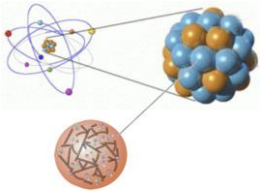


# What is matter and how is it formed?

## Lesson 1: Atoms, Isotopes and Radioisotopes.

In 1896, **Henri Becquerel** .....

In 1898, **Marie and Pierre Curie** .....

**Terrestrial Radiation** comes from .....

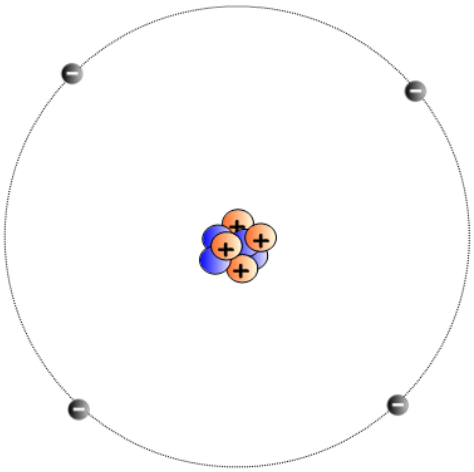
**Cosmic Radiation** comes from .....

.....

**Nuclear** radiation is emitted from the ..... of the atom

### Atomic Structure

An atom of any element consists of a relatively tiny **nucleus** containing ..... and positively charged ..... at its centre, surrounded by a cloud of negatively charged .....



An **electron** has the same magnitude of charge as a ..... but only **1/2000** of its mass.

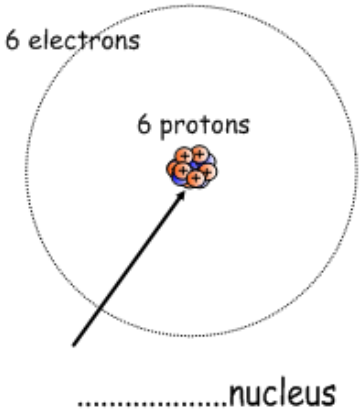
The **nucleus** contains virtually all the ..... of the atom but occupies only a tiny fraction, less than $10^{-12}$ of the .....

Relatively speaking the **nucleus** is the size of a ..... in the centre of the Melbourne Cricket Ground where the **electrons** orbit around the boundary fence.

**Chemical properties** of atoms are determined by how they **bond** together and this in turn depends on the ..... arrangement.

## Naming the Nucleus

In a **neutral** atom, number of ..... (+ve charged) = number of ..... (-ve charged).

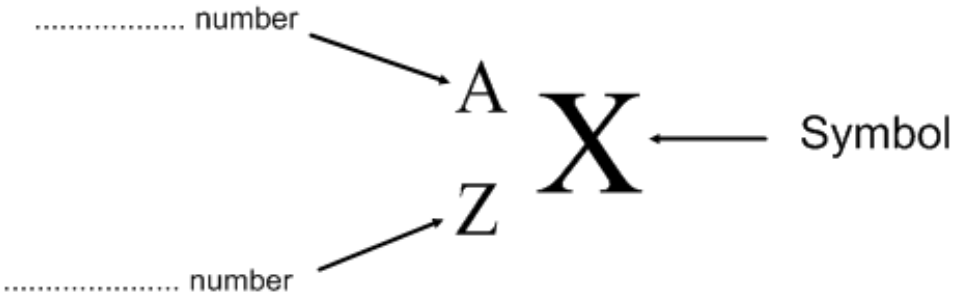



We borrow the name of the chemical ..... to describe its nucleus.

The ..... number specifies the element.

For example, the **element** with **atomic number** equal to six is .....

### Naming convention for the nucleus

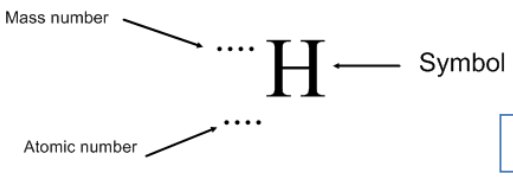



**Atomic Number, Z** = number of ..... in the nucleus.

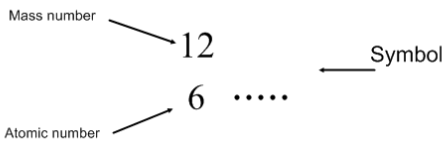
**Mass Number, A** = total number of ..... **and** ..... in the nucleus.

**Examples**

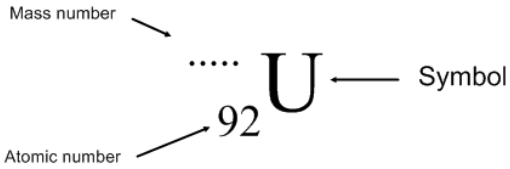
***Hydrogen*** *Nucleus*




***Carbon*** *Nucleus*




***Uranium-238*** *Nucleus*



**Examples (Continued)**

A single **proton** $_{1}^{1}p$ 

A single **neutron** $_{0}^{1}n$ 

## The Periodic Table of Elements

***Refer to the periodic table to find atomic numbers and chemical symbols for nuclides.***

| Period | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | 1 H 1.01 | | | | | | | | | | 2 He 4.00 |
| 2 | 3 Li 6.94 | 4 Be 9.01 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 3 | 11 Na 22.99 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.06 | 17 Cl 35.45 | 18 Ar 39.95 |
| 4 | 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.90 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.71 | 29 Cu 63.54 | 30 Zn 65.37 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.91 | 36 Kr 83.80 |
| 5 | 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (99) | 44 Ru 101.07 | 45 Rh 102.91 | 46 Pd 106.4 | 47 Ag 107.87 | 48 Cd 112.40 | 49 In 114.82 | 50 Sn 118.69 | 51 Sb 121.75 | 52 Te 127.60 | 53 I 126.90 | 54 Xe 131.30 |
| 6 | 55 Cs 132.91 | 56 Ba 137.34 | 57 La 138.91 | 72 Hf 178.49 | 73 Ta 180.95 | 74 W 183.85 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.09 | 79 Au 196.97 | 80 Hg 200.59 | 81 Tl 204.37 | 82 Pb 207.19 | 83 Bi 208.98 | 84 Po (210) | 85 At (210) | 86 Rn (222) |
| 7 | 87 Fr (223) | 88 Ra (226) | 89 Ac (227) | 104 Rf (261) | 105 Db (262) | 106 Sg (263) | 107 Bh (264) | 108 Hs (277) | 109 Mt (268) | 110 Ds (271) | 111 Rg (272) | 112 Uub (277) | 113 Uut | 114 Uuq (289) | 115 Uup | 116 Uuh (289) | 117 | 118 Uuo (293) |

Lanthanides

| 58 Ce 140.12 | 59 Pr 140.91 | 60 Nd 144.24 | 61 Pm (145) | 62 Sm 150.35 | 63 Eu 151.96 | 64 Gd 157.25 | 65 Tb 158.92 | 66 Dy 162.50 | 67 Ho 164.93 | 68 Er 167.26 | 69 Tm 168.93 | 70 Yb 173.04 | 71 Lu 174.97 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Actinides

| 90 Th 232.04 | 91 Pa (231) | 92 U 238.03 | 93 Np (237) | 94 Pu (242) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (249) | 99 Es (254) | 100 Fm (253) | 101 Md (256) | 102 No (254) | 103 Lr (257) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Every isotope of these elements is radioactive

**Define the following terms:**

**Nuclide**

**Nucleon**

**Isotopes** are atoms which have the **same** number of ..... (and hence same atomic number and chemical symbol) but **different** numbers of .....

Stable isotopes do **not** emit nuclear radiation and most elements have stable isotopes.

An **isotope** and/or **nuclide** is specified by the name of the particular **element** followed by a ..... and the ..... number.

carbon-12, carbon-13 helium-3, helium-4 uranium-235, uranium-239

## Radioisotopes

Many isotopes are **unstable**. They lose ..... by emitting a particle and change into a different element or isotope.

Unstable isotopes are radioactive.

A **radioactive** isotope is called a .....

Most elements on earth have **naturally occurring** radioisotopes.

Carbon has two stable isotopes $^{12}_{6}C$ and $^{13}_{6}C$

and one naturally occurring radioisotope $^{14}_{6}C$

## Artificial Transmutation

There are about ..... naturally occurring radioisotopes.

About ..... radioisotopes have been manufactured by a process called **artificial transmutation.**

Radioisotopes used in ..... and ..... are **synthesised** by artificial transmutation.

In Australia, this is done at the ..... reactor in Sydney

Complete the Nuclear "equation" for artificial transmutation which synthesises **cobalt-60**

$$^{1}_{0}n + {}^{\cdots}_{27}Co \rightarrow {}^{60}_{\cdots}Co + \text{radiation}$$

Briefly describe **three uses** for the gamma radiation emitted from synthesised cobalt-60

1.

2.

3.

For the **worked example** below, write your answers in the **spaces provided**.

## Worked Example

An isotope of uranium is labelled **uranium-238**.

**a** Use the periodic table to find the atomic number (Z) of this isotope.

**b** What is the mass number (A) of this isotope.

**c** How many neutrons are there in this isotope?

**d** What is the chemical symbol for this isotope.

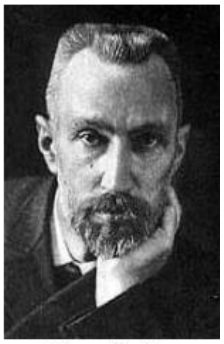
**e** Designate this isotope using the $^{A}_{Z}X$ format.

**f** How many nucleons are there in this isotope?

# Summary

The study of radioactivity began with the discovery of **natural radioactivity** by ..... ..... in 1886.

Marie Curie
1867 - 1934

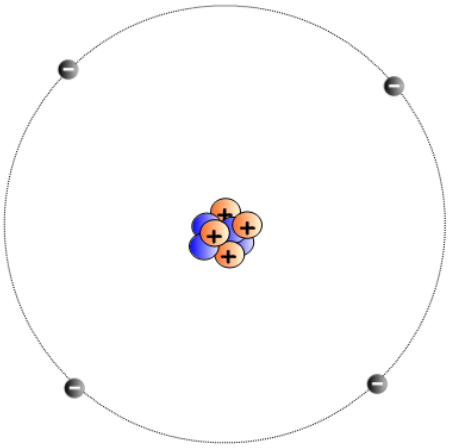


Pierre Curie
1859 - 1906

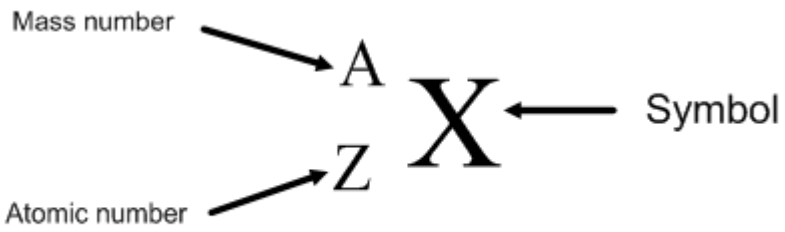
In 1890**, Marie** and **Pierre Curie** isolated two radioactive elements, ..... and **polonium**.

Natural radiation consists of **terrestrial** radiation from the earth's crust and atmosphere and ..... radiation from space.

The atom consists of a tiny ..... surrounded by a "cloud" of .....



**Naming Nuclides**




**mass number** A = number of ..... and neutrons

**atomic number** Z = number of .....

**X** = chemical symbol

**Nuclear radiation** is radiation that is emitted from the ..... of an atom.

**Isotopes** are atoms which have the **same** number of ..... (and hence same atomic number and chemical symbol) but **different** numbers of .....

Stable isotopes do **not** emit nuclear radiation.

Many isotopes are unstable.

Radioisotopes are **unstable**. They lose energy by emitting a particle and change into a different element or isotope.

Most elements on earth have naturally occurring radioisotopes.

### Artificial Transmutation

About 2000 artificial radioisotopes have been manufacture by a process called artificial transmutation.

Radioisotopes used in industry and medicine are synthesised by artificial transmutation.

EXTRA NOTES