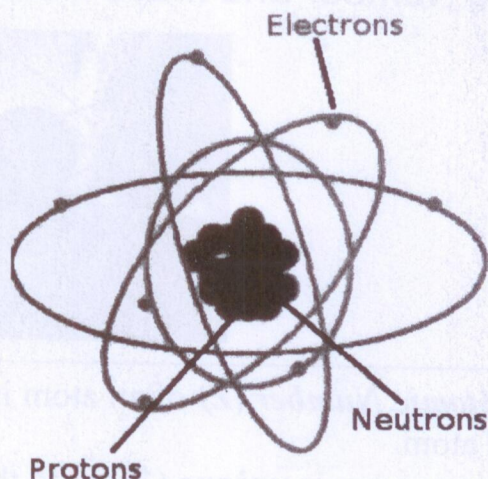


Atoms 原子



A. Atoms

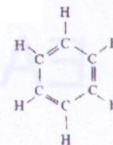
- An **atom** is the *smallest part* of an **element** which can ever exist.
- An **element** is a substance that is made up of **ONLY** one kind of _____.

Atoms are made up of **THREE** sub-atomic particles :

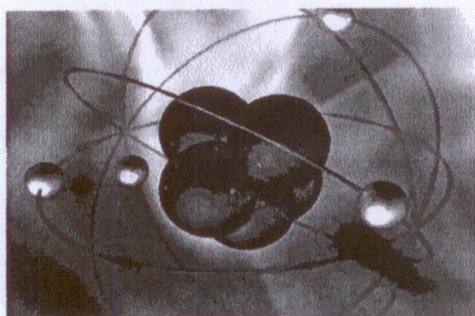
1. _____ (質子) : positively (+) / negatively (-) charged
2. _____ (中子) : positively (+) / negatively (-) charged
3. _____ (電子) : positively (+) / negatively (-) charged

- The **positively charged** _____ and the **neutral** _____ are **concentrated** in the _____ (原子核).
 - The tiny negatively charged _____ are moving around the nucleus.
- ∴ Most of the space of an atom is just _____ space.

	Symbol	Mass (g)	Relative mass	Relative electric charge	Position in the atom
Proton		1.6725×10^{-24}			
Neutron		1.6748×10^{-24}			
electron		9.109×10^{-28}			



B. Atomic Number and Mass Number



The **Atomic Number (Z)** of an atom is the number of protons / neutrons / electrons in the atom.

Atomic number is **unique** (獨一) to the element.

Example : If an atom with 8 protons is added with 1 proton in its nucleus, what happens ?

An atom is **electrically neutral**.

→ number of _____ () = number of _____ ().

Example : How many electrons does a fluorine atom contain ?

The **Mass Number (A)** of an atom is the total number of _____ () and _____ () in the atom.

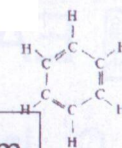
Example : What is the mass number of a sulphur atom which contains 16 neutrons.

Full Atomic Symbol

A	Atomic Symbol
Z	

Example : Write the full symbol for an aluminium atom containing 14 neutrons.

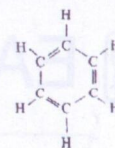
Example : Write the full symbol for a phosphorus atom containing 16 neutrons.



Atom	No. of protons	No. of neutrons	No. of electrons	Full symbol	State at room conditions
	1	0			
	2	2			
	3	4			
	4	5			
	5	6			
	6	6			
	7	7			
	8	8			
	9	10			
	10	10			
	11	12			
	12	12			
	13	14			
	14	14			
	15	16			
	16	16			
	17	18			
	18	22			
	19	20			
	20	20			

Example : The atomic number of iron is 26 and its mass number is 56.

- Find the number of **protons**, **neutrons** and **electrons** it contains.
- Why are the *numbers* of **p** and **e⁻** equal in the atom ?
- Write its **full symbol**.
- In which part of an atom can most of its mass be found ?



C. Isotopes (同位素)

- ALL atoms of the **same element** MUST have the same number of _____.
- However, some atoms of **same element** have **different masses**
 - since they contain different number of _____
 - they are called **ISOTOPES**

Isotopes are _____ of the *same* _____ (or same _____ number or same number of _____) which have *different* numbers of _____ (or **different** _____ number).

- For example, the element **hydrogen** has THREE *natural isotopes* :

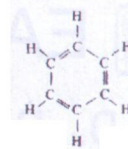
Atomic symbol	No. of protons	No. of neutrons	No. of electrons	Full symbol
H		0		
H		1		
H		2		

- **Relative abundance** (相對存量) of isotopes :

Element	Isotopes	% abundance of isotopes in nature
Hydrogen		99.984 %
		0.016 %
		very small %
Carbon		98.892 %
		1.108 %
		very small %
Oxygen		99.76 %
		0.04 %
		0.20 %
Sodium		100 %
chlorine		75.4 %
		25.6 %

Questions :

1. If we breath in 10,000 oxygen atoms, how many are **oxygen-16** isotope ?
2. How many *isotopes* does **sodium** have ?

MCQ

1. The nuclei of all atoms contain

- (1) protons
- (2) neutrons
- (3) electrons

- A. (1) only
- B. (1) and (2) only
- C. (1) and (3) only
- D. (2) and (3) only

2. Which of the four atoms are isotopes of the same element ?

Atoms	W	X	Y	Z
Mass number	36	39	40	40
Number of neutrons	18	20	21	22

- A. W & Z only
- B. W & X and Y & Z only
- C. X & Y only
- D. X & Y and W & Z only

3. The isotopes of an element have the SAME

- (1) mass number
- (2) atomic number
- (3) number of electrons
- (4) chemical properties
- (5) physical properties

- A. (1), (2) and (5)
- B. (1), (3) and (4)
- C. (2), (3) and (4)
- D. (3), (4) and (5)

D. Relative Mass of Atoms

- The **actual mass** of an atom is *very small*.
- In 1961, scientists took **one isotope of carbon (carbon-12)** as the **standard** to compare the masses of other atoms.
- They took the **relative mass** (相對質量) of one ^{12}C atom as exactly 12.000 00.

$$\text{Isotopic Mass} = \text{Mass Number}$$

Example 1 : What is the **isotopic mass** of

(a) ^{37}Cl

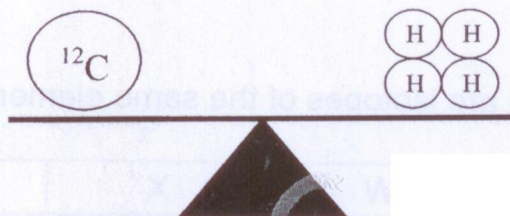
(b) ^{35}Cl

(c) ^{11}B

(d) ^{238}U

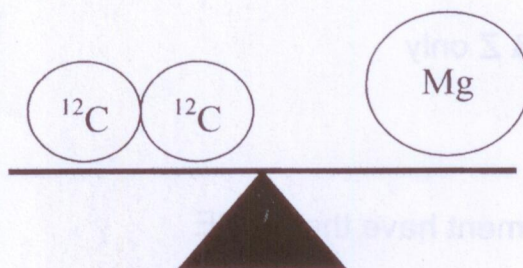
(e) K

Example 2 :

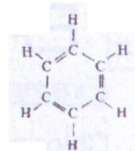


- What is the **relative mass** of one hydrogen isotope on the balance ?
- Hence, write the **full atomic symbol** of that isotope.
- How many **neutrons** does this isotope contain ?

Example 3 :



- What is the **relative mass** of *one* magnesium isotope on the balance ?
- Hence, write the **full atomic symbol** of that isotope.
- How many **neutrons** does this isotope contain ?



Relative Atomic Mass (相對原子質量)

- The element **sodium** has only ONE isotope (^{23}Na)
 - the relative isotopic mass is _____.
 - the relative atomic mass is _____.

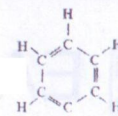
- If element X has TWO isotopes, ^{10}X and ^{12}X , relative abundance of each is 50 % and 50 % respectively.
 - the relative isotopic mass of ^{10}X is _____ and that of ^{12}X is _____.
 - What is the **relative atomic mass** of X ?

- If element Y has TWO isotopes, ^8Y and ^9Y , relative abundance of each is 20 % and 80 % respectively. What is the **relative atomic mass** of Y ?

- If element Z has TWO isotopes, ^{24}Z and ^{25}Z , relative abundance of each is 40 % and 60 % respectively. What is the **relative atomic mass** of Z ?

- Element W has 3 isotopes, ^2W , ^3W and ^4W , relative abundance of each is 10 %, 30 % and 60 %. Find the **relative atomic mass** of W.

The **RELATIVE ATOMIC MASS** of an element is the _____ of the isotopic masses (_____ number) of its isotopes on the _____.

Example 1

Chlorine consists of two natural isotopes, ^{35}Cl and ^{37}Cl , with percentage abundance of 75.4 % and 24.6 % respectively. Calculate the **relative atomic mass** of chlorine.

Example 2

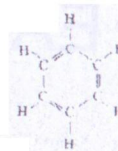
Neon has two isotopes ^{20}Ne and ^{22}Ne . The relative atomic mass of neon is 20.2. Calculate the **relative abundance** of the two isotopes.

Example 3

An element has three isotopes : ^{20}X , ^{21}X , ^{22}X . The ratio of abundances of ^{20}X and ^{22}X is 2 to 1, and the relative atomic mass of X is 20.86. Find the **percentage abundance** of each isotope.

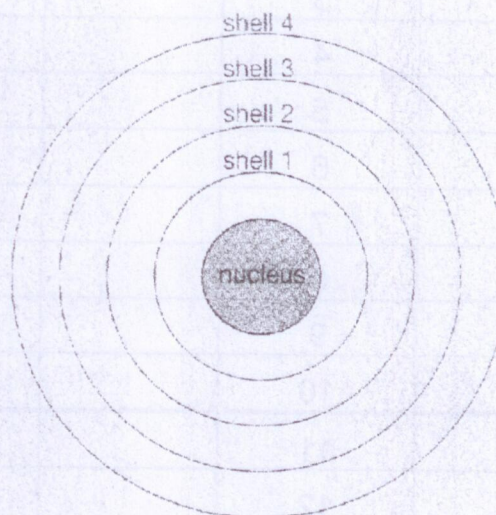
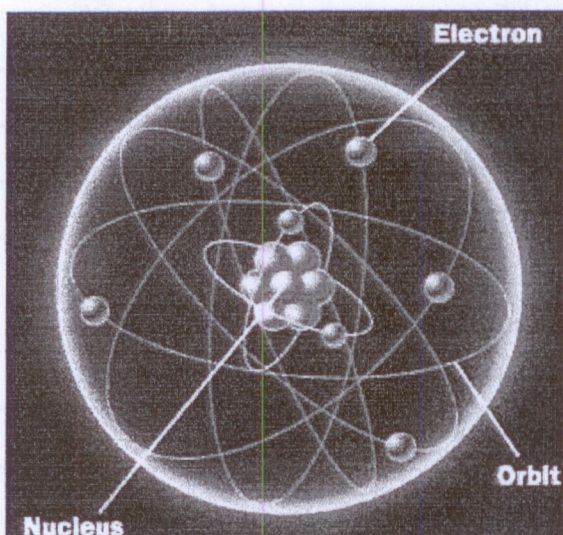
Example 4

If the relative atomic mass of an element is NOT a whole number, what *deduction* can you make ?



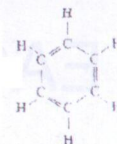
E. Electronic Arrangement of Electrons

- Electronic arrangement = electronic _____
- Electrons are *moving* around the _____. (in the form of *orbitals*)
- Electrons in an atom are arranged in _____ (電子層)



- Electrons fill into the shells one by one, starting from the one which is **nearest** to the **nucleus** (also called _____). When the shell is 'full', any remaining electrons go into the **next shell**.
- The electron shell which is **farthest** from the nucleus is called _____.
- The **maximum number of electrons** each shell can hold are shown :

Shell number (n)	Maximum number of e ⁻ (2n ²)
1	
2	
3	
4	
5	



Atomic symbol	Atomic number	No. of e ⁻ in electronic shells				Electronic arrangement
		1 st	2 nd	3 rd	4 th	
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					
	13					
	14					
	15					
	16					
	17					
	18					
	19					
	20					

Octet Rule : - Noble gases with ____ outermost shell electrons are especially **stable**.
 - EXCEPT **helium** which has ____ electrons in its shell (_____)

He : 2

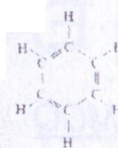
Ne : 2, 8

Ar : 2, 8, 8

Kr : 2, 8, 18, 8

Xe : 2, 8, 18, 18, 8

Rn : 2, 8, 18, 32, 18, 8



Draw the 'Electron diagrams' of the following atoms :

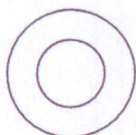
(a) Hydrogen atom



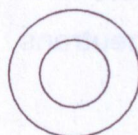
(b) Helium atom



(c) Beryllium atom



(d) carbon atom



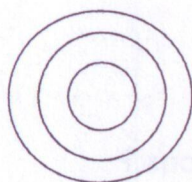
(e) Oxygen atom



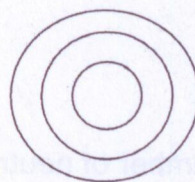
(f) Neon atom



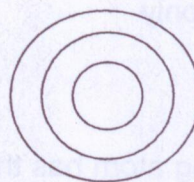
(g) Sodium atom



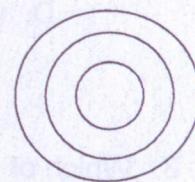
(h) aluminium atom



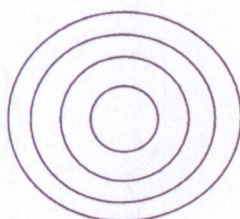
(i) Chlorine atom



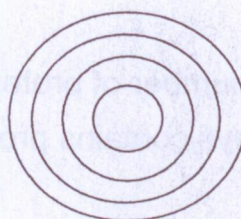
(j) Argon atom

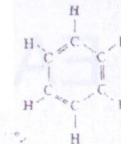


(k) Potassium atom



(l) Calcium atom



MCQ

1. Which of the following statements concerning an atom is/are correct ?

- (1) The number of protons is always equal to the number of electrons.
- (2) Atomic number is equal to the number of protons the atom carries.
- (3) Mass number is equal to the sum of number of protons and the number of electrons.

- A. (1) only
- B. (2) only
- C. (1) and (2) only
- D. (2) and (3) only

2. Which of the following statements about isotopes are INCORRECT ?

- (1) They have the same number of protons and neutrons.
- (2) They have the same number of electrons.
- (3) They have the same mass number.

- A. (1) only
- B. (3) only
- C. (1) and (3) only
- D. (2) and (3) only

3. Which of the following atom has the largest number of neutrons and electrons ?

- A. 1H
- B. 2H
- C. 3H
- D. 4He

True or False

1. A particle always has equal number of protons and electrons. ()
2. The nucleus of an atom always contains protons and neutrons ()