

Mystery Powder from a Crime Scene

1. You will find multiple versions of each student experiment available—one for each supported data-collection software or app (Logger *Pro*, Graphical Analysis 4, and LabQuest App). Deliver to your students the version that supports the software and hardware they will use.
2. We suggest that you set up the Conductivity Probes before the experiment. If your sensors have a range switch, set the switch to the 0–20000 $\mu\text{S}/\text{cm}$ setting. Go Direct Conductivity Probes automatically adjust to the proper range.
3. The use of 13 \times 100 mm test tubes is suggested. For Go Direct Conductivity Probes and Go Direct pH Sensors, a larger volume of solution may be needed so that the whole end of the probe will be immersed.
4. The factory calibration on the pH Sensor and Conductivity Probe should be adequate for this activity.
5. Preparation of solutions (prepare all solutions in distilled water):
 - Preparation of ferric nitrate solution, 0.2 M $\text{Fe}(\text{NO}_3)_3$: Dissolve 8.08 g $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ in enough 1.0 HNO_3 to make 100 mL of solution.
 - Preparation of 1.0 M HNO_3 : Dissolve 6.3 mL of concentrated nitric acid in enough distilled water to make 100 mL of solution
 - Providone or tincture of iodine from the grocery store works well for this activity.
6. Mystery powders suggested for this activity are aspirin, baking soda, baking powder, corn starch, powdered sugar. It is suggested that the crime scene powder be aspirin. Other analgesics that may work are Tylenol[®] (acetaminophen) and Excederin[®] (combination of acetaminophen, aspirin, and caffeine).
7. Consider the time required to perform a melting point when planning for this activity. Each run could take 20 minutes or more. Consider having different groups of students do different compounds and then share the data. Using the suggested compounds will produce three useful melting points: aspirin, sucrose, and the crime scene aspirin.
8. Baking powder and starch will decompose in the capillary tube to a brown or black residue in the Melt Station. This will not damage the device but will not produce a useful melting point. Baking soda will decompose to sodium carbonate, which will not melt in the Melt Station.
9. Store bought sugar may contain anti-caking agents, which may interfere with the melting point determination. Baker's sugar works well.
10. Grind solids with a mortar and pestle for best melting point results.
11. Reagent grade chemicals work better for melting point determination. Store bought analgesics contain additives and coatings that may affect the melting process.

Experiment 1

	Melting point (°C)
sucrose	186
aspirin (acetylsalicylic acid)	135
Tylenol (acetaminophen)	169
caffeine	235

12. To save time, pH and conductivity data can be collected using the Selected Events mode in the data-collection software. Data will be recorded in the data table automatically. Only numeric values are allowed, so students will need to keep track of each substance.
13. For additional information about the Vernier probeware used in this experiment, including tips and product specifications, visit www.vernier.com/manuals and download the appropriate user manual.
14. If you are using Go Direct sensors, see www.vernier.com/start/go-direct for information about how to connect your sensor.

HAZARD ALERTS

The chemical safety signal words used in this experiment (DANGER, WARNING, and N/A) are part of the Globally Harmonized System of Classification and labeling of Chemicals (GHS). Refer to the Safety Data Sheet (SDS) that came with the chemical for proper handling, storage, and disposal information. These can also be found online from the manufacturer.

Acetylsalicylic acid, aspirin, solid: DANGER: Do not eat or drink when using this product. Causes skin and serious eye irritation. Do not ingest any over-the-counter medications. They are for laboratory use only.

Baking soda, sodium bicarbonate: Exposure may aggravate those with pre-existing eye, skin, or respiratory conditions. Prolonged contact with dust can produce mechanical irritation.

Starch: WARNING: May form combustible dust concentrations in air.

Providone Iodine: WARNING: Hazardous in case of eye contact (irritant), of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant, permeator).

Acidified Iron (III) nitrate, $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$: DANGER: Causes severe skin and eye irritation. Do not breathe mist, vapors, or spray. Oxidizing liquids. May intensify fire; oxidizer. Keep away from heat, sparks, open flames, and hot surfaces. No smoking.

Nitric acid, concentrated, HNO_3 : DANGER: May intensify fire—oxidizer. Keep away from heat, sparks, open flames, and hot surfaces. Causes severe skin burns and eye damage. Do not breathe mist, vapors, or spray—toxic if inhaled. Avoid contact with acetic acid and readily oxidized substances.

ANSWERS TO CASE ANALYSIS QUESTIONS

1. Answers will vary. Students should cite both chemical and physical data to support their claim.
2. The nitric acid reacts with carbonate containing substances such as baking soda and baking powder.
3. Answers will vary. Students should cite melting point data to support their claim.
4. Spectroscopy, density.

SAMPLE RESULTS

Part I Chemical and Physical Properties

Powder	Conductivity of solution ($\mu\text{S}/\text{cm}$)	pH of solution	Observations with iodine solution	Observations after addition of Fe^{3+}
Crime scene	540	3.10	yellow	pink
Baking powder	1957	7.71	black	yellow + bubbles
Baking soda	7262	8.34	yellow	yellow + bubbles
Aspirin	569	3.07	yellow	pink
Cornstarch	11.9	5.17	black	no change
Sucrose	4.5	5.15	yellow	no change

Powder	Rough initial melting temp ($^{\circ}\text{C}$)	Rough final melting temp ($^{\circ}\text{C}$)	Second initial melting temp ($^{\circ}\text{C}$)	Second final melting temp ($^{\circ}\text{C}$)	Range of melting temps ($^{\circ}\text{C}$)
Crime scene			132.4	136.3	1.9
Baking powder	NA				
Baking soda	NA				
Aspirin			133.4	135.7	2.3
Cornstarch	NA				
Sucrose	186	190	182.3	186.6	2.0

Experiment 1

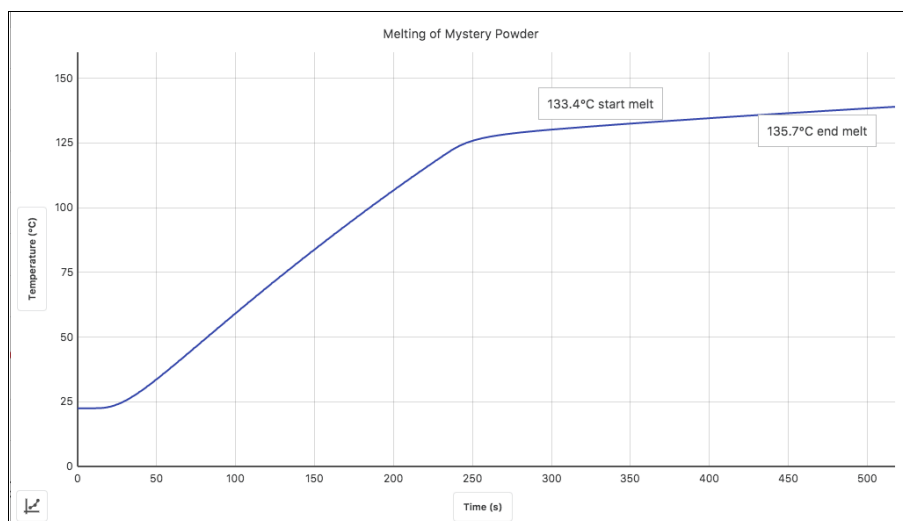


Figure 1 Mystery Powder Melting Point graph

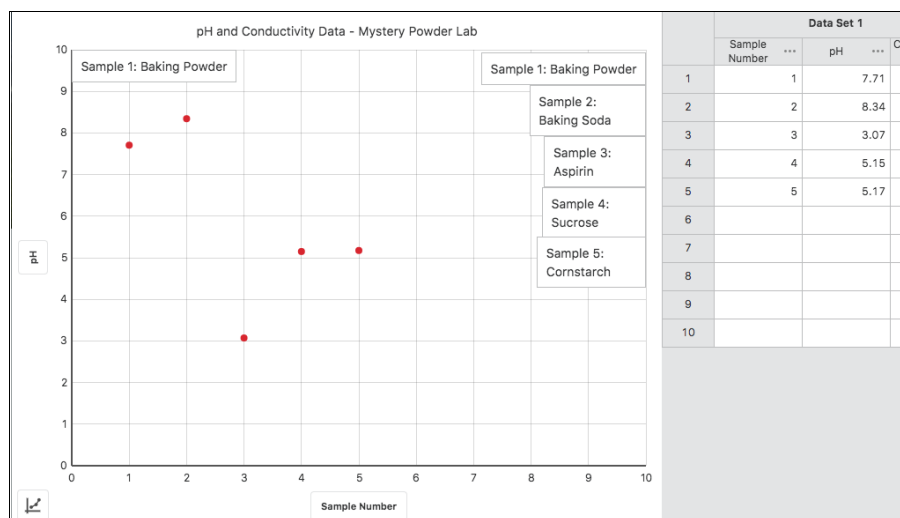


Figure 2 Mystery Powder known substances pH and Conductivity data using Selected Events mode