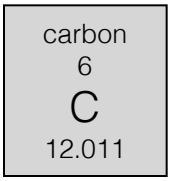
name: _____ date: _____

isotopic abundance - practice problems

The **atomic mass** for each element appearing on the periodic table represents the weighted average of masses for each individual isotope of an element. For example, the atomic mass of carbon is reported as 12.011 amu (atomic mass units). Carbon is composed primarily of two isotopes; carbon-12 and carbon-14. The atomic mass is calculated using *both* the relative abundance and the masses for each of these two isotopes. Using the equation below, the atomic mass for carbon can be calculated.

$$\text{atomic mass} = \left(\text{mass}_1 \times \%_1\right) + \left(\text{mass}_2 \times \%_2\right) + \ldots$$



Carbon-12 accounts for 99.45% of all of the carbon atoms, while carbon-14 only accounts for the remaining 0.55%. Since the carbon-12 isotope is more abundant, its mass is weighted more in the calculation of carbon's atomic mass. The calculation of the atomic mass is shown below.

isotope	% abundance	mass (amu)
carbon-12	99.45	12.000
carbon-14	0.55	14.003

$$\text{atomic mass} = \left(12.000 \times 0.9945\right) + \left(14.003 \times 0.0055\right)$$

$$\text{atomic mass} = \left(11.934\right) + \left(0.077\right) = 12.011 \text{ amu}$$

Directions: Use the equation for atomic mass to complete the following problems.

1. Argon has three naturally occurring isotopes: argon-36, argon-38, and argon-40. Based on argon's reported atomic mass, which isotope exist as the most abundant in nature? Explain.

2. Copper exists as a mixture of two isotopes. Copper-63 is 69.17% abundant and it has a mass of 62.9296 amu. Copper-65 is 30.83% abundant and it has a mass of 64.9278 amu. Calculate the atomic mass of copper.

3. Calculate the atomic mass of silicon. The three silicon isotopes have atomic masses and relative abundances of 27.9769 amu (92.2297%), 28.9765 amu (4.6832%) and 29.9738 amu (3.0872%).

4. Gallium has two naturally occurring isotopes. The mass of gallium-69 is 68.9256 amu and it is 60.108% abundant. The mass of gallium-71 is 70.9247 amu and it is 39.892% abundant. Calculate the atomic mass of gallium.

5. Bromine has two naturally occurring isotopes. Bromine-79 has a mass of 78.918 amu and is 50.69% abundant. Using the atomic mass reported on the periodic table, determine the mass of bromine-81, the other isotope of bromine.

6. Calculate the atomic mass of lead. The four lead isotopes have atomic masses and relative abundances of 203.973 amu (1.4%), 205.974 amu (24.1%), 206.976 amu (22.1%) and 207.977 amu (52.4%).

7. Antimony has two naturally occurring isotopes. The mass of antimony-121 is 120.904 amu and the mass of antimony-123 is 122.904 amu. Using the average mass from the periodic table, calculate the abundance of each isotope.

name: **suggested answers** date: _____

isotopic abundance - practice problems

The **atomic mass** for each element appearing on the periodic table represents the weighted average of masses for each individual isotope of an element. For example, the atomic mass of carbon is reported as 12.011 amu (atomic mass units). Carbon is composed primarily of two isotopes; carbon-12 and carbon-14. The atomic mass is calculated using *both* the relative abundance and the masses for each of these two isotopes. Using the equation below, the atomic mass for carbon can be calculated.

$$\text{atomic mass} = \left(\text{mass}_1 \times \%_1\right) + \left(\text{mass}_2 \times \%_2\right) + \ldots$$

carbon
6
C
12.011

Carbon-12 accounts for 99.45% of all of the carbon atoms, while carbon-14 only accounts for the remaining 0.55%. Since the carbon-12 isotope is more abundant, its mass is weighted more in the calculation of carbon's atomic mass. The calculation of the atomic mass is shown below.

isotope	% abundance	mass (amu)
carbon-12	99.45	12.000
carbon-14	0.55	14.003

$$\text{atomic mass} = \left(12.000 \times 0.9945\right) + \left(14.003 \times 0.0055\right)$$

$$\text{atomic mass} = \left(11.934\right) + \left(0.077\right) = 12.011 \text{ amu}$$

Directions: Use the equation for atomic mass to complete the following problems.

1. Argon has three naturally occurring isotopes: argon-36, argon-38, and argon-40. Based on argon's reported atomic mass, which isotope exist as the most abundant in nature? Explain.

argon has an atomic mass of 39.948 amu, which is closet to argon-40, suggesting that it is the most abundant isotope

2. Copper exists as a mixture of two isotopes. Copper-63 is 69.17% abundant and it has a mass of 62.9296 amu. Copper-65 is 30.83% abundant and it has a mass of 64.9278 amu. Calculate the atomic mass of copper.

am = (62.9296 x 0.6917) + (64.9278 x 0.3083) = 43.5284 + 20.0172 = 63.5556 amu

3. Calculate the atomic mass of silicon. The three silicon isotopes have atomic masses and relative abundances of 27.9769 amu (92.2297%), 28.9765 amu (4.6832%) and 29.9738 amu (3.0872%).

am = (27.9769 x 0.922297) + (28.9765 x 0.046832) + (29.9738 x 0.030872) = 25.8030 + 1.3570 + 0.9253 = 28.0853 amu

4. Gallium has two naturally occurring isotopes. The mass of gallium-69 is 68.9256 amu and it is 60.108% abundant. The mass of gallium-71 is 70.9247 amu and it is 39.892% abundant. Calculate the atomic mass of gallium.

am = (68.9256 x 0.60108) + (70.9247 x 0.39892) = 41.4298 + 28.2933 = 69.7231 amu

5. Bromine has two naturally occurring isotopes. Bromine-79 has a mass of 78.918 amu and is 50.69% abundant. Using the atomic mass reported on the periodic table, determine the mass of bromine-81, the other isotope of bromine.

79.904 = (78.918 x 0.5069) + ($mass_2$ x 0.4931) → 79.904 = 40.0035 + $mass_2$0.4931 → $mass_2$ = 80.9177 amu

6. Calculate the atomic mass of lead. The four lead isotopes have atomic masses and relative abundances of 203.973 amu (1.4%), 205.974 amu (24.1%), 206.976 amu (22.1%) and 207.977 amu (52.4%).

atomic mass = (203.973 x 0.014) + (205.974 x 0.241) + (206.976 x 0.221) + (207.977 x 0.524) = 207.217 amu

7. Antimony has two naturally occurring isotopes. The mass of antimony-121 is 120.904 amu and the mass of antimony-123 is 122.904 amu. Using the average mass from the periodic table, calculate the abundance of each isotope.

121.760 = 120.904(x) + 122.904(1-x) → 121.760 = 120.904x + 122.904 - 122.904x → -1.144 = -2x → x = 0.572

^{121}Sb = 57.2 %, ^{123}Sb = 42.8 %