

Transition Metals, Alloys and Corrosion Notes

Science Exams Sorted



www.scienceexamssorted.co.uk

At GCSE we don't have to know an awful lot about transition metals. There is much more that must be known for A level. We have included the key points that could form questions that we may see.

Why are they called transition metals? All elements in the transition metals have variable oxidative states. That means that ions of elements can be different. For example we could have Fe^{2+} and Fe^{3+} . So, simply, the charges can vary.

Most metals are transition metals. They include elements such as iron, silver, gold, copper and chromium. The transition elements are in the central part of the periodic table. The figure below shows the transition metals.

45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30
89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48
139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80
[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	[285] Cn copernicium 112

Some properties of transition elements are different from those of the metals in group 1 and group 2. Transition metals have the following characteristics.

Similarities between transition metals and group 1 & group 2 metals

1. Ability to conduct electricity. Due to the capacity of their delocalised electrons to move and carry charge.
2. Are shiny when they are first cut.
3. All are solids at room temperature (except Mercury, which is a liquid).

Differences between transition metals and group 1 & group 2 metals

1. **Melting and boiling points** – transition metals have higher melting and boiling points.
2. **Density** – transition metals have higher densities.
3. **Less reactive with water** – transition metals are less reactive with water.
4. **Coloured compounds** – transition metals can form coloured compounds. What we mean by that is...
When iron reacts with oxygen it goes brown. When copper reacts with oxygen it goes green.
Note: when all the metals in group 1 and group 2 react with oxygen they produce white compounds.
5. **Can be used as catalysts** – transition metals can be used as catalysts.

For GCSE we need to know the conditions that are required for corrosion (rusting) to occur. We also need to know the experiment that investigates the conditions for corrosion. Finally, we need to know methods to prevent corrosion occurring.

Corrosion: the gradual deterioration of a substance when it reacts with substances in the environment. When a metal corrodes it reacts with oxygen. The metal becomes weaker over time, and eventually all of it may become metal oxide.

Hydrated iron(III) oxide = rust

What conditions are needed for corrosion? Oxygen and Water – both have to be present for rusting to occur. The equation below shows the reaction of iron with oxygen and water.

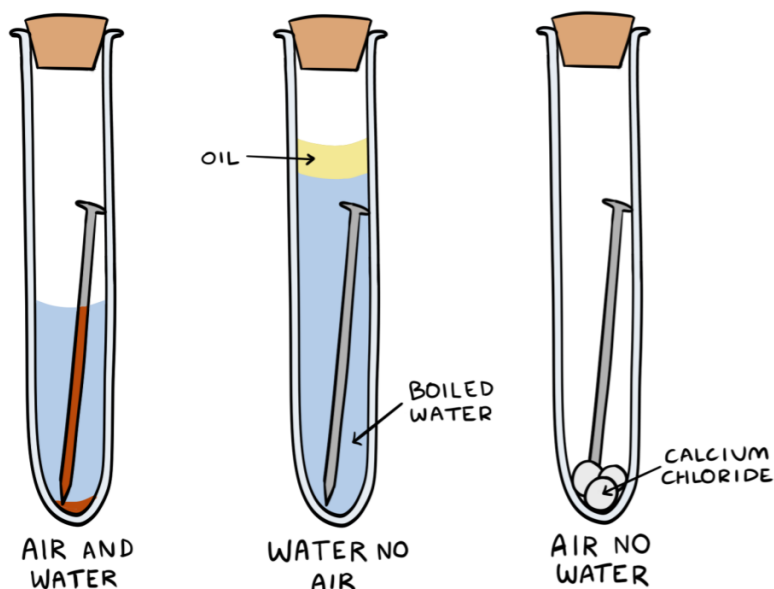
iron + oxygen + water → hydrated iron(III) oxide

Rusting is an oxidation reaction.

The Rusting Experiment

In class you will have done the experiment on rusting with iron nails. If you haven't or missed it don't worry, we cover everything you need here 😊

Aim: To show the conditions necessary for rusting to occur.



Exam note: A lot of exam questions are based on this practical and many look like the practical above. You should learn WHY rusting has occurred in the first tube and just as importantly WHY rusting did not occur in either of the other tubes.

1. **Rusting occurs** in the first tube as it has both conditions needed, **oxygen and water are present**.
2. **Rusting did not occur** in the second tube as where **there was water but no oxygen**.
Note: Boiling the water beforehand removed most of the oxygen. The oil layer prevents oxygen in the air diffusing back into the boiled water.
3. **Rusting did not occur** in the third tube as **there was oxygen (air) but no water present**.
The calcium chloride is a drying agent and has absorbed all the water vapour from the air inside the tube.

Preventing Corrosion

The main thing to consider in preventing corrosion is how to keep oxygen and water away from the metal. The following are the methods that we need to know for GCSE.

Physical Barriers

These include:

1. Painting.
2. Oiling and greasing.
3. Coating with plastic.

These all keep oxygen and water away from the surface of the material 😊

Electroplating

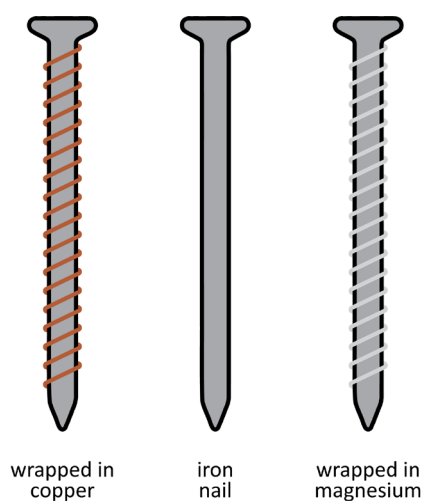
Electroplating involves using electrolysis to put a thin layer of a metal on the object. Cutlery is often electroplated with silver. This prevents corrosion as silver is unreactive. **How does Electroplating actually work?** I'm glad you asked 😊

Electroplating uses electrolysis to coat a cheaper metal with a thin layer of a more expensive or unreactive metal (like silver or gold) to improve its appearance or to prevent corrosion. To set it up we need the following:

1. **The cathode (negative electrode):** This is the object you want to plate. a steel metal spoon for example.
2. **The anode (positive electrode):** This is a piece of the pure metal you want to use for the coating (e.g., pure silver).
3. **The Electrolyte:** This must be a solution containing ions of the plating metal (e.g., silver nitrate solution). As the current flows, metal ions from the electrolyte are deposited onto the cathode, while the anode dissolves to replace those ions in the solution.

Sacrificial Protection

Iron can be protected from rusting if it is in contact with a more reactive metal, such as zinc. The more reactive metal oxidises more readily than iron, so it '**sacrifices**' itself and corrodes instead of the iron while the iron does not rust. Once the sacrificial metal has corroded away, it can simply be replaced.



Results: magnesium is more reactive than iron.

It oxidises more easily than iron so the nail does not rust.
Iron is more reactive than copper.

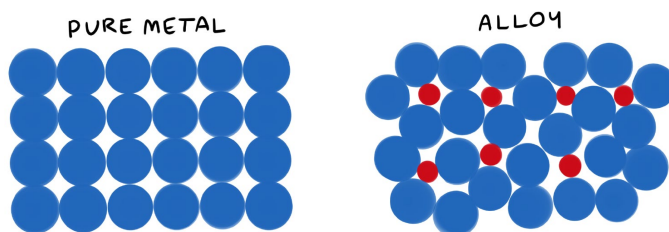
This means it oxidises more easily than copper, so it rusts faster than the nail alone which we realise is the opposite of what we want.

Galvanising

When iron is coated in zinc, the process is called galvanising. The zinc oxide layer stops oxygen and water reaching the iron. Zinc is more reactive than iron, so it also acts as a sacrificial metal. This protection works, even if the zinc layer is scratched.

Alloys

An alloy is a mixture of two or more elements, where at least one element is a metal. Many alloys are mixtures of two or more metals.



Alloys are usually harder and stronger than the pure metals they contain. This is because the different sized atoms make it harder for the layers of atoms to slide over each other. Alloys are useful because they allow the best properties of metals to be combined. Steel is an alloy, it is a mixture of iron and carbon, (mostly iron though). Are there any other alloys we need to know about? Yeah, two 😊

Brass: an alloy made of **copper** and **zinc**. It is hard, resistant to corrosion, and a good electrical conductor.

Uses: Electrical plug pins, door handles, musical instruments.

Magnalium: an alloy made of **aluminium** and **magnesium**. It is stronger than pure aluminium but maintains a very low density (it is lightweight). **Uses:** to make aircraft parts and scientific instruments.