

# Chem!stry

Name: ..... ( )

Class: .....

Date: ..... / ..... / .....

## Metals – Macroconcepts: Systems and Change

Metals are an important part of modern-day living, conducting electricity through the integrated circuit boards in computers and mobile phones and giving strength to skyscrapers, aircraft fuselages and the chassis of motorcars. Some metals are better than others for certain applications, based upon their properties, availability and cost. It is also possible to modify the properties of a metal by combining it with small quantities of other elements to form *alloys*.

Most metals do not occur in nature as the pure element, but exist chemically combined with oxygen in the Earth's crust. To be of any use, the metal must first be extracted from its ore. The recycling of metals is also becoming increasingly important in order to safeguard the Earth's limited natural resources.

Many metals corrode (oxidise) upon exposure to air and water, and this is especially evident with the rusting of iron. Precautions can be taken in order to reduce the corrosion of iron and therefore extend the useful working life of cars, bridges and household tools.

### Question 1.

List the typical physical and chemical properties of metals. For each property, state an application that makes use of this property.

Property	Application

**Question 2.**

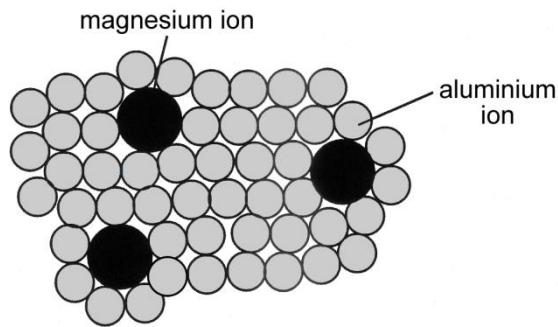
a) What is an *alloy*?

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b) Give some examples of alloys.

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c) Study the structure of the alloy shown below:



i) In what ways are the properties of the alloy *similar* to those of the metals that it is made from?

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ii) In what ways are the properties of the alloy *different* to those of the metals that it is made from?

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**Question 3.**

a) Why is it important to recycle metals?

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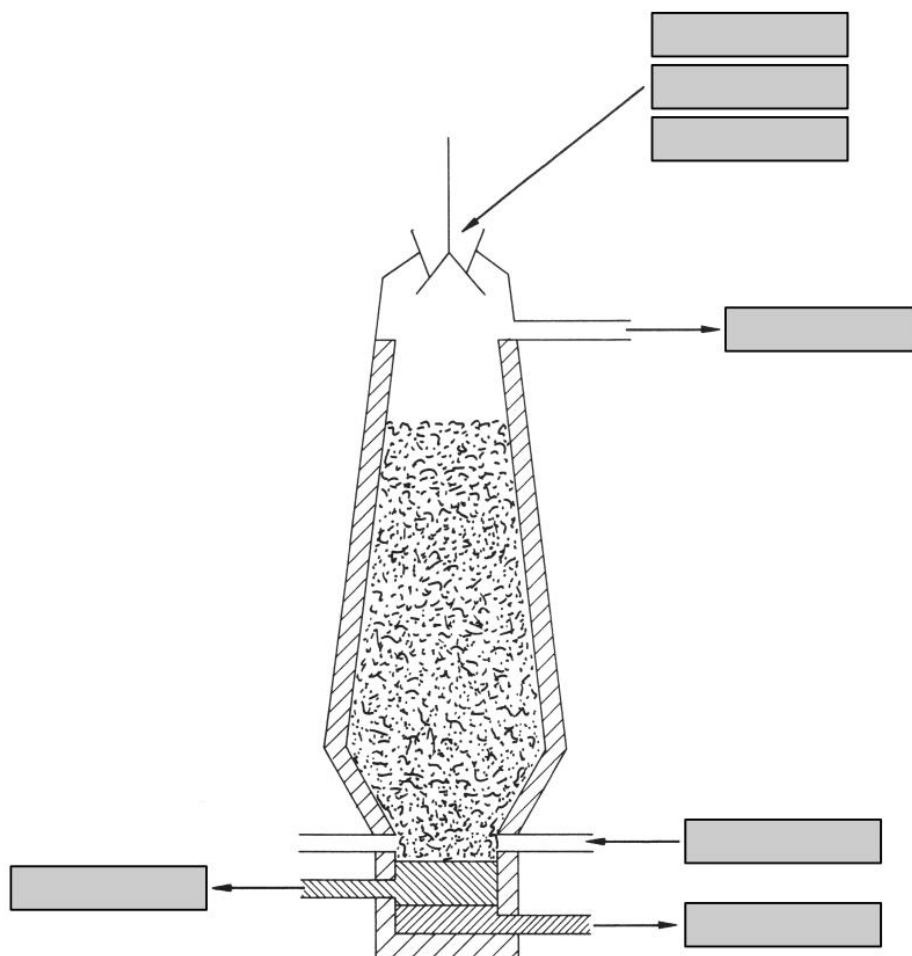
b) What are the advantages and disadvantages / problems of recycling metals?

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**Question 4.**

Iron is extracted from the ore, haematite, by heating it with coke and limestone in a blast furnace.

- a) Label the diagram of the blast furnace to clearly indicate where the various chemicals enter and leave the system.



- b) Use a cross (×) to identify the hottest part of the blast furnace.
- c) Haematite is iron(III) oxide. Explain why iron can be extracted from haematite by heating it with coke (carbon).

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- d) i) Write a balanced chemical equation for the reaction between coke (carbon) and oxygen to form carbon dioxide. What effect does this reaction have on the temperature inside the blast furnace?

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- ii) Write a balanced chemical equation for the thermal decomposition of limestone (calcium carbonate) into calcium oxide and carbon dioxide.

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iii) Write a balanced chemical equation for the reaction between carbon dioxide and coke (carbon) to form carbon monoxide. Why is it hazardous to form carbon monoxide on an industrial scale?

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iv) Write a balanced chemical equation for the reaction between haematite (iron(III) oxide) and carbon monoxide to form iron and carbon dioxide.

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v) Sand is an impurity present in the haematite. Write a balanced chemical equation for the reaction between calcium oxide and sand (silicon dioxide) to form slag (calcium silicate).

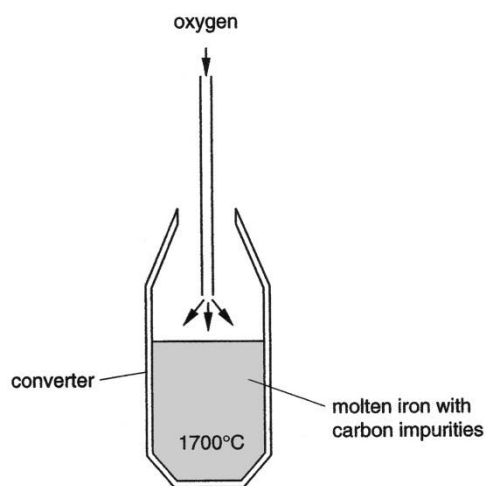
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**Question 5.**

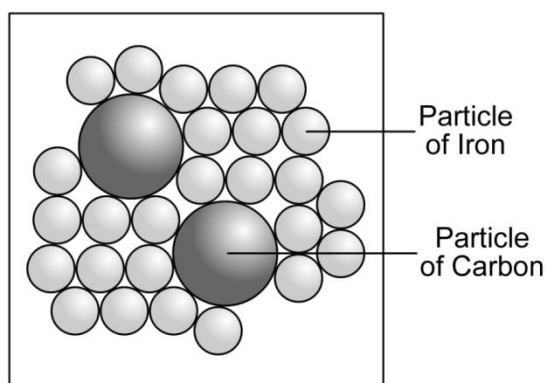
The carbon content of iron produced in a blast furnace can be adjusted in a *converter*. When oxygen is blown onto the surface of the iron / carbon mixture, the carbon is oxidised to carbon dioxide which is removed as a gas. Consequently, the carbon content of the iron is reduced.

a) What is the origin of the carbon that is mixed with the iron?

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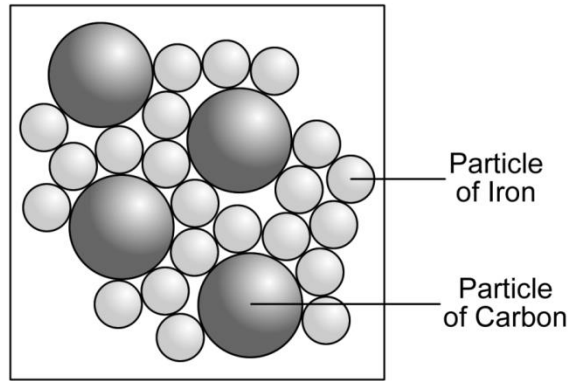
b) The diagram below represents the structure of *low carbon steel* or *mild steel*.



Explain how the properties of low carbon steel are different from the properties of pure iron.  
 What are some uses of low carbon steel?

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c) The diagram below represents the structure of *high carbon steel*.



Explain how the properties of high carbon steel are different from the properties of pure iron.  
 What are some uses of high carbon steel?

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d) What is added to iron ion order to produce *stainless steel*? State some uses of stainless steel.

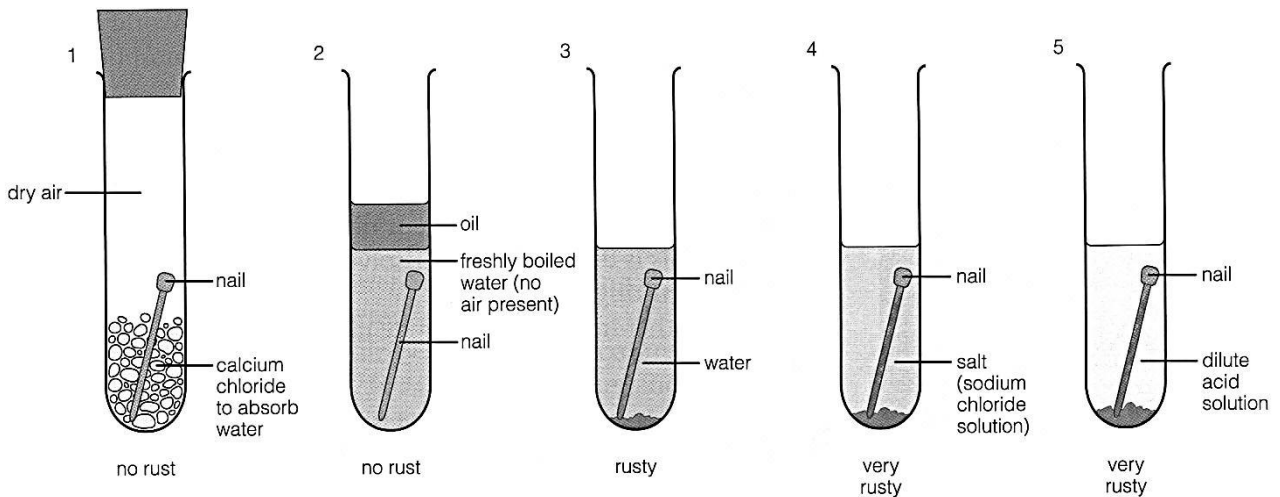
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**Question 6.**

The diagram below shows iron nails exposed to a variety of different conditions.



a) Identify the conditions that cause iron to corrode / rust.

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b) What can be done to objects made out of iron in order to reduce the extent to which they corrode / rust?

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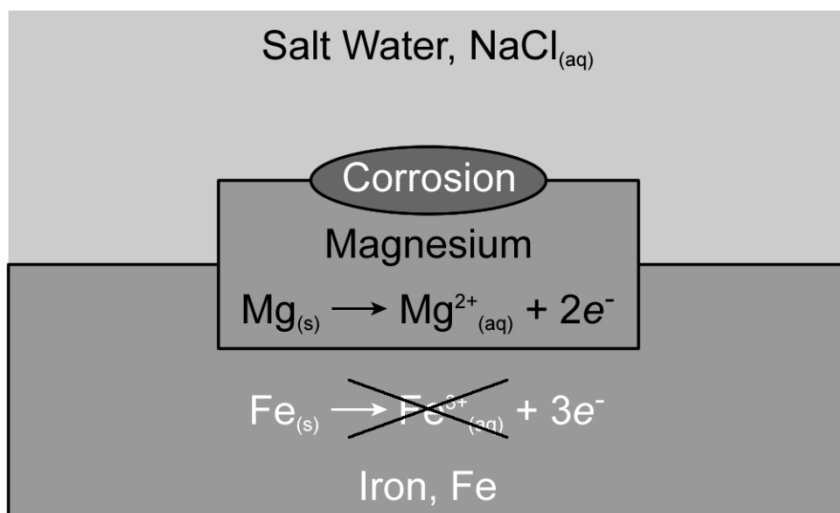
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c) The diagram below illustrates the concept of *sacrificial protection*.



Describe how sacrificial protection prevents the iron from corroding / rusting.

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- Scan the QR code given below to view the answers to this assignment.



[http://www.chemist.sg/metals/metals\\_worksheet\\_ans.pdf](http://www.chemist.sg/metals/metals_worksheet_ans.pdf)