Predicting the melting temperature of carbon

Introduction

Part of doing science involves spotting patterns, and making predictions which can be tested by experiments. In this exercise you will be asked to make a prediction based on information you will be given. It is not important whether your prediction is correct, as long as it is based on the information given.

Information about some elements

This section is to make sure you remember what is meant by the relative molecular mass of an element.

Many substances are said to be 'molecular' - they are comprised of vast numbers of separate identical particles. The name given to the tiny particles in these substances is molecules. Usually a molecule can be thought of as several atoms bonded together. In a few substances the molecules are single atoms. Often these substances are called atomic substances.

The formula of helium is He. It consists of single atoms. The relative atomic mass of helium, A_r(He), is 4.0, and its relative molecular mass, M_r(He), is also 4.0.

The formula of fluorine is F_2. It has molecules that can be thought of as two atoms bonded together. The relative atomic mass of fluorine, A_r (F), is 19.0, and its relative molecular mass, M_r (F_2), is therefore 38.0.

The formula of sulfur is S_8. It has molecules that can be thought of as eight atoms bonded in a ring arrangement. The relative atomic mass of sulfur, A_r(S), is 32.1, and its relative molecular mass, M_r(S_8), is therefore 256.8.

1. The formula of neon is Ne. It consists of single atoms. The relative atomic mass of neon, A_r(Ne) is 20.2. What is the relative molecular mass of neon?

M_r(Ne) = _____

2. The formula of chlorine is Cl_2. It has molecules that that can be thought of as two atoms bonded together. The relative atomic mass of chlorine, A_r(Cl), is 35.5. What is the relative molecular mass of chlorine?

$M_r(Cl_2)$ = _____

3. The formula of carbon is C. The relative atomic mass of C is 12.0. What do you think the relative molecular mass of carbon will be?

M_r(C) = _____

The table below shows the melting temperatures (in Kelvin, K) of some elements.

Element	M_r	Melting temperature/K
Helium (He)	4.0	4
Carbon (C)	12.0	
Neon (Ne)	20.2	25
Fluorine (F_2)	38.0	53
Chlorine (Cl_2)	71.0	172
Bromine (Br_2)	159.8	266
Iodine (I_2)	253.8	387
Sulphur (S_8)	256.8	392

It has been suggested that there is a general relationship between the relative molecular mass of an element, and the temperature at which the solid element melts.

4. Can you see any relationship in the data given in the table? Describe any pattern you can see:

_____

_____

_____

_____

_____

The melting temperature of carbon is not given in the table.

5. Predict the (approximate) melting temperature for carbon? Make an estimate, and explain your reasons:

Solid carbon will melt at about _____

I think this because

_____

_____

_____

_____

Now ask your teacher for the second set of sheets.

Explaining the melting temperature of carbon

Write your prediction of the approximate melting temperature of carbon in the box below.

Prediction: about _____ K

This is your prediction based upon the data you were given. In science it is important to make predictions, because while testing the predictions we are also testing the ideas we use to explain things. Often when our predictions are wrong it helps us find better ways of understanding things.

Experiments show that solid carbon is difficult to melt and only changes into a liquid at a very high temperature. The melting temperature of carbon is 3823K. How close was your prediction? (tick one box)

❑ just about right ❑ a little bit out ❑ a long way out

On the separate sheet you will find four diagrams showing the particles in neon, chlorine, sulfur and carbon. It is not possible to draw accurate diagrams to show exactly what atoms and molecules are like. These picture are very simple models of how scientists sometimes think about these particles.

Look at the four diagrams, and use them to help you answer the following questions:

1. Do the diagrams help you understand why carbon has such a high melting temperature? (Explain your answer.)

_____

_____

_____

_____

2. Scientists sometimes describe carbon as having a giant covalent structure. What do you think is meant by giant covalent?

_____

_____

_____

_____

3. It is sometimes suggested that the symbol for the carbon macromolecule should be C_{∞} rather than just C. What do you think the ∞ symbol is meant to show in C_{∞}?

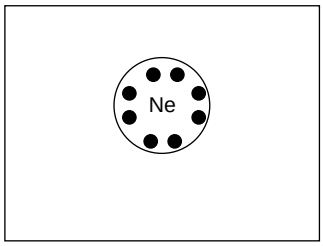
_____

_____

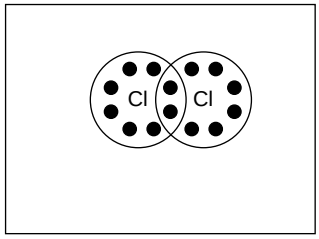
_____

_____

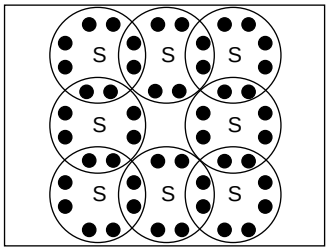
The following diagrams show how scientists picture particles of neon (Ne), chlorine (Cl), sulfur (S) and carbon (C).



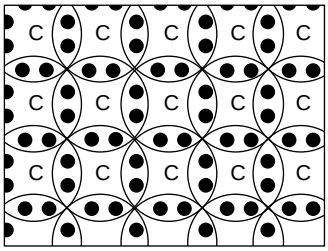
A neon atom, Ne



A chlorine molecule, Cl_2



A sulfur molecule, S_8



Part of the giant covalent structure of carbon C or C_∞

(There are many ways of drawing atoms and molecules - and we choose a type of diagram depending on which aspects we are interested in. For example, the diagrams above show the particles as flat. Molecules are not flat, but the shapes of the molecules were not important in this particular piece of work. At another time it might be important to show the shapes of the molecules.)