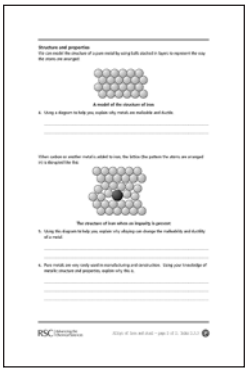
Alloys of iron – steels

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Answers

1. The properties listed could include any of the following:

- Conduct electricity
- Conduct heat
- Ductile
- Malleable
- Shiny
- Sonorous
- Strong
- Hard
- Dense

2. Mild steels might be expected to be more ductile (and malleable) than high carbon steels. (Properties like conduction and density would probably be a little different.)

3.

a. Scalpel and other surgical instruments – high carbon steel as it is less malleable and stronger than mild steel.
b. Paper clip – mild steel as it is easy to bend.
c. Hammer – high carbon steel, otherwise it might change shape when used to hit something.

4. The layers of the metal can slide over each other, allowing it to change shape easily:

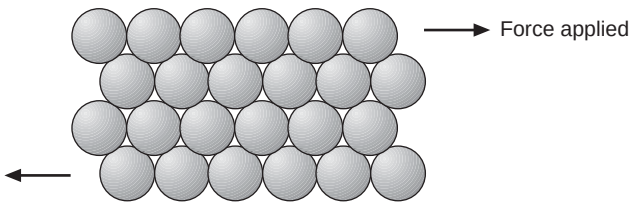

Figure 1 The arrangement of atoms in a metal

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The layers can slip over each other to form the pattern shown below:

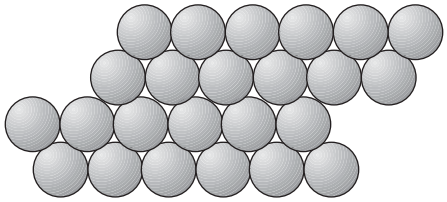

Figure 2 Atoms in a metal can slide over one another

5. Alloying can change the malleability and ductility of a metal by preventing the layers from sliding over each other. (This is called 'pinning' the position of the atoms.)

6. Pure metals are not often used in manufacturing and construction as they are soft and readily deformed because the layers of metal atoms can easily slide over each other. In contrast, alloys are harder and more difficult to deform because other atoms are present in the structure and these prevent the movement of the layers.

Acknowledgements and references

The practical work in this resource is based on an idea of Dr Martin Carr from the Department of Materials at Oxford University.

The following websites contain further information on iron, steel and alloying and should be easily understood by most students:

http://www.schoolscience.co.uk/content/4/chemistry/steel/index.html (accessed November 2005)

http://learningzone.coruseducation.com/schoolscience/KS5specialiststeels/index.html (accessed November 2005).

Alloys of iron – steels

Steels are a large family of metals. All of them are made of iron mixed in various proportions with other metals and carbon. The amount of carbon varies but is rarely more than about 1.5%.

1. List eight properties of metals.

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Steels can be made to have almost any combination of these properties, depending on their composition. They are divided into mild, medium and high carbon steels according to how much carbon they contain.

Type of steel	% of carbon
Mild	Up to 0.25%
Medium carbon	0.25–0.45%
High carbon	0.45–1.5%

2. Using your experiment with plasticine and sand as a guide, describe how you would expect the properties of mild steels to be different from those of high carbon steels.

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Different types of steel are suited to different purposes. Drinks cans are made from mild steel but scissors from high carbon steel.

3. Would you expect the following items to be made from mild or high carbon steel? Explain your answers.

a. Scalpel and other surgical instruments

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b. Paper clip

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c. Hammer.

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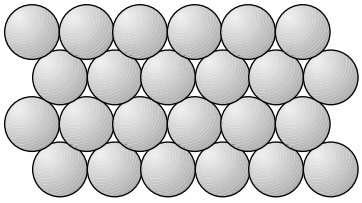
Structure and properties

We can model the structure of a pure metal by using balls stacked in layers to represent the way the atoms are arranged:



A model of the structure of iron

4. Using a diagram to help you, explain why metals are malleable and ductile.

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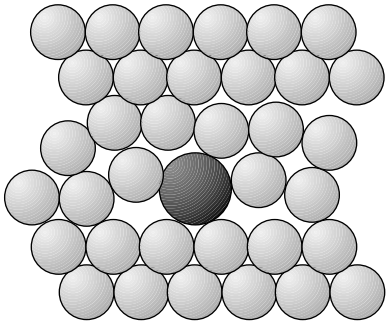
When carbon or another metal is added to iron, the lattice (the pattern the atoms are arranged in) is disrupted like this:



The structure of iron when an impurity is present

5. Using this diagram to help you, explain why alloying can change the malleability and ductility of a metal.

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6. Pure metals are very rarely used in manufacturing and construction. Using your knowledge of metallic structure and properties, explain why this is.

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