## Atomic and Molecular Mass

## Isotopes

- Nuclei that have the same number of protons but a different number of neutrons
- Have identical chemical properties (all have same number of protons and thus electrons) but different physical properties
- The existence of isotopes is evidence for the existence of neutrons inside the nucleus

Mass number

$$^{A}_{Z}X$$

Element symbol

Atomic or proton number

## Examples

$^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$ (hydrogen)

$^{238}_{92}U$, $^{235}_{92}U$ (uranium)

Sometimes we drop the atomic number

$^{24}Mg$, $^{25}Mg$, $^{26}Mg$ (magnesium)

We can also represent the isotope like this:

Sodium-23, Sodium-24 (sodium)

Carbon-12, Carbon-14 (carbon)

## Relative Atomic Mass ($A_r$)

- Atoms are small and therefore measuring mass in kilograms or grams would give extremely small numbers.
- Instead the mass of an atom is compared with that of an atom of carbon-12.
- The relative atomic mass of carbon-12 is taken to be 12.

## Average Atomic Mass

- If the relative atomic mass is based on carbon, why doesn't carbon have a mass of exactly 12?
  - Carbon has more than one isotope
  - The mass quoted on the periodic table is really the average atomic mass of all atoms of carbon
  - The amount of each isotope of an element is known as the percent abundance

## Calculating Average Atomic Mass

- The average atomic mass is the weighted average of all of the isotopes of the element

$$
\begin{aligned}
&(\text{mass of isotope 1})(\text{percent abundance of isotope 1}) + \\
&(\text{mass of isotope 2})(\text{percent abundance of isotope 2}) + \\
&(\text{mass of isotope 3})(\text{percent abundance of isotope 3}) + \ldots \\
&= \text{average atomic mass}
\end{aligned}
$$

## Example

- Potassium (K)

| Isotope | Percent Abundance | Atomic Mass (u) |
|---|---|---|
| K-39 | 93.2581 | 38.963707 |
| K-40 | 0.0117 | 39.963998 |
| K-41 | 6.7302 | 40.961826 |

$$
\begin{array}{r}
(38.963707)(0.932581) \\
(39.963998)(0.000117) \\
+\underline{(40.961826)(0.067302)} \\
39.098301 \ \text{u}
\end{array}
$$