1.4.7.1: Practice Atomic Mass

Exercise 1.4.7.1.1

The element lithium is found in nature as a mixture of ^{6}Li and ^{7}Li. Given that the average atomic mass of lithium is 6.94 amu, which isotope is more abundant?

Answer

^{7}Li is more abundant. Since the average mass is really close to 7 amu, you have a lot more of the isotope with a mass of 7 amu than you do of the isotope with a mass of 6 amu.

Exercise 1.4.7.1.1

The element strontium has the following natural abundances. Calculate the average atomic mass.

82.58 % is ^{88}Sr with mass of 87.9056 amu

9.86 % is ^{86}Sr with mass of 85.9093 amu

7.00 % is ^{87}Sr with mass of 86.9089 amu

0.56 % is ^{84}Sr with mass of 83.9134 amu

Answer

Add up (uncertain digits are underlined):

$72.5\underline{9}244$ amu

$8.4\underline{7}066$ amu

$6.0\underline{8}362$ amu

$0.4\underline{6}992$ amu

Total is $87.6\underline{1}664$ amu which rounds to 87.62 amu

Exercise 1.4.7.1.1

If there were chemists on another planet, their periodic table might be different because the elements might have different "natural" abundances. If on the other planet, the element titanium had the following natural abundances, calculate the average atomic mass that the chemists on that planet would use.

73.64 % is ^{49}Ti with mass of 48.9479 amu

18.82 % is ^{50}Ti with mass of 49.9448 amu

7.54 % is ^{48}Ti with mass of 47.9479 amu

Answer

Add up (uncertain digits are underlined):

$36.0\underline{4}523$ amu

$9.39\underline{9}61$ amu

$3.6\underline{1}527$ amu

Total is $49.0\underline{60}11$ amu which rounds to 49.06 amu

Calculating the other way:

I realized that this is not one our our goals for Chem 142. We do this in Chem 101. I left the problems here anyway in case you are curious.

Exercise 1.4.7.1.1

The element antimony is made up of two isotopes, ^{121}Sb with a mass of 120.9038 amu and ^{123}Sb with a mass of 122.9042 amu. Given that the average atomic mass is 121.760 amu, what are the percent abundances of the two isotopes?

Hint

The average atomic mass is equal to the sum of the fractional abundance times mass of each isotope.

average = (fractional abundance of ^{121}Sb)(mass of ^{121}Sb) + (fractional abundance of ^{123}Sb)(mass of ^{123}Sb)

Set the fractional abundance of ^{121}Sb = x. Since there are only 2 isotopes, and they must add up to 1 whole, the fractional abundance of ^{123}Sb = 1 – x

Answer

121.760 amu = (x)(120.9038 amu) + (1 – x)(122.9042 amu)

121.760 amu = (x)(120.9038 amu) + 122.9042 amu – (x)(122.9042 amu) now subtract 122.9042 amu from both sides

– 1.14$\underline{42}$ amu = (x)(120.9038 amu) – (x)(122.9042 amu) combine terms on right

– 1.14$\underline{42}$ amu = (x)(–2.000$\underline{4}$ amu) divide both by – 2.0004 amu

0.571$\underline{9}$86 = x

So fractional abundance of ^{121}Sb is 0.5720, and percent abundance is 57.20 %.

Fractional abundance of ^{123}Sb is therefore 0.4280, and percent abundance is 42.80 %

Exercise 1.4.7.1.1

On our imaginary planet, the element zinc is made up of two isotopes, ^{66}Zn with a mass of 65.9260 amu and ^{68}Zn with a mass of 67.9248 amu. Given that their average atomic mass for zinc is 66.840 amu, what are the percent abundances of the two isotopes on that planet?

Answer

66.840 amu = (x)(65.9620 amu) + (1 – x)(67.9248 amu)

66.840 amu = (x)(65.9620 amu) + 67.9248 amu – (x)(67.9248 amu) now subtract 67.9248 amu from both sides

– 1.08$\underline{48}$ amu = (x)(65.9620 amu) – (x)(67.9248 amu) combine terms on right

– 1.08$\underline{48}$ amu = (x)(–1.962$\underline{8}$ amu) divide both by – 1.9628 amu

0.552$\underline{6}$798 = x

So fractional abundance of ^{66}Zn is 0.5527, and percent abundance is 55.27 %.

Fractional abundance of ^{68}Zn is therefore 0.4473, and percent abundance is 44.73 %