

Lesson 6: Isotopes

Orally: *The average Canadian household has 1.5 children. What happened to the other half! Since this is a calculated average we don't expect to find half a kid, but we do expect to find that perhaps one family has 1 child while another has 2.*

Isotopes: - atomic species that have the same atomic number but different masses.

Q: If the atomic number is the same, how can the masses be different?

A: The atoms have a different number of neutrons.

The Atomic mass on the periodic table represents the average mass of the different isotopes. (This is why some of the masses have a decimal).

Orally: *Let's assume, for the purpose of the following example, that the following percentages represent the naturally occurring masses of 3 hydrogen isotopes.*

Calculate the atomic mass for the hydrogen isotopes below.

99.96% for protium (hydrogen with 1p⁺ and no neutrons)

0.031% for deuterium (hydrogen with 1p⁺ and 1n)

0.009% for tritium (radioactive hydrogen with 1p⁺ and 2n)

Orally: *To do this, we need to calculate what is called a weighted average. You may not simply add the three masses and divide by three, because the isotopes are not equally represented.*

Mass of the isotope x percent as a decimal = isotopes mass contribution

(Protium) $1.0 \times 0.9996 = 0.9996$

(Deuterium) $2.0 \times 0.00031 = 0.00062$

(Tritium) $3.0 \times 0.00009 = 0.00027$

Weighted Average (i.e., atomic mass) = 1.00049 a.m.u.

Practice: Have students try the following questions.

1. If Bromine has two isotopes with the corresponding % abundances, calculate the atomic mass of Bromine. 10% ^{79}Br and 90% ^{80}Br

$$^{79}\text{Br} \quad 79 \times 0.1 = 7.9$$

$$\underline{^{80}\text{Br} \quad 80 \times 0.9 = 72.0}$$

$$\text{Atomic Mass} = 79.9 \text{ a.m.u.}$$

2. A hypothetical element Woolgarium has 3 isotopes. 5% ^{299}Wl , 15% ^{300}Wl and 80% ^{301}Wl .

Orally: First think about the average as an estimate. Where do you think the average is likely to be (i.e., closer to 299 or 301).

$$^{299}\text{Wl} \quad 299 \times 0.05 = 14.95$$

$$^{300}\text{Wl} \quad 300 \times 0.15 = 45.0$$

$$\underline{^{301}\text{Wl} \quad 301 \times 0.80 = 240.8}$$

$$\text{Atomic Mass} = 300.75 \text{ a.m.u.}$$

Assign Hebden Exercise p. 149 # 22, and 23a, c, d.

Start Part I lesson on Bohr's theory of the atom.