# Tutankhamun’s Dagger

## LESSON PLAN

<table>
<thead>
<tr>
<th>Learning objectives strands 2–5</th>
<th>Learning objectives: strand 1 (HSW)</th>
<th>PLTS</th>
<th>APP</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Elements and compounds show characteristic chemical properties and patterns in their behaviour.</td>
<td>• Recognise that modern science has its roots in many different cultures.</td>
<td>• Team workers: carry out practical activities cooperatively</td>
<td>• AF1 – Thinking scientifically</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Independent enquirers: support conclusions using reasoned arguments and evidence</td>
<td>• AF3 – Communicating and collaborating in science</td>
</tr>
</tbody>
</table>

### Starter

<table>
<thead>
<tr>
<th>• Metals in the tomb</th>
<th>Display photos of objects that were placed in Tutankhamun’s tomb more than 3000 years ago. There are many more gold objects than iron ones, and iron objects were more valuable. Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tomb metal reactivity</td>
<td>Students use the reactivity series poster to rank metals in order of how strongly they are joined to atoms of other elements in their compounds.</td>
</tr>
</tbody>
</table>

### Differentiation

<table>
<thead>
<tr>
<th>Help</th>
<th>Tell students that the order of how strongly metals are joined to atoms of other elements in their compounds is the same as the order of metals in the reactivity series.</th>
</tr>
</thead>
</table>

### Resources

- Tutankhamun’s tomb web site (see URL at the end of this lesson plan)
- Tutankhamun’s iron dagger photo (see URL at the end of this lesson plan)
- Activity sheet 1

### Main

**Students extract metals using similar techniques to those that might have been used by the ancient Egyptians:**

- **Practical 1 – Panning for gold** Separate ‘gold’ from a mixture of sand and small stones.
- **Practical 2 – Extracting copper and iron** Extract copper and iron by heating with charcoal.

### Differentiation

<table>
<thead>
<tr>
<th>Extension</th>
<th>Use the website (see URL at the end of this lesson plan) to research the metals available to the ancient Egyptians, and to find out where they came from and how they were obtained.</th>
</tr>
</thead>
</table>

### Resources

- Teacher and Technician Notes
- Practical sheet 1
- Practical sheet 2
- Mixture of pieces of iron pyrites, sand, and small stones, plates with sloping edges, washing-up bowls, water.
- Bottle tops, spatula, iron(III) oxide, copper oxide, charcoal powder, Bunsen burner, heatproof mat, bar magnet.
# Tutankhamun's Dagger

## Lesson Plan

<table>
<thead>
<tr>
<th>Plenary</th>
<th>Differentiation</th>
<th>Resources</th>
</tr>
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</table>
| **Ranking metals** - Rank gold, copper, and iron in order of ease of extraction. Does this explain the rarity and high value of iron objects compared to gold?  
**Why was iron so rare and valuable?** Read the paragraph and answer the true/false questions. | Extension  
- Students feedback on research task (see Main differentiation above). |  
- Teacher and Technician Notes  
- Activity sheet 2 |

## Homework

- Create a poster or PowerPoint display to explain why iron was rarer and more valuable than gold in Tutankhamun’s time.

## Learning outcomes

**Level 3**  
- Model the extraction of gold by panning.

**Level 4**  
- Know that copper and iron can be extracted from their oxides by heating with carbon.

**Level 5**  
- Explain why copper and iron can be extracted from their oxides by heating with carbon.  
- Explain why a lower temperature is required to separate copper from its oxide than iron.

**Level 6**  
- Take account of several factors when explaining why iron was more valuable than gold in Tutankhamun’s time.

**Level 7**  
- Explain how different pieces of evidence contribute to explaining why iron was more valuable than gold in Tutankhamun’s time.

## Useful weblinks

**Starter**  
[http://www.bbc.co.uk/history/ancient/egyptians/tutankhamun_gallery.shtml](http://www.bbc.co.uk/history/ancient/egyptians/tutankhamun_gallery.shtml)  
[http://www.ancient-egypt.co.uk/cairo%20museum/cm,%20tutankhamun,%20artifacts/pages/tutankhamun's%20bronze%20and%20iron%20knives%201.htm](http://www.ancient-egypt.co.uk/cairo%20museum/cm,%20tutankhamun,%20artifacts/pages/tutankhamun's%20bronze%20and%20iron%20knives%201.htm)

**Main**  
[http://www.digitalegypt.ucl.ac.uk/metal/metalinegypt.html](http://www.digitalegypt.ucl.ac.uk/metal/metalinegypt.html)

**Plenary and homework**  
[http://www.reshafim.org.il/ad/egypt/trades/metals.htm#gold](http://www.reshafim.org.il/ad/egypt/trades/metals.htm#gold)

**Useful teacher background**  
[http://www.digitalegypt.ucl.ac.uk/metal/metalinegypt.html](http://www.digitalegypt.ucl.ac.uk/metal/metalinegypt.html)
In this lesson, students discover the secrets of the metals in Tutankhamun’s tomb. Why were so many items made of gold? Why was his iron dagger so precious? How did the ancient Egyptians get hold of these metals?

The lesson begins with a display of pictures of some of the artefacts found in the tomb, and a brief discussion in which pairs speculate on reasons for the rarity of iron objects in Tutankhamun’s time.

There are two practicals in the main section of the lesson. In the first, students pan for ‘gold’, to show that this metal is easily extracted. Secondly, students try extracting iron and copper from their oxides by heating with carbon. These activities lead into the plenary, in which students compare the ease of extraction of the three metals, and use their findings to suggest why iron was relatively rare in the times of the ancient Egyptians. As an alternative plenary, a true/false activity is provided.

<table>
<thead>
<tr>
<th>Equipment required per group:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Starter</strong></td>
</tr>
<tr>
<td>• <strong>Activity sheet 1</strong></td>
</tr>
<tr>
<td><strong>Main</strong></td>
</tr>
<tr>
<td>• Practical 1 – Panning for gold. Per pair:</td>
</tr>
<tr>
<td>• <strong>Practical sheet 1</strong></td>
</tr>
<tr>
<td>• plastic or metal plate with lip (the children’s plastic plates sold by IKEA are ideal)</td>
</tr>
<tr>
<td>• tweezers</td>
</tr>
<tr>
<td>• washing-up bowl, or empty equipment tray</td>
</tr>
<tr>
<td>• mixture of sand, small stones, and pieces of iron pyrite (or other gold substitute)</td>
</tr>
<tr>
<td>• access to tap water</td>
</tr>
<tr>
<td>• Practical 2 – Extracting copper and iron from their oxides. Per pair:</td>
</tr>
<tr>
<td>• <strong>Practical sheet 2</strong></td>
</tr>
<tr>
<td>• two bottle tops with the plastic lining burnt out</td>
</tr>
<tr>
<td>• heatproof mat</td>
</tr>
<tr>
<td>• Bunsen burner</td>
</tr>
<tr>
<td>• spatula</td>
</tr>
<tr>
<td>• charcoal powder</td>
</tr>
<tr>
<td>• iron(III) oxide powder</td>
</tr>
<tr>
<td>• copper(II) oxide powder</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Health and Safety notes:</th>
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<tr>
<td>• Students must wear eye protection.</td>
</tr>
<tr>
<td>• Beware – the apparatus is hot.</td>
</tr>
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</table>

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<tbody>
<tr>
<td>1 <strong>Metals in the tomb</strong> Display photos of objects that were placed in Tutankhamun’s tomb more than 3000 years ago. There are many more gold objects than iron ones – the only iron objects found were a dagger, and a set of chisels. Ask pairs of students to discuss and suggest why iron objects were comparatively rare in the times of the ancient Egyptians, and why they were so valuable. If you wish, use the first part of <strong>Activity sheet 1</strong> to support this activity.</td>
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<tr>
<td>2 <strong>Metals in the tomb</strong> Display photos of objects that were placed in Tutankhamun’s tomb more than 3000 years ago. There are many more gold objects than iron ones – the only iron objects</td>
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found were a dagger, and a set of chisels. Ask pairs of students to discuss and suggest why iron objects were comparatively rare in the times of the ancient Egyptians, and why they were so valuable. If you wish, use the first part of Activity sheet 1 to support this activity.

3 **Tomb metal reactivity** Students use the second part of **Activity sheet 1** to list five metals in order of reactivity – they can do this either by referring to the poster, or by drawing on previous knowledge of the reactivity series. The correct order, from most reactive to least reactive, is iron, tin, lead, copper, gold.

**Main**

1 **Practical 1 – Panning for gold** Pairs or small groups follow the instructions to separate ‘gold’ (iron pyrite) from a mixture of sand and small stones, as the ancient Egyptians would have extracted gold from stream and river beds. The purpose of this activity is to show how simple the process is, and how little energy is required. Note – although the Egyptians extracted some gold in this way, they dug most of their gold from local underground mines.

Possible responses to the questions:

1. Yes – the technique could have been used by the Egyptians. They had all the equipment necessary.
2. The Egyptians might have hammered the metal into shape, or melted it and poured it into moulds.
3. The density of gold is much higher than that of the other materials. This is why it sinks to the bottom of the mixture.

2 **Practical 2 – Extracting copper and iron from their oxides** Students follow the instructions on **Practical sheet 2** to try to extract copper and iron from their oxides by heating with powdered charcoal. Most groups should succeed in seeing a reddish substance – copper – after heating to high temperature. Only a few groups – if any – will manage to extract iron. The practical therefore illustrates the relative ease of extraction of the two metals. Copper can be extracted more easily, and at lower temperatures, than iron. This is because iron atoms are more strongly joined to atoms of other elements in their compounds.

Emphasise safety during this practical – it is very easy for students to burn themselves.

Possible responses to the questions:

1. Copper – every group managed to extract this metal.
2. Possibly – the technology is simple, and likely to have been available.
3. It would have been easier to melt copper than iron, since copper has a lower melting point.

**Plenary**

1 **Ranking metals** Student pairs rank the metals gold, copper, and iron in order of ease of extraction. The expected order – in line with the reactivity series – is gold (easiest), copper, iron (most difficult).

2 **Why was iron so rare and valuable?** Students read the information on **Activity sheet 2**, and answer the true/false questions below. Alternatively, ask the questions aloud, and ask students to respond on miniwhiteboards. The true statements are those numbered 3, 5, 6, 7, 9, and 10.
Metals in the tomb

Ninety years ago, in February 1923, Howard Carter opened the tomb of Tutankhamun. He opened the door to reveal 5000 amazing objects, including a spectacular gold mask, a silver trumpet, and an iron dagger.

A great number of Tutankhamun’s belongings were made of solid gold, or decorated with thin sheets of gold leaf. Many items were of bronze, which is a mixture of two metals – copper and tin. Only very few objects – including a dagger and a set of chisels – were made from iron.

Iron was rare in Tutankhamun’s time. Iron objects were highly treasured. Can you suggest why? Discuss your ideas with your partner.

Tomb metal reactivity

The metals in the list below were all used by the ancient Egyptians.

- gold
- copper
- bronze (a mixture of copper and tin)
- iron
- lead

List the metals in order of how easy it is to extract them from their compounds, easiest first. Use the reactivity series to help you.
Egyptian metals

Read the passage in the box, then answer the true-or-false questions that follow.

The ancient Egyptians loved gold, and buried Tutankhamun with many gold objects. Gold is very near the bottom of the reactivity series. It does not react with oxygen, water, or dilute acids. Gold forms very few compounds, and exists naturally as the element on its own. It was easy for the Egyptians to find gold in stream beds, and separate it from the sandy mixture. The Egyptians also mined huge quantities of gold from under the ground.

Copper is above gold in the reactivity series. It is usually found naturally in compounds, joined to other elements. The Egyptians mined these copper compounds, and extracted copper metal from them. The process involved heating to temperatures of about 800 ºC.

Iron is higher than copper in the reactivity series. It is almost always found naturally in compounds. Iron atoms are joined strongly to atoms of other elements in these compounds. Extracting iron metal from one of its compounds, iron(III) oxide, involves heating to temperatures of over 1000 ºC. There was no coal in Egypt, so it was difficult to reach these high temperatures. This explains why iron was discovered later than copper and gold. It also explains why, for many years, little iron was extracted from its compounds, even though its compounds are common. The rarity of iron explains why it was so precious. Its properties also made it very suitable for making weapons and tools.

Some people think that the Egyptians obtained some iron from meteorites that landed on Earth.

True or false?

1. Gold is near the top of the reactivity series.  
2. The ancient Egyptians found gold in stream beds only.  
3. Copper is above gold in the reactivity series, and below iron.  
4. Extracting copper from its compounds involves heating to temperatures above 1000 ºC.  
5. Iron is almost always found naturally in compounds.  
6. Iron atoms are joined strongly to atoms of other elements in compounds.  
7. Higher temperatures are needed to extract iron from its compounds than are needed to extract copper from its compounds.  
8. Iron compounds are rare.  
9. In the times of the ancient Egyptians, iron was precious partly because it was rare.  
10. The properties of iron make it suitable for making weapons and tools.

To find out more about how the ancient Egyptians used and extracted metals, see http://www.reshafim.org.il/ad/egypt/trades/metals.htm#gold
Panning for gold

In some areas, gold is found mixed with sand and small stones at the bottom of a river or stream. In this activity you will model the separation of gold from this mixture.

Safety

Wear eye protection.

Equipment and materials

- plastic or metal plate with lip
- tweezers
- big bowls or bucket
- mixture of sand, small stones, and pieces of ‘gold’ (iron pyrite or other gold substitute)
- tap water

Method

1. Half fill your plate with the mixture of sand, water, and ‘gold’.
2. Tilt the plate down, away from you.
3. Swirl the plate around, and let the sand and some water slip off the far side, into a bowl.
4. Add more water, and repeat steps 2 and 3 a few more times.
5. Look for gold in the bottom of the plate. Pick out the pieces with tweezers.
Results

Describe what you observe when you have finished separating the mixture.

____________________________________________________________________

Questions

1  Do you think this separation technique is one that could have been used by the ancient Egyptians? Give a reason for your decision.

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

2  Suggest how the Egyptians might have made masks and other objects from the gold they separated in this way.

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Extension

3  The table gives density values for some components of the mixture. Use the data to explain why the separation technique you used in this experiment works.

<table>
<thead>
<tr>
<th>Material</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gold</td>
<td>19.3</td>
</tr>
<tr>
<td>sand</td>
<td>1.0</td>
</tr>
<tr>
<td>water</td>
<td>1.9 (approximately)</td>
</tr>
</tbody>
</table>
Extracting copper and iron from their oxides

Copper and iron are not normally found on their own, as elements. Instead, they are found joined with atoms of other elements in compounds. In this experiment you will heat metal oxides with charcoal to extract two metals – copper and iron. Which is extracted more easily?

Safety

Wear eye protection and do not touch hot apparatus (even if it doesn’t look hot!).

Equipment and materials

- two bottle tops with the plastic lining burnt out
- heatproof mat
- Bunsen burner
- spatula
- charcoal powder
- iron(III) oxide powder
- copper(II) oxide powder

Method

1. Place a bottle top on a heatproof mat.
2. Place two spatula measures of copper oxide in the bottle top. Add two spatula measures of charcoal powder. Mix.
3. Light the Bunsen burner and adjust until there is a roaring flame. Hold the base of the Bunsen burner.
4. Heat the mixture in the bottle top from above, until you see a colour change. Then stop heating. Do not touch the bottle top – leave it to cool.
5. Repeat steps 1–4 for a mixture of iron(III) oxide and charcoal powder. Before you start, test the iron(III) oxide powder with a magnet. At the end, after cooling, test the product in the bottle top with the magnet.

Results

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Appearance before heating</th>
<th>Appearance during heating</th>
<th>Appearance after heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper oxide and charcoal powder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron oxide and charcoal powder</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions

1. Which metal easier to extract from its oxide? Explain why you made this choice.

______________________________________________________________________________
______________________________________________________________________________
2 Do you think the ancient Egyptians might have been able to use similar methods to extract copper and iron from their oxides? Give a reason for your decision.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Extension

3 The table gives melting-point data for the two metals you extracted in this experiment. Which might the ancient Egyptians have found easier to melt? Explain your choice.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Melting point (ºC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>copper</td>
<td>1083</td>
</tr>
<tr>
<td>iron</td>
<td>1535</td>
</tr>
</tbody>
</table>

____________________________________________________________________
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