Neon's Hidden Mix

Model nuclei and calculate an abundance weighted atomic mass

CHE.2.2 "Construct models (e.g., ball and stick, online simulations, mathematical computations) of atomic nuclei to explain the abundance weighted average (relative mass) of elements and isotopes on the published mass of elements."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each abundance in the table, underline each measured mass, and number the isotopes from fewest to most neutrons to help you build a model and calculate neon's average mass.

What Is Inside a Neon Sign?

1. A neon sign can look uniform even though its atoms are not identical. Every neon nucleus contains 10 protons, but some hold different numbers of neutrons. The table gives three naturally occurring neon isotopes, their measured atomic masses, and their approximate abundances. An isotope's mass number counts its protons and neutrons.

NATURALLY OCCURRING NEON ISOTOPES

Isotope	Measured mass (u)	Abundance
Neon-20	19.9924	90.48%
Neon-21	20.9938	0.27%
Neon-22	21.9914	9.25%

2. To build a nucleus model, show protons and neutrons as separate labeled dots. For instance, a carbon-13 nucleus contains 6 protons and 7 neutrons because 13 minus 6 equals 7. Changing neutron count changes the isotope without changing the element. A larger nucleus usually has a greater mass, although measured atomic masses are not exact whole numbers.

3. To predict an element's listed atomic mass, multiply each isotope's measured mass by its abundance written as a decimal, then add the products. A 25% share becomes 0.25 in that calculation. Neon has a published atomic mass near 20.18 atomic mass units, or u. That value reflects an abundance weighted average, not the mass of one particular atom.

2 ANSWER WITH EVIDENCE

Use the passage

1. For nucleus models of neon-20 and neon-22, how many protons and neutrons would you show in each? What stays the same?

2. What is neon-21's contribution to the weighted average mass? Show the multiplication using its measured mass and abundance.

3. Use all three measured masses and abundances to calculate neon's weighted average mass. Show your expression and round to the nearest hundredth of a u.

4. If the three isotopes were equally abundant, what average would their measured masses give? Round to the nearest hundredth of a u, then explain why it differs from neon's published mass.

3 YOUR TURN

Your own words

Invent a hypothetical sample of oxygen, atomic number 8, containing only oxygen-16 and oxygen-18. Choose unequal percentage abundances that add to 100%, give the proton and neutron counts for both nuclei, calculate the sample's approximate average mass using 16 u and 18 u, and explain which isotope's mass the average is closer to.

ANSWER KEY

Neon's Hidden Mix

HIGH SCHOOL · CHE.2.2

PART 1 · READ AND MARK

Circle each abundance in the table, underline each measured mass, and number the isotopes from fewest to most neutrons to help you build a model and calculate neon's average mass. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	For nucleus models of neon-20 and neon-22, how many protons and neutrons would you show in each? What stays the same?	**Neon-20 has 10 protons and 10 neutrons. Neon-22 has 10 protons and 12 neutrons. The proton count stays the same.**
2	What is neon-21's contribution to the weighted average mass? Show the multiplication using its measured mass and abundance.	**20.9938 u × 0.0027 = 0.05668326 u, or about 0.0567 u.**
3	Use all three measured masses and abundances to calculate neon's weighted average mass. Show your expression and round to the nearest hundredth of a u.	**(19.9924 × 0.9048) + (20.9938 × 0.0027) + (21.9914 × 0.0925) = 20.18001128 u, which rounds to 20.18 u.**
4	If the three isotopes were equally abundant, what average would their measured masses give? Round to the nearest hundredth of a u, then explain why it differs from neon's published mass.	**(19.9924 + 20.9938 + 21.9914) ÷ 3 = 20.992533... u, or 20.99 u. Natural neon contains far more neon-20 than either of the heavier isotopes, so its published mass is lower.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My sample is 80% oxygen-16 and 20% oxygen-18. The oxygen-16 nucleus has 8 protons and 8 neutrons; the oxygen-18 nucleus has 8 protons and 10 neutrons. Its approximate average mass is (16 u × 0.80) + (18 u × 0.20) = 16.4 u. The average is closer to 16 u because oxygen-16 is more abundant in my sample.

Accept correct calculations with reasonable rounding. For the open task, accept any two unequal abundances totaling 100% with matching nucleus models, a correct weighted average, and an explanation consistent with the chosen abundances.