

METALLURGY WORKSHEET

Complete the gaps from 1-7 with the sentences from A-G

Metallurgy is a domain of materials science and engineering that studies the physical and chemical behavior of metallic elements, their intermetallic compounds, and their alloys. Metallurgy is also the technology of metals: the way in which science is applied to the production of metals, and the engineering of metal components for usage in products for consumers and manufacturers. **(1)**

Metallurgy is distinguished from the craft of metalworking, although metalworking relies on metallurgy for technical advancement.

Metallurgy is subdivided into ferrous metallurgy (black metallurgy) and non-ferrous metallurgy or colored metallurgy. **(2)**_____

The production of ferrous metals accounts for 95 percent of world metal production.

Extractive metallurgy is the practice of removing valuable metals from an ore and refining the extracted raw metals into a purer form. In order to convert a metal oxide or sulphide to a purer metal, the ore must be reduced physically, chemically, or electrolytically.

Extractive metallurgists are interested in three primary streams: feed, concentrate (valuable metal oxide/sulphide), and tailings (waste). **(3)**

Concentrating the particles of value in a form supporting separation enables the desired metal to be removed from waste products.

Ore bodies often contain more than one valuable metal. Tailings of a previous process may be used as a feed in another process to extract a secondary product from the original ore. **(4)**_____

That concentrate would then be processed to separate the valuable metals into individual constituents.

Alloys

Common engineering metals include aluminium, chromium, copper, iron, magnesium, nickel, titanium and zinc. These are most often used as alloys. Much effort has been placed on understanding the iron-carbon alloy system, which includes steels and cast irons. Plain carbon steels (those that contain essentially only carbon as an alloying element) are used in low-cost, high-strength applications where weight and corrosion are not a problem.

(5)_____

Stainless steel or galvanized steel are used where resistance to corrosion is important. Aluminium alloys and magnesium alloys are used for applications where strength and lightness are required.

Copper-nickel alloys (such as Monel) are used in highly corrosive environments and for non-magnetic applications. Nickel-based superalloys like Inconel are used in high-temperature applications such as gas turbines, turbochargers, pressure vessels, and heat exchangers. For extremely high temperatures, single crystal alloys are used to minimize creep.

Production

In production engineering, metallurgy is concerned with the production of metallic components for use in consumer or engineering products. **(6)**_____

The task of the metallurgist is to achieve balance between material properties such as cost, weight, strength, toughness, hardness, corrosion, fatigue resistance, and performance in temperature extremes.

(7)_____

In a saltwater environment, ferrous metals and some aluminium alloys corrode quickly. Metals exposed to cold or cryogenic conditions may endure a ductile to brittle transition and lose their toughness, becoming more brittle and prone to cracking. Metals under continual cyclic loading can suffer from metal fatigue. Metals under constant stress at elevated temperatures can creep.

- A- Additionally, a concentrate may contain more than one valuable metal.
- B- Ferrous metallurgy involves processes and alloys based on iron while non-ferrous metallurgy involves processes and alloys based on other metals.
- C- This involves the production of alloys, the shaping, the heat treatment and the surface treatment of the product.
- D- After mining, large pieces of the ore feed are broken through crushing and/or grinding in order to obtain particles small enough where each particle is either mostly valuable or mostly waste.
- E- Cast irons, including ductile iron, are also part of the iron-carbon system.
- F- To achieve this goal, the operating environment must be carefully considered.
- G- The production of metals involves the processing of ores to extract the metal they contain, and the mixture of metals, sometimes with other elements, to produce alloys.

Complete the gaps with the words provided below:

Metal shaping

Metals are shaped by 1 _____ such as:

casting – molten metal is poured into a shaped mold.

forging – a red-hot billet is 2 _____ into shape.

rolling – a billet is passed through successively narrower rollers to create a 3 _____.

hammered
sheet
processes

laser cladding – metallic powder is blown through a movable laser beam. The resulting melted metal reaches a substrate to form a melt pool. By moving the laser head, it is possible to stack the tracks and build up a three-dimensional piece.

extrusion – a hot and malleable metal is forced under pressure through a 4 _____, which shapes it before it cools.

compressed
cold
die

sintering – a powdered metal is heated in a non-oxidizing environment after being 5 _____ into a die.

machining – lathes, milling machines, and drills cut the 6 _____ metal to shape.

Cold-working

structural

fabrication – sheets of metal are cut with guillotines or gas cutters and bent and welded into 7 _____ shape.

3D printing – Sintering or melting powder metal in a very small point on a moving 'print head' moving in 3D space to make any object to shape.

8 _____ processes, in which the product's shape is altered by rolling, fabrication or other processes while the product is cold, can increase the strength of the product by a process called work hardening. Work hardening creates microscopic defects in the metal, which resist further changes of shape.

Heat treatment

Metals can be heat-treated to alter the 9. _____ of strength, ductility, toughness, hardness and/or resistance to corrosion. Common heat treatment processes include annealing, precipitation strengthening, quenching, and tempering. The **annealing** process softens the metal by heating it and then allowing it to cool very slowly, which gets rid of stresses in the metal and makes the grain structure large and 10. _____ so that when the metal is hit or stressed it dents or perhaps bends, rather than breaking; it is also easier to sand, grind, or cut annealed metal. **Quenching** is the process of cooling a high-carbon steel very quickly after heating, thus 11. _____ the steel's molecules in the very hard martensite form, which makes the metal harder. There is a balance between hardness and toughness in any steel; 12 _____ the steel, the less tough or impact-resistant it is; and the more impact-resistant it is, the less hard it is. **Tempering** relieves stresses in the metal that were caused by the hardening process; tempering makes the metal less hard while making it better able to sustain impacts without 13 _____.

Often, mechanical and thermal treatments are combined in what are known as **thermo-mechanical treatments** for 14 _____ properties and more efficient processing of materials. These processes are common to high-alloy special steels, superalloys and titanium alloys.

better *soft-edged* *breaking* *"freezing"*
properties *the harder*

Plating

Electroplating is a chemical surface-treatment 15 _____. It involves bonding a thin layer of another metal such as gold, silver, chromium or zinc to the surface of the product. It is used to 16 _____ corrosion as well as to improve the product's aesthetic appearance.

Thermal spraying

Thermal spraying techniques are 17 _____ popular finishing option, and often have better high temperature properties 18 _____ electroplated coatings.

reduce *than* *technique* *another*