Covalent structure and bonding

This resource is from the **Johnstone's triangle** series, which can be viewed at: rsc.li/4fElNbx

Use this resource after completing our **Covalent bonding in water: Johnstone's triangle** worksheet which can be viewed at: rsc.li/4fzQHSr

Learning objectives

LO	Objective	Where assessed
1	Recognise a diagram that shows the structure of a given covalent compound.	Q1
2	Draw and connect a dot and cross diagram with a molecular diagram.	Q2
3	Use dot and cross diagrams to explain the construction of molecular models.	Q3
4	Draw dot and cross diagrams and 3D models from the formula of a given covalent compound.	Q4
5	Explain why silicon dioxide forms a giant covalent structure.	Q5

How to use the resource

Use these questions to develop your learners' mental models of the different structures of carbon. The icons in the margin indicate which level of understanding the question is developing. Ask learners to first complete the **Covalent bonding in water: Johnstone's triangle** worksheet (available from rsc.li/4fElNbx) then refer to it to support them in answering these questions.

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.

For questions with the 'macroscopic' icon in the margin, it is useful for learners to observe these macroscopic properties first-hand. You can circulate examples of substances in the classroom or show a teacher demonstration of properties. For questions with the 'symbolic' icon in the margin it is useful for learners to have physical models to use and manipulate, such as a Molymod™ kit.

You can use this resource in a variety of ways. It works best as a follow up activity to an initial teaching or discussion of ionic structure. Use worksheet straight away in the same lesson or as a homework. If completing as an in-class activity it is best to pause and check at intervals, as often one question builds on the previous one. You can also use the resource as a retrieval/revision activity later on to check that students do not have any misconceptions. Depending on the learners, the activity should take from 15 to 30 minutes. The resource works well as a worksheet for independent work but you can also use the questions for group or class discussions.

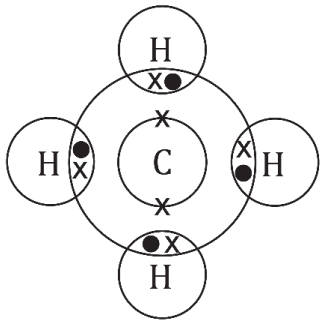
Scaffolding

The earlier questions are designed to be accessible to all learners. The activity becomes more challenging in the latter stages. You can choose to give extra explanations for the more challenging questions.

Answers

1. (a) C
(b) C

2. (a) B
(b)

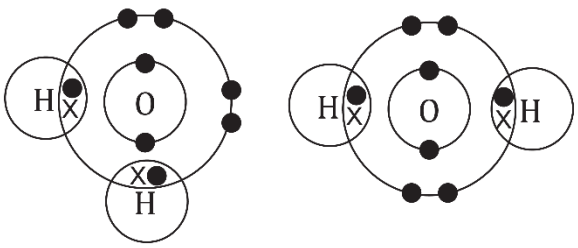


(c) This diagram shows hydrogen atoms that form two covalent bonds. A hydrogen atom is only able to form one covalent bond.

3. (a) The black balls are made with four holes because they represent carbon atoms. Each carbon atom can form four covalent bonds.

(b) The ball and stick model shows the 3D shape of a methane molecule.

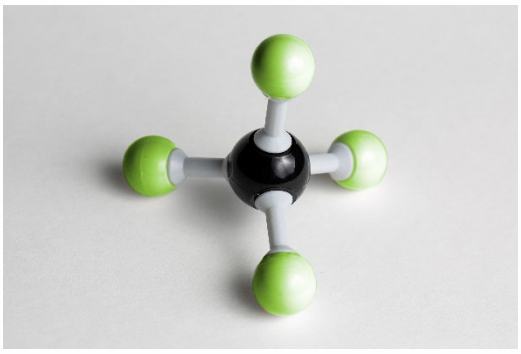
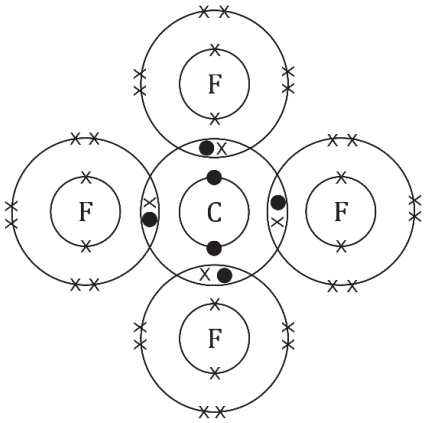
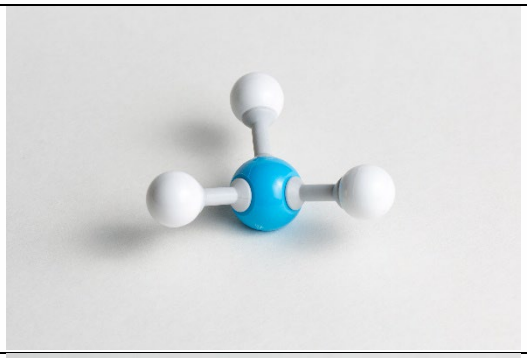
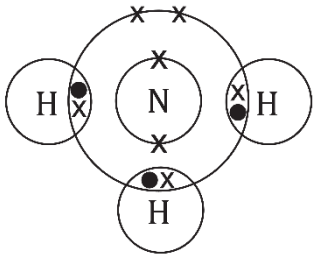
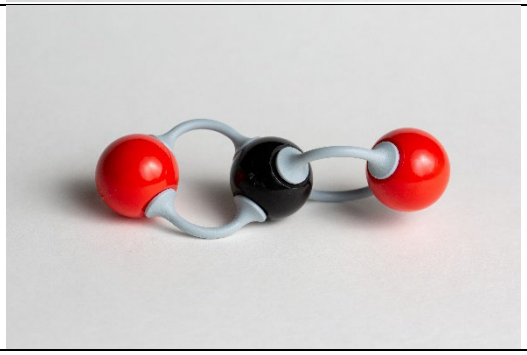
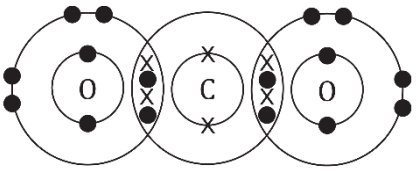
(c) Either of the following arrangements is acceptable:



(d) Each red ball should be made with two holes, because an oxygen atom can form two covalent bonds.

(e) In a three-dimensional molecule the hydrogen molecules are not arranged in a straight line because the bonds are in the same position as two of the bonds in methane. (The remaining pairs of electrons are in roughly the same position as the other two bonds in methane but this is beyond the scope of the question).

4. Learners should have made the model on the left and drawn the model on the right:

(a)		
(b)		
(c)		

5. (a) For every atom of silicon there are **two oxygen atoms.**
(b) seven
(c) one
(d) Silicon can form four covalent bonds with four oxygen atoms. Each oxygen atom can form two bonds. This means that each oxygen atom can bond with another silicon atom. This means that a giant covalent structure can be formed.