

# Help from MOM

## A Colourful Antacid Demonstration



### Introduction

Milk of magnesia (MOM) and other antacids are bases that relieve heartburn by neutralizing the acid found in the stomach's gastric juices. When hydrochloric acid and universal indicator are added to milk of magnesia, a dramatic rainbow of colour changes is observed as the antacid neutralizes the simulated stomach acid. This is a great demonstration to teach concepts of acids and bases, solubility, digestion, and "antacid-testing" consumer biochemistry.

### Concepts

- Acid–base neutralization
- Digestion
- Antacids

### Materials (for each demonstration)

Milk of magnesia (MOM), 20 mL	Graduated cylinder, 25-mL or 50-mL
Hydrochloric acid, HCl, 3 M, approximately 20 mL	Ice, crushed (or ice cubes)
Universal indicator solution, 4–5 mL	Magnetic stirrer and stir bar
Water, distilled or deionized, 800 mL	Pipets, thin-stem, disposable, 2
Beaker, 1-L (or other large beaker)	Universal Indicator Colour Chart

### Safety Precautions

*Milk of magnesia that has been brought into the lab is considered a laboratory chemical and is intended for laboratory use only. Hydrochloric acid solution causes severe skin burns and eye damage and respiratory tract irritation. It is harmful if swallowed and may be corrosive to metals. Universal indicator solution contains ethyl alcohol and is a flammable liquid. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all normal laboratory guidelines. Please review current Safety Data Sheets for additional safety, handling, and disposal information.*

### Procedure

1. Measure 20 mL of milk of magnesia (MOM) using a graduated cylinder and pour it into a 1-L beaker.
2. Add a stir bar to the MOM solution and place the 1-L beaker on a magnetic stirrer. (If a magnetic stirrer is not available, use a stirring rod to mix the solution as other reactants are added in steps 3–5.)
3. Add water and crushed ice (or ice cubes) to give a total volume of approximately 800 mL. Turn on the stir plate so as to create a vortex in the mixture.
4. Add about 4–5 mL (about 2 pipets-full) of universal indicator solution. Watch as the white suspension of milk of magnesia turns to a deep purple colour. The colour indicates that the solution is basic.
5. Add 2–3 mL (1 pipet-full) of 3 M HCl. The mixture quickly turns red and then goes through the entire range of universal indicator colour changes back to purple.
6. Repeat this process, adding HCl one pipet-full at a time, waiting after each addition until the mixture turns back to blue–purple.
7. The process can be repeated a number of times before all of the milk of magnesia has dissolved and reacted with the HCl. As more acid is added, the colour changes will occur more rapidly and eventually the suspended solid in MOM will be completely dissolved. The final solution, when all the MOM has reacted, will be red and clear.

### Disposal

It is recommended that you consult your local school board and/or municipal regulations for proper disposal methods that may apply before proceeding.

## Tips

- If a 1-L beaker is not available, use a 600-mL or 400-mL beaker. Adjust chemical amounts accordingly. *Note:* The amount milk of magnesia added does not have to be exact in order for the demonstration to work.
- The acid used in the demonstration is 3 M hydrochloric acid (HCl). Actual stomach acid ranges approximately from 0.1 to 1 M HCl. The higher concentration is used in this demonstration in order to limit the total acid volume and allow the reaction to go to completion with a reasonable volume of acid. If desired, use 1 M HCl to perform the experiment as written. The volume of acid needed will be three times greater.
- The reaction is performed with ice in order to slow down the colour changes so that all colours in the universal indicator colour range can be viewed. The reaction may be performed without the use of ice.

## Discussion

Hydrochloric acid secreted in the stomach gives the gastric juice a pH of between 1.5 and 3.5, depending upon the amount of food within the stomach. The pH of an empty stomach is usually less than 2. When gastric juices contact the esophagus, the acid may irritate and partially digest the esophageal lining. The resulting heartburn is often treated with antacids. Antacid literally means “against acid.” Antacids are weak bases that work by neutralizing the acidic environment of the stomach. This demonstration uses the antacid milk of magnesia (MOM). The active ingredient in milk of magnesia is magnesium hydroxide,  $\text{Mg}(\text{OH})_2$ . MOM works well for the demonstration because the magnesium hydroxide forms a suspension in water due to its very low solubility—0.0009 g/100 mL in cold water and 0.004 g/100 mL in hot water. This limited solubility makes it an ideal compound for use in commercial antacids because, rather than dissolving all at once, it slowly dissolves as it reacts with and neutralizes stomach acid. As the “excess stomach acid” neutralizes the dissolved magnesium hydroxide, more magnesium hydroxide enters the solution from the solid suspension state until the solution is neutralized or all of the reactants are used up.

Universal indicator is added to the MOM suspension to help visualize the neutralization reaction as it occurs. The initial colour of universal indicator in the MOM suspension is violet, corresponding to a basic solution ( $\text{pH} \geq 10$ ). (See the Universal Indicator Colour Chart on the next page.) When hydrochloric acid (the simulated “stomach acid”) is added, the mixture quickly turns red ( $\text{pH} 4$ ) as the acid disperses throughout the beaker and neutralizes a small amount of dissolved magnesium hydroxide. Some unreacted acid is still present, however, so the solution remains red. However, the unreacted acid causes more magnesium hydroxide from the suspension to gradually dissolve and react. As more of the magnesium hydroxide goes into solution, the excess acid is neutralized and eventually the solution turns blue or violet ( $\text{pH} 9\text{--}10$ ) again, indicating excess magnesium hydroxide is present. The added universal indicator allows this process to be observed. During the process, the colour of the mixture cycles through the entire universal indicator colour range—from red to orange to yellow to green to blue and finally back to violet. By adding more “stomach acid,” the process can be repeated several times before all of the magnesium hydroxide dissolves and is neutralized. The final solution, after all the MOM has dissolved and reacted with HCl, is red and clear.

Universal Indicator Colour Chart

Colour	Red	Orange	Yellow	Green	Green–blue	Blue	Violet
pH	4	5	6	7	8	9	10

The neutralization reaction is the reaction between  $\text{Mg}(\text{OH})_2$  (a weak base) and HCl (a strong acid). The overall reaction is summarized in Equation 1.



In aqueous solution, the reacting species for the strong acid, HCl, is the hydrogen ion,  $\text{H}^+$ . The products are a  $\text{H}_2\text{O}$  molecule and a  $\text{Mg}^{2+}$  ion in solution. The chloride ion,  $\text{Cl}^-$ , from HCl is considered a “spectator” ion (it is not involved in the reaction), and thus is not included in the net ionic equation.

## Acknowledgments

Special thanks to Bette Bridges, retired, B.R.H.S.; Bridgewater, MA; Annis Hapkiewicz, retired, O.H.S., Okemos, MI; and Penney Sconzo, W.S., Atlanta, GA for separately bringing this demonstration to our attention.

## References

Summerlin, L. R.; Borgford, C. L.; Ealy, J. B. *Chemical Demonstrations: A Sourcebook for Teachers*, Vol. 2; American Chemical Society: Washington, DC, 1988; p 173.

**Materials for *Help from MOM—A Colourful Antacid Demonstration* is available from Flinn Scientific Canada Inc.**

Catalogue No.	Description
AP7237	Magnetic Stirrer, 7" × 7"
MJ0122	Magnesium Hydroxide, Saturated Solution, 500 mL
UJ0002	Universal Indicator Solution, 500 mL
HJ0034	Hydrochloric Acid Solution, 3 M, 500 mL
HJ0013	Hydrochloric Acid Solution, 1 M, 500 mL
AP5367	Universal Indicator Overhead Colour Chart

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