Acid Test

Overview: Geologists use a number of tests to identify minerals, one of which is the acid test. Regular old vinegar, also known as dilute acetic acid, is used to test for the presence of calcium carbonate, which will help you tell the difference between specimens that look similar, but really aren't, like marble and quartz.

What to Learn: Your goal is to identify samples according to their reactivity with acid. Minerals that react are called *chemical* rocks, and minerals that don't are called *clastic* rocks. Some chemical rocks contain carbonate minerals, like limestone, dolomite, and marble which react with the acid.

Materials

- Acetic acid (plain distilled white vinegar) in a dropper bottle or in a small cup with a medicine dropper
- Pie tin
- Paper towels
- Steel nail
- Optional: handheld magnifier
- Rock samples (in the video: bituminous coal, limestone, conglomerate, coquina, shale, siltstone, sandstone, and dolomite)

Experiment

1. Number and label your samples using the data table.
2. Use a dropper to take vinegar out of its bottle.
3. Drop a few drops onto your sample and watch for a reaction. You're looking for bubbles, both in size and quantity. A few tiny bubbles don't count. You're looking for a reaction similar to the baking soda and vinegar reaction you are probably familiar with.
4. Optional: check with your hand lens while the reaction is taking place.
5. Record your observations in your data table.
6. Wipe your samples dry with a clean, damp cloth.
7. Test the hardness of your sample with the nail and record it in your data table. If the sample is softer than the nail, you'll see a scratch and a powder left behind. Scratch it a couple of times to dig up more powder, then add a drop of the vinegar to the powder. Record your results. Did you see bubbles on the powder?

Acid Test Data Table

After you run your tests, circle the rock samples (in the left column) that are clastic.

Sample	Color	Hardness	Did it React and Fizz?	Powder Reaction?

Reading

If your sample fizzed, you've got carbonate in your sample, and your sample might be calcite, marble, coquina, or limestone. If the powder fizzed, you've probably found dolomite, which is similar to calcite except it also has magnesium, which bonds more tightly than calcium, making the sample less reactive than limestone.

The reaction doesn't always occur quickly. Sometimes you've got to be patient and wait. For example, magnesite has a weak reaction with acid, and if you grind it to a powder and then test, you have to wait half a minute for tiny bubbles to form. Magnifiers are helpful for these smaller, weaker reactions.

A lot of rocks contain small amounts of calcite or other carbonate minerals, so all of these make a fix even though carbonate is only a small part of the rock. There might be small veins or crystals of carbonate minerals that you can't even see, yet when you place a drop of acid on them, they bubble up. You can tell these types of rocks from the real thing because you won't be able to do more than one acid test on them. The second time you try to add a drop of acid, there will be no reaction. The acid test is just one of many tests used, and shouldn't be the only one that you use to determine your sample's identification.

Chemically speaking, when you add the acid to the samples, you're dissolving the calcium in the samples and releasing carbon dioxide gas into the car (these are the bubbles you see during the reaction).

For calcium carbonate and vinegar, the reaction looks like this:

$$2CH_3COOH + CaCO_3 \rightarrow Ca(CH_3COO)_2 + H_2O + CO_2$$

The first term on the left CH_3COOH is the acetic acid (vinegar), and the second term $CaCO_3$ is the calcium carbonate. They both combine to give water H_2O, carbon dioxide CO_2, and calcium acetate $Ca(CH_3COO)_2$.

Carbonate minerals that react with acid (either vinegar or hydrochloric acid (HCl) as shown in the video) include aragonite, azurite, calcite, dolomite, magnesite, malachite, rhodochrosite, siderite, smithsonite, strontianite, and witherite. You can increase the reactivity with HCl by warming the HCl solution before using for the acid test.

You can do this experiment in other ways, too! Place a piece of chalk in a cup of vinegar and watch the tiny bubbles form on the chalk. This also works for egg shells, because they also contains calcium.

Do not let kids test their minerals with hydrochloric acid.

(For teachers demonstrating the HCl version of this test: $CaCO_3 + 2HCl \rightarrow Ca^{++} + 2Cl^{--} + H_2O + CO_2$)

Note: a few rocks, like coquina, oolite, and tufa can produce an extreme reaction with hydrochloric acid because they have a lot of calcite, and/or a lot of pore space that allows for high surface areas (exposing more of the calcium carbonate to the acid). The reaction will be quick, foamy, and vigorous, which is why we only use *one* drop of acid at a time.

Exercises

1. What state(s) of matter is/are present during the chemical reaction of the acid test?
2. Write the chemical equation that describes the reaction using your own words. For example, to make water, you'd write: oxygen + hydrogen = water. What would you write for the reaction on the rocks?

Answers to Exercises: Acid Test

1. What state(s) of matter is/are present during the chemical reaction of the acid test? (gas: CO_2, solid: sodium acetate and calcium carbonate, liquid: water and vinegar)
2. Write the chemical equation that describes the reaction using your own words. For example, to make water, you'd write: oxygen + hydrogen = water. What would you write for the reaction on the rocks? (calcium carbonate (solid) + vinegar (liquid) = carbon dioxide (gas) + calcium acetate (solid))