A Visit with Marie Curie
Curriculum Guide

This document contains optional classroom activities for students in grades 4 through 12 to supplement the program "A Visit with Madame Curie." I welcome feedback and suggestions. I particularly recommend that students ponder what question they might ask Marie Curie *prior* to the day of the program. Asking each student to write down one question on a 3x5 card is one way to facilitate this.

Regards,
Susan Marie Frontczak

Preparation for the Performance

GEOGRAPHY / HISTORY

Where are Poland and France on the map? How have Poland's borders changed over the centuries?

Contemplate what the world was like 100 years ago. This can range from the very simple to the ambitious. Which of the following were around 100 years ago? Telephone, telegraph, computers, copy machines, automobiles, airplanes, X-ray, antibiotics. (Telephone and telegraph were available, but not universally. Automobiles and X-ray were in their infancy. Airplanes were experimental. Copy machines, computers, and antibiotics were not yet invented.)

Marie Curie discovered two elements. She also discovered radioactivity — that certain elements give off very high energy rays. But she lived in a time that no one expected a woman to study science, let alone excel at it. What would you like to ask this famous person?

SCIENCE

It is helpful if students understand these concepts from chemistry: Our world is made up of a finite number of elements. Some we recognize easily: gold, silver, iron, copper, carbon (as charcoal). Many elements combine in different ways to make compounds. (e.g. Sugar is made of carbon, hydrogen, and oxygen. Salt, or sodium chloride, is made of sodium and chlorine. Some elements and compounds, when mixed together, do not combine into new compounds, but remain as a mixture.

Where are radioactive elements mined? What are the dangers of working with radioactive materials?

What would you like to ask this famous scientist about her work?

Susan Marie Frontczak
Speaker / Writer / Actor / Storyteller
303 442-4052 • www.storysmith.org • susanmarie@storysmith.org • 3664 Chase Court, Boulder CO 80305

<u>**Following the Performance**</u>

SCIENCE

This section describes two kinds of activities. The first is an easy, fun, and safe chemistry experiment that can be done in the classroom or at home. The second describes exploratory activities. Both can be adjusted as appropriate to grades 4-12.

1. An Experiment. Within the program Marie Curie describes her fractional crystallization process. She compares the salt we eat (sodium chloride) with the salts she is working with, a mixture of barium chloride and radium chloride.

Concepts: super saturated solution, Evaporation, crystallization.

Materials:

sugar
salt
water
beakers
petri dishes, or some dish in which to place the saturated solution to dry and crystallize
a Bunsen burner (optional). With younger students, for safety reasons, the experiment can be done with room-temperature water or warm tap water.
microscopes

Activities:

- Observe salt crystals and sugar crystals under the microscope. Pierre Curie was fascinated with the topic of symmetry. On what axis are salt crystals and/or sugar crystals (or other crystals) symmetrical?

- Look at the chemical formula for salt (NaCl) and for sugar ($C_{12}H_{22}O_{11}$). [Glucose is $C_6H_{12}O_6$]

- Hypothesis #1. How much salt can dissolve in a quarter cup of hot water? (Or, better, use metric units. But a liter is rather more than you want every student or pair of students to deal with.)

- Hypothesis #2. Do you think you can dissolve more sugar in a given amount of hot water or more salt in that same quantity of water?

- Measure by experiment: how much salt can dissolve in a cup of hot water? (Or, better, use metric units. But a liter is probably more than you want to deal with.) Have the students design the experiment. It is non-trivial to figure out how much salt to keep adding, without going overboard. If you just dump in a whole lot of salt and a bunch of the salt doesn't dissolve, then you don't find the answer to your question and you have to start over.

- Once you have dissolved as much as you can, take the mixture off the heat and observe as it cools. (They will notice that salt starts to crystallize almost immediately. The sugar becomes a thick syrup and does not immediately crystallize. Depending on how humid it is and how much liquid you started with, it will take some number of days for all the water to evaporate. The quickest way is to pour a bit in a petri dish. But it is fun to have at least one beaker in the classroom that has rather more in it. The crystals form all over the wall of the beaker and up over the edge. It's rather pretty and impressive.)

- Measure, likewise, for dissolving sugar in the same quantity of water. (The students will be surprised. A great deal more sugar dissolves than salt. And it turns into a very thick syrup.)

- Again, once you have dissolved as much sugar as you can, take the mixture off the heat and observe as it cools. (Sugar crystallizes much more slowly. You will first see a thin layer across the top, like ice freezing on a pond. Depending on how humid it is and how deep the fluid is in the beaker, it will take one to three months for the sugar to completely crystallize. Once again, a petri dish will give quicker results. But have at least one beaker with a couple inches of syrup in it. With sugar, much larger crystals form under water as the weeks go by, and it is fun to see them grow.)

- Students who understand valence can be given the puzzle of figuring out the chemical formula for radium chloride and barium chloride, as compared to sodium chloride. That is $RaCl_2$ and $BaCl_2$ as compared with NaCl.

Request for suggestions:

- More advanced: Can you suggest a mixture another pair of salts (non-radioactive!) which the students could separate using fractional crystallization? If you can suggest such an experiment, I'd be interested in knowing what salts (or other substances) you use, and what method you would recommend for determining increased purity. Marie could measure the increased radioactivity when separating the radium chloride from the barium chloride. There would need to be some other measurement when separating salts that are not radioactive.

- Students who understand chemical formulas can get the idea that you can get a salt by taking an acid and replacing the hydrogen with a metal. Can you recommend a chemical transformation from acid to salt that could be done in a school laboratory?

2. Exploratory activities

A. Marie Curie figured out that radioactivity was an atomic property of the element uranium. Her next question was whether any other element also "exhibited this remarkable property" of emitting rays. So her next experiment was to gather examples of every known element to test in her electrometer. How many elemental samples can the students come up with? This activity develops an understanding of and familiarity with the periodic table. Students will notice that there are some areas of the periodic table for which it is easy to come up with pure samples (gold, silver, copper, iron, aluminum, carbon). The activity raises awareness that some elements are very plentiful on our planet while others are rare. If they cannot come up with an elemental example of a given element, can they come up with a compound that contains that element? (For example, a student might figure out that water contains both hydrogen and oxygen, which are harder to 'capture' as gases.) Or can a student come up with something that contains the pure element? For example, a student might figure out that she can bring in a medical thermometer to represent mercury. Another might notice that certain vitamin supplements contain potassium or calcium or magnesium, etc.) For students that understand chemical formulas, it gets them to think about what elements are "hidden" in objects or substances that they know.

B. Ask the students: How are radioactive elements used today? Students could search the web or encyclopedias. Some of the uses they may come up with are radiation therapy for cancer, inspecting welding joints, carbon dating of ancient artifacts, sterilizing surgical equipment, preserving foods, and powering smoke detectors in homes.

ENGLISH COMPOSITION / ESSAY

1. Marie Curie has been called a "preeminent woman of science." How would you defend this description of her based on your knowledge of her accomplishments in collaboration with her husband Pierre Curie and her individual contributions to the world of science?
2. In addition to being a scientist, Marie Curie was a wife, a mother, and a patriot. How does her life show that she valued all these roles even as she was making scientific discoveries that would change the world?
3. Success is often measured by one's ability to overcome obstacles. What are some obstacles that Marie Curie faced? (Examples: not being allowed to speak her native language of Polish, being told as a woman she couldn't attend university, and not having money to go to college. Later she coped with the tragic death of her husband and co-worker, Pierre; and her own illness.) How successful was she in overcoming these significant obstacles?

GEOGRAPHY / HISTORY

- Find Poland and France on the map.

- How did people communicate 100 years ago? How did people travel?

- What did the map of Europe look like 100 years ago? What wars were being fought 85 to 100 years ago?

- What were the rights of women 100 years ago? (Women did not yet have the right to vote. In France a woman's income was the property of her husband. At the same time that Maria Sklodowska (later to become Marie Curie) was studying physics at the University of Paris, Octave Mirbeau wrote, in Belle Époque [1890's] Paris, "Woman is not a brain, she is a sex, and that is much better. She has only one role in this world, to make love, that is, to perpetuate the race. She is not good for anything but love and motherhood. Some women, rare exceptions, have been able to give, either in art or literature, the illusion that they are creative. But they are either abnormal or simply reflections of men." This is the world in which Marie Curie lived, and excelled in spite of her surroundings.)