

Lab: Over the Counter Drugs

FOR THE TEACHER

Summary

In this lab, students will conduct several chemical tests on given samples of over the counter medications. They will then use their results to identify an unknown drug sample.

Grade Level

High school

Objectives

By the end of this lesson, students should be able to

- Understand that each drug reacts uniquely to chemical testing based on its active ingredients.
- Analyze data to identify an unknown.

Chemistry Topics

This lesson supports students' understanding of

- Organic chemistry
- Pharmaceuticals
- Chemical change

Time

Teacher Preparation: 30 minutes Lesson: 1 class period

Materials

For each group:

One Aspirin tablet

- One Tylenol tablet
- One Advil tablet
- One Bufferin tablet
- One Excedrin tablet
- One Tums tablet
- One Rolaids tablet
- One Alka-Seltzer tablet
- One Zantac tablet
- pH paper with color charts
- Tooth picks (20-25)
- 0.5M HCl (in dropper bottle or container with lid)
- 0.2M Fe(NO₃)₃ (in dropper bottle or container with lid)
- 25ml of water in beaker
- 2–3 disposable pipettes

Safety

• Always wear safety goggles when handling chemicals in the lab.

- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- When working with acids, if any solution gets on students' skin, they should immediately alert you and thoroughly flush their skin with water.
- HCl is a caustic chemical, do not ingest or inhale; avoid contact with skin.
- Remind students that they should not consume the drugs being tests. Students should not consume lab materials even if they are otherwise edible products.

Teacher Notes

- The active ingredients in the pain relievers are listed below:
 - Aspirin acetylsalicylic acid
 - Tylenol acetaminophen
 - Advil ibuprofen
 - Bufferin acetylsalicylic acid in combination with a base (commonly calcium carbonate)
 - $\circ \quad Excedrin-acetyl
salicylic acid and acetaminophen$
 - The active ingredients in the antacids are listed below:
 - Tums calcium carbonate
 - Rolaids calcium carbonate and magnesium hydroxide
 - Alka-Seltzer acetylsalicylic acid, citric acid, sodium bicarbonate
 - Zantac ranitidine hydrochloride
- Fe(NO3)3 is used to test for the presence of a benzene ring (phenol group) that is contained in the molecular structure of many pain relievers.
- Water solubility is an important test, as the drug's active ingredient may be effected by water (ex: aspirin), in that its acidity can change, resulting in side effects when ingested.
- The purpose of the HCl test is to mimic the conditions of the stomach after ingestion.
- pH testing will help differentiate between all drug samples.
- If you don't have access to all drugs, you can reduce the list of samples to test.
- To speed up the time needed to conduct the experiment, you can grind the drug samples prior to the lab. Otherwise, each student group should be responsible for using a mortar and pestle to grind each of their drug samples.
- Unknown drug samples (1–2) should be prepared ahead of time by the teacher, otherwise students may be able to determine the identity based on the appearance of the tablet.

FOR THE STUDENT

Student Activity Sheet: Over the Counter Drugs

Lesson

Background

Many drugs, including the over the counter drugs you will use in this experiment, can be identified based on its chemical reaction with certain substances, as well as by its pH value and level of solubility in water.

Prelab Questions

- 1. What is the scientific definition of "drug"? (you may use the internet to help you)
- 2. The drugs you will test today are either considered as an "antacid" or a as "pain reliever." Categorize each drug from the materials list as one type or the other.
- 3. What active ingredient is present in each drug? (you may use the internet to help you) Include the chemical structure and chemical formula for the active ingredients.
- 4. Are there any common ingredients between the drugs you will test today? If so, identify which drugs.

Problem

Using several laboratory tests, you will collect data about each drug and use it for comparison in order to identify an unknown drug sample.

Materials

- Two well plates
- Mortar & Pestle
- Spatula
- One Aspirin tablet
- One Tylenol tablet
- One Advil tablet
- One Bufferin tablet
- One Excedrin tablet
- One Tums tablet
- One Rolaids tablet
- One Alka-Seltzer tablet
- One Zantac tablet
- pH paper w/ color charts
- tooth picks (20-25)
- 0.5M HCl in dropper bottle
- 0.2M Fe(NO₃)₃ in dropper bottle
- 25 ml water in beaker
- 2-3 disposable pipettes

Safety

- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- When the lab is complete clean up your materials and dispose of any chemicals according to your teacher's instructions.
- You will be working with acids, if any solution gets on your skin, immediately alert the teacher and thoroughly flush your skin with water.
- HCl is a caustic chemical, do not ingest or inhale; avoid contact with skin.
- Do not consume lab materials, even if they're otherwise edible products.

Procedure

1. In order to properly analyze each drug, an organized well plate must be created.

- 2. First, label above each column on the well plate with the name of each drug that will be used. If you cannot write directly on the well plate, place the plate on a blank piece of paper and label the paper. Use the data tables below for a layout guide.
- 3. If the drug samples have not been grinded into a powder, you must do so for each drug using a mortar and pestle. Clean the mortar and pestle after each use to avoid cross-contamination.
- 4. Using a clean, dry spatula add a very small (only a few granules) amount of each drug to each of the four spots in its labeled column on the spot plate. Clean the spatula after each drug had been deposited to avoid cross contamination.
- 5. In the first row of the data table, record initial observations for the appearance of the drug sample (color, size of granules, etc.). Do not add anything to the first row of wells on the well plate!
- 6. Using a pipette, add approximately 5 drops of water to the second well for every drug. Using a clean tooth pick for each well, stir the solution. Record any observations as well as the solubility: a final clear solution indicates that the drug is soluble; a final cloudy solution indicates that it is partially soluble; if the drug is distinctly separate from the water, then it is insoluble.
- 7. Using pH paper and a corresponding color chart, dip one end of a strip of pH paper into the second wells (the same wells that have the drug sample and water). Using the pH color chart for comparison, record the pH value for each drug sample in the data table. Use a new pH paper strip for ach well.
- 8. Using a pipette or dropper add approximately 5 drops of the HCl solution to each of the drug samples in the third well row. Using new toothpicks, and a different toothpick for each well, stir the contents of each well. Record any notable observations in the table, including bubbles, color change, solubility, etc.
- 9. Next, use strips of pH paper to determine the pH of each of these wells in row 3 (the same wells that have the drug sample and HCI). Compare the color of the pH paper to the color chart and record the pH value in the data table.
- 10. In the final row of wells, using a pipette or dropper add approximately 5 drops of Fe(NO₃)₃, Iron (III) Nitrate, to each well. Using clean toothpicks, stir the contents of each well (do not cross-contaminate). Carefully analyze each well, and record all observations, including bubbles, color change, solubility, etc. in the data table. *Note:* Be certain to thoroughly describe any color change observed in a well.
- 11. Do not discard the well plate contents until all tests have been run for the known and unknown samples.
- 12. Using the results of all of the known Over the Counter Drug Samples, compare the results to the unknown drug samples.

Observations

	Aspirin	Tylenol	Advil	Bufferin	Excedrin	Unknown #1
Appearance						
Solubility and pH						
HCl reaction and pH						
Fe(NO₃)₃ reaction						

	Tums	Rolaids	Alka-Seltzer	Zantac	Unknown#2
Appearance					
Solubility and pH					
HCI reaction and pH					
Fe(NO₃)₃ reaction					

Analysis

- 1. What is the identity of drug unknown #1 and drug unknown #2? Explain.
- 2. Why should you store drugs in a dry place, based on your observations?
- 3. What was the purpose of testing the drug samples with HCl?
- 4. If you have a "sensitive stomach," which pain killer(s) should you avoid, which is/are better?
- 5. Are all pain killers really the same? Explain based on your observations and answers to your pre-lab questions.