of the deprotonated state as the H+ ions are removed from the indicator.  Education:  − in a basic solution (pH 8.3-10.0), phenolphthalein loses H+ ions and acquires a fuchsia colour, indicating a basic medium.  -in an extremely basic solution (pH > 10.0), the slow change of phenolphthalein from fuchsia to colourless occurs, since it is transformed into its In(OH)3- form; it is used in chemistry classes for the study of reaction kinetics.  - in an acidic solution (pH 0-8.3), phenolphthalein remains colourless  - in an extremely acidic solution (pH < -1) phenolphthalein acquires an orange colour.  Entertainment: phenolphthalein is used in the production of toys, for example as a component of magic inks or paint for doll hair. In ink, it is mixed with sodium hydroxide, which reacts with carbon dioxide in the air. This reaction leads to a decrease in pH below the threshold of colour change, since hydrogen ions are released by the reaction:  OH- (aq) + CO2 (g) → CO2−3(aq) + H+(aq).  To achieve its aesthetic purpose, the ink is sprayed with a hydroxide solution, which leads to the appearance of hidden colours by the same mechanism described above for changing the colour in alkaline solution. The pattern will eventually disappear again, due to the reaction with carbon dioxide.  Medical uses: phenolphthalein has been used for over a century as a laxative, but has been removed from the composition of laxatives without a prescription due to concerns about carcinogenicity. Laxative products that previously contained phenolphtalein were rethought to have alternative active ingredients: Feen-a-Mint switched to bisacodyl and Ex-Lax was switched to a senna extract.  Phenolphthalein has been added to the European Chemicals Agency's candidate list for Substances of Very High Concern (SVHC).  A reduced form of phenolphthalein, phenolphthaline, which is colourless, is used in a test to identify the presence of blood, a reaction known as the Kastle–Meyer test. A dry sample is collected with a swab or filter paper. A few drops of alcohol, then a few drops of phenolphthaline, and finally a few drops of hydrogen peroxide are dripped on the sample. If the sample contains haemoglobin, it will turn pink immediately after the addition of peroxide.  Chemical reaction:  + HO- →  After completing the theoretical part of the lesson, the students will view the VR material again, thus having the opportunity to confirm or disprove their assumptions about the behaviour of phenolphthalein. | 15’ |
| **Follow up** | The teacher will randomly distribute worksheets with various substances. Students will go through the worksheets and they will have to answer whether phenolphthalein will indicate a basic pH or not when added to those substances. Then, the students will check their answers. | 5’ |
| **Formative Assessment** | Students will receive small amounts of phenolphthalein, with which they will determine the pH of various liquids available in the laboratory or outside it (tap water, juices, coffee, other liquids that do not pose a danger when handling, etc.). At the end, they will present the conclusions drawn from the experiments carried out. | 10’ |