

Measuring pH of substances

Overview

Prerequisite Skills:

- This activity is an introduction to the pH (potential of hydrogen) of substances . It does not require any particular previous knowledge.

Learning Goals:

- Measure the pH of different substances.
- Distinguish between an acidic substance and a basic or alkaline one.
- Classify and compare the substances according to their pH.

Key questions:

- What are acids and bases?
- How do you measure the acidity and basicity of a substance?

Materials:

- Computers/tablets for students individually or in pairs
- PhET *pH Scale: Basics* simulation:
https://phet.colorado.edu/sims/html/ph-scale-basics/latest/ph-scale-basics_en.html
- pH Pre-Lab (1 per student)
- pH Activity Sheet (1 per student)

Estimated Time:

Approximately 50 minutes (max 60 min)

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Pre-Lab

15 minutes

Students may have the following incorrect preconceptions about acidic and basic substances:

- Acidity is the opposite of sweetness, especially, when the topic is introduced in a food-related context.
- Acidity is the opposite of water, in part because of the misinterpretation of the word “base.”
- Only acids can corrode or burn materials, likely a result of how acids are described in media and movies.

At the beginning of the activity it is okay for students to have these ideas. Test them using this activity: pH - Pre-Lab.

Important: Students are frequently more familiar with the term “acid”, and less so with “alkaline” or “base”. During this activity we interchangeably use the terms “alkaline” and “base” to emphasize they are synonyms.

| Open play time | 7-10 minutes |
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| <i>Teacher will...</i> | <i>Students will...</i> |
| <ul style="list-style-type: none"> ● Distribute the activity worksheet. Ask the students to work in pairs. ● Before exploring the simulation, ask students to complete the initial answers regarding activity #1, and allow them to share their answers with other teams. ● Encourage students to take a few minutes to explore the pH Scale: Basics simulation. ● Circulate the room and ask students: <ol style="list-style-type: none"> 1. What is the simulation about? 2. How can you distinguish acidic and basic substances in the simulation? 3. Which tools can you use to measure the pH of a substance in the simulation? <p>Important: After using indicators like litmus or pH paper, students may think that the color of a liquid itself is related to its pH. To tackle this idea, the teacher may show battery acid and drain cleaner with the exact same color. You may check the teacher guide for this simulation available here (you need to sign in in your PhET account) to see other model simplifications.</p> <ul style="list-style-type: none"> ● Ask students to briefly share what their thoughts and impressions of the simulation are; what questions do they have; what do they write down regarding question #1 from the activity worksheet and discuss any of the questions above. | <ul style="list-style-type: none"> ● Make and write predictions on activity #1 before the simulation exploration. ● Begin by openly playing around with the simulation for about 5 minutes. ● Figure out how to use the simulation, find the controls. ● Respond to teachers’ informal questioning. |
| Gathering data and interpreting the evidence | 15-20 minutes |
| <i>Teacher will...</i> | <i>Students will...</i> |
| <ul style="list-style-type: none"> ● Encourage students to begin working on #2-7 from the activity worksheet in pairs, but writing in their own worksheets. Try to give them at least 5 minutes where the teacher is silent before probing/aiding. ● Circulate the room to be available for questions and ask probing questions, such as: | <ul style="list-style-type: none"> ● Complete #2-7 on the activity sheet. ● Respond to teacher questions. ● Ask questions or ask for help if needed. |

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| <ol style="list-style-type: none"> 1. How can you classify solutions as acids or bases given their pH? 2. What happens to the pH of a substance after you add water? Does the pH increase or decrease? 3. Describe two different ways you could fill the beaker with a solution with pH of 6.00. Is it possible to use hand soap to do this task? Explain. | <ul style="list-style-type: none"> • After answering, share your answers with other teams. |
| <p>Discussion and Summary</p> | <p>10-15 minutes</p> |
| <p><i>Teacher will...</i></p> | <p><i>Students will...</i></p> |
| <ul style="list-style-type: none"> • Encourage students to begin working on #8-10 on the activity worksheet. • Facilitate a class discussion to bridge an understanding and compare the answers they gave to each question. Ask students whether the answers are different and why. • Remind students to cover their laptop screens with their worksheets so they are not distracted. Use an established teaching strategy such as randomly pulling names, or small group discussions (print out or display questions and have groups talk to each other and write down any consensus for a representative “speaker” to share aloud with class). • An example of misinformation is given in the last question (#10) of the Conclusion section to the student. The image there reflects false information that circulated on social media during the COVID-19 pandemic. As a teacher it is important to comment on the purpose of discussion and argumentation, which is to justify a conclusion. An argument is made up of: <ul style="list-style-type: none"> • Thesis or personal opinion regarding the situation. In this activity the thesis is: The information shown in this image is false. • Logical reasoning. The reasons behind your opinion. • Evidence to support your opinion. In this case you should use the evidence collected from the simulation. • At the end of the discussion the teacher can ask a quick question to check: | <ul style="list-style-type: none"> • Complete #8-12 on the activity sheet. • Answer questions and question answers: students should be able to determine if they agree/disagree with others’ claims and justify their own responses. |

1. Which concept from those introduced during the lesson was most difficult for you?
2. Which one/s are the key concepts introduced by today's activity?
3. What else would you like to know on today's topic?

Going forward...

During the discussion, to capture the attention of the students, the teacher can add a space to show (or assign an activity for students to look for information) the importance and applications of pH. For example, you can mention the concept of “acid rain” and how it can be dangerous for our health or can affect both vegetation and other fauna. You can find more information about acid rain here: <https://www.epa.gov/acidrain> . Other applications are found in industry, like soaps and detergents, in foods such as cheeses and yogurts, or in alcohols such as beer and wine.