# Measuring the acidity of rain

## Introduction

Rainwater is formed by the condensation of water vapour in the atmosphere. Initially it's like distilled water - neutral and it's pH value is 7. On the way to the ground the rain is polluted by the absorption of other substances (especially $CO_2$) and becomes slightly acidic. Regular rainwater has a pH factor in the range of 5.6 - 6.2. If rainwater absorbs more pollutants, especially sulphates and nitrates, due to polluted air, and it's pH drops below 5.6, we would refer to this as acid rain. Acid rain damages facades, cultural monuments and soil, causes the death of fish in lakes and significantly harms trees. Acid rain often occurs a long way from air pollution, because wind can easily carry sulphur and nitrogen oxides long distances

## Learn about the problem

Use the internet, (scientific / popular) literature or in collaboration with experts to find available information on the causes of acid rain. Also focus on the following questions:

- What pH value does rain usually have in your area?
- Did acid rains occur in your area?
- Is there a specific season?
- Can you identify damage caused by acid rain on cultural monuments or on the health of a nearby forest?
- Can you identify air polluters in your area?

## Recommended resources

Source 1:
Acid rain, explained

Source 2:
Air pollution still harming Europe's ecosystem

Source 3:
Acid Rain: Causes, Effects and Solutions

## Verify the occurrence of a problem in your area with your own research

## Goal

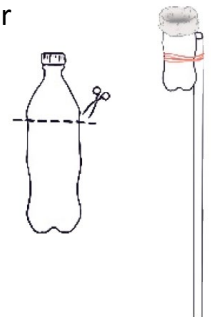
Students can analyse the pH of a rain sample, learn the negative effects of acid rain, and understand the relationship between wind direction and acidity of rain.

## Tools & Materials

- wooden or metal rod (180 – 200 cm)
- collection container / collector (cut 2 a litre plastic bottle with a diameter of about 10 cm)
- two rubber bands
- new plastic bags for collecting rainwater (one for each day) and clean rubber gloves
- litmus papers or digital pH meter
- measuring cylinder
- place for the monitoring station
- recording card
- calculator
- web page with meteorological data or mobile phone application
- camera / mobile to record activity

## Implementation

Based on your climate, choose a monitoring period in which you can expect rainfall. Then, choose the number of days you would like to measure the acidity of the rain (at least 5 in order to get a good results). Find a suitable location for the station in the school grounds (a suitable distance away from buildings, trees, and where it cannot be tampered with, to prevent the sample being contaminated or the station being damaged). Insert a rod into the ground, the rod should stand approximately 150 cm above the surface. Under the supervision of an adult, cut off the top of the plastic bottle. Fasten the bottom of the bottle to the rod with the rubber bands. The top of the container needs to be slightly higher than the end of the rod. Place a new plastic bag into the bottle on the first monitoring day. Insert the bag as follows: put on clean rubber gloves and insert a clean rain bag into the bottle.



## Measurement

Collect rainwater in the monitoring station during the selected period. Each day (e.g. in the morning) change the plastic bag and write all the necessary data onto the recording card. When you are taking measurements, follow these steps:

- Check the station (mainly its stability).
- In the absence of rainwater in the collector (less than the teaspoon), do not take any measurements.
- If you have enough rainwater, put rubber gloves on and insert the litmus paper or the digital PH meter sensor into the collected rainwater. Write the measured pH on the record card.
- Record the type of precipitation (snow, ice, rain) and assign the appropriate value of ratio.
- Check for rainwater pollution (bird droppings, dust, insects, parts of plants and other impurities) which can potentially affect the measured data and assign the appropriate value of ratio.
- Multiply measured pH value with ratios.
- Pour the collected rainwater from the bag into the measuring cylinder. Record the amount of rainfall (ml) onto the card.
- Replace the plastic bag with a new one, without touching the inside with your fingers.
- Use the weather portal or application to determine the wind direction.

After the monitoring period, calculate the arithmetic mean of the non-zero pH values and analyse the data obtained.

## Analysis of results and proposal of solution

What is the average pH value of the rain during the monitoring period? What do you think is the cause of the potential acidity? Can you identify the link between the wind direction, the source of air pollution and the results of the rainwater analysis? Suggest solutions that may help lower the acidity. Write down your suggestions.

## Implementation of the solution and evaluation

Did you manage to implement any of the suggestions? Were they successful? What would you do differently next time?

**How would you evaluate your feelings after implementing the selected solution?**

| **Frustrated** | **Disappointed** | **Rather Negative** | **Neutral** | **Rather Positive** | **Satisfied** | **Enthusiastic** |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## Publicity

Record and share photos on social networks with #mybioprofile during the activity.
Help others to join us.

## Example

| Recording card | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Class** | 9 | | | | | | |
| **School** | Elisabeth's Elementary school | | | | | | |
| **City** | London | | | | | | |
| Is there a source of local air pollution within a radius of 10 km from the monitoring station? If so, please specify: | | | | | | ~~yes~~ | **no** |
| **Date and time** | **Wind direction** | **Amount of precipitation (ml)** | **Measured pH** | **Ratio for the type of precipitation snow, ice = 1,1 rain = 1** | **Ratio for bird droppings: yes = 1,2 no = 1** | **Ratio for dust, insects: yes = 1,1 no = 1** | **Calculated pH (multiplied by ratios)** |
| | | | | **Apply ratios only if measured pH is different than 5.6 – 6.5** | | | |
| 3.6.2019 / 8:00 | S | 0 | 0 | - | - | - | 0 |
| 4.6.2019 / 8:00 | S | 0 | 0 | - | - | - | 0 |
| 5.6.2019 / 8:10 | SW | 0 | 0 | - | - | - | 0 |
| 6.6.2019 / 8:00 | SW | 52 | 5,7 | - | - | - | 5,7 |
| 7.6.2019 / 8:05 | W | 70 | 5,2 | 1 | 1 | 1,1 | 5,72 |
| 10.6.2019 / 8:00 | W | 120 | 6,1 | - | - | - | 6,1 |
| 11.6.2019 / 8:00 | W | 65 | 5,9 | - | - | - | 5,9 |
| 12.6.2019 / 8:00 | W | 60 | 5,4 | 1 | 1 | 1,1 | 5,94 |
| 13.6.2019 / 8:00 | W | 40 | 4,9 | 1 | 1,2 | 1 | 5,88 |
| 14.6.2019 / 8:00 | W | 0 | 0 | - | - | - | 0 |
| **Arithmetic average of calculated non-zero pH** | | | | | | | 5,87 |

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## Recording card: The acidity of rain

| Recording card | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Class** | | | | | | | |
| **School** | | | | | | | |
| **City** | | | | | | | |
| Is there a source of local air pollution within a radius of 10 km from the monitoring station? If so, please specify: | | | | | | yes | no |
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| **Arithmetic average of calculated non-zero pH** | | | | | | | |