Topic Two : The Microscopic World

Unit Five: Atomic Structure　原子結構

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Common elements and their Symbol

I. Metal

Element	Symbol	State	Element	Symbol	State
Aluminium 鋁	Al	s	Magnesium 鎂	Mg	s
Barium 鋇	Ba	s	Manganese 錳	Mn	s
Beryllium 鈹	Be	s	Mercury 汞	Hg	l
Calcium 鈣	Ca	s	Nickel 鎳	Ni	s
Chromium 鉻	Cr	s	Platinum 鉑	Pt	s
Cobalt 鈷	Co	s	Potassium 鉀	K	s
Copper 銅	Cu	s	Silver 銀	Ag	s
Gold 金	Au	s	Sodium 鈉	Na	s
Iron 鐵	Fe	s	Tin 錫	Sn	s
Lead 鉛	Pb	s	Zinc 鋅	Zn	s
Lithium 鋰	Li	s			

II. Non-metal

Element	Symbol	State	Element	Symbol	State
Bromine 溴	Be	l	Iodine 碘	I	s
Carbon 碳	C	s	Nitrogen 氮	N	g
Chlorine 氯	Cl	g	Oxygen 氧	O	g
Fluorine 氟	F	g	Phosphorus 磷	P	s
Hydrogen 氫	H	g	Sulphur 硫	S	s

III. Semi-metal

Element	Symbol	State
Boron 硼	B	s
Silicon 矽	Si	s

IV. Noble Gas

Element	Symbol	State
Argon 氬	Ar	g
Helium 氦	He	g
Neon 氖	Ne	g

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Comparison between metals, metalloids and non-metals

	Metals	Metalloids	Non-metals
State	Solid ~~/ Liquid / Gas~~ Except: Hg is liquid	Solid ~~/ Liquid / Gas~~	Solid / ~~Liquid~~ / Gas Except: Br is liquid
Appearance	~~Dull /~~ Shiny	Dull ~~/ Shiny~~	Colourful for some gases; Usuallu dull for solid
Hardness and strength	Hard and strong	Hard but brittle	Non-uniform (e.g. diamond is a hard and strong solid, but oxygen is a gas)
Density	High ~~/ Low~~ Except: Hg	High ~~/ Low~~	~~High /~~ Low Except: Diamond and Graphite
Melting / boiling point	High ~~/ Low~~ Except: Hg	High ~~/ Low~~	~~High /~~ Low Except: Diamond and Graphite
Electrical / heat conductivity	Good ~~/ Poor~~	~~Good /~~ Poor	~~Good /~~ Poor Except: Graphite
Malleability and ductility	Good (malleable and ductile)	Neither malleable nor but brittle	Neither malleable nor but brittle (for solids)
Sound produced when hit	A ringing sound	A low tone sound	A low tone sound

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Compound	Elements
Water	Hydrogen, Oxygen
Carbon dioxide	Carbon, Oxygen
Sodium chloride	Sodium, Chlorine
Iron(II) sulphide	Iron, Sulphur

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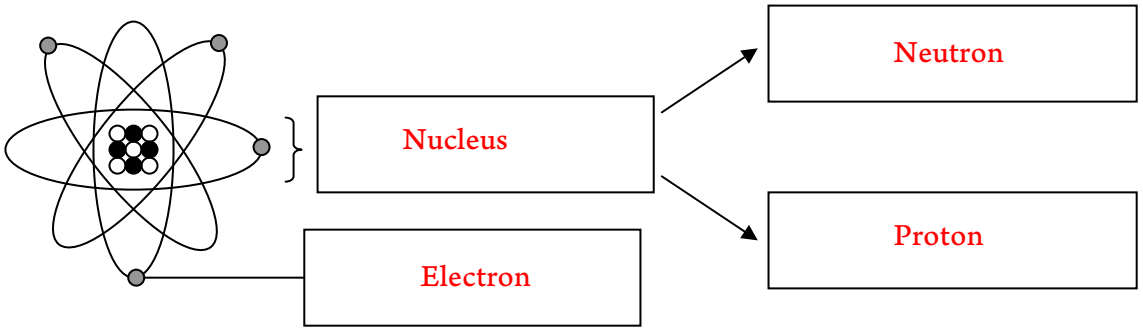

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For example:

1. Hydrogen

$^{1}_{1}H$

A hydrogen atom has _____1_____ proton, _____1_____ electron, _____0_____ neutron.

2. Sodium

$^{23}_{11}Na$

A sodium atom has ____11_____ proton, _____11_____ electron, _____12_____ neutron.

3. Chlorine

$^{35}_{17}Cl$

A sodium atom has ____17_____ proton, ____17_____ electron, ____18_____ neutron.

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Exercise :

1. a) Write the symbol for lead which has an atomic number of 82 and a mass number of 208.
   b) Find the number of neutrons in an atom of lead.

a) $^{208}_{82}Pb$

b) No. of neutrons = mass no. – no. of protons
= 208 – 82
= 126

2. Find the
   a) number of protons,
   b) number of electrons, and
   c) number of neutrons in an atom of the element $^{39}_{19}K$.

a) No. of protons = 19

b) No. of electrons = 19

c) No. of neutrons = mass no. – no. of protons
= 39 – 19
= 20

3. a) Write down the symbol of Rubidium.
   b) How many neutrons does one Rubidium atom contain?

a) $^{85.5}_{37}Rb$

b) No. of neutrons = mass no. – atomic no.
= 85.5 – 37
= 42.5

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✧ Definition: **Atoms** having the **same atomic number** but **different mass numbers** are **isotopes.** (i.e. Isotopes have the same number of protons_____ but different number of ____ neutrons ____)

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Exercise

1. Find the relative atomic mass of lead.

Isotopic mass	204.0	206.0	207.0	208.0
% abundance	2	24	22	52

Relative Atomic Mass = 204 x 0.02 + 206 x 0.24 + 207 x 0.22 + 208 x 0.52 = 207.22

2. The relative atomic mass of chlorine is 35.5. Find the ratio of $^{35}_{17}Cl$ to $^{37}_{17}Cl$.

Let x be the abundance of $^{35}_{17}$ Cl.
35x + 37 (1-x) = 35.5
35x + 37 – 37x = 35.5
1.5 = 2x
x = 0.75
∴ Ratio of $^{35}_{17}Cl$ to $^{37}_{17}Cl$ is 3 : 1

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Shell	**Maximum number of electrons**
First	(n=1) : $2(1)^2 = 2$
Second	(n=2) : $2(2)^2 = 8$
Third	(n=3) : $2(3)^2 = 18$
Fourth	(n=4) : $2(4)^2 = 32$

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Exercise

1. Give the electronic configuration of (a) a chlorine atom and (b) a nitrogen atom.
2. Element X has the electronic configuration 2, 8, 18, p and element Y has the electronic configuration 2, 8, q. Given that the atomic number of X and Y are 30 and 16 respectively, calculate the values of p and q.

1. a) Cl: 2,8,7
   b) N: 2,5
2. p = 30 – 2 – 8 – 18 = 2
   q =16 – 2 – 8 = 6

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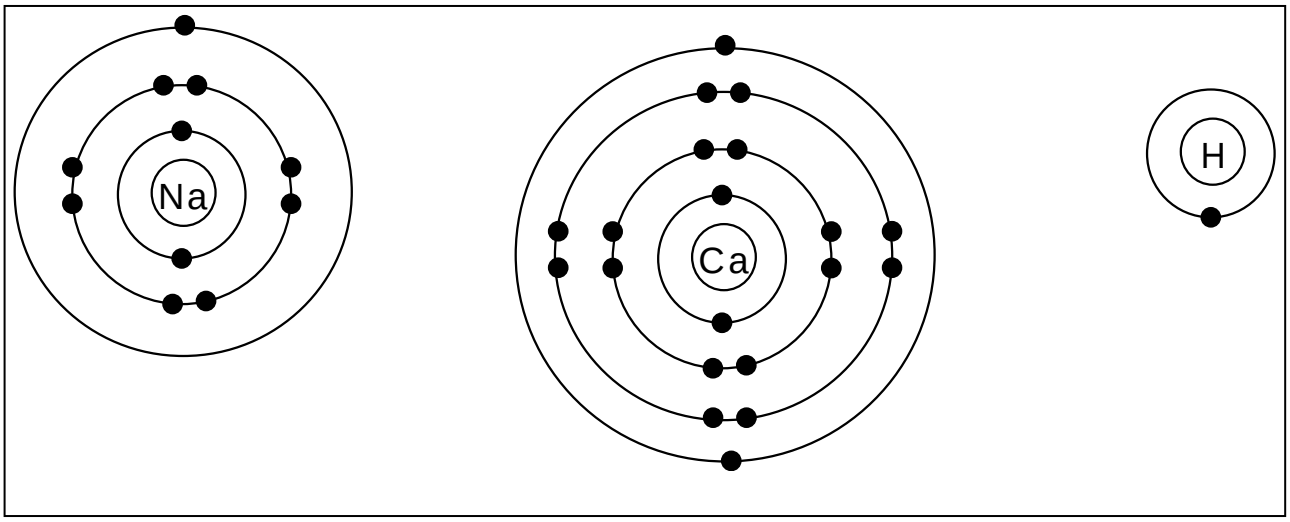
Exercise

Draw the electronic diagram of a hydrogen atom, sodium atom and calcium atom.



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Exercise

An atom has the electron arrangement 2, 8, 4.

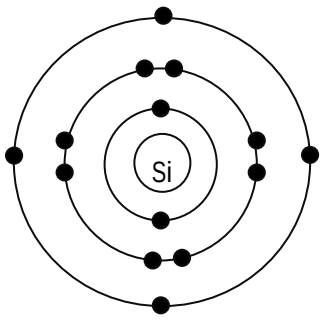
(a) What is the atomic number of the element?

(b) Draw an electron diagram for the atom.

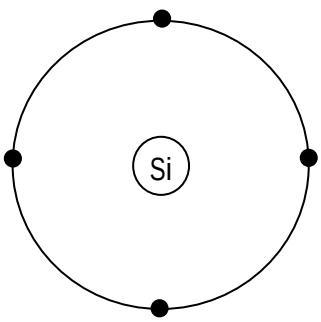
(c) Draw an electron diagram for the atom, showing the outermost electrons only.

a) Atomic no. = 2 + 8 + 4

b)



c)



Supplementary Exercise

1. (a) What is meant by the term "isotopes"?
   (b) How many isotopes does chlorine possess? What are they?
   (c) Do isotopes have similar chemical properties? Explain your answer.
   (d) Do isotopes have the same physical properties? Explain your answer.
   (e) The following data refers to the element A

Isotopic mass	54	56	57
Relative abundance (in %)	6.0	92.2	2.0

(Remark: Total % is not equal to 100)
Calculate the relative atomic mass of element A.

1. a) Isotope is atoms that have the same no. of protons but different no. of neutrons.
(Isotope is atoms that have the same atomic no. but different mass no.)

b) 2, they are $^{35}_{17}Cl$ and $^{37}_{17}Cl$.

c) Yes, since they have the same electronic configuration.

d) No, since they have different mass no.

e) Relative atomic mass = 54 x (6/100.2) + 56 x (92.2/100.2) + 57 x (2/100.2)
= 55.90