Bonding , structure and properties

a) Atomic Structure and Mixtures

b) Periodic Table

c) Structure and Bonding

d) Quantitative Chemistry

e) Chemical Changes

f) Energy Changes

- Ionic Bonding
- Covalent Bonding
- Metallic Bonding
- State of Matter
- Ionic compounds
- Covalent Compounds
- Diamond and Graphite
- Nanoparticles
- Graphere and Fullerene

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Atoms bond to gain full outer shell or noble gas electronic configuration

BONDING

Ionic Bonding
transfer of electron between metals and non metals
between metal and non metals

Covalent Bonding
sharing of electron between non metals
between non metals

Metallic Bonding
Electrostatic force of attraction between fixed positive ions and delocalised electrons.
between metals

Period ↓ / Group →	1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																		2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc		22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y		40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				*	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				*	90	91	92	93	94	95	96	97	98	99	100	101	102	103	

Carbon dioxide (CO_2) — Covalent

Ammonia (NH_3) — Covalent

Nitrogen (N_2) — Covalent

Water (H_2O) — Covalent

Sodium chloride — Ionic Bonding

Calcium fluoride — Ionic Bonding

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IONIC BONDING: Metals and Non Metals

It is between a metal and a non metal

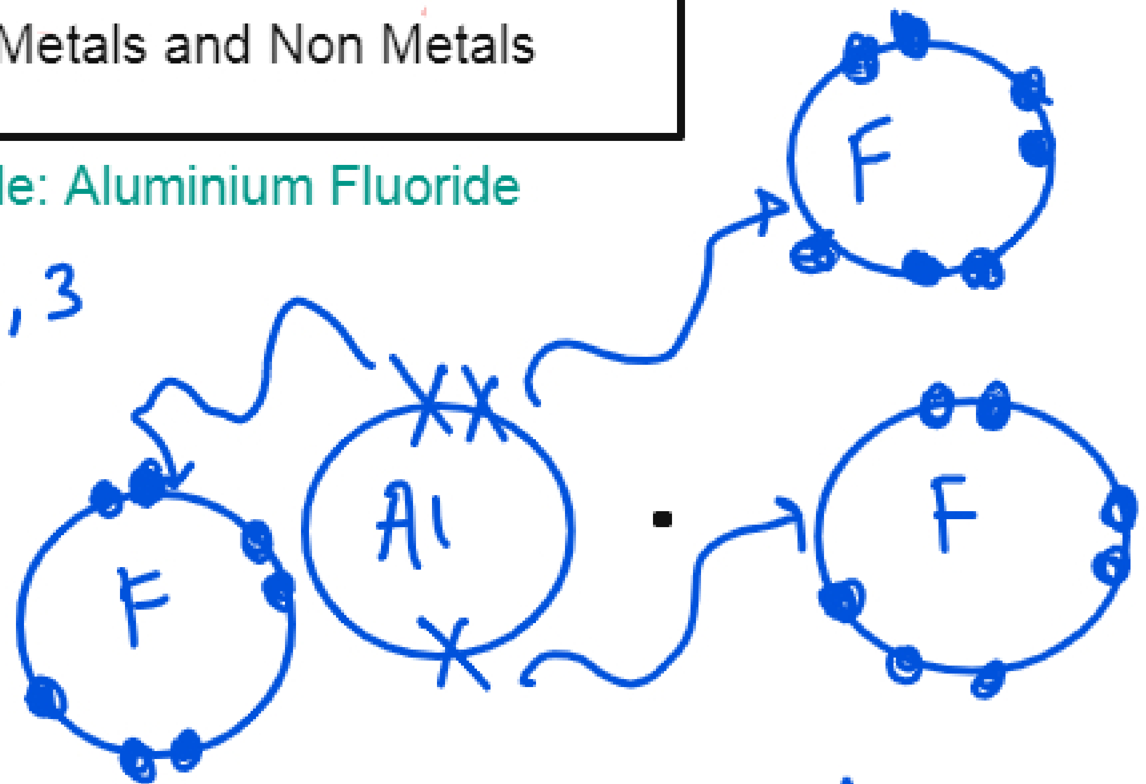
Metal gains an electron and become positively charged.

Non- Metal looses an electron and becomes negatively charged.

There is a strong electrostatic force of attraction between opposite charged ions resulting in ionic bonding.

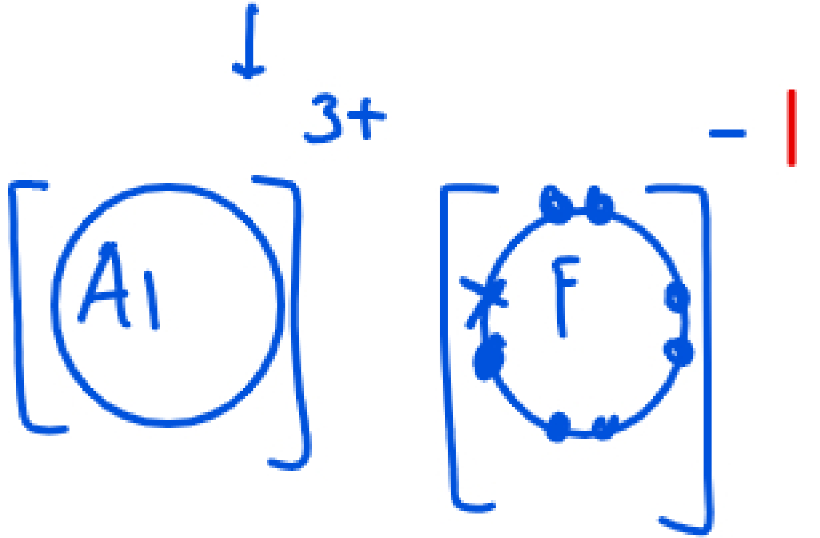
Example: Aluminium Fluoride

Al = 2, 8, 3
F = 2, 7



Dot and Cross Diagram

Write the symbols
Write electronic configuration
show outer electrons
show transfer
show charges



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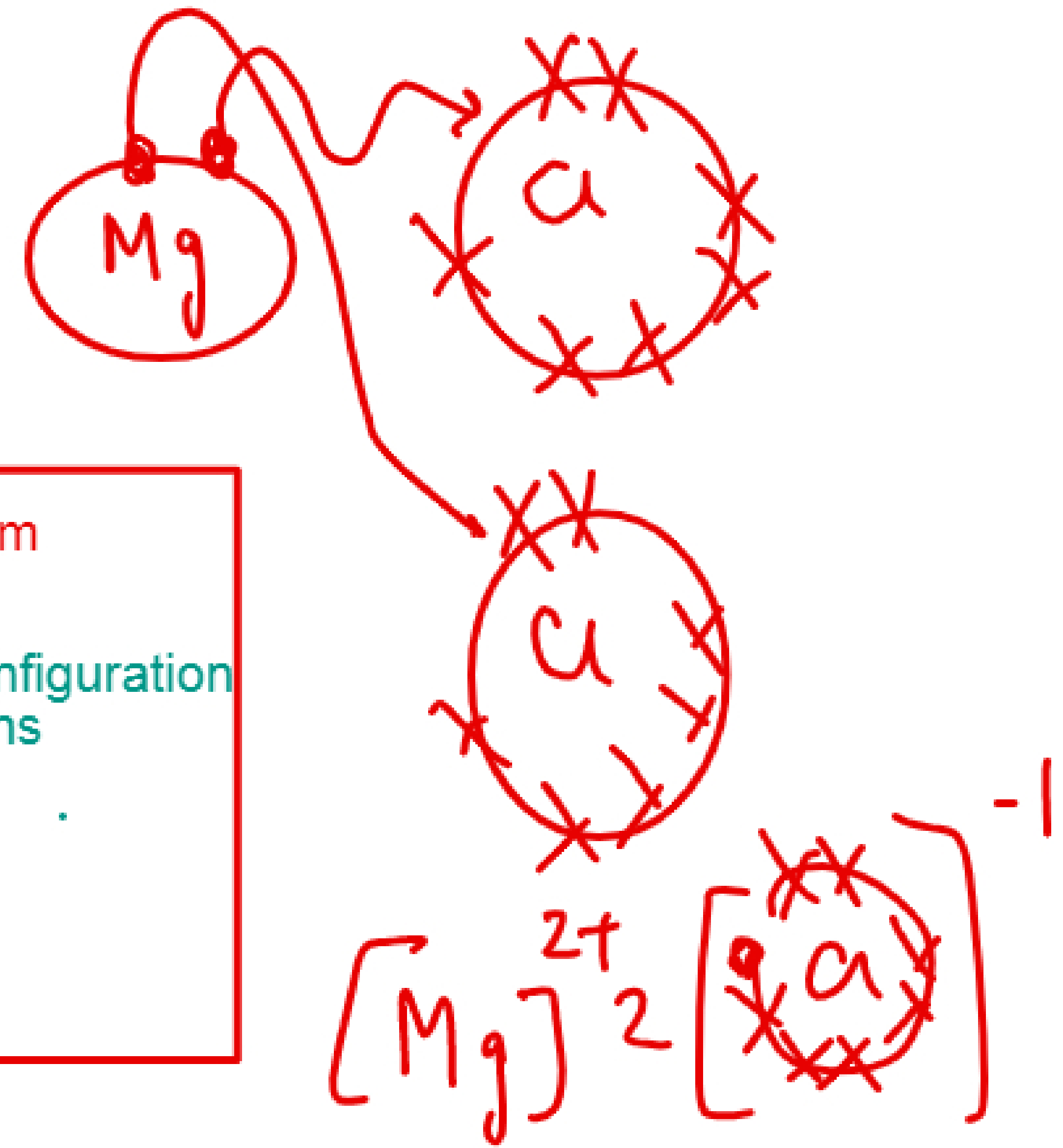
IONIC BONDING: Metals and Non Metals

- It is between a metal and a non metal
- Metal ~~gains~~ loose an electron and become positively charged.
- Non- Metal ~~looses~~ gains an electron and becomes negatively charged.
- There is a strong electrostatic force of attraction between opposite charged ions resulting in ionic bonding.

Example: Magnesium Chloride

Mg= 2, 8, 2

Cl, 2, 8, 7



Dot and Cross Diagram

- Write the symbols
- Write electronic configuration
- show outer electrons
- show transfer
- show charges

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PROPERTIES OF IONIC COMPOUNDS !!!!!

Ionic Compound Properties

- Brittle solids with definite crystal shapes
- Good insulators in solid form, but become good conductors in liquid or dissolved form
- High melting and boiling point compared to molecular compounds

Source: Flickr.com

In Ionic compounds, there is a strong electrostatic force of attraction between the opposite charged ions. This results in the formation of giant ionic lattice.

In the solid form, the ions are not free to move as they are held together by strong electrostatic force of attraction. In molten or when they are dissolved in water the ions are free to move and conduct electricity.

In Ionic compounds, there is a strong electrostatic force of attraction between the opposite charged ions. This results in the formation of giant ionic lattice. Large amount of energy is required to overcome the strong electrostatic force of attraction. Therefore, ionic compounds have high melting and boiling point.

Greater the charge of an ionic lattice, stronger is the electrostatic force of attraction. Greater the melting and bp.
For ex Aluminium chloride > Magnesium chloride> sodium chloride

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FORMULAE OF IONIC COMPOUNDS !!!

- Write the Symbols
- Write the charges
- (Upto group the charge is same as the group number. After group 4 it is group number -8)
- Criss Cross

Ca^{2+} O^{2-}

Na^{+} O^{2-} =

Mg^{2+} N^{3-}

a) Sodium Oxide = Na_2O

b) Magnesium Nitride = Mg_3N_2

c) Calcium Oxide = CaO

d) Sodium Sulphide = Na_2S

e) Sodium Chloride NaCl

f) Magnesium chloride — $MgCl_2$

g) Aluminium Chloride $AlCl_3$

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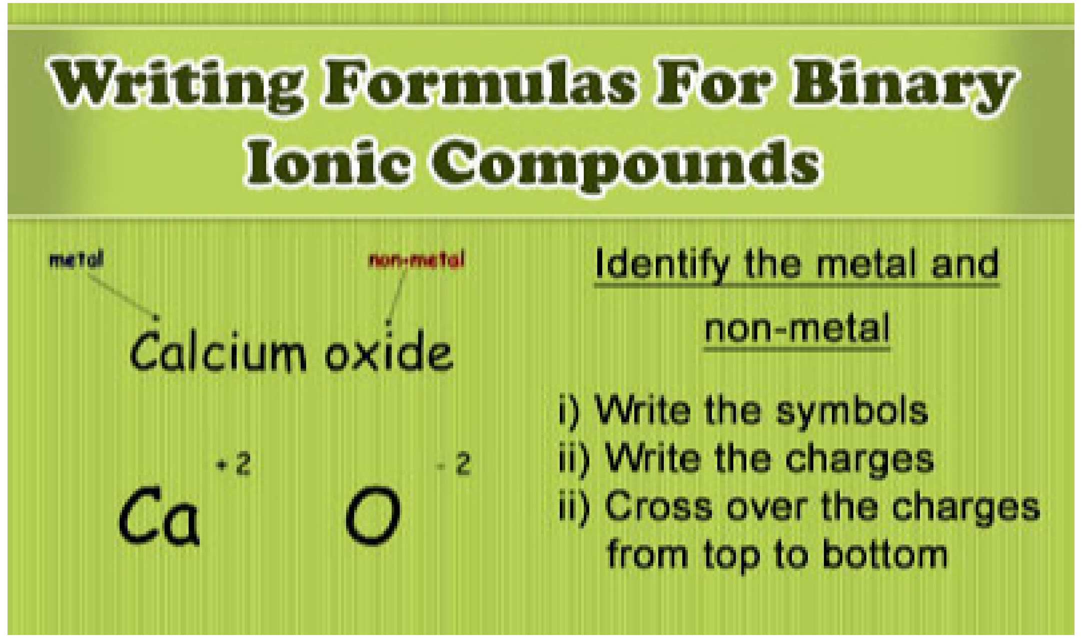

Source: Flickr.com

Group→ ↓Period	1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																		2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc		22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y		40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				*	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				**	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

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Positive	Negative
Ammonium NH_4^+	Hydroxide – OH^-
	Carbonate – CO_3^{2-}
	Sulphate – SO_4^{2-}
	Nitrate – NO_3^-
	Phosphate – PO_4^{3-}

FORMULAE OF COMPLEX IONS

a) Magnesium HYdroxide = $Mg(OH)_2$

b) Aluminium Sulphate = $Al_2(SO_4)_3$

c) Calcium Phosphate = $Ca_3(PO_4)_2$

d) Magnesium nitrate = $Mg(NO_3)_2$

e) Calcium Carbonate = $CaCO_3$

f) Sodium Phosphate

Na_3PO_4

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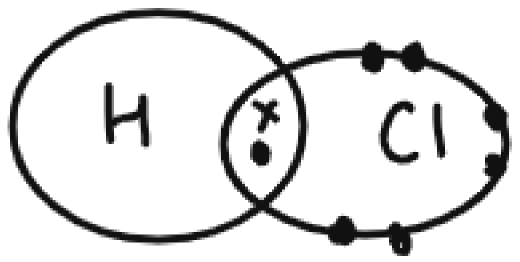
COVALENT BONDING

It is between two non metals

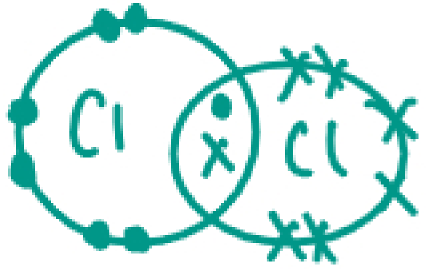
It involves the sharing of electrons between two non metals.

More than one electron pair can also be shared resulting in the formation of single double and triple bonds.

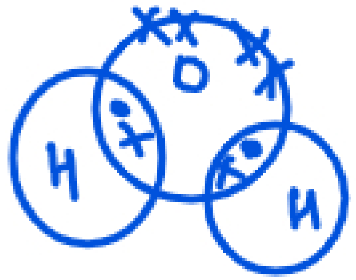
HCl



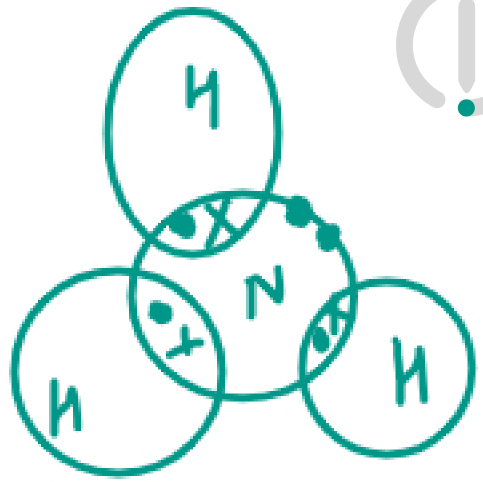
Cl_2



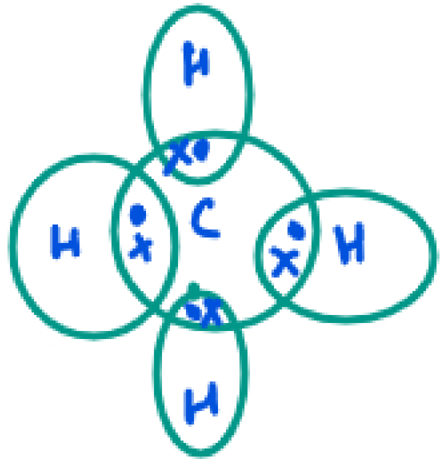
H_2O



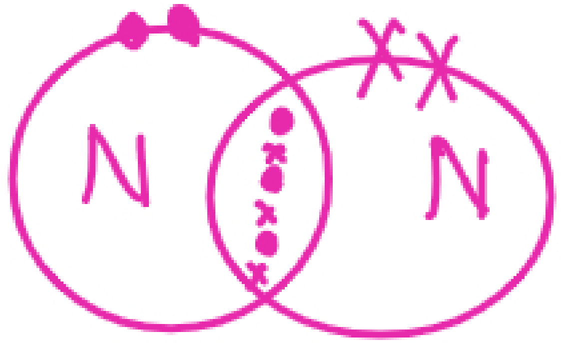
NH_3



CH_4



N_2



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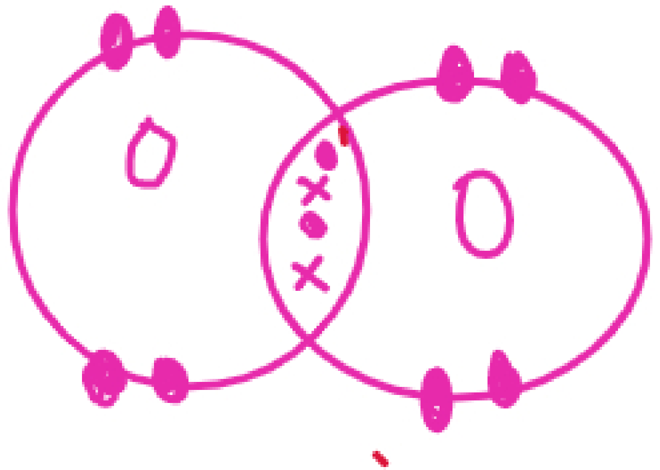
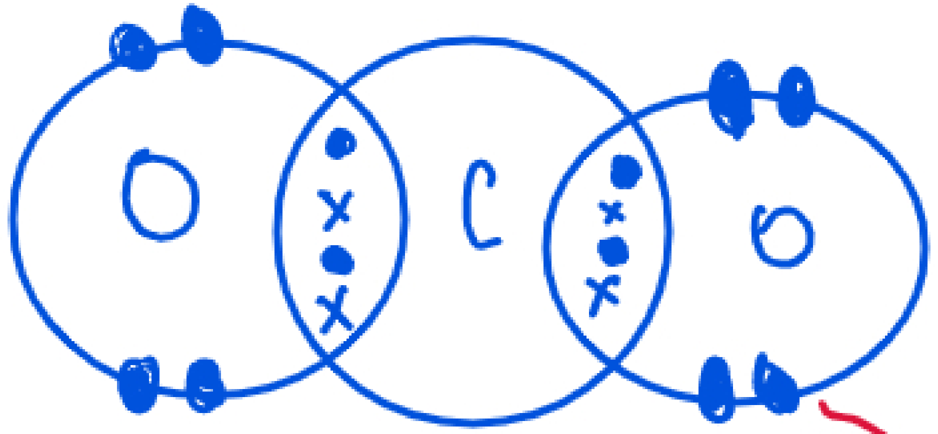
O_2



$O=O$

CO_2



$O=C=O$

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Properties of Covalent Compounds !!!!!

Source: Flickr.com

Simple Molecule

• eg O_2, Cl,
CH_4

★ They have weak intermolecular forces in them so have a lower melting and a boiling points

★ The intermolecular forces increases with increase in size as the surface area between the molecules increases.

★ Therefore, polymers which have covalent bonding between them have high melting and boiling point due to increase in chain length.

Giant Covalent

Diamond

Graphite

Silicon Dioxide

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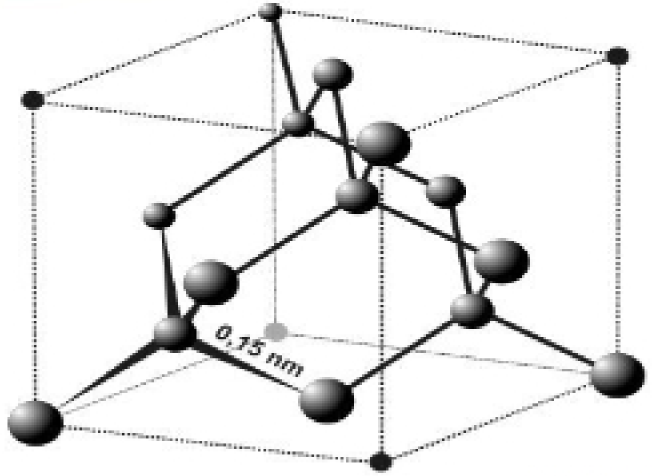
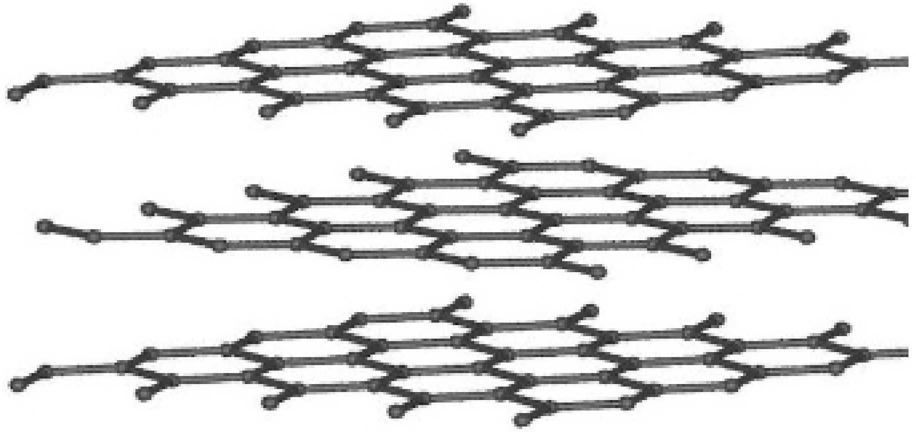
GIANT COVALENT STRUCTURES !!!!

Substances which have huge netword of atoms joined together by covalent bonds form giant covalent structures.

Diamond

Graphite





DIAMOND	GRAPHITE
It is hard.	It is soft and greasy.
It is an insulator	It is a conductor
It has a high density.	It has a lower density than diamond.
Each carbon atom is covalently bonded to four other carbon atoms giving it a strong rigid structure.	Carbon atoms are bonded in the form of layer in the form of hexagons. No covelent bonding between the layers so they can slide past. Each carbon atom is bonded with three other carbon leaving the fourth electron has delocalized
No delocalised electrons present	It has delocalised electrons
Used in cutting or jewellery	It is used in pencil leads.

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PROPERTIES OF GRAPHITE !!!!!!

Q1 Why graphite is soft and slippery ?

In graphite, Carbon atoms are bonded in the form of layers in the form of hexagons. No covelent bonding between the layers so they can slide past each other. The layers have only weak intermolecular forces between them. By applying a little pressure then layers can easily slide past each other making graphite soft and slippery.

Q2 Why graphite conduct electricity ?

In graphite, Carbon atoms are bonded in the form of layer in the form of hexagons. No covelent bonding between the layers so they can slide past. Each carbon atom is bonded with three other carbon leaving the fourth electron has delocalized, These delocalized electrons are mobiles electrons which can move and conduct electricity.

Insert an **apostrophe** in the correct place in the sentence below.

Pupils coats should be hung on the pegs.

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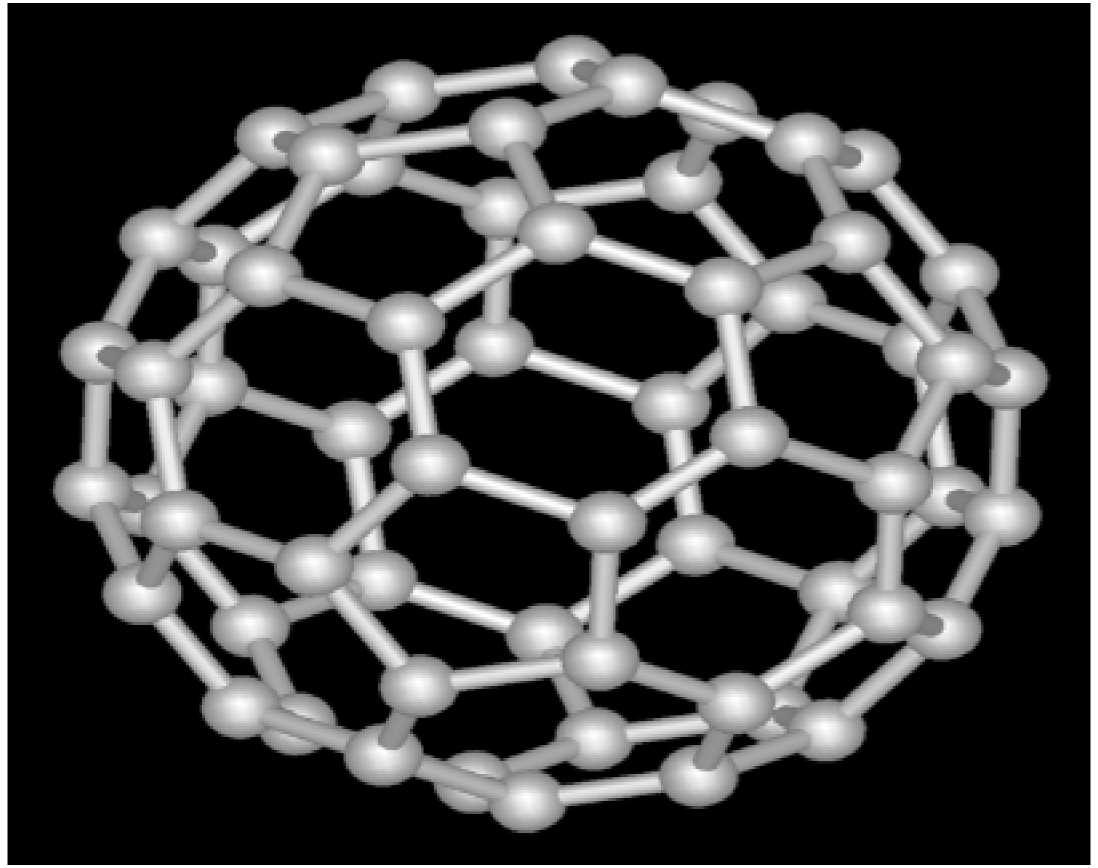
Source: Wikimedia Commons !!!

FULLERENE AND GRAPHENE !!!!

Fullerene: Hollow shaped molecule having hexagonal rings like a bucky ball.

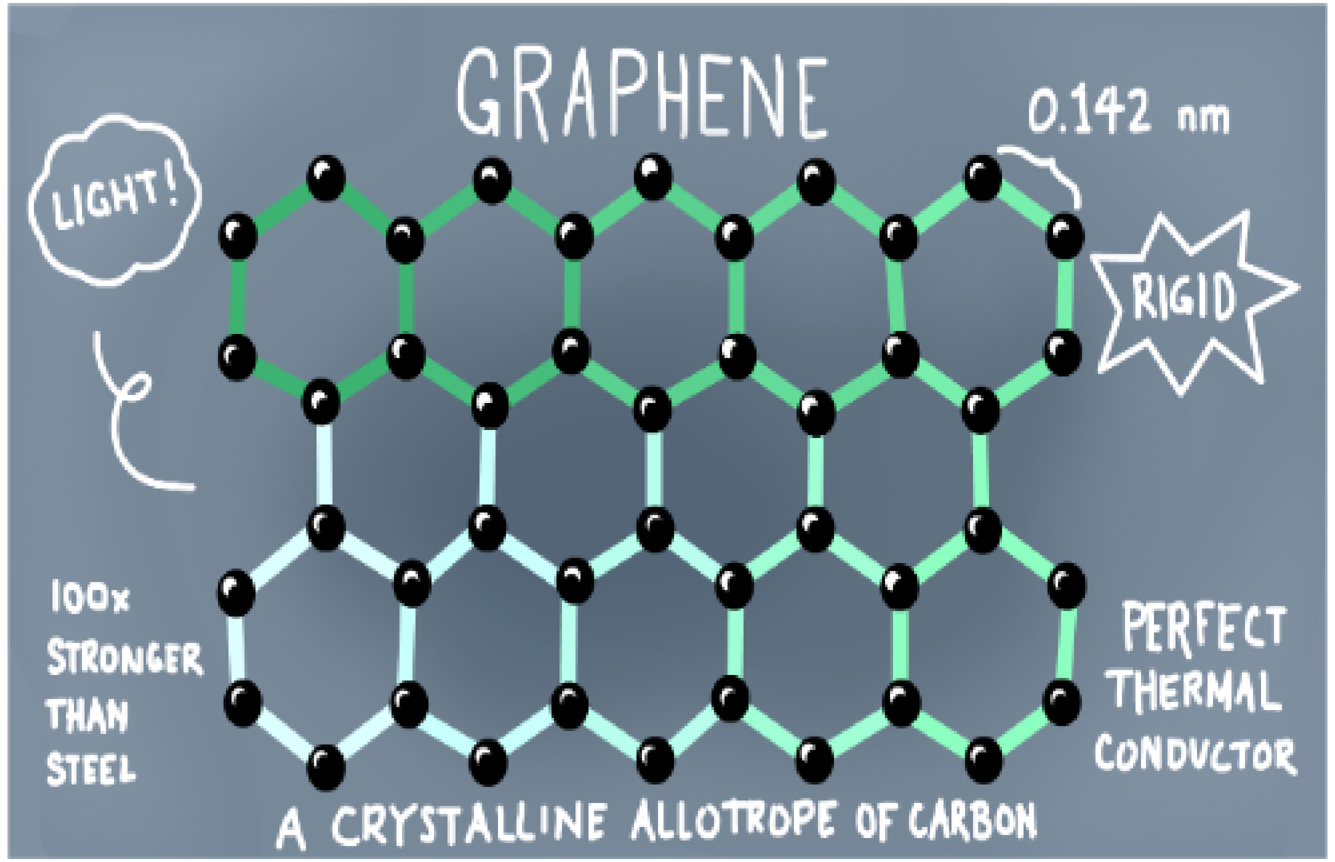


Also known as bucky ball or buckminsterfullerene.

Carbon can be in the form of pentagon or hexagon rings

Used as catalyst, drug delievery and treating cancer.

Graphene: Layer of interlocking hexagonal rings like single sheet of graphite.



It is a better conductor than graphite, light and have low density.
Used in making computer chips and flexible electronic displays.

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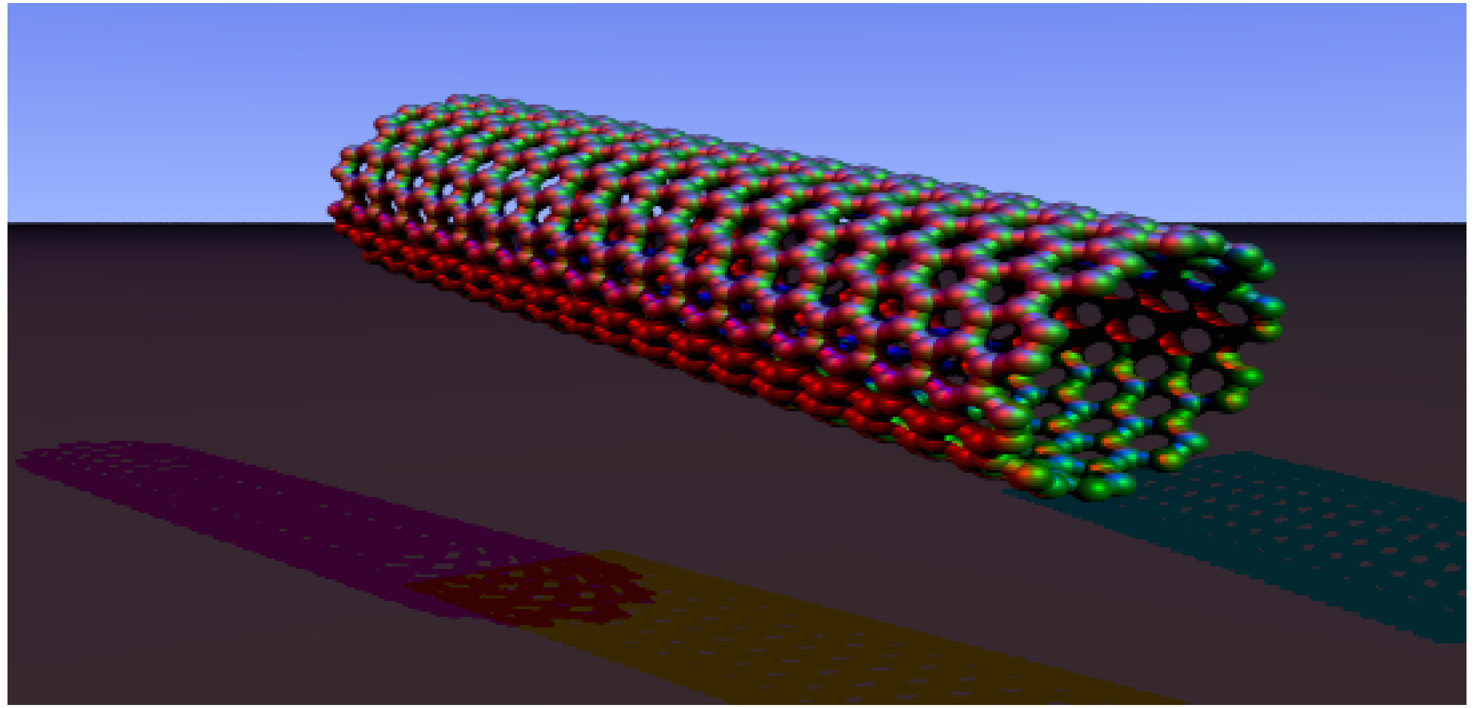
CARBON NANOTUBES !!!!!

Cylinderical fullerene with the length greater than the diameter.

- High tensile strength
  ↓
  Used in making reinforced composite materials
- High electronic conductivity
  ↓
  used in electronic industry



Source: Wikipedia

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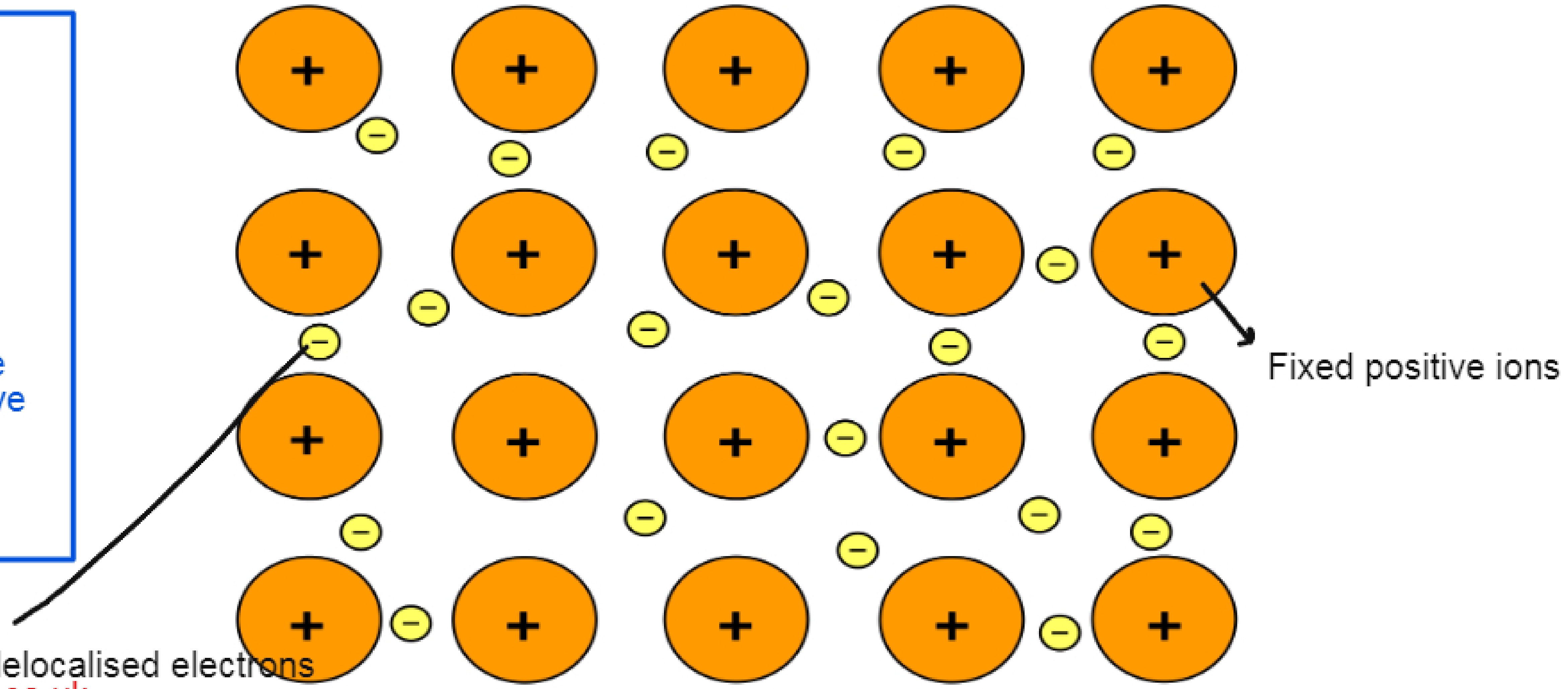
METALLIC BONDING !!!!

It is between two metals.

There are fixed positive ions present in the sea of delocalised electrons.

There is strong electrostatic force of attraction between fixed positive ions and delocalized electrons resulting in metallic bonding.

Layered structure



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Metals are malleable

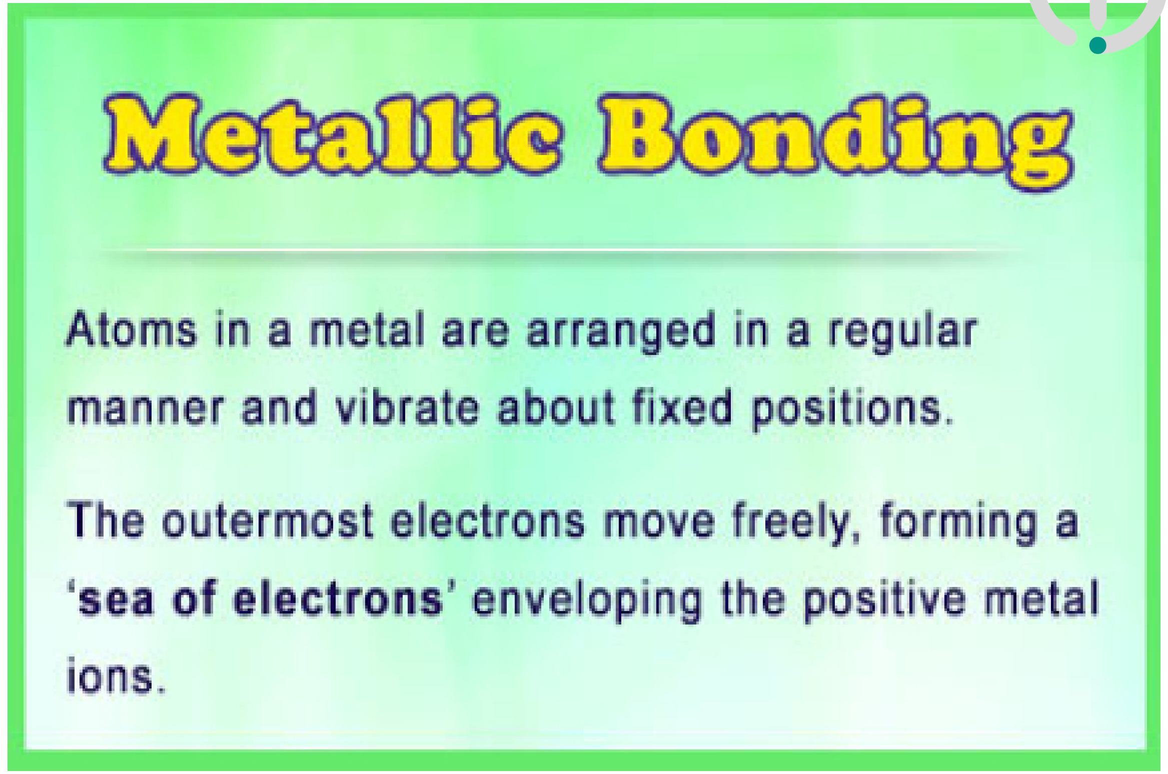
Malleable means that the metals can be hammered into any shape.

Metals have layered structure and layers can slide past each other by hammering giving metals different shapes.

Metals are ductile

Ductile means that the metals can be drawn into thin wires.

Metals have layered structure and layers can slide past each other by hammering giving metals a wire shape.


Metallic Bonding

Atoms in a metal are arranged in a regular manner and vibrate about fixed positions.

The outermost electrons move freely, forming a '**sea of electrons**' enveloping the positive metal ions.

Source: Flickr.com

Metals are good conductors of electricity

Metals have delocalised electrons.

They are mobile and conduct electricity.

These mobile electrons or delocalised electrons conduct heat and electricity.

Metals have high melting and boiling points

There is strong electrostatic force of attraction between fixed positive ions and delocalized electrons.

Large amount of energy is required to overcome strong electrostatic force of attraction.

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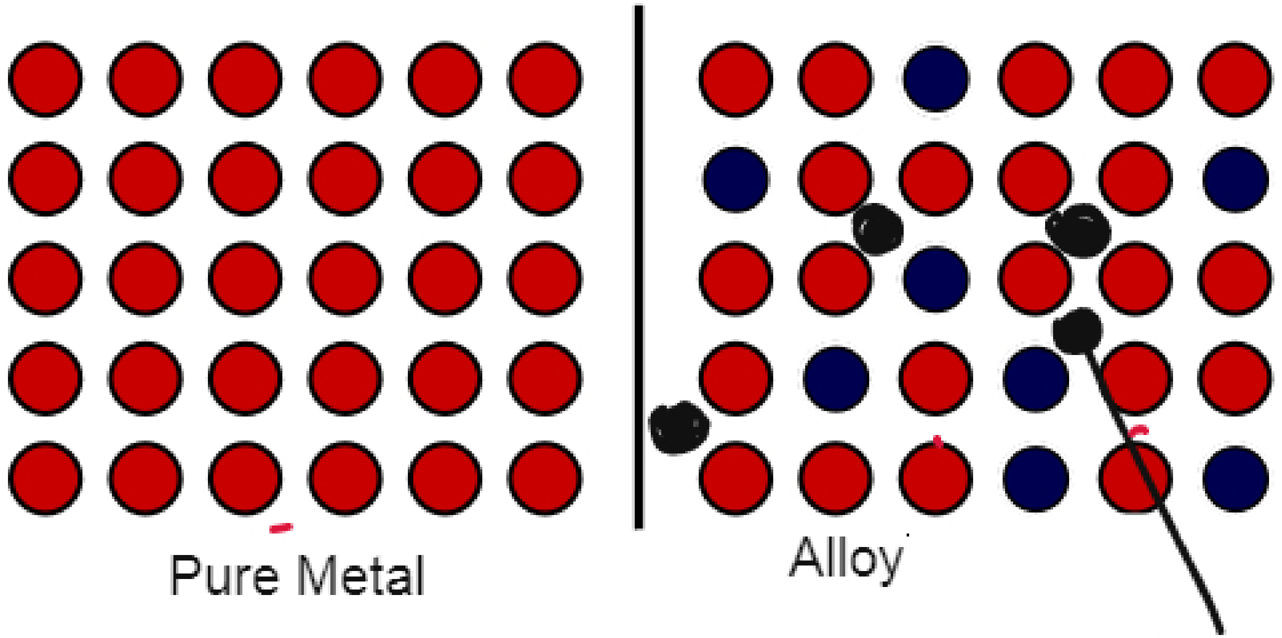
ALLOYS

Alloys are the mixture of metals with another metal or a non metal which make the metal stronger.



Pure Metal

Alloy

Layers distorted by another metal or a non metals

Example: Steel is the alloy of iron which is more strong and resistant to corrossion.

In metals the particles are arrranged in layers. There is a regular arrangement of fixed positive ions which can slide past each by applying pressure.

In alloys there is a mixture of metals with another metal or a non metals. Another metal being different in shape and size distort the regular arrangement of the metal lattice.

As a result the layers of the metal can no longer slide past each other making it strong

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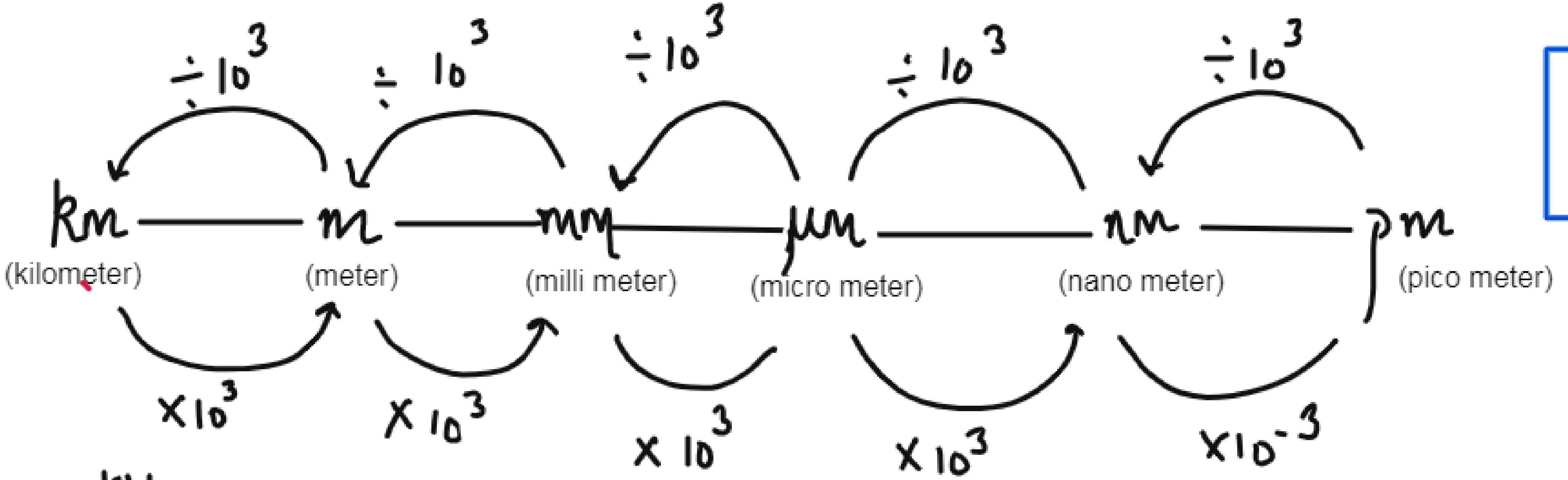
$\div 10^9$

NANOPARTICLES

Nanoparticles are the particles that deals with the paricles of size 1 to 100 nm.



1nm

$1nm = 1 \times 10^{-9} m$

KIL — Killing

MET — Metal

MIL — Milo

MIC — Mickey

NAN — Nano

PIC — Pictures

Convert 10 nm to :-

a) meter — $nm \xrightarrow{\div 10^9} m = \frac{10}{10^9} m = 10^{-8} m$

b) micrometer → $\mu m \xrightarrow{\div 10^6} m = \frac{10}{10^6} m = 10^{-5} m$

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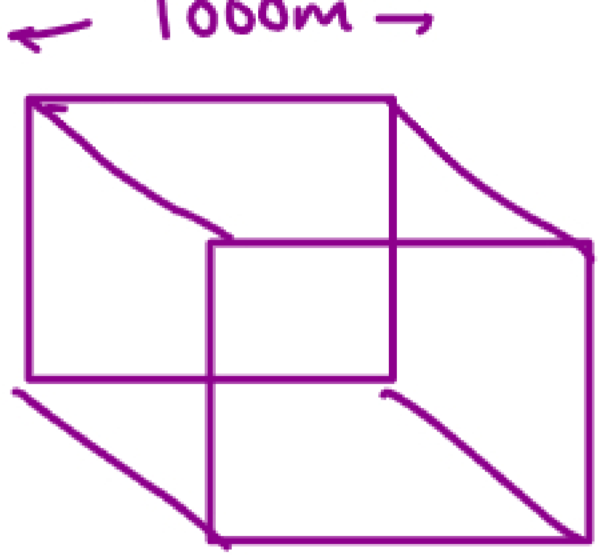


Surface Area = 6 x side X side m^2

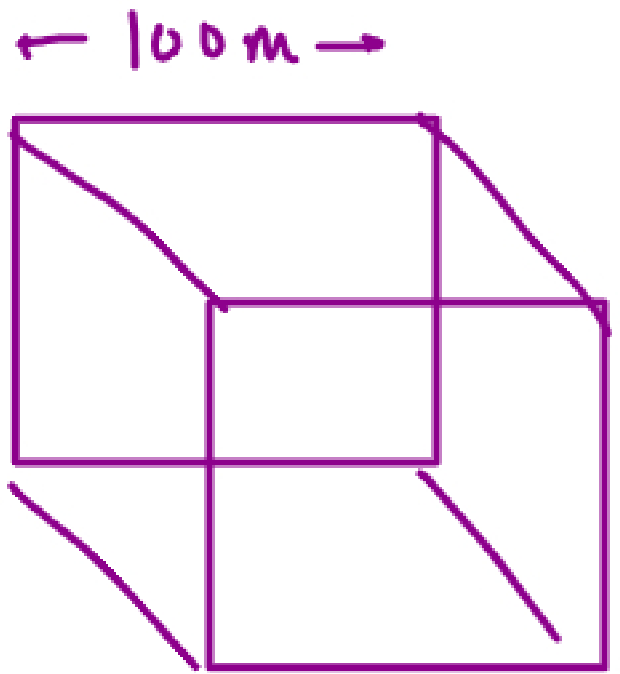
$= 6 \times 1000 \times 1000$

$= 6 \times 10^6 \, m^2$

Volume = side X side x side

$= 10^9 \, m^3$

$SA : Volume = \frac{6 \times 10^6}{10^9} = 6 \times 10^{-3} / m$



Surface Area = 6 x side X side

$= 6 \times 100 \times 100$

$= 6 \times 10^4 \, m^2$

Volume = side X side x side

$= 10^6 \, m^3$

$SA : Volume = 6 \times 10^{-2}$

As the size decreases the surface area to volume ratio increases.

Therefore Nano particles being very small in size have large surface area to volume ratio making them very useful in Science and Medicine.

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APPLICATIONS OF NANOPARTICLES

MEDICINES

To kill cancer and tuomour cells

For drug delievery

COSMETICS

Used in Sunscreen to block sunlight

CATALYST

They have large surface area to volume ratio.

Used in small quantities so highly effective

HOUSEHOLD

Self cleaning window panes

Nano particles breaks dirty in the presence of sunshine which is washed away by water while raining.

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RISKS OF NANOPARTICLES

- Due to small size can cause difficulty in breathing
- They can accumulate in the envrionment and cause air pollution
- Due to their large surface area a small spark can result in violent explosion making them risky to use.
- They are toxic and cause breathing and respiratory problems.
- Due to their small size they can also cause water pollution and risk the aquation life.

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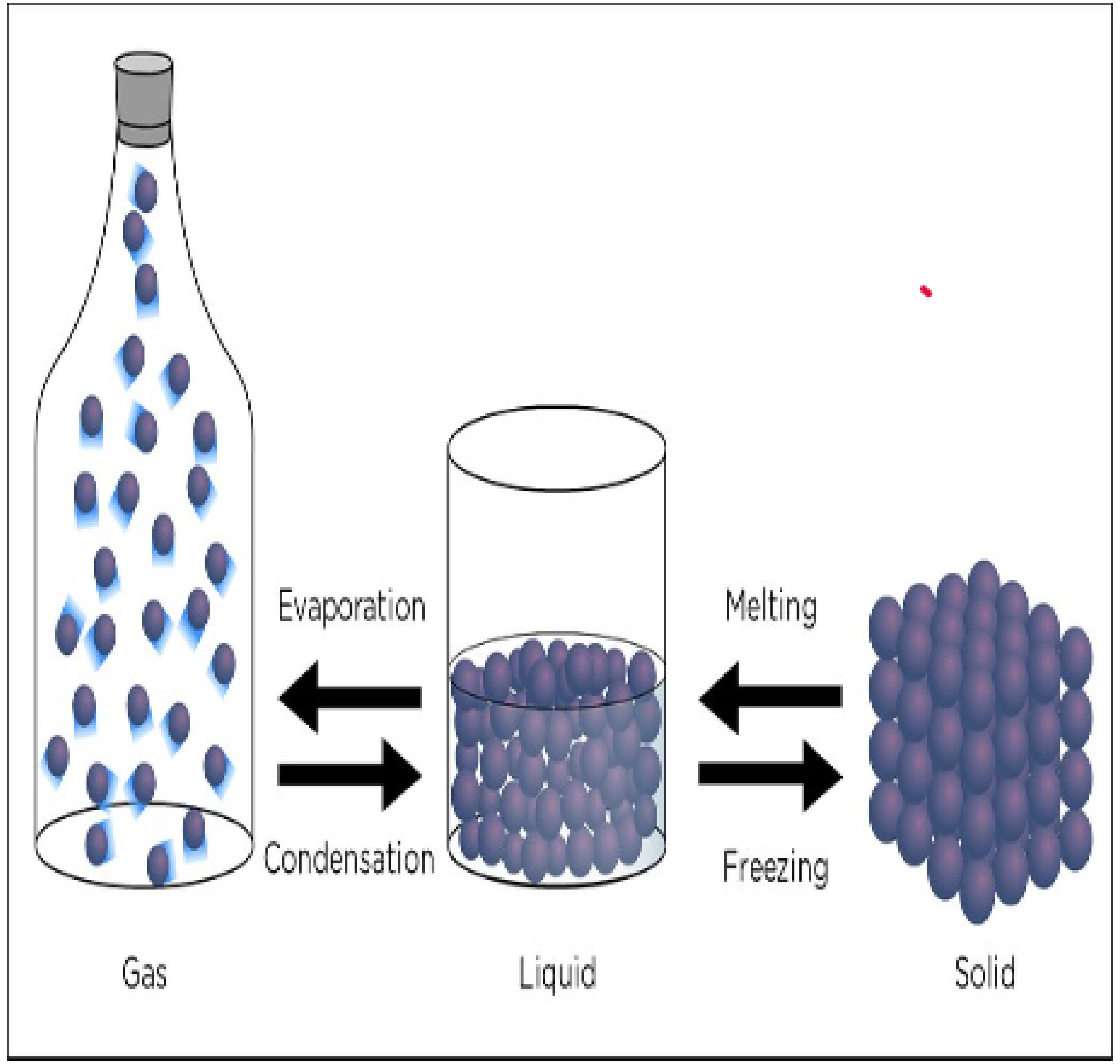

Source: Flickr.com

SOLIDS	LIQUIDS	GASES
Particles are close to each other.	Particles are slightly closer to each other.	Particles are far apart.
Have fixed shape	Do not have fixed shape	Do not have fixed shape
Strong forces between the particles	Weak forces between the particles	Very weak forces between the particles.
Have definite volume	Have fixed volume	Do not have fixed volume
cannot be compressed	Can be compressed	Highly compressible
Cannot flow	Can flow	Can flow

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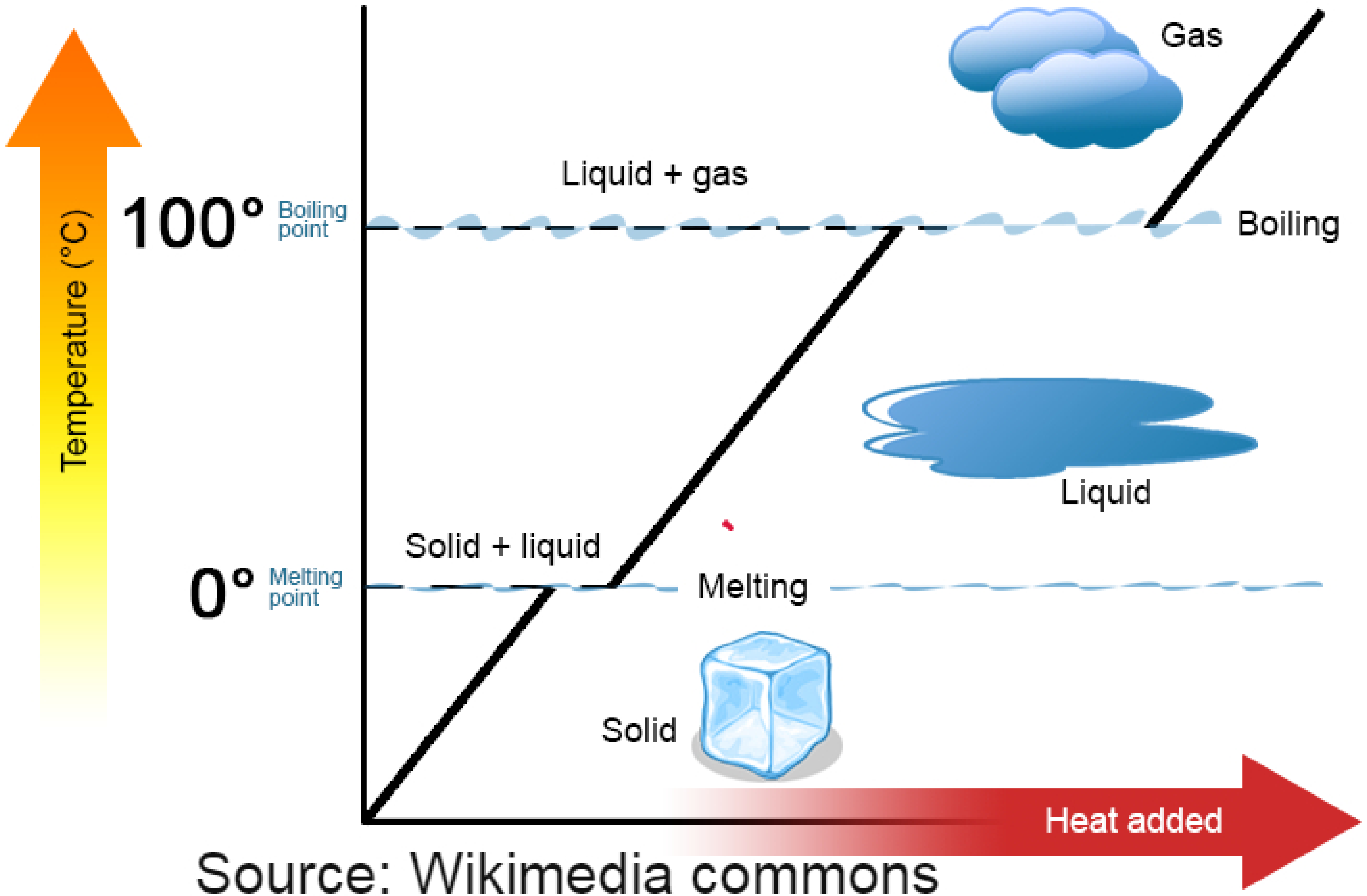

Source: Wikimedia commons

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KEY TERMS !!!!

Ions – charged atoms with unequal number of protons and electrons.

Ionic Bonding – bond formed between a metal and a non metal which involves complete transfer of electrons from metal to a non metal.

Dot and Cross – diagram that show transfer of electron in an ionic bond or sharing of electrons in a covalent bond.

Covalent Bonding – bonding between two non metals which involves sharing of electrons.

Metallic Bonding – bonding in metals which involves strong electrostatic forces of attraction between fixed positive ions and delocalised electrons.

Intermolecular Forces – The forces between the molecules which determines the melting or a boiling point.

Giant Covalent Molecules – Covalently bonded molecules which forms large giant structure.

Polymers – Molecules which are made up of many repeating units

Delocalised electrons – Mobile electrons that are free to move as they are not associated with a bond or an

Fullerene – Allotrope of carbon which forms a cage like structure like bucky ball.

Graphene – Allotrope of carbon which is equivalent to single layer of graphite

Alloys – Mixture of metals with another metal or a non metal.

Nanoparticles – Particles which are of the size of 1 nm to 100 nm.

Nanoscience – It is the branch of science that deals with nanoparticles.

State of Matter – Different forms that a matter can take. They are solids, liquids and gas.

Solids – States of matter with fixed shape and volume.

Liquids – States of matter without fixed shape but fixed volume.

Gases – States of matter with fixed shape and volume.

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TEST YOURSELF !!!!!

Q1 Name the type of bonding in the following compounds :-

a) Sodium Chloride
b) Magnesium
c) Nitrogen
d) Carbon Dioxide
e) Water
f) Ammonia

Q2 Draw dot and cross diagram to represent bonding in the following
a) sodium chloride
b) Water
c) Magnesium

Q3 Differentiate Between Diamond and Graphite

Q4 Why Ionic compounds do not conduct electricity in solids ?

Q5 Why Alloys are stronger than metals

Q6 Why alumunium has a stronger melting point than sodium

Q7 What are nanoparticles ? Write the properties and applications of nanoparticles

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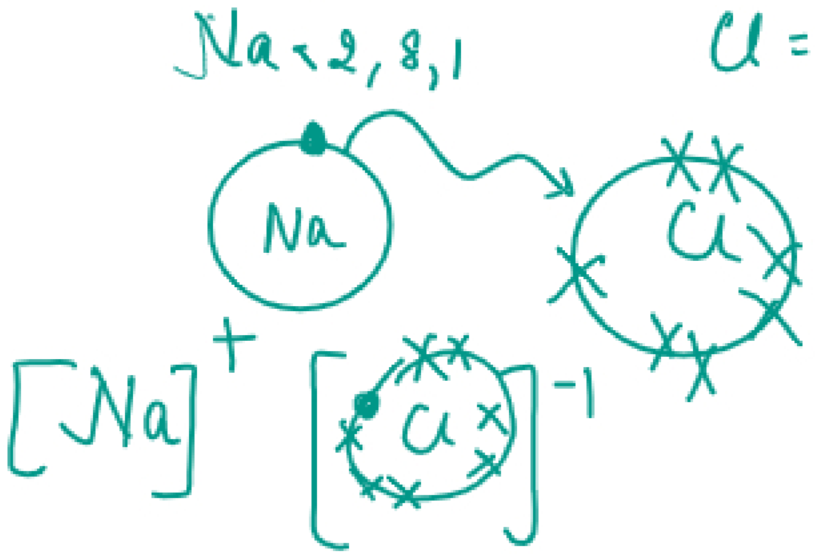
Q1 Name the type of bonding in the following compounds :-

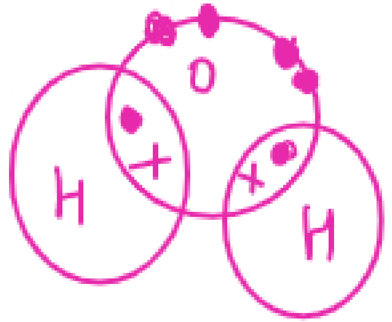
a) Sodium Chloride — Ionic
b) Magnesium — Metallic
c) Nitrogen — Covalent
d) Carbon Dioxide — Covalent
e) Water — Covalent
f) Ammonia — Covalent

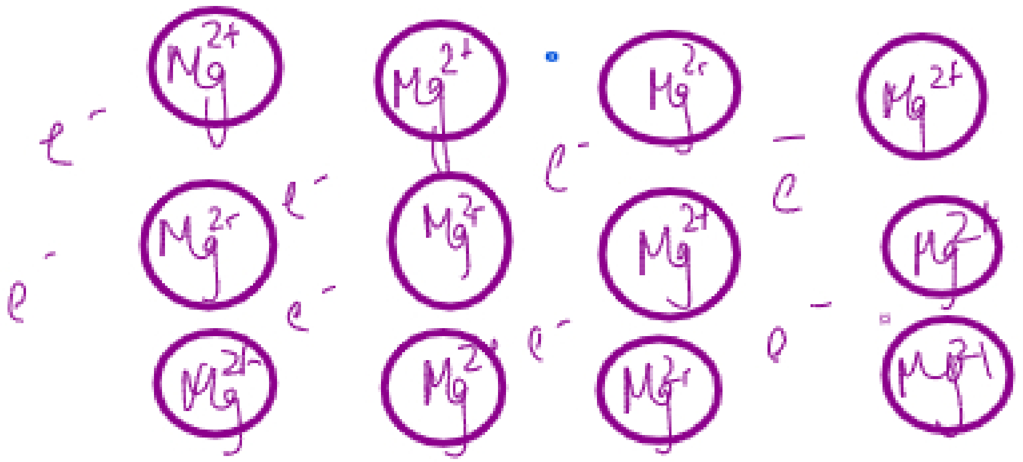
Q3 Differentiate Between Diamond and Graphite

DIAMOND	GRAPHITE
It is hard.	It is soft and greasy.
It is an insulator	It is a conductor
It has a high density.	It has a lower density than diamond.
Each carbon atom is covalently bonded to four other carbon atoms giving it a strong rigid structure.	Carbon atoms are bonded in the form of layer in the form of hexagons. No covelent bonding between the layers so they can slide past. Each carbon atom is bonded with three other carbon leaving the fourth electron has delocalized
No delocalised electrons present	It has delocalised electrons
Used in cutting or jewellery	It is used in pencil leads.

Q2 Draw dot and cross diagram to represent bonding in the following
a) sodium chloride
b) Water
c) Magnesium







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Q4 Why Ionic compounds do not conduct electricity in solids ?

In solids, the ions are held together by strong electrostatic force of attraction in the giant ionic lattice. In molten state the ions are free to move therefore conduct electricity.

Q5 Why Alloys are stronger than metals

Alloys are the mixture of metals which distors the regular arrangement of metal as a result of which layers are not able to slide past each other making alloys stronger than metals.

Q6 Why alumunium has a stronger melting point than sodium

Aluminium has a greater charge. Due to greater charge of aluminium there is a stronger electrostatic forces of attraction between fixed positive ions and delocalised elecctrons. As a result aluminium has a greater melting point than sodium.

Q7 What are nanoparticles ? Write the properties and applications of nanoparticles

Nanoparticles are the particles betwen the size of 1 to 100 nm.

Due to smaller size they have large surface area to volume ratio making them highly useful in medicine, catalysts, cosmetics and electronic industry.

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NEXT STEP !!!!!

- ★ Check the specification
- ★ Do Exam Style Questions on this topic

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