

***Bold italic = Paper 2 only***

## Some useful phrases:

Strong electrostatic forces of attraction between oppositely-charged ions require a lot of energy to break

Weak intermolecular forces of attraction require little energy to break

***Giant lattice of positive ions in a sea of delocalized electrons***

***Electrostatic attraction between positive ions and delocalized electrons***

***Layers of positive ions slide over each other***

Strong electrostatic attraction between a shared ***pair*** of electrons and the nuclei of ***both*** atoms making up the bond

## Don't get mixed up:

Ionic substances conduct electricity when molten/in aqueous solution because IONS are free to move

***Metals conduct electricity because delocalized ELECTRONS are free to move***

Graphite conducts electricity because delocalized ELECTRONS are free to move

## Do not:

- Mention the words *molecules/intermolecular* forces when talking about ionic compounds
- Get mixed up between *ammonia* ( $\text{NH}_3$  – a covalent molecule) and *ammonium* ( $\text{NH}_4^+$  an ion)
- Get mixed up between sulfide ( $\text{S}^{2-}$ ) and sulfate ( $\text{SO}_4^{2-}$ ) or between nitride ( $\text{N}^{3-}$ ) and nitrate ( $\text{NO}_3^-$ )
- Mention the word 'electrons' when explaining why ionic compounds conduct electricity

## Remember:

Intermolecular forces are between *molecules*

Covalent bonds are between *atoms*.

When a covalent molecular substance melts/boils only the weak intermolecular forces of attraction are broken – this does not require much energy.

If a compound contains a metal it is almost certainly ionic (exceptions will be things like ammonium chloride)

Diamond and graphite have giant structures but  $\text{C}_{60}$  fullerene has a simple molecular structure

Covalent molecular substances with higher relative molecular masses usually have higher melting/boiling points because the intermolecular forces are stronger.

# Bonding Revision

1 Complete the sentences:

positive ions are formed when atoms ..... electrons

negative ions are formed when atoms ..... electrons

2 Give the charges on the ions followed by the following atoms:

K	Al	Cl	S	Ca	N

3 Give the formulae of the following ions:

Hydroxide	Nitrate	Sulfate	Carbonate	Ammonium	Silver	iron(II)	Zinc	lead(II)

4 Draw dot and cross diagrams showing the ions present in each of the following – you only need to show outer shell electrons

Lithium fluoride	sodium oxide
Calcium Oxide	Magnesium Chloride

5 Work out the formulae of the following compounds:

Potassium oxide	Calcium chloride	Magnesium hydroxide	Barium nitrate	Ammonium sulfate	Sodium carbonate
Copper(II) sulfate	Lead(II) nitrate	Silver bromide	Zinc sulfate	iron(II) hydroxide	iron(III) chloride

# Bonding Revision

6 Fill in the gaps:

(a) Ionic bonding is a ..... electrostatic attraction between  
..... ions

(b) An ionic crystal is a ..... three-dimensional ..... structure  
held together by the attraction between .....

7 Explain the following in terms of structure and bonding:

(a) ionic compounds have high melting points

.....  
.....

(b) ionic compounds conduct electricity only when molten or in solution

.....  
.....

8 Use the following words to fill in the gaps. Each word may be used once, more than once or not at all.

*electrons    nuclei    electrostatic    sharing    both    transfer*  
*pair    shared    electromagnetic    ions    molecule    weak*

Ionic bonding involves the ..... of electrons from one atom to  
another. Covalent bonding involves the ..... of a ..... of .....

The atoms in a covalent bonds are held together by the ..... attraction  
between the ..... of ..... atoms making up the bond and the  
..... of .....

9 State the type of structure and bonding for each of the following by putting ticks in boxes

SUBSTANCE	IONIC	COVALENT	SIMPLE MOLECULAR	GIANT
Potassium chloride				
Water				
Ammonia				
Magnesium oxide				
Sulfur dioxide				
Diamond				
Graphite				
C <sub>60</sub> fullerene				

# Bonding Revision

10 Draw dot and cross diagrams (showing outer shells only) for the following:

<b>H<sub>2</sub></b>	<b>HCl</b>	<b>F<sub>2</sub></b>	<b>C<sub>2</sub>H<sub>6</sub></b>
<b>NH<sub>3</sub></b>	<b>H<sub>2</sub>O</b>	<b>CH<sub>4</sub></b>	<b>CH<sub>3</sub>Cl</b>
<b>N<sub>2</sub></b>	<b>C<sub>2</sub>H<sub>4</sub></b>	<b>O<sub>2</sub></b>	<b>CO<sub>2</sub></b>

11 Methane, CH<sub>4</sub>, has a simple molecular structure. Explain whether you would expect it to have a high or low melting/boiling point?

Melting/boiling point:      High      Low      *circle the correct answer*

Explanation:.....

12 The boiling point of the halogens are shown in the table.

	Boiling point / °C
Fluorine, F <sub>2</sub>	-188
Chlorine, Cl <sub>2</sub>	-34
Bromine, Br <sub>2</sub>	59
Iodine, I <sub>2</sub>	184

(a) State the type of structure and bonding in these substances:

Structure: .....      Bonding:.....

(b) Explain the trend in boiling point in terms of structure and bonding

.....  
 .....

# Bonding Revision

13 Diamond has a giant covalent structure. Explain whether you would expect it to have a high or low melting/boiling point?

Melting/boiling point:      High      Low      *circle the correct answer*

Explanation:.....

14 Complete the table by putting ticks in the appropriate boxes.

SUBSTANCE	Structure		Melting point		Hardness		Electrical conductivity	
	SIMPLE MOLECULAR	GIANT	High	Low	Hard	Soft	Good	Poor
Diamond								
Graphite								
C <sub>60</sub> fullerene								

15 Explain why fullerene, C<sub>60</sub>, has a lower melting point than diamond

.....

.....

.....

16 Delete words as appropriate to make the following paragraph correct.

Covalent compounds are usually **good/poor** conductors of electricity. This is because they **don't** contain charged particles that are **free/not free** to move

## Extension Question

17 A student gives the following answer in an exam:

*I would expect ethene (C<sub>2</sub>H<sub>4</sub>) to have a higher boiling point than ethane (C<sub>2</sub>H<sub>6</sub>) because there is a double bond between the carbon atoms in ethane but only a single bond between the carbon atoms in ethane. A double bond is stronger than a single bond, therefore more energy is needed to break it and therefore ethane has a higher boiling point.*

Discuss the student's answer

.....

.....

.....

.....

**Metallic Bonding – Paper 2 only**

18 Draw a labelled 2D diagram to show the structure of a metal and describe its structure.

Diagram	Description
	..... ..... ..... ..... .....

19 Complete the following sentence by inserting appropriate words in the spaces.

Metallic bonding is the ..... attraction between .....  
and .....

20 Explain the following in terms of structure and bonding:

(a) metals are malleable

.....  
.....  
.....

(b) metals are good conductors of electricity

.....  
.....  
.....