During Class Invention

Isotope Practice

Name(s) with Lab section in Group

____

____

1. The element boron is composed of two different isotopes, ^{35}Cl and ^{37}Cl. The percent abundance of ^{35}Cl is 75.53% and the percent abundance of ^{37}Cl is 24.47%. The relative atomic mass of ^{35}Cl is 34.96885 u and the relative atomic mass of ^{37}Cl is 36.96590 u.

a) Set up the mathematical equation that you would use to solve this problem and substitute the values for all known quantities.

RWAAM = Σ(fraction abundance$_i$ * isotopic mass$_i$)

RWAAM = fraction abundance$_1$ * isotopic mass$_1$ + fraction abundance$_2$ * isotopic mass$_2$

Substituting the data from this problem,

average mass = 0.7553 * 34.96885 u + 0.2447 * 36.96590 u = 35.46 u

b) What does the sum of the fractional abundances of the two isotopes of chlorine add to? Explain.

0.7553 + 0.2447 = 1.00

Since there are only two isotopes the sum of their fractional abundances must add to 1.

2. The two naturally occurring isotopes of potassium with reasonable abundance are ^{39}K and ^{41}K. The atomic masses of these two isotopes are 38.9637 u and 40.9618 u. If the relative weighted average atomic mass for potassium is 39.10 u, calculate the fractional abundance of each isotope in nature assuming these are the only two important isotopes for potassium.

b) Show the mathematical set up.

Let x = fractional abundance of $^{39}_{19}K$ and y = fractional abundance of $^{41}_{19}K$.

RWAAM = Σ(fraction abundance$_i$ * isotopic mass$_i$)

RWAAM = fraction abundance$_1$ * isotopic mass$_1$ + fraction abundance$_2$ * isotopic mass$_2$

RWAAM = 39.10 u = (38.9637 u · x + 40.9618 u · y)

1 = x + y

c) Solve

Let x = 1 – y and substitute into the RWAAM equation

$$39.10\ u = (38.9637\ u \cdot (1 - y) + 40.9618\ u \cdot y)$$

$$39.10\ u = (38.9637\ u - 38.9637\ u \cdot y + 40.9618\ u \cdot y)$$

Collect terms

$$39.10\ u - 38.9637\ u = -38.9637\ u \cdot y + 40.9618\ u \cdot y$$

$$0.1363\ u = 1.9981 \cdot y$$

$$y\left({}^{41}_{19}K\right) = \frac{0.1363\ u}{1.9981\ u} = 0.068 \quad x\left({}^{39}_{19}K\right) = 1 - 0.068 = 0.932$$

3. The atomic mass for a proton is 1.00727 u and for a neutron the atomic mass is 1.00886 u.

a) How many protons and neutrons in each isotope of potassium listed in 2?

$^{39}_{19}K$ has 19 protons and 20 neutrons

$^{41}_{19}K$ has 19 protons and 22 neutrons

b) Calculate the atomic mass of the isotope ^{39}K and the isotope ^{41}K should be using your answers in part a and the information given in the stem of this problem.

For $^{39}_{19}K$: 19 · 1.0073 u (protons) + 20 · 1.0087 u (neutrons) = 39.3127 u

For $^{41}_{19}K$: 19 · 1.0073 u (protons) + 22 · 1.0087 u (neutrons) = 41.3301 u

c) Explain why the mass you calculated in b) for each isotope does not agree with the mass for these two isotopes in 2.

From Q2 the isotopic masses are 38.9637 u for $^{39}_{19}K$ and 40.9618 u for $^{41}_{19}K$. The mass of each isotope as calculated in part b is greater than the actual measure isotopic mass. The extra mass for both isotopes is converted to energy to keep the protons and neutrons in the same very small region of space.