Covalent structure and bonding

Introduction

These questions are designed to help you to develop your mental models (pictures in your head) of covalent structures so that you can visualise covalent molecules in different ways. Use the icon in the margin to find out which level of understanding the question is developing. You can refer back to your **Covalent bonding in water: Johnstone's triangle** worksheet to support you.

Macroscopic: what we can see. Think about the properties that you can observe, measure and record.

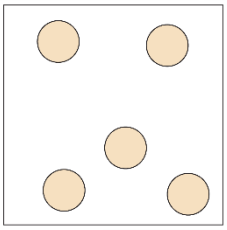
Sub-microscopic: smaller than we can see. Think about what is happening at a particle or atomic level.

Symbolic: how we represent what is happening. Think about the models you use to represent what you cannot see including diagrams and symbols.

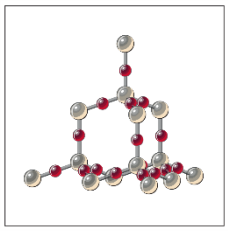
Questions

1. Covalent compounds exist in the solid, liquid and gas state at room temperature. Carbon dioxide is a colourless gas at room temperature. Silicon dioxide is a crystalline solid at room temperature.

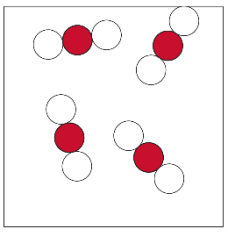
(a) Select the diagram that best represents the structure of carbon dioxide.



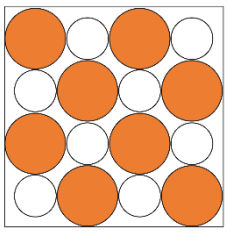
A



B

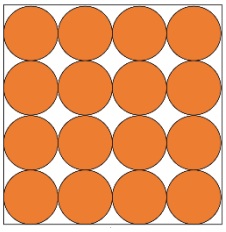


C

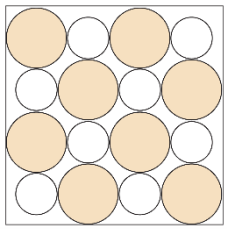


D

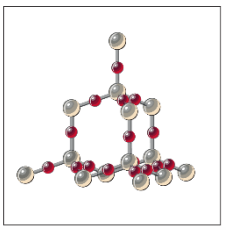
(b) Select the diagram that best represents the structure of silicon dioxide.



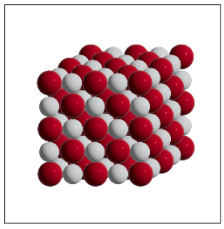
A



B



C



D

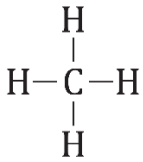
2. The formula for methane is CH_4.

(a) Select the diagram that represents the atoms and covalent bonds in a molecule of methane.

A.

C–H–H–H–H

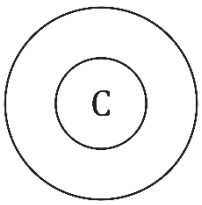
B.



C.

C–H–C–H–C–H–C–H

(b) Draw a dot and cross diagram of a methane molecule.
Carbon atoms have 6 electrons and hydrogen atoms have 1 electron.



(c) Another diagram of CH_4 shows the carbon atom in the middle with two hydrogen atoms on each side.

H–H–C–H–H

Explain why this diagram cannot be correct.

_____

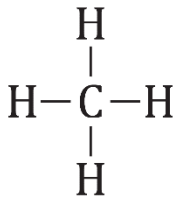
_____

_____

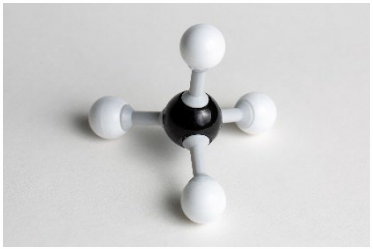
3. A Molymod™ kit uses balls and connecting sticks to represent how atoms in a molecule are joined by covalent bonds.
In the kit, a carbon atom is represented by a black ball.

(a) Explain why the black balls in the kit are made with four holes.

(b) These diagrams show two models of a methane molecule.



bond diagram



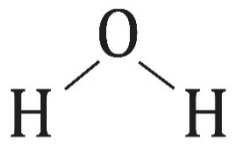
Molymod™ kit model

State one advantage of the Molymod™ kit model.

(c) The formula of water is H_2O. Draw a dot and cross diagram of a water molecule.
An oxygen atom has 8 electrons and a hydrogen atom has 1 electron.

(d) In the Molymod™ kit, a red ball represents an oxygen atom.
Suggest how many holes each red ball is made with.
Give a reason for your answer.

(e) The diagram below shows the shape of a water molecule.



Suggest why the bonds in a water molecule are not in a straight line. Refer to the structure of a methane molecule in your answer.

_____

_____

_____

4. For each of the following compounds, build the model using a Molymod™ kit and then draw a dot and cross diagram for the model you have made.

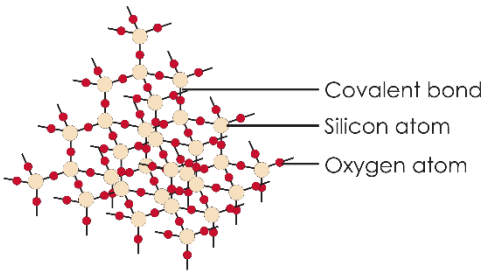
(a) carbon tetrafluoride (CF_4)

(b) ammonia (NH_3)

(c) carbon dioxide (CO_2)

5. The formula for silicon dioxide is SiO_2. The formula for silicon dioxide does not tell us that it forms giant covalent structures.

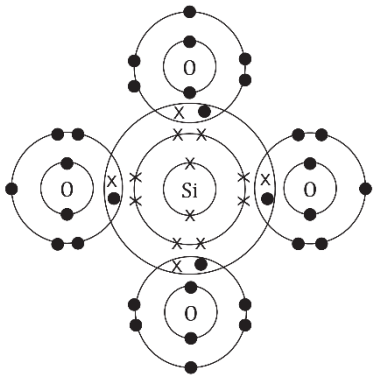
The diagram below shows a ball and stick model of silicon dioxide.



(a) Complete the sentence to describe what the formula SiO_2 represents.

"For every atom of silicon there are _____."

The diagram below shows a dot and cross diagram for one silicon atom and four oxygen atoms. This diagram shows a section of the bonding in the giant silicon dioxide structure. It does not show a separate molecule.



(b) Give the number of electrons in the outer shell of each oxygen atom. _____

(c) State how many more covalent bonds each oxygen can make. _____

(d) Explain why silicon and oxygen are able to form a giant covalent structure.

_____

_____

_____