pH of Mars

Overview

Age Range:

10-14

Lesson Time:

45 Minutes (including 1 video)

Equipment Needed:

Computer

Projector

Topics Covered:

- Chemistry (pH)
- Biology (Life in extremes)
- Astronomy (Mars surface conditions)

Activity Outline

Understand how the pH of the Mars may affect the habitability of the Red Planet.

Learning Outcomes

After completing this activity, pupils will:

- Understand pH scales.
- Describe how factors on Mars can affect pH.
- Discuss how pH affects habitability.

Background Material:

Slide 1 - Introduction	In this lesson we will be looking at the pH of certain environments of Mars and how this can affect its potential habitability.
Slide 2 - Objectives	Can be seen above in Learning Outcomes.
Slide 3 – What is pH	But before we go into the effects of pH, can anybody explain what is meant by pH? (Take answers) pH is how we measure acidity and alkalinity. Bases and acids are seen as chemical opposites because the effect of an acid is to increase the hydronium (H_3O^+) concentration in water, whereas bases reduce this

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concentration. A reaction between aqueous solutions of an acid and a base is called neutralisation, producing a solution of water and a salt in which the salt separates into its component ions. If the aqueous solution is saturated with a given salt solute, any additional such salt precipitates out of the solution.

Slide 4 – pH scale	pH is usually measured using the pH scale. Low pH compounds are acidic, which ranges from a strong acid at pH 1 to a weak acid at pH 6. pH 7 is considered neutral and a pH above this is basic, from pH 8 to 14.
Slide 5 – Discuss what you think pH might be like on Mars?	Now that you have some background information, what would you expect the average pH on Mars to be? (Take answers)
Slide 6 – How can we detect pH?	In order to know this, we must first be able to detect pH. How can we do this? (Take answers) pH scales are often coloured. This is due to the common use of a solution called universal indicator, which changes colour to indicate pH. It will exhibit a red colouration in the presence of an acid, the solution will turn green at neutral pH and will go a deep blue/purple colouration in the presence of a base. However, there are other indicators such as phenolphthalein, which turns pink in the presence of a base and exhibits no colour change with an acid. pH indicators can even be commonly found in the kitchen - such as the juice of a red cabbage, which in the presence of a base will turn blue-green and pink with an acid.
Slide 7 – Detecting pH video	Here we have a video which demonstrates the changing colours of a solution when using universal indicator: https://youtu.be/wX8GXsxe5a0 Video background information: In this video there is a solution of weakly concentrated sodium hydroxide (NaOH). Universal indicator solution is added turning the solution purple. A 5% acetic acid solution is then added in the form of commercially available cooking white vinegar. The solution containing universal indicator turns red.
Slide 8 – What happened? Why?	Please discuss in groups what you observed in this video. Why do you think this happened? (Allow time for group discussion)

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(Take answers)

Slide 9 – Rio Tinto River

There are areas on Earth with extreme pH readings. One such location is the Rio Tinto river in Spain. The pH of the Rio Tinto reaches as low as 2.3 in some areas of the river, showing that this environment is highly acidic. This low pH is caused by interactions between rocks and microorganisms in the river, known as rock-water-biology interactions. This causes large quantities of compounds, such as sulphuric acid, sulphates and ferric iron to be present within the river water, the latter being what gives the Rio Tinto its distinctive red colouration.

Both eukaryotic and prokaryotic organisms have been observed in this extreme environment, thriving within the acidic conditions. Therefore, the Rio Tinto is a planetary field analogue site that can inform us on the prospects of life in extreme environments elsewhere in the Solar System.

Slide 10 – How does CO_2 affect pH?

Turning our attention back to Mars, the martian atmosphere is mostly comprised of carbon dioxide and there are large depositions of solid carbon dioxide at the poles of Mars.

What effect do you think carbon dioxide has on pH? Please discuss in groups.

(Allow time for group discussion)

(Take answers)

Carbon dioxide, when dissolved into water, produces carbonic acid which will lower the pH on Mars. Carbonic acid is something which many people encounter on a daily basis in the form of carbonated drinks. If you have ever noticed an odd aftertaste in sparkling water, this is due to the presence of carbonic acid. In fact, one of the reasons so much sugar is used in the development of fizzy drinks, is to mask this very taste.

Slide 11 – How do you think this might affect habitability?

How do you think the presence of carbonic acid would affect the potential habitability of Mars? Please discuss in groups.

(Allow time for group discussion)

(Take answers)

Slide 12 - Review

From this lesson, students should be able to answer the following:

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- What does a pH scale show?
- What factors on Mars (past or present) could affect pH?
- How could pH affect the habitability of Mars?

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