

## The Sun and Solar Wind: A Search for the Beginning

# MASS, MASS – Who has the MASS? Analyzing Tiny Samples

### STUDENT ACTIVITY

### INSTRUCTIONS

#### PART 1

1. Your goal is to devise an experimental method of distinguishing among the four new superheavy elements: Pn, Nik, Di, and Q. These elements are one-atom samples that have been given to you by the teacher. The scientist and the robot should discuss some possible ways of distinguishing among these elements before getting started. Write down some of your ideas on the [Reporting/Data Sheet](#) supplied by the teacher. Remember that touching and visual observations by the scientist are not presently possible, but the robot is pretty smart!
2. The scientist should now choose a method that can be carried out in the classroom for distinguishing among the four new “elements.” Remember, the scientist has had an accident and is temporarily unable to see and feel. Describe the chosen method on Reporting/Data Sheet. The scientist should direct the robot to make and record the distinguishing measurements for each of the new elements.
3. The robot should now make the measurements and record the results in the Data Table. Use appropriate units. Then answer question “d” on the Reporting/Data Sheet.
4. Indicate to your teacher that you have finished Part 1.



**Now the scientist has recovered fully from the accident and can participate in all of the activity procedures.**

#### PART 2

1. Shortly after the new elements were created, it was discovered that the elements Pn and Nik differed. Additional information about Di and Q is not presently available. Obtain samples of these new forms,  $^5\text{Pn}$ ,  $^2\text{Nik}$ , and  $^3\text{Nik}$ , from your teacher.
2. Measure the same property for each of these new forms that you measured in PART 1 and record the results on the appropriate line in Data Table #1.
3. Calculate the average value, or mean, of the property that you have measured for the elements and record the results on Reporting/Data Sheet.

#### PART 3

1. It has now been established that the element Di comes in three different forms:  $^1\text{Di}$ ,  $^2\text{Di}$ , and  $^4\text{Di}$ . Furthermore, it has been determined that there is always twice as much  $^2\text{Di}$  present as there is of each of the other forms. It also has been determined that there is only one form of element Q. Obtain a collection of “atoms” that represent the new forms of element Di from your teacher.

- Determine the fractional and percent abundance of each form of the element Di and record your results on the Reporting/Data Sheet.
- Measure the same property for each of these new forms of Di that you measured in PART 1 and record the results in the Data Table #1.
- For the element Di, determine the weighted average of the property that you have been measuring. Record your result on the Reporting/Data Sheet.

**PART 4**

As you finish your work on these new elements, a NASA scientist rushes into your lab. The scientist hands your robot a sample containing 12,000 atoms of one of these new superheavy elements and asks you to determine quickly which it is. You quickly weigh the sample and find that its mass is  $6.8 \times 10^5$  grams. On the Reporting/Data Sheet, enter the identity of the element in the sample.

