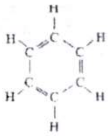
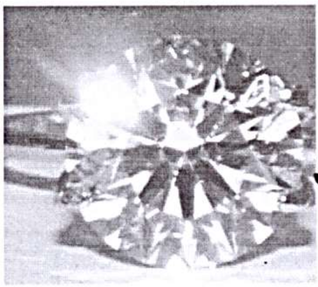
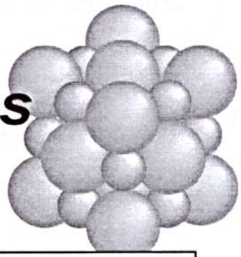


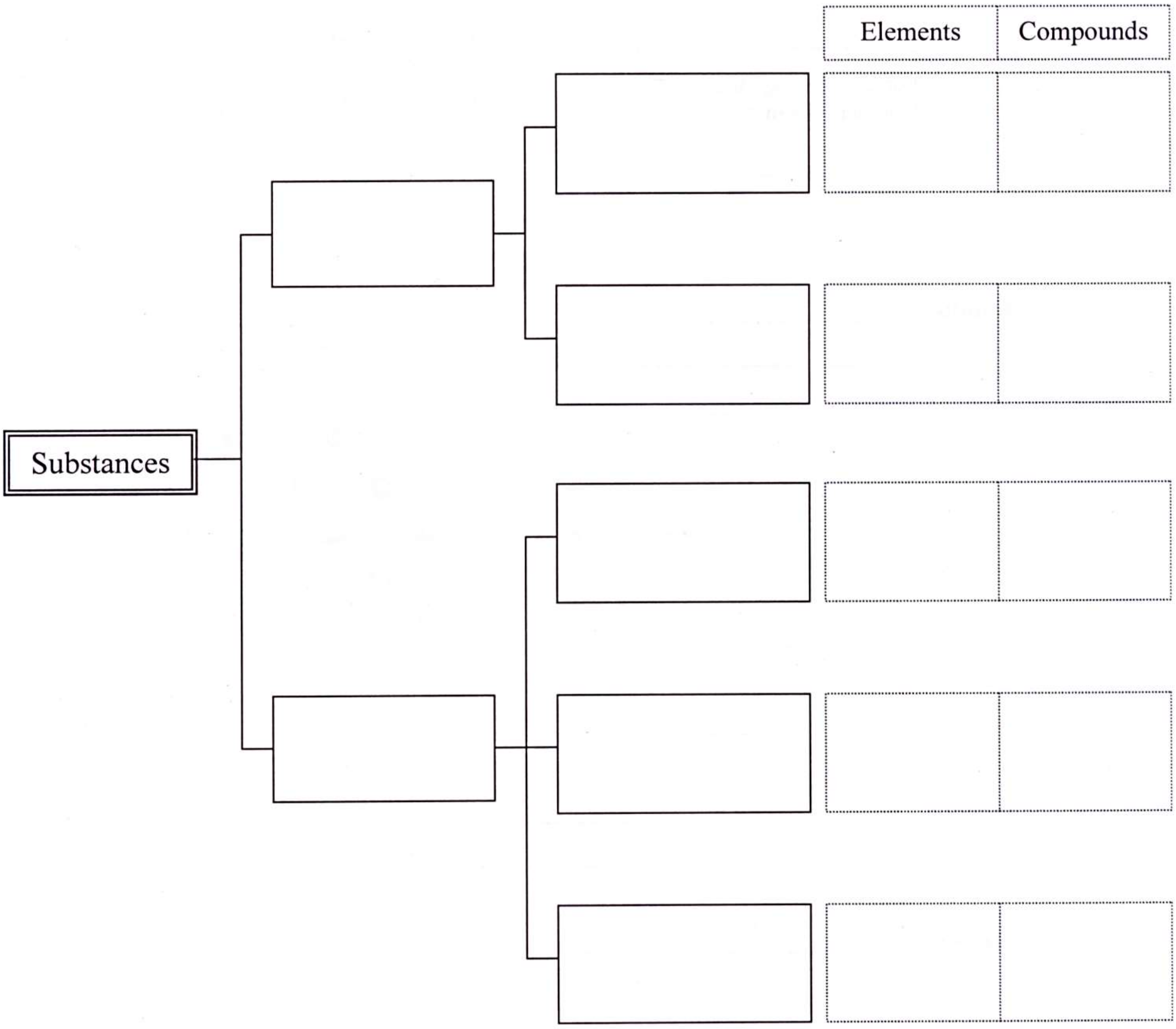


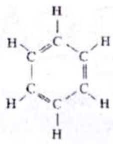
Structures and Properties



Structure (結構) of a substance is a description of what its constituent particles are and the way they are *arranged*.

Classification of substances

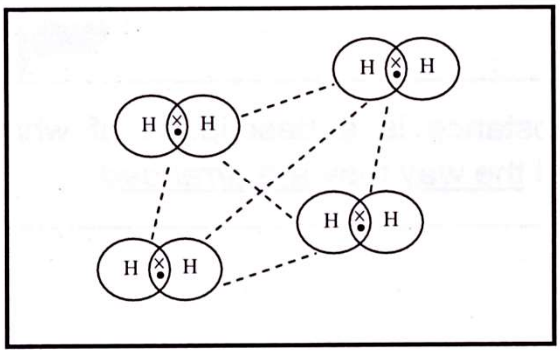




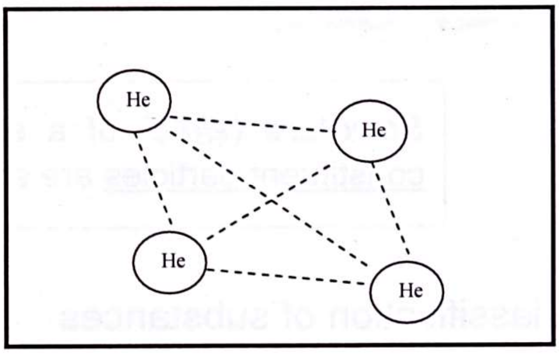
1. Simple Molecular Structures (簡單分子結構)

- basic units (constituent particles) : ____________

Hydrogen gas



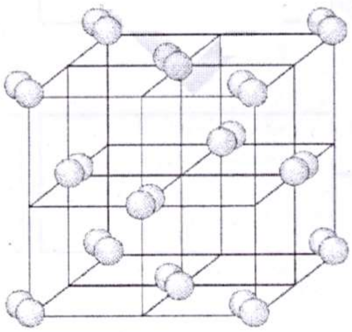
Helium gas



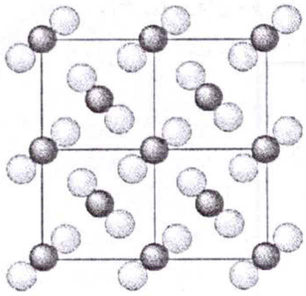
Forces joining the atoms together **within** molecules : ________________________

Forces **between** molecules (intermolecular forces) : ________________________(范德華力)

- **solids** : ____
____



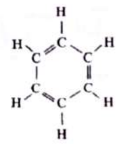
____



____

- **liquids** : ____
____

- **gases** : ____
____



Physical properties of Simple Molecular Structures

(a) Melting point and Boiling point (m.p. & b.p.)

High / low m.p. and b.p.

Reason : ____

____

* The **larger** the molecule, the smaller / larger the **van der Waals' forces**. This explains why the *m.p./b.p.* of **halogens** increases / decreases *down* the group.

(b) Hardness

usually soft / hard

Reason : Molecules are joined by weak van der Waals' forces,

∴ little _______ is required to separate the molecules and break down the crystal

(c) Solubility

Water (a non-aqueous solvent / non-polar solvent)	**CCl_4** (a non-aqueous solvent / non-polar solvent)

I_2(s) dissolves in only one of these solvent, which one is it ? _____

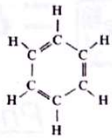
∴ Simple molecular substances are usually __________ **in water** but **very soluble** in _______________ **solvents**

Reason : ____

____

____

____



(d) Electrical Conductivity

Conductors / Non-conductors

Reason : Molecules are electrically __________ and they contain **neither** _______________ **nor**_______________.

Exceptions :

Some molecular substances such as **acids (HCl)** and **alkalis (NH_3)** when dissolved in water, will conduct electricity because they ***react with water*** to form **mobile ions.**

Example 1 :

Example 2 :

This process is called **ionization** (電離) :

____

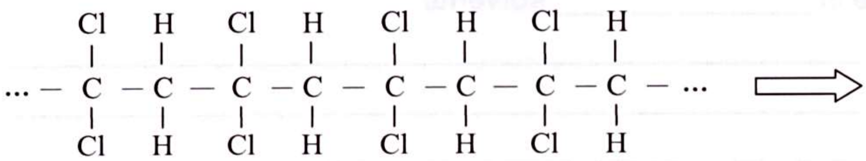
(e) Density

Low / high density

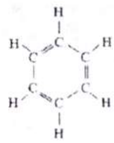
Reason : Since the **intermolecular forces** are **weak**, therefore the molecules are **NOT** _______________________.

2. Macromolecules (巨大分子)

- examples : *starch*, *proteins* and *plastics*

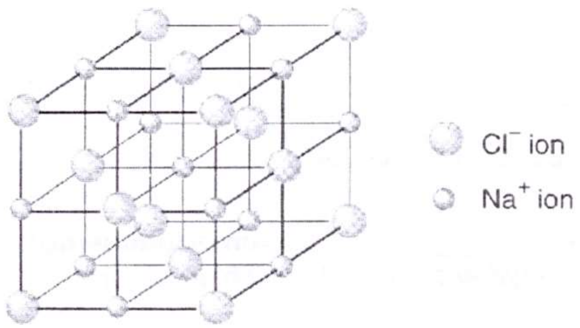


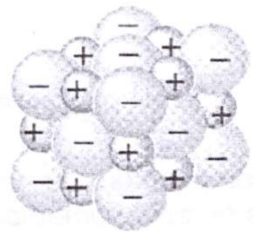
- Forces between molecules are still ___________________________________.



3. Giant Ionic Structures (巨型離子結構)

- basic units (constituent particles) : __________
- ALL ionic substances have **Giant ionic structure**.
- Ionic substance is a _________ _________ (巨型晶格) which consists of a _________ (網絡) of _______ joined together by ________ ________ bonds (directional / non-directional electrostatic force).





Physical Properties of Giant Ionic Structures

(a) Hardness

ALL ionic compounds are generally very hard / soft, crystalline (晶狀的) **solids**.

Reason : - The **oppositely charged ions** (_______ & ________) are attracted together by ________ ________ ________.

∴ In solid ionic substances, a giant lattice of ions are formed

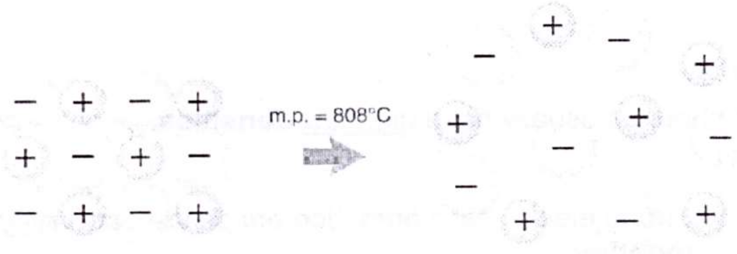
∴ a **strong** ________ is needed to break the structure

(b) Melting and boiling point

Ionic compounds *usually* have high / low m.p. and b.p.

Reason : - The oppositely charged ions are tightly joined together by **strong ionic bonds**

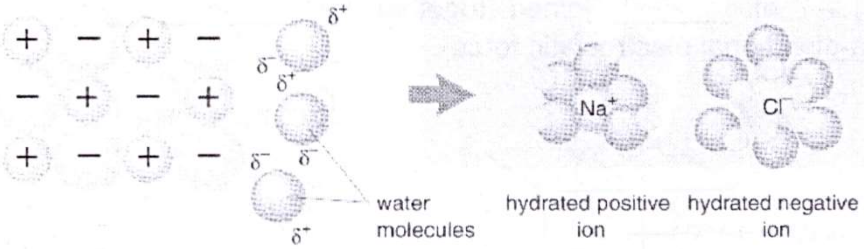
∴ a **large amount of** ________ is needed to **separate the ions**



(c) Solubility

Ionic compounds are *usually** __________ in **aqueous/polar solvents** such as **water**.

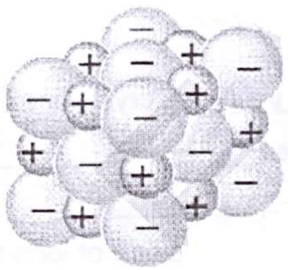
Reason : - Ions in compounds are attracted by the **polar water molecules** and become **free to move** (ions become __________).

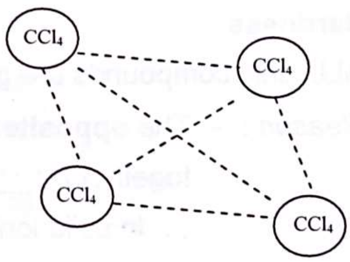


* Some ionic compounds (e.g. AgCl, $CaCO_3$) are insoluble in water.

Ionic compounds are *usually* ____________ in **non-aqueous/non-polar solvents** such as *tetrachloromethane*, *methylbenzene*, *1,1,1-trichloroethane*.

Reason : - The attraction between the molecules of the non-aqueous solvents (mainly weak van der Waals' forces) is **not similar** to that between the ions (strong ionic bonds)





(d) Electrical conductivity

ALL ionic compounds are ______________ (電解質).

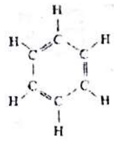
In **solid state**, they <u>do/do not</u> conduct electricity because ions are **not free to move** (____________).

They conduct electricity ONLY when _________ or in __________ state (dissolved in water) because ions are __________.

(e) Density

Ionic compounds usually have <u>high/low</u> **densities**.

Reason : Strong electrostatic attraction brings the oppositely charged ions **close together**.



4. Giant Covalent Structures (巨型共價結構)

- basic units (constituent particles) : ________________

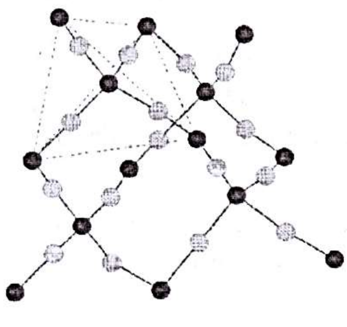
  NEVER use the term "molecules" to describe the structures because there are NO discrete (separate) molecules in the structures.

- **Non-metal atoms** are joined together by a __________(網絡) of **strong** __________ bonds to form a __________ __________ (巨型晶格).

(a) Silicon (IV) oxide (silicon dioxide)

- Two forms of silicon (IV) oxide can be found on earth :

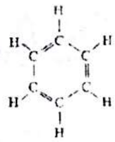
  1. __________ (*pure* form)
  2. __________ (*impure* form)



● silicon atom ◌ oxygen atom

- Forces between **Si** and **O** atoms : ____________________________
- each **Si** atom is surrounded by __ O atoms

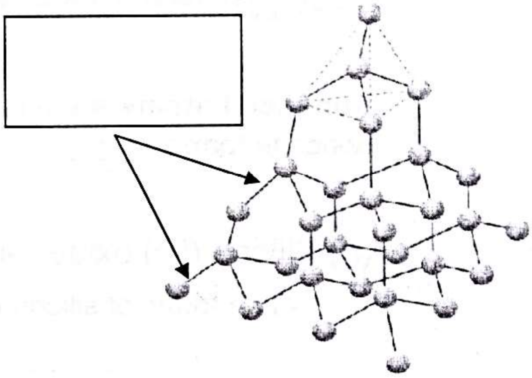
  each **O** atom is surrounded by __ Si atoms
- **empirical formula** (NOT molecular formula) : ____________



(b) Carbon

(i) Diamond

- each carbon atom is bonded to ___ carbon atoms

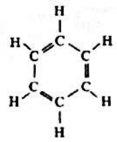


- *Uses* of diamond : 1. ______________________________
  2. ______________________________

(ii) Graphite

- each carbon atom is bonded to ___ carbon atoms
- **layers** of carbon atoms are formed

- Forces **within** layers : ____________________________
- Forces **between** a layer : ______________________________
- *Uses* of graphite : making ______________



Physical properties of Giant Covalent Structures

(a) Hardness

very **hard** (*diamond* and *quartz*) except ___________ which is **soft**

Reason :

The structures of *diamond* and *silicon(IV) oxide* consist of a ________ of _________ covalent bonds. A **great force** is needed to separate the _________ apart and break the structure.

In graphite, due to the **weak van der Waal's forces** between / within **carbon layers**, it is very easy for the layers to ________ over each other.

(b) Melting point and Boiling point

- ALL of them exist as solids / liquids / gases
- ____________ m.p. and b.p.

	Melting point (°C)	Boiling point (°C)
Silicon dioxide		
Diamond		
Graphite		

Reason :

The structure consists of a **giant network** of **strong covalent bonds**.

∴ **Large amount of** _______ is needed to separate the atoms apart.

(c) Electrical Conductivity

- *Diamond* and *silicon(IV) oxide* are **non-conductors** of electricity.

Reason : they contain no ________________ and ________.

- *Graphite* is a **conductor** of electricity.

Reason : since each C atom is bonded only to 3 carbon atoms, each carbon atom still has one mobile _________ for conducting electricity.

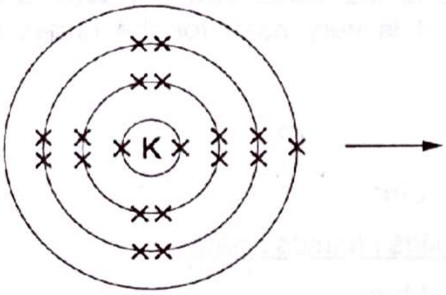
(d) Solubility

soluble / insoluble in any solvent

5. Giant Metallic Structure (巨型金屬結構)

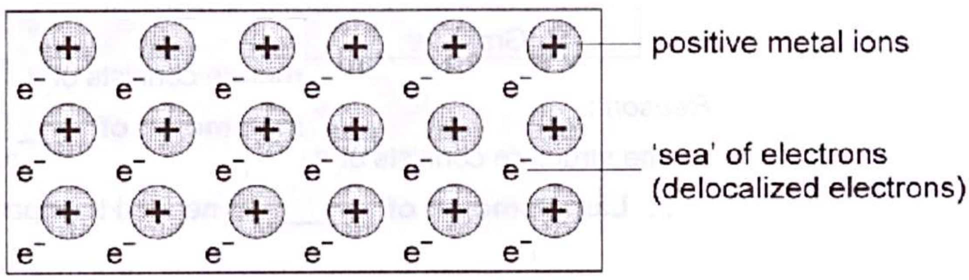
Example : **Potassium** (electronic configuration : ___________)

Since the only **outermost shell electron** is **loosely attracted** by the **positively charged nucleus**, ∴ this <u>outermost shell electron</u>* can easily **escape**.



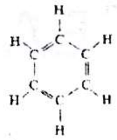
* mobile electron, delocalized electron, freely moving electron

Result :



Giant Metallic Structure is a **giant lattice** of ______________________ surrounded by a **'sea' of** ____________________ **electrons**

Metallic Bond : ____ ____ ____

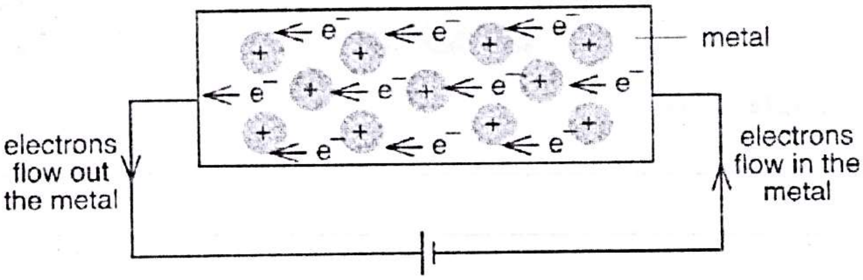


Physical Properties of Metals

ALL metals have the following properties :

(a) Electrical Conductivity

- Metals are **good** conductors of electricity.



Explanation :

____

____

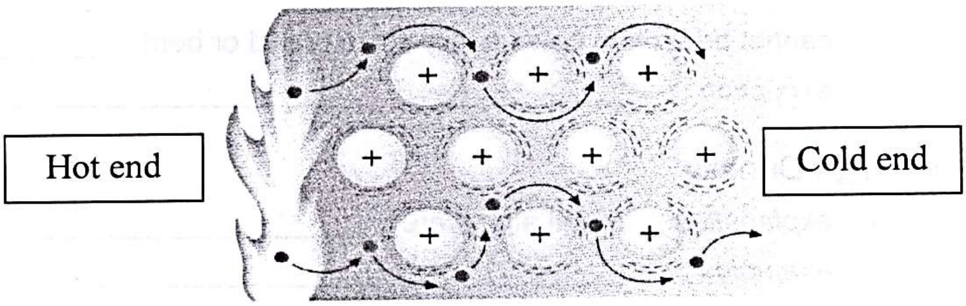
____

____

- Is there any *decomposition* during conduction ? _______

(b) Thermal Conductivity

- Metals are **good** conductors of heat.



Explanation :

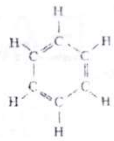
____

____

____

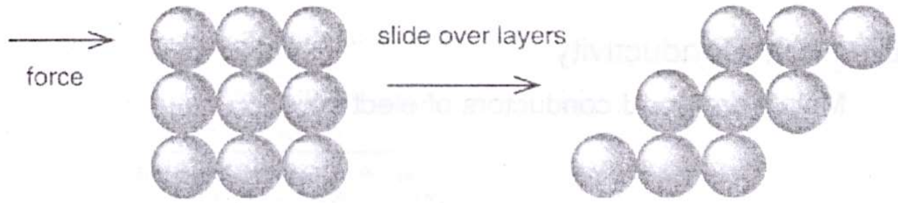
____

____



(c) Malleability (展性) and Ductility (延性)

- Metals are **malleable** and **ductile**



Explanation :

____

____

____

____

Other Properties that Metals generally possess :

(a) High Melting points and Boiling points

- ALL metals are solid EXCEPT __________.
- *explanation* : metals form a *giant lattice* of *strong metallic bonds*
- *example* : ____
- *exception* : ____

(b) High Strength

- cannot be broken down easily when pulled or bent : __________________
- *exception* : ______________________________________

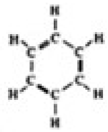
(c) High Density

- *explanation* : metal atoms are ___________ ___________
- *examples* : ________________________________
- *exception* : ____

(d) Lustre

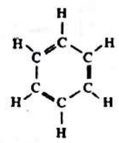
- *explanation* : ALL metals reflect most of the light incident on it.
- All metals are shiny when freshly cut.
- Some reactive metals (e.g. _______) *tarnishes* (變黑) when exposed to air for a while.

(e) Sonorous (鏗鏘的)



Comparing the Physical Properties of Substances

	Ionic Substances	**Covalent Substances**		
	Giant ionic structure	**Simple molecular structure**	**Giant covalent structure**	**Giant metallic structure**
metals / non-metals				
Typical examples				
Basic Unit				
Bonding				
m.p. & b.p.	Usually low / high	Usually low / high	Usually low / high	Usually low / high
Volatility	Usually low / high	Usually low / high	Usually low / high	Usually low / high
State at room temperature	Usually s / l / g	Usually s / l / g	Usually s / l / g	Usually s / l / g
Hardness	Usually Soft / hard	Usually Soft / hard	Usually Soft / hard	Usually Soft / hard
Electrical conductivity				
Solubility in aqueous solvents	Usually soluble / insoluble	Usually soluble / insoluble	Usually soluble / insoluble	Usually soluble / insoluble
Solubility in non-aqueous solvents	Usually soluble / insoluble	Usually soluble / insoluble	Usually soluble / insoluble	Usually soluble / insoluble
3D Structure				



Predicting formula, structure and properties of substances

Examples

1. A compound Z is formed from the reaction between two elements X and Y. Their electronic arrangement are :

Element	Electronic arrangement
X	2,8,8,2
Y	2,8,18,7

(a) Draw the electron diagram of Z (showing the outermost electrons only).

(b) Predict the following properties of Z :

(i) melting point and boiling point;

(ii) hardness;

(iii) solubility in water;

(iv) electrical conductivity.

2. Some physical properties of four substances are summarized in the following table :

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity	
			Solid	Molten
A	44	280	Nil	Nil
B	-182	-161	Nil	Nil
C	808	1465	Nil	Good
D	3550		Nil	Nil

(a) Which of them would

(i) have a giant ionic structure ?

(ii) be a solid with simple molecular structure at room temperature ?

(iii) be a gas with simple molecular structure at room temperature ?

(iv) have a giant covalent structure ?

(b) Match *A-D* to the following substances :

carbon, phosphorus, sodium chloride, methane