3 FORCES ON MATERIALS

Unit 3 looks at the properties of materials, such as flexibility and rigidity, and the way that engineers can use these properties to construct the effective machinery. It also looks at the forces which act on components, like tension and compression, and how engineers have to take these forces into account when constructing machines.

Skills focus

Listening

- preparing for a lecture
- predicting lecture content
- making lecture notes
- using different information sources

Speaking

- reporting research findings
- formulating questions

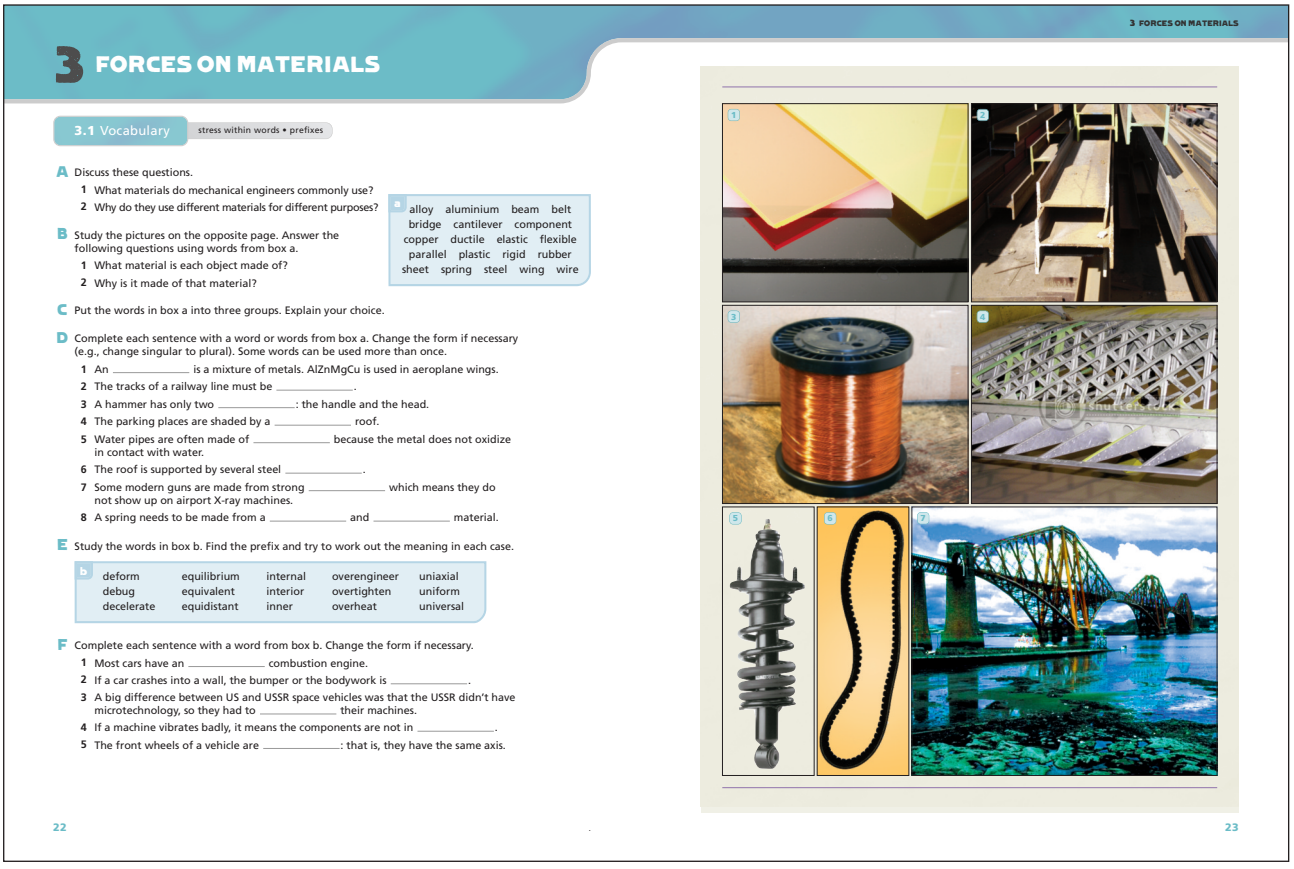
Vocabulary focus

- stress patterns in multi-syllable words
- prefixes

Key vocabulary

alloy	equal (adj)	quality
aluminium	equilibrium	rigid
beam	equivalent	rubber
belt	external	shear
cantilever	flexible	sheet
characteristic	force (n)	spring (n)
component	internal	steel
compression	materials	strain (n)
copper	opposite	stress (n)
deform	overengineer	tension
deformation	parallel	torque
ductile	permanent	underengineer
elastic (adj)	plastic (n and adj)	uniaxial
elasticity	property	wire

3.1 Vocabulary



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3.1 Vocabulary stress within words • prefixes

A Discuss these questions.
1 What materials do mechanical engineers commonly use?
2 Why do they use different materials for different purposes?

a alloy aluminium beam belt bridge cantilever component copper ductile elastic flexible parallel plastic rigid rubber sheet spring steel wing wire

B Study the pictures on the opposite page. Answer the following questions using words from box a.
1 What material is each object made of?
2 Why is it made of that material?

C Put the words in box a into three groups. Explain your choice.

D Complete each sentence with a word or words from box a. Change the form if necessary (e.g., change singular to plural). Some words can be used more than once.
1 An _____ is a mixture of metals. AlZnMgCu is used in aeroplane wings.
2 The tracks of a railway line must be _____.
3 A hammer has only two _____: the handle and the head.
4 The parking places are shaded by a _____ roof.
5 Water pipes are often made of _____ because the metal does not oxidize in contact with water.
6 The roof is supported by several steel _____.
7 Some modern guns are made from strong _____ which means they do not show up on airport X-ray machines.
8 A spring needs to be made from a _____ and _____ material.

E Study the words in box b. Find the prefix and try to work out the meaning in each case.

b deform equilibrium internal overengineer uniaxial debug equivalent interior overtighten uniform decelerate equidistant inner overheat universal

F Complete each sentence with a word from box b. Change the form if necessary.
1 Most cars have an _____ combustion engine.
2 If a car crashes into a wall, the bumper or the bodywork is _____.
3 A big difference between US and USSR space vehicles was that the USSR didn't have microtechnology, so they had to _____ their machines.
4 If a machine vibrates badly, it means the components are not in _____.
5 The front wheels of a vehicle are _____: that is, they have the same axis.

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General note

Read the *Vocabulary bank* at the end of the Course Book unit. Decide when, if at all, to refer your students to it. The best time is probably at the very end of the lesson or the beginning of the next lesson, as a summary/revision.

Dictionaries will be useful in this lesson.

Lesson aims

- gain a greater understanding of the importance of stress within words and some of the common patterns
- extend knowledge of words which contain prefixes
- gain fluency in the target vocabulary

Introduction

1 Revise the vocabulary from the first two units. Check:
   - meaning
   - pronunciation
   - spelling
2 Ask students to name all the different materials they can see in the room. Write the names on the board as they identify items. Ask students why that particular material was used for that purpose. Accept any reasonable answer, but force students to think about the question seriously, e.g., *Why is the door made of wood? Because it is light, cheap and easy to work.*

Exercise A

1 Refer students to the first question. Ask *Which of these materials (on the board) are commonly used in mechanical engineering?* You should be able to elicit at least the following engineering materials:
   - metals, especially steel, possibly aluminium; perhaps you can get them to deduce that there is copper inside wires in the room
   - plastics
   - ceramics
   - wood
   - glass
   - rubber (perhaps holding in the glass of the windows?)

Check pronunciation of these words, especially the stress in the multi-syllable words.

2 Put students in pairs to discuss the second question. Feed back orally. If students know particular words for qualities, e.g., *ductile*, accept but do not try to explain each point to the whole class. Point out that you are going to deal with this later.

Answers

Students may tell you about the qualities/properties of particular materials, but the simple answer is that any engineering material has its own properties/qualities/characteristics (teach all three words), which make it suitable for a particular purpose.

Exercise B

Refer students to the pictures on the opposite page. Set questions 1 and 2 for pairwork. Tell students to select relevant words from the box – there are some extra words. They should also identify each item.

Feed back. As students are naming the items, materials and properties, check/correct pronunciation, especially the stress in the multi-syllable words. Elicit the extra words *(parallel, component)* and check/teach the meanings. Point out that the spring and the fan belt are *components*, i.e., parts of something bigger.

Language note

In British English, the word *aluminium* has five syllables and is stressed on the third syllable. In American English, the word *aluminum* is spelt without the second *i*, has four syllables and is stressed on the second syllable.

Answers

The pictures show:

1 **a plastic sheet** which could be used as a cover for a car port because plastic is light, **flexible** and waterproof

2 a **steel beam** which could be used to support, e.g., a bridge, because it is **rigid** (and, in fact, **flexible** so it can expand and contract with temperature and resonance)

3 a **copper wire** which could be used to carry electricity because copper is **ductile**, i.e., it can be drawn into a wire and is a good conductor

4 an aeroplane **wing**, probably made from an **aluminium** or aluminium **alloy** because it is strong but light (it is probably the alloy AlZnMgCu)

5 a **steel spring** which could be used as a shock absorber in a car because steel made into a spring is **elastic**

6 a **rubber belt** which could be used as a fan belt in a car because rubber is **elastic**

7 a **steel cantilever bridge** which could be used to span a gap because you only need to support it at the ends, not in the middle, which could of course be difficult to do if you are spanning a river or a deep gorge

Methodology note

From now on, whenever you present a group of words in a box, as here, ask students for the part of speech of each word. This is good practice and also good preparation for changing the form of the word if a different part of speech is required in the associated exercise(s).

Exercise C

1 Set for individual work and pairwork checking. After a few moments, check that students have noticed the three groups and can name them – the headings in the table in the Answers section below.

Feed back, building up the table on the board. Point out there is one extra word – *parallel*. Ask students to add one more word to each list.

2 Set for individual work and pairwork checking. Feed back.

Answers

Model answers:

1/2

Material	Quality of the material (adj)	Object
'alloy alu'minium 'copper 'plastic* 'rubber steel	'ductile e'lastic 'flexible 'plastic* 'rigid	beam belt 'cantilever 'bridge com'ponent sheet spring wing wire
ceramic glass textile	dense heavy light	hundreds of possibilities

*Note that *plastic* can be a noun or an adjective. As an adjective, it means a material which can be forced into a shape and it will remain in that shape. Students could check this with a dictionary.

Language note

In English, speakers emphasize the stressed syllable in a multi-syllable word. Sometimes listeners may not even hear the unstressed syllables. Vowels, in any case, often change to schwa or a reduced form in unstressed syllables.

Multi-syllable words may seem to have more than one stressed syllable. This is a secondary stress, e.g., *ˌalu'minium*. For the present purposes, students should identify only the primary, or strongest, stress in the word.

Stress sometimes moves to fit common patterns when you add a suffix, e.g., *e'lastic, elas'ticity.*

Exercise D

Set for individual work and pairwork checking. Feed back orally.

Answers

Model answers:

1 An alloy is a mixture of metals. AlZnMgCu is used in aeroplane wings.
2 The tracks of a railway line must be parallel.
3 A hammer has only two components: the handle and the head.
4 The parking places are shaded by a cantilever/plastic roof.
5 Water pipes are often made of copper because the metal does not oxidize in contact with water.
6 The roof is supported by several steel beams.
7 Some modern guns are made from strong plastic(s) which means they do not show up on airport X-ray machines.
8 A spring needs to be made from a flexible and elastic material.

Exercise E

Set for pairwork. Students should look at all three words to find and then deduce the meaning of the prefix. Encourage them to use a phrase as a definition rather than a single-word translation. They need to develop a sense of the broader meaning of the prefix. Feed back, getting the meanings on the board.

Answers

Model answers:

de = remove from, decrease, change

equi = equal to, the same as, even

in = on the inside, going in

over = more than is necessary

uni = one, all the same as

Exercise F

This is further practice in using words with prefixes. Remind students that they must make sure the form of the word fits into the sentence. If students are struggling, point out that all the missing words are from the top row of the box.

Feed back, checking pronunciation and stress patterns.

Answers

Model answers:

1 Most cars have an internal combustion engine.
2 If a car crashes into a wall, the bumper or the bodywork is deformed.
3 A big difference between US and USSR space vehicles was that the USSR didn't have microtechnology, so they had to overengineer their machines.
4 If a machine vibrates badly, it means the components are not in equilibrium.
5 The front wheels of a vehicle are uniaxial: that is, they have the same axis.

Methodology note

With some of these words it is difficult to work out the base word, e.g., *librium*. However, you can point out that you can sometimes understand roughly what a technical word means if you understand the prefix, e.g., *equilibrium* must be something to do with *equal*, so context will help you to guess the rough meaning.

Closure

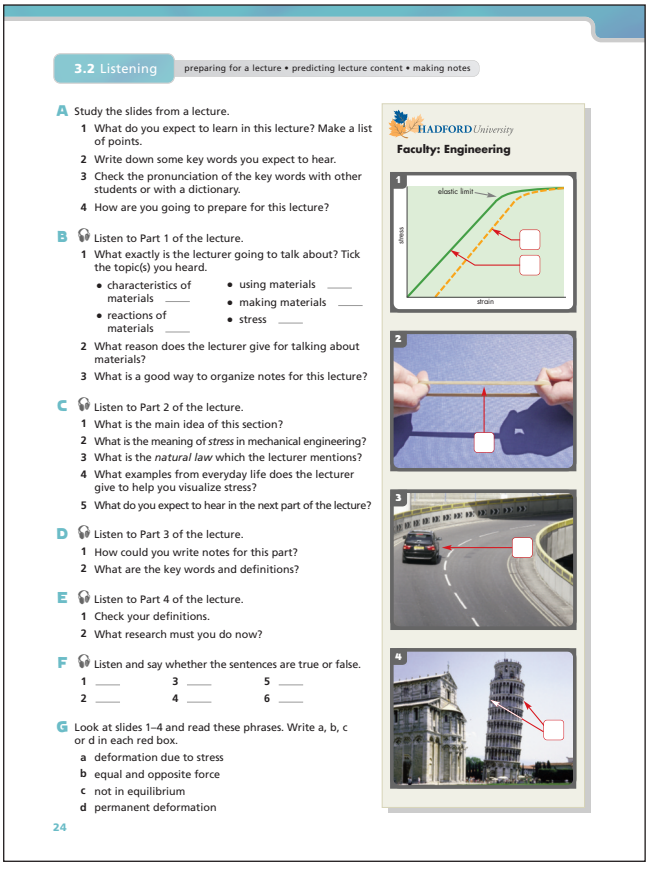
1 Check meanings of words using the pictures. Ideally, copy onto an OHT or other visual medium and work through the materials and properties again.
2 If you have not already done so, refer students to the *Vocabulary bank* at the end of Unit 3. Work through some or all of the stress patterns.

Language note

The patterns shown in the *Vocabulary bank* in Unit 3 are productive, i.e., they enable you to make more words or apply the rules accurately to other words. The words with unusual patterns tend to be the more common ones, so if students come across a new multi-syllable word at this level, it is likely to conform to the patterns shown. Native speakers recognize the patterns and will naturally apply them to unusual words, e.g., proper nouns. How, for example, would you pronounce these nonsense words?

felacom
bornessity
shimafy
emtonology
scolosphere
nemponium
cagoral
andimakinize
ortepanimation

3.2 Listening



3.2 Listening preparing for a lecture • predicting lecture content • making notes

A Study the slides from a lecture.
1 What do you expect to learn in this lecture? Make a list of points.
2 Write down some key words you expect to hear.
3 Check the pronunciation of the key words with other students or with a dictionary.
4 How are you going to prepare for this lecture?

B Listen to Part 1 of the lecture.
1 What exactly is the lecturer going to talk about? Tick the topic(s) you heard.
- characteristics of materials ___
- reactions of materials ___
- using materials ___
- making materials ___
- stress ___

2 What reason does the lecturer give for talking about materials?
3 What is a good way to organize notes for this lecture?

C Listen to Part 2 of the lecture.
1 What is the main idea of this section?
2 What is the meaning of *stress* in mechanical engineering?
3 What is the *natural law* which the lecturer mentions?
4 What examples from everyday life does the lecturer give to help you visualize stress?
5 What do you expect to hear in the next part of the lecture?

D Listen to Part 3 of the lecture.
1 How could you write notes for this part?
2 What are the key words and definitions?

E Listen to Part 4 of the lecture.
1 Check your definitions.
2 What research must you do now?

F Listen and say whether the sentences are true or false.
1 ___ 3 ___ 5 ___
2 ___ 4 ___ 6 ___

G Look at slides 1–4 and read these phrases. Write a, b, c or d in each red box.
a deformation due to stress
b equal and opposite force
c not in equilibrium
d permanent deformation

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1 elastic limit stress strain
2
3
4

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Lesson aims

Further practice in:

- planning and preparing for a lecture
- predicting lecture content
- choosing the best form of notes
- making notes

Introduction

Review key vocabulary by:

- using flashcards
- playing the alphabet game in the extra activities section at the end of this unit

Exercise A

Refer students to the handout with the slides. Write the title *Forces on materials in engineering* on the board.

1 Set for individual work and pairwork checking. Feed back, eliciting some ideas.
2 Brainstorm to elicit key words. Allow the class to decide whether a word should be included.
3 Set for pairwork.
4 Elicit some points – the four Ps (Plan, Prepare, Predict, Produce). If necessary, refer students to Unit 1 *Skills bank* to review the preparation for a lecture. One way to help the students to make provisional notes is to:

- brainstorm what they would include
- organize their topics into a logical sequence

Answers

Answers depend on the students.

Exercise B

1 Tell students they are only going to hear the introduction to the lecture. Ask what information they expect to get from the introduction (i.e., the outline of the lecture). Give students time to read the choices of topics. Check that they understand the meaning and relevance. Remind them they will only hear the introduction once, as in a lecture. Play Part 1. Allow them to compare answers.

   Feed back. Ask them to justify their choice by saying what they heard related to it. Confirm the correct answer.
2 Elicit ideas. Confirm or correct.
3 Elicit ideas.

Answers

Possible answers:

1 reactions of materials; stress
2 Choosing the correct materials for components is fundamental to good design.
3 Perhaps into a table with materials and their reactions, or headings with bullet points, e.g.,

Features of stress
- …
- …
- …

Reactions of materials
- …
- …
- …