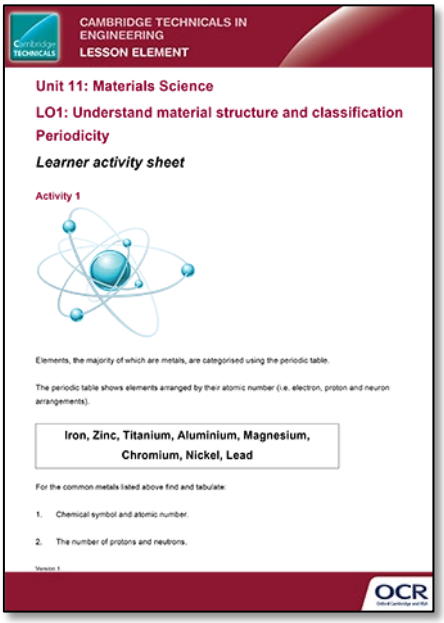
Unit 11: Materials Science

LO1: Understand material structure and classification

Periodicity

Instructions and answers for teachers

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


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 11: Materials Science

LO1: Understand material structure and classification

Periodicity

Learner activity sheet

Activity 1

Elements, the majority of which are metals, are categorised using the periodic table.

The periodic table shows elements arranged by their atomic number (i.e. electron, proton and neuron arrangements).

Iron, Zinc, Titanium, Aluminium, Magnesium, Chromium, Nickel, Lead

For the common metals listed above find and tabulate:

1. Chemical symbol and atomic number.
2. The number of protons and neutrons.

Version 1

OCR

The Activity:

Learners might require an introduction to atomic structures, elements and categorisation using the periodic table before commencing these activities.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

1 hour

Activity 1

1–5. Learners might use internet-based sources in order to answer the questions – tabulating their answers as below:

Element	Chem. Symbol	Atomic Number	Protons	Neurons	Electrons*	Atomic Mass amu	Melting point °C
Iron	Fe	26	26	30	2+8+14+2	55.845	1535
Zinc	Zn	30	30	35	2+8+18+2	65.39	419.58
Titanium	Ti	81	81	123	2+8+18+32+18+3	204.4	1668
Aluminium	Al	13	13	14	2+8+3	26.98	660.37
Magnesium	Mg	12	12	12	2+8+2	24.305	650
Chromium	Cr	24	24	28	2+8+13+1	51.996	1857
Nickel	Ni	28	28	31	2+8+16+2	58.69	1726.15
Lead	Pb	82	82	126	2+8+18+32+18+4	207.2	327.5

* Electrons number is from innermost to outermost shell

Teachers might extend the first part of the activity by tasking learners to sketch the atomic arrangement for each of the element – showing the correct shell position for the electrons.

6. Atomic mass in order:

The following table shows the elements arranged in atomic mass order. Learners should note that the most lightweight elements are magnesium and aluminium, and the heaviest elements are titanium and lead. Learners could further explore the applications of materials across this range, considering strength and weight and strength/weight ratio.

Element	Atomic Mass amu
Magnesium	24.305
Aluminium	26.98
Chromium	51.996
Iron	55.845
Nickel	58.69
Zinc	65.39
Titanium	204.4
Lead	207.2

7. Melting point in order:

The following table orders the elements by melting point. Learners should note that lead has the lowest melting point and chromium the highest. Learners could further explore the effect of melting point on ease of manufacturing using these elements, and in their suitability for different application.

Element	Melting point °C
Lead	327.5
Zinc	419.58
Magnesium	650
Aluminium	660.37
Iron	1535
Titanium	1668
Nickel	1726.15
Chromium	1857

Activity 2

1. Learners should note that these metals are not in the periodic table as they are not pure metals – they are alloys. Alloys are a combination of one or more metals and other elements.

2 and 3. The table below shows the typical composition of each of the alloys along with typical applications. Learners may find further derivatives of each alloy, and further applications.

Alloy	Composition (typical)	Applications
amalgam	mercury + silver, tin, copper, zinc	Dental filling, gold extraction processes
brass	copper and zinc	Nuts, bolts, pipe fittings, taps, electrical terminals, injectors
bronze	copper + tin + manganese	Sculptures, door and window frames, pots, furniture hardware, boat propellers
solder	lead and tin	Electrical solder, solder for pipe fittings
cast iron	iron and carbon + silicon	Bridges, pipes, machine bedplates, engine blocks
steel	iron + carbon + other metals	Bridges, structural beams, cutlers, railway tracks, wire ropes, domestic appliance casings, car bodywork

4. Alloys have properties that are different from the pure metals they contain. This makes them more useful than pure metals alone. This could make them harder than a pure metal, or more resistant to corrosion. It might also increase the strength or durability of the alloyed metal.