Dynamic Design:
Launch and Propulsion

I Can't Believe I Ate
the Whole Thing

STUDENT TEXT

There is a pain that usually happens at least once a year, generally during holidays or special gatherings with relatives and friends. You get a burning acid sensation in your stomach or chest. You feel knotted up inside. The pain may move to your neck and throat and may last as long as two to three hours. The pain may get so bad that you have trouble breathing or it may cause a loud embarrassing belch. Perhaps you just ate a very large meal consisting of several courses and two trips to the dessert bar, or perhaps you just ate spicy foods, onions, or chocolate.

The pain is gastroesophageal reflux! This is commonly known as heartburn or acid indigestion.

The stomach's digestive fluids contain hydrochloric acid (HCL), a strong acid that produces lots of hydrogen ions (H+) when it is dissolved in water. The strength of an acid is measured on a pH scale. The more hydrogen ions in the solution, the stronger the acid and the lower the pH. The strongest acids have a pH of 0; weak acids have pH ranges of 4 to 6.

The pH of your stomach acid is normally between 2 and 3. If the pH is lower than this, acid indigestion occurs. If the lower esophageal sphincter, the valve between your stomach and your esophagus, is weakened, hydrochloric acid can move from your stomach to your esophagus, causing heartburn. A non-medicine solution to nighttime heartburn is to elevate the bed such that the head and torso are higher than the feet. Many people, however, will use an antacid.

An antacid is a weak base (or a salt that acts as a weak base) that is used to alleviate pain and discomfort by reacting with some of the stomach acid and raising the pH back into the normal range. Bases also vary in strength and their solutions have a pH of 8 to 14. The bases used as antacids range in pH from 8.5 to 10.5. Antacids do not bring the pH of the stomach fluids to a neutral 7. This would interfere with the normal digestive process.

Some of the most widely used antacids include:
- Alka Seltzer®, which contains sodium bicarbonate, $NaHCO_3$, and potassium bicarbonate, $KHCO_3$, plus citric acid
- Milk of Magnesia®, made of magnesium hydroxide, $Mg(OH)_2$
- Rolaids®, a complex of aluminum hydroxide and sodium carbonate, $Al(OH)_2 NaCo_3$
- Tums®, made of calcium carbonate, $CaCO_3$
- Di-Gel®, which contains aluminum hydroxide, $Al(OH)_3$

Antacids containing sodium are potent and fast acting, but the large amounts of sodium they contain is harmful for people with high blood pressure or for people with dietary restrictions. Calcium antacids are also potent and fast acting, but heavy doses can cause constipation. Antacids containing magnesium have the effect of a laxative and can cause diarrhea. Therefore, magnesium is combined with aluminum in order to counteract this effect. Aluminum by itself can cause constipation also, so it is often combined with other ingredients. Antacids will ease the symptoms of heartburn, but if you need to take antacids more often than twice a day you should consult your doctor.
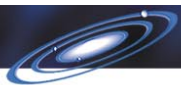
Like all medication, it is important to read and follow the directions for use when taking an antacid for heartburn. The directions on antacid containers instruct the user to fully dissolve the tablets in water before ingesting. You may have noticed during the "Pop Rocket Variables" activity that the when one puts antacid tablets in water, the tablets start to fizz. Alka Seltzer® for instance contains citric acid and baking soda (a base). When the tablet is placed in water, the acid and base react and fizz. This is similar to what happens when one adds baking soda and vinegar together. The gas that is in the bubbles is carbon dioxide.

The pressure of the gas generated from this acid-base reaction powered the pop rocket used in the activity. You will learn how this pressure caused the rocket to "lift off" in the activity "Pop Goes Newton" in the Exploration section of this module.