PEiU Materials, corrosion

Study the texts and do the exercises:

1 Material types

A Metals and non-metals

Engineering materials can be divided into:

- **metals** – examples of **metallic** materials are iron (Fe) and copper (Cu)
- **non-metals** – examples of **non-metallic** materials are carbon (C) and silicon (Si).

As iron is such a widely used material, metals can be divided into:

- **ferrous metals** – those that contain iron
- **non-ferrous metals** – those that do not contain iron.

B Elements, compounds and mixtures

With regard to the **chemical composition** of materials – the chemicals they contain, and how those chemicals are combined – three main categories can be used:

- **Elements** are pure materials in their most basic form. They cannot be broken down into different **constituents** ('ingredients'). Examples of elements widely used in engineering materials are iron, carbon and aluminium (Al).
- **Compounds** consist of two or more elements that are **chemically bound** – that is, combined by a chemical reaction. An everyday example is water, which is a **compound of** hydrogen (H) and oxygen (O).
- **Mixtures** consist of two or more elements or compounds which are mixed together, but which are not chemically bound. In engineering, common examples are alloys – that is, metals which have other metals and/or non-metals mixed with them. A common example is steel, which is an **iron–carbon alloy**, and can include other **alloying** metals – metals which are added to alloys, in small quantities relative to the main metal. Examples of widely used alloying metals are chromium (Cr), manganese (Mn) and tungsten (W).

BrE: aluminium /ˌæl.jʊˈmɪn.i.əm/; AmE: aluminum /əˈluː.mɪ.nəm/

Note: For a list of chemical elements and their symbols, see Appendix IV on page 104.

C Composite materials

The article below is from an engineering journal.

Materials under the microscope: composites

When you think of examples of hi-tech materials, **composite materials** come to mind – such as carbon-fibre, used in aerospace and Formula 1 cars. But although we think of **composites** as hi-tech and highly expensive, that's not always true. The earliest examples of composite materials were bricks made from mud and straw. Or, to use the correct composite terms, from straw **reinforcement** – the structural network that reinforces the material inside, and a mud **matrix** – the material surrounding the reinforcement. These terms explain what a composite material is: a matrix with a **reinforcing material** inside it. A modern, everyday example is fibreglass – correctly called **glass-reinforced plastic (GRP)** – which has a plastic matrix **reinforced with** glass fibres.

1/ Drag the words to the suitable places in the sentences:

metal non-metal metallic non-metallic ferrous non-ferrous

1. Carbon is a _____ .
2. Copper is a _____ metal.
3. Aluminium is a common _____ .
4. Steel is a widely used _____ metal.
5. Although it is used in steel, carbon is _____ .
6. Aluminium is rather light for a _____ materiál.

2/ Are the sentences true or false?

1.	The elements that make up a compound are chemically bound.	T	F
2.	Alloys are chemical compounds that are frequently used in engineering.	T	F
3.	Alloys can contain both metallic and non-metallic elements or compounds.	T	F
4.	Steel is a metallic element.	T	F

Rewrite the false sentences correctly:

3/ Read the text. Find two elements, two compounds, an alloy and a composite.

Generally, the steel used in reinforced concrete will have previously been exposed to water and to the oxygen in the air. As a result, it will usually be partly corroded, being covered with a layer of iron oxide (rust). However, once the steel is inside the hardened concrete, it will be protected from air and water, which prevents further rusting. Additionally, the cement in concrete does not react aggressively with the iron in steel.

Element	Compound	Alloy	Composite

4/ After reading the text about Corrosion, complete the table below with words related to *corrode, oxide* and *rust.* Then use some of the words in correct forms to complete the sentences.

Corrosion

One weakness of mild steel is that it **corrodes** – its surface progressively deteriorates due to a chemical reaction. This reaction takes place between the iron in the steel and the oxygen (O_2) in the air, to form **iron oxide**. When iron corrodes, we say that it rusts. In some metals, such as aluminium (Al), the presence of **corrosion** is not a problem, as the layer of **oxide** around the metal remains hard, which prevents it from **oxidizing** any further. However, when mild steel **goes rusty**, the **rust** on the surface comes off continuously, and a new **rusty** layer forms, progressively 'eating into' the metal.

Verb	Noun	Adjective
		corroded
		oxidized
/go rusty		

1. When steel is exposed to air and water, it _____ .
2. A brown/red material on the surface of steel is called _____ .
3. The strength of steel is reduced if it is _____.

5/ Read the text, drag the words in suitable places:

chromium ***corrodes*** ***corrosion*** ***grade*** ***iron***
oxide ***rusty*** ***stainless*** ***steel***

Weathering steel

The perennial problem with mild (1) ..... is that it (2) ..... when exposed to air and water. Generally, the only solution is either to apply a protective coating, or to use another (3) ..... of steel that is resistant to the (4) ..... process – the most well-known being (5) ..... steel, which contains significant quantities of (6) ..... and, often, nickel.

There is, however, an alternative solution. So-called weathering steel is a special alloy suitable for outdoor use. But rather than being completely protected from corrosion, the surface of the steel is allowed to go (7) ..... . Once a layer of (8) ..... has formed on the surface, it stabilizes and forms a hard protective layer. This layer differs from ordinary (9) ..... oxide, as it does not continue to eat into the metal. While not everyone may like the 'rusty look', weathering steel has been widely used in architectural applications and outdoor sculptures.