

## Chapter 4.3 –Atomic Structure

● How is an atom arranged?

- Atoms have a center or core called a nucleus
- The nucleus contains 2 subatomic particles:
  - Proton that has a positive charge
  - Neutron that has a NEUTRAL charge
  - Protons and neutrons together are called nucleons because they are in the nucleus
- The nucleus is surrounded by a cloud of very tiny particles called electrons
  - Electrons have a negative charge
- The negative charge on the electron cancels out the positive charge of the proton

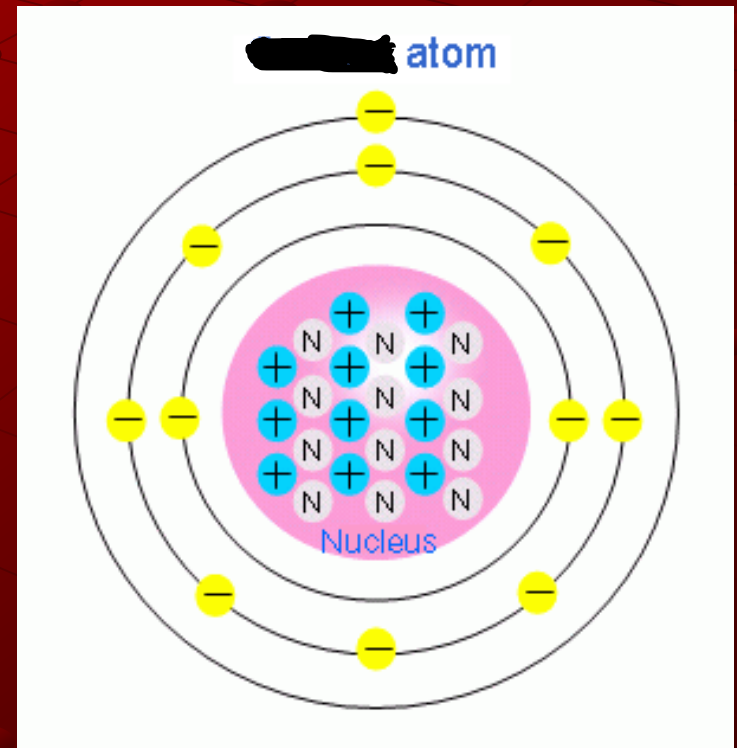
# Chapter 4.3 Atomic Structure

● What is the relationship between elements and their Atomic Number?

- Atoms of different elements have different numbers of protons
- Protons have a positive charge and are found in the nucleus of an atom
- The number of protons in the nucleus is called the **ATOMIC NUMBER**.
- Each element has a different atomic number because atoms of different elements have different numbers of protons

# Chapter 4.3 Atomic Structure

- What is the importance of the Atomic Number?
  - No two elements can have the same number
  - The number of protons in the nucleus tells you what that element is
  - Count the positive charges to find the number of protons
  - Then look it up on the PT
  - What is this element?



# Chapter 4.3 Atomic Structure

● How is the Atomic Number related to Electrons?

- If you know the atomic number of an element—you know the number of.....

- protons

- Most elements are assumed to be electrically neutral—not positive or negative in charge
- This means that the + charges of the protons must be cancelled out by – charges of electrons
- So in a neutral atom, the number of electrons **MUST** equal the number of protons



# Chapter 4.3 Atomic Structure

## ● What is an Atomic Mass Unit?

- Try to imagine weighing a single atom, one that you can't even see
- The mass of an atom is extremely small
- Scientists had to invent a new measuring unit
- This unit is called ATOMIC MASS UNIT
- It is abbreviated amu (all lower case letters)
- Scientists decided that 1 amu is equal to the mass of 1 proton

# Chapter 4.3 Atomic Structure

● What is the mass of a neutron?

- Scientists found that the mass of a neutron is about the same as a proton
- So the mass of 1 neutron is also 1 amu

□ What is the mass of an electron?

- Electrons are SO SMALL that the mass is almost nothing
- Electrons are not counted when determining the mass of an atom
- Scientists only count the number of protons and neutrons to find the total mass of one atom

## Chapter 4.3 Atomic Structure

### ● What is the mass number?

- The total number of protons and neutrons in an atom is called the mass number
- It is also called the nucleon number

### ● How can you find the mass number for any element?

- Round the average atomic mass, found on the periodic table to the nearest whole number

### ● How do I determine Neutrons?

- Total weight of an atom is made up of only 2 particles—protons and neutrons



# Chapter 4.3 Atomic Structure

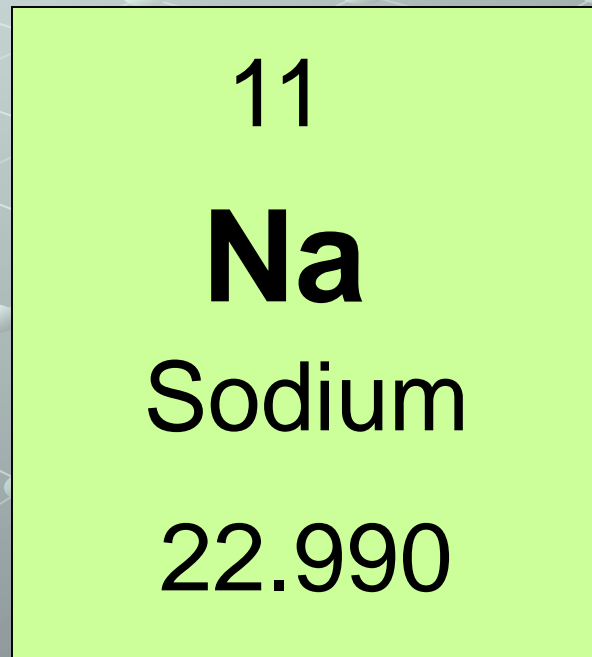
- You need to know the atomic number and the atomic mass to find the neutrons
  - Subtract the atomic number (number of protons) from the atomic mass
  - You will be left with the mass of the neutrons
  - Remember the electrons will equal the protons in number but HAVE NO WEIGHT
- Example: (mass - number = neutrons)
- Aluminum—atomic number 13 (same as # protons)  
atomic mass 27 (includes protons + neutrons)  
 $27 - 13 = 14$  (the only thing left is neutrons)



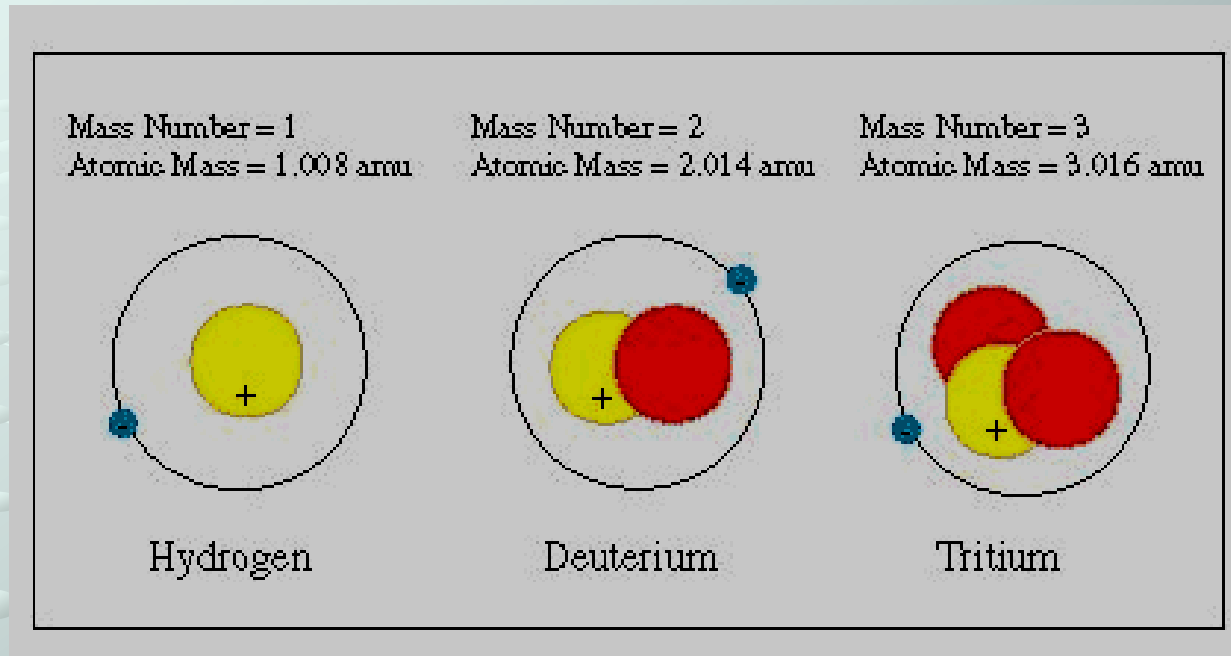
## Chapter 4.3 Atomic Structure

● You can find the number of neutrons in any atom by using this formula

$$\text{atomic mass} - \text{atomic number} = \# \text{ of neutrons}$$



# Chapter 4.3 Atomic Structure



- The yellow particles are protons
- The red particles are neutrons
- What do you notice about the atomic mass in each picture?

# Chapter 4.3 Isotopes

## ● What are isotopes?

- Isotopes = atoms with the same number of protons but different numbers of neutrons
- Example—bananas contain potassium (K)
- After analysis it is shown that:
  - 93.25% of the K atoms have 20 neutrons
  - 6.7302% of the K atoms have 22 neutrons
  - 0.0117% have 21 neutrons
  - This adds up to 100%
- The number of protons stays the same
- The number of electrons is the same

# Chapter 4.3 Isotopes

- Total mass of a K atom = protons + neutrons
- Therefore the mass of these 3 atoms is different
- Isotopes can be written with the mass of the isotope following the name of the element:
  - Potassium-39 (19 protons, 20 neutrons, 19 electrons)
  - Potassium-40 (19 protons, 21 neutrons, 19 electrons)
  - Potassium-41 (19 protons, 22 neutrons, 19 electrons)



# Chapter 4.3 Isotopes

● You can also show isotopes by using the chemical symbol, atomic mass and atomic number:



# Chapter 4.3 Isotopes

- The atomic mass of an element is the weighted average of its isotopes

- This means you take in to consideration which isotope is naturally present in what percentage.

- Example using chlorine:

- Chlorine-35 exists in 75.770% abundance

- Chlorine-37 exists in 24.230% abundance

- Atomic mass =

- $35 \text{ amu} \times .75770 = 26.496 \text{ amu}$

- $37 \text{ amu} \times .24230 = 8.957 \text{ amu}$

- $26.496 \text{ amu} + 8.957 \text{ amu} = 35.453 \text{ amu}$  (see PT)

# Chapter 4.3 Radioactive Isotopes

## What are radioactive isotopes?

- Isotopes of atoms with unstable nuclei are called radioactive isotopes or *radioisotopes*.
- These unstable nuclei emit (give off) radiation
- They do this to acquire a more stable atomic configuration
- This process is called radioactive decay.
- During radioactive decay, unstable atoms lose energy by giving off a type of radiation
- The most common types of radiation are called alpha ( $\alpha$ ), beta ( $\beta$ ) or gamma ( $\gamma$ )

# Chapter 4.3 Radioactive Isotopes

## What are the uses of radioactive isotopes?

- Radioactive isotopes are used in medical and industrial situations
- With proper safety procedures, radiation can be very useful.

## What are some Medical Uses?

- Radioactive isotopes are sometimes given to patients in a special drink so that doctors can see if internal organs are working properly.
- PET scans are one form of diagnostic test that uses radioactive isotopes



# Chapter 4.3 Radioactive Isotopes

What are some industrial Uses of Radioactive Isotopes?

- Computer chip manufacturers use these isotopes to analyze the composition of highly purified silicon wafers
- Radioactive isotopes can also be used to follow the path of an element in a chemical reaction