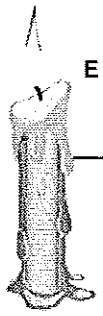
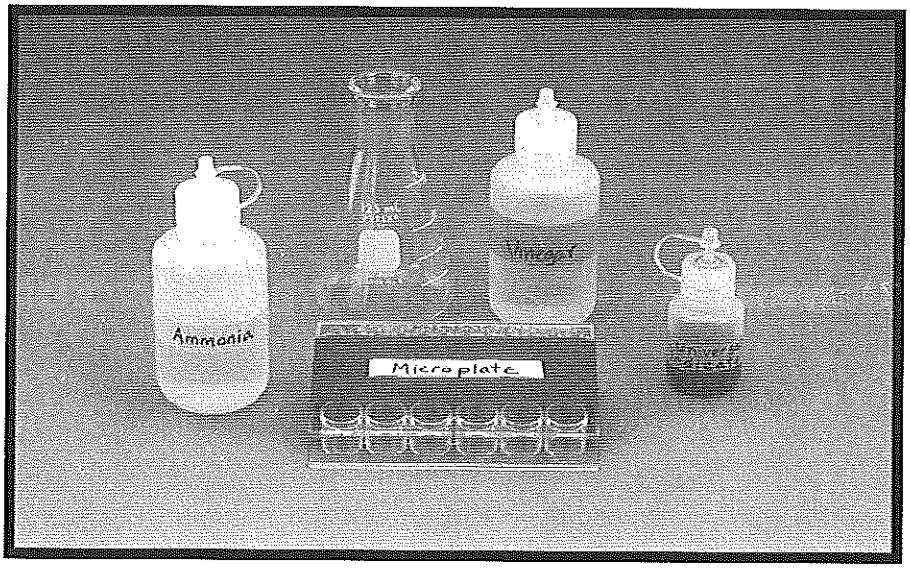


EXPERIMENT

Forwards & Backwards

Visitors prepare six solutions combining vinegar and ammonia that range incrementally from acid (all vinegar) to base (all ammonia). They add an indicator to each solution and compare the resulting colors to those on a pH scale chart. Visitors then use a flask containing water and indicator solution. They add drops of ammonia and vinegar, experimenting with the number of drops it takes to change the color of the water (indicating pH) from acid to base and back again.



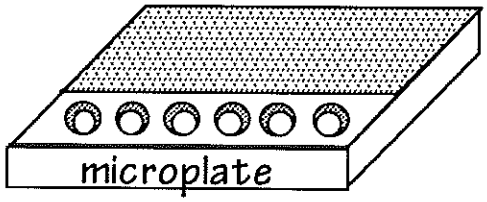
OBJECTIVES:

Visitors learn about pH and the pH scale, and about acid and base solutions. They learn that they can test for pH with an indicator solution. They also learn that some chemical reactions are reversible.

SCIENCE TOPICS	PROCESS SKILLS	VOCABULARY
Chemical Reactions	Observing	Acid/Base
Reversibility of Reactions	Measuring	Indicator
Indicators	Classifying	Ion
pH	Comparing/Contrasting	pH
Acids And Bases	Controlling Variables	Solution
Properties of Solutions	Investigating	

Forwards & Backwards

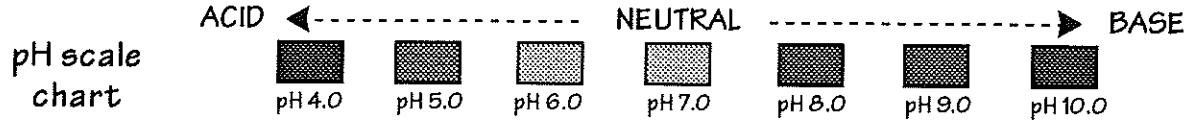
Procedure:



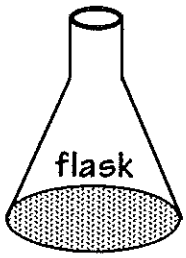
1. Always wear safety goggles.
2. Rinse the microplate and the flask.
3. In the microplate wells, combine the following solutions:

• No ammonia • 10 drops vinegar	• 2 drops ammonia • 8 vinegar	• 4 drops ammonia • 6 vinegar	• 6 drops ammonia • 4 vinegar	• 8 drops ammonia • 2 vinegar	• 10 drops ammonia • No vinegar

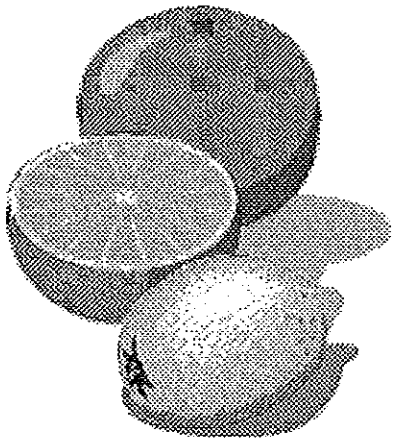
4. Add 1 drop indicator to each well. Compare the colors to those below:



- Is vinegar basic (high pH) or acidic (low pH)?
- How about ammonia?

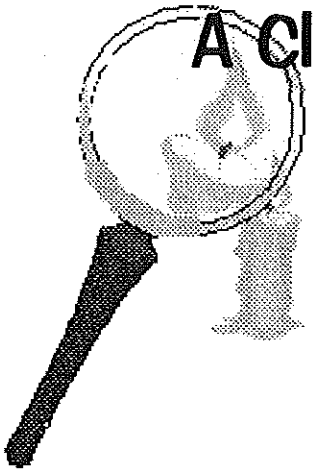


5. Add 75 ml water (H_2O) to the flask.
   Add 10 drops of indicator solution to the flask.
6. Add 1 drop ammonia (NH_3) to the flask; swirl to mix. Note the color change.
   Add 1 drop vinegar ($C_2H_4O_2$); swirl to mix. Note the color change.
7. Add 2 more drops of vinegar. Can you get the color back to blue with 1 drop of ammonia? Two drops of ammonia?
8. Rinse the flask and microplate in the sink.



What is an acid?

Why did the colors change back and forth?



A Closer Look:

What is the pH scale?
The pH scale measures the amount of hydrogen ions (H^+) in solution. A low pH or acidic solution has a high number of hydrogen ions. A high pH or basic solution has a low number of hydrogen ions. Both strong acids (low pH) and strong bases (high pH) are corrosive.

Chemical reactions go forwards and backwards depending on the chemical environment, such as the pH level. In this experiment, an indicator reacts with hydrogen ions (H^+) in solution to produce different colors. The changing colors identify the changing pH levels.

The word "acid" comes from the Latin word for "sour." Vinegar is sour . . . so is the citric acid in lemons and oranges.

MATERIALS

(with amounts to have on hand)

- One microplate–six wells across
- 125-ml flask
- Household grade ammonia (keep 32 oz on hand)
- Two 150-ml dropper bottles
- Vinegar (keep 32 oz on hand)
- Universal indicator (keep 4 oz on hand)
- One 30-ml dropper bottle

Setup/Takedown Procedures

ORIGINAL SETUP

- ❑ Tape the microplate so only six wells show, or cut off one row of the microplate.
- ❑ Label the 150-ml dropper bottles "Vinegar" and "Ammonia."
- ❑ Label the 30-ml dropper bottle "Universal Indicator."

WEEKLY SETUP

- ❑ Place the bottles of vinegar and ammonia in the unit tub under counter.

DAILY SETUP

- ❑ Set out the visitor instructions in a Plexiglas holder.
- ❑ On a tray lined with a white mat, set out the following:
  - Labeled dropper bottles with ammonia, vinegar, and universal indicator
  - Microplate
  - Flask
- ❑ Refill all chemical bottles.
- ❑ Ammonia and vinegar may be diluted with a small amount of water.
- ❑ Use the universal indicator at full strength.

DAILY TAKEDOWN

- ❑ Rinse the microplate, flask, and mat.
- ❑ Check the bottles for damage or leaks; store tightly capped bottles in an upright position.
- ❑ Place all supplies in the tub.

WEEKLY TAKEDOWN

- ❑ Sponge out the tub.
- ❑ Tightly close the dropper bottles.
- ❑ Clean the tray and leave it at the station.

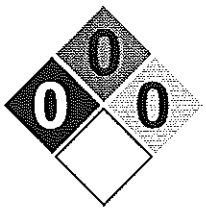
RUNNING SUGGESTIONS

- ◊ Check the results periodically to ensure that the solutions are not contaminated (the universal indicator should be same color as in stock bottle, usually red or green).

EXTENSIONS

Other examples of reversible reactions and pH changes: fish tank/ swimming pool, dry ice, and phenol red indicator; refer to pH poster.

SAFETY & DISPOSAL



No special precautions needed; follow standard lab safety procedures.