

## Iron – a metal: true or false?










This resource is from **Chemical misconceptions – prevention, diagnosis and cure**, which can be viewed at: [rsc.li/456d4fE](https://rsc.li/456d4fE). This series of resources includes classroom activities you can use to identify learner misconceptions; to challenge some of these alternative ideas; and to help learners construct the chemical concepts required by the curriculum.

### How to use this resource

Learners can struggle with using atomic/molecular-level models of matter to explain the properties of substances (read more about learners' beliefs in alternative ideas at: [rsc.li/44mXmJf](https://rsc.li/44mXmJf)). It is also common for learners to begin their post-16 studies believing that all materials have either covalent or ionic bonding and that ionic and metallic materials are molecular (read more about learners' misconceptions related to chemical bonding at: [rsc.li/3pgyO61](https://rsc.li/3pgyO61)).

Ask learners to decide whether the statements about iron (a familiar example of a metal) on the student sheet are true or false. By reviewing their answers, you can identify and address any misconceptions learners hold about the properties of particles vs the bulk properties of substances.

Emphasise to learners that the diagram shows just a small part of a slice through the lattice structure and that the real structure is three-dimensional. Check that learners understand that the shading in the diagram represents delocalised electrons.

<b>When to use?</b>	 Introduce	 Develop	 Revise	 Assess
	Use with learners in the 14–16 age range who have been introduced to the properties of metals and to the basic notion of metallic bonding.			
<b>Group size?</b>	 Independent	 Small group	 Whole class	 Homework
	Instruct learners to do the task independently in class so you can identify misconceptions.			
<b>Topics assessed?</b>	Metallic structure and bonding; explaining properties using the particle model.			
<b>How long?</b>			10–15 minutes	

## Lesson plan available

Build a lesson around a shorter version of this activity with our **Metallic bonding and the structure of iron** lesson plan. Learners work in groups to challenge misconceptions using ten true or false questions based on the questions in this diagnostic probe. Available to download as part of a complete lesson with presentation slides at: [rsc.li/3botPEO](https://rsc.li/3botPEO)



## Answers

1. Iron has a type of bonding called metallic bonding.

**True:** Iron is a metal and all metals exhibit metallic bonding. In metallic bonding, the outer shells of adjacent atoms overlap and the outer shell electrons are free to move about through the lattice. The metal consists of positive metal ions and a balancing number of these 'free' electrons.

2. Iron atoms do not have a full outer shell of electrons and this makes iron very reactive.

**False:** Although an isolated iron atom does not have a full outer shell, the outer electrons are involved in the bonding in a metal. Iron is not very reactive, although it will slowly rust.

3. Iron is a silvery-grey metal because iron atoms are silvery-grey.

**False:** The colour of iron is a property of the arrangement of positive ions and electrons. A single atom of iron would not have a colour.

4. Iron can conduct electricity because iron atoms can slip over their neighbours and move through the solid.

**False:** The positive iron ions are normally fixed in their lattice positions. It is the electrons from the outer shells that are able to move about, allowing electrical current to flow through the metal.

5. Iron can be re-shaped, without changing the shape of iron atoms.

**True:** Metals can be worked into different shapes by hammering to force the positive ions to slip over each other. The ions change position but not shape.

6. Iron rusts because iron atoms will rust if exposed to damp air.

**False:** Rusting is due to a chemical reaction between iron, oxygen and water vapour in the air. During the reaction some of the iron becomes part of a red chemical compound (the rust), but the atoms themselves do not corrode.

7. In iron metal, each atom is bonded to each of the other iron atoms surrounding it.

**True:** The iron atoms are packed together so that each positive iron ion is surrounded by eight others, as if it is in the centre of a cube. The structure is held together by metallic bonding.

8. Iron conducts electricity because iron atoms are electrical conductors.

**False:** Iron conducts electricity because the outer shell electrons are able to move through the metallic lattice structure. The individual atoms do not conduct.

9. Iron is a solid because that is the natural state for metals.

**False:** The state of a metal depends on the temperature. Deep in the earth – where it is very hot – iron is a liquid. Mercury is a metal that is liquid at room temperature.

10. A metal consists of positive metal ions and negative electrons which move around the solid between the ions.

**True:** The structure of iron consists of positive iron ions surrounded by fast-moving delocalised electrons. Sometimes this is called a 'sea' of electrons.

11. An iron atom will reflect light and so freshly polished iron shines.

**False:** Polished metal will form a mirror because of the regular lattice of positive metal ions and the 'sea' of electrons. Individual iron atoms would not reflect light.

12. Iron becomes a liquid when heated because the bonds melt.

**False:** The metal melts when enough energy is provided to allow the positive ions to slip over each other. The bonds in the liquid metal are weaker than in a solid metal. If the liquid was heated until it boiled the bonds would break (but not 'melt').

13. Iron conducts electricity because it contains a 'sea' of electrons.

**True:** The electrons are able to move about and will pass along the metal when it is connected to a battery.

14. The atoms in iron are held together by ionic bonds.

**False:** The bonding in a metal is metallic bonding. This is different from ionic bonding as there are no anions (negative ions) present.

15. Iron conducts heat because there is room between the atoms for hot air to move through the metal.

**False:** The positive iron ions are held close together by the metallic bonding and there is no room for other atoms and molecules to get between them. Heat passes along the metal due to lattice vibrations and the movement of electrons.

**16. Iron is hard because iron atoms are hard.**

**False:** Hardness is a property of the metal due to the strong bonding holding the structure together. It is the arrangement of positive ions and free electrons which makes the metal hard.

**17. Iron contains molecules held together by magnetism.**

**False:** There are no molecules in a metal – each positive metal ion is bonded to all those around it by the ‘sea’ of electrons, and those ions are bonded to others, and so on. Each ion in a metallic crystal is bonded (indirectly) to all the others.

**18. If iron is heated to a very high temperature, it will become a gas.**

**True:** If a solid is heated it will melt and if heating is continued to a high enough temperature the liquid metal will boil. The melting point of iron is 2861°C.

**19. Iron expands when it is heated because iron atoms get bigger.**

**False:** When the metal is heated, the positive ions vibrate more and move a little further apart.

**20. Chemical bonds are needed to hold the atoms together in iron, even though all of the atoms are of the same type.**

**True:** The atoms would not remain joined together if there was no bonding between them. This is true for all solids whether the atoms are of one type (in an element) or different types (in a compound).