Crime Scene Chemistry: Determine the Identity of an Unknown Chemical Substance

https://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p093/chemistry/how-to-identify-a-chemical-unknown (http://www.sciencebuddies.org/science-fair-projects/project-ideas/Chem_p093/chemistry/how-to-identify-a-chemical-unknown)

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Experimental Procedure

1. The kit contains three samples marked *unknown*. According to the scenario in the Introduction, these were taken from an ill elderly lady's kitchen from the containers where she supposedly keeps her sugar, salt, and cornstarch for baking. But the doctor is concerned that one of them may be aspirin instead. Your task is to determine if any of the unknown samples are aspirin. Based on your background reading, do you think you'll be able to determine this using the tests described below? Why or why not?
2. Put on a pair of disposable gloves.
3. Place a reaction plate on your work surface.
4. Use the wax pencil (or a permanent marker) to label each column of wells as follows:
    a. *C,* for **control,** which in this case, is aspirin.
        - The other samples may be "mislabeled," but this control sample is *known* for sure to be aspirin.
    b. *Su,* for sugar
    c. *Sa,* for salt
    d. *CS,* for cornstarch
5. Label the first three rows of the reaction plate, as follows:
    a. *Water*
    b. *Iron*
    c. *Iodine*
6. The reaction plate should look like Figure 1:

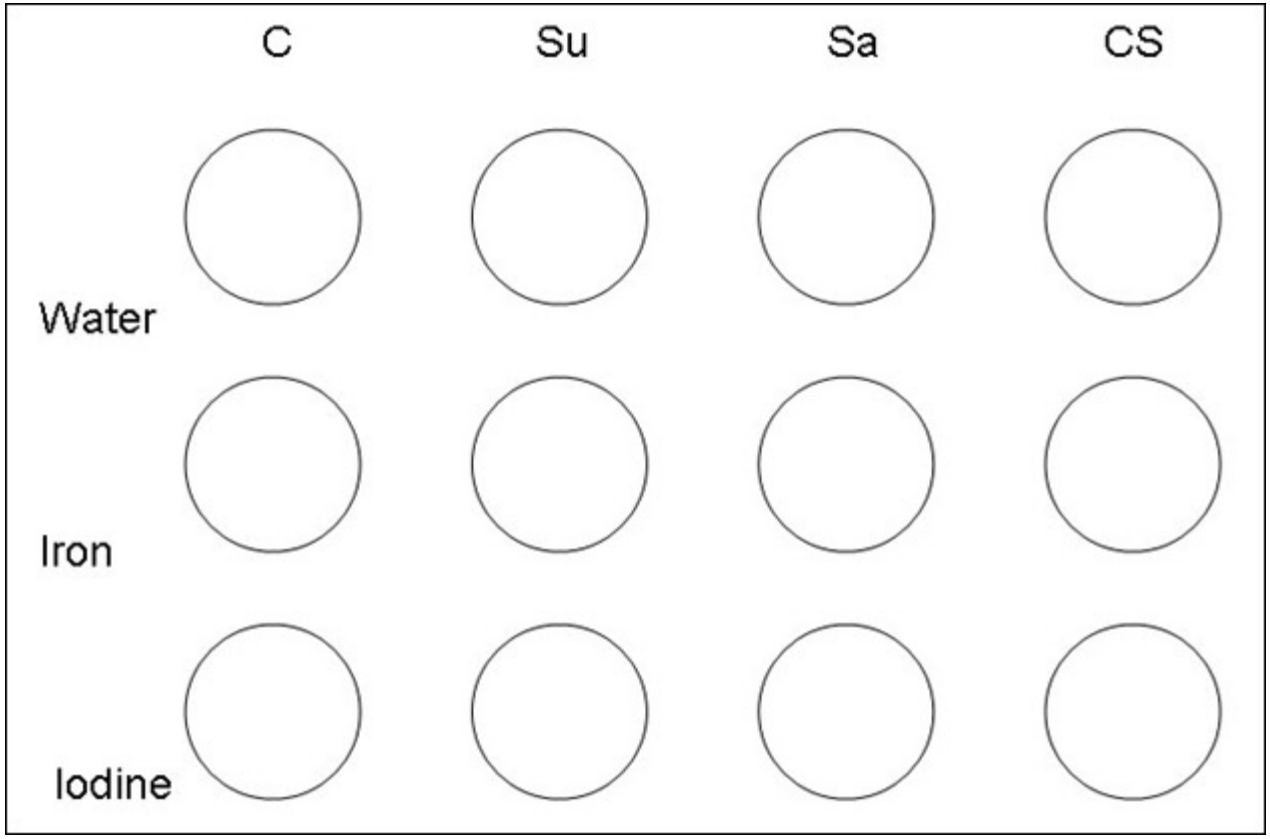

Figure 1. Reaction plate for "crime scene" analysis.

6. Place a small scoopful of the appropriate substance to be tested in each of the wells for the labeled column. Use a clean toothpick as a "scoop" for each substance. The sample marked aspirin should go in the aspirin column. The unknown sample presumed to be sugar should go in the sugar (Su) column. The unknown sample presumed to be salt should go in the salt (Sa) column, and the unknown sample presumed to be cornstarch should go in the cornstarch (CS) column.
    a. The sample marked aspirin should go in the aspirin column.
    b. The unknown sample presumed to be sugar should go in the sugar (Su) column.
    c. The unknown sample presumed to be salt should go in the salt (Sa) column.
    d. The unknown sample presumed to be cornstarch should go in the cornstarch (CS) column.
7. Record your physical observations of each powder in your lab notebook.
    a. Record color, whether the substance appears crystalline or not, and any other characteristics you can identify.

    b. Do any of the unknown substances have the same physical characteristics as aspirin?
8. Add several drops of water to each substance in the row labeled *Water.* Mix each sample gently with a clean toothpick. Use a different toothpick for each sample so you do not contaminate any of them!
9. Record your observations for each substance in your lab notebook. Do any of the unknowns behave like the aspirin sample when mixed with water? If so, which one(s)? Do any act differently? Which one(s) and how so?
10. Add two or three drops of NaOH (sodium hydroxide) solution to each sample in the row labeled *Iron.* Mix each sample gently with a different clean toothpick.
11. Wait 5–10 seconds and add two or three drops of iron nitrate solution to each sample in the row labeled *Iron.*
    a. Sodium hydroxide reacts with aspirin to form salicylic acid and acetic acid. Salicylic acid has the interesting ability to cause iron (Fe III) to turn blue/purple. So to test for aspirin in an unknown sample, you first treat the sample with sodium hydroxide, to convert any aspirin in the sample to salicylic acid, then add iron. If a blue/purple color forms, then the test is positive for aspirin!
12. Record your observations for each substance in your lab notebook. Do any of the unknowns behave like the aspirin sample? If so, which one(s)? Do any samples react differently? If so note which one(s) and how they react.
13. Place two or three drops of Lugol's iodine in the row labeled *Iodine.*
14. Record your results in your lab notebook. Do any of the unknowns behave like the aspirin sample? If so, which one(s)? Do any samples react differently? If so, note which one(s) and how they react.
15. Perform the procedure two more times with clean materials. This will show that your results are repeatable.
    a. To dispose of the reaction plates, wipe up each liquid on the plate with a paper towel and place the paper towels and the reaction plates in a regular trash.
    b. If you would like to re-use the reaction plates (for example, to do the optional experiment in step 17 below) simply wash the wiped up reaction plates with soap and water.
16. Analyze your results and make a table. What does each test tell you about the unknown substances? Are any of them aspirin?
    a. You may need to do some research about the tests in order to answer this question.
17. *Optional:* Compare known samples of sugar, salt, and cornstarch from your own kitchen with the unknown samples in the kit. Compare both their physical appearances and how they react to the three tests: water, iron, and Lugol's iodine. Is it possible to know from your observations exactly what each substance is? Why or why not?