Mystery Light

Use atomic data to identify an unlabeled sample.

CHE.1.c "Analyze and interpret data to identify or describe an element based on its number of protons, its relative abundance of isotopes, its organization and placement of electrons, and its light emission spectrum."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline proton counts, circle isotope percentages, box electron arrangements, and write matching numbers beside the wavelength pairs for the unlabeled tube and its reference. Use your marks to connect the clues.

The Unlabeled Tube

1. At a lab station, sealed tubes glow when electricity passes through the material inside. A label has fallen off one tube. The number of protons fixes an atom's element, while its number of neutrons can vary among isotopes. Isotope percentages tell how common each isotope is in a sample. Changing those percentages can shift the sample's average atomic mass without changing its element.

2. Electrons occupy energy levels around the nucleus. An electron arrangement lists how many electrons occupy each level, starting closest to the nucleus. When excited electrons drop to lower energy levels, atoms release light at particular wavelengths. A spectroscope separates that light into bright lines. Matching lines can support an identification, especially when proton and electron data agree.

3. The lab records below describe three reference samples and one unlabeled tube. The percentages in each isotope pair add to 100% for that sample. Wavelengths are rounded to the nearest nanometer, and only two selected bright lines are listed. Treat the records as results from separate tests. Check whether the clues point to the same element.

LAB RECORDS FOR FOUR SAMPLES

Sample	Protons	Isotopes (% of atoms)	Electron arrangement	Bright lines (nm)
Helium reference	2	helium-3: 20%; helium-4: 80%	2	588, 668
Neon reference	10	neon-20: 90%; neon-22: 10%	2, 8	585, 640
Argon reference	18	argon-36: 5%; argon-40: 95%	2, 8, 8	697, 707
Unlabeled tube	18	argon-36: 30%; argon-40: 70%	2, 8, 8	697, 707

2 ANSWER WITH EVIDENCE

Use the passage

1. Identify the element in the unlabeled tube. Which two different kinds of data support your answer?

2. Use the isotope percentages and mass numbers to estimate the average mass of each argon sample. How do the averages compare?

3. How many electrons does the unlabeled tube's electron arrangement show? Explain how this supports the identity of its neutral atoms.

4. A second tube shows bright lines at 585 nm and 640 nm. Which reference fits, and why does the helium reference not fit?

3 YOUR TURN

Your own words

Write a four-sentence lab note for a new sample of one named reference element. Invent isotope percentages that total 100% and differ from its listed percentages, then state its proton count, electron arrangement, two bright lines, and calculated average isotope mass using the listed mass numbers.

Mystery Light

PART 1 · READ AND MARK

Underline proton counts, circle isotope percentages, box electron arrangements, and write matching numbers beside the wavelength pairs for the unlabeled tube and its reference. Use your marks to connect the clues. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Identify the element in the unlabeled tube. Which two different kinds of data support your answer?	**Argon. Its 18 protons and its bright lines at 697 nm and 707 nm match the argon reference.**
2	Use the isotope percentages and mass numbers to estimate the average mass of each argon sample. How do the averages compare?	**Unlabeled: (0.30 × 36) + (0.70 × 40) = 38.8 u. Argon reference: (0.05 × 36) + (0.95 × 40) = 39.8 u. The unlabeled sample's average is 1.0 u lower.**
3	How many electrons does the unlabeled tube's electron arrangement show? Explain how this supports the identity of its neutral atoms.	**The arrangement shows 2 + 8 + 8 = 18 electrons. That equals its 18 protons, as expected for neutral argon atoms.**
4	A second tube shows bright lines at 585 nm and 640 nm. Which reference fits, and why does the helium reference not fit?	**Neon fits because both listed lines match. Helium's listed lines are 588 nm and 668 nm, so neither matches.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My new helium sample contains 40% helium-3 and 60% helium-4. Its atoms have 2 protons and an electron arrangement of 2. Its average isotope mass is (0.40 × 3) + (0.60 × 4) = 3.6 u. It should show bright lines near 588 nm and 668 nm because it is still helium.

Accept any named reference with a new isotope mixture totaling 100%, a correct weighted average using the listed mass numbers, and matching proton, electron, and wavelength data. Average masses are estimates because isotope mass numbers are used in place of exact isotope masses.