

Properties and uses of metals

1. This question is about the properties of transition metals.

Match properties, A, B, C and D, with the numbers 1–4 in the table.

- A good conductors
- B high melting points
- C made into alloys
- D tough

What this tells you about transition metals	
1	They are mixed with similar metals to make them harder for everyday use.
2	They are liquids only if they are very hot.
3	They allow an electric current to pass through them easily.
4	They do not crack or crumble if you hit them with a hammer.

2. Metals are used for different purposes depending on their properties.

Match properties, A, B, C and D, with the numbers 1–4 in the sentences.

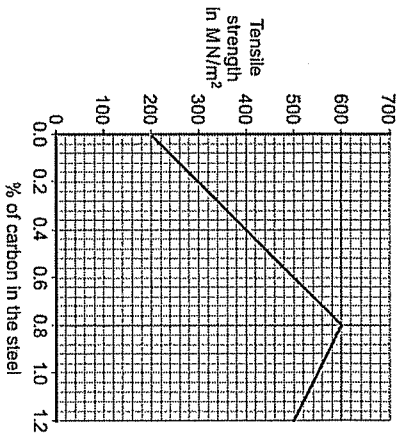
- A a good conductor of electricity
- B easy to bend when hot
- C resistant to corrosion
- D very easily worn away

Iron is used for making garden gates because it is ... 1 ...
 Aluminium is used for window frames because it is ... 2 ...
 Copper wire is used in electrical circuits because it is ... 3 ...
 Pure gold is not normally used for jewellery because it is ... 4 ...

3. Materials with a high tensile strength do not break easily when pulled.

To measure the tensile strength of steel, a sample is pulled with a larger and larger force until it breaks.

The graph shows how the tensile strength of different steels depends on the percentage (%) of carbon the steels contain.



(a) One type of steel has a tensile strength of 400 MN/m².

How much carbon does it contain?

- 1 0.3%
- 2 0.4%
- 3 0.5%
- 4 4.0%

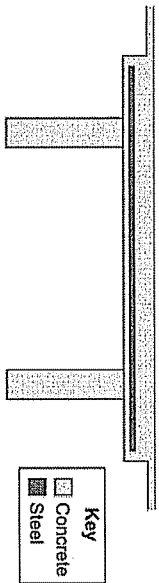
(b) The steel with the highest tensile strength is one with ...

- 1 0.6% carbon.
- 2 0.8% carbon.
- 3 1.2% carbon.
- 4 8.0% carbon.

(c) From the evidence on the graph, what is the best way to describe how carbon affects the tensile strength of steel?

- 1 As the carbon content decreases, the tensile strength increases.
- 2 As the carbon content increases, the tensile strength decreases.
- 3 As the carbon content increases, the tensile strength increases then decreases.
- 4 The tensile strength increases when the carbon content is greater than 0.8%.

(d) The diagram shows one type of bridge design.



The tensile strength of concrete is very low compared with the tensile strength of steel. Some other comparisons of concrete and steel are shown below.

	Compressive strength (MN/m ²)	Density (kg/m ³)	Cost
Concrete	30	2300	Low
Steel	250	7700	Medium

Two reasons why the bridge is not made only of steel are that . . .

- 1 steel has a high density and is expensive.
- 2 steel has a high compressive strength and a high density.
- 3 steel has a high tensile strength and a high compressive strength.
- 4 steel has a high tensile strength and a high density.

4. In each part choose only one answer.
Iron is about twice as strong as aluminium.
Some other properties of aluminium and iron are shown in the table.

	Electrical conductivity	Density in grams per cm ³	Resistance to corrosion
Aluminium	very good	2.7	good
Iron	good	7.8	poor

- A Iron is better than aluminium for making bridges.
This is because iron . . .
- 1 is a better insulator.
 - 2 is more easily painted.
 - 3 is stronger.
 - 4 has a higher density.
- B Aluminium is better than iron for making cans for fizzy drinks.
The main reason is that . . .
- 1 aluminium conducts electricity better.
 - 2 aluminium is harder.
 - 3 iron cannot be recycled.
 - 4 aluminium is more resistant to corrosion.

C Aluminium has a low density and good electrical conductivity.
Which use for aluminium depends on both of these properties?

- 1 for cooking pans
- 2 for aeroplanes
- 3 for overhead power cables
- 4 for racing cars

D Most of the iron that is made is converted into steel.
Compared with low carbon steel, high carbon steel . . .

- 1 corrodes more quickly.
- 2 is a better electrical conductor.
- 3 is harder.
- 4 is more easily shaped.

Extracting metals

1. Impure iron is produced in a blast furnace by reducing the iron compound found in one of its ores. Match substances, A, B, C and D, with the numbers 1-4 in the sentences.

- A carbon
- B cast iron
- C iron
- D iron oxide

The main ore from which iron is extracted contains the compound ... 1 ...

This is reduced in the blast furnace by reacting it with ... 2 ...

The metal produced from the blast furnace contains about 96 % ... 3 ...

The product is brittle and is known as ... 4 ...

2. In each part choose only one answer.

Jobs for bacteria – metal miners

Copper is found in the Earth's crust as the ore copper sulfide.

Traditionally, copper-rich ores are roasted and smelted to extract the metal.

Copper compounds can now be extracted from low-grade ores by bioleaching. In one type of bioleaching, the copper compounds are extracted from heaps of the crushed ore using bacteria.

- The bacteria live in the ore and gain their energy by slowly breaking down the copper compounds.
- The bacteria produce acidic solutions in which the copper compounds dissolve from the rocks and can be collected.
- The bacteria usually live at 35 °C to 40 °C. This means that breakdown of the compounds takes place only very slowly in the heaps of crushed ore.
- If these bacteria could work at a temperature 10 °C higher, then it is estimated that the rate of breakdown of the compounds would be twice as fast.

- A Which of the following is a disadvantage of extracting copper by bioleaching rather than by the traditional method?

- 1 Bioleaching allows us to use low-grade ores.
- 2 Bioleaching is more economical.
- 3 Bioleaching is slower.
- 4 Bioleaching uses less energy.

- B Copper compounds can be extracted more quickly from the ore in tanks at a temperature of 75 °C.

Where might bacteria able to work at this temperature be found?

- 1 in rivers running through rainforests
- 2 in polluted rivers
- 3 in streams on the sides of active volcanoes
- 4 in tropical seas

- C About 20% of the world's copper is now extracted from low-grade ores by bioleaching.

Some scientists think that this figure will steadily increase in the next few years.

An increase in the use of bioleaching may not happen if ...

- 1 the price of copper increases dramatically.
- 2 large new deposits of high-grade ore are discovered.
- 3 the cost of energy rises quickly.
- 4 sulfur dioxide levels in the atmosphere reach dangerous levels.

- D Copper can be obtained from solutions containing copper compounds by ...

- 1 electrolysis.
- 2 oxidation.
- 3 fractionation.
- 4 combustion.

3. In each part choose only one answer.

Aluminium can be obtained by extracting it from aluminium ore, and by recycling used objects made from aluminium.

- A One disadvantage of extracting aluminium from aluminium ore is that ...

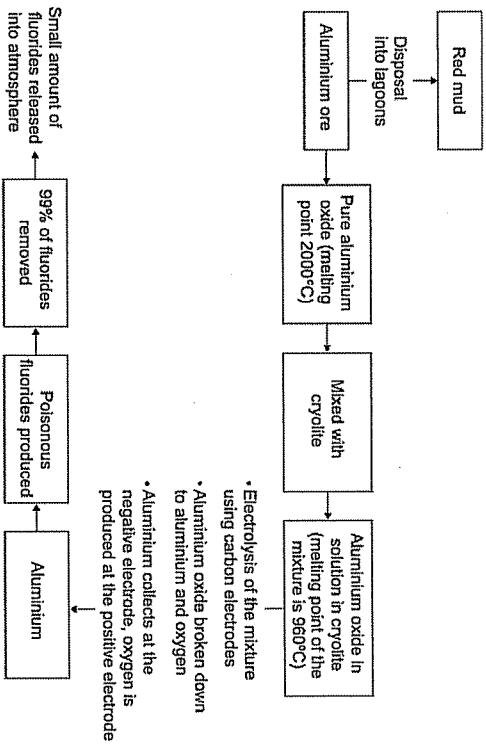
- 1 aluminium ore contains very small amounts of aluminium.
- 2 aluminium ore is a limited resource.
- 3 the aluminium obtained corrodes easily.
- 4 the aluminium obtained has a high density.

- B It is better to recycle aluminium than to extract it from aluminium ore because ...

- 1 aluminium ore contains few impurities.
- 2 aluminium ore produces low grade aluminium.
- 3 digging up aluminium ore destroys the local environment.
- 4 recycling produces 'smart' aluminium alloys.

- C It makes economic sense to recycle aluminium because extracting it from its ...
- 1 is a cheap process.
 - 2 takes too long.
 - 3 employs more people.
 - 4 uses large amounts of energy.
- D If aluminium cans are not recycled, they can affect the environment by ...
- 1 causing acid rain.
 - 2 filling up landfill rubbish tips.
 - 3 producing poisonous gases.
 - 4 rapidly corroding in lakes and rivers.

4. The flow chart shows the stages in the extraction of aluminium.



(a) The red mud from the aluminium ore is disposed of by dumping in lagoons. The red mud contains iron oxide.

- The most likely reason why iron is not extracted from the red mud is that ...
- 1 the iron oxide evaporates too quickly.
 - 2 there is no transportation system nearby.
 - 3 it is not economic compared to other sources of iron.
 - 4 iron oxide from the lagoons cannot be reduced by carbon.

- (b) Why is pure aluminium oxide mixed with cryolite before electrolysis?
- 1 to produce an aluminium alloy
 - 2 to reduce the breakdown of aluminium oxide
 - 3 to lower the melting point so less energy is used during electrolysis
 - 4 to react with impurities in the aluminium oxide
- (c) During electrolysis, the positive carbon electrode is rapidly used up causing emissions. The main component of these emissions contributes to ...
- 1 global dimming.
 - 2 global warming.
 - 3 acid rain.
 - 4 red mud lagoons.
- (d) It is important to monitor the amount of poisonous fluorides released into the atmosphere. Plants absorb these fluorides. The amounts of fluorides in plants can be found by chemical analysis. The best information would be found by chemical analysis of plants that are growing ...
- 1 in all the workers' homes.
 - 2 at exactly one kilometre in all directions from the factory.
 - 3 at various distances in all directions from the factory.
 - 4 at various distances in an easterly direction from the factory.