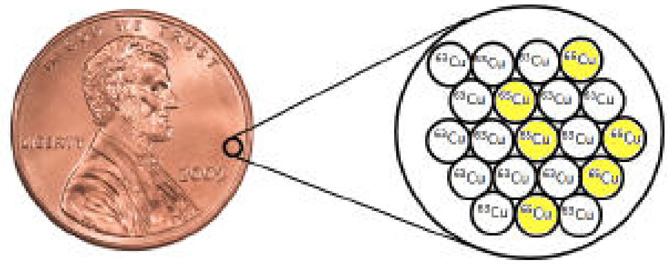
Name __________73 points__________ Block __________

Unit 3 Lab Activity: Isotopes and Mass Spectrometry

Answer all questions below in a color other than black.

1. Shade in all the ^{65}Cu isotopes in the sample of copper. How many atoms of each isotope exists? ^{63}Cu = _**14**__ ^{65}Cu = __**6**__



2. What is the percent of of each isotope? Show your work to earn credit. **70% and 30%** **part/whole x 100 = %**

3. a) What is the average atomic mass of copper listed on the periodic table? **63.546**

   b) Is it closer to 63 amu or 65 amu? **63**

   c) How does the information from the picture above explain the answer to the previous question? **Since there are more ^{63}Cu atoms the average mass will be closer to 63.**

4. Consider the data given in the table below. Determine the average mass of an element based on data table the isotopic abundance and the mass of each isotope

Isotope	% Abundance
^{20}Ne	90.48
^{21}Ne	0.27
^{22}Ne	9.25

(Mass x Abundance) + (Mass x Abundance) + etc.

(20 x 0.9048) + (21 x 0.0027) + (22 x 0.0925) = **20.1877 amu**

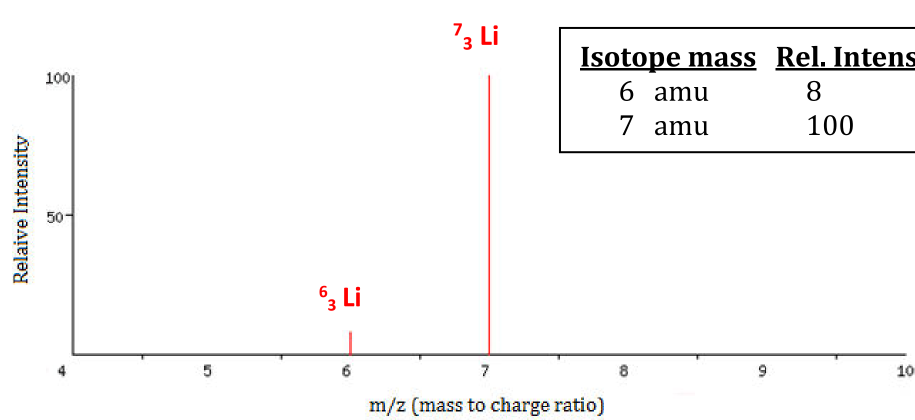
Notice Abundance is in decimal form, not percent form!

5. There are two stable isotopes of calcium: Ca - 40 (39.96) and Ca - 46 (45.95). Using the average atomic mass of calcium from the periodic table, calculate the % abundance of each isotope of calcium.

39.96(x) + 45.95(100-x) = 40.08(100)

x = 98% for ^{40}Ca so that means ^{46}Ca = 2%

The graph below was produced when an element, lithium, was analyzed in a mass spectrometer. Use the graph to answer the questions on the next page.



Isotope mass	Rel. Intensity
6 amu	8
7 amu	100

Mass spectrum of Lithium

6. How many isotopes of Lithium exist? **2**

7. What masses are present on the graph for the following

   a) The mass of the most abundant isotope **7**

   b) The mass of the least abundant isotope. **6**

8. Label the each peak on the previous page with the nuclide symbol for each isotope. should be on front page

9. Without performing any calculations, predict the approximate atomic mass for lithium. Explain the basis for your prediction.

   Answer should be less than 7 since two isotopes exist. Answer should NOT be 6.5, since both isotopes are not 50%.

10. Now calculate the average atomic mass of the element from the mass spectrum data. **The height of each peak is the relative intensity, *not the % abundance*.** You will first need to calculate the % abundance and then the average atomic mass.

    a) What is the relative intensity of each peak listed on the previous page?

    Peak 1 = __**8**__

    Peak 2 = __**100**__

    b) What is the total combined relative intensity of the peaks?

    Total = ___**108**__

    c) Calculate the % abundance based on the intensity of each peak using the formula below.

    Peak 1% = __**7.4%**__

    Peak 2% = __**92.6%**__

$$\%\,Abundance = \frac{Peak\ Intensity}{Total\ Combined\ Peak\ Intensity}$$

    d) You've just determined the % abundance for each isotope of the element. Complete the table and calculate the average atomic mass of the element to three decimal places.

Isotope Notation	Mass	% Abundance
$^{6}_{3}Li$	6 amu	7.4%
$^{7}_{3}Li$	7 amu	92.6%

    Average atomic mass = __**6.926**____amu

11. The modern use of mass spectrometry provides another example of how experimental data can be used to test or reject a scientific model.

    a) Does data from mass spectrometry demonstrate evidence which supports or contradicts Dalton's early model of the atom? Explain.

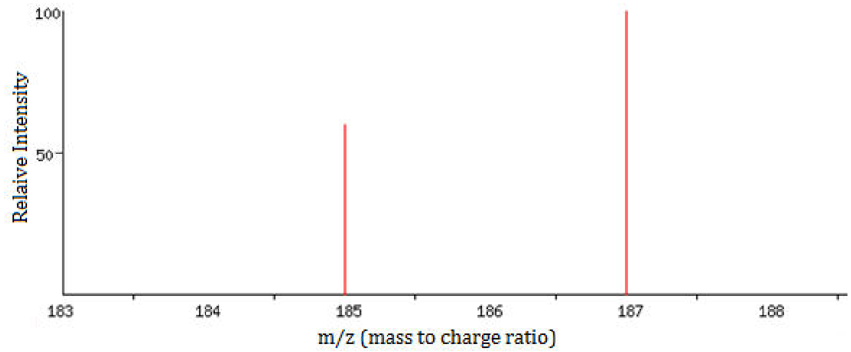
    Contradict - Dalton said all atoms are identical but mass spec indicates isotopes.

b) How does data from mass spectrometry demonstrate direct evidence of different isotopes of the same element? **Masses are close together but different, and they have different relative intensities.**

12. What element's mass spectrum is represented to the right? Explain your answer.

Rhenium = Re atomic #75

The average atomic mass of Re on the periodic table is 186.287 amu.



13. a) What is the average atomic mass of Boron listed on the periodic table? **10.811 amu**

b) If there are two predominant isotopes of Boron on earth, ^{10}B and ^{11}B, which do you think is most abundant? **^{11}B**

c) Make an estimate of the percentage of each isotope of Boron.

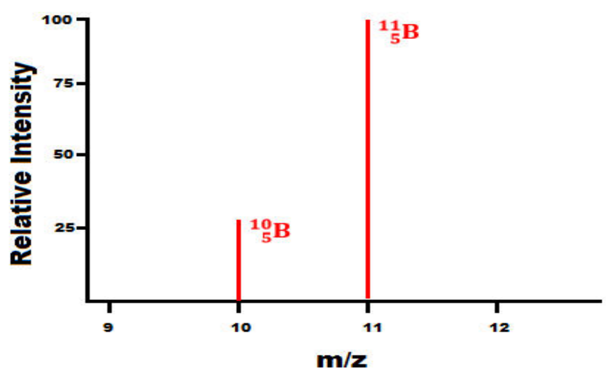
19% to 20% ^{10}B and 80% to 81% ^{11}B

d) Draw a rough sketch for the mass spectrum of Boron. Label each peak with the appropriate nuclide symbol. The largest peak should have a Relative Intensity of 100. Calculate the height of the second peak using the equation below. (x = height of smaller peak)

$$\frac{smaller\ \%}{100} = \frac{smaller\ height}{100 - height}$$

$$\frac{19\ \%}{100} = \frac{h}{100 - h}$$

x = height of smallest peak = 23



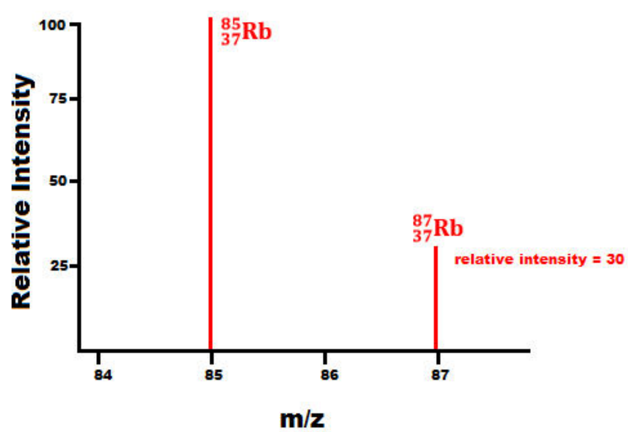
14. There are two naturally occurring isotopes of rubidium, ^{85}Rb and ^{87}Rb. Use the process above to draw a rough sketch for the mass spectrum of rubidium. Show calculations for height of smaller peak's intensity.

85(100-x) + 87(x) = 85.4678(100)

x = 23% for ^{87}Rb

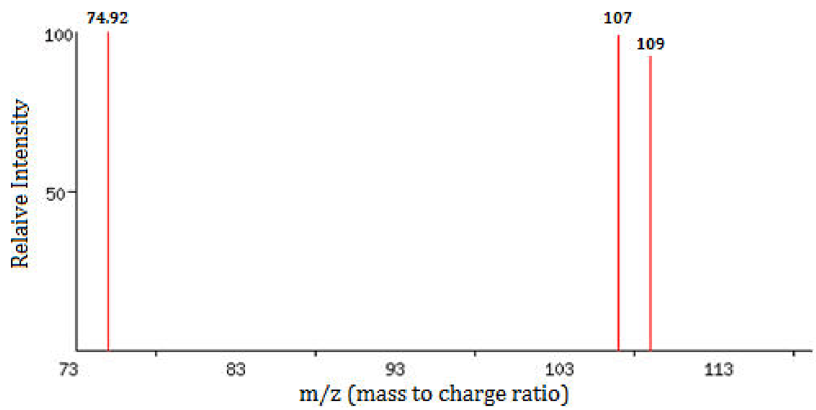
$$\frac{23}{23+77} = \frac{x}{100+x}$$

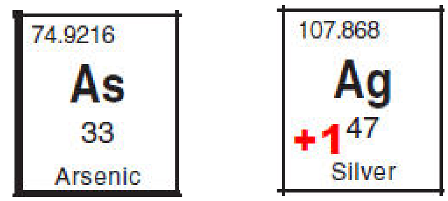
X = height of small peak = 29.87



Exercises

15. The mass spectrum below represents a mixture of elements. What elements are present? Justify your answer.





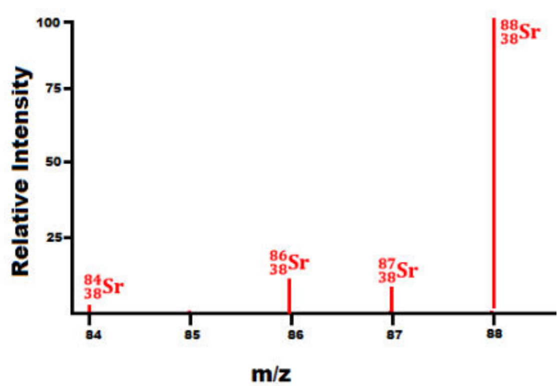
Since 107 and 109 are close together, they represent two isotopes of one element.

16. The mass spectrum of strontium gives four peaks. Use the data to calculate the percent abundance of each isotope.

$$\%\ \boldsymbol{Abundance} = \frac{\boldsymbol{Peak\ Intensity}}{\boldsymbol{Total\ Combined\ Peak\ Intensity}}$$

m/z	84	86	87	88
Relative intensity	0.68	11.94	8.48	100.00
% Abundance	**0.58%**	**9.86%**	**7.00%**	**82.58%**

a) Sketch the mass spectrum that would be obtained from naturally occurring strontium. ***Remember that the height of each peak is the relative intensity, <u>not the % abundance</u>.***



b) Label each peak on the mass spectrum with the appropriate nuclide symbols. **see above**

c) Calculate the average atomic mass of strontium in the sample rounded to two decimal places.

(84 x 0.0056) + (86 x 0.0986) + (87 x 0.0700) + (88 x 0.8258) = 87.71 amu