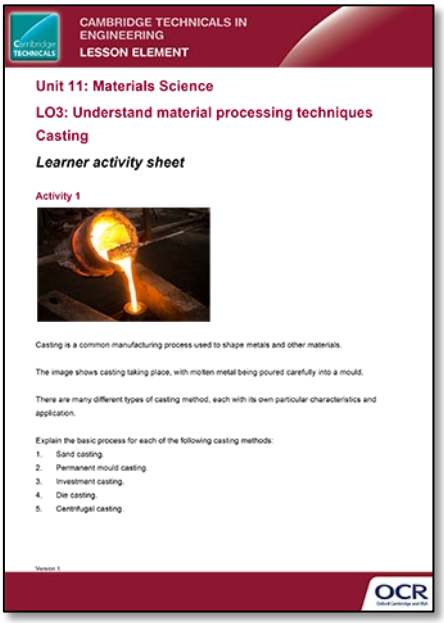
Unit 11: Materials Science

LO3: Understand material processing techniques

Casting

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Casting' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 11: Materials Science

LO3: Understand material processing techniques

Casting

Learner activity sheet

Activity 1

Casting is a common manufacturing process used to shape metals and other materials.

The image shows casting taking place, with molten metal being poured carefully into a mould.

There are many different types of casting method, each with its own particular characteristics and application.

Explain the basic process for each of the following casting methods:

1. Sand casting.
2. Permanent mould casting.
3. Investment casting.
4. Die casting.
5. Centrifugal casting.

OCR

The Activity:

Learners might independently investigate and summarise each of the casting methods listed. Web-based sources may prove useful.

In Activity 2 learners are required to investigate the solidification process in casting, and the effects it has on the grain size within the metal.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

1 hour

Activity 1

Learners might independently investigate and summarise each of the casting methods listed. Web-based sources may prove useful.

These are summarised in the table below:

Casting process	Method
Sand casting	In sand casting, sand is used as the mould into which molten metal is poured. Removable patterns are used to make the required cavity within the sand mould. Sand castings are produced in foundries.
Permanent mould casting	Permanent mould casting is a metal casting process that employs reusable moulds (permanent moulds), usually made from metal. The most common process uses gravity to fill the mould, however gas pressure or a vacuum are also used.
Investment casting	Investment casting is an industrial process also called lost-wax casting. It is one of the oldest known metal-forming techniques. A pattern is made from wax, and coated within a refractory coating. The coating is hardened using heat, and the wax melted out. Molten metal is poured into the mould (left by the refractory coating). Once the molten metal has cooled, the mould is broken away from the casting.
Die casting	In die casting molten metal is forced under pressure into a mould cavity. The mould cavity consists of two hardened tool steel dies which have been machined to the required cavity shape. Once the molten metal has cooled, the dies are separated and the work piece removed.
Centrifugal casting	Centrifugal asting (or rotocasting) is a technique used to produce thin walled cylinders. Molten metal is poured into a mould that rotates continuously about its axis. The molten metal is thrown centrifugally to the inner surface of the mould where it solidifies on cooling.

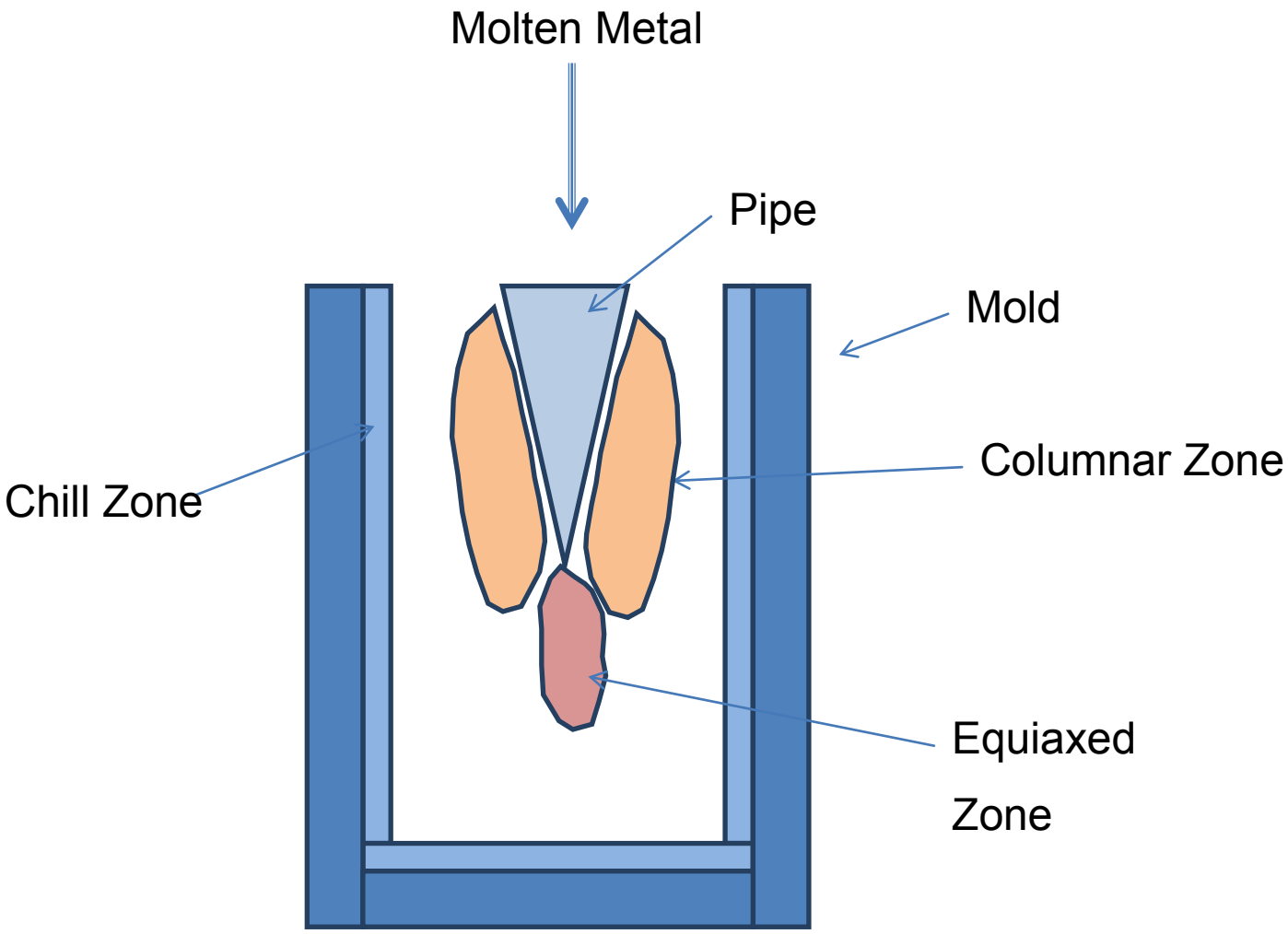
Learners might extend their description of each casting method, and could add simplified sketches to illustrate each.

Activity 2

In Activity 2 learners are required to investigate the solidification process in casting, and the effects it has on the grain size within the metal.

The following web-link may prove useful once learners have completed the activity.
http://www.doitpoms.ac.uk/tlplib/casting/microsegregation.php

The process is described below:



1. The metal solidifies in the order: chill zone, columnar zone, equiaxed zone.

2. Each of the zones is described below, including the grain structure in each.

Zone	What takes place .....
Chill zone	First solid formed – consists of fine grains on mould surface, with random orientations. Many grain nuclei form due to initial under-cooling on cold mould wall. This is termed the nucleation phase of the solidification process.
Columnar zone	As more heat is removed the grains grow towards the center of the casting. These are thin, long columns that are perpendicular to the casting surface, which are undesirable because they have anisotropic properties (i.e. different properties in different directions).
Equiaxed zone	The final liquid to solidify in the centre of the mould. It contains fine grains that nucleate heterogeneously (i.e. randomly and of different size) to form chill crystals. This is desirable as the small grains reduce microsegregation.

Learners may need some guidance with the terminology used within the explanation of how a metal solidifies (i.e. the process of crystallisation and grain growth within the metal).

3.

Pipe	This forms as the solid is more dense than the molten metal – so the materials takes up less volume when it solidifies (i.e. the metal shrinks)

4. Microsegregation in the casting process refers to the first crystals being formed having a lower concentration than the final crystals formed. It means that solid formed later has a higher concentration (i.e. the concentration of crystals throughout the mould is not consistent).

5. A dendrite in metallurgy is a characteristic tree-like structure of crystals growing as molten metal freezes. As the liquid solidifies, there is little trace of the dendritic structure – only the grain into which the dendrites have grown.

Teachers might extend this activity by showing learners images of dendritic growth, and microscopy of grain structure within metals.