

Key terms

- **atom** The smallest possible amount of matter which still retains its identity as a chemical element, consisting of a nucleus surrounded by electrons.
- **atomic mass** The average mass of an atom, taking into account all its naturally occurring isotopes.
- **atomic number** The number of protons in an atom.
- **half-life** The time it takes for half of the original concentration of an isotope to decay back to its more stable form.
- **isotope** Any of two or more forms of an element where the atoms have the same number of protons, but a different number of neutrons within their nuclei.
- **mass number** The sum of the number of protons and the number of neutrons in an atom.
- **neutron** A subatomic particle forming part of the nucleus of an atom and having no charge. It is equal in mass to a proton or it weighs 1 amu.
- **proton** Positively charged subatomic particle forming part of the nucleus of an atom and determining the atomic number of an element. It weighs 1 amu.
- **radiocarbon dating** By comparing the ratio of the ^{14}C concentration found in an object to the amount of ^{14}C in the atmosphere, the age of the object can be determined.

The Structure of the Atom



- Isotopes
- Atomic Number and Mass Number
- Overview of Atomic Structure

Isotopes

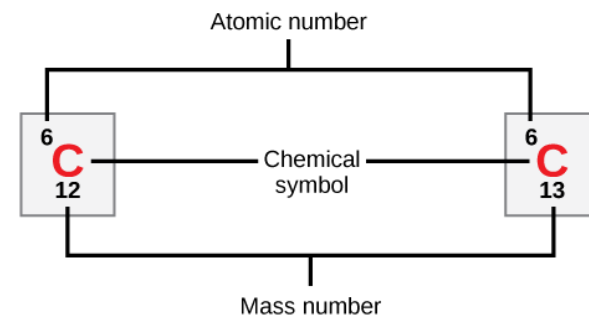
- Isotopes are atoms of the same element that contain the same number of protons but a different number of neutrons.
- Despite having different numbers of neutrons, isotopes of the same element have very similar physical properties.
- Some isotopes are unstable and will undergo radioactive decay to become other elements.
- The predictable half-life of different decaying isotopes allows scientists to date material based on its isotopic composition, such as with Carbon-14 dating.



Application of carbon dating

Atomic Number and Mass Number

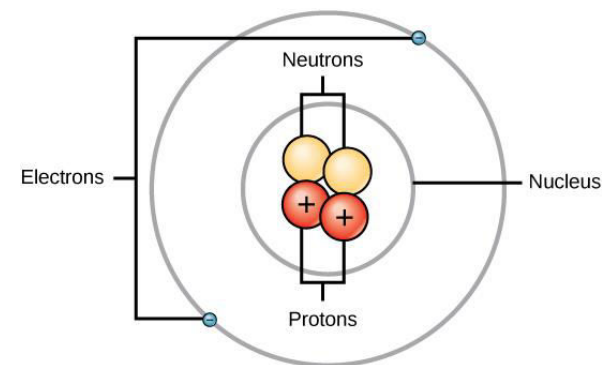
- Atoms of each element contain an equal number of protons and electrons.
- The number of protons determines an element's atomic number and is used to distinguish one element from another.
- The number of neutrons is variable, resulting in isotopes, which are different forms of the same atom that vary only in the number of neutrons they possess.
- Together, the number of protons and the number of neutrons determine an element's mass number.
- Since an element's isotopes have slightly different mass numbers, the atomic mass is calculated by obtaining the mean of the mass numbers for its isotopes.



Atomic number, chemical symbol, and mass number

Overview of Atomic Structure

- An atom is composed of two regions: the nucleus, which is in the center of the atom and contains protons and neutrons, and the outer region of the atom which holds its electrons in orbit around the nucleus.
- Protons and neutrons have approximately the same mass, about 1.67×10^{-24} grams, which scientists define as one atomic mass unit (amu) or one Dalton.
- Each electron has a negative charge (-1) equal to the positive charge of a proton (+1).
- Neutrons are uncharged particles found within the nucleus.



Structure of an atom

Protons, Neutrons, and Electrons

	Charge	Mass (amu)	Location
Proton	+1	1	nucleus
Neutron	0	1	nucleus
Electron	-1	0	orbitals

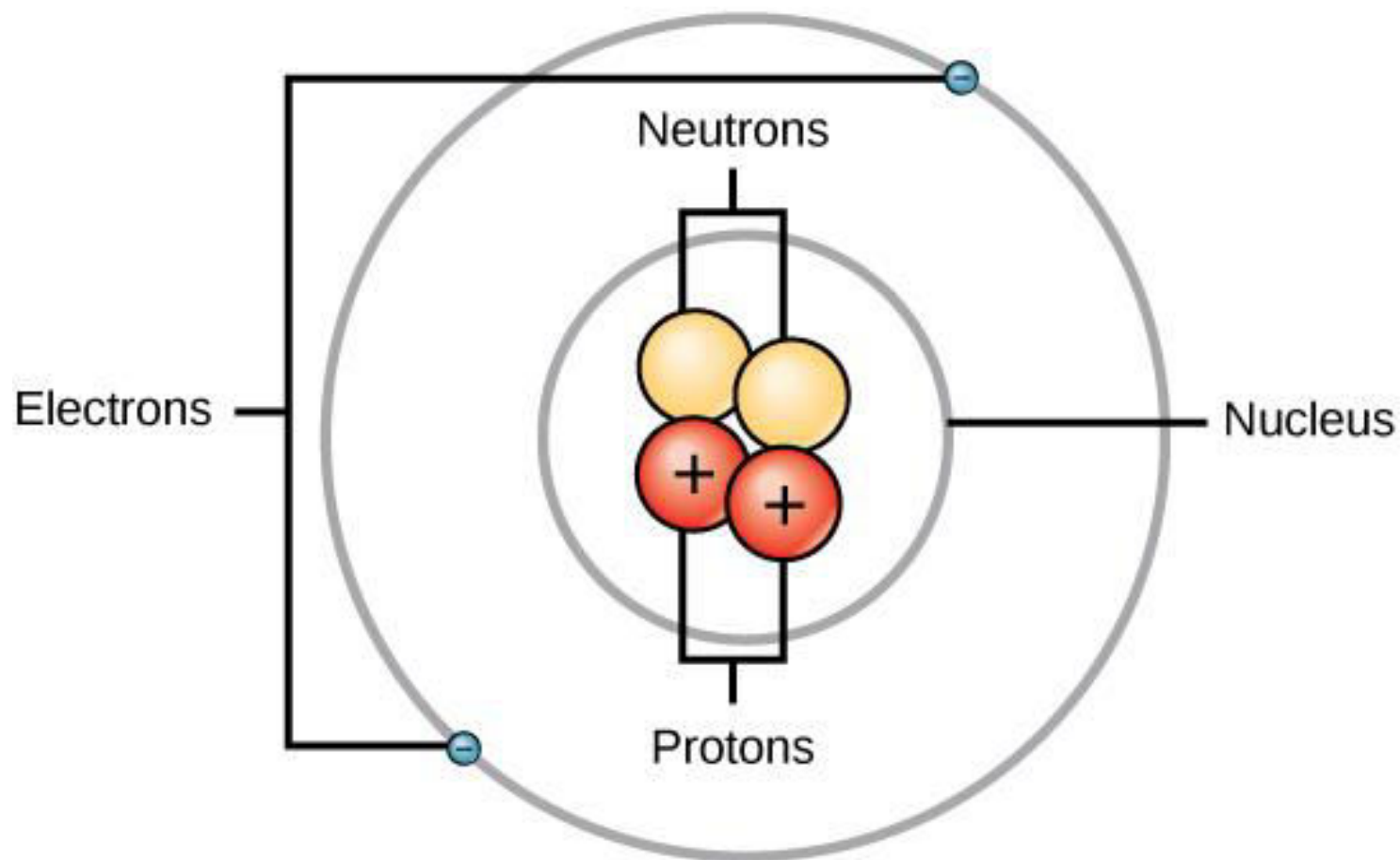
Protons, neutrons, and electrons

Both protons and neutrons have a mass of 1 amu and are found in the nucleus. However, protons have a charge of +1, and neutrons are uncharged. Electrons have a mass of approximately 0 amu, orbit the nucleus, and have a charge of -1.



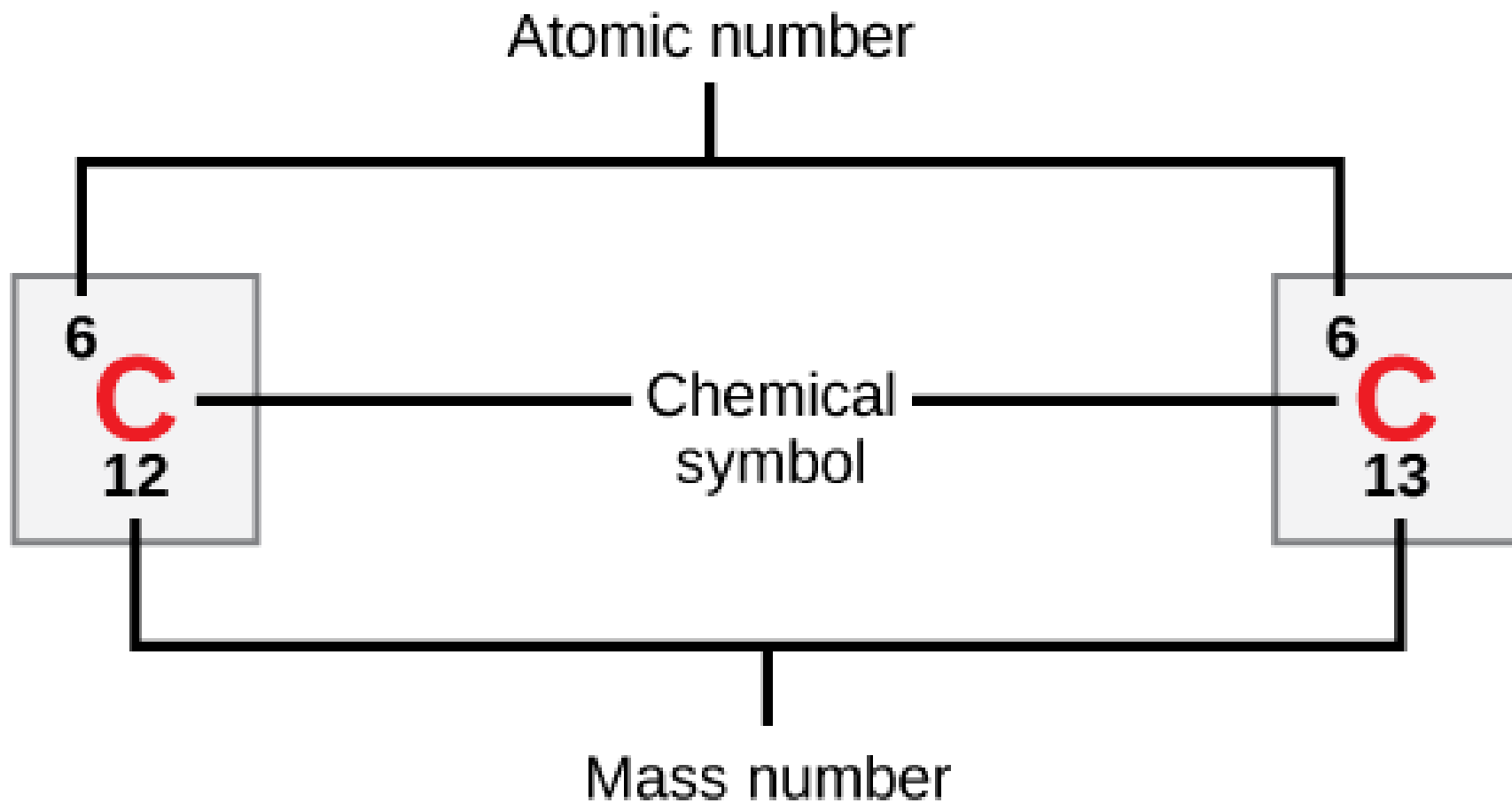
Application of carbon dating

The age of carbon-containing remains less than about 50,000 years old, such as this pygmy mammoth, can be determined using carbon dating.



Structure of an atom

Elements, such as helium, depicted here, are made up of atoms. Atoms are made up of protons and neutrons located within the nucleus, with electrons in orbitals surrounding the nucleus.



Atomic number, chemical symbol, and mass number

Carbon has an atomic number of six, and two stable isotopes with mass numbers of twelve and thirteen, respectively. Its average atomic mass is 12.11.