

FACTFILE: GCSE

Technology and Design



UNIT: TECHNOLOGY AND DESIGN CORE CONTENT - MATERIALS AND THEIR GENERAL PHYSICAL, AESTHETICS AND STRUCTURAL CHARACTERISTICS



1.2 Heat Treatment

Learning Outcomes

You should be able to:

- demonstrate understanding of the following heat treatments:
 - annealing;
 - normalising;
 - hardening; and
 - tempering.

Course Content

Heat Treatment



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Figure 1

Heat treatment is the process of heating and cooling metals to change their properties. Different types of heat treatment can be used to make a metal harder, stronger or even softer. Not all of these properties can be improved together, for example, improving hardness can reduce toughness. Heat treatment involves heating metal to very high temperatures in a controlled way for a set period of time. The rate of cooling is equally crucial. Heat treatment is usually carried out in a furnace as shown in Figure 1 but can also be achieved using an oxy-acetylene flame in a school

workshop. There are several types of heat treatment which all involve three stages.

Heating

Metal must be heated slowly and evenly to avoid cracking. Heating times will vary depending on the type and size of the metal amongst other factors. Heating temperatures vary from several hundred degrees to over one thousand degrees Celsius.

Soaking

The metal is held at a certain temperature for a specific period of time. If a metal needs to be heated to a temperature of 900°C it will be pre-heated to perhaps 300°C and held at that temperature until the heat has spread uniformly throughout the metal before quickly being reheated to full temperature.

Cooling

Metals can be cooled quickly by quenching them in water, oil or other liquids. Slow and controlled cooling can also be employed. In this case furnace cooling is generally used.

Types of Heat Treatments

Annealing

Annealing is the process of softening a metal such as copper steel and brass to make it more malleable and ductile. Aluminium can be annealed using a gas flame in a workshop. The metal is simply heated and held at a specific temperature for a set period of time (soaking) before being left to cool very slowly, usually in the furnace or a sandbox. Both groups of metal (ferrous and non-ferrous) can be annealed so that they are easier to cut, shape and machine.



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Figure 2

Normalising

Normalising is similar process to annealing except that it is strictly for ferrous metals (various types of steel). The steel is usually heated to temperatures between 810°C - 930°C. Normalising steel refines the internal grain and gives the metal a more stable and uniform structure (relieving internal stress). Normalising is less expensive than annealing and produces stronger metal and is often used to produce sheet metal as illustrated in Figure 2.



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Figure 3

Hardening

Hardening is the process of making metal hard by heating and quickly cooling it in oil or water as shown in Figure 3. Hardening is often used to create tools made from steel. Although the steel becomes very hard it can also result in increased brittleness in which case the process of tempering is required.

Tempering

Tempering reduces the hardness of metal in order to increase its toughness. It is often carried out after the hardening process by re-heating the steel (usually at a much lower temperatures) and quickly cooling it. If tempering is performed correctly (by observing colour changes in the metal) then a good balance between hardness and toughness can be achieved.

Student Task

Use the links below to watch the animations of how a chisel can be hardened and tempered. Write out a step by step explanation of how this process could be undertaken in a school workshop.

<http://www.wikihow.com/Harden-Steel>

<http://www.technologystudent.com/equip1/heat1.htm>

Revision questions

1. Steel is a common metal used in building and construction but can also be used for general workshop fabrication. Explain the advantage of using annealed steel in the workshop.

2. Heat treatment is the process of heating and cooling metal in a controlled way to change its properties. Outline the purpose of 'soaking' within this process.

3. Which of the following products require hardening and tempering?

a. fizzy drinks can

b. hacksaw blade

c. hammer

d. aluminium pop-rivet

4. Explain why tools such as a centre-punch must be hardened and tempered.

