The Atom's Family Tree

A Story About Atomic Number, Mass Number, and Isotopes

During a school science fair, Anika and Rohan discovered a booth called The Atom Detective Agency.

Professor Arya: "Welcome, detectives! Your mission is to identify mysterious atoms!"

A screen displayed an atom with six protons.

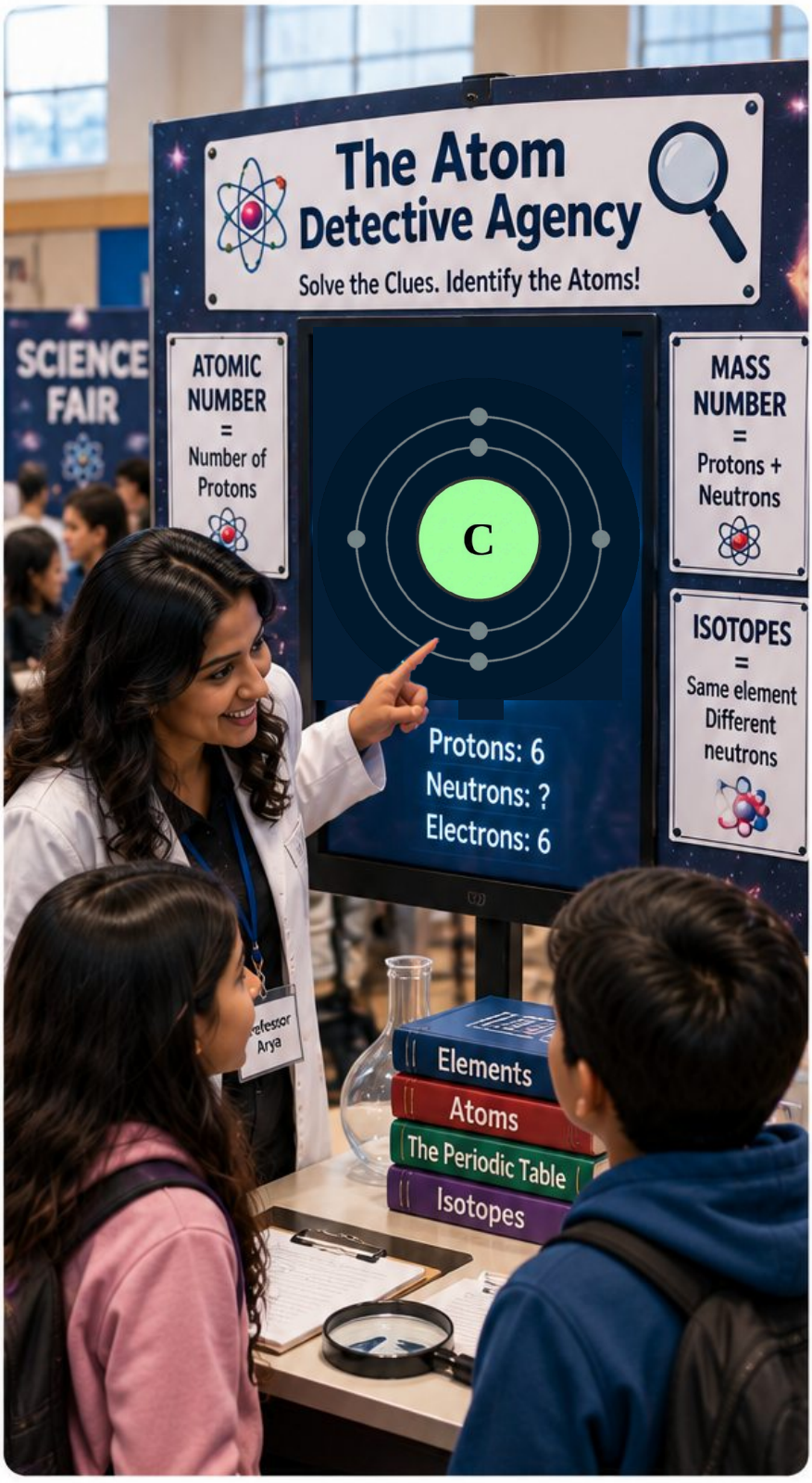
Anika: "How do we identify it?" Anika asked.

Professor Arya: "Every element has a unique **atomic number**. It tells us the number of protons in its nucleus."

Rohan: "Six protons means carbon!" Rohan exclaimed.

Professor Arya: "Correct! And in a neutral atom, the number of electrons equals the number of protons."

Anika: "So atomic number is like an atom's identity card!" Anika said.



Science Fact: Atomic number (Z) is the number of protons in an atom's nucleus.

Science Fables

The Mass Number Mystery!

Professor Arya opened another mystery box.

Professor Arya: "This carbon atom has six protons and six neutrons. Can you find its mass number?"

Rohan: "What's mass number?" Rohan asked.

Professor Arya: "It's the total number of protons and neutrons."

Anika: Anika calculated, "Six plus six equals twelve!"

Professor Arya: "Excellent! This is carbon-12."

Professor Arya wrote:

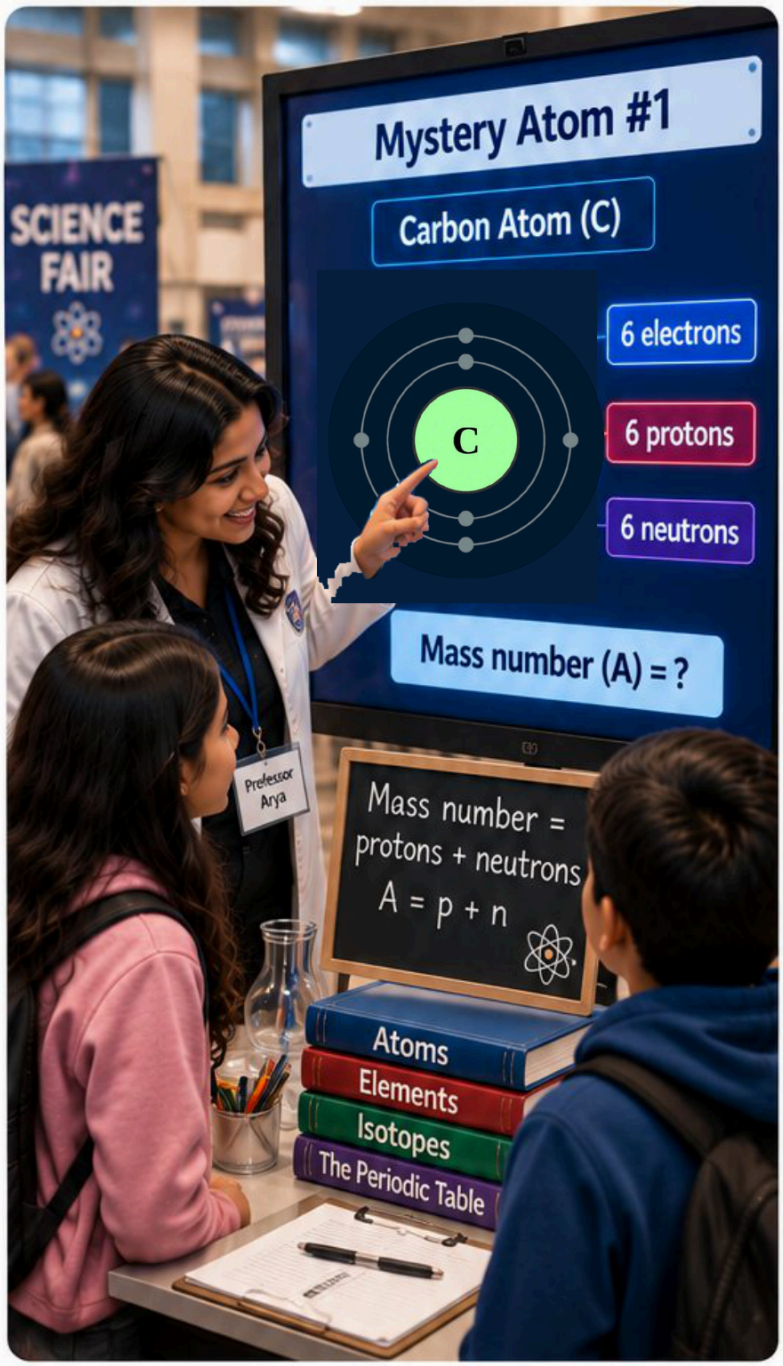
Mass Number (A) = Protons + Neutrons

Rohan: "Can we find neutrons if we know the mass number?" Rohan asked.

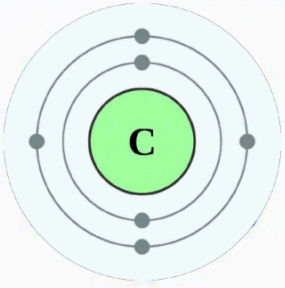
Professor Arya: "Of course! Just subtract the atomic number."

Neutrons = A – Z

Anika: "For sodium-23, that's 23 – 11 = 12 neutrons!" Anika said.



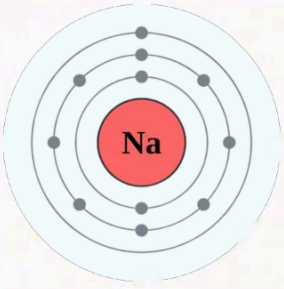
Carbon-12



Protons = 6
Neutrons = 6
Mass number (A) = 6 + 6 = 12

Carbon-12 (^{12}C)

Sodium-23



Atomic number (Z) = 11
Mass number (A) = 23
Neutrons = A – Z
= 23 – 11
= 12

Sodium-23 (^{23}Na)

Science Fact: Mass number (A) counts the protons and neutrons in an atom.

Science Fables

Meet the Atom Family!

The next exhibit displayed three mysterious carbon atoms.

Professor Arya: "Meet carbon-12, carbon-13, and carbon-14!" Professor Arya announced.

Rohan: "Are they different elements?" Rohan asked.

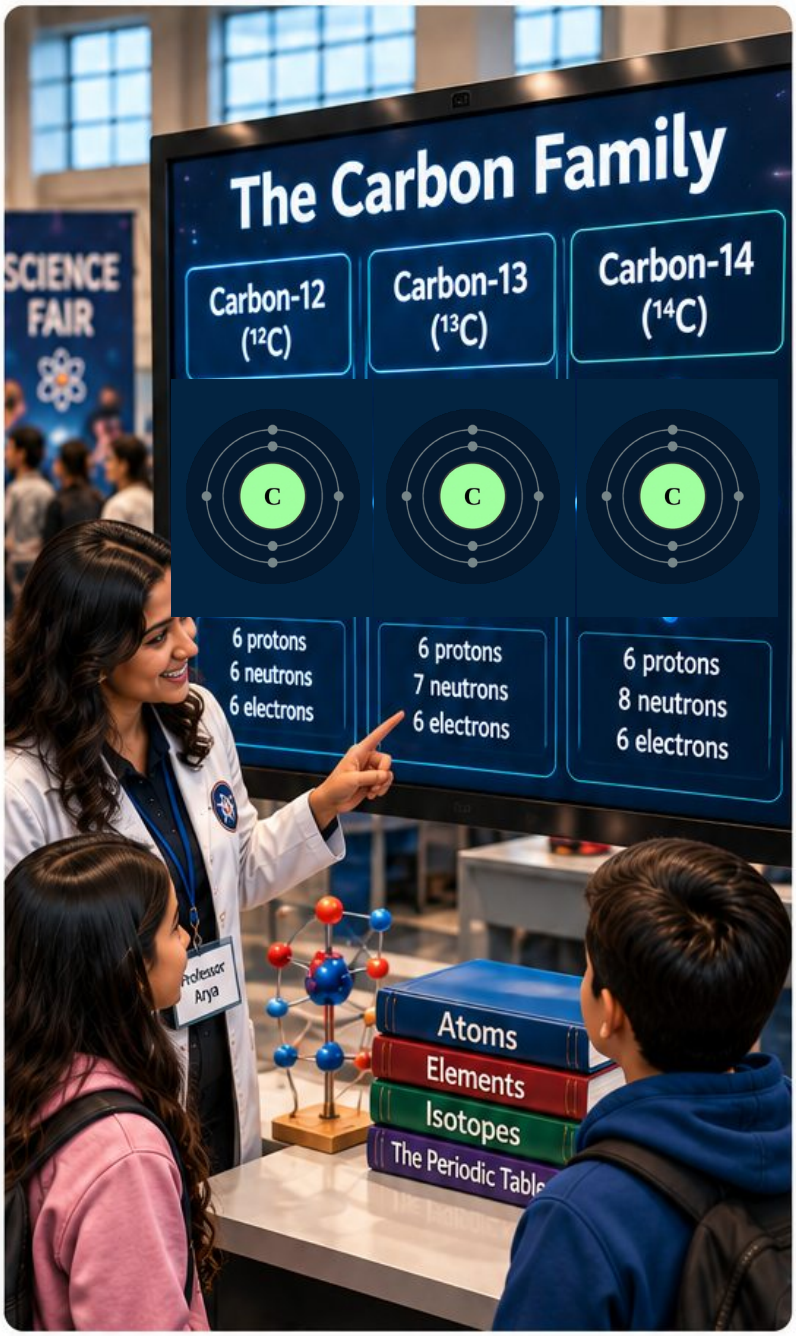
Professor Arya: "No! They all have six protons, but different numbers of neutrons."

Isotope	Protons	Neutrons
Carbon-12	6	6
Carbon-13	6	7
Carbon-14	6	8

Anika: "They're like members of the same family!" Anika said.

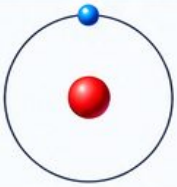
Professor Arya: "Exactly! Atoms of the same element with different numbers of neutrons are called **isotopes**."

Professor Arya: "Hydrogen has isotopes too. Protium, deuterium, and tritium have zero, one, and two neutrons respectively."



Hydrogen Isotopes

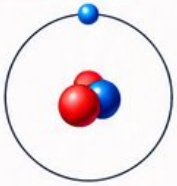
Protium (^1H)



Protons = 1
Neutrons = 0
Electrons = 1

Hydrogen-1 (^1H)

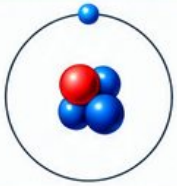
Deuterium (^2H)



Protons = 1
Neutrons = 1
Electrons = 1

Hydrogen-2 (^2H)

Tritium (^3H)



Protons = 1
Neutrons = 2
Electrons = 1

Hydrogen-3 (^3H)



Science Fact: Isotopes have the same atomic number but different mass numbers.

Science Fables

The Chlorine Puzzle!

A glowing periodic table appeared.

Anika: "Why does chlorine have an atomic mass of about 35.5?" Anika wondered. "Aren't mass numbers whole numbers?"

Professor Arya: "Great question!" Natural chlorine contains different isotopes."

She displayed:

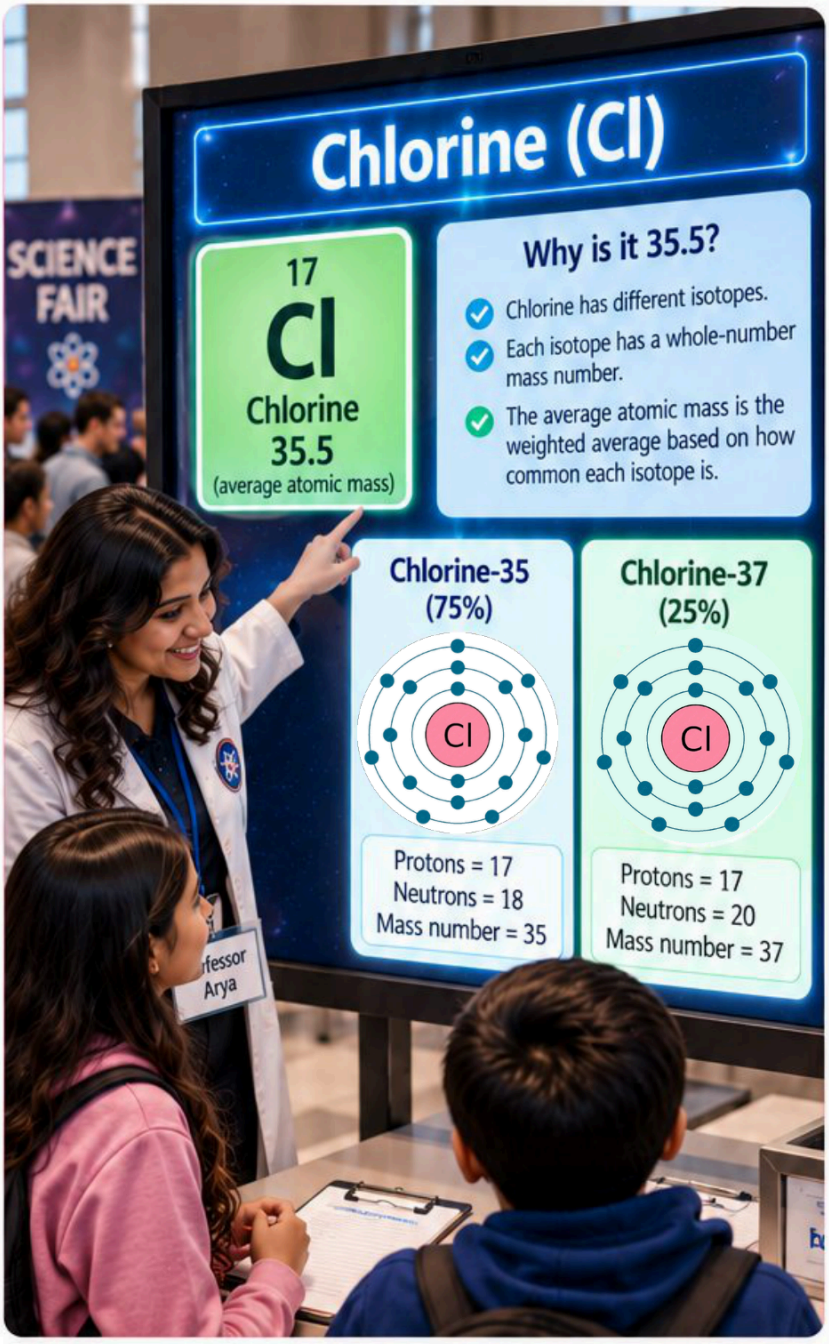
- **Chlorine-35:** approximately 75%
- **Chlorine-37:** approximately 25%

"The average atomic mass depends on how common each isotope is."

$$\frac{75 \times 35 + 25 \times 37}{100} = 35.5$$

Rohan: "So 35.5 is a weighted average!" Rohan exclaimed.

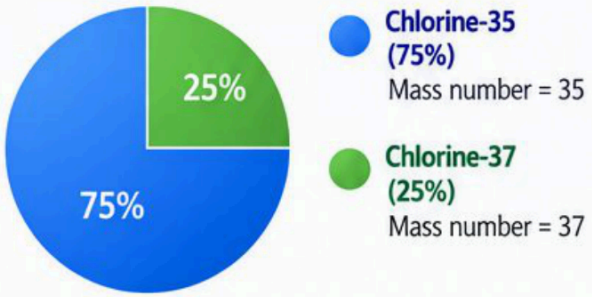
Professor Arya: "Exactly! Each isotope has a whole-number mass number, but the average atomic mass can be a decimal."



Calculating the Average Atomic Mass of Chlorine

$$\frac{75 \times 35 + 25 \times 37}{100} = 35.5$$

$75 \times 35 = 2625$ (contribution from chlorine-35)
$25 \times 37 = 925$ (contribution from chlorine-37)
$2625 + 925 = 3550$
$3550 \div 100 = 35.5$



Science Fact:

Average atomic mass is the weighted average of the masses of an element's naturally occurring isotopes.

Science Fables

The Final Detective Challenge!

Professor Arya activated the final screen.

MISSION: SOLVE THE ATOM MYSTERY!

Professor Arya: "What does atomic number tell us?"

Anika: "The number of protons!" Anika answered.

Professor Arya: "What does mass number tell us?"

Rohan: "Protons plus neutrons!" Rohan replied.

Professor Arya: "An atom has eight protons and nine neutrons. Its mass number?"

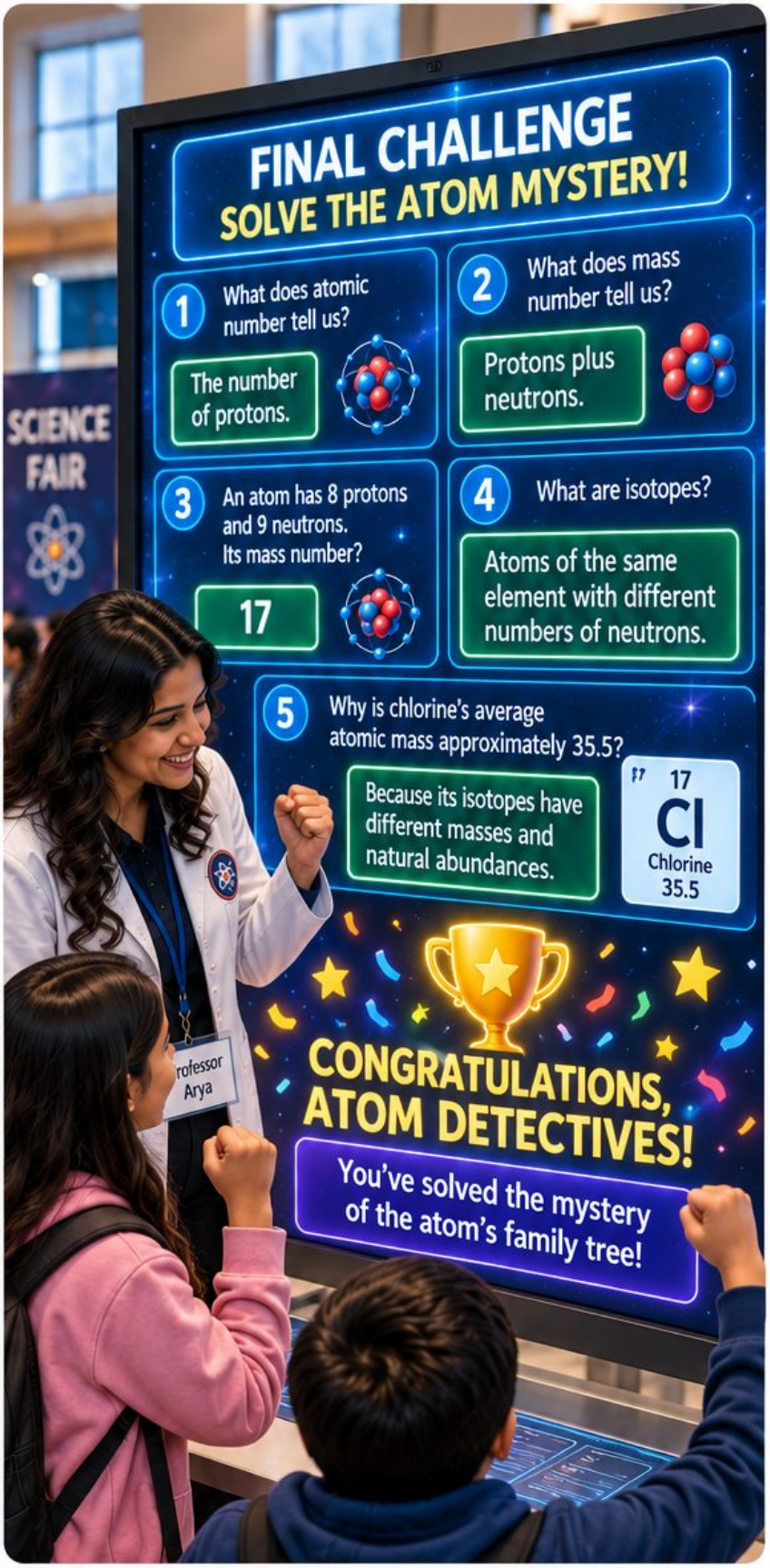
Anika: "Seventeen!" Anika exclaimed.

Professor Arya: "And what are isotopes?"

Rohan: "Atoms of the same element with different numbers of neutrons!" Rohan answered.

Professor Arya: "Excellent! Why is chlorine's average atomic mass approximately 35.5?"

Anika: "Because its isotopes have different masses and natural abundances!" Anika explained.



Science Fact:

Atomic number identifies an element, mass number counts its protons and neutrons, and isotopes explain why atoms of the same element can have different masses.

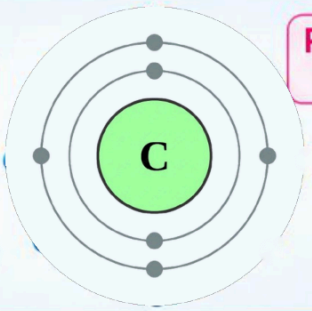
Science Fables

Science Element: Remember!

1 Atomic Number (Z)

- Number of protons in the nucleus.
- In a neutral atom, protons = electrons.
- Identifies the element.

Atomic number (Z) = number of protons



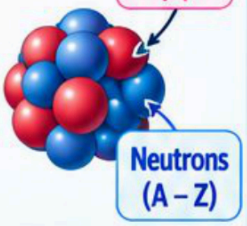
2 Mass Number (A)

- The total number of protons and neutrons.
- Counts the particles in the nucleus.

A = Protons + Neutrons

Neutrons = A – Z

A = mass number Z = atomic number



3 Nuclide Symbol

A nuclide symbol shows the mass number and atomic number of an element.

$$ {}^{A}_{Z}X $$

A = Mass number (protons + neutrons)
Z = Atomic number (protons)
X = Element symbol

Example: Carbon-14

$$ {}^{14}_{6}C $$

A = 14
Z = 6
X = C (carbon)

4 Understanding Isotopes

- Isotopes are atoms of the same element with different numbers of neutrons.
- They have the same atomic number but different mass numbers.

Isotope	Protons	Neutrons
Protium (^{1}H)	1	0
Deuterium (^{2}H)	1	1
Tritium (^{3}H)	1	2
Carbon-12	6	6
Carbon-13	6	7
Carbon-14	6	8

5 Mass Number vs. Atomic Mass

Mass Number (A)	Atomic Mass
Counts protons and neutrons	Measures an atom's mass
Whole number	Can be a decimal
No units	Measured in atomic mass units (u)
Carbon-12: A = 12	Carbon-12: exactly 12 u

The average atomic mass on the periodic table is calculated using isotopic masses and natural abundances.

17
Cl
Chlorine
35.5
(atomic mass)

The Golden Rule

Atomic Number:	How many protons?
Mass Number:	How many protons and neutrons?
Isotopes:	Same protons, different neutrons!

Remember!

Every element has its own atomic number, but atoms of the same element can have different mass numbers because they contain different numbers of neutrons.

Science Fables