Air
Section 3: Acid Precipitation

Look at the picture of U.S. rainfall patterns below:

Why do the regions directly downwind from major producers of particulate pollutants have greater rainfall amounts than the areas that are upwind?

Now look at a picture of the average acidity of precipitation across the U.S.:

Which areas have precipitation with the highest acidity?

The lowest acidity?

Why?
EQ: What causes acid precipitation and how does it affect soils, plants, humans, and ecosystems?

What Causes Acid Precipitation?

- Acid precipitation is ____________________________
  ____________________________
  ____________________________________________
  that contains a __________ concentration of __________, often because of the
  ____________________________________________.
- When ________________________________ are burned, they release
  ____________________________________________ and
  ____________________________
  ____________________________
- When these oxides ________________________________ in the atmosphere, they form
  ____________________________________________ and
  ____________________________, which falls as
  ____________________________________________.

Say What??

What does this actually look like? Let's draw a visual in the space below:
What Causes Acid Precipitation?

Then What??

- This acidic water flows ________________________________, and ________________________________.
- Acid precipitation can ________________________________, and can result in the ________________________________ of some local ________________________________.

How is Acid Precipitation Measured?

- A ________________________________ number is ________________________________ that is used to express the ________________________________ of a system.
- Each whole number on the scale indicates a tenfold ________________________________.
  - A pH of 7 is ________________________________.
  - A pH of less than 7 is ________________________________.
  - A pH of greater than 7 is ________________________________.
- Pure water has a pH of _____________, while normal precipitation has a pH of about ___________.

![Acid Rain Formation](image)

### pH READING CHART

- pH 7.5: Alkaline
- pH 7.0: Neutral
- pH 6.5: Slightly Acid
- pH 6.0: Acid
- pH 5.5: Acid
- pH 5.0: Very Acid
- pH 4.5: Very Acid

Refer to pH Values for limiting recommendations.
***Challenge Question***
Based on this information, is normal precipitation "basic" or "acidic"?

__________________________________________

Why?

• Because atmospheric ___________________________________ dissolves into the precipitation and forms ________________________________.

• Precipitation is considered acid precipitation if it has a pH of __________________________

• The pH of precipitation ________________________ among different geographic areas.
  – Example: The pH of precipitation in the eastern U.S. and Canada ranges from ____________________

• Most acidic precipitation occurs around ________________________________________.

pH Scale Analysis Questions

Using the pH scale shown above, answer the following questions:

1) Is human blood acidic or basic? __________________________

2) Is vinegar acidic or basic? __________________________

3) Which is more acidic – lemon juice or tomato juice? __________________________

4) Using data from the pH scale, explain why it is important to brush your teeth after drinking a carbonated soft drink. __________________________
How Acid Precipitation Affects Soils and Plants

- Acid precipitation can cause a _______________________________ of soil and water. This __________________________ in the concentration of acid is called _________________________________.

- When the acidity of soil __________________________, some ________________________________ by acid precipitation.

- It also can cause ________________________________ and possibly absorbed by the roots of plants causing _________________________________.

- ________________________________ in water vapor ________________________________ on the surfaces of plants.

***Challenge Question***

Acid precipitation has killed 30% of the trees in a nearby forest ecosystem. Using the space below, show how this can directly and indirectly impact the ecosystem.
Acid Precipitation and Aquatic Ecosystems

- Aquatic animals are adapted to live in an environment with a _________________.
  - The result of acid precipitation on a lake can ________________ aquatic plants and animals.
- In addition, acid precipitation causes ________________ to ________________ (______________) out of the soil surrounding a lake.
  - Aluminum accumulates in the ________________ and interferes with ________________ exchange.
  - End result → ________________

Acid Precipitation and Aquatic Ecosystems

- ________________ is the ________________ when snow melts in the spring or when heavy rains follow a drought.
- This phenomenon causes ________________, and affects the reproduction of fish and amphibians that remain.
  - ________________, and those eggs often do not hatch.
  - Offspring that do survive end up with ________________ and ________________.
Acid Precipitation and Aquatic Ecosystems

• To counteract the effects of acid precipitation on aquatic ecosystems, some states in the U.S. and some countries spray:
  – (calcium carbonate) to help restore their natural pH.

  • Because lime has a pH that is ___________________________, the lime ___________________________ the pH of the water.

  • Unfortunately, enough lime ___________________________ be spread to ___________________________ to lakes.

**Challenge Question**

Acid precipitation has killed 30% of the fish in a nearby lake ecosystem. Using the space below, show how this can directly and indirectly impact the ecosystem.
Acid Precipitation and Humans

- Examples of toxic metals include:
  - ________________________________
  - ________________________________

- Can be released into the environment when soil acidity ________________________________.
- Can find their way into _________________________________. The toxins can then, when consumed by humans, ________________________________ the human body.
- A possible connection also exists between ________________________________ and ________________________________.

Acid Precipitation and Humans

- The ________________________________ for some people is affected by acid precipitation.
- Some effects of acid precipitation on humans include:
  - ________________________________ numbers of fish, which affects commercial fishermen and the sport-fishing industry
  - Trees being ________________________________ by acid precipitation
  - Dissolving ________________________________ in common building materials, such as concrete.

***Writing Exercise***

In 2-3 sentences and using the information you have learned so far, answer the following question:

Do you think it would be better to prevent the release of acid-producing pollutants through expensive pollution-control equipment OR to find ways of cleaning up the environmental effects of acid precipitation after it has occurred. Explain your reasoning.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
Take a look at the following images. How has acid precipitation affected human-made objects and structures? Explain what the before & after pictures are showing:

Before:

__________________________________________________________
__________________________________________________________

After:

__________________________________________________________
__________________________________________________________

Before:

__________________________________________________________
__________________________________________________________

After:

__________________________________________________________
__________________________________________________________

Before:

__________________________________________________________
__________________________________________________________

After:

__________________________________________________________
__________________________________________________________

(a) Before acid rain damage

(b) After acid rain damage
International Conflict

• One problem in controlling acid precipitation is that pollutants may be released in __________________________________________________________ and __________________________ to the ground _______________________________________________________.

• For example, almost half of the acid precipitation that falls in __________________________________________________________ results from pollution produced in the ___________________________________________________ (including Ohio, Indiana, Pennsylvania, Illinois, Missouri, West Virginia, and Tennessee).

• Because acid precipitation falls ______________________________________, the problem of solving acid precipitation has been __________________________________, especially on the international level.

• Canada and the United States signed the ____________________________________________.
  – Both countries agreed to __________________________________________ acidic emissions that flowed across the Canada-U.S. boundary.

• More international agreements such as this may be necessary to control the acid-precipitation problem.
*Critical Thinking Questions*

In YOUR opinion, is it fair to expect a country that releases a significant amount of pollutants into the air that falls as acid precipitation in another country to pay some of the costs of clean-up? Why or why not?

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

Now imagine you are the leader of a country that is adding a significant amount of pollution to the air that is leading to acid precipitation in other countries. Make a PRO/CON list of (at least 3) reasons why you WOULD and WOULD NOT support clean-up efforts in those other countries.

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Now imagine you are the leader of a country that is receiving a significant amount of acid precipitation due to another country’s polluting the air. Make a PRO/CON list of (at least 3) reasons why you WOULD and WOULD NOT support other country’s helping your clean-up efforts in your own country.

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***SECTION 3 SUMMARY QUESTIONS***

1. What does pH stand for? ________________________________________________

2. Describe one way in which countries are working together to solve the acid precipitation problem.
   ________________________________________________
   ________________________________________________
   ________________________________________________

3. When soil acidity increases, what are some toxins that can be released?
   ________________________________________________

4. What is an indirect effect that pollution can have on birds?
   ________________________________________________
   ________________________________________________