14–16 years

Structured talk: structure and bonding

ROYAL SOCIETY OF CHEMISTRY

Education
Inspiring your teaching and learning

Learning objectives

1. Apply descriptions of covalent, ionic and metallic bonding to justify the different physical properties of covalent, ionic and metallic structures.

2. Develop speaking and listening skills by using the structured talk foundations to help manage your group's discussion.

3. Build a shared understanding of the structure and bonding in the different forms of carbon, distinguishing between simple and giant structures from information about physical properties.

4. Evaluate how successful your group's word bridge is by comparing to the other examples.

Foundations

- **Knowledge:** aim for accuracy when you speak.
- **Reasoning:** when you say something, explain why you're saying it (in other words, justify what you are saying).
- **Community:** listen to others and show respect, even if you don't agree with them.

Speaking

- Take turns when speaking.
- Be prepared to change your mind.
- Clarify, summarise and build on each other's ideas and respect other people's.
- If you disagree, say so politely.
- Invite someone to contribute by asking a question.
- Come to a shared agreement.

Listening

Focus

- Give the speaker your full attention. Face them and give eye contact.
- Do not interrupt.

Accept

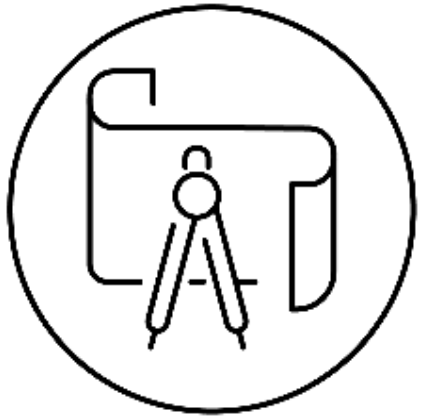
- Nod or smile to show that you understand.
- Listen with interest and respect even if you disagree.

Draw out

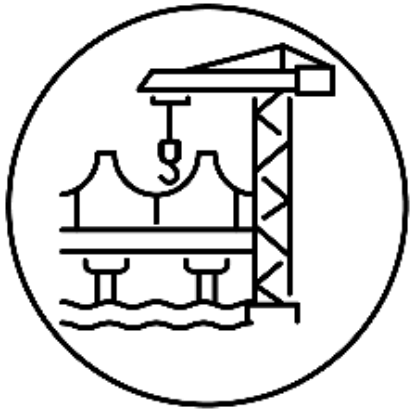
- In response, summarise and seek clarification rather than simply stating your answer or opinion.

Roles

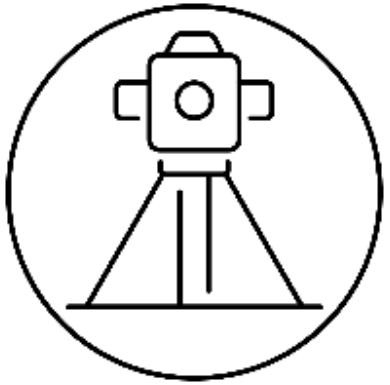
You will have either role A, B or C.



A is the architect.
They start.



B is the bridge builder.
They respond.



C is the civil engineer.
They summarise.

Building word bridges

Start with 30 seconds silent thinking time.

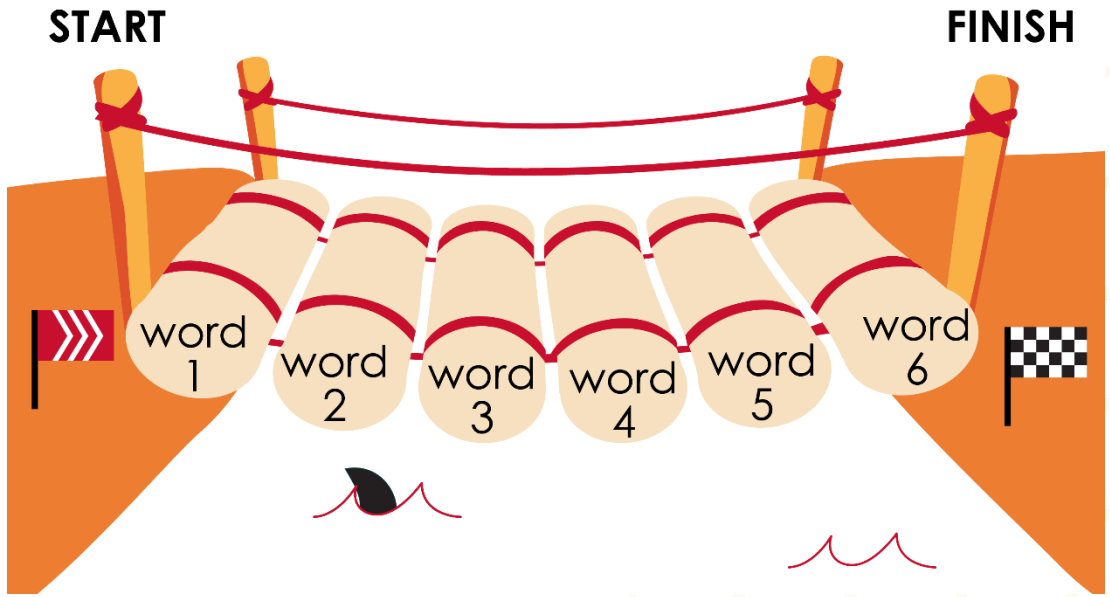
You have 2 minutes to build the best bridge you can.

A starts the discussion trying to correctly use as many words from the word bridge table as they can.

B responds, either reinforces (agrees with), or fixes (disagrees with) the bridge started by A.

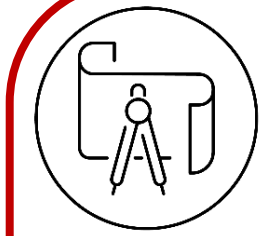
Lastly, **C summarises** the bridge constructed by A and B, seeks their agreement and feeds back to the class.

Build the bridge. Get from the start to the finish by linking all the given words.



Start	Fact		Finish
	Sodium chloride is an example of a giant ionic lattice.		
	Link these words		
	Words		
The formula NaCl represents	positive sodium ions	negative chloride ions	forming an open network called a lattice.
	electrostatic forces of attraction	electrostatic forces of repulsion	
	like charges	opposite charges	

Sentence starters



A is the architect. They start:

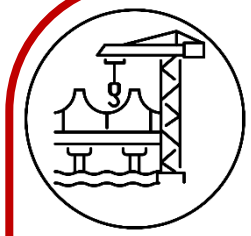
‘I know that … and it’s relevant to this discussion because … ’

‘I think that …’

‘I am not sure about … but I think … ’

‘Before I begin, remind me what … means?’

‘Can you please help me to start?’



B is the bridge builder. They respond:

‘Linking to that I would add … ’

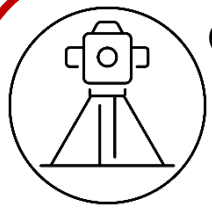
‘Considering what I already know about … I think that ... ’

‘I suggest that we change that because of … ’

‘Can you explain why you said that?’

‘Have you thought of?”

‘That’s brilliant because … ’



C is the civil engineer. They summarise:

‘I think you said … ’

‘Can you just explain … ?’

‘What was your reasoning when you said … ?’

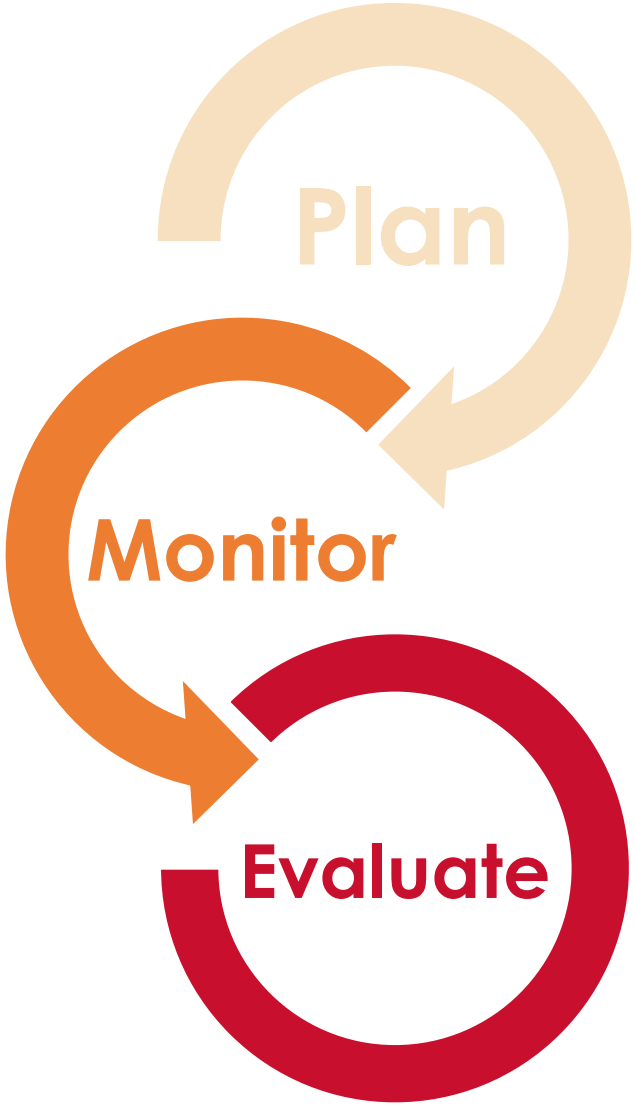
‘Have I got that right?’

‘I’m not sure about … ’

‘Do we all agree?’

‘Our final answer is … ’

Ask yourself these questions



Before doing the task:

What do I see or hear that helps me understand?

What are some steps I can take to figure this out?

During the task:

How can I tell if I'm doing a good job?

After doing the task:

How do I feel about this task? Why?

Worked example

Start	Fact		Finish
	Sodium chloride is an example of a giant ionic lattice.		
	Link these words		
	Words		
The formula NaCl represents	positive sodium ions	negative chloride ions	forming an open network called a lattice.
	electrostatic forces of attraction	electrostatic forces of repulsion	
	like charges	opposite charges	

The formula NaCl represents positive sodium ions and negative chloride ions held in place by the electrostatic forces of attraction between opposite charges and electrostatic forces of repulsion between like charges, forming an open network called a lattice.

Word bridge 1

Talk in your three to build the word bridge, from the start to the finish. Link the words and use the fact to help you. Keep to your speaking role – either A, B or C.

Start

Metallic bonding involves a giant

Fact

Metals are good conductors of electricity and heat because the delocalised electrons can move throughout the structure.

Link these words

Words

lattice	delocalised
sea	ions
surrounded	electrons

Finish

allowing metals to conduct electricity and be malleable.

Word bridge 1 – sample answer

Metallic bonding involves a giant lattice of positive metal ions surrounded by a sea of delocalised electrons, allowing metals to conduct electricity and be malleable.

Fix the bridge

Start with 30 seconds silent thinking time.

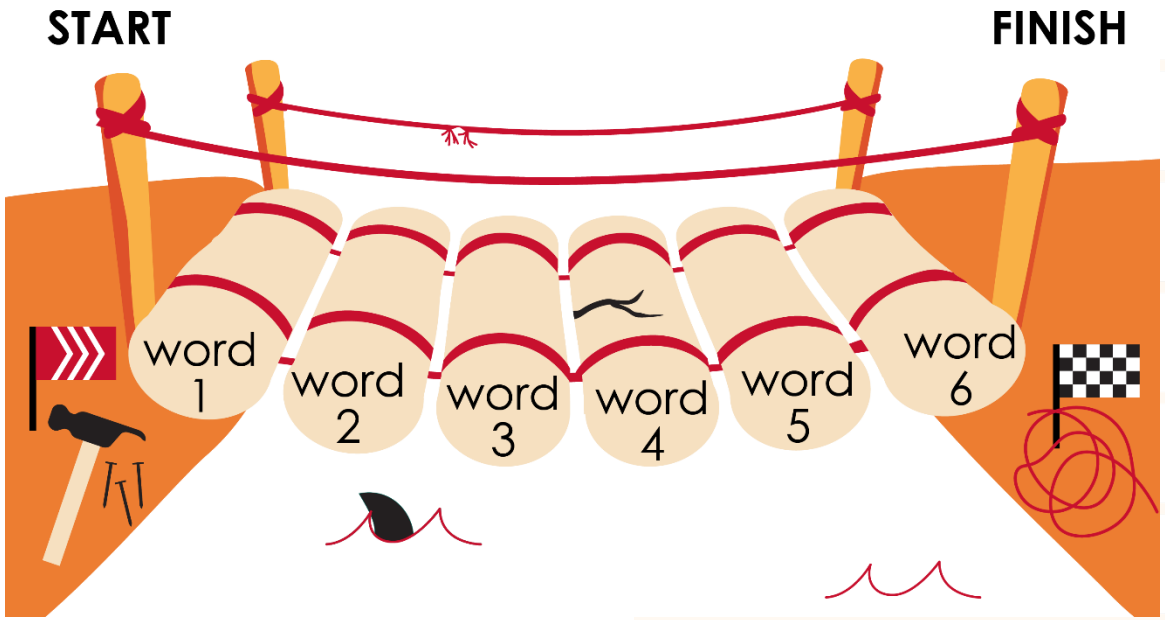
You have 2 minutes to fix a wrong statement, or to unpick and clarify a challenging statement.

A starts the discussion by making a suggestion.

B responds to the comment and if they disagree, they explain why.

A responds to B by clarifying their point before adding to it.

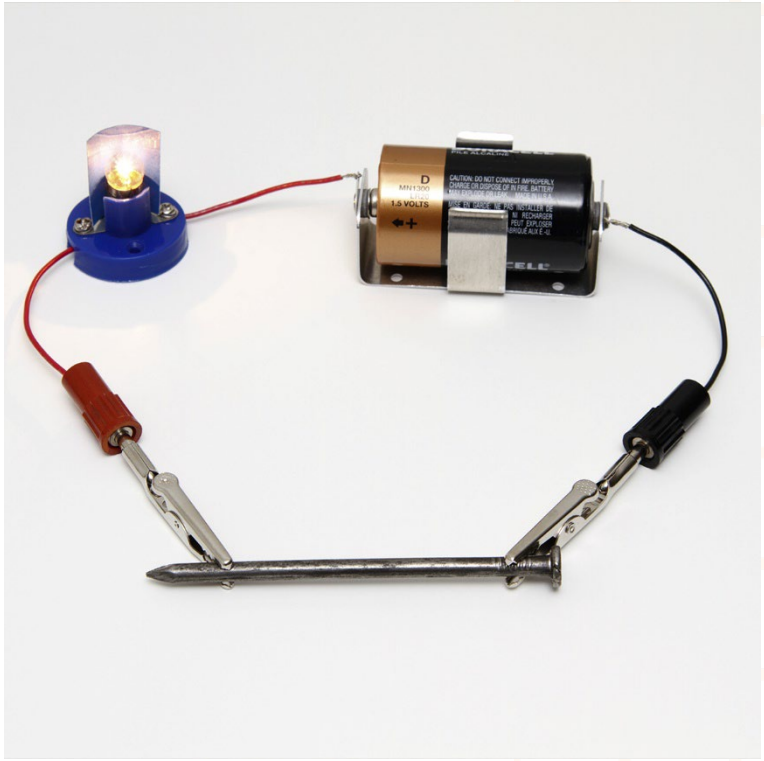
Lastly, **C summarises** the ideas of A and B, seeks their agreement and feeds back to the class.



Fix the bridge 1

There is something wrong with the statement below, can you fix it?

Metals conduct electricity better in their solid state than ionic compounds, even though both involve charged particles.



Fix the bridge 1 – sample answer

Electric current is the flow of charged particles. In metals, the positive ions are fixed in place and the delocalised electrons can flow through the structure. In an ionic solid, the ions are fixed in place with ionic bonds and the electrons are not delocalised, so no charged particles can flow.

Word bridge 2

Talk in your three to build the word bridge, from the start to the finish. Link the words and use the fact to help you. Keep to your speaking role – either A, B or C.

Start

The balance between

Fact

Ionic bonding occurs through the transfer of electrons from a metal atom to a non-metal atom, resulting in oppositely charged ions.

Link these words

Words

like charges	opposite charges
repulsion	forces
attraction	electrostatic

Finish

holds ions in a strong electrostatic lattice.

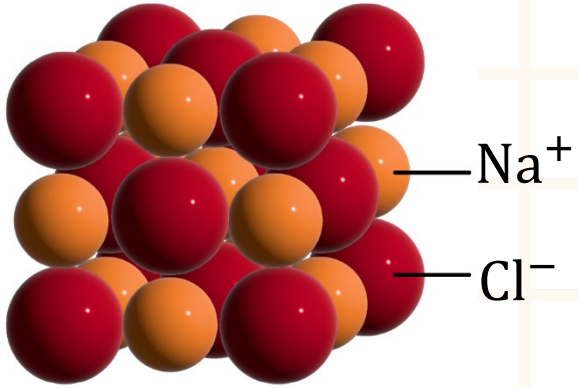
Word bridge – 2 sample answer

The balance between the electrostatic forces of attraction between opposite charges and repulsion between like charges holds ions in a strong electrostatic lattice.

Fix the bridge 2

There is something wrong with the statement below, can you fix it?

The number of ionic bonds an ion can form is determined by the electronic configuration.



Fix the bridge 2 – sample answer

The number of electrons that an atom can readily gain or lose can be determined using the electronic configuration.

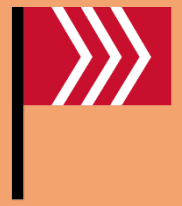
The ionic bond results from the electrostatic force of attraction between oppositely charged ions.

The ratio of the ions in the ionic compound is determined by the size of the charges on the ions.

Word bridge 3

Talk in your three to build the word bridge, from the start to the finish. Link the words and use the fact to help you. Keep to your speaking role – either A, B or C.

Start



Water is a

Fact

Water is a molecule formed from one oxygen atom covalently bonded to two hydrogen atoms.

Link these words

Words

strong	attraction
forces	molecules
liquid	close

Finish

at room temperature.

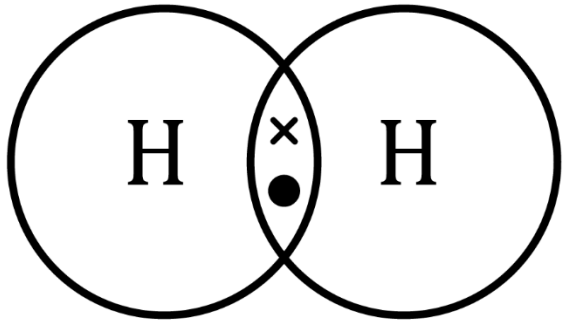
Word bridge 3 – sample answer

Water is a liquid because there are forces of attraction between the molecules strong enough to keep the molecules close together at room temperature.

Fix the bridge 3

Can you unpick and clarify this challenging statement?

Atoms are held together because they share electrons, so sharing electrons is like a force.



Fix the bridge 3 – sample answer

Covalent bonds occur because of the forces that result from the sharing of electrons. The shared electron pair is attracted to the nucleus of both atoms.

Word bridge 4

Talk in your three to build the word bridge, from the start to the finish. Link the words and use the fact to help you. Keep to your speaking role – either A, B or C.

Start

Allotropes of carbon are

Fact

Graphite can conduct electricity, but diamond cannot, even though both are made of carbon atoms.

Link these words

Words

3 covalent bonds	molecules
3 covalent bonds	diamond
4 covalent bonds	graphite

Finish

called fullerenes (molecular cages).

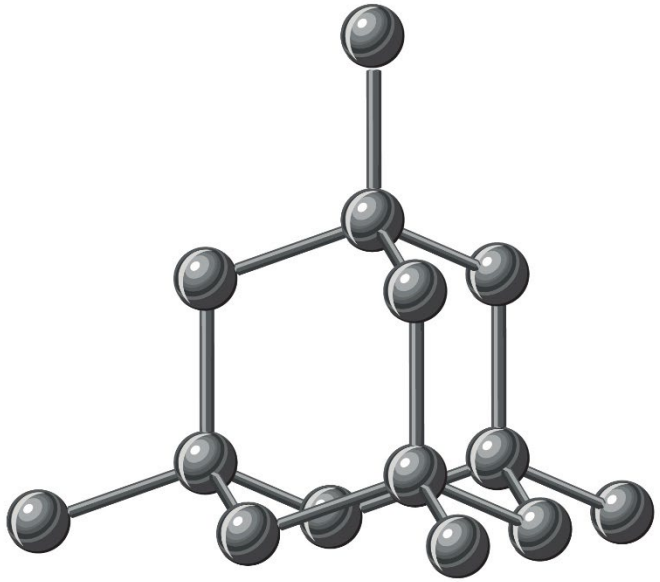
Word bridge 4 – sample answer

Allotropes of carbon are diamond with 4 covalent bonds between carbon atoms, graphite with 3 covalent bonds between carbon atoms and molecules with 3 covalent bonds between carbon atoms called fullerenes (molecular cages).

Fix the bridge 4

There is something wrong with the statement below, can you fix it?

Strong intermolecular forces exist in a continuous covalent network.



Fix the bridge 4 – sample answer

Diamond forms a continuous covalent network because each carbon atom is covalently bonded to four other carbon atoms.

In contrast, graphite does not form a continuous covalent network, as each carbon atom is bonded to only three others.

In graphite, atoms within each layer are held together by covalent bonds, while unbonded electrons exist between the layers. These layers are held together by intermolecular forces.

Word bridge 5

Talk in your three to build the word bridge, from the start to the finish. Link the words and use the fact to help you. Keep to your speaking role – either A, B or C.

Start

Two iodine atoms

Fact

Covalent bonding involves the sharing of electron pairs between non-metal atoms to achieve a full outer shell.

Link these words

Words

molecule	electrons
covalent	pair
strong	share

Finish

and has a simple structure.

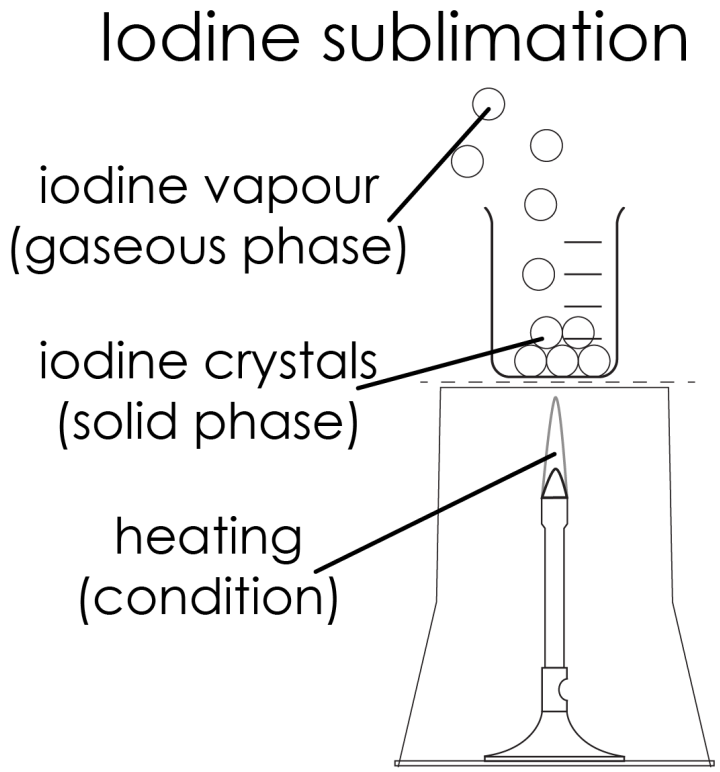
Word bridge 5 – sample answer

Two iodine atoms share a pair of electrons forming a strong covalent bond. Iodine is a molecule and has a simple structure.

Fix the bridge 5

Can you unpick and clarify this challenging statement?

Covalent bonds are weaker than ionic bonds and break first on heating.



Fix the bridge 5 – sample answer

Giant covalent and giant ionic structures have very high melting points because they are held together by strong bonds throughout their structures.

Simple covalent substances like iodine have strong covalent bonds between the atoms in the molecule but weak forces of attraction between molecules. It is these weak forces that break easily when heated.

Reflection

- How do you feel about this task? Why?
- Did everyone keep to the speaking and listening rules?
- How did you find roles A, B and/or C?
- What went well and what was difficult?
- What have you learnt doing this structured talk, that you can use next time you talk about chemistry?

Acknowledgements

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