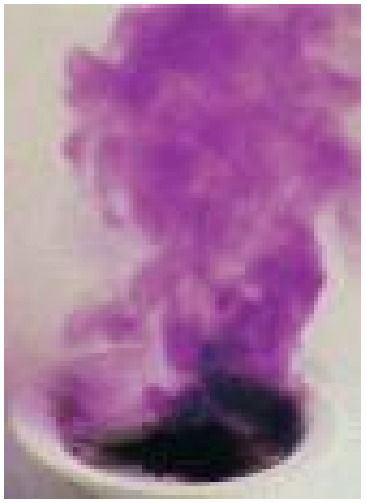
What is an Atom?

Chemistry 2021
Unit 1
Module 2

Module Concepts

- Basic Atomic Structure
  - Regions
  - Subatomic Particles
    - Calculating subatomic particles using information from periodic table
- Ions
  - Cations
  - Anions

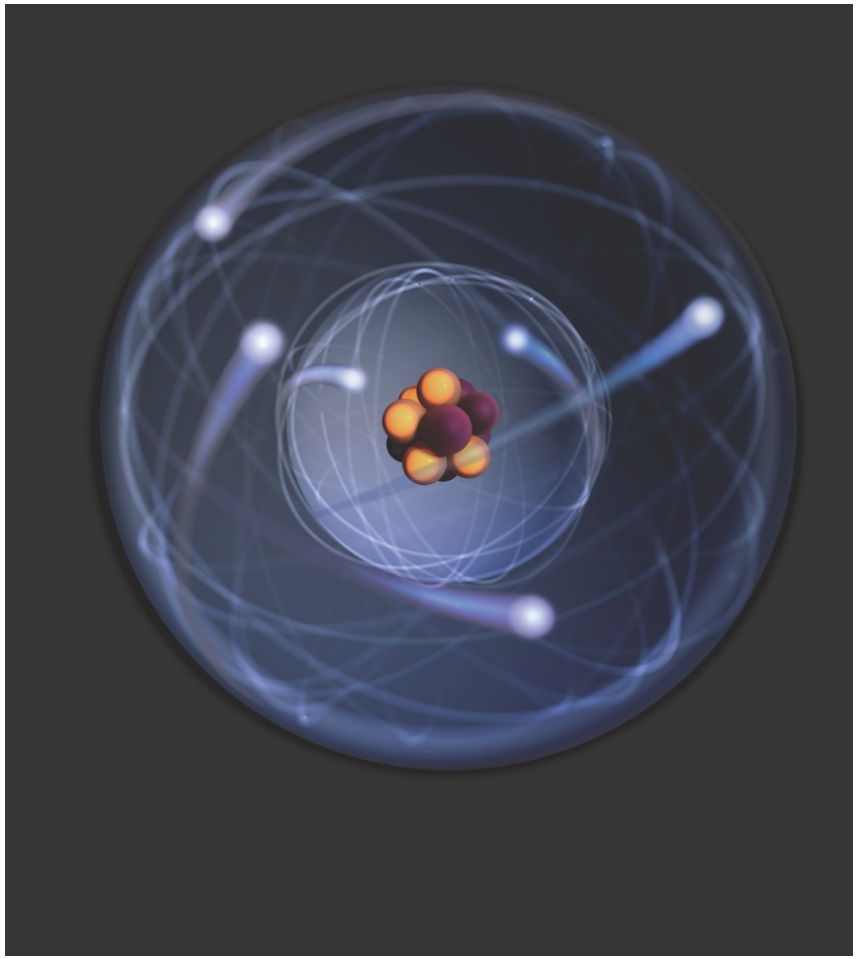
Elements



- The pictures below are of substances in their elemental state. What are elements made of?

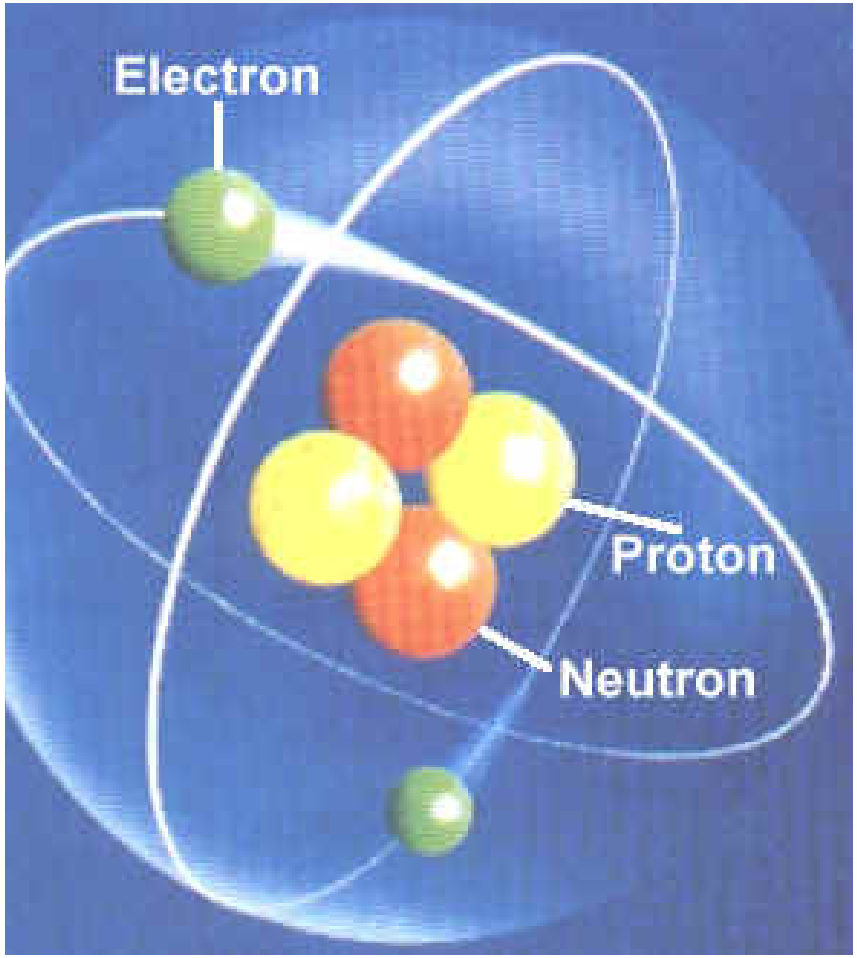
Basics of Atomic Structure

- There are three major sub-atomic particles located within two regions of the atom
- Regions
  - Nucleus
  - Electron Cloud
- Particles
  - Proton
  - Neutron
  - Electron



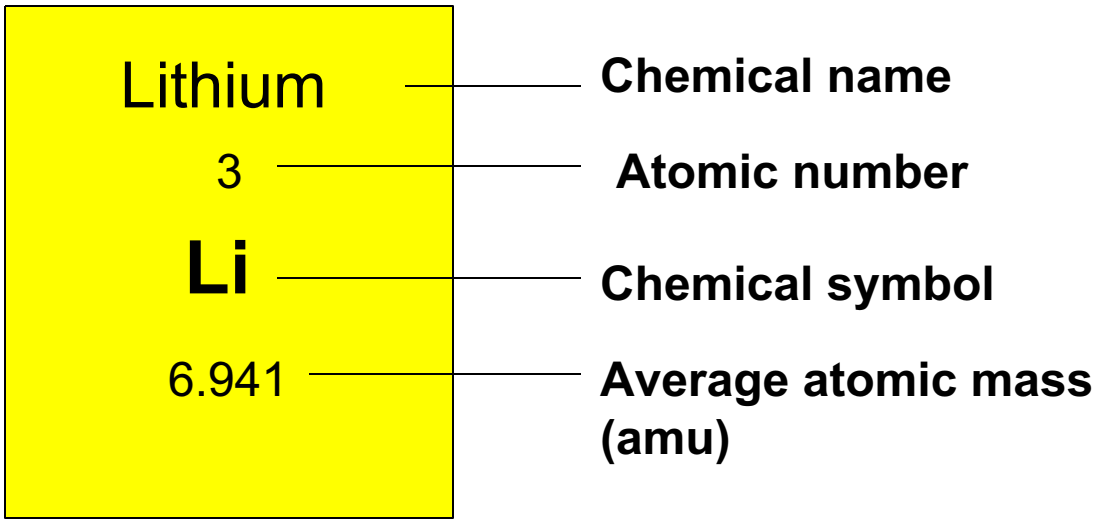
Basics of Atomic Structure

- Protons (P+) have a positive charge of 1+ and are found in the nucleus, the central region of an atom.They have a relative mass of 1.
- Neutrons (n) have no charge and are also found in the nucleus. They have a relative mass of 1.
- Electrons (e-) have a negative charge of 1-. The charge on one electron equals the charge on one proton. Electrons reside in the electron cloud region of the atom which surrounds the nucleus. They have a relative mass of 0.



Subatomic Particles

- The periodic table can be used to identify the number of protons, neutrons, and electrons in an atom or ion. How?



Differences Between Atoms

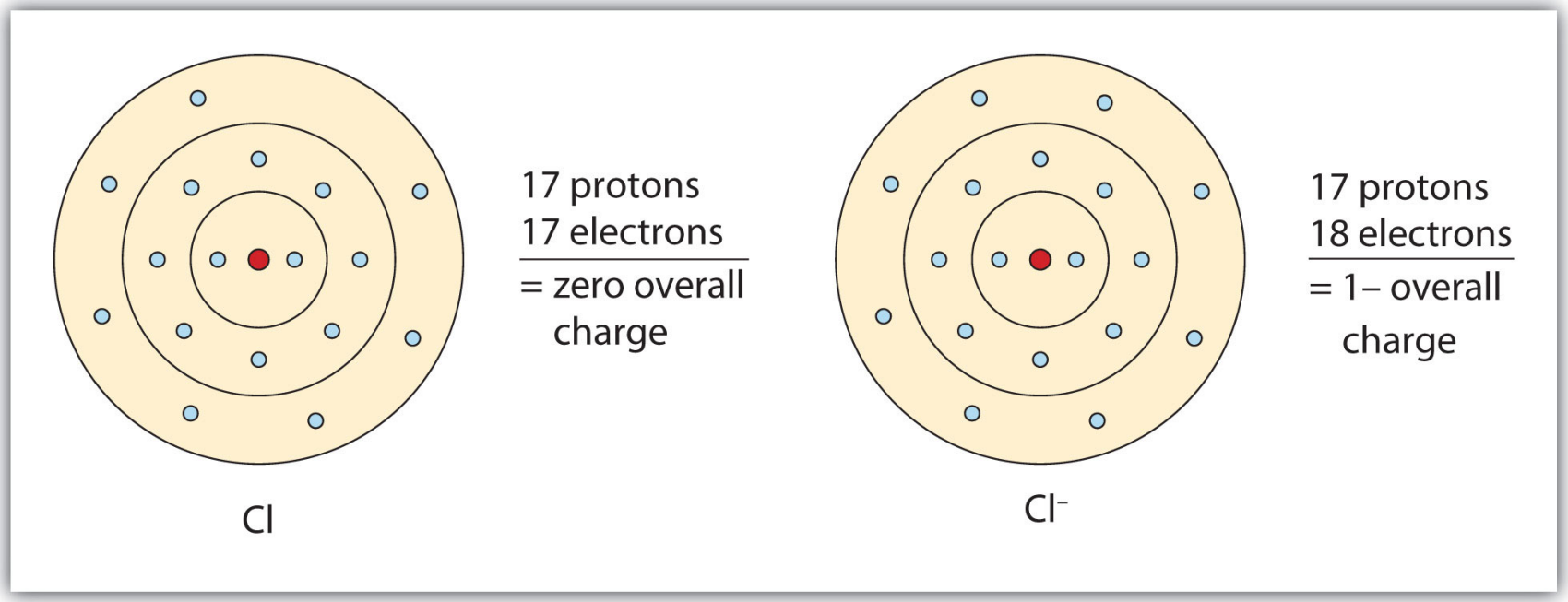
- Protons (p^+)
  - The atomic number is equal to the number of protons in an atom.
  - The number of protons determines the identity of the element. In other words, change the number of protons, change the element.
  - The number of protons is equal to the number of electrons (e^-) in a neutral atom.

- Neutrons (n^0)
  - The number of neutrons in the nucleus can vary, which leads to different isotopes for elements having the same atomic number but different mass numbers.
  - The number of neutrons is equal to the total mass of the atom (the mass number) minus the number of protons (atomic number).

- Electrons (e^-)
  - The number of electrons can also vary.
  - Changes in the number of electrons (without a change in the number of protons) cause a difference in charge.
  - Atoms with a charge (either positive or negative) are called ***ions***.

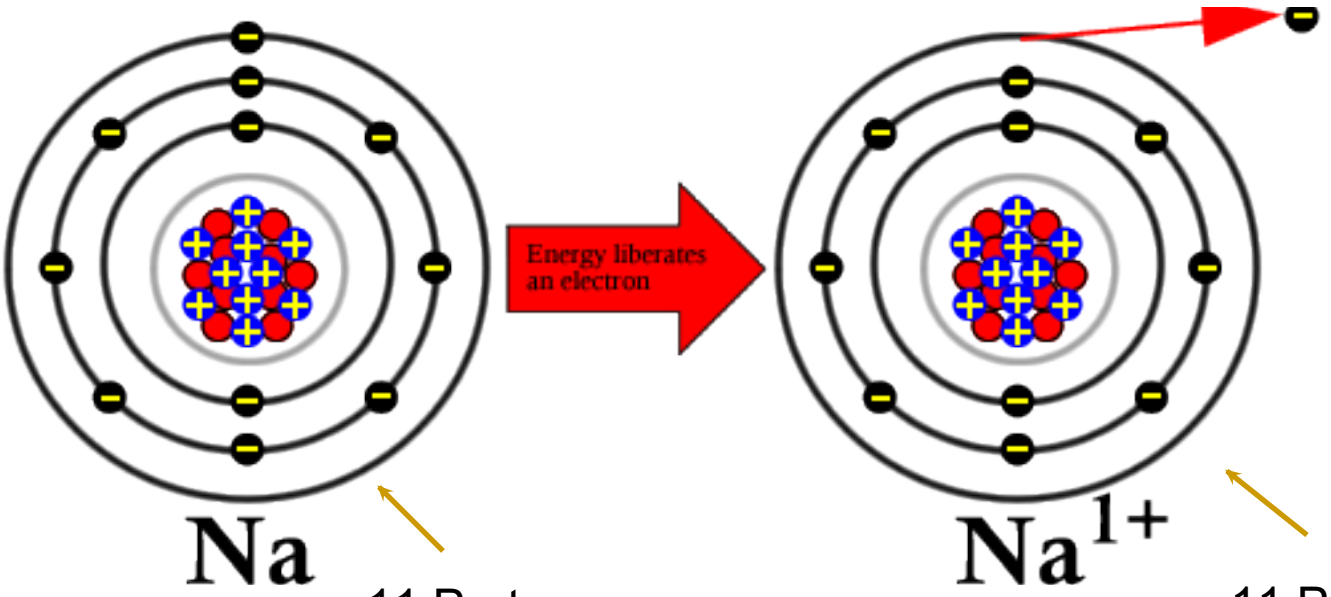
Ions

- Atoms with more electrons than protons have a negative charge and are called ***anions***.



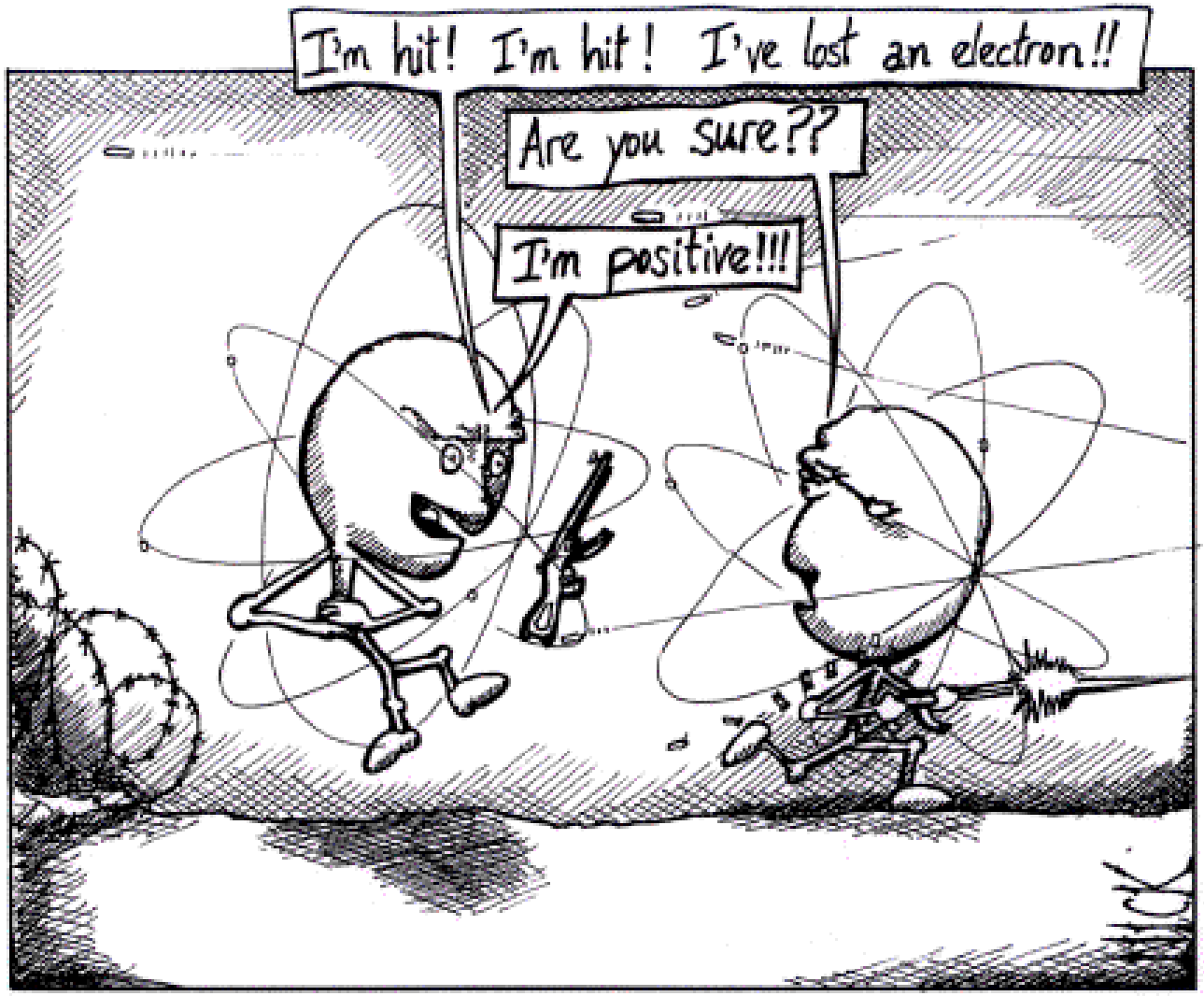
Ions

- Atoms with more protons than electrons have a positive charge and are called ***cations***.



11 Protons
11 electrons
= zero overall charge

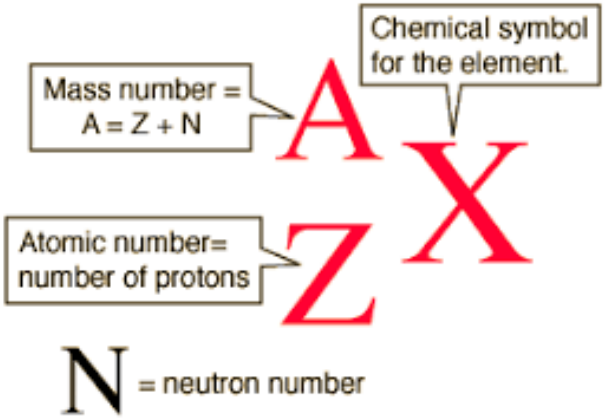
11 Protons
10 electrons
= 1+ overall charge



ANOTHER CASUALTY IN THE WAR OF THE SODIUM ATOMS

Subatomic Particles - Summary

- For any neutral element:
  - Number of Protons = Atomic Number
  - Number of Electrons = Number of Protons = Atomic Number
  - Number of Neutrons = Mass Number - Atomic Number
  - Atomic/Nuclear Symbol =



Example – Calculating Subatomic Particles

- Identify the number of protons, neutrons, and electrons in a neutral atom of sodium.
- ***Solution:***
  - Find sodium on the periodic table. (Sodium = Na)
  - Identify its atomic number. (11)
  - Identify its mass number - 23 (i.e. atomic mass rounded to the nearest whole number unless otherwise specified)
  - Atomic number = # Protons = # electrons = 11
  - # neutrons = mass number – atomic number
    = 23 - 11 = 12

Example – Calculating Subatomic Particles

- Identify the number of protons, neutrons, and electrons in Carbon - 14, an isotope of Carbon (This is called a hyphen notation where the mass number of a specific isotope is provided.)
- ***Solution:***
  - Find carbon on the periodic table. (Carbon = C)
  - Identify its atomic number. (6)
  - Identify its mass number - 14 (***Hint: In a hyphen notation, the number after the hyphen is the mass number of a specific isotope***)
  - Atomic number = # Protons = # electrons = 6
  - # neutrons = mass number – atomic number

    = 14 - 6 = 8

Example – Calculating Subatomic Particles

- Identify the number of protons, neutrons, and electrons in the Na^{1+} ion.
- ***Solution:***
  - Find sodium on the periodic table. (Sodium = Na)
  - Identify its atomic number (11)
  - Identify its mass number - 23 (i.e. atomic mass rounded to the nearest whole number unless otherwise specified)
  - Atomic number = # Protons = 11
  - # electrons = 11 – 1 = 10 (subtract 1 electron for positive one charge)
  - # neutrons = mass number – atomic number
    = 23 - 11 = 12

Example – Calculating Subatomic Particles

- Identify the number of protons, neutrons, and electrons in the Cl^{1-} ion.
- ***Solution:***
  - Find chlorine on the periodic table. (Chlorine = Cl)
  - Identify its atomic number (17)
  - Identify its mass number - 35 (i.e. atomic mass rounded to the nearest whole number unless otherwise specified)
  - Atomic number = # Protons = 17
  - # electrons = 17 + 1 = 18 (add 1 electron for negative one charge)
  - # neutrons = mass number – atomic number
    = 35 - 17 = 18