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 praesodymium 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 $A$?

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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 praesodymium 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 = 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 = 20 neutrons. B) The heaviest isotope of nickel is called nickel-78 and has N = 78 - 28 = 50 neutrons.

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

A) Tin (A= 125, Z=50) N = ?
   Answer: N = 125-50 = 75
B) Niobium (N = 54, Z= 41 ) A= ?
   Answer: 54 = A - 41 so A = 54 + 41 = 95
C) Nobelium (A = 253, N = 151 ) Z = ?
   Answer; 151 = 253 - Z so Z = 253-151 = 102.
D) Francium (A=232, Z= 87 ), N=?
   Answer: N = 232 - 87 = 145.
E) Oxygen ( Z = 8  N= 16) A=?
   Answer: 16 = A - 8 so A = 24.