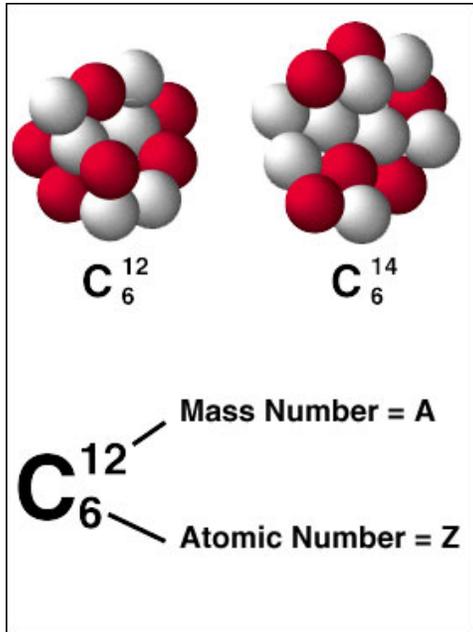


Nuclear Arithmetic



Over 100 elements have been discovered over the last century. The nucleus of each atom contains two kinds of particles: protons and neutrons.

Scientists classify each element by the number of protons (Z) and the mass of the element (A).

Z is called the Atomic Number
 A is called the Atomic Mass

The number of neutrons (N) in the nucleus is given by the formula:

$$N = A - Z$$

Problem 1 - In the above example for the element carbon, there are two different forms for carbon. A) How many protons are in the nucleus of carbon-12 and carbon-14? B) How many neutrons are in each nucleus?

Problem 2 - The element praeosodymium has an atomic number of 59 and an atomic mass of 141. How many nuclear neutrons does it contain?

Problem 3 - The element nickel ($Z=28$, $A=58$) has 30 isotopes that have the same atomic number, but whose atomic masses range from $A=48$ to $A=78$. A) How many neutrons does the lightest isotope of nickel have? B) How many neutrons does the heaviest isotope have?

Problem 4 - Solve the formula $N = A - Z$ to determine the missing information:

- | | | | |
|--------------|-----------|---------------|------------|
| A) Tin: | $A = 125$ | and $Z = 50$ | what is N? |
| B) Niobium: | $N = 54$ | and $Z = 41$ | what is A? |
| C) Nobelium: | $A = 253$ | and $N = 151$ | what is Z? |
| D) Francium: | $A = 232$ | and $Z = 87$ | what is N? |
| E) Oxygen: | $Z = 8$ | and $N = 16$ | what is A? |

Answer Key

Problem 1 - In the above example for the element carbon, there are two different forms for carbon. A) How many protons are in the nucleus of carbon-12 and carbon-14? B) How many neutrons are in each nucleus?

Answer: A) Carbon-12 has $Z=6$ and so does carbon-14 so they both have the same number of protons. B) Answer; The mass of carbon-12 is $A=12$, while carbon-14 has $A=14$ so carbon-12 has $12-6 = 6$ neutrons while carbon 14 has $14-6 = 8$ neutrons. Physicists call carbon-14 an isotope of carbon-14 for this reason.

Problem 2 - The element praeosodymium has an atomic number of 59 and an atomic mass of 141. How many nuclear neutrons does it contain?

Answer: $Z = 59$ and $A = 141$ so $N = 141-59 = \mathbf{82}$.

Problem 3 - The element nickel ($Z=28$, $A=58$) has 30 isotopes that have the same atomic number, but whose atomic masses range from $A=48$ to $A=78$. A) How many neutrons does the lightest isotope of nickel have? B) How many neutrons does the heaviest isotope have?

Answer; A) The lightest isotope is called Nickel-48 and has $N = 48 - 28 = \mathbf{20}$ neutrons. B) The heaviest isotope of nickel is called nickel-78 and has $N = 78 - 28 = \mathbf{50}$ neutrons.

Problem 4 - Solve the formula $N = A - Z$ to determine the missing information:

A) Tin ($A= 125$, $Z=50$) $N = ?$

Answer: $\mathbf{N = 125-50 = 75}$

B) Niobium ($N = 54$, $Z= 41$) $A = ?$

Answer: $54 = A - 41$ so $\mathbf{A = 54 + 41 = 95}$

C) Nobelium ($A = 253$, $N = 151$) $Z = ?$

Answer; $151 = 253 - Z$ so $Z = 253-151 = \mathbf{102}$.

D) Francium ($A=232$, $Z= 87$), $N=?$

Answer: $N = 232 - 87 = \mathbf{145}$.

E) Oxygen ($Z = 8$ $N= 16$) $A=?$

Answer: $16 = A - 8$ so $\mathbf{A = 24}$.