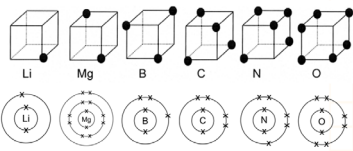
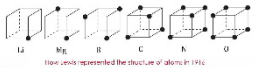


Bonding models

This resource is from the **Stretch and challenge** series. This series contains extension resources designed to fit into regular topics as either individual differentiation or whole class challenges.

Resource components

<p>Discussion activity</p> <ul style="list-style-type: none"> Compare the advantages and disadvantages of the cubic model with the circular dot and cross model.  <p>Li Mg B C N O</p> <ul style="list-style-type: none"> Why do you think Lewis abandoned cubes for representing atoms? <p>Activity 3</p>	<p>STUDENT SHEET Stretch and challenge 14–16 years</p> <p>Bonding models</p> <p>The periodic table's layout is incredibly useful, but the dot and cross model of bonding is not. As we saw earlier (Class 1), Lewis' model (1916–1918) was one of the first to represent the structure of atoms and molecules in a way that was both simple and powerful.</p> <p>Lewis' ideas developed over a long period of time, based on his observations of the periodicity of the elements and the way they combined to form molecules. He noticed that the elements could be grouped into columns, and that the elements in the same column had similar properties. This led him to develop his model of the atom, which was based on the idea of electron shells.</p> <p>He initially represented electron shells as cubes, but later changed to the circular dot and cross model.</p>  <p>Li Mg B C N O</p> <p>How Lewis represented the structure of atoms in 1916.</p> <p>He found several important things:</p> <ul style="list-style-type: none"> The elements in the same column had similar properties. A metal atom or non-metal atom can have more than one electron shell. The number of electrons in an atom is equal to the number of protons in the nucleus. The number of electrons in an atom is equal to the number of protons in the nucleus. The number of electrons in an atom is equal to the number of protons in the nucleus. <p>© 2023 Royal Society of Chemistry</p>
<p>Presentation: four learner activities including questions to help explore an alternative model, physical modelling activity, group discussion task and a research task.</p>	<p>Student worksheet: questions for Activity 1 can be printed as a student worksheet.</p>

Learning objectives

- 1 Model elements and compounds using an alternative representation of electron configuration.
- 2 Compare this alternative model with the dot and cross model of bonding.
- 3 Evaluate this alternative model for electron configuration and bonding.

Introduction

Many learners complain during their post-16 chemistry course that their teachers 'lied' to them in their pre-16 course. This is particularly true when revisiting atomic structure and bonding in post-16 courses. What learners do not appreciate (and perhaps we don't teach them) is the nature of scientific models and how they are used in science. The general principle is that we use the simplest model available that works for the situation under consideration. We refine or replace the model when it fails to explain or predict observed phenomena. A model should not be regarded as 'truth' but as a useful systematic way of explaining or predicting events.










Learners may be aware of an example of this in physics, that at low speeds Newtonian mechanics works fine but at speeds approaching the speed of light Einstein's special theory of relativity needs to be used.

Some learners will develop the skill of holding alternative models together in their minds and choosing which to use based on the particular question – e.g. alternative models of the bonding in benzene.

This activity gets learners to think of the model that they have been taught as a model rather than the 'truth'.

How to use this resource

Explain to learners that the aim of the activity is to learn about the nature of models rather than giving them a new model of bonding.

When to use?	 Introduce	 Develop	 Revise	 Assess
	Use after initial teaching or discussion of dot and cross diagrams and covalent and ionic bonding.			
Group size?	 Independent	 Small group	 Whole class	 Homework
	This could be used with a whole class or as a differentiated activity for part of a class. Learners work in small groups for the modelling and discussion activities.			
How long?			Whole lesson	
Materials?	Each group will need some modelling clay (preferably two colours) and several cocktail sticks.			



This symbol on the PowerPoint means those questions are best tackled as a discussion if a group of learners are doing this activity.

When learners have completed the questions in Activity 1 (either on the printed worksheet or via the questions on the presentation slides) give them the answers (either as a printout or use the presentation slides to discuss as a class). They can check their own work or conduct a peer review of the work of another learner or group.

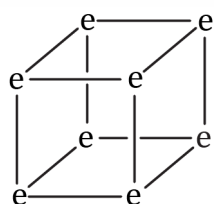
Answers

Worksheet (Activity 1)

1. Learners' answers may include:

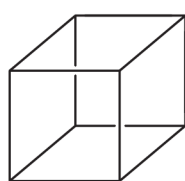
- Cubes have eight corners which fits nicely with the idea of having eight electrons in a shell.
- Cubes could stack easily together like crates in a warehouse.
- Perhaps Lewis was influenced by the visible shape of crystals and imagined the atoms as tiny versions of these.

2.

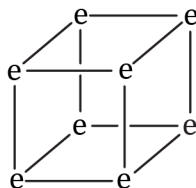


Ne

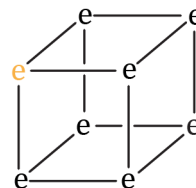
3.



or

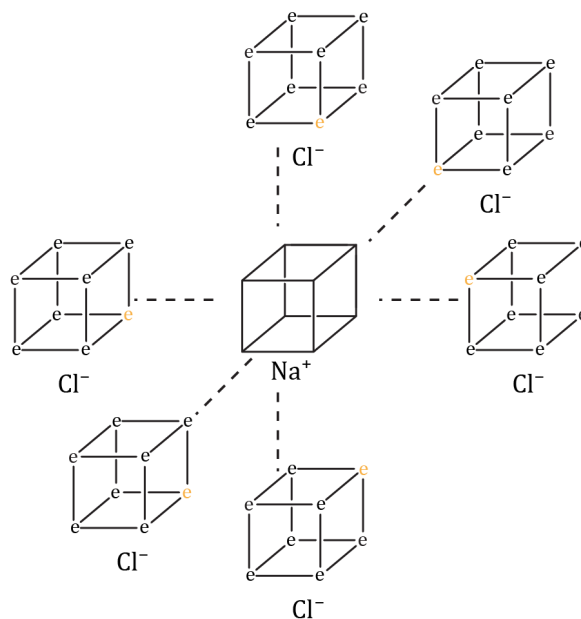


Na⁺

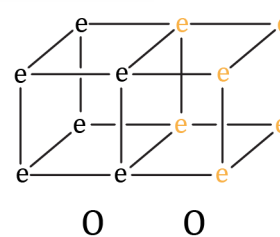
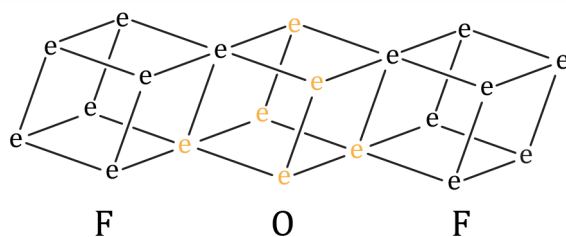


Cl⁻

4. Each cube has six faces so could have six oppositely charged ions all equidistant alongside each face.



5.



6. No, the most electrons that two atoms could share could be two each as the cubes touch faces.

Modelling activity (Activity 2)

Please see the presentation slides for photos of completed models: rsc.li/430a2bN

The preferred arrangement for CCl_4 is the one where the atoms are not all in the same plane as this allows the chlorine atoms more space. The CCl_4 molecule is really three dimensional, not flat. However, this is more tricky to build using modelling clay as the structure is not self-supporting.

Discussion activity (Activity 3)

Advantages of the Lewis cube model	Disadvantages of the Lewis cube model
<ul style="list-style-type: none"> Highlights that atoms and molecules are three dimensional, not two dimensional. Easy to show a double bond. Gives a rationale for eight electrons in the outer shell. 	<ul style="list-style-type: none"> Does not show that electrons go in pairs. Very hard to draw complex molecules. Cannot represent triple bonds. Cannot represent hydrogen and helium, which only have space for two electrons in their outer shell. Atoms lower down the periodic table can have more than eight electrons in their outer shell – so you need to abandon the cube for a polyhedron with more corners.

All of the disadvantages listed above would have contributed to Lewis abandoning the cube model but importantly:

- The cubes are too hard to draw in complex molecules.
- Atoms are certainly not cuboid in shape, but neither are they circular, or even truly spherical.