

Alloys as useful materials

4.10.3.2 · Using resources · revision notes

What alloys are, why they are harder than pure metals, the alloys named in the specification and their uses, and how the purity of gold is measured in carats. This is in GCSE Chemistry only, not in Combined Science. Expect recall of alloys and uses, carat calculations and questions where you interpret data about an unfamiliar alloy on Paper 2.

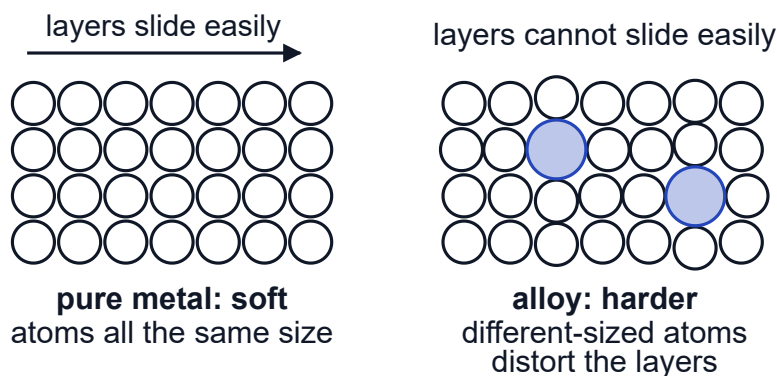
Key facts

- Alloy = mixture of a metal with other elements; harder than the pure metal
- Brass = copper + zinc (musical instruments, door handles)
- High carbon steel: strong but brittle (cutting tools); low carbon steel: soft, easily shaped (car bodies)
- Aluminium alloys: low density (aircraft)
- Bronze = copper + tin (statues, medals, bells)
- Steel = iron + carbon (+ other metals)
- Stainless steel: contains chromium and nickel; hard, resists corrosion (cutlery)
- 24 carat = 100% gold; 18 carat = 75% gold; % gold = $\text{carats} \div 24 \times 100$

Notes

Why alloys are useful

- Most metals in everyday use are **alloys**: mixtures of a metal with other elements, usually other metals (or carbon, in steel).
- In a pure metal the atoms are all the same size, arranged in layers that can slide over each other easily, so pure metals are soft.
- In an alloy, atoms of different sizes **distort the layers**, making it more difficult for them to slide. So alloys are **harder** than pure metals.



Atoms of a different size make it harder for the layers to slide.

Alloys to know

- **Bronze** = copper + tin. Hard and resistant to corrosion: statues, medals, bells.
- **Brass** = copper + zinc. Hard, resistant to corrosion and gold-coloured: musical instruments such as trumpets, door handles, taps and plumbing fittings.
- **Gold** used for jewellery is usually an alloy with silver, copper and zinc, which makes it harder.
- **Aluminium alloys** have a **low density**: aircraft, bicycle frames.

Steels

- **Steels** are alloys of iron that contain specific amounts of carbon and other metals.
- **High carbon steel** is strong but brittle: cutting tools such as chisels and drill bits.
- **Low carbon steel** is softer and more easily shaped: car body panels, wire, food cans.
- **Stainless steels** contain chromium and nickel. They are hard and resistant to corrosion: cutlery, sinks, surgical instruments.

Carats

- The proportion of gold in a gold alloy is measured in **carats**. **24 carat is 100%** gold (pure gold) and **18 carat is 75%** gold.
- Percentage of gold = $\text{carats} \div 24 \times 100$. For example, 9 carat gold is $9 \div 24 \times 100 = 37.5\%$ gold.
- Pure gold is too soft for everyday jewellery, so lower-carat alloys are used. They are harder and cheaper.

How to answer each type of question

Recall alloys, their metals and uses

1 to 3 marks

Grade 4

1. Learn the metals in each named alloy: bronze, brass, steels, gold alloys.
2. Give a use that matches a property of the alloy.
3. If asked to explain a use, name the property that makes the alloy suitable.

Example. (a) Name the **two** metals in brass. (1 mark)

(b) Give **one** use of stainless steel and the property that makes it suitable for that use. (2 marks)

Model answer. (a) Copper and zinc (both needed) (1)

(b) Cutlery / sinks / surgical instruments (1); it is resistant to corrosion / does not rust (1)

Don't lose marks

- ✗ Swapping bronze (copper + tin) and brass (copper + zinc).
- ✗ Saying alloys are harder 'because they are mixed'. Explain with different sized atoms distorting the layers so that they cannot slide.
- ✗ Calling an alloy a compound. It is a mixture.
- ✗ Saying high carbon steel is soft and easily shaped. That is low carbon steel; high carbon steel is strong but brittle.

✗ Dividing by 100 instead of 24 in carat questions.

More tips

Memory tricks

- Link each alloy to a famous object: bronze statues and medals (copper + tin), brass trumpets (copper + zinc).
- Carats are 24ths: 18
 $\text{carat} = 18/24 = 3/4 = 75\%$; 12 carat = half; 9 carat = 37.5%.
- More carbon in steel = harder but more brittle.
- Stainless steel has chromium and nickel: it stays shiny because it resists corrosion.

Exam technique

- When asked to explain a use, give the property that makes the alloy suitable, not just the use.
- For unfamiliar alloys, use only the data given and quote the numbers with units.
- In 'why is an alloy harder' answers the key words are layers, different sized atoms, distorted and slide.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State what an alloy is

A mixture of a metal with at least one other element, usually another metal (or carbon, in steel).

Grade 4

Name the metals in bronze and brass

Bronze is copper and tin; brass is copper and zinc.

Grade 4

Recall a use for each named alloy

For example, bronze for statues, brass for musical instruments, stainless steel for cutlery, aluminium alloys for aircraft.

Grade 5

Compare high carbon, low carbon and stainless steel

High carbon steel is strong but brittle; low carbon steel is softer and easily shaped; stainless steel is hard and resists corrosion.

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