



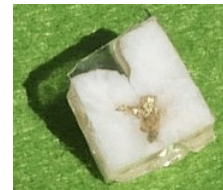
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Introduction

The exercise you are going to complete uses a collection of websites, data tables and charts to lead you through the key ideas that you need in order to understand the relationship between the reactivity, price and extraction methods of different metals.



- In order to access the websites referenced in this exercise, you will need to open up the links page on the Science Department Website (www.sciencepages.co.uk). Navigate to Key Stage 4 > GCSE Chemistry and select 'The extraction of metals' All of the websites in this exercise are linked to from that page.

Part 1 - Metals and their ores

READ

Most metals are not found as elements in the earth's crust. Instead they are combined with other elements into compounds found in minerals in rocks.

An **ore** is a naturally-occurring group of minerals in a rock from which a metal or metals can be extracted with profit.

Simple ores are ores that yield a single metal.

Complex ores are ores that yield more than one metal.

TASK 1

→ **Web-sites: 'Metal ores' and 'Web Elements'**

Use the information on the **Metals** website to complete the first three columns of the following table (note that the links to copper and iron ores are towards the top of the page) Use the **Web Elements** site to complete the third column of the table; record information on the uses and history of the metals. On the Web Elements site, select the metal from the periodic table. Information on the uses of the metal is accessed via a menu from the left hand side of the new page. (The entry for aluminium has been done for you).

| Metal | Common ores | Formulae of ores | Information about uses / history / properties |
|-----------|-------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aluminium | Bauxite | Al_2O_3 | Only discovered in 1825. Very light and strong. Used for making cans and foils and aircraft. Used also in electricity cables because it is cheaper (though less conductive) than copper. |
| Iron | | | |

| Metal | Common ores | Formulae of ores | Information about uses / history / properties |
|--------|--------------------------------------------------|------------------|-----------------------------------------------|
| Lead | | | |
| Zinc | | | |
| Tin | | | |
| Copper | | | |
| Gold | None (occurs native in rock as gold the element) | N/A | |

Part 2 - The discovery of the metals

READ

Here is data on the abundance of different metals in the earth's crust:

| Metal | % by mass in earth's crust | Date of discovery (b.p. = years before present) |
|-----------|----------------------------|-------------------------------------------------|
| aluminium | 8.1 | 1825 |
| iron | 5.0 | about 4000 b.p. |
| calcium | 3.6 | 1808 |
| sodium | 2.8 | 1807 |
| potassium | 2.6 | 1807 |
| magnesium | 2.1 | 1775 |
| zinc | 0.11 | 1500 |
| copper | 0.001 | about 5000 b.p. |
| silver | about 0.00003 | about 5000 b.p. |
| gold | less than 0.000001 | at least 8000 b.p. |

N.B. over 70% by mass of the Earth's crust is made of two elements: **oxygen** (46%) and **silicon** (28%).

1. Why do you think that gold is much more expensive than iron, aluminium, or zinc?

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2. Were the most **common** metals in the earth's crust discovered first? Can you think of any reasons for your answer?

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We can order the metals according to how reactive they are. We call this order the **REACTIVITY SERIES**.

Potassium
Sodium
Calcium
Magnesium
Aluminium
CARBON
Zinc
Iron
Lead
Copper
Silver
Gold

The reactivity series

We have also placed the non-metal CARBON into the reactivity series (you will see the reason for this later).

3. Is there any relationship between the **reactivity** of the metals and their date of discovery?

Describe any relationship you can see.

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4. How can we test metals to assess how reactive they are? You should be able to suggest at least two possible methods.

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Part 3 - The Extraction Of Metals

Different metals are extracted from their ores in different ways.

→ Web-sites: 'GCSE Chemistry (the extraction of metals)' and 'Essaybank - extraction of metals'

TASK

Complete the following table to show how different metals are extracted from their ores. At this stage you should not worry about the details of the methods (formulae etc.) but please include general information - e.g. where the reaction takes place, temperature etc.

| Metal | Method of extraction | Notes on the method |
|-----------|----------------------|---------------------|
| Aluminium | | |
| Iron | | |

| Metal | Method of extraction | Notes on the method |
|--------|--------------------------|---------------------|
| Copper | (Method of extraction) | |
| | (Method of purification) | |

5. Which of the methods described do you think is most difficult to carry out? Which do you think is most expensive to carry out?

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6. Why do you think that aluminium wasn't discovered until 1825? What technological breakthrough was required before we could acquire aluminium metal?

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READ

- The method used to extract a metal from its ore largely depends on how reactive the metal is.
- If the metal is less reactive than CARBON it can be extracted by **reducing** the compound by heating with carbon.
- If the metal is more reactive than carbon, the only method of extraction is often to carry out electrolysis (passing electricity through the melted ore or a solution of the compound)

7. Why does aluminium have to be extracted by electrolysis?

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8. Why can iron be extracted by heating with carbon?

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9. Copper can be extracted by heating with carbon, but the resulting copper is not very pure. Name some of the uses for copper where purer copper is essential.

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Part 4 - Metal prices

Here is some data on the price of metals (prices are in US dollars) :

| Metal | Price (in US dollars) per 100 grammes. |
|-----------|----------------------------------------|
| Iron | \$0.02 |
| Lead | \$0.08 |
| Gold | \$1200 |
| Silver | \$14 |
| Aluminium | \$0.12 |
| Copper | \$0.24 |
| Magnesium | \$0.32 |

10. Using the data from **all of the tables** (reactivity, abundance, method of extraction) presented so far, try and give reasons for the following:

a. Why is aluminium more expensive than iron?

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b. Why is gold more expensive than copper?

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c. Why is copper more expensive than iron?

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11. Not all of the differences in the cost of metals can be explained in terms of the metals' abundances or how easy it is to extract them from their ores. Can you think of any other reasons why some metals are more expensive than others? (HINTS: why do we want the metals in the first place? Lead jewellery anyone?)

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