GRAYS TUITION CENTRE – Online Tutoring

WEEK: 11

Week Beginning: (01/03/2021)

Subject: SCIENCE

Year: 9

Lesson Objective:

- **Go through homework answers**
- **To understand what simple molecular substances are**
- **To understand properties of simple molecular substances**
- **To understand what polymers are, and their properties**
- **To understand the properties of giant covalent structures**

Keywords/ Concepts

- **Simple molecular substance**
- **Covalent bonding**
- **Intermolecular forces**
- **Conducting electricity**
- **Polymers**
- **Repeating unit**
- **Giant covalent structures**
- **Diamond, graphite, silicon dioxide**

Class Worksheets

- Questions below
- CGP sheet on simple molecular substances

Homework

- 2 CGP worksheets

Additional Notes

Simple Molecular Substances

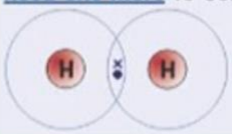
These molecules might be simple, but you've still gotta know about them. I know, the world is a cruel place.

Learn These Examples of Simple Molecular Substances

Simple molecular substances are made up of molecules containing a few atoms joined together by covalent bonds. Here are some common examples that you should know...

Hydrogen, H_2

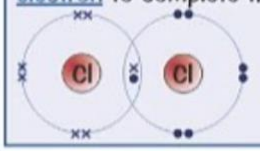
Hydrogen atoms have just one electron. They only need one more to complete the first shell...



...so they often form single covalent bonds, either with other hydrogen atoms or with other elements, to achieve this.

Chlorine, Cl_2

Each chlorine atom needs just one more electron to complete the outer shell...



...so two chlorine atoms can share one pair of electrons and form a single covalent bond.

Oxygen, O_2

Each oxygen atom needs two more electrons to complete its outer shell...

...so in oxygen gas two oxygen atoms share two pairs of electrons with each other making a double covalent bond.

Nitrogen, N_2

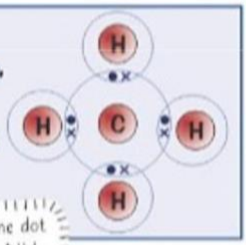
Nitrogen atoms need three more electrons...

...so two nitrogen atoms share three pairs of electrons to fill their outer shells. This creates a triple bond.

Methane, CH_4

Carbon has four outer electrons, which is half a full shell.

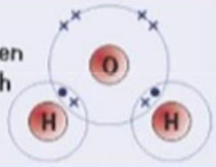
It can form four covalent bonds with hydrogen atoms to fill up its outer shell.



Make sure you can also draw the dot and cross diagram of ammonia, NH_3, which is on the previous page.

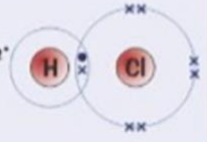
Water, H_2O

In water molecules, the oxygen shares a pair of electrons with two H atoms to form two single covalent bonds.

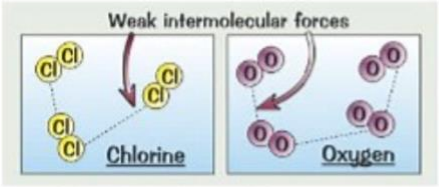


Hydrogen Chloride, HCl

This is very similar to H_2 and Cl_2. Again, both atoms only need one more electron to complete their outer shells.



Properties of Simple Molecular Substances



1) Substances containing covalent bonds usually have simple molecular structures, like the examples above.
2) The atoms within the molecules are held together by very strong covalent bonds. By contrast, the forces of attraction between these molecules are very weak.
3) To melt or boil a simple molecular compound, you only need to break these feeble intermolecular forces and not the covalent bonds. So the melting and boiling points are very low, because the molecules are easily parted from each other.
4) Most molecular substances are gases or liquids at room temperature.
5) As molecules get bigger, the strength of the intermolecular forces increases, so more energy is needed to break them, and the melting and boiling points increase.
6) Molecular compounds don't conduct electricity, simply because they aren't charged, so there are no free electrons or ions.

May the intermolecular force be with you...

Never forget that it's the weak forces between molecules that are broken when a simple molecular substance melts.

Q1 Explain why oxygen, O_2, is a gas at room temperature. [1 mark]

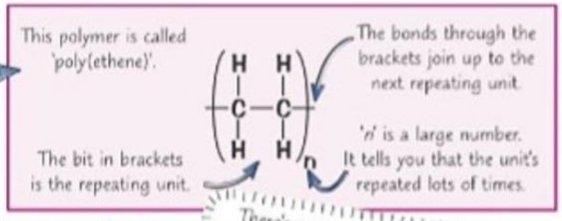
Q2 Explain why nitrogen, N_2, doesn't conduct electricity. [1 mark]

Polymers and Giant Covalent Structures

Wouldn't it be simply marvellous if only simple molecular substances had covalent bonds, and it was now time to put your feet up? Well it's not like that. Polymers and giant covalent substances also have covalent bonds.

Polymers Are Long Chains of Repeating Units

1) In a polymer, lots of small units are linked together to form a long molecule that has repeating sections.
2) All the atoms in a polymer are joined by strong covalent bonds.
3) Instead of drawing out a whole long polymer molecule (which can contain thousands or even millions of atoms), you can draw the shortest repeating section, called the repeating unit, like this:
4) To find the molecular formula of a polymer, write down the molecular formula of the repeating unit in brackets, and put an 'n' outside.
5) So for poly(ethene), the molecular formula of the polymer is $(C_2H_4)_n$.
6) The intermolecular forces between polymer molecules are larger than between simple covalent molecules, so more energy is needed to break them. This means most polymers are solid at room temperature.
7) The intermolecular forces are still weaker than ionic or covalent bonds, so they generally have lower boiling points than ionic or giant molecular compounds.

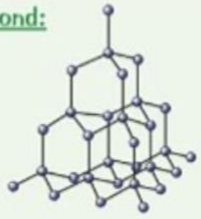


There's more about how polymers are made on p.80 and p.83 and more about their properties and uses on p.96-97.

Giant Covalent Structures Are Macromolecules

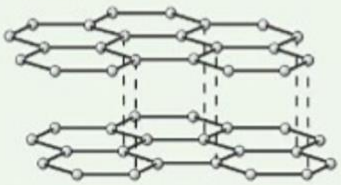
1) In giant covalent structures, all the atoms are bonded to each other by strong covalent bonds.
2) They have very high melting and boiling points as lots of energy is needed to break the covalent bonds between the atoms.
3) They don't contain charged particles, so they don't conduct electricity — not even when molten (except for a few weird exceptions such as graphite, see next page).
4) The main examples that you need to know about are diamond and graphite, which are both made from carbon atoms only, and silicon dioxide (silica).

Diamond:



Each carbon atom forms four covalent bonds in a very rigid giant covalent structure.

Graphite:



Each carbon atom forms three covalent bonds to create layers of hexagons. Each carbon atom also has one delocalised (free) electron.

Silicon dioxide:

Sometimes called silica, this is what sand is made of. Each grain of sand is one giant structure of silicon and oxygen.

There's more about diamond and graphite, as well as other types of carbon structure, on the next page.

What do you call a vehicle made of sand? Sili-car...

To melt or boil a simple molecular substance or a polymer, only the weakish intermolecular forces need to be broken. To melt or boil a giant covalent substance, you have to break very strong covalent bonds.

Q1 The repeating unit of poly(chloroethene) is shown on the right. What's the molecular formula of poly(chloroethene)? [1 mark]

Q2 Predict, with reasoning, whether diamond or poly(ethene) has a higher melting point. [3 marks]

Class work:

1) What are intermolecular forces?

2) Why can't simple molecular compounds conduct electricity?

3) What is a polymer?

4) Why do polymers still have a lower melting point/boiling point than ionic compounds or giant covalent compounds?

5) Give me 3 examples of giant covalent compounds. Why do they have a high melting/boiling point?

6) Why are giant covalent compounds generally poor conductors of electricity?

Simple Molecular Substances

1 This question is about the forces in simple molecular substances. Grade 4-6

1.1 Compare the strength of the bonds that hold the atoms in a molecule together with the forces that exist between different molecules.

.....

.....

[2]

1.2 When a simple molecular substance melts, is it the bonds between atoms or the forces between molecules that are broken?

.....

[1]

[Total 3 marks]

2 HCl and N_2 are both simple molecular substances. Grade 6-7

2.1 Draw a dot and cross diagram to show the bonding in a molecule of HCl. Show all of the outer shell electrons and use different symbols for electrons from different atoms. There is no need to show inner shell electrons.

[2]

2.2 Draw a dot and cross diagram to show the bonding in a molecule of N_2. Show all of the outer shell electrons and use different symbols for electrons from different atoms. There is no need to show inner shell electrons.

[2]

2.3 State **one** difference between the bonding in HCl compared to N_2.

.....

.....

[1]

[Total 5 marks]

Homework:

3 Iodine, I_2, is a simple molecular substance. Grade 6-7

3.1 At room temperature, iodine is a solid. Explain, with reference to the forces between molecules, why this is unusual for a simple molecular substance.

.....

.....

[2]

3.2 Predict, with reasoning, whether iodine can conduct electricity in any state.

.....

.....

[2]

[Total 4 marks]

4 Both methane (CH_4) and butane (C_4H_{10}) are simple covalent compounds that are gases at room temperature. Methane has a lower boiling point than butane. Grade 7-9

4.1 Explain, in terms of particles, what happens when methane boils and why the boiling point of methane is lower than that of butane.

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[5]

4.2 Explain why a carbon atom can form up to four covalent bonds, whilst a hydrogen atom only ever forms one covalent bond.

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[2]

4.3 Suggest how many covalent bonds an atom of silicon would form. Explain your answer.

.....

.....

[2]

[Total 9 marks]

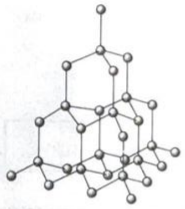
Exam Practice Tip

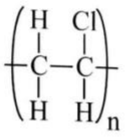
Each atom in a molecule should have made enough covalent bonds to get a full outer shell. So to check that you've drawn your dot and cross diagrams correctly, count up how many electrons there are in the outer shell. Unless it's hydrogen, there should be eight electrons in the outer shell. Hydrogen should end up with two electrons in its outer shell.

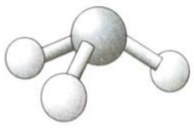
Polymers and Giant Covalent Substances

Warm-Up

Circle the diagram below that represents a compound with a giant covalent structure.







1 Graphite and diamond are compounds with very high melting points. Grade 4-6

1.1 Which of the following compounds is not an example of a giant covalent structure? Tick **one** box.

☐ Ammonia ☐ Diamond ☐ Graphite ☐ Silicon dioxide

[1]

1.2 To melt a giant covalent compound, the covalent bonds between atoms must be broken. Explain why this causes giant covalent compounds to have very high melting points.

.....

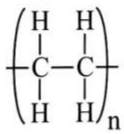
.....

[2]

[Total 3 marks]

2 **Figure 1** below represents a large molecule known as a polymer. Grade 6-7

Figure 1



2.1 What is the molecular formula of this polymer?

.....

[1]

2.2 Is this molecule likely to be a solid, liquid or gas at room temperature? Explain your answer.

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[3]

2.3 State what type of bonds hold the atoms in the polymer together.

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[1]

[Total 5 marks]