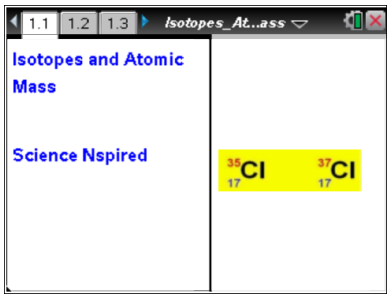
Science Objectives

- Students will run a mass spectrometer simulation to gain an understanding of how the masses and abundances of the isotopes are determined experimentally.
- Students will learn the relationship between the average atomic mass and the masses of the stable isotopes of that element.



Vocabulary

- amu
- average atomic mass
- ionization
- isotope
- magnetic field
- mass spectrometer
- percent abundance

About the Lesson

- This lesson features a simulation of a mass spectrometer. Students will use a slider to adjust the magnetic field to direct either Cl-35 or Cl-37 to the detector.
- In doing this activity students will:
  - Gain an understanding of how the masses and abundances of the isotopes are determined experimentally.
  - Practice doing problems involving isotopic masses and abundances and average atomic mass.
  - Learn the relationship between the average atomic mass (as found in the Periodic Table) and the masses of the stable isotopes of that element.

Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

TI-Nspire™ Navigator™

Send out the *Isotopes_Atomic_Mass.tns* file.

- Monitor student progress using Class Capture.
  Use Live Presenter to spotlight student answers.

Lesson Files:

Student Activity

- Isotopes_Atomic_Mass_Student.doc
- Isotopes_Atomic_Mass_Student.pdf

TI-Nspire document

- Isotopes_Atomic_Mass.tns

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Discussion Points and Possible Answers

Move to pages 1.2 – 1.4.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q1. Most elements have two or more **isotopes**, like Cl-35 and Cl-37. _____. All of the isotopes of an element have the same number of _____. (More than one response may be correct.)

Answer: A. protons and C. electrons

Q2. Isotopes of an element have a different number of _____. (More than one response may be correct.)

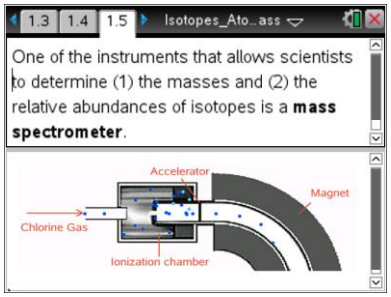
Answer: B. neutrons

Q3. Isotopes of an element have the same mass.

Answer: B. False

Move to page 1.5.

1. The students should study the schematic diagram of a mass spectrometer.



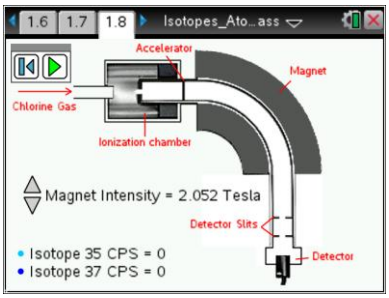
Move to page 1.6.

Have students answer the question on either the device, on the activity sheet, or both.

Q4. In the first stage of the mass spectrometer the atoms in the vaporized gas (chlorine in this case) _____.

Answer: A. are ionized to become +1 ions

Move to pages 1.7 and 1.8.



2. Students should read the instructions on page 1.7 for running the mass spectrometer simulation on page 1.8. After starting the simulation, the students will use the up/down arrows to adjust the magnetic field so that either Cl-35 or Cl-37 enters the detector. The counts per second are given for each isotope. Remind students to be patient to allow the counts per second to stabilize to ±1 cps.

Tech Tip: Press menu if you need to view the directions again.

Tech Tip: Select **Tools > Directions** to view the directions again.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter and have the student demonstrate the mass spectrometer. You may want to ask students (1) how the intensity of the magnetic field affects the trajectory of the isotopes and (2) what is the relationship between the value of the required magnetic field and the mass of the isotope (the heaver isotope requires a larger magnetic field to "bend" the trajectory enough to reach the detector).

Move to pages 1.9 – 1.21.

Have the students answer questions 5 – 12. Interspersed between the question pages are note pages (pages 1.11, 1.13, 1.15, 1.18, and 1.20) with the data needed to answer the questions.

Q5. Based on the data from the mass spectrometer, which Cl isotope has the greatest abundance?

Answer: A. Cl-35

Q6. To three significant figures, the percent of Cl-35 is _____%.

Answer: 75.8

Q7. If chlorine were 50% Cl-35 and 50% Cl-37, the average atomic mass of Cl (to four significant figures) would be _____ amu.

Data: Cl-35 is 34.97 amu.
Cl-37 is 36.97 amu.
1 amu = 1.66054×10^{-27} kg

Answer: 35.97

Q8. The average atomic mass (four significant figures) for Cl is _____ amu.
Data: The abundance of Cl-35 (34.97 amu) is 75.78%.
The abundance of Cl-37 (36.97 amu) is 24.22%.

Answer: 35.45

Q9. 10,000 carbon atoms have a mass of _____ amu.
Data: The abundance of C-12 (12.000 amu) is 98.93%.
The abundance of C-13 (13.003 amu) is 1.07%.

Answer: B. 12,010

Q10. The average atomic mass of C is _____ amu.
Data: The abundance of Mg-24 (23.985 amu) is 78.99%.
The abundance of Mg-25 (24.986 amu) is 10.00%.
The abundance of Mg-256 (25.983 amu) is 11.01%.

Answer: B. 12.01

Q11. The average atomic mass (four significant figures) for Mg is _____ amu.

Answer: 24.31

Q12. The percentage of Ga-69 found in nature is _____% (three significant figures).
Data: Ga is 69.723 amu.
Ga-69 is 68.926 amu.
Ga-71 is 70.925 amu.

Answer: 60.1

TI-Nspire Navigator Opportunities

Use Live Presenter to display the calculator pages for the quantitative questions students answer. The calculator pages will show the steps (correct and incorrect steps) the students used to answer the questions. If students answer the questions within the .tns file, the files can be collected at the end of class and graded electronically and added to the Portfolio.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.