CAMBRIDGE Professional English

Cambridge English for Engineering

Mark Ibbotson

Series Editor: Jeremy Day

With Audio CDs

UNIT 1 Technology in use

- Describing technical functions and applications
- Explaining how technology works
- Emphasising technical advantages
- Simplifying and illustrating technical explanations

Describing technical functions and applications

1 a In pairs, think about two or three products you use regularly and discuss the following questions.

- What are the main functions of the products? (What do they do?)
- What are their different applications? (What are they used for?)

b What do you know about Global Positioning System (GPS) devices? In pairs, describe their main function, and give some examples of different applications of GPS devices.

2 a ▶1.1 Paula, a design engineer for a GPS manufacturer, is discussing product development with José, a senior manager new to the company. Listen to the conversation and complete the following notes.

• the primary application of GPS	(1) ______________________
• associated applications	Tracking systems for (2) ______________
	Tracking systems for (3) ______________
• more creative features	(4) ______________________ alarms
	(5) ______________________ buttons
• not technical innovations	(6) ______________________ the technology

b Complete the following extracts from the discussion with words that come from *use*.

1 *Then you've got associated applications, ______ that are related to navigating ...*

2 *... tracking systems you can ______ for monitoring delivery vehicles ...*

3 *... from the end-______ point of view, accuracy is no longer the main selling point. Most devices are accurate enough. The key is to make them more ______ .*

3 a Match the GPS applications (1–6) to the descriptions (a–f).

1	topographical surveying	a	navigation and safety at sea
2	geological exploration	b	setting out positions and levels of new structures
3	civil engineering	c	mapping surface features
4	avionics equipment	d	applications in mining and the oil industry
5	maritime applications	e	highway navigation and vehicle tracking
6	GPS in cars and trucks	f	air traffic control, navigation and autopilot systems

b In pairs, practise explaining the applications of GPS in Exercise 3a to a colleague who has limited knowledge of the devices using the following phrases.

used for -ing   used to   useful for   another / a similar use

4 a Complete the following extracts from the conversation by underlining the correct words.

1 *... there's a setting on the GPS that* ***allows/prevents*** *it to detect the movement ...*

2 *... an alarm sounds to warn you, and* ***allows/prevents*** *the boat from drifting unnoticed.*

3 *... and* ***enables/ensures*** *that you don't lose track of where you were, which then* ***enables/ensures*** *you to turn round and come back to the same point ...*

b Match the words in Exercise 4a to the synonyms.

1 ______ = makes sure   2 ______ / ______ = permits   3 ______ = stops

c Complete the following extract from the user's manual of a GPS device using the verbs in Exercise 4a. Sometimes, more than one answer is possible.

INTRODUCTION

The core function of your GPS receiver is to (1) ______ you to locate your precise geographical position. To (2) ______ the device to function, it receives at least three signals simultaneously from the GPS constellation – 30 dedicated satellites which (3) ______ receivers can function anywhere on earth. To (4) ______ extremely precise positioning and (5) ______ errors from occurring due to external factors, this device is designed to receive four separate signals (see enhanced system accuracy on page 18).

5 In pairs, explain the main functions and applications of a product made by your company or a product you know about. Student A, you are an engineering manager; Student B, you are a new employee. Use the language from this section and the phrases in the box. Swap roles and practise again.

I see. So ...   OK. In other words ...   So you mean ...

Explaining how technology works

6 a In pairs, look at the picture and discuss the following questions.

- How do you think a space elevator would work?
- What could it be used for?
- What technical challenges would it face?
- How seriously do you think the concept of space elevators is being taken at present?

b Read the following article and compare it to your answers in Exercise 6a.

Space elevators: preparing for takeoff

IN his 1979 novel, *The Fountains of Paradise*, Arthur C Clarke wrote about an elevator **connecting** the earth's surface to space. Three decades later, this science-fiction concept is preparing to take off in the real world. NASA has launched the Space Elevator Challenge, a competition with a generous prize fund, and several teams and companies are working on serious research projects aimed at winning it.

As its name suggests, a space elevator is designed to **raise** things into space. Satellites, components for space ships, supplies for astronauts in space stations, and even astronauts themselves are examples of payloads that could be **transported** into orbit without the need for explosive and environmentally unfriendly rockets. However, the altitude of orbital space – a colossal 35,790 km above the earth – is a measure of the challenge facing engineers. How could such a height be reached?

The answer is by using an incredibly strong and lightweight cable, strong enough to **support** its own weight and a heavy load. The design of such a cable is still largely theoretical. This would be **attached** to a base station on earth at one end and a satellite in geostationary orbit (fixed above a point on the equator) at the other. Lift vehicles would then **ascend** and **descend** the cable, **powered** by electromagnetic force and **controlled** remotely.

c Match the verbs (1–9) from the text in Exercise 6b to the definitions (a–i).

1	connecting	a	carried (objects, over a distance)
2	raise	b	hold something firmly / bear its weight
3	transported	c	climb down
4	support	d	provided with energy / moved by a force
5	attached	e	joining
6	ascend	f	driven / have movement directed
7	descend	g	fixed
8	powered	h	climb up
9	controlled	i	lift / make something go up

7 a James, an engineer, is giving a talk on space elevators. Complete his notes using the correct form of the verbs (1–7) in Exercise 6c.

Space Elevators

- *Challenge of (1) connecting a satellite to earth by cable is significant.*
- *To (2) ________ its own weight, and be securely (3) ________ at each end, cable would need phenomenal strength-to-weight ratio.*
- *How could vehicles be (4) ________ into space, up cable?*
- *Self-contained energy source problematic, due to weight (heavy fuel or batteries required to (5) ________ vehicle).*
- *Two possible ways round problem:*
  1 Transmit electricity wirelessly. But technique only at research stage.
  2 Solar power. But would only allow vehicle to (6) ________ slowly. Not necessarily a problem, as car could be controlled remotely, allowing it to (7) ________ payloads unmanned.

b ▶1.2 **Listen to part of James' talk and check your answers in Exercise 7a.**

c **What kinds of word are missing from the notes? In pairs, compare the audioscript on page 86 with the notes in Exercise 7a.**

8 a **Some space elevator designs propose an offshore base station. In pairs, discuss how such a system might work using words in Exercise 6c. What advantages might an offshore base have compared with a land base?**

b ▶1.3 **James goes on to discuss offshore base stations. Listen to the talk and answer the following questions.**

1 How would an offshore base station be supported?
2 What would the function of its anchors be?
3 How would payloads reach the base station?
4 What problem would a mobile base station help to prevent?
5 What would the procedure be if there was an alert?

9 a **You are members of a space elevator research team designing a concept for offshore base stations. In pairs, analyse the notes below, which were made during a briefing given by your manager. Imagine you are giving a presentation. Begin by reading out the abbreviated notes in full.**

OFFSHORE BASE STATION – ANCHORING & PROPULSION ISSUES

Anchoring system

Wind loads on cable will be huge. What implications for anchoring system? Base will need to be moved continually, sometimes urgently. What temp system could be used to hold base in position?

Base in shallow water near coast, or deep water further offshore? Choice will have impact on design of anchor system.

Propulsion system

Will weight of cable allow base to be moved by own propellers? Or more powerful system for propulsion and control nec.? E.g. extern. power source?

b **In pairs, discuss the questions raised in the notes and think of some suitable solutions for the anchoring system and the propulsion system. At this stage, these should be overall concepts, not detailed designs. Remember to make notes.**

c **In small groups, take turns to give a short talk using your notes to explain how the systems work, in general terms. Imagine you are speaking to a small group of colleagues, including your manager.**

d **Write two or three paragraphs to summarise your talk. These will be included in your manager's longer report on offshore base stations.**

Emphasising technical advantages

10 **In pairs, discuss the term *technical advantage*. Give some examples of technology you are familiar with.**

11 a **Read the first paragraph of some promotional literature from Otis, a leading elevator company. What is the Gen2™ system?**

b **Match the words (1–6) from the text in Exercise 11a to the synonyms (a–f).**

1	conventional	a	decreases
2	eliminates	b	better / the best
3	superior	c	improved
4	energy-efficient	d	standard, usual
5	enhanced	e	gets rid of
6	reduces	f	has low energy consumption

c **Complete the following text using the correct form of the words (1–6) in Exercise 11b. You will need to use some words more than once.**

OTIS Unique Flat Belt

The key to Otis's patented drive technology

At the heart of the Gen2™ elevator system is a flat belt (developed by and unique to Otis). It is just 3mm thick. Yet it is stronger than **conventional** steel cables. It lasts up to three times longer. And it has enabled Otis to completely re-invent the elevator. The flat, coated-steel belt totally **eliminates** the metal-to-metal effect of conventional systems. Coupled with a smooth-surface crowned machine sheave, the result is exceptionally quiet operation and **superior** ride comfort. Furthermore, the flexible flat belt enables a more compact, **energy-efficient** machine, which can be contained in the hoistway. This **enhanced** technology **reduces** building and system operating costs, and frees up valuable space.

Protecting the environment

Neither the belt nor the gearless machine, with its permanently sealed bearings, requires any lubrication so the Gen2™ system is cleaner for the environment. The highly (1) energy-efficient gearless machine, with its permanent-magnet synchronous motor, (2) ________ power consumption by as much as 50 percent over (3) ________ geared machines and 15 percent over other machines with permanent-magnet motors of axial construction.

Reliable by design

Long-lasting flat belts, smooth, crowned sheaves and minimal moving parts in the gearless machine dramatically (4) ________ wear and increase durability and efficiency. To further (5) ________ reliability and safety, Otis developed the Pulse™ system, which continually monitors the status of the belts' steel cords. Unlike visual inspections of (6) ________ steel ropes, the Pulse™ system automatically detects and reports belt faults to maintenance personnel for rapid response, providing owners with greater peace of mind. With flat belt technology, Otis has created a (7) ________ system that (8) ________ the need for a machine room, is quiet, clean, reliable and economical, and easy to install and maintain.

d **In pairs, summarise the advantages of the flat belt system. Discuss durability, wear, noise, space, cleanliness, efficiency, automation, maintenance and cost.**

12 **a Complete the following tips on emphasising technical advantages using the words in the box.**

conventional eliminated enhanced reduced superior

When describing technical advantages, it's useful to emphasise ...

a (1) ___________ performance, compared with the older model of the same product.

b negative issues that have been (2) ___________ , or completely (3) ___________ .

c special features that differentiate the technology from (4) ___________ systems.

d performance levels that make the technology (5) ___________ to the competition.

b ▶1.4 **Stefan, an engineer, is briefing some sales colleagues on the advantages of a new pump design. Listen to the briefing and match the tips (a–d) in Exercise 12a to the extracts (1–4).**

Extract 1 _____ Extract 2 _____ Extract 3 _____ Extract 4 _____

c Complete the following sentences from the briefing by underlining the correct emphasising word.

1 *We've come up with a* ***completely/significantly*** *unique profile.*
2 *It* ***completely/dramatically*** *reduces vibration.*
3 *Machines like these can never be* ***entirely/highly*** *free from vibration.*
4 *The new design runs* ***dramatically/extremely*** *smoothly.*
5 *Another advantage of the new profile is that it's* ***considerably/entirely*** *lighter.*
6 *So compared with our previous range, it's* ***highly/totally*** *efficient.*
7 *Trials so far suggest the design is* ***completely/exceptionally*** *durable.*
8 *We expect it to be* ***entirely/significantly*** *more reliable than rival units.*

d Match the words in Exercise 12c to the synonyms.

considerably dramatically entirely exceptionally highly totally

1 ___________ / ___________ = completely
2 ___________ / ___________ = significantly
3 ___________ / ___________ = extremely

13 **You are Otis engineers back in the 1850s, when elevators were new. In pairs, prepare a short talk to brief your sales colleagues on the advantages of elevators for lifting people and goods. Emphasise the points below, using the phrases and techniques from this section. Remember that people at this time are sceptical about the technology.**

Elevators are ...

- safe – a reliable braking system eliminates the danger of a car falling if a cable fails
- simple – they're controlled from the car and are very easy to operate
- convenient – they're easier on the legs than the conventional alternative (stairs)
- valuable – they enhance the value of land by allowing taller buildings on smaller areas

Simplifying and illustrating technical explanations

14 a ▶1.5 **Richard, a structural engineer, often takes clients on guided tours of their new buildings during construction. He is talking about explaining technical concepts to non-specialists. Listen and answer the following questions.**

1 What does Richard say about explaining technical concepts?
2 What does he mean by *dull* explanations?
3 What is *being patronising*?

b In pairs, think of some tips on how to solve the following problems.

1 not being understood
2 being patronising
3 explaining difficult concepts
4 sounding dull

c ▶1.6 **Richard is giving some advice about the problems in Exercise 14b. Listen and summarise his ideas. Compare his tips with your suggestions.**

15 a Richard has made notes for a guided tour of a site. The project is a skyscraper in the early stages of construction. During the tour he explains the technical terms to the non-specialist group. In pairs, discuss the following terms and try to interpret them using everyday language to rephrase them.

SUBSTRUCTURE

- *Pile foundations (in general)*
- *Bored in situ concrete piles*
- *Pre-cast driven concrete piles*
- *Pile driver*
- *Pile auger*
- *Bentonite*

b ▶1.7 **Richard is giving a tour of a construction site. Listen and make notes of his explanations of the following technical terms. Compare your ideas with his.**

1 the substructure the part of the structure below ground
2 a pile foundation ....
3 to bore (a pile) ....
4 in situ concrete ....
5 pre-cast piles ....
6 to drive in (a pile) ....
7 a pile driver ....
8 a pile auger ....
9 bentonite ....

c **Listen again and compare Richard's explanations with the tips in Exercise 14c. Which techniques did he use? Were they successful?**

d **Complete the following table using the words in the box.**

basically (x2) call effectively essentially imagine other picture refer ~~simple~~ simply

Function	Words / Phrases
1 Simplifying the language	in simple terms / put _____ / in _____ words / _____
2 Simplifying the concept	_____ / _____ / _____
3 Focusing on technical terms	what we _____ / what we _____ to as
4 Illustrating with images	if you _____ / if you _____

e **In pairs, practise explaining the technical terms in Exercise 15a using the simplified words and phrases in Exercise 15d.**

16 **Read the textbook description of two types of pile foundation. Use the words and phrases in Exercise 15d and the following notes to rephrase it.**

From a structural perspective, pile foundations can be divided into two categories: end-bearing piles and friction piles.

Imagine water and the seabed

End-bearing piles are driven or bored through soft ground in order to attain firm substrata below. The pile then transmits load vertically to firm subsoil or bedrock. The soft ground surrounding the sides of the pile is structurally redundant.

Like standing on stilts in water

Friction piles counteract downward loads from the structure through frictional resistance between the sides of the pile and the surrounding ground, and do not therefore rely on firm substrata. In some cases, the diameter of the concrete at the pile's base is widened by compaction, allowing the increased area to give the friction pile a certain degree of end-bearing resistance.

Like a nail in wood

Imagine a leg and a foot

17 **You are showing a non-specialist visitor around your company and explaining technical concepts using simplified language. In pairs, practise explaining a product or type of technology that you are familiar with.**

UNIT 2 Materials technology

- Describing specific materials
- Categorising materials
- Specifying and describing properties
- Discussing quality issues

Describing specific materials

1 **In pairs, discuss the benefits and problems of recycling. Use the following examples and your own ideas.**

breaking up ships demolishing buildings recycling electronics scrapping cars

2 a **Read the following web page and complete the missing headings using the words in the box.**

Aluminium Copper Glass Plastic Rubber ~~Steel~~ Timber

RECYCLABLE MATERIALS

1 Steel Scrap can be sorted easily using magnetism. If the metal is galvanised (coated with zinc) the zinc is fully recyclable. If it is stainless steel, other metals mixed with the iron, such as chromium and nickel, can also be recovered and recycled. More ...

2 ________ Sorting is critical, as there are key differences between the clear and coloured material used in bottles and jars, and the high-grade material used in engineering applications, which contains traces of metals. More ...

3 ________ Scarcity makes recycling especially desirable, and justifies the cost of removing insulation from electric wires, which are a major source of scrap. Pure metal can also be recovered from alloys derived from it, notably brass (which also contains quantities of zinc, and often lead) and bronze (which contains tin). More ...

4 ________ The cost of melting down existing metal is significantly cheaper than the energy-intensive process of electrolysis, which is required to extract new metal from ore. More ...

5 ________ Hardwood and softwood can be reused. However, the frequent need to remove ironmongery and saw or plane off damaged edges, can make the process costly. More ...

6 ________ Tyres are the primary source of recyclable material. These can be reused whole in certain applications. They can also be ground into crumbs which have varied uses. More ...

7 ________ An obstacle to recycling is the need to sort waste carefully. While some types can be melted down for reuse, many cannot, or result in low-grade material. More ...

b **Match the materials from the web page (1–8) in Exercise 2 to the definitions (a–h).**

1	stainless steel	a	a metal used to make brass, and in galvanised coatings on steel
2	zinc	b	the predominant metal in steel
3	iron	c	a type of steel not needing a protective coating, as it doesn't rust
4	bronze	d	a dense, poisonous metal
5	lead	e	rocks from which metals can be extracted
6	hardwood	f	an alloy made from copper and tin
7	ore	g	timber from pine trees
8	softwood	h	timber from deciduous trees

c **Complete the following sentences using *from*, *with* or *of*.**

1 Bronze contains significant amounts __of__ copper.
2 Galvanised steel is steel coated ______ zinc.
3 Steel is an alloy derived ______ iron.
4 Pure metals can usually be recovered ______ alloys.
5 To produce stainless steel, iron is mixed ______ other metals.
6 Stainless steel contains quantities ______ chromium and nickel.
7 Glass tableware contains traces ______ metals, such as lead.
8 When new metal is extracted ______ ore, the costs can be high.

d **In pairs, ask and answer questions about different materials using the following phrases.**

Can ... be recycled? What's ... made from? Where does ... come from?

3 **a** **Irina, an ecological adviser, is talking to a group of engineers on a training course about environmentally friendly design. In pairs, discuss the ideas from her slide and give some examples.**

Environmental audit

Product phases:

- Pre-use
- In use
- Post-use

b **▶2.1 Listen to an extract from the talk and compare your ideas with what Irina says. What example does she use to illustrate her main point?**

c **▶2.2 Irina asks the engineers to do a simplified environmental audit. Their task is to compare steel and aluminium car bodywork from an ecological perspective. Listen to Sophia and Pete, two of the engineers, discussing the topic and make notes of their ideas.**

d **In pairs, do an environmental audit for the following applications and materials. Use the words and phrases in the box.**

	Application	Materials
1	electrical wires in vehicles	copper and aluminium
2	external walls in houses	bricks and softwood

as far as I know ... I think so / I'd say so I'm (not) sure
that's an important consideration that needs to be researched
coated derived mixed recovered recycled

Categorising materials

4 **What do you know about braking systems? In pairs, discuss the following questions.**

1 Generally speaking, what do brakes do and how do they work?
2 What kinds of material are used in brake pads and brake discs in different vehicles?

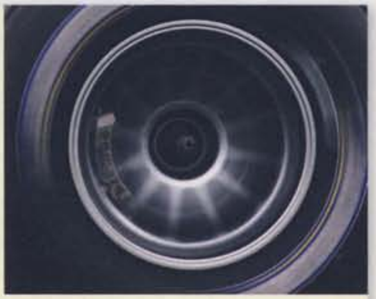
5 a **Read the article on braking systems. In the title of the article, what do the colours green and red refer to?**

b **In pairs, answer the following questions.**

1 Why do most braking systems waste energy?
2 What are regenerative braking systems, and how do they save energy?
3 What characteristics are required of materials used for the brakes on racing cars?
4 What is meant by *heat soak*, and why is it a problem in racing cars?

GREEN BRAKES

– A RED HOT TOPIC IN MOTOR RACING



As motor racing goes green, Formula 1 is aiming to lead automotive research in finding hi-tech efficiency gains. One of the keys to this ecological drive is regenerative braking (also known as kinetic energy recovery), which recovers energy generated during deceleration, and stores it as a source of power for subsequent acceleration.

Regenerative brakes limit the energy loss inherent in traditional braking systems. In most vehicles, conventional brakes comprise pads previously made from asbestos-based composites, but now consisting of **compounds*** of **exotic**, non-hazardous materials, and discs made of **ferrous** metal. The resulting friction generates heat, which is wasted. In performance cars, this phenomenon is taken to extremes, and due to the high temperatures generated, brake discs are often made out of **ceramics**.

The carbon discs and pads used on Formula 1 cars generate so much heat that they glow red hot. High temperatures are, in fact, necessary for the effective operation of carbon brakes. But there's still plenty of potential for recovering the kinetic energy, rather than merely dissipating it in the form of heat.

The potential for recovering energy also extends to the heat generated by engines and exhaust systems. This area has also been discussed as a possible area for future exploitation in motor racing. Heat recovery might offer the added benefit of reducing heat soak (thermal absorption by the chassis) as delicate **alloy** parts and sensitive **non-metallic** materials, such as **polymers**, are susceptible to heat damage.

c **Match the materials from the text (1–7) to the descriptions (a–g).**

1	compounds	a	materials that are not metal
2	exotic	b	iron and steel
3	ferrous	c	combinations of materials
4	ceramics	d	mixture of metals
5	alloy	e	plastic materials
6	non-metallic	f	minerals transformed by heat
7	polymers	g	rare or complex

d **In pairs, take turns to describe an object using the words from Exercise 5c and the phrases in the box. Ask your partner to guess what it is.**

comprise consist of made from made of made out of

6 a **You are going to give a talk on composites technology at a construction materials trade fair. In part of the talk, you focus on reinforced concrete as a well-known example of a composite material. Prepare your talk using words and phrases from this section and the following notes.**

Composite materials

Common example: reinforced concrete (very widely used composite)

Cement (derived from lime)

Aggregate – fine aggregate (sand) + coarse aggregate (gravel or crushed stone)

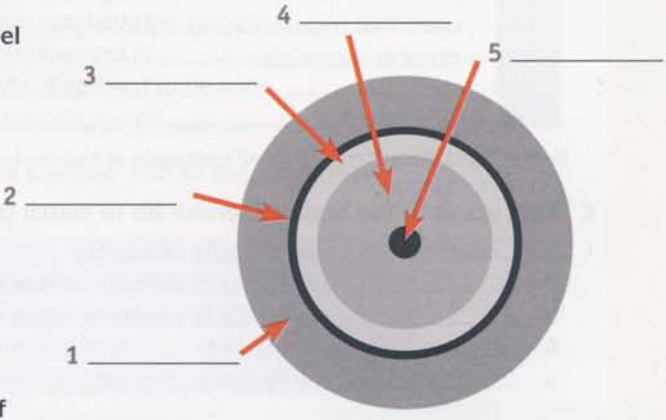
Water + chemical additives (e.g. plasticiser to improve workability)

Reinforcement (steel bars, fixed together with steel tie wire)

b **In small groups, take turns to give your talk.**

c **Margit, a sales engineer, is describing a high-voltage cable. Before you listen, label the cross-section with the parts (a–e).**

a insulation
b waterproof membrane
c outer jacket
d armoured protection
e conductor



d **▶2.3 Listen to the description and check your answers in Exercise 6c.**

e **Match the parts of the cable (a–e) in Exercise 6c to the following categories of materials (1–5). You will need to use some parts more than once.**

1 non-metallic a ______ ______
2 metallic ______ ______
3 ferrous metal ______
4 non-ferrous metal ______
5 polymer-based ______ ______ ______

7 **Imagine you are presenting a product or appliance you know well to a potential client. Describe the categories of material used to make the different parts.**

Specifying and describing properties

8 a In pairs, discuss what you know about the properties of Kevlar® and how it is used.

b Read the following extract from DuPont™'s technical guide to Kevlar®. Compare the information with your ideas from Exercise 8a.

WHAT IS KEVLAR®?

DuPont™ KEVLAR® is an organic fiber in the aromatic polyamide family. The unique properties and distinct chemical composition of KEVLAR® distinguish it from other commercial, man-made fibers.

KEVLAR® has a unique combination of high modulus, toughness, abrasion resistance and thermal stability. It was developed for demanding industrial and advanced-technology applications. Currently, many types of KEVLAR® are produced to meet a broad range of end uses that require strong, lightweight, durable materials.

Copyright DuPont de Nemours

DuPont™ and Kevlar® are registered trademarks or trademarks of E.I.du Pont de Nemours Company or its affiliates

c Find words in the text in Exercise 8b to match the following definitions.

1 toughness = the opposite of fragility
2 ____________ = resistance to damage caused by friction
3 ____________ = resistance to problems caused by temperature change
4 ____________ = long-lasting
5 ____________ = the opposite of heavy

9 a Match the automotive parts (1–5) to the descriptions (a–e).

1	drive belts	a	sheets inserted between parts to prevent gas or fluid leakage
2	brake pads	b	pneumatic envelopes in contact with the road surface
3	tyres	c	flexible bands used in transmission systems
4	sealing gaskets	d	protective barriers capable of resisting gunshots
5	bullet-resistant armour	e	pads pressed against discs to induce deceleration

b Read the information from DuPont™ on the following page explaining some of the automotive applications of Kevlar®. Complete the text using the automotive parts in Exercise 9a.

Car and truck (1) ______ have incorporated Kevlar® into their construction because it offers superb puncture, abrasion and tear resistance.

The high modulus and abrasion resistance of Kevlar® help (2) ______ retain their original shape and tension over the millions of revolutions they go through over the lifespan of a vehicle.

The frictional forces that (3) ______ are designed to endure take less of a toll on those made with Kevlar® pulp. The enhanced thermal stability and inherent abrasion resistance of Kevlar® allow them to last long and stop the vehicle safely and quietly.

Kevlar® provides an effective, lightweight (4) ______ solution for vehicles that require protection against ballistic attack, allowing cars and light trucks to retain most of their original handling characteristics.

Chemical stability and thermal stability help make (5) ______ reinforced with Kevlar® pulp strong and durable. The galvanic corrosion resistance of Kevlar® also contributes to improved long-term engine performance.

c **In pairs, discuss why the properties of Kevlar® are especially important for each application described in the text.**

a **▶2.4 Listen to a conversation about the properties of materials used in a specific type of tool and answer the following questions.**

1 Where does the conversation take place?
2 What tool is being discussed?
3 Which materials can be used for its different parts?

b **Complete the following extracts from the conversation using the properties in Exercise 8c. Listen again and check your answers.**

1 The handle mustn't be heavy. *Ideally, you want it to be* ______ .
2 Resisting friction is essential. *The key requirement is* ______ ______ .
3 The bur has to be built to last. *Obviously, they need to be very* ______ .
4 Heat builds up in the bur. *You need a good degree of* ______ ______ .

c **Match the words and phrases (1–5) from Exercise 10b to the synonyms (a–e).**

1	ideally	a	it's clear that
2	obviously	b	for the best results
3	the last thing you want	c	the most important factor
4	the key requirement	d	a lot of / a high level of
5	a good degree of	e	the worst situation

a **You work for a manufacturer of hand tools and have been asked to investigate using alternative materials in your products. In pairs, read the notes and discuss the main properties required of the materials used to make the tools.**

Hammers a) Joiners' hammers (for nails)
b) Lump hammers (for masonry chisels)
Consider the hammer head and the hammer shaft.

Saws a) Wood saws (for cutting wood)
b) Hacksaws (for cutting metal)
Consider the saw blade and the saw handle or frame.

b **Think of a product you know well.**
In pairs, discuss the materials used in it and what properties make the materials suitable. Discuss whether alternative materials could be used.

Discussing quality issues

12 **In pairs, answer the following questions.**

1 In advertising, what hi-tech, high-performance situations are often used to promote watches?
2 What messages are they intended to send about the quality of products?
3 What quality issues differentiate higher-quality watches from lower-quality ones?
4 What is the difference between describing something as water-resistant and waterproof?

13 **a** ▶2.5 **Louisa, a marketing executive for a watch manufacturer, is discussing material selection with Tom, one of her engineering colleagues. Listen to the discussion and complete the four quality issues that are mentioned in the meeting.**

1 ______ resistance
2 ______ resistance
3 ______ resistance
4 ______ resistance

b **In pairs, discuss what is meant by each of the quality issues in Exercise 13a.**

14 **a** ▶2.5 **Listen again and answer the following questions.**

1 What point does Tom make about the reasons for selecting materials?
2 What does he say about submarine-grade steel to exemplify the above point?
3 What problem does he describe with regard to the marketability of many materials?
4 What hard commercial fact does Louisa give?

b **In pairs, mark the following statements True (T) or False (F) according to the views expressed in the conversation. Read the audioscript on page 87 and check your answers.**

1 Often, exotic-sounding materials are not that suitable, technically.
2 People think that a submarine steel watch must be tremendously water-resistant.
3 The corrosion resistance of submarine steel is exceptionally good.
4 Submarine-grade steel looks fairly good.
5 Tom thinks submarine steel is particularly suitable for watches.
6 The firm has often used materials that are not adequately durable.
7 Often, the compositions of good watch materials are relatively complex.
8 Materials with complicated names are pretty good for marketing.

c ▶2.6 **Listen to the following phrases from the conversation and underline the stressed syllable. Practise saying the phrases.**

1 not particularly suitable
2 exceptionally resistant
3 not at all suitable
4 tremendously marketable
5 relatively complex
6 not all that good

d **Complete the following table using the words in the box.**

~~exceptionally~~ fairly insufficiently not adequately not (all) that not particularly pretty relatively tremendously

extremely	quite	not very	not enough	definitely not
exceptionally	________	________	________	________
________	________	________	________	
	________			

15 **In pairs, discuss the key properties and different types and grades of the following materials. Give examples of the properties that make each material good or bad for watch-making, from a quality perspective.**

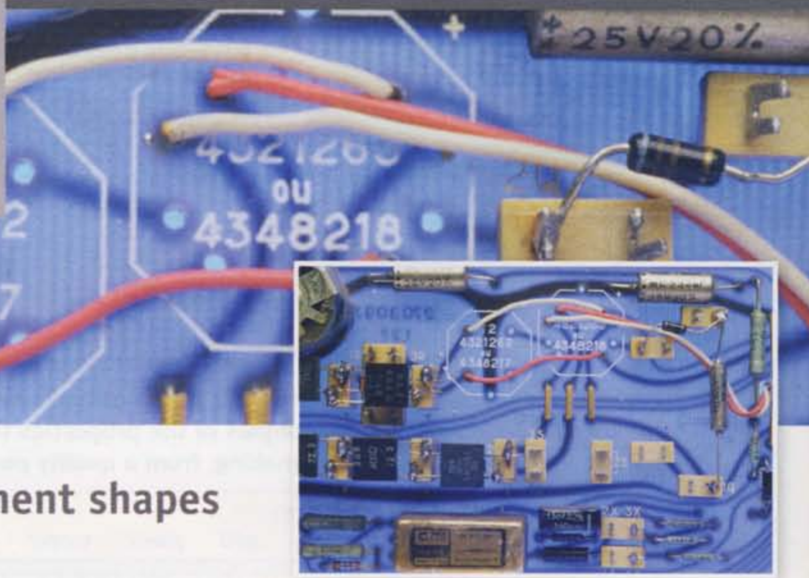
Materials
steel glass aluminium titanium gold plastic copper rubber

Properties
water-resistant abrasion-resistant corrosion-resistant shock-resistant tough brittle elastic durable heavy lightweight thermally stable

16 **In small groups, choose a well-known consumer product or appliance and discuss it from a quality perspective. How suitable are the materials used? How good is the product, compared with others sold by competitors?**

UNIT 3 Components and assemblies

- Describing component shapes and features
- Explaining and assessing manufacturing techniques
- Explaining jointing and fixing techniques
- Describing positions of assembled components



Describing component shapes and features

1 **What do you know about the electrical plugs and sockets used in different countries? In pairs, describe some specific designs.**

2 a ▶3.1 **Jan, a project manager for a firm that manufactures electrical plugs and sockets, is briefing some of his engineering colleagues. Listen to the briefing and summarise the aim of the project.**

b **In pairs, discuss what is meant by *profile of the pins* and *standard configuration*.**

c ▶3.2 **Erin, an engineer with the same company, is describing different electrical plug and socket formats during the briefing. Listen and match the descriptions (1–6) to the pictures (a–f).**

a ______

b ______

c ______

d ______

e ______

f ______

d **Complete the following phrases from the descriptions using adjectives based on the words in brackets.**

1 *... there are* circular *pins for live and neutral.* (circle)
2 *... the earth slot's got a flat base with one side* ________ *over to form a semi-circle.* (round)
3 *This one has* ________ *blades for live, neutral and earth ...* (rectangle)
4 *... it has a* ________ *slot to receive the earth pin.* (cylinder)
5 *... the pins are arranged in* ________ *configuration.* (line)
6 *... they're laid out in* ________ *configuration.* (triangle)

e **3.3 Listen and underline the stressed syllable in each of the following words.**

rectangle	rectangular	triangle	triangular
cylinder	cylindrical	line	linear

3 a **3.4 Listen to a longer description from the meeting. Which picture (a–f) in Exercise 2c does Erin describe?**

b **Complete the following extracts from the description using the correct form of the words in the box.**

flush with   groove   ~~hole~~   pin   recess   ridge   set back

1 *... there's a circular slot at the top. It's obviously a blind* hole*, it doesn't go right through.*
2 *... there are two plastic* ________ *, one on either side of the plug casing, and they slot into corresponding* ________ *at each side of the socket. In addition, the centre of the socket is* ________ *. So rather than being* ________ *the front of the socket, on the same face, the circular area that receives the plug is* ________ *from the surrounding casing ...*
3 *These covers only open when pressure is applied to both by the two* ________ *of the plug simultaneously.*

c **In pairs, describe the different plug and socket formats in the pictures in Exercise 2c.**

4 a **3.5 Andy and Karin, two electrical engineers, are evaluating a plug and socket format in Exercise 2c. Listen to the conversation and make notes of the advantages and disadvantages of the following features.**

1 Plug slots into a recess in the socket:
Advantages ________
Disadvantages ________
2 Covers protect live and neutral slots:
Advantages ________
Disadvantages ________

b **In pairs, discuss the advantages and disadvantages of the plug and socket formats in Exercise 2c. Use the following phrases from the conversation.**

an advantage/disadvantage of this format is ...   another advantage/disadvantage is ...
the problem with this system is ...   this (shape/format/feature) stops ... from ... -ing
this (shape/format/feature) allows it to / helps it to / makes it easy to / makes it difficult to ...

Explaining and assessing manufacturing techniques

5 **In pairs, think of some examples of machining operations that are often used in manufacturing involving metalworking.**

6 a ▶3.6 **Evan, a sales engineer with a metal fabrication company, is showing Mr Barrett, a new customer, around their plant. Listen to the conversation and mark the statements True (T) or False (F).**

1 The company specialises in sheet metal working.
2 The company does a lot of metal casting.
3 Metal bashing is a precise technical term for hammering.
4 Drills and milling machines are always noisy.
5 Grinding is a process that uses abrasives.
6 The press is used for shearing metal.

b **Complete the following training material for graduate engineers using the words in the box.**

Drilling	Flame-cutting	Milling	Sawing	Shearing

MANUFACTURING TECHNIQUE EVALUATION: CUTTING OPERATIONS

Key factors in determining the most appropriate cutting technique are: material characteristics (notably hardness, and thermal and electrical properties), component thickness, component shape and complexity, required edge quality, and production volume. Select cutting options below for a detailed analysis of techniques.

CUTTING OPTIONS

(1) ____________ : abrasive cutting, removing a kerf of material. Includes cutting with toothed blades and abrasive wheels. More ...

(2) ____________ : use of pressure on smooth-edged blades for guillotining and punching. More ...

(3) ____________ : removal of material across the full diameter of a hole, or using hole-saws for cutting circumferential kerfs. More ...

(4) ____________ : removal of surface layers with multiple cutting wheel passes. More ...

(5) ____________ : using oxy fuel (oxygen + combustible gas, often acetylene). More ...

c **Complete the following definitions using the words in the box.**

abrasive wheel	guillotine	hole-saw	kerf	punch	toothed blade

1 A ___punch___ makes holes by applying pressure to shear the material.
2 A ____________ makes straight cuts by applying pressure to shear the material.
3 A ____________ is the width of the saw cut.
4 A ____________ has sharp edges for cutting or milling.
5 A ____________ has a hard, rough surface for cutting or grinding.
6 A ____________ cuts a circular piece to remove an intact core of material.

7 a **Read the following extract of promotional literature from a leading producer of ultra-high-pressure (UHP) waterjet cutting machines. In pairs, explain the phrases in bold.**

Flow

What makes waterjets such a popular cutting option? Water jets require few **secondary operations**, produce **net-shaped parts** with no **heat-affected zone**, heat distortion, or **mechanical stresses** caused by other cutting methods, can cut with a **narrow kerf**, and can provide better usage of raw material since parts can be **tightly nested**. As a result of the FlowMaster™ PC control system and intuitive operation, waterjets are extremely easy to use. Typically, operators can be trained in hours and are producing high-quality parts in hours. Additionally, waterjets can cut virtually any material, leaving a satin-smooth edge.

b ▶3.7 **Evan is talking to Mr Barrett about UHP waterjet cutting. Listen to the conversation and match the phrases in the box to the extracts (1–4).**

heat-affected zone   mechanical stresses   narrow kerf   net-shaped parts

Extract 1 ____________   Extract 3 ____________

Extract 2 ____________   Extract 4 ____________

c **Complete the following extracts from the conversation by underlining the correct phrases.**

1 *So they are **especially good when** / **not so good when** you have intricate shapes.*
2 *Saw blades are obviously **perfect when** / **useless when** you're cutting curved shapes.*
3 *... sawing is **the ideal solution** / **not the best solution** if you want to avoid altering the material.*
4 *... it's **ideal for** / **totally unsuitable for** metals.*

8 **In pairs, assess the different cutting techniques in terms of**
- **shape/size of cut**
- **material types/characteristics**
- **cut width/quality.**

Use the phrases in the box.

ideal/perfect/especially good for + -ing   the ideal/perfect solution for
not particularly suitable / not so good if you need ...
not the best solution if you don't want ...   totally unsuitable / useless

Cutting techniques
drilling with a bit
drilling with a hole-saw
flame-cutting
grinding
guillotining
milling
punching
sawing
waterjet cutting

Shape/size of cut
angular   blind holes   curved   large   small   straight
thick   thin   through holes

Material types/characteristics
ceramics   metals   plastics   timber   hard   tough
brittle

Cut width/quality
heat-affected zone   narrow kerfs   no kerf   rough edges
smooth edges   wide kerfs

Explaining jointing and fixing techniques

9 **In pairs, think of some examples of ways of joining materials together.**

10 a **▶3.8 Pedro, a purchasing manager with a kitchen appliance manufacturer, is talking to Alicia, a sales manager from one of their main suppliers. Listen to the conversation and answer the following questions.**

1 What objective does Pedro describe regarding his company's relationship with suppliers?
2 What is Alicia concerned about?
3 How does he respond to her concerns?

b **Complete the following table using the words in the box.**

adhesive ~~bolt~~ clip rivet screw weld

Mechanical fixings	Non-mechanical fixings
bolt	________
________	________
________	
________	

c **Label the photos (1–6) with the words in Exercise 10b.**

1 weld

2 ________

3 ________

4 ________

5 ________

6 ________

d **Match the types of connection in the box to the following groups.**

bolting bonding ~~connecting~~ fixing gluing joining riveting welding

1 connecting ________ ________ = describes any kind of connection.
2 ________ ________ = describes mechanical connections only.
3 ________ ________ ________ = describes non-mechanical connections only.

11 a **Complete the following questions using the words in the box.**

each other on onto to together

1 How can we fix these two components ________ ?
2 How can we fix these two components to ________ ?
3 How can we fix this component ________ ?
4 How can we fix this component ________ / ________ this component?

b **Complete the following training web page using the words in Exercise 11a.**

MANUFACTURING TECHNIQUE EVALUATION: JOINTS AND FIXINGS

The most suitable method of joining components depends on many factors, which extend beyond the obvious issue of required strength.

- Will the joint need to be disconnected in the future? If a part is bolted (1) ______ , it can obviously be removed at a later date. If two components are bonded to (2) ______ with strong adhesive, or welded (3) ______ then subsequent removal will clearly be more difficult. More ...
- What external factors might affect the joint? Water or heat can weaken adhesive joints. And no matter how tightly nuts are screwed (4) ______ bolts, vibration can cause them to work loose over time. More ...
- How quality-sensitive is the jointing technique? Components are rarely joined (5) ______ each other in ideal conditions. Inadequately tightened fixings, improperly prepared surfaces, or flawed welds are inevitable. How could such imperfections affect the joint negatively? More ...

c **In pairs, answer the following questions using the information on the web page in Exercise 11b.**

1 What are the main advantage and disadvantage of mechanical fixings?
2 What is the main disadvantage of non-mechanical jointing?
3 What issues can negatively affect mechanical fixings and non-mechanical joints?

12 a **In pairs, discuss the following jointing techniques used in aircraft and say how the parts are fixed together.**

1 Early aircraft: timber frame / adhesive or screws
2 Modern jet aircraft: alloy body panels / rivets
3 Aircraft cabins: seats/floor/bolts
4 Aircraft cockpit: windshield/fuselage/adhesive

b **Your company has launched a competition for its engineers to build a homemade model glider that is as cheap as possible to assemble. In pairs, discuss what types of materials and joints you could use.**

Describing positions of assembled components

13 a In pairs, read the title of the article and suggest ways of making a garden chair fly. Discuss any potential problems.

b Read the article and match the questions (a–d) to the paragraphs (1–4).

a How did the actual flight differ from the one that was planned? ______
b What incidents occurred just before and just after the landing? ______
c What is said about the modern equivalent of this type of activity? ______
d What components were used to assemble the flying machine? ______

CRAZY BUT TRUE: LARRY WALTERS AND THE FLYING GARDEN CHAIR

1 On July 2, 1982, a Californian truck driver named Larry Walters sat outside his house on a garden chair. To say that he was out to get some air is an understatement, for projecting above him a cluster of ropes was tied to 42 helium-filled weather balloons. Anchor ropes, situated underneath the chair, were fastened around the bumper of his car, which was positioned just below the makeshift flying machine.

2 Mr Walters intended to climb gently to an altitude of a few hundred feet, before drifting slowly out of town and across country. He then planned to use an airgun to shoot some balloons and descend gradually to earth. But as the helium gas contained within the balloons warmed up in the summer sun, it progressively generated more lift. When the anchor ropes were released, the self-assembly airship shot up like a rocket. Too shocked to reach for the pistol inserted in his pocket, the first-time pilot held on for life. In just a few minutes, Larry Walters was 16,000 feet above the ground, floating over the city of Long Beach. A short time later, there were further complications; he suddenly found himself inside controlled airspace, adjacent to Long Beach Airport. The occupants of passing Delta Airlines and TWA aircraft looked on at the curious spectacle outside, as wide-eyed as the garden chair pilot hovering beside them.

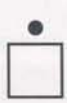
3 Eventually, after managing to shoot some balloons, Mr Walters descended safely to earth despite an anchor rope, which was still suspended beneath the chair, getting tangled with a power line located alongside the landing site (in someone's garden). He was immediately arrested by waiting police officers, and was later fined for breaking Federal aviation laws.

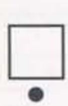
4 Today, cluster ballooning, while still a fairly marginal sport, is steadily starting to gain in popularity.

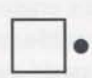
c Answer the questions in Exercise 13b.

14 a Label the diagrams using the prepositions in the box.

~~above~~ adjacent to alongside around below beneath beside inside outside over underneath within

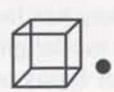
a

above
______

b

______
______
______

c

______
______
______

d

______

e

______

f

______
______

b **Complete the following sentences about the flying garden chair using the prepositions in the box. Check your answers against the text in Exercise 13b.**

in	above	around	beneath	within

1 Projecting ________ the chair was a cluster of ropes, tied to 42 helium-filled weather balloons.
2 Anchor ropes were fastened ________ the bumper of the car.
3 Larry Walters had an airgun inserted ________ his pocket.
4 The helium contained ________ the balloons warmed up in the sun.
5 After takeoff, the anchor ropes remained suspended ________ the chair.

c **Complete the following descriptions of how the garden chair airship was assembled by underlining the correct words.**

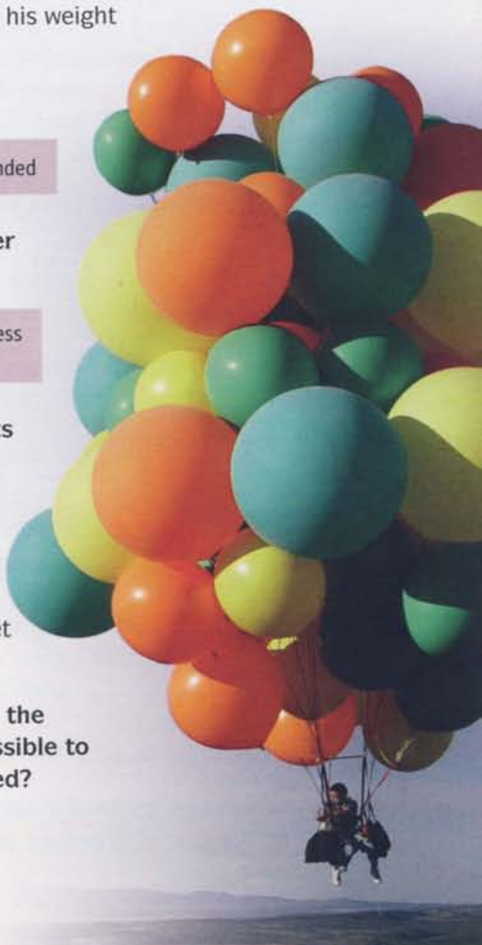
1 A quantity of helium gas was **contained/suspended** inside each balloon.
2 A tube was **inserted/projected** inside the openings of the balloons, to inflate them.
3 The balloons were **situated/suspended** over the chair, in a large cluster.
4 The chair was **contained/suspended** under the balloons by ropes.
5 Arm rests, **contained/located** beside the pilot, at each side, helped to hold him in place.
6 The landing gear, **inserting/projecting** below the seat, consisted, simply, of the chair legs.
7 The pilot was **positioned/projected** underneath the balloons, so his weight was low down.

d **Which two other words have the same meaning as *positioned*?**

contained	fastened	inserted	located	projected	situated	suspended

15 **a** **In pairs, look at the photo and describe how you think the cluster balloon is assembled from the following components.**

bags balloons helium nylon ropes nylon straps paragliding harness
plastic cable sand/water ballast ties tape



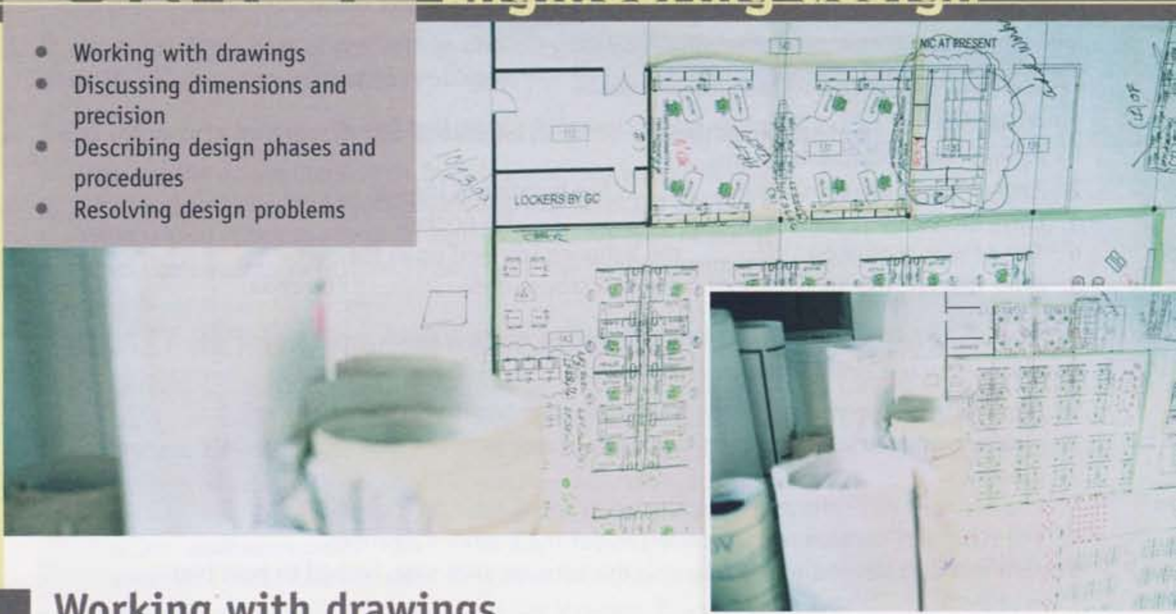
b ▶ 3.9 **Eva and Lenny, two engineers working for an extreme sports equipment manufacturer, are discussing cluster ballooning. Listen to the conversation and summarise what they say about the following issues.**

1 assembly time
2 how plastic cable ties are used
3 a tree structure
4 how water bags are used
5 the advantage of tying each individual balloon
6 the problem of using a net to contain the balloons

c **In pairs, discuss ways of overcoming the problems mentioned in the conversation. How could cluster ballooning be made more accessible to a mass market? What other equipment/assemblies could be used?**

UNIT 4 Engineering design

- Working with drawings
- Discussing dimensions and precision
- Describing design phases and procedures
- Resolving design problems



Working with drawings

1 **In pairs, discuss the different types of design information needed on a complex engineering project, such as the construction of a large cruise ship. How many different drawings do you think might be produced for such a project? How would they be organised and categorised?**

2 a ▶4.1 **Joe, a technician at a shipyard, is talking to Linda, one of his engineering colleagues in the design office. He is asking about some information which he can't find on any of the drawings. Listen to the conversation and answer the following questions.**

1 What area of the ship are they discussing?
2 What does the technician need to know?

b **Complete the following definitions using the types of drawing in the box.**

cross-section	elevation	exploded view	note	~~plan~~	schematic
specification					

1 A __plan__ gives a view of the whole deck, from above.
2 An __________ gives a view of all the panels, from the front.
3 An __________ gives a deconstructed view of how the panels are fixed together.
4 A __________ gives a cutaway view of the joint between two panels.
5 A __________ gives a simplified representation of a network of air ducts.
6 A __________ gives a brief description or a reference to another related drawing.
7 A __________ gives detailed written technical descriptions of the panels.

c **Which two types of drawing in Exercise 2b are examples of general arrangement drawings, and which two are examples of detail drawings?**

d Read the following technical questions that came up during the shipbuilding project and decide which type of drawing is required to answer each question.

1 How many panels are there altogether on this wall? ___________
2 What profile are these hollow beams: rectangular or circular? ___________
3 What are the positions of all the floodlights around the deck perimeter? ___________
4 How many branches come off the main sprinkler supply pipe? ___________
5 How do all the internal components of the fan unit fit together? ___________

3 **a What is meant by *scale* on a drawing? In pairs, explain how a scale rule, like the one shown in the picture, is used.**

b ▶4.2 After receiving the drawings for the panels, Joe is now discussing some details with Pavel, a colleague. Listen to the conversation and answer the following questions.

1 What piece of information is not shown on the drawing?
2 What *golden rule* is mentioned?

c Complete the following extracts from the conversation and explain what is meant by each one.

1 *Is this drawing ______ scale?*
2 *It's one ______ five.*
3 *... you shouldn't scale ______ drawings ...*
4 *... it's actual size, on a ______-scale drawing ...*

4 **You are engineers on a project to design the metal handrail that will run around the perimeter of the top, outdoor deck of a large cruise ship. In pairs, discuss what drawings you will need to produce for manufacturing and installation with regard to the following issues:**

- the types of view that will be required and what each one will show
- the approximate scale of different drawings and views
- what written information you will need to provide in the specification.

5 **You are going to provide design information to enable a production team to manufacture a product or appliance you know well. Make a list of some of the drawings that will be needed, noting what each one will show.**

Discussing dimensions and precision

6 a In pairs, discuss what is meant by *precision* and *accuracy*.

b Read the technical advice web page and answer the following questions.

1 How is a superflat floor different from an ordinary concrete floor?
2 What accuracy can be achieved with ordinary slabs, and with superflat slabs?
3 What problem is described in high bay warehouses?

Superflat Floors: FAQ

What is a superflat floor?

Compacting and finishing the surface of wet concrete is an inherently imprecise process. For an ordinary concrete slab to be laid within tolerance, engineers can only realistically expect the surface to be finished to plus or minus 5mm. By contrast, superflat concrete floors are finished to meet extremely close tolerances, being accurate to within 1mm across their upper surface.

Where are superflat floors used?

Floor surfaces with extremely tight tolerances are frequently specified in warehouses where Automated Guided Vehicles operate. Uneven floors are especially problematic in high bay warehouses, which use automated forklifts with a vertical reach of 30 metres or more. At such a height, slight variations in floor level are amplified in the form of vertical tilt, causing inaccurate manoeuvring at high level. If these variations are outside tolerance they can lead to collisions with racking elements, or cause items to be dropped from pallets.

c In pairs, discuss what is meant by *tolerance* in the context of dimensions and precision.

d Complete the following expressions from the web page which are used to describe tolerances.

1 ____________ tolerance (inside the limits of a given tolerance)
2 ____________ or ____________ 5mm (+/– 5mm)
3 ____________ tolerance (close tolerance)
4 ____________ tolerance (not inside the limits of tolerance)

e Complete the following sentences using the expressions in Exercise 6d.

1 The frame's too big for the opening. The opening's the right size, so the frame must be ____________________ .
2 The total tolerance is 1mm. The permissible variation either side of the ideal is ____________________ .
3 The engineer specified +/– 5mm for the slab finish, and we got it to +/– 2mm. So it's well ____________________ .
4 You can't finish concrete to +/– 0.1mm. There's no way you can work to such a ____________________ .

f In some situations, engineers describe tolerances using *plus or minus*, for example *+/– 1mm*, and in other situations as *within*, for example *within 1mm*. In pairs, discuss the difference in meaning between these two descriptions, giving examples of situations where each description might be used.

7 a ▶4.3 **Mei, a structural engineer, is talking to Lewis, a project manager, about the floor specification for a manufacturing plant that is currently at design stage. Listen to the conversation and answer the following questions.**

1 What has the client requested with regard to the floor slab?
2 What are free movement floors and defined movement floors?
3 What issue does the engineer discuss regarding quality?
4 What option is discussed involving grinding?
5 What can be done to the reinforcement to permit grinding?

b Complete the following table using the words in the text in Exercise 6b and audioscript 4.3 on page 89.

	Name of dimension	Large dimension	Small dimension
1	What's the ________?	Is it ________?	Is it short?
2	What's the width?	Is it ________?	Is it narrow?
3	What's the ________?	Is it high?	Is it low?
4	What's the thickness?	Is it ________?	Is it thin?
5	What's the ________?	Is it deep?	Is it shallow?

c Mei has done a revised drawing for the floor slab. Read the extract from her email about the new design and complete the message using the correct form of the words in Exercise 7b.

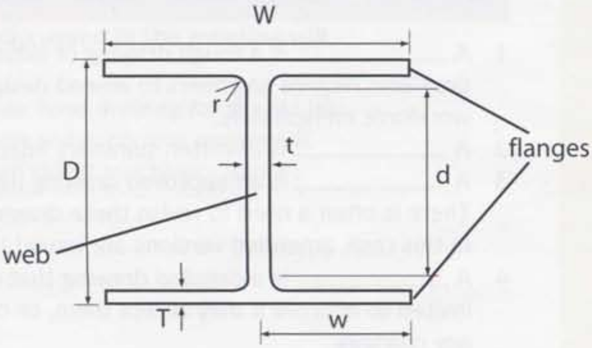
To: Lewis Rosas
Subject: Revised floor slab drawing

Please find attached a revised drawing for the floor slab, now reconfigured for defined movement. In order to accommodate guided vehicles 1 080mm (1) wide (as specified by the client) we propose a standard (2) ________ of 1 280mm for each superflat lane. At 14.5m, the (3) ________ of the longest lane on the network is within the maximum slab run that can be cast in a single concrete pour, thus avoiding construction joints on straight runs. On curved sections, a standard 8.5m turning radius is used, as per the guided vehicle manufacturer's recommendations.

In order to allow for the eventuality of future grinding, we have located the top layer of reinforcement 10mm deeper below the slab surface. This additional (4) ________ has not, however, been added to the overall slab (5) ________ , which remains 275mm. The reinforcing bars also remain in 12mm diameter. As a result, the levels of wall-mounted process installations – many of which need to be fixed at a precise (6) ________ above finished floor level – are unaffected.

d Which two words in the email relate to circles? What aspects of a circle do they describe?

8 The manufacturing plant in Exercise 7 will be built from a steel frame. The vertical elements of the frame will be Universal Columns (UCs). Look at the section of a UC. In pairs, describe the different dimensions that define a UC profile by explaining what the letters on the section refer to.



Describing design phases and procedures

9 **In pairs, discuss what is meant by a *design process*. In engineering, what are the stages in the development of designs?**

10 a **The following extracts from emails relate to a project to build an indoor ski complex in Australia, using artificial snow. The messages were circulated by an engineer to members of the design team, and to a specialist contractor. Read the emails and, in pairs, answer the following questions. Note that the emails are not in the correct order.**

1 What are all the emails about?
2 What different types of documents are mentioned?

a

We now have a full set of working drawings for the main ski lift (attached). These incorporate some amendments requested by the client, which have now been approved. Hard copies have been forwarded to the relevant contractors' premises, for fabrication.

b

I attach a summary of our meeting with the client last Tuesday. It outlines ideas expressed by the client's marketing team, and describes what an experience at the ski complex should be like, from a visitor's point of view. We'll be going through these notes at the project kick-off meeting next Thursday, to clarify the design brief, so please formulate any queries before then.

c

Please find attached a full set of preliminary drawings, as submitted to the client for approval / comments. These are for information only at this stage.

d

Attached are a few rough sketches setting out the overall layout of the ski complex. At this point, these are initial ideas based on the client's suggestions and the approximate dimensions specified in the design brief. I look forward to any feedback by the end of this week.

e

Please note that dwg 18A is currently being revised, to resolve problems encountered during assembly of the ski lift. Revision B will be circulated next week. Until the amended drawing is issued, please treat dwg 18A as superseded. If you require specific details urgently, please contact me, and I will arrange for a suitable sketch to be issued.

b **Put the emails in the correct sequence.**

1 ______ 2 ______ 3 ______ 4 ______ 5 ______

c **Complete the following definitions using the types of drawing in the box.**

design brief preliminary drawing sketch working drawing

1 A ____________ is a rough drawing of initial ideas, also used when production problems require engineers to amend design details and issue them to the workforce immediately.
2 A ____________ is a written summary intended to specify design objectives.
3 A ____________ is an approved drawing used for manufacturing or installation. There is often a need to revise these drawings to resolve production problems. In this case, amended versions are issued to supercede the previous ones.
4 A ____________ is a detailed drawing that colleagues and consultants are invited to approve if they accept them, or comment on if they wish to request any changes.

d **Find synonyms for the following words in the definitions in Exercise 10c.**

1 accept / approve
2 amend / ________
3 approximate / ________
4 circulate / ________
5 give feedback / ________
6 replace / update / ________
7 state / ________
8 solve / ________

e **In pairs, suggest what needs to be done next in each of the following situations.**

1 They've found a problem with drawing 63 on site. The detail we've specified doesn't work.
2 I've done a preliminary design for the duct layout, but the client hasn't seen it yet.
3 I've got a feeling the drawing they have on site isn't the latest one.
4 We've just revised drawing 14. The changes are going to affect three different contractors.
5 This is the client's written design brief. How shall we kick off the design work?

11 **a** **Leo is the ski complex project manager. With design work about to begin, he is meeting senior engineers from the design teams to discuss design coordination. In pairs, explain the items on the meeting agenda and suggest what kinds of issue might be discussed.**

Australian Ski complex – Design Coordination Meeting Agenda
Tuesday 8th May
Conference room 9.30am – 11.00am
To: RN, LG, SB, CW, SH

Item

a Design interface (mechanical, electrical)
b Design and information flow procedure (structural, mechanical, electrical)
c Inter-team communication – formal and informal

b ▶4.4 **Listen to three extracts from the meeting and match each extract (1–3) to an agenda item (a–c).**

1 ______ 2 ______ 3 ______

c ▶4.4 **Listen again and make notes about the problems discussed in the meeting. In pairs, discuss some possible solutions to the problems.**

d ▶4.5 **Listen to Leo summarising the solutions that have been agreed in the meeting. What has been decided regarding the following points?**

1 The decision that the senior engineer in each team must make, regarding drawings
2 The circulation procedure that will be used for each drawing
3 The role of the M&E coordinator in relation to the senior engineers and the project manager
4 The arrangement that will make informal communication easier

e **In pairs, discuss how the design procedures discussed in the meeting will work in the following situations.**

1 Issuing the first draft of a specialised hydraulic hose drawing for the ski lift
2 Designing an electrical supply system for some water-cooling equipment
3 Revising the connection details between some ski-lift machinery and its concrete foundation

Resolving design problems

12 **In pairs, discuss problems that can arise when different drawings that make up a design are not properly coordinated.**

13 a **The following records are from the indoor ski complex project. They show correspondence between the design team and construction team. Read through the texts quickly and answer the following questions.**

1 What is the general subject of the correspondence?
2 What is meant by *query* and *instruction*?
3 Some queries refer to earlier conversations. Suggest why these have been followed up in writing.
4 What is meant by *dwg* and *dims*?

CONTRACTOR'S QUERY No. 867	ENGINEER'S INSTRUCTION
Following our telephone conversation today, we note that there is a discrepancy between dwgs 76E and 78E, which indicate conflicting dimensions for the width of the roof opening. Please clarify which dimension is correct.	We confirm the correct dimension is on dwg 76E. Please disregard the dims on dwg 78E.
CONTRACTOR'S QUERY No. 868	ENGINEER'S INSTRUCTION
As discussed this morning on site, we confirm there is a clash between the proposed cable tray (dwg E56) and air-conditioning ductwork (now installed as per dwg M118) in the ceiling void at Grid D14. Please advise on an alternative cable route.	Please work to attached sketch S33. Revision of dwg E56 to follow.
CONTRACTOR'S QUERY No. 869	ENGINEER'S INSTRUCTION
A note on dwg 11A specifies black bolts at the base of the ski lift cable support. This contradicts the specification, which states that all joints to comprise High Strength Friction Grip bolts. We propose using HSFG fixings at this location.	Please provide further details of the HSFG bolts you are proposing.
CONTRACTOR'S QUERY No. 870	ENGINEER'S INSTRUCTION
Further to Query 869, the proposed HSFG bolts are as per those specified for all other bolted joints on the ski lift supports. Our intention is to use a single bolt spec to facilitate assembly.	Approved.

b **Read the correspondence in detail. Write the query numbers in Exercise 13a next to the descriptions (1–5). You will need to refer to some queries more than once.**

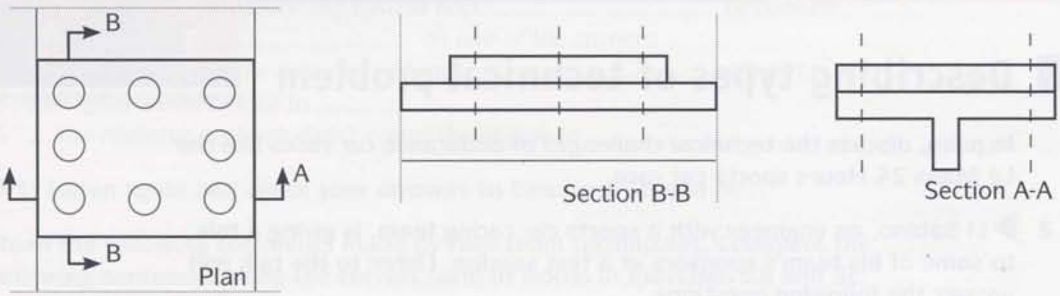
1 An installation that won't fit, as components are in each other's way 868
2 A response from the engineer asking for more information ______
3 Queries that suggest a solution, which will require the engineer's approval ______ ______
4 Requests to the engineer to instruct the contractor or make something clear. ______ ______
5 Separate documents referring to details that don't correspond with each other ______ ______ ______

c Complete the following pairs of sentences using the verbs in the box.

advise clarify clash propose request

1 The components are in each other's way. = The components ________ .
2 Please ask for more information. = Please ________ more information.
3 Can I suggest a solution to the problem? = Can I ________ a solution?
4 Please instruct the supplier to send the parts to this address. = Please ________ the supplier.
5 Any conflicting details must be queried. = You must ________ any conflicting details.

4 **a In pairs, look at the following plan and sections from a drawing on the ski complex project, showing steelwork details on part of a ski lift. Examine how the rectangular plate is bolted to the T profile below it. Can you find the discrepancy between the details, and the clash preventing the connection from being assembled?**



b Chen, a technician, is explaining the problem in Exercise 14a to Ron, an engineer. Complete the conversation using the words in the box.

alternative as per clarify clash confirm contradicts ~~discrepancy~~ propose

Chen: *There's a (1) discrepancy between these details that you might be able to (2) ________ straight away. On the plan of this plate, it shows eight bolts. But on section A, here, there are no bolts shown in the middle. So there would only be six, which obviously (3) ________ the plan. But as you can see, this plate's going to be bolted to a T profile. So we couldn't put a row of bolts down the middle, because they'd (4) ________ with the flange running along the middle of the T. So I'd (5) ________ just going for two rows of bolts. The (6) ________ would be to redesign the T section, which would obviously be a bigger job.*

Ron: *Yes. Let's go for two rows of bolts, (7) ________ the sections.*

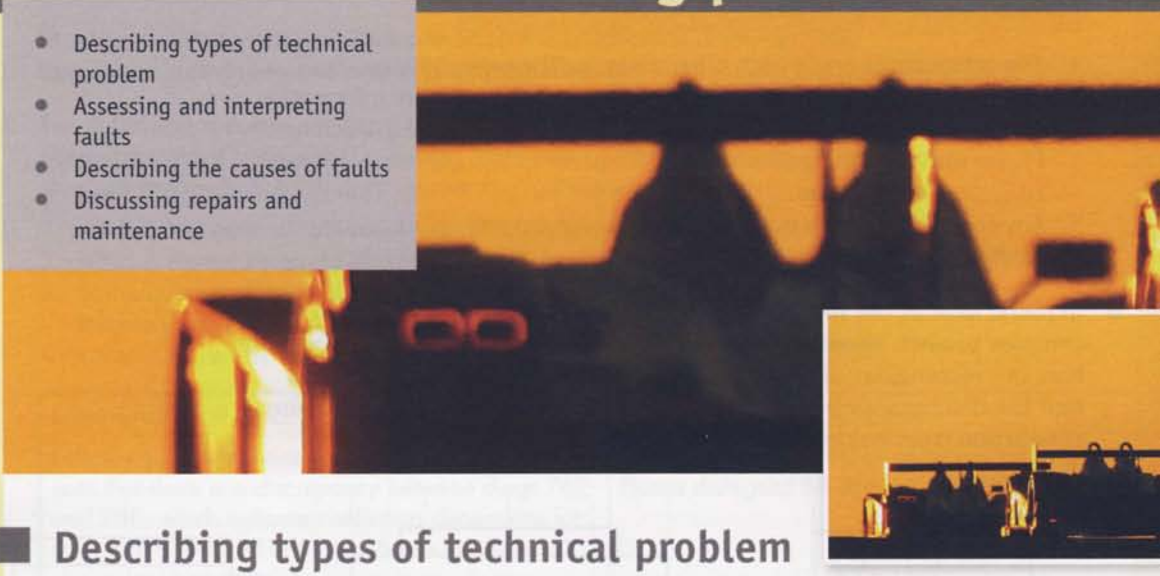
Chen: *OK, fine. Will you send an email to (8) ________ that?*

c ▶ 4.6 Listen to the conversation and check your answers to Exercise 14b. How does the explanation compare with your description of the problem?

d Write an email from Ron to Chen, confirming the revision agreed in the discussion above.

UNIT 5 Breaking point

- Describing types of technical problem
- Assessing and interpreting faults
- Describing the causes of faults
- Discussing repairs and maintenance



Describing types of technical problem

1 **In pairs, discuss the technical challenges of endurance car races like the Le Mans 24 Hours sports car race.**

2 a ▶5.1 **Sabino, an engineer with a sports car racing team, is giving a talk to some of his team's sponsors at a test session. Listen to the talk and answer the following questions.**

1 What saying emphasises the importance of reliability?
2 What expression refers to things that can cause failures?
3 What expression describes damage caused by normal use?

b ▶5.1 **In the talk, Sabino names five engineering enemies. Complete the following list. Listen again and check your answers.**

1 h__________ = high temperatures
2 p__________ = loads from expanding gases or liquids
3 v__________ = continuous high-frequency movement or shaking
4 s__________ = sudden impacts
5 a__________ = damage to surfaces caused by friction

c **In pairs, suggest which engineering enemies in Exercise 2b can be the most problematic for each of the following car parts.**

1 chassis	4 suspension	7 wings
2 engine	5 brakes	8 cooling system
3 gearbox and clutch	6 tyres	9 nuts and bolts

3 a ▶5.2 **Listen to Sabino talking about some technical problems the team have had at the test and mark the following statements True (T) or False (F).**

1 Some liquid was lost from a pipe.
2 A car lost all its coolant with the engine still running.
3 A car's engine stopped on the circuit.
4 Some tyres were damaged.
5 A wheel nut fell off a car on the circuit.
6 A car's suspension was broken.

b **Complete the following extracts from the talk using the words in the box.**

bend blocking crack jam snap

1 *... you don't want anything ________ the airflow to the radiators.*
2 *... they had a wheel nut ________ , it wouldn't turn.*
3 *... he didn't hit the barriers and ________ the suspension or ________ it completely.*
4 *... it didn't ________ the tub – the chassis.*

c **Complete more extracts from the talk using the correct form of a verb in box 1 and a word in box 2.**

1	2
blow clog cut leak run wear ~~work~~	~~loose~~ up out

1 *... a nut* worked loose *on a radiator pipe, which resulted in coolant liquid ________ ________ .*
2 *... he switched off before the system had ________ ________ of coolant.*
3 *... the engine ________ ________ on one of the corners.*
4 *... the openings in the side pods always ________ ________ with dirt.*
5 *The tyres weren't close to ________ ________ ...*
6 *... the radiator problem didn't cause the engine to ________ ________ .*

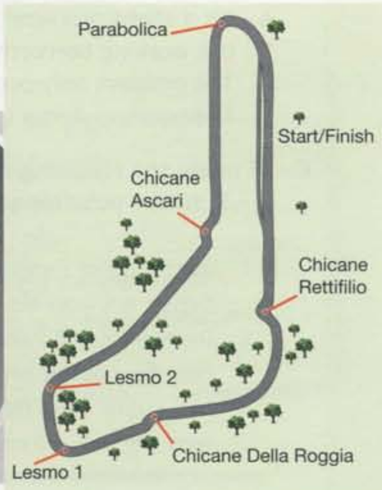
d ▶5.2 **Listen again and check your answers to Exercises 3b and 3c.**

e **Read the following comments made by race team technicians. Complete the following sentences using the correct form of words in Exercises 3b and 3c.**

1 There's smoke and flames pouring out of the engine. It's blown up .
2 There's a pool of oil under the car. Something's ________ .
3 This cylinder head bolt won't loosen. It's ________ .
4 The air filter's full of dirt. It's completely ________ .
5 This wing support's been moving about. The bolts have ________ .
6 Something's stopping the oil flow. The pipe might be ________ .
7 Are you sure that pushrod's straight? It looks as if it's ________ .
8 We'll need to change these brake pads. They're nearly ________ .
9 There's hardly any fuel left in the car. In another lap, we'll ________ .

4 **Read the technical facts about the Italian motor racing circuit, Monza, and summarise how the track is different from most others. In pairs, discuss the technical problems that racing cars could have at Monza as a result of the factors described in the text.**

The circuit is characterised by long straights and chicanes. This means the cars' engines are at full throttle for over 75% of the lap, a higher percentage than most other circuits.
The track requires heavier-than-average braking over a given lap, as the cars repeatedly decelerate at the end of some of the world's fastest straights for the slow chicanes.
The chicanes are lined by rugged kerbs. Riding over these hard is crucial for fast laps.
The long straights require small wings for minimum drag. This means lower downforce, resulting in lower grip on corners and under braking, and less stability over bumps.
The main high-speed corners Lesmo 1, Lesmo 2 and Parabolica are all right turns.
Parts of the circuit are surrounded by trees, which means leaves can be blown onto the track.



Assessing and interpreting faults

5 a In pairs, discuss a technical problem you've experienced with a device, equipment or vehicle. Describe the fault, and how you tried to solve the problem.

b Read the training notes for telephone helpline staff working for a manufacturer of mining plant. In pairs, discuss what each point means.

Problem-solving checklist

1 User's observations:
- nature of fault
- circumstances of fault
- external factors

2 Process of elimination

3 Identify the failure

4 Determine action and urgency

6 a ▶5.3 Mr Rooney, an engineer at a quarry firm, is talking to Al, a helpline consultant, about a technical problem with a diesel engine. Listen to the conversation and answer the following questions.

1 What does the warning message say?
2 What external factor is discussed as a possible cause?
3 Why is this possible cause eliminated?
4 In what circumstances does the fault occur?
5 What does the consultant identify as the most likely cause?
6 What action is required, and how urgent is it?

b Match the words in the box to their synonyms in the sentences (1–7).

defect defective ~~fault~~ faulty intermittently major minor properly systematically

1 There's a **problem**. fault / ________
2 Perhaps something in the fuel injection system is **wrong**. ________ / ________
3 It's a **serious** problem. ________
4 It's a **slight** problem. ________
5 Is it working **correctly**? ________
6 The problem only occurs **from time to time**. ________
7 The problem doesn't occur **every time**. ________

c Al made the following notes about three engine problems. Match the faults (1–3) to the possible causes (a–c).

1 Starter motor sometimes works, sometimes doesn't. Engine is 9 years old.
2 Distribution belt failed. Engine blew. Belt replaced recently – almost new
3 New engine. Runs for 20 mins, then temp. gauge always goes into red, and engine cuts out (safety override)

a Cooling system problem. Fan? Water pump?
b Electrical contact problem. Loose connection?
c Manufacturing defect? Incorrect fitting? Not wear

d **In pairs, describe the problems in Exercise 6c using the following phrases.**

> a faulty part   a sudden problem   a systematic problem   an installation problem
> an intermittent problem   caused by wear and tear   It's / It was ...   It's / It was probably ...
> Perhaps it's / it was ...   This is / was a ...

e **Complete the following table using the phrases in the box from the conversation.**

> I doubt it's   it can't be   it could be   it might be   ~~it must be~~   it sounds like it's

1 It's certainly / it must be	a problem with ...
2 It's probably / ______	
3 It's possibly / ______ / ______	
4 It's probably not / ______	
5 It's certainly not / ______	

f ▶5.3 **Complete the following extracts from the conversation using phrases in Exercise 2e. Listen again and check your answers.**

1 *Obviously,* it must be *some sort of defect in the fuel injection system.*
2 *So* ______ *a software problem.*
3 *... maybe* ______ *a defective sensor.*
4 *Presumably,* ______ *anything too serious.*
5 ______ *water, then, if the fuel went in directly from a delivery.*
6 ______ *a faulty fuel pre-heater.*

7 **a** **In pairs, analyse the problem described below. Underline the words in the box that describe it.**

> major   minor   sudden   systematic   intermittent

The problem

The driver of a dump truck, which operates in a quarry, has noticed that the truck's diesel engine is slightly down on power. The problem has become progressively worse over several weeks. Apart from the power loss, the engine is performing consistently, with no misfiring and no overheating. The degree of power loss remains constant throughout a given period of use, from starting the engine to turning it off. No increase in fuel consumption has been noted.

b **Read the notes and assess the possible causes of the problem in Exercise 7a using the words in Exercises 6d and 6e.**

Possible causes of the engine problem

- *water in the fuel supply*
- *a lubrication problem*
- *a clogged fuel filter*
- *a blockage in the exhaust system*
- *a compression leak from the piston cylinders*

Describing the causes of faults

8 **Look at the following strategies for preventing and dealing with technical problems in aviation. In pairs, discuss what is meant by the following terms and how they are used by engineers and pilots.**

1 checklists
2 standard procedures
3 back-up installations
4 planned maintenance

9 a **Read the article on the right and answer the following questions.**

1 How did the problem start?
2 What were the initial, unseen consequences?
3 What were the subsequent consequences?

b **Complete the sequence of events that followed the fuel leak on the Airbus A330 using the extracts (a–d).**

"We have a problem"

The true story of Air Transat Flight 236.

The chain of events began during routine maintenance work on an Air Transat Airbus A330. An incorrect hydraulic pipe was fitted to the right-hand engine. The component was oversized, leaving inadequate clearance with an adjacent fuel line. Subsequently, the two pipes rubbed together, causing the fuel line to wear progressively. The problem went undetected, until the night of August 24, 2001, at 35,000 feet above the Atlantic. With Flight 236 en route from Toronto to Lisbon, carrying 306 people, the fuel line ruptured, resulting in a major leak. Less than two hours later, the aircraft was completely out of fuel, gliding silently through the night sky ...

04:38 The flight data recorder registered an abnormal increase in fuel consumption. At this stage, however, this slight anomaly was insufficient to cause warning lights to come on to alert the crew to any imminent danger.

04:58 ______

05:33 A warning message came up, alerting the crew to an imbalance between the amount of fuel in each wing tank. Initially, the problem was thought to be an instrument malfunction. But further analysis by the crew revealed that the amount of fuel remaining in the right tank was significantly below the planned quantity.

05:36 ______

05:45 As a precaution, the crew decided to divert to the nearest airport - the Lajes military airbase in the Azores.

06:13 ______

06:26 ENG 2 FAIL appeared, and the left engine cut out. Having completely run out of fuel, and with both engines now down, the Airbus A330 was gliding, descending at 2,000 feet per minute.

06:27 ______

06:46 With the airport in sight, the landing gear was lowered manually. The pilot then performed a series of spectacular zigzag manoeuvres to slow the plane down as much as possible. The aircraft touched down on the runway at 370 km/h – exceeding the standard approach speed by over 100 km/h. The pilot applied emergency braking, causing several tyres to blow out and catch fire. But the plane stopped safely, well before the end of the runway.

a An alarm sounded, a red master warning lit up and the message ENG 1 FAIL came up on the screen. Seconds later, the right engine flamed out, due to insufficient fuel.

b During a routine instrument check, the crew noticed a disproportionate amount of oil had been used by each engine. Oil pressure and temperature readings for each engine were also irregular, but the levels were found to be within acceptable parameters.

c As the aircraft was now powerless and potentially uncontrollable, an emergency ram air turbine was deployed automatically to generate back-up electrical power for the fly-by-wire controls and instruments. However, with the main hydraulics shut down, the flaps and spoilers used to slow the plane before and after landing were inoperable. The co-pilot calculated the plane could remain airborne for 15–20 minutes, and that Lajes airbase was an estimated 20 minutes away.

d The crew decided to take action to correct the anomaly, opening a cross-feed valve to transfer fuel from the left tank to the right tank.

c **Make opposites of the following words using the prefixes in the box.**

ab- dis- im- in- (x4) ir- mal- over- un-

1 correct incorrect
2 undersized ________
3 adequate ________
4 detected ________
5 normal ________
6 sufficient ________
7 proportionate ________
8 regular ________
9 balance ________
10 function ________
11 operable ________

d **Complete the following sentences using the words in Exercise 9c. Sometimes more than one word is possible.**

1 The temperature gauge was faulty. That's why it was giving ________ readings.
2 The shaft was thinner than it should have been, so its strength was ________ .
3 The power output from the motor varies. We don't understand why it's ________ .
4 The bolt's ________ . It's too big to fit into the hole.
5 The machine's not working as it should. There's some kind of ________ .
6 The braking force on both front wheels should be the same. There shouldn't be an ________ .
7 The fault was ________ . None of the maintenance technicians had noticed it.
8 The control panel isn't working, so you can't control the machine. It's totally ________ .

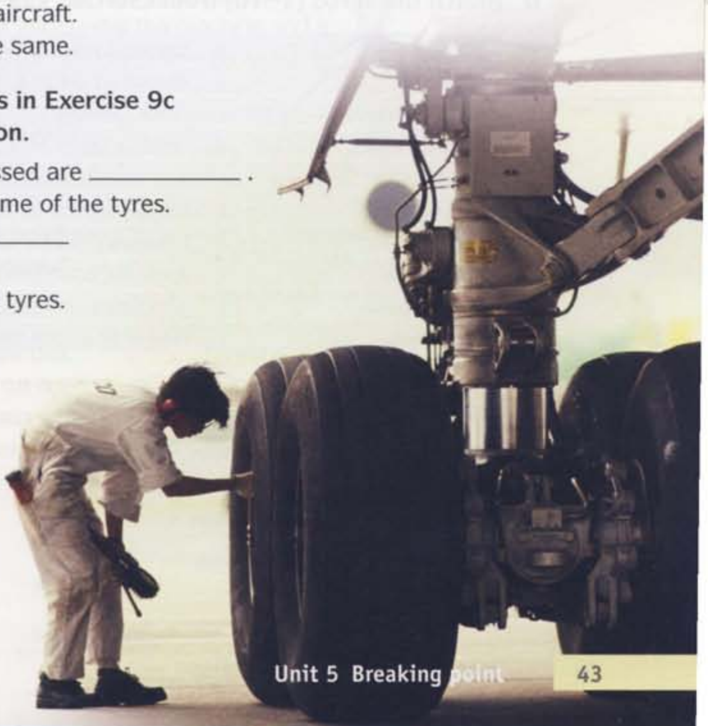
10 a ▶5.4 **Julia, an aircraft service technician, is phoning Alan, a colleague, about a problem with the tyres on a plane. Listen to the conversation and mark the statements True (T) or False (F).**

1 The tyre pressures on the block being discussed are OK.
2 There is too little air inside some of the tyres.
3 The tyre pressures are the same across the aircraft.
4 The degree of wear across all the tyres is the same.

b **Complete the following sentences using words in Exercise 9c to make true sentences about the conversation.**

1 The tyre pressures on the block being discussed are ________ .
2 There is ________ air pressure inside some of the tyres.
3 The tyre pressures on that block are ________ to the rest of the aircraft.
4 The wear rate is ________ across all the tyres.

c **In pairs, discuss the possible causes of insufficient tyre pressure in general, and the specific problem Julia describes in Exercise 10a, and say why each general cause you discussed is likely or unlikely in this case.**



Discussing repairs and maintenance

11 a In pairs, discuss the difference between repairs and maintenance and decide whether the following words relate to repairs, maintenance or both.

broken clogged defective faulty worn

b In pairs, compare car maintenance with aircraft maintenance. Which aspects are quite similar and which are very different?

12 a Match the content sections (1–10) of an aircraft service manual to the descriptions (a–j).

Contents

1 Opening and dismantling access panels f
2 Topping up, draining and replacing coolants and lubricants ☐
3 Replacing filters ☐
4 Safely isolating electrical components ☐
5 Safely disconnecting and reconnecting electrical components ☐
6 Mechanical connections to be checked/ tightened at each service ☐
7 Parts susceptible to wear/damage, to be examined at each service ☐
8 Sensitive devices to be adjusted at each service ☐
9 Information on non-serviceable parts / sealed units ☐
10 Table of component life spans ☐

a Switching off the power supply
b Making sure certain parts haven't worked loose
c Changing parts that can become clogged
d Adding and changing fluids
e Equipment that needs to be set up precisely
~~f Taking something to pieces to allow maintenance~~
g Taking parts off and refitting them without danger
h Components that can't be repaired on site
i Details of how long parts are designed to last
j Making sure parts are still in good condition

b Match the verbs (1–10) from Exercise 12a to the definitions (a–j).

1	adjust	a	carry out planned maintenance
2	drain	b	change an old or damaged part
3	disconnect	c	check carefully
4	dismantle	d	empty a liquid
5	examine	e	add more fluid to fill a tank to the recommended level
6	replace	f	set up carefully by making small changes
7	reconnect	g	take apart assembled components
8	service	h	apply the correct torque, for example to loose bolts
9	tighten	i	establish a connection again
10	top up	j	remove or isolate from a circuit or network

13 a ▶5.5 **A service technician is examining some machinery and talking to a colleague. What does he say about each point on the maintenance checklist?**

Maintenance Checklist

1 Coolant level ______________________
2 Coolant condition ______________________
3 Coolant filter condition ______________________
4 Blade wear/damage ______________________
5 Blade alignment ______________________

b ▶5.5 **Listen again. Do you think the technicians are working on an aircraft or on an industrial machine?**

c **In pairs, discuss what maintenance needs to be carried out on the machinery in Exercise 13a, describing the operations step by step.**

14 a **You work for IPS, a producer of industrial packaging machinery. As a member of the global service team your role is to travel abroad dealing with serious technical problems at your clients' plants. Read the following email from a plant in Helsinki and summarise the problem.**

To: Chris McLean
Subject: Forklift damage to IPS15 Helsinki

Following our phone conversation this morning I confirm that a forklift truck has hit our IPS15 unit. The impact has made a large hole in the main panel on the side of the machine. Our technician who is trained to carry out routine adjustments on the machine has made an external visual inspection. He has advised me that the mechanisms for adjusting the precise alignment of the cutting blades have been damaged. Liquid lubricant is also leaking out from under the machine and a crackling sound can be heard inside the unit when it is switched on – presumably due to earthing/short-circuiting resulting from electrical damage.

I confirm my request for intervention by your service team.

b **In pairs, describe the sequence of steps you'll need to take to carry out repairs when you arrive in Finland, using the notes to help you.**

IPS15 Helsinki

- internal damage
- old parts
- electrical supply: on / off
- lubricant: in / out
- external panels
- alignment of cutting blades
- test
- new parts

15 **Think back to some repairs or maintenance you did, or had done for you, in the past, for example on a car, bike or domestic appliance. In pairs, explain what servicing or repairs were required, and the main steps involved in carrying them out.**

UNIT 6 Technical development

- Discussing technical requirements
- Suggesting ideas and solutions
- Assessing feasibility
- Describing improvements and redesigns

Discussing technical requirements

1 **What is *needs analysis*? In pairs, discuss why the following factors are important in needs analysis, giving examples of products and installations.**

budget capacity dimensions layout looks performance regulations timescale

2 a **▶6.1 Claudia, an engineer, is asking Kevin and Dave, the managers of a fun park, about their requirements for a proposed space module simulator called *Mars Lander*. Listen to the conversation and note the three main areas Claudia asks about.**

1 ______ 2 ______ 3 ______

b **▶6.1 How do Claudia and Kevin focus on specific subjects? Complete the following phrases from the conversation using the words in the box. Listen again and check your answers.**

concerned regard regarding regards terms

1 *... with ______ to the capacity, ...*
2 *... in ______ of the number of people ...*
3 *... as far as size is ______ .*
4 *... And as ______ the graphics ...*
5 *... ______ the schedule ...*

c **Write questions using the following prompts and the phrases in Exercise 2b.**

1 dimensions: what / overall size / module? With regard to the dimensions, what is the overall size of the module?
2 materials: what / bodywork / made of?
3 schedule: when / work start?
4 power: what / maximum output / need / be?
5 heat resistance: what sort / temperature / paint / need / withstand?
6 tolerance: what level / precision / you want us / work to?

3 a ▶6.2 **Claudia goes on to ask about the physical effects the simulator needs to produce. Listen to the conversation and make notes on the following points.**

1 Possible variation in simulator movement ____________
2 Extent of physical effects required ____________
3 Best way to assess physical effects ____________

b ▶6.2 **Listen again and explain what is meant by the words and phrases in bold.**

1 *... **to what extent** do you want the experience to be physical?*
2 ***The degree to which** it moves can be varied ...*
3 *... it's obviously difficult to **quantify** something like this ...*
4 *The only way to **determine** what's right is to actually sit in a simulator ...*
5 *... you can **assess** the possibilities.*

c **Following the meeting, Claudia writes an email to update Rod, an engineering colleague. Read the extract and choose a word or phrase from Exercise 3b that means the same as the words in bold. Sometimes more than one answer is possible.**

To: Rod Nelson
Subject: Mars Lander

In order to (1) **find out about** the simulator's dynamic capabilities, we looked at the types of effect the simulator should produce, and (2) **the amount** these physical effects should be felt by passengers. Specifically, the following issues were discussed:

- (3) **How severely** should the module generate vibration, to simulate engine thrust?
- How much buffeting should be simulated? That is, (4) **how severely** the module generates jolting, due to supposed atmospheric turbulence.
- (5) **How much** will passengers be exposed to constant linear G-force, to simulate deceleration?

In order to (6) **work out** the magnitude of the above parameters, it was decided that the prototype will be equipped with variable controls. This will enable the client to (7) **evaluate** different levels of severity through trials inside the simulator.

1 assess
2 ____________
3 ____________
4 ____________
5 ____________
6 ____________
7 ____________

4 **You are consulting engineers preparing to work with a space agency to design an unmanned landing module. The module, which will carry scientific equipment, is intended to detach from a space ship orbiting Mars and land on the planet. At this stage, this is all you know about the project. In pairs, prepare a list of the main questions you will need to ask at the needs analysis meeting using the following ideas.**

- type of scientific equipment
- size/weight of equipment
- solidity/fragility of equipment
- surface conditions at landing site

Suggesting ideas and solutions

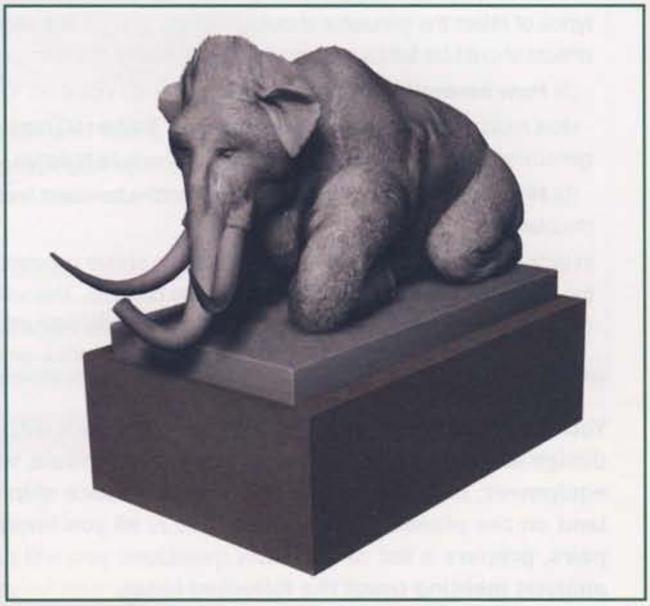
5 **In pairs, discuss the following questions about creative thinking.**

- What are the most effective ways of coming up with ideas and finding ingenious solutions to technical problems?
- What do you think of brainstorming – generating lots of ideas randomly in a group session, without analysis initially, then subjecting each idea to analysis and criticism as a second phase?
- What do you think of evaluating ideas progressively – continually subjecting them to analysis and criticism?
- When creative thinking is required to solve problems, what are the pros and cons of working individually, in small groups, or in large groups?

6 a **Read the newspaper article and answer the following questions.**

1 How is the statue being made, and what is it being made from?
2 What is Rick Gilliam's role?
3 What will the statue be placed on in its final position in front of the museum?
4 What technical problem did they have to solve?

MAMMOTH PROBLEM BAFFLES ENGINEERS, SOLVED BY CAVEMEN



The new statue outside the Museum of Natural History has been a mammoth project, literally. The soon-to-be-completed sculpture portrays a life-sized woolly mammoth, carved from a single block of sandstone. Initially, one aspect of the project had engineers baffled. Rick Gilliam, the engineer overseeing the logistics, admitted that he and his colleagues had fried their brains trying to figure out how the 36-tonne monster could be lowered onto the stone plinth that will support it.

'We knew that we could put slings under the base of the statue, and pick it up with a crane,' he explained, and that transporting it from the stonemason's yard on a low-loader wouldn't be a problem. 'The problem is placing it on the flat plinth that supports it. How do you prevent the crane's slings from getting trapped between the base and the plinth, so that they can be withdrawn? We couldn't think of an easy way to do it.' The creative answer eventually came, not from the engineers, but from the stonemasons, who had affectionately been nicknamed the 'cavemen'.

b **Rick is talking to Gabriella, an engineering colleague, about the problem of placing the statue. Before you listen, explain what is meant by the following terms and try to guess what the three possible solutions are.**

bar   drill   friction   a grab (on the end of a crane jib)
horizontal   lifting eyes   resin   vertical

c ▶6.3 **Listen to the conversation and summarise the ideas. How do their ideas compare with yours? Why is each suggestion rejected?**

d **Complete the following suggestions from the conversation using the words in the box.**

about   alternatively   another   could   couldn't   don't   ~~not~~

1 *Why* ____not____ *come up with a way of hooking onto the side of the statue?*
2 *Well,* ________ *we drill into it, horizontally ...?*
3 *We* ________ *fill all the holes, couldn't we?*
4 *Or,* ________ *, we could make sure the holes were out of sight.*
5 *What* ________ *drilling into the top, vertically?*
6 *I suppose* ________ *option would be to use some sort of grab, on the end of the crane jib.*
7 *Why* ________ *we ask them?*

e **You are engineers working on the mammoth statue project, with the following technical requirements. In pairs, discuss possible solutions to the problem of placing the statue on the plinth using the phrases in the box.**

Alternatively   Another option would be ...   Couldn't we ...   We could ...
What about ... ?   Why don't we ... ?   Why not ... ?

- No holes, slots or grooves may be cut in the statue. All of its surfaces must remain intact.
- No spacers may be left between the underside of the statue's flat base and the flat upper surface of the plinth. The two surfaces must be left in direct contact with each other.
- The statue must not be subjected to shocks. Sudden drops, even of a few millimetres, are out of the question, given the fragility of the sculpture, especially at its corners and edges, which can be damaged easily.
- Any accessory equipment may be used, within the limits of technical possibility and reasonable cost.

f **The stonemasons suggested a solution to the statue problem. Read their idea on page 99 and compare it with your solution. What external factors could cause some problems with their idea? How could these be solved?**

Assessing feasibility

8 a In pairs, dscuss what is meant by *feasibility*.

b Look at the flow chart and, in pairs, discuss how budgets and schedules affect the technical feasibility of design, development and manufacturing solutions.

Size of budget A bigger/smaller budget often means ...	→	Technical feasibility ... more/less sophisticated/innovative design. ... higher/lower quality/reliability/efficiency.
Length of schedule A longer/shorter schedule often means ...	→	

9 a ▶6.4 Viktor, an engineer from a German company that makes and installs industrial gantry cranes, is phoning Rajesh, the construction manager of a manufacturing plant currently being built near New Delhi, India. They are discussing the gantry crane due to be installed at the plant. Listen to the conversation and answer the following questions.

1 Why are holes needed in the concrete walls?
2 What are *core drilled holes* and what are *preformed holes*?
3 In this context, what is meant by *play*?
4 What impact will the lack of play around the bolts have (on the construction)?
5 Apart from technical questions, what two issues will determine the most feasible way of forming the holes?

b In pairs, compare core drilling and preforming with regard to the following feasibility issues. Which technique is most suitable for the situation in Exercise 9a?

cost   precision   timescale

c ▶6.5 Viktor and Rajesh are assessing the most suitable method of forming the holes in the walls. Listen to the conversation and compare their answers with yours.

d ▶6.5 Listen again and answer the following questions.

1 What are the advantages of using preformed holes in terms of cost and timescale?
2 What's the main disadvantage of core drilling the holes?
3 What tolerance can easily be achieved with preformed holes?
4 What tolerance is required for the holes on this project?
5 What's the risk of using preformed holes?
6 What key feasibility issue does Rajesh identify?

e **Complete the following expressions from the conversation using the words in the box and indicate the degree of feasibility each expression describes.**

borderline ~~dead~~ forever leg painstaking peanuts perfectly stretching tall way

		☺	😐	☹
1	*it'll be* dead *easy*	☑	☐	☐
2	*it'll cost* ________	☐	☐	☐
3	*it'll be quite a* ________ *job*	☐	☐	☐
4	*it's* ________ *feasible*	☐	☐	☐
5	*it's achievable, but it's* ________ *it*	☐	☐	☐
6	*there's no* ________ *you can do it*	☐	☐	☐
7	*it's* ________	☐	☐	☐
8	*it's a* ________ *order*	☐	☐	☐
9	*it'll take* ________	☐	☐	☐
10	*it'll cost an arm and a* ________	☐	☐	☐

perfectly feasible	☺
feasible but challenging	😐
completely unfeasible	☹

f **How feasible do you thing the following suggestions are? Label them ☺ 😐 or ☹ according to the key in Exercise 9e.**

1 The machine parts are tricky to paint with brushes, or to spray. Why don't we dip them in paint?
2 The steel bar is 100mm in diameter. Couldn't it be cut by hand, using a hacksaw?
3 Silver's a good conductor. Why don't we use it for wiring, instead of copper?
4 Instead of putting lead ballast in the helium balloon basket, why don't we use water containers?
5 They've used the wrong type of fuel in the engine. I'd suggest stripping the whole thing down and cleaning it by hand.
6 They produce 6,000 units per day and normally do a quality check on 1% of them. Couldn't they check every single product?

g **In pairs, give an appropriate response to the suggestions in Exercise 9f using the expressions in Exercise 9e.**

10 **In pairs, discuss the feasibility of the following solutions to the problem of forming accurately positioned holes through the plant walls in New Delhi. Student A, you are Viktor; Student B, you are Rajesh. Discuss technical issues, cost and timescale, and rank the solutions in order of feasibility.**

1 Is a diamond drill really needed to go through reinforced concrete? Surely you can drill into concrete with an ordinary hammer-action drill? Wouldn't that reduce the cost?
2 Couldn't they make the preformed holes wider than required, so there's extra tolerance? Then, once the bolts are fixed, the space around them could be filled with cement.
3 Why not drill the holes in the steel beams on site, instead of pre-drilling them? Then they could be positioned to suit the location of the preformed holes in the wall. That way, it wouldn't matter if the holes in the walls were slightly out of position.
4 Instead of bolting through the concrete, what about adding extra steel columns that run down the walls? The beams could then be supported on these, and no holes would be required through the concrete.

Describing improvements and redesigns

11 **Look at the slide from an engineers' training course, *Total Technical Improvement*. In pairs, suggest examples of technical improvements to illustrate each one. Are there other points that could be added to the list?**

DEFINING IMPROVEMENT:

- BETTER-QUALITY MATERIALS
- LOWER UNIT COST
- MAKE LIFE EASIER FOR USER

12 **a** **Look at the slide from a design meeting at a computer printer manufacturer. In pairs, suggest ways that the following printer factors might be improved in some of the areas on the list.**

cables/connections   case   ink/toner cartridges   paper   power   software

Possible areas for improvement

1 Aesthetics
2 User interface
3 Reliability
4 Consumables
5 Output quality and speed
6 Maintenance
7 Manufacturing
8 Environmental impact

b ▶6.6 **Marta, a manager at the printer manufacturer, is briefing the design team on key requirements for the redesign of a printer. Listen to the start of the meeting. Which two areas on the slide in Exercise 12a are discussed?**

c ▶6.6 **Listen again and answer the following questions.**

1 Should the layout and components of the new printer differ much from the existing design? Why (not)?
2 How many times has the existing model been improved in the past?
3 What consideration is behind the decision on how different the new software should be?
4 To what extent should the new software system differ from the existing one?

d **Look at the following verbs from the discussion and find three examples where *re-* means *again*. Match the other three verbs to the definitions in the box.**

improve overall   improve the details   stay (the same)

1 redesign design again	3 refine ________	5 rethink ________
2 reinvent ________	4 revamp ________	6 remain ________

e ▶ 6.6 **Complete the following expressions from the discussion using the words in the box. Listen and check your answers.**

Achilles back drawing board ground heel improvement
leap quantum ~~reinvent~~ room scratch up ~~wheel~~

1 reinvent *the* wheel
2 *designing the whole thing from the* ______
3 ______ *for* ______
4 *the* ______
5 ______ *to the* ______
6 *make a* ______
7 *designing the system from* ______

f **Match the expressions (1–6) in Exercise 12e to the definitions (a–f).**

a waste time re-creating something that has already been created 1
b the biggest weakness ______
c start again because the first plan failed ______
d make huge progress ______
e design from the beginning ______ / ______
f potential for doing a better job ______

g **Rewrite the following sentences using the correct form of the expressions in Exercise 12e.**

1 Unfortunately, we had to scrap the concept and start again.
We had to go back to the drawing board.
2 This problem is the product's most serious shortcoming.
______
3 There's no point redesigning what already works perfectly well.
______
4 It's a totally new design – we started from the very beginning.
______
5 The new design is so much better – it's a transformation.
______
6 I think there's definitely a possibility to do better in this area.
______

3 **a** **In pairs, discuss how computer pointing devices have improved since the first mouse was invented. Use the language from this section and the words in the box.**

ball buttons first mechanical mouse optical mouse optical sensors
refined mechanical mouse sensitive surface touchpad wheel wireless

b **You have been asked by a computer hardware manufacturer to think of some functional improvements and technical solutions for pointing devices. In pairs, discuss your ideas.**

c **Present your ideas in Exercise 13b to another pair.**




UNIT 7 Procedures and precautio

- Describing health and safety precautions
- Emphasising the importance of precautions
- Discussing regulations and standards
- Working with written instructions and notices

Describing health and safety precautions

1 **Some engineering or industrial activities are especially dangerous. In pairs, think of more examples to add to the following list.**

- Manufacturing processes using dangerous chemicals
- Casting and welding involving high temperatures

2 a **In pairs, discuss what is meant by the items on the Health and Safety meeting agenda.**

Dorian Food Processing
Health & Safety Meeting Agenda

Wednesday 16 April, Conference Room, 2.00pm – 4.0C

To: RM, MA, DB, SM, BP, LJ
Chair: Rosana Martinez

1 Hazardous substances & Personal Protective Equipment
2 Harmful gases/fumes & asphyxiation hazards
3 Fire/Explosion hazards
4 Machinery: guards and safety devices
5 Access ways, guardrails and emergency exits
6 Electrical installations
7 Noise hazards

b ▶7.1 **Rosana, the assistant manager at a Dorian Food Processing plant, is chairing the weekly Health and Safety meeting. Listen to four extracts from the meeting and match each extract (a–d) to an agenda item (1–7).**

a ______ c ______

b ______ d ______

c ▶7.1 **Listen again and match the words from the meeting (1–8) to the definitions (a–h).**

1	confined spaces	a	burns the skin
2	CO_2 detector	b	contact (with a danger)
3	exposure	c	sources of ignition
4	irritant	d	small areas without ventilation
5	toxic	e	measures carbon dioxide
6	corrosive	f	poisonous
7	flammable	g	causes skin to react
8	naked flames/sparks	h	catches fire easily

d **Which four types of PPE shown in the photos are mentioned at the meeting?**

e **In pairs, discuss the hazards in the following situations and the precautions that should be taken.**

1. Working inside a container with limited air circulation
2. Cleaning metal using acid that can burn the skin and which gives off fumes
3. Using a grinder to cut through a steel plate
4. Applying paint that can cause painful rashes on the hands

3 **a** **Stephanie, Dorian's senior safety officer, is attending a meeting on standard procedure for some engineering work that will be carried out at several of Dorian's plants around the world. Before the meeting she made notes. Read her notes and answer the following questions.**

1. What is meant by *hazard analysis*?
2. What is another way to say *safe system of work*?
3. What type of work is going to be carried out, and where?
4. What is meant by *access to silos*?
5. What are the specific hazards relating to confined spaces in this situation?

Hazard analysis & safe system of work
Operation: Maintenance to grain silos involving welding (with oxy-acetylene)
Location: Interiors of empty silos (approx 3m diameter x 15m deep), at bottoms
Main safety issues: Access to silos for workers & equipment. Confined space hazards

b ▶7.2 **Stephanie is discussing some of the hazards with Ben, one of Dorian's engineering managers. Listen to the conversation and note the hazards that they mention.**

1. Access hazards: ______________________________
2. Confined space hazards: ______________________________

c ▶7.2 **Listen again and answer the following questions.**

1. What safety precautions are discussed?
2. Which precaution might make one of the hazards worse, and how?

4 **In pairs, discuss suitable health and safety precautions and PPE for the following operations on an existing steel petrol storage tank at a processing plant. Student A, you are a safety officer; Student B, you are an engineering manager. Use the phrases in the box. Swap roles and practise again.**

- An opening needs to be cut through the wall.
- A new steel outlet pipe must then be welded onto the opening.
- The existing paint must then be removed from the external surface of the tank, by shot-blasting.
- The tank must then be repainted.

The main danger/hazard is ...	They'll have to take care that ...
Another danger/hazard is ...	They'll have to be (very) careful ...
There's a risk of ... -ing	To be safe, they'll need to ...

Emphasising the importance of precautions

5 a Dorian Food Processing is currently standardising safety procedures at its plants around the world. Read the following extract from the contents page of the company's new safety documentation and answer the following questions.

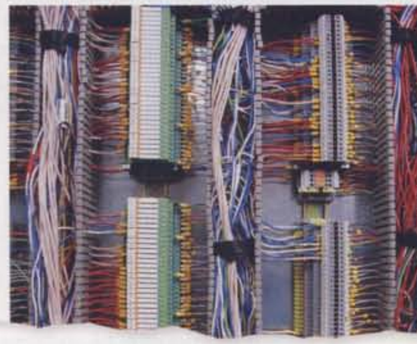
1 What is meant by LV and HV electrical maintenance operations?
2 What kinds of electrical maintenance might be carried out in a factory?

LV & HV ELECTRICAL MAINTENANCE OPERATIONS

Part 1 Identifying and designating Restricted Areas (switchboards, transformer stations, areas with exposed conductors)

Part 2 Authorising maintenance
- The role of the Electrical Supervisor
- Procedures for issuing Permits to Work

Part 3 Isolating and energising circuits
- Lock-Out Procedure
- Temporary Warning Notices on switchboards



b ▶7.3 Listen to Stephanie explaining the safety procedures to Lin, the plant manager in Beijing. What is meant by the following phrases?

1 restricted areas
2 a permit to work
3 the electrical supervisor
4 the lock-out procedure

c ▶7.3 Complete the following extracts from the conversation by underlining the phrases that give the strongest emphasis. Listen to the conversation again and check your answers.

1 *Restricted areas are places where a serious danger is present. So it's essential that these should be kept locked* ***at all times / all the time****.*
2 ***Under no circumstances should anyone / Nobody should under any circumstances*** *be able to access them ...*
3 *... it's important that permits are issued* ***each time / every single time*** *someone enters ...*
4 *And it's crucial that there's* ***just one / just a single*** *key to each restricted area.*
5 *Then, while they're working,* ***it's vital / it's advisable*** *that they keep the key on them ...*

d Which of the following phrases give more emphasis than *it's important*, and which give less?

1 it's crucial
2 it's essential
3 it's preferable
4 it's vital

e Rewrite the following precautions using the phrases in the box to add emphasis.

~~at all times~~ every single it's crucial it's essential it's vital under no circumstances

1 The fire exit should always be kept clear.
The fire exit should be kept clear at all times.
2 It's important to test that the circuit is isolated.
3 You should reset the alarm routinely when you start the system.
4 It's a good idea to check that the cable is not damaged.
5 It's recommended that you should only store non-flammable materials in this zone.
6 Nobody should enter the restricted area without permission.
7 Before pressurising the system, make sure all the connections are tight.

f In pairs, discuss the following basic precautions for working on electrical circuits.

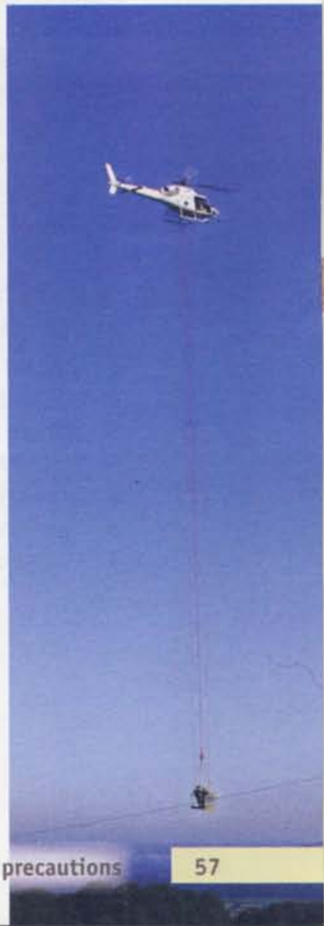
Before starting:
- Isolate circuit at switchboard
- Test circuit – no current

During work:
- Tighten connections fully
- Don't damage insulation

To finish:
- Check no loose wires
- Test circuit

6 a Read the following extract from an electricity company newsletter. What procedure does the article describe?

A helicopter hovers between the towering pylons of an extra-high-voltage power line. In a cradle, suspended several metres below the aircraft, stand two line men, shrouded in hooded, stainless-steel threaded hot suits. Just a few feet away is a live electric cable, fizzing with 400,000 volts. One of the men, holding a short metal wand, reaches out towards the cable. Pocket-sized lightning bolts arc through the air. There's no discernible electric shock, just a slight tingling sensation. A lead is then clipped to the live cable to maintain an electrical connection with the cradle and helicopter. The line men are now on, and maintenance work on the live power line can begin.



c In pairs, discuss the main precautions you think should be taken during live line maintenance work by helicopter with regard to the following hazards.

1 Collisions and snagging (getting caught/trapped)
2 Hazards from electrocution and heat
3 Mechanical failure (helicopter and equipment)

d ▶7.4 Krisztof, an electrical engineer, is describing live line maintenance by helicopter for a TV documentary. What precautions does he describe for each of the three types of hazard in Exercise 6c?

7 In pairs, think of an operation you are familiar with that requires safety precautions. Student A, you are a safety officer; explain the precautions to a new employee. Student B, you are a new employee. Swap roles and practise again.

Discussing regulations and standards

8 **In pairs, discuss what is meant by *regulations* and *standards*, for example *safety regulations* and *design standards*. Give some examples of organisations and departments in your country and international bodies that produce these kinds of rules.**

9 a **Offshore oil platforms are covered by extensive safety regulations and design standards. In pairs, discuss the main hazards that oil platform workers face and suggest some safety precautions that need to be taken.**

b **▶7.5 Isobel, a Health and Safety specialist, is speaking to newly recruited oil platform technicians on a training course. Listen to the introduction to her talk and answer the following questions.**

1 What kinds of regulation will the course deal with?
2 What examples does the trainer give?
3 What important point is emphasised?

c **Complete the following extract from Isobel's talk by underlining the correct words.**

The focus of the course will be on your personal (1) ***legislation / obligations*** *in terms of looking after your own safety, and the safety of others. That means we'll be focusing on specific safety regulations. For instance, we'll be looking at personal protective equipment that's (2)* ***compulsory / prohibited****. Or activities that are (3)* ***compulsory / prohibited*** *in certain areas, such as smoking. The majority of the obligations we'll deal with are legal (4)* ***requirements / permits****. In other words, they're (5)* ***permitted / stipulated*** *by law as part of health and safety (6)* ***legislation / obligation****. If you (7)* ***contravene / comply with*** *these kinds of regulations, it's not the same as turning up for work late, or merely breaching your contract of employment in some way. If someone fails to (8)* ***contravene / comply with*** *health and safety regs, they're breaking the law. It's as simple as that. I'm sure you're all aware of that, but it is an important point to emphasise.*

d **Complete the following groups of synonyms using the words in bold in Exercise 9c.**

1 illegal / banned / forbidden / prohibited
2 allowed / authorised / ________
3 adhere to / conform to / ________ ________
4 stated / ________
5 break (the law) / breach (regulations) / ________ (regulations)
6 laws / regulations / ________ / legal ________ / personal ________
7 obligatory / ________

a Read the extract from a guide to safety in the offshore oil industry. Complete the text using the words you wrote in Exercise 9d.

The helicopter flights that ferry personnel to and from the platform are subject to specific safety (1) legislation. The procedures and standards that are (2) ________ by this regulations relate, principally, to the following areas:

- Helicopter sea crash evacuation training. Courses are (3) ________ for all personnel
- Design and safe operation of oil platform helidecks
- Specialised pilot training.

For North Sea oil platforms that fall within UK (4) ________, operations must (5) ________ ________ the legal (6) ________ of British Health and Safety regulations, and Civil Aviation Authority rules. They must also satisfy the additional specific (7) ________ laid down by the UK Health and Safety Executive and the Offshore Industry Advisory Committee, Helicopter Liaison Group (OIAC-HLG).

b Read the following notes on the design requirements for helidecks on oil platforms. In pairs, discuss the possible reasons for these design standards.

1 Diameter of helideck: at least total length of largest helicopter - no parts of aircraft overhanging perimeter

2 Approach/takeoff routes: adjacent structures below level of helideck - no tall structures

3 Perimeter protection (to prevent personnel from falling): handrail that can be lowered or horizontal net - no fixed handrails

4 Equipment to cope with bad weather / poor visibility: perimeter landing lights and anchor points

Imagine you are training new engineers in your workplace (or a workplace you know). In pairs, explain the main requirements of some regulations or standards that are relevant to your industry using the following points.

- key legal requirements
- the kinds of operation that must comply with regulations
- practices/procedures that are permitted
- practices/procedures that are prohibited

Working with written instructions and notices

12 **Think of situations where written notices and instructions are used in industry. In pairs, discuss the following questions.**

1 What different kinds of information do they communicate?
2 What are the characteristics of effective notices and instructions?

13 a **The following warning notices are from a guillotine for sheet metal and a precision weighing device in a manufacturing plant. In pairs, discuss whether each notice warns of a problem that could injure workers, damage the machine, or both.**

a b c d e

b **Look at the first word in each sign and answer the following questions.**

1 Which word is only used to warn of a risk of injury to people? ________
2 Which word is only used to warn of a risk of damage to equipment? ________

14 a **The following extracts are from the instruction manuals of three of the machines in Exercise 13a. In pairs, answer the questions (1–6).**

a

> In the event of a fire water extinguishers should not be used on this machine as it contains electrical circuits, and can therefore cause electrocution. Only a carbon dioxide extinguisher should be used.

1 Why is it unsafe to put water on the machine?
2 What type of fire extinguisher is recommended?

b

> When lifting this machine, it is essential that only the two lifting eyes marked in red should be used. No other parts of the frame are load-bearing and must not, therefore, be used as anchor points.

3 What is the purpose of the items marked in red on the machine?
4 What could happen if the machine was lifted by other parts of the frame?

c

> Care should be taken when cleaning below the guillotine blade as there is a danger that the blade may descend. Before cleaning, the control lever should always be set in the Blade Locked position. Protective gloves should be worn during cleaning as the sump below the blade may contain sharp metal off-cuts.

5 Why is it important to lock the guillotine blade?
6 What other danger is there, and what precaution should be taken as a result?

b ▶7.6 **Petrus, an engineer from a machine manufacturer, is giving instructions about the machines in Exercise 14a to a client. As you listen, follow the written texts (a–c) and identify as many differences as you can between the spoken instructions and the written instructions. Use the following ideas.**

1 grammatical differences
2 use of contractions
3 differences in words used

a **Read the following spoken explanations of the operating precautions for an industrial blower. Rephrase them as written instructions, making changes based on the differences between spoken and written language style you identified in Exercise 14b.**

> You shouldn't place objects in front of the air inlet. And you should keep the inlet grille free from obstructions, and clean it regularly. If there's damage to the inlet grille, stop the blower immediately. Foreign bodies entering the duct can cause serious harm, because the unit contains precision-engineered parts revolving at speed, so it's highly susceptible to damage.

Objects should not be placed in front of the air inlet.

> Before you start the blower, it's important to ensure that the external vents at the end of the air-intake duct are open. When you open the vents, fully extend the adjusting handle. Then when you close them, turn the handle and allow it to return under the force of the spring. Don't push the handle, because that can strain the spring mechanism, and result in damage.

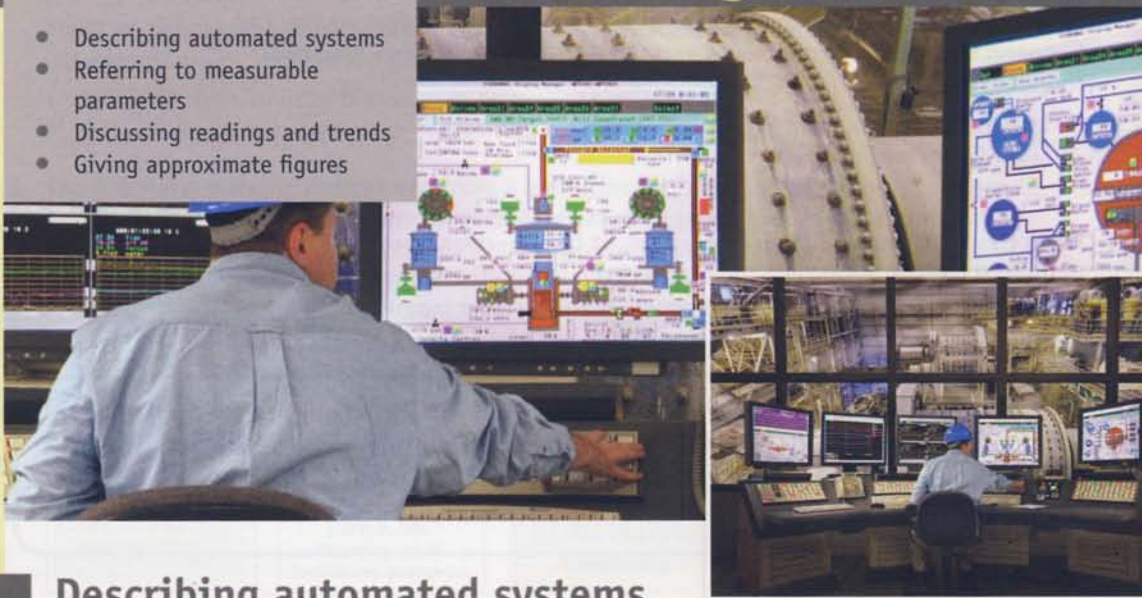
Before starting the blower, ...

b **Think of some safety or operating precautions you are familiar with for a machine or process you know. Write one or two paragraphs of instructions, explaining the main precautions that should be taken.**

c **In pairs, explain the safety or operating precautions for the machine or process using your instructions as a guide.**

UNIT 8 Monitoring and control

- Describing automated systems
- Referring to measurable parameters
- Discussing readings and trends
- Giving approximate figures



Describing automated systems

1 **In pairs, discuss the difference between an automated and a manual system. What do you think a Building Management System (BMS) does in intelligent buildings? Suggest some operations that can be monitored and controlled automatically by the BMS in large buildings such as offices.**

2 a ▶8.1 **Roland, a mechanical and electrical services (M&E) engineer, is talking to Saskia, an architect, about the design of a new building. Listen to the conversation and answer the following questions.**

1 What is a key characteristic of the client company?
2 How will this characteristic affect the building design?
3 What do you think is meant by *presence detectors*?
4 What does Roland say about design options and how does he describe option one?

b ▶8.2 **Roland gives some examples of sensors and controls. Listen to the next part of the conversation and tick the points he mentions.**

1 controlling the electric lighting inside the building ☐
2 controlling the amount of solar radiation entering the building ☐
3 controlling the air flowing in and out through the windows of the building ☐
4 controlling the flow of warm and cool air around the interior of the building ☐

c **Match the words in the box to the synonyms (1–5).**

detect ~~detector~~ pick up reading regulate set off trigger

1 sensor / detector
2 measurement / ____________
3 control (adjust) / ____________
4 sense / ____________ / ____________
5 activate / ____________ / ____________

d **Complete the following extracts from the conversation by underlining the correct words.**

1 *Not just the usual systems that* ***activate/detect*** *the lights ...*
2 *We could use presence detectors to* ***pick up/control*** *other systems ...*
3 *... a presence detector* ***sets off/senses*** *that everyone's left a meeting room ...*
4 *... a temperature sensor picks up a positive* ***detector/reading*** *...*
5 *... the sensor* ***detects/regulates*** *sunlight, and* ***senses/triggers*** *the blinds ...*
6 *... those sensors* ***set off/sense*** *a circulation system ...*
7 *... we'd use presence detectors and heat sensors to* ***detect/regulate*** *as many systems as possible?*

e **In pairs, describe the following automated systems using the words in Exercise 2d.**

	sensor	parameter	system
1	presence detector	movement	lights
2	smoke detector	smoke	fire alarm
3	thermostat	room temperature	electric convector heater
4	pressure plate	weight of a person	intruder alarm

3 **a** ▶8.3 **Roland and Saskia go on to discuss an alternative control system in the building. Listen to the conversation and answer the following questions.**

1 What assumption is the idea based on?
2 What design approach might be taken with regard to controls?
3 What is the advantage of this approach?

b **You are in the M&E design team for the new building project and have received the following email from the project engineer asking for your input. Read the email and, in pairs, discuss what the engineer wants you to do.**

To: Lauren Harvey
Subject: Presence detectors

Could you look into the practicalities of using presence detectors for controlling the lights in different parts of the building? We'll probably have a mixture of detector-controlled systems and manual switches. The question is, which type of control do we want to have in each location? (Please see my list below.) A critical issue will be setting the switch-off delay in different locations, i.e. how long the lights remain on after the last movement is detected. On my last project, we had a lot of complaints from the client about the lights going off while people were still in rooms. So can you think about different timer delays for different locations in the building?

Main locations: open-plan offices, individual offices, meeting rooms, corridors, store rooms

c **Prepare notes for a short talk to brief the project engineer using your ideas from Exercise 3b. Student A, you are an M&E engineer. Brief the project engineer on your ideas. Student B, you are the project engineer. Listen to the briefing and ask questions about specific details. Swap roles and practise again.**

Referring to measurable parameters

4 **In pairs, think of monitoring and control systems that are widely used around the home. Discuss how the following parameters are measured and/or controlled in these common domestic appliances.**

Parameters: temperature pressure time actions/movement
Appliances: boilers heating systems refrigerators washing machines

5 a **Match the sensor or measuring system (1–5) to the industrial applications (a–e).**

1	pressure measurement	a	monitoring the speed of water travelling along a supply pipe
2	temperature measurement	b	measuring the level of heat generated by an exothermic reaction
3	flow measurement	c	monitoring the number of cans moving along a conveyor belt
4	level measurement	d	monitoring the amount of ethanol contained in a storage tank
5	process recorders	e	checking the force exerted by steam inside a vessel

b **In pairs, think of other uses for the kinds of sensor and measuring equipment in Exercise 5a.**

6 a **▶8.4 Jochem and Katerina, two process engineers at a chemicals plant, are discussing the monitoring and control systems that will be needed for a new production line. Listen to three extracts from their discussion and answer the following questions.**

Extract 1 a What problem is discussed?
b What mechanical safety precaution is proposed?
Extract 2 c What issue is discussed?
d What three parameters related to consumption are important?
e To calculate the parameters, what does consumption need to be continuously measured against?
Extract 3 f What issue is discussed?
g Which two measurements need to be taken?
h What optimum value needs to be determined?

b **Match the words (1–10) from the discussion to the definitions (a–j).**

1	input	a	the best / the most effective/efficient
2	output	b	how often something happens
3	optimum	c	the amount of supplies/fuel used
4	differential	d	the total quantity so far
5	consumption	e	a specified period
6	cumulative	f	a value often expressed with per, for example units per hour
7	rate	g	the exit value, for example at the end of a process
8	cycle	h	the entry value, for example at the start of a process
9	frequency	i	the gap between two values
10	timescale	j	all the steps in a process, from start to finish

c **The following specification was written following the conversation. Complete the text using the words in Exercise 6b.**

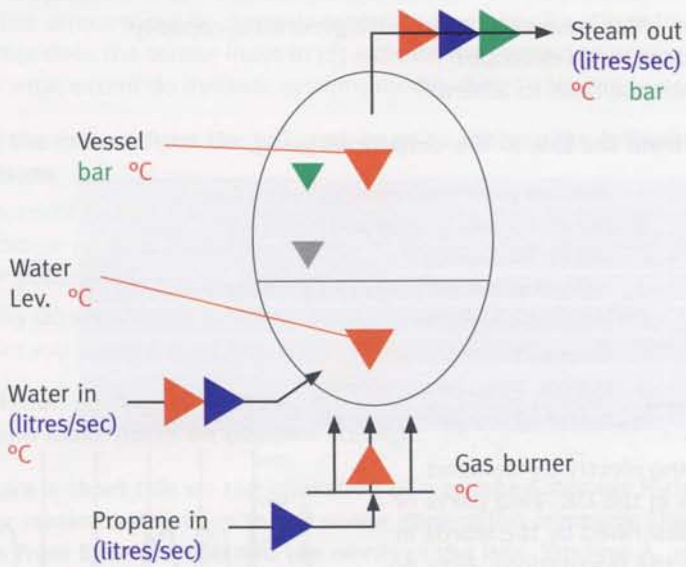
<u>Vessel B1: Sensor and Measuring System Requirements</u>

Two pressure sensors: one located inside the vessel, and a second situated on the pipe running downstream, to enable any pressure (1) differential to be detected.

A flow meter to monitor gas (2) ___________ . Data will be recorded as a (3) ___________ figure (total usage), and as flow (4) ___________ , in litres per second. Note: Software will be configured to log flow against the (5) ___________ of a system clock, in order to pinpoint peak flow periods occurring between the start and finish of a given reaction (6) ___________ , and to assess the (7) ___________ with which they occur.

Two temperature sensors: one at the entry point of the vessel, to measure (8) ___________ temperature, and a second at the outlet point to monitor (9) ___________ temperature. Note: Precise regulation of the entry temperature will be key to obtaining (10) ___________ reaction performance.

7 **a** **You and your partner are process engineers working with Jochem and Katerina at the chemical plant. You need to assess the sensors and measuring equipment required for the steam production facility. In pairs, discuss the requirements using the information in the diagram. Make notes of your ideas.**



b **In pairs, discuss what parameters can be determined for the installation of a heating cycle using your ideas from Exercise 7a. You should assume that all the measurements will be recorded against a timescale.**

Discussing readings and trends

8 a In pairs, discuss the factors that cause mains electricity consumption to vary.

b ▶8.5 Helen, an electrical engineer at a power station, is giving a talk to a group of visiting investors. Listen to the talk and note the five factors that influence electricity consumption.

1 ______ 3 ______ 5 ______
2 ______ 4 ______

c Complete the following extracts from the talk using the correct form of the words in the box.

decrease fall increase rise

1 *During periods of very cold or very hot weather, demand* increases *. The ______ in demand is obviously due to millions of electric radiators coming on ...*
2 *... a key factor which ______ or ______ demand, is whether or not it's light or dark ...*
3 *... on cold, dark, winter evenings, the ______ in demand is significant ...*
4 *Generally, demand ______ during the week, when factories and offices are operational ...*
5 *So demand ______ at the weekend.*
6 *There can be a sudden ______ when people rush to switch kettles on, or heat up snacks in microwaves, and then a sudden ______ shortly afterwards.*

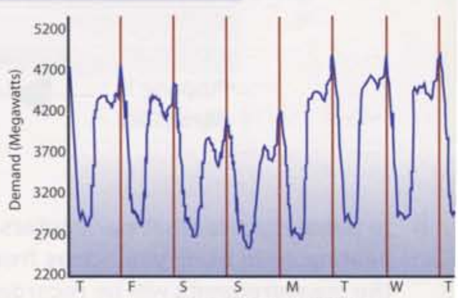
d ▶8.6 Listen to the next part of Helen's talk and answer the following questions.

1 Why does the company often have significant spare generating capacity?
2 What ideal situation does Helen describe?
3 Why is this ideal situation difficult to achieve?

e Match the words (1–8) from the talk to the definitions (a–h).

1	continuous	a	maximum power requirement at a given time
2	fluctuations	b	amount between an upper and lower limit
3	peaks and troughs	c	without interruption
4	peak demand	d	high points and low points on a graph curve
5	range	e	regular and repetitive
6	band of fluctuation	f	momentary rises followed by a fall
7	blips	g	changes, movements in general
8	continual	h	zone of up-and-down movement

f Look at the graph showing electricity demand fluctuations over a week in the UK. Find parts or patterns on the graph described by the words in Exercise 8e and analyse the fluctuations. How do they compare with Helen's explanation?



Day of the week (November)
Daily peak demand 8pm

9 **a** **Read the document on energy saving aimed at industrial plant and facility managers. Complete the text using the words in Exercise 8e.**

> Dynamic demand control systems can be fitted to electrical appliances that operate on duty cycles, i.e. appliances that start up, run for a time, shut down again, and then remain on standby for a while before repeating the same cycle. Heating and refrigeration units are common examples of power-hungry equipment that operate on this start-run-stop-wait basis.
>
> Dynamic systems exploit the fact that duty cycle appliances do not require (1) continuous power. The purpose of the systems is to help smooth power demand for the benefit of electric utilities. To achieve this, they delay the start-up of the appliances they control during periods of (2) __________. However, only minor adjustments are made to timing as, generally, the appliances concerned can only be held on standby for short periods as they need to run on a (3) __________ basis. But this still benefits electric utilities as it helps to avoid problematic, momentary (4) __________ on the demand curve.
>
> Dynamic controls work by detecting slight (5) __________ in the frequency of the mains AC supply. Although this varies only within a very narrow (6) __________, small drops in frequency indicate that power station turbines are working close to full capacity. The dynamic control system can therefore hold the appliance on standby for a short time until mains frequency increases again.

b **Read the text again and answer the following questions.**

1 What is meant by *duty cycle*?
2 What problem is dynamic control designed to avoid?
3 What sensor input do dynamic controls rely on to allow them to function?
4 What does the sensor input in (3) indicate with regard to power stations?
5 To what extent do dynamic systems modify duty cycles?

10 **a** **Read the extract from the talk and, in pairs, discuss the following questions.**

... electrical charge is extremely difficult to store in large amounts, you can't just charge up huge batteries. So we use an innovative technique to store up power potential during off-peak periods.

1 Why do you think this is such a major issue for power stations?
2 Can you suggest what innovative technique is used to solve the problem?

b **▶8.7 Helen goes on to describe the solution to the problem. Listen to the talk and make notes on pumped storage.**

c **Prepare a short talk on the operation of a pumped storage hydroelectric power station for visitors to the power generation company. Use your notes from Exercise 10b and the words in the box. Student A, you are an electrical engineer; Student B, you are a visitor on a tour of the plant. In pairs, give your talk and ask and answer questions. Swap roles and practise again.**

gravity	high level	low level	mountain	pumps	reservoir	turbines

Giving approximate figures

11 a Read the email extract and answer the following questions.

1 Who do you think sent the email? What is their role within the company?
2 What type of review is the company going to undertake?
3 What is the objective of the review?

To: Gerry Klein
Subject: Internal review

Dear colleagues,

As you know, we are preparing to undertake a comprehensive internal review of the company's organisation and facilities. A key area of this review will be to assess how efficiently your engineering expertise is being utilised. I would emphasise that the aim of this assessment is not to question your professional competence. On the contrary, I and the company's new shareholders recognise the high degree of technical expertise within the organisation. Our intention is to work towards optimising this valuable resource by identifying the demands on your time that are largely unproductive (such as administrative tasks) in order to allow your skills to be used more productively.

b The following extract is from a questionnaire used in the review which was sent to staff in the company's design department. Read the questionnaire and match each question (1–3) to points (a–c).

Approximately what percentage of your time do you spend on the types of task below? For each question, the sum of values given for A + B should equal 100%.

1 A Doing technical tasks that use my engineering skills extensively ______ %
B Doing moderately technical tasks that a less qualified colleague could do ______ %

2 A Doing technical tasks that add value (e.g. designing, problem-solving) ______ %
B Doing tasks that do not add value (e.g. administration) ______ %

3 A Doing tasks that are purely technical ______ %
B Doing tasks that relate to technical organization and decision-making ______ %

a The extent of technical role versus management role ______
b The degree of commercial exploitation of technical skills ______
c The degree of application of expertise and experience ______

c ▶ 8.8 Eleanor and Gerry, two design engineers, are talking about the questionnaire. Listen and write approximate values, to the nearest 10%, for Gerry's answers to the questions.

d Complete the following sentences using the words or phrases in the box. Sometimes more than one answer is possible.

~~ballpark figure~~ off the top of my head nowhere near pretty much roughly somewhere in the region of

1 They asked for a ballpark figure for setting up the new system.
2 I've got the figures in my computer, but I couldn't tell you ______ .
3 The work is ______ finished, there's just the tidying up to do.
4 The actual cost of the stadium was ______ the estimate at £2m over budget.
5 I think it'll take ______ two weeks to complete the report.
6 The development will cost ______ $10m.

e **In pairs, ask and answer the questions from the questionnaire in Exercise 11b using the phrases in Exercise 11d. Note down your partner's answers.**

1 A ______ % B ______ %

2 A ______ % B ______ %

3 A ______ % B ______ %

12 **a** **8.9 As part of the company's internal review, an assessment is being made of the hardware and software that make up the firm's Computer Aided Design (CAD) system. Dan, a design engineer, is talking to Beatrice, his manager, about the state of the system. Listen and mark the following statements True (T) or False (F).**

1 Most of the screens are too small.
2 Engineers spend a lot of time working on screen.
3 Large numbers of drawings are printed at their office.

b **Find words and phrases in audioscript 8.9 on page 93 to match the following definitions (1–5).**

1 approximately / ______________
2 much more than / ______________
3 at least / ______________ (two thirds)
4 most / ______________
5 almost zero / ______________

c **Complete the following replies to express the figures in approximate terms using the words in Exercises 11d and 12b. Sometimes more than one answer is possible.**

1 How old is this equipment? A good five years old. (at least 5 years)
2 What percentage of the PCs need changing? ______ all of them. (95%)
3 How many of the computers are up to spec? ______ all of them. (70%)
4 How many of the staff use the CAD system? ______ half of them. (55%)
5 How much would the new printers cost? ______ $2,000. ($3,120)
6 How much does an adapter like this cost? ______ . ($2)
7 How long would a full system take to install? ______ 5 days. (4–6 days)
8 Can most of our clients read these files? Yes, ______ of them. (95%)

13 **You are setting up a small company of consulting engineers employing seven members of staff – five engineers and two assistants. You need to rent an office, equip it with a computer network with CAD system and admin software, and buy other basic office equipment. In pairs, discuss some ballpark figures relating to the following questions.**

- What computer equipment will be required and how much will it cost to buy?
- What other items of furniture/equipment will be needed, and how much will this cost?
- How much floor space will be required in the open-plan office?
- How long will it take to set up the office – install the furniture and equipment?

UNIT 9 Theory and practice

- Explaining tests and experiments
- Exchanging views on predictions and theories
- Comparing results with expectations
- Discussing causes and effects

Explaining tests and experiments

1 **In pairs, discuss the following tests and experiments and their main advantages and disadvantages.**

1 computer models and simulations 2 reduced-scale testing 3 full-scale testing

2 a **In pairs, suggest how the following development tools could be used for aerodynamic testing.**

- Computational Fluid Dynamics (CFD)
- field testing
- a wind tunnel equipped with a rolling road

b ▶9.1 **An international team of researchers are collaborating on the design of an experimental energy-efficient vehicle. They are discussing the tools available for developing the vehicle's aerodynamic design. Listen to the conversation and answer the following questions.**

1 What options are available for wind tunnel testing in terms of scale?
2 Why are rolling roads useful in wind tunnels when testing vehicles?
3 What issue will determine whether or not a rolling road is necessary?
4 What point is made about the reliability of CFD and wind tunnel data?
5 What problem is mentioned with regard to outdoor testing?

c ▶9.1 **Listen again and complete the following extracts from the conversation using the words and phrases in the box.**

The acid test back-to-back testing in the field mock-up trial run tried-and-tested validate ~~virtual~~

1 *... the tests would obviously be* virtual *, based on a computer model.*
2 *... go into a wind tunnel, with a scale model, or a full-size* ________ .
3 *... it's not just about data gathering. You also have to* ________ *the data.*
4 *The* ________ *only comes when you try out a full-scale prototype in real conditions. We need to make sure that everything is* ________ *outside, with a full-scale* ________ .
5 *... with changeable weather, it's not easy to do* ________ *out* ________ .

d Match the words and phrases in Exercise 2c to the definitions (a–h).

a a 3D model simulating shape and size, but without internal components
mock-up

b proven to be reliable through real use / trials ____________

c outdoors, in a real situation ____________

d describes something simulated by software, not physical ____________

e a crucial trial to prove whether or not something works ____________

f trials to compare two different solutions, in the same conditions ____________

g prove theoretical concepts by testing them in reality ____________

h a practical test of something new or unknown to discover its effectiveness
____

e Complete the aerodynamic design development plan of the energy-efficient vehicle using stages (a–e).

a Test model in wind tunnel to validate data from scale tests

b Carry out back-to-back tests in wind tunnel with mock-ups

c Build full-size working prototype

d Select best design, based on data from wind tunnel tests

e Narrow down design options to three, based on computer data

Aerodynamic design development plan

1 Experiment using CFD software

2 ____________

3 Produce reduced-scale mock-ups of designs and test in wind tunnel

4 ____________

5 Build first full-scale mock-up

6 ____________

7 Produce two revised designs to improve on full-scale mock-up

8 ____________

9 Select best design, based on data from tests

10 ____________

11 Carry out field tests with trial runs outside

3 You are members of a technological research team similar to the one in Exercise 2b. You have been asked to design a test programme for an experimental system for air-dropping cargo. Read the brief and, in pairs, discuss the types of test required and their sequence.

Design brief

The system allows relatively fragile cargo to be air-dropped from planes into remote locations on the ground. It comprises a parachute, attached to a cylindrical container two metres long with a diameter of 1.5 metres. The container is surrounded by a deformable protective structure.

The aims of testing are to develop the designs of:

a) the parachute

b) the protective structure, in order to minimise the impact to cargo inside the container.

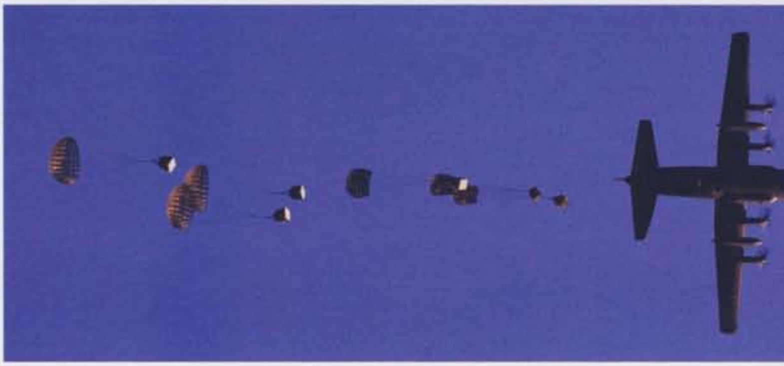
The number of tests must be maximised within a limited budget. As tests involving real drops from aircraft are costly, these must be kept to a minimum.

Exchanging views on predictions and theories

4 a In pairs, answer the following questions.

1 What kinds of cargo is sometimes dropped from aircraft, and why?

2 What are the advantages and disadvantages of air-drops?



b Read the following predictions of how a container air-dropped with parachutes might behave while falling, and on hitting the ground. Complete the predictions by underlining the words you think are correct.

1 The longer the container is in the air, the more its horizontal speed will **decrease/increase**.

2 Compared with a low-altitude drop, the vertical speed of a high-altitude drop will be **lower/higher**.

3 In terms of damage to the container, a high **vertical/horizontal** impact speed is potentially worse.

4 A very low-altitude drop will most likely cause the container to **slide/roll** along the ground.

c ▶9.2 Arnaud and Jenna, two engineers, are talking at the start of an air-drop research project. Which predictions in Exercise 4b do they agree on, and which do they disagree on? How do their ideas compare with yours?

5 a Rephrase the words in brackets to complete the following extracts from the conversation.

1 *So,* __________ (in theory), *the horizontal speed will keep decreasing …*

2 *So,* __________ (assume) *the drop altitude's very low, …*

3 *…* __________ (sure) *a low vertical speed is the critical factor.*

4 *Because,* __________ (presume), *if the groundspeed's quite high, there's a danger the container will roll …*

5 *So,* __________ (argue), *rolling is the worst problem, …*

b Rephrase the words in bold in the following sentences using the words in Exercise 5a.

1 **I suppose** there'll always be a certain amount of groundspeed.

2 **If we assume** the container will roll, we'll need to protect it accordingly.

3 **According to the hypothesis**, groundspeed will almost always be positive.

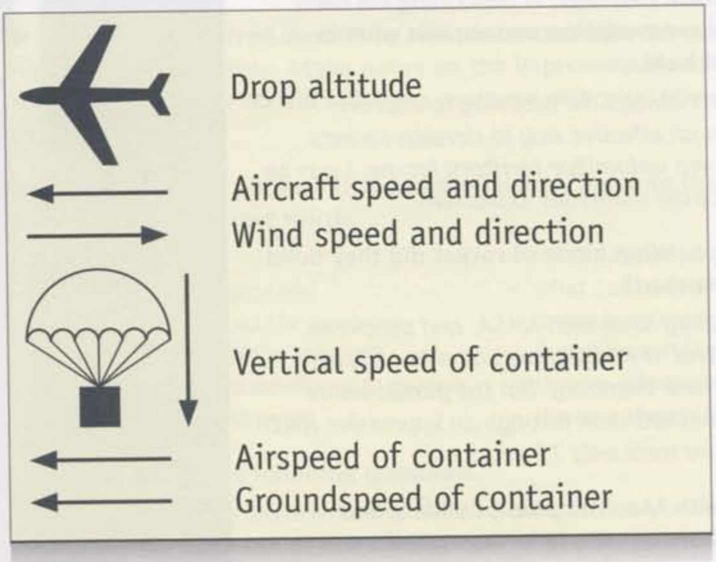
4 **You could say that** it's inevitable the container will roll and bounce along.

5 **I'm convinced that** high vertical speed is less problematic than high groundspeed.

c In pairs, decide whether the following words and phrases are used to agree or disagree. Can you think of other phrases for agreeing and disagreeing?

Absolutely I'm not convinced I'm not so sure Not necessarily
Of course True

d Look at the diagram and, in pairs, discuss the following questions.



1 What is the difference between airspeed and groundspeed? How do wind speed and wind direction result in a difference between an aircraft's airspeed and its groundspeed?
2 If an aircraft's groundspeed and airspeed are the same, what must the wind speed be?
3 In theory, an aircraft can fly with a groundspeed of zero in certain extreme conditions. What would these conditions be, with regard to wind speed and the aircraft's direction relative to the wind?
4 To minimise the horizontal groundspeed of an air-dropped container on landing, what should the aircraft's direction be, relative to the wind?
5 If several air-drops are carried out from the same altitude with different wind speeds, how will higher wind speeds affect the groundspeed of the container on landing?

6 a In pairs, discuss which of the following options you think is preferable and why.

1 a low-level drop with low vertical speed and high horizontal speed
2 a high-level drop with high vertical speed and low horizontal speed

b In pairs, discuss how the design of the container used for dropping cargo would be different for each of the two options in Exercise 6a. For each situation, consider how the container could be built to cushion the type of impact. In particular, think about the shape of the container and the protective structure around it.

Comparing results with expectations

7 a In pairs, discuss the difference between expectations and results. Give an example relating to research and development (R&D) in engineering.

b Manfred Haug, an aeronautical engineer, is describing his early rocket experiments. Read the description and explain what is meant by the expressions in bold.

Relying on ***trial and error*** *isn't always the best way to improve technology, but I found it was an effective way to develop rockets. Especially as rocket science was* ***unfamiliar territory*** *for me. I was* ***on a steep learning curve****, hence the numerous explosions.*

c Read more of the description. What kinds of rocket did they build and how do you think they worked?

I should say that this had nothing to do with NASA, and happened a long way from Cape Canaveral. It was just me and a few friends on a windswept football field near Hamburg. But the plastic bottle water rockets we built and launched went through an impressive R&D programme, bearing in mind we were only 12 years old!

8 a ▶9.3 Listen to an interview with Manfred about building and launching water rockets and answer the following questions.

1 How full were the bottles?
2 What coincidence was helpful?
3 How powerful was the rocket?
4 What problem occurred?

b Read the following extracts from the interview. What is meant by the words in bold?

1 *... we* ***expected*** *it would shoot up reasonably fast ...* ________
2 *... we* ***didn't anticipate*** *just how powerful it would be.* ________
3 ***It totally exceeded our expectations.*** ________

9 a In pairs, discuss two or three solutions to the problem experienced with the rocket, based on basic materials and simple assembly techniques. For each potential solution, explain how you would expect the rocket to perform and why, describing potential problems for each solution.

b ▶9.4 Manfred goes on to describe how he and his friends solved the problem. Listen to the description and summarise the solution, explaining why it was effective. How does the solution compare with your ideas in Exercise 9a?

c ▶9.4 Listen again and complete the following phrases from the description.

1 (as expected) *It didn't go exactly* ________ .
2 (extremely well) *It worked* ________ .

10 a In pairs, discuss possible ways of making the water rocket more powerful to allow it to attain higher altitudes. The basis of the design should be the same and you may only use basic materials. For each solution, explain the following points.

- Why you would expect the rocket to be more effective
- Any potential problems

b ▶9.5 Listen to Manfred describing how the rocket was developed and the results of further tests. Make notes on the improvements made and their consequences. How do the solutions compare with your ideas from Exercise 10a?

c Read the following phrases that Manfred uses. Complete the definitions by underlining the correct words.

1	*as it turned out*	= what happened in **theory/practice**
2	*what actually happened*	= what happened in **theory/practice**
3	*we underestimated the pressure*	= it was **less/more** than we thought
4	*we overestimated the strength*	= it was **less/more** than we thought
5	*plastic bottles are hardly up to the job*	= they're **adequate/inadequate**
6	*I learned the hard way.*	= it was a **theoretical/practical** lesson

d In pairs, discuss the following questions.

- Did you have any experiences of building things when you were younger which didn't turn out as you'd expected? What did you underestimate or overestimate? What lessons did you learn the hard way?
- When you were younger, what experiences were most beneficial in helping you to improve your technical skills? What technical principles did you learn?

11 Amateur rocket scientists have produced water rockets capable of reaching altitudes of several hundred metres in competitions. In pairs, think of initial ideas for a suitable design which complies with the following competition rules.

Water Rocket Competition

- Rockets must be assembled entirely from consumer products purchased from supermarkets or DIY stores. For safety reasons, no glass or metallic components are permitted.
- Rockets will be pressurised, and anchored during pressurisation using a compressor and launch pad provided by the organisers.
- Release of the rocket will be triggered by competitors, from a distance, by rope, at the moment deemed appropriate by the competitor, based on a reading on the pressure gauge of the compressor.

Discussing causes and effects

12 **In pairs, discuss the difference between cause and effect in each of the following situations.**

1 a vehicle tyre overheating
2 an electrical circuit overloading
3 a ship's hull corroding

13 a **Read the title of the article in Exercise 13b and explain what you think it means.**

b **Read the article and answer the following questions.**

1 What are chicken cannons designed to do?
2 Why was a chicken cannon used for a train test?
3 What were the effects of the test?

CHICKEN CANNON GOOF MAKES TECH EGGHEADS LOOK LIKE TURKEYS

When new aircraft are developed, jet engines and cockpit windshields are tested to simulate bird strikes (mid-air collisions with birds), which can result in damage. The tests are carried out using special compressed-air cannons that fire dead chickens. On one occasion such a gun was lent, by an aeronautical company, to some engineers developing a new train. Bird strikes were a potential danger, owing to the train's high speed. Having received instructions in how to use the cannon, the train designers bought an oven-ready chicken from a local supermarket, and subsequently fired it at their prototype.

The effects were devastating. As a result of the impact, a hole was smashed, not just through the windshield, but also through the back of the driver's compartment. It was hard to believe a chicken had caused so much destruction. Consequently, the engineers contacted their aeronautical colleagues to enquire if the problem might be due to an issue with the gun, some sort of fault that could have caused it to exceed its normal firing power. No malfunctions were found. However, it was later discovered that the unexpected damage had occurred because of a temperature issue.

c **The text in Exercise 13b is an urban legend (or urban myth) – a commonly told story that is said to be true, but which is not. Can you guess what temperature issue caused the unexpected effects?**

d **Complete the following sentences using the words and phrases in the box.**

because of (x2) caused consequently due to owing to ~~result in~~ result of

1 Bird strikes can result in damage to aircraft.
2 Bird strikes were a potential problem for the train, ___________ / ___________ / ___________ its speed.
3 During the test, the train was severely damaged as a ___________ the impact.
4 The damage occurred ___________ a problem relating to temperature.
5 The impact of the chicken ___________ it to enter the train.
6 The engineers thought the gun was faulty, so ___________ they called their colleagues.

e Read the following engineering urban legends and complete the descriptions of causes and effects using the correct form of the words and phrases in Exercise 13d. Sometimes more than one word or phrase is possible.

1 Apparently, the biggest challenge in space exploration was developing a pen for astronauts to use in orbit as ordinary ballpoint pens don't work in space, because of / due to / owing to the fact that there's no gravity. So __________ this problem, there were teams of researchers working for years, trying to find a solution. Eventually, someone came up with the idea of using a pencil.

2 When they designed the foundations of the library on the university campus, they forgot to allow for the weight of the books on the shelves, which __________ the building to start sinking. So __________, half of the floors have had to be left empty, without books, to keep the weight down.

3 Did you hear about that Olympic-sized swimming pool that was built? They got the length wrong, __________ the tiles. They forgot to take into account the thickness, which __________ the pool measuring a few millimetres too short. So __________, it can't be used for swimming competitions.

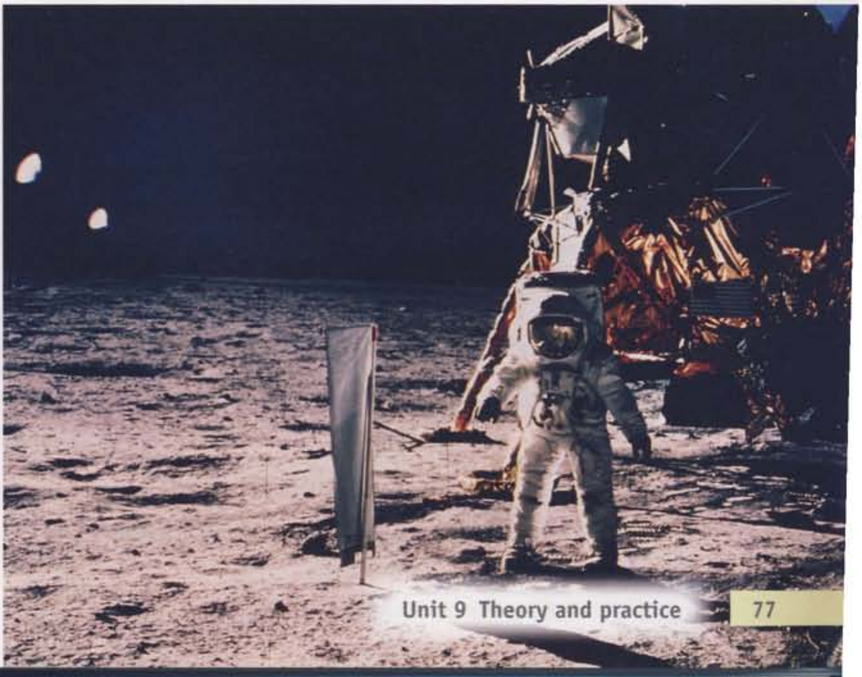
14 **a One popular topic for urban legends is the suggestion that the moon landings didn't really take place and were filmed on Earth. In pairs, discuss the following questions.**

- In photos taken of astronauts on the moon, why are no stars visible in the sky?
- In film footage, why is the flag planted on the surface of the moon seen moving slightly?
- Why do photos of astronauts' footprints appear to be on a wet surface and not in dry dust?
- Why is no blast crater caused by engine thrust during the landing visible below the module?

b ▶9.6 Caroline and Renato, two colleagues at an engineering firm, are talking about the moon landings during a coffee break. Listen to the conversation and compare what they say with your ideas from Exercise 14a.

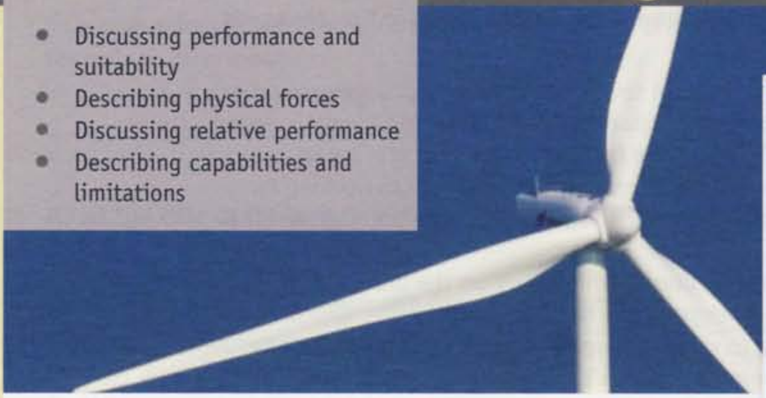
c In pairs, discuss any urban legends you have heard relating to engineering and technology. Use the following ideas to help you.

- unbelievable design faults
- bizarre incidents involving cars
- rumours about amazing experimental technology
- bad workmanship by builders, plumbers and electricians



UNIT 10 Pushing the boundaries

- Discussing performance and suitability
- Describing physical forces
- Discussing relative performance
- Describing capabilities and limitations



Discussing performance and suitability

1 a In pairs, answer the following questions about wind turbines.

1 What function do wind turbines perform?
2 What are the main advantages and disadvantages of wind turbines?
3 What types of location are most suitable for wind farms?

b In pairs, discuss the functions and technical characteristics of the following wind turbine components.

blades   tower   generator

2 a ▶10.1 Mike, Loreta and Hanif, engineers at a wind turbine constructor, are discussing performance and suitability issues relating to offshore wind turbines. Listen to the conversation and answer the following questions.

1 Which wind turbine component do the engineers discuss?
2 What is the big problem with offshore installations?
3 Which two types of construction material are being compared?
4 Why are coastal defences mentioned?
5 What point does Hanif make about regular maintenance?
6 What comparison needs to be made with regard to lifespan?

b Match the words (1–6) from the discussion to the definitions (a–f).

1	appropriate/suitable	a	the right solution for a particular situation
2	consistent/reliable	b	good enough for the intended function
3	cost-effective/economical	c	performs a function well
4	effective	d	works quickly and well
5	efficient	e	makes the most of resources, isn't wasteful
6	sufficient/adequate	f	doesn't break down, always performs in the same way

c Make the following words negative by adding the prefixes in- or un-.

1 adequate inadequate
2 appropriate ________
3 consistent ________
4 economical ________
5 effective ________
6 efficient ________
7 reliable ________
8 sufficient ________
9 suitable ________

d ▶10.1 **Listen again. What issues do Mike, Loreta and Hanif agree and disagree on?**

3 a **The following information is from the web site of Sigma Power, a firm that advises corporate and government clients on wind energy projects. Complete the text using the words in Exercise 2c.**

Wind Turbines - FACT FILE

1 The fact that wind turbines consume no fuel and waste very little energy is clearly a fundamental advantage. But just how ___efficient___ are they? Key figures

2 Clearly, wind turbines need to be located on relatively windy sites in order to function. From a meteorological standpoint, what kinds of geographical location are the most __________ ?

3 Turbines are generally placed at the tops of tall towers, where wind speeds are higher, thus making them more __________ . What other positioning factors influence performance?

4 Wind turbines rarely function continuously, due to the fact that wind speeds are __________ . How significant is the impact of variable weather conditions on power generating capacity?

5 Transmitting electricity over long distances is inherently __________ , due to power loss from overhead or underground power lines. Find out more about the advantages of generating power locally.

6 The generating capacity of wind turbines is generally __________ for it to be relied upon 100%. What percentage of total generating capacity can wind turbines realistically provide?

7 Some early wind turbines were __________ , suffering breakdowns caused by inaxial stresses stemming from higher wind loads on the upper blade. However, this problem has been overcome on modern units. Learn more about the technical evolution of wind turbines.

b **You are engineers at Sigma Power. The marketing manager has asked you to provide some technical answers for the frequently asked questions section of the company's website. The FAQ section is aimed primarily at potential clients who are thinking of installing wind turbines at their sites – factories, office complexes, hospitals, and university campuses. In pairs, discuss the following questions and write the answers for the website using the information in the fact file and your own knowledge.**

Frequently Asked Questions

A common-sense introduction to wind turbines

1 What's the big advantage of having a wind turbine at my site?

2 How dependable are wind turbines as a source of power, given that weather conditions are changeable?

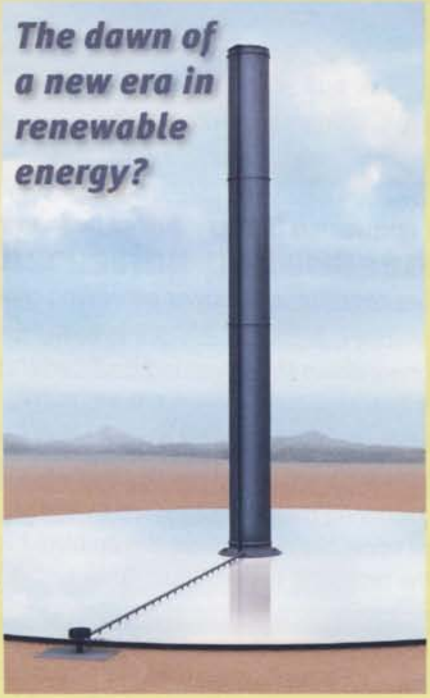
3 What kinds of site are most suitable for wind turbines, relative to natural factors such as hills, the coast, and height above sea level?

4 What's the most appropriate location for my wind turbine, relative to local features on the site, such as trees and buildings?

Describing physical forces

4 a **Read the following article. What is a solar tower and how does it use the forces of expansion and pressure?**

SOLAR TOWERS



The need to develop renewable energy is widely seen as a futuristic technological challenge. In reality, some of the most effective ways of harnessing horsepower from nature are based on concepts that have existed for donkey's years. The wind turbine is an obvious example. Another – less well known, but conceived almost a century ago – is the solar tower or solar chimney. And if the Australian company EnviroMission completes an ambitious solar tower project in the New South Wales desert, the technology could capture not just the sun's rays but the public's imagination worldwide. The firm is planning to construct a tower a colossal one kilometre high. If built, it will be the world's tallest structure by a huge margin.

How it works

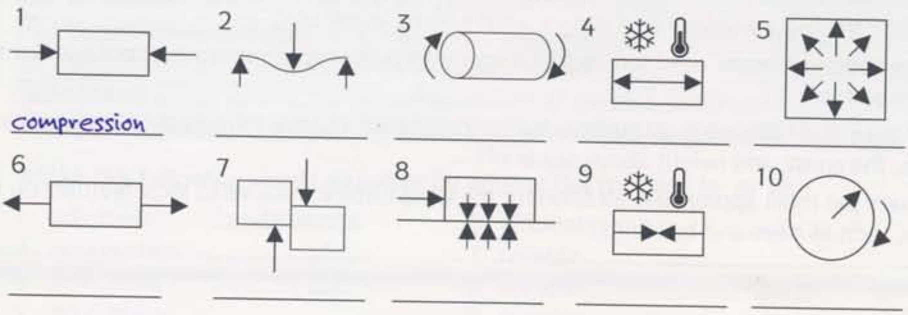
A large glass enclosure is built, with a chimney at its centre. The sun heats the enclosure, causing expansion of the air inside. At the top of the chimney, the lower temperature and lower pressure due to the higher altitude create a pressure differential known as stack effect. This causes air to flow up the chimney. Electricity is generated by turbines at the bottom of the chimney, which are driven by the flow of air. The bigger the area of glass and the taller the chimney, the greater the airflow and the higher the generating capacity.

b **What physical forces would act on a solar tower 1 km high?**

c ▶10.2 **Su, a structural engineer specialising in the design of very tall structures, is giving a talk to a group of engineering students. Listen to the talk. Which of the forces in the box doesn't she mention?**

bending	centrifugal force	compression	contraction	expansion
friction	pressure	shear	tension	torsion/torque

d **Label the diagrams using the forces in Exercise 4c.**

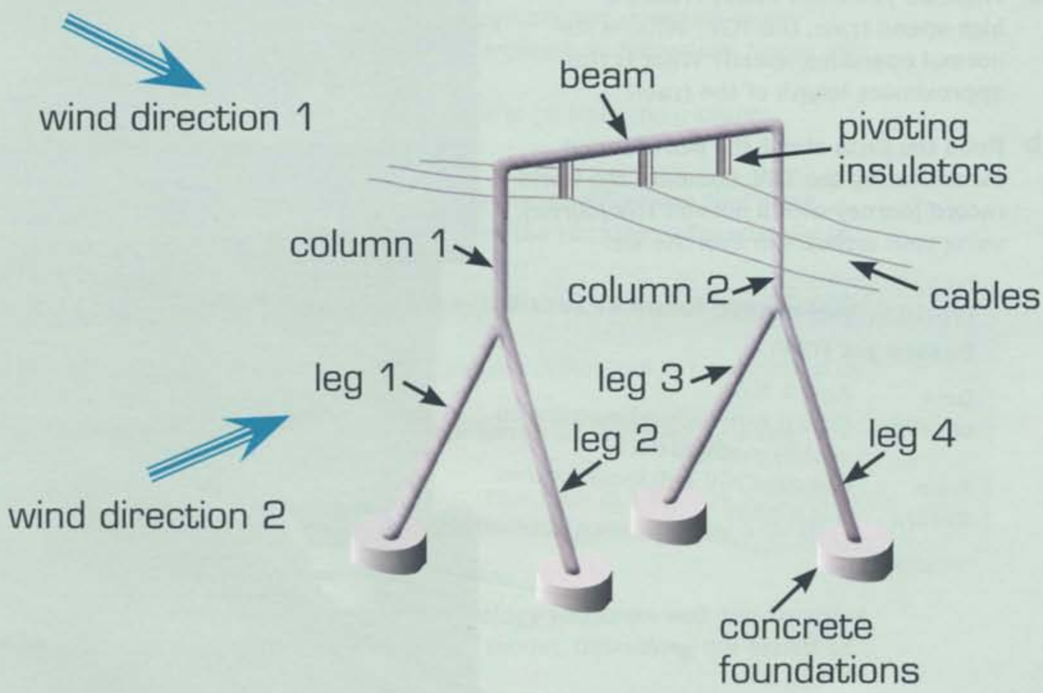


e ▶10.2 **Complete the following sentences from the talk using the forces in Exercise 4c. Listen again and check your answers.**

1 *So that downward force means the structure is in* compression *, especially near the bottom.*
2 *... a horizontal load, exerted by air ________ against one side of the structure.*
3 *Because the structure is fixed at ground level, and free at the top, that generates ________ forces.*
4 *... when elements bend, you have opposing forces: ________ at one side, ________ at the other.*
5 *... the wind effectively tries to slide the structure along the ground, and the foundations below the ground resist that. The result of that is ________ force ...*
6 *... the foundations need to rely on ________ with the ground to resist the pull-out force, ...*
7 *The action of the wind can also generate ________ . You get a twisting force ...*
8 *When concrete absorbs heat from the sun, you get ________ ; as soon as the sun goes in, there's ________ .*

f **You and your partner specialise in designing structures for electrical transmission grids. You are currently working on a cable support concept for power lines near wind farms exposed to severe weather. You have come up with the following design. In pairs, hold a short meeting to evaluate your design concept. Explain the forces acting on the structure.**

Severe weather cable support concept



Discussing relative performance

5 a In pairs, discuss the advantages and disadvantages of air and high-speed rail travel. Focus on trips of between 500km and 1,500km, the journey length over which planes and trains often compete for the same passengers.

b Read the extract from an article about transport in a popular science and technology magazine and answer the following questions.

1 What factors should be considered in the comparative analysis described?
2 What is the purpose of the comparative analysis?
3 What suggestion is made about Europe?

Speed, convenience, efficiency, and environmental-friendliness: four factors with which to assess the relative effectiveness of different long-distance, mass-transport solutions for passengers. Technology: the key criterion in determining what transport solutions are available. And distance: the main consideration when categorising routes. Blend these variables together in varying quantities, and you have a model for calculating the optimum way of moving people.

On a European scale, whichever way you mix the various criteria, the most advantageous way of getting people around the heart of the continent seems to be on high-speed, electric trains.

c Find words in the text in Exercise 5b to match to the following definitions. Which one of the words has a plural form?

1 standard by which you judge something ________
2 fact or situation which influences the result of something ________
3 number, amount or situation which can change ________

6 a What do you know about France's high-speed train, the TGV? What is its normal operating speed? What is the approximate length of the train?

b Read the facts about the world speed record set by the TGV. Compare the world record journey with a normal TGV journey, using your answers in Exercise 6a.

World Speed Record for an In-Service Passenger Train

Date	April 3, 2007
Location	France: Paris to Strasbourg line on slightly modified track
Train	Standard TGV with fewer coaches
Record	574.8 km/h

c ▶ 10.3 **Andrej, a consulting engineer specialising in rail technology, is talking about the TGV world speed record. Listen to the talk and answer the following questions.**

1 Overall, how heavily modified was the train?
2 How long was the record-breaking TGV?
3 Why was some of the bodywork modified?
4 Why was the diameter of the wheels changed?

d ▶ 10.3 **Listen again and complete the following table about the modified TGV using the figures in the box.**

+ 68%   + 19%   - 15%   - 50%   + 80%

Technical criteria	Modified TGV: % difference from standard model
Maximum speed	
Train length (with coaches)	
Aerodynamic drag	
Diameter of wheels	
Motor power output	

e **Complete the following sentences from the talk by underlining the correct words.**

1 *The record speed exceeded the standard operating speed by a* ***tiny/huge*** *margin.*
2 *The train was modified to a* ***certain/considerable*** *extent ...*
3 *... the modified train was* ***significantly/slightly*** *shorter, ...*
4 *... changes were made to the bodywork, to make it* ***slightly/much*** *more aerodynamic ...*
5 *The wheels on the modified train were* ***marginally/substantially*** *bigger ...*
6 *... the power of the electric motors was* ***marginally/substantially*** *higher than the standard units ...*
7 *... standard high-speed trains can be made to go faster by a* ***slight/ considerable*** *amount.*

f **Rewrite the following sentences to describe the modifications that were made to the TGV for the record attempt. Use the phrases in Exercise 6e to replace the words in bold.**

1 The supply voltage in the catenary cables had to be increased **from 25,000 to 31,000 volts**.
2 To limit oscillation, the tension of the catenary cables had to be increased **by 60%**.
3 On some curves, the camber of the track had to be increased **by a few centimetres**.
4 The 574.8km/h record beat the previous record, set in 1990, **by 59.5 km/h**.
5 In perfect conditions the TGV could probably have gone faster **by 5 to 10 km/h**.

7 **In pairs, choose a product or type of technology you know well and compare its performance and quality with an earlier model, describing the extent of the differences.**

Describing capabilities and limitations

8 a Look at the photos and read the extracts from *The Story of John Paul Stapp*, by Nick T. Spark, and answer the following questions.

1 When and where do you think it took place?
2 What do you think the aim of the test was?
3 What do you think John Stapp's profession was?
4 What equipment do you think was used?
5 What do you think happened in the experiment?

With five seconds to go Stapp activated the sled's movie cameras, and prepared for the shock. *Sonic Wind*'s nine rockets detonated with a terrific roar, sending out trails of fire and blasting Stapp down the track.

... *Sonic Wind* hit the water brake. The rear of the sled tore away. The front continued, hardly slowing at all until it hit the second water brake. Then, spray exploded from the back of *Sonic Wind*. It stopped like it had hit a concrete wall.

b ▶10.4 Listen to an extract from a documentary about the experiment and check your answers to Exercise 8a.

c Complete the following data on the *Sonic Wind* test using the figures in the box.

1.2 3 20 46 1015

1 Max speed: ______ km/h
2 Acceleration from 0 to max speed: ______ seconds
3 Acceleration force: ______ Gs
4 Deceleration time: ______ seconds
5 Deceleration force: ______ Gs

d ▶10.5 Listen to the next part of the documentary and check your answers to Exercise 8c.

e Complete the following groups of synonyms using the words in the box.

able to capable of cope with exceed incapable of intended for ~~subjected to~~ surpass unable to withstand

1 exposed to (a force) / subjected to
2 resist (a force) / ____________ / ____________
3 go beyond (a limit) / ____________ / ____________
4 suitable for (a use) / ____________
5 can / ____________ / ____________
6 can't / ____________ / ____________

f Complete the following sentences about *Sonic Wind* using the correct form of the words in Exercise 8e.

1. The bolts fixing the camera to the sled had to cope with high shear forces.
2. The sled's rockets were ________ generating enormous thrust.
3. The pools at the end of the track were ________ stop the sled rapidly.
4. The skids on the sled had to ________ high levels of friction.
5. At full speed, John Stapp was ________ several tonnes of air pressure.
6. The rear of the sled was ________ resist the shock of deceleration, and broke off.
7. Doctors thought people were ________ surviving forces of 17 Gs and above.
8. John Stapp ________ the 17 G limit by a huge margin.

9 a You are a consultant engineer and your firm have received an email from an entrepreneur with an ambitious plan. Read the following email extract and note the key information.

b In pairs, discuss the key information in Exercise 9a and consider the following points.

- the level of G force
- a safe length for the track
- the feasibility of using wheels
- the suitability of the braking systems suggested

c ▶10.6 Jasmine and Andrew, consulting engineers, are discussing the issues in Exercise 9b. Listen and compare what they say with your ideas from Exercise 9b.

d In pairs, discuss the points raised in their conversation and make notes summarising your thoughts in preparation for a meeting with the entrepreneur.

e Prepare a short presentation for the entrepreneur using your notes from Exercise 9d. Student A, you are the consultant engineer. Give the presentation. Student B, you are the entrepreneur. Listen and ask questions about specific details. Swap roles and practise again.

To: Jasmine Murray
Subject: Rocket sled ride

The proposal is to build a rocket sled ride on a desert site in Western Australia. The ride will be aimed at wealthy tourists, and will allow them to experience supersonic speeds. We envisage carrying two passengers at a time, seated behind the pilot. The idea is inspired by the Sonic Wind experiments, which I'm sure you're familiar with. However, it goes without saying that safety will be the number one priority, which means that extremes of acceleration and deceleration must be avoided. For instance, a water brake, like the one used in the Sonic Wind tests, is clearly out of the question.

The site is large enough to accommodate a track up to 16 km long, though I reckon 10 km would be adequate. According to my rough calculations, that would be sufficient to allow progressive acceleration up to and through the sound barrier to about 350 m/s, and progressive deceleration to a standstill without exceeding 2 G (20 m/s²), while still leaving three to four kilometres of track as a safety margin. However, I'm not an engineer, so would appreciate your professional opinion on that.

In terms of basic technology, I assume the most suitable vehicle would be a rail-mounted sled, with steel skids that grip the track, above and below the rails, to prevent derailing, and avoid problems with aerodynamic lift. I assume wheels wouldn't be feasible given the speeds involved, though I'm not 100% sure about that. Perhaps you can advise. Propulsion would be provided by a rocket or aircraft jet. I already have a consultant sourcing a suitable engine, however, so that angle is being looked into.

As far as your input is concerned, the main area where I need your expertise is on the braking system. As I said, violent braking is out of the question. As I see it, suitably gentle options include systems that apply friction to the rails, aerodynamic flaps, parachutes, or reversed engine thrust. But, again, I'm not an engineer, so I look forward to discussing your thoughts on these issues.

GLOSSARY

This glossary contains useful technical words from the texts and audioscripts which are *not* covered specifically in the exercises.

Word	Definition	Translation
Unit 1		
bearing	mechanism containing balls or rollers placed around a component which spins, e.g. a shaft, to reduce friction	
belt (drive belt)	closed band placed around two or more wheels (pulleys), allowing one wheel to drive the other(s)	
cable	rope made of many wires, usually metal	
component	individual part of an assembly/mechanism	
electromagnetic	has/uses an electrically generated magnetic field	
foundation	base supporting a building or structure, usually made of concrete	
gears	wheels with cogs (teeth) which mesh together to transfer drive from one wheel to the other where the wheels are side by side	
inertia	the resistance of an object to acceleration or deceleration due to its mass	
lubricant	liquid or viscous solid (e.g. oil) used to reduce friction between moving parts whose surfaces are touching	
(electric) motor	device which transforms electrical energy into rotary motion	
pile	foundation comprising a vertical column of concrete in the ground	
propeller	device with spinning blades used to push boats or aircraft through water or air	
reinforcement	networks of fibres or bars placed inside a material to strengthen it, e.g. steel reinforcement in concrete	
remote control	system used to control a device or vehicle from a distance, usually via a wireless connection	
sheave	alternative term for pulley (see *belt* above)	
solar power	energy from sunlight converted into electrical energy	
strength-to-weight ratio	toughness of a material (ability to resist breaking) relative to its density (density = mass/volume)	
structural engineer	engineer specialising in the design of structures, e.g. bridges	
wind load	force exerted on a structure by the wind	
wireless	signal transmission without a physical connection by wire, e.g. by radio waves or infrared waves	
Unit 2		
aggregate	solid particles or lumps of material used in a mixture, e.g. sand and gravel in concrete	
automotive	related to vehicle design and manufacturing	
blade	cutting device, often metal with a sharp or toothed edge	
cement	lime-based powder mixed with water to make concrete	
chassis	base of a vehicle to which all main components are fixed	
composite (material)	combined materials; consists of a bulk material (called a matrix) reinforced with fibres or bars, e.g. glass-reinforced plastic (plastic matrix with glass fibres)	
conductor	material that conducts (carries) electricity or heat – in engineering, usually refers to an electrical conductor	
electrolysis	passing an electrical current through a liquid or solid in order to separate chemical compounds	
exhaust	system for evacuating smoke or gases, e.g. from an engine	
galvanized	coated with zinc – used to protect steel from corrosion (rusting)	
insulation	protective layer to prevent or reduce conduction of heat or electricity	
ironmongery	collective term for small metal items commonly used in buildings, e.g. door handles, hinges, screws, nails	
kinetic energy	energy in the form of movement, e.g. a spinning wheel	
melt down	change a solid substance into a liquid by heating it	
membrane	thin layer of material, often acting as a barrier, e.g. to prevent water passing	
puncture	hole causing a leak of air or liquid, e.g. in a tyre	
rust	common name for iron oxide – produced when iron corrodes as a result of exposure to air and water	
scrap	used/recovered material intended for recycling; often refers to metal	

Word	Definition	Translation
Unit 3		
acetylene	gas commonly mixed with oxygen in welding (oxy-acetylene)	
ballast	dense material used to add weight, e.g. as a counter-balance or to resist lift	
cable tie	plastic strap used to fix several cables together side by side, or to fix cables to a supporting structure	
casting	pouring molten material into a mould	
earth	electrical connection between a circuit and the ground	
live	in a mains electrical circuit, the wire through which current flows into an appliance – also means a circuit is energised (current is flowing)	
machining	collective term for processes involving cutting, drilling, etc.	
milling machine	machine with cutting wheels used to cut away the surface of metal in thin layers	
neutral	in a mains electrical circuit, the wire though which current flows out of an appliance	
Unit 4		
black bolt	in construction, an ordinary bolt	
cable tray	long metal plate on which cables are laid – designed to support large numbers of cables	
column	vertical support in a structure	
construction joint	joint between two sections of concrete that were poured at different times (where concrete structures are poured in several stages)	
duct	large section pipe, with a circular or square profile, for carrying air; or a protective cover for cables or hoses	
fabrication	making/assembling, often used to describe metalwork	
fixings	collective term for bolts, screws, rivets and clips	
high strength friction grip (HSFG) bolt	bolt which holds plates together by friction (gripping them tightly together) rather than by shear force	
M&E	abbreviation for *mechanical and electrical* – in construction, refers to electrical installations, water pipes, air-conditioning, etc.	
pour (concrete)	place/cast concrete	
slab	large flat area of concrete, for a floor or roof	
Unit 5		
clearance	distance between components designed to fit together closely	
clutch	friction mechanism allowing engine motion to be transferred to wheels progressively	
coolant	liquid in a cooling system	
drag	resistance to movement through a gas or liquid, e.g. when a plane moves through the air	
electrical contact	point where two electrical conductors are connected	
engine	often refers to an *internal combustion engine* – i.e. one which burns petrol or diesel	
fan	spinning device with blades used to generate a flow of air	
filter	material with small holes located in a flow of gas or liquid; used to block solid particles, e.g. to prevent them from damaging a sensitive mechanism such as a pump	
flaps	moveable panels on aircraft wings which increase lift to assist low-speed flight, e.g. during take-off and landing	
fly-by-wire	aircraft controls which operate moveable devices (e.g. flaps) electronically, rather than mechanically	
fuel injection	system for injecting fuel vapour into the piston cylinder of an engine	
temperature gauge	device which shows a temperature reading	
gearbox	case containing shafts with gears, usually with a gearshift mechanism, allowing gears to be moved to change between different gear ratios	
hydraulics	high-pressure oil circuits used to push pistons called hydraulic rams	
isolate	separate an electrical component or part of a circuit from the rest of the circuit – e.g. by opening a switch – to prevent electricity from flowing through it	
landing gear	wheels of an aircraft	
loose connection	electrical connection that is not fully tight, often causing the circuit to be broken, preventing current from flowing	
misfire	when an engine is not running smoothly due to a fuel or ignition problem	
non-serviceable (part)	part that cannot be repaired by maintenance technicians, only by the manufacturer	
piston	mechanism which transfers linear motion (backward and forward movement) to rotary motion (turning movement), usually pushed by expanding gas	

Word	Definition	Translation
radiator	heat-exchange device that dissipates heat into the air, usually from a hot liquid (e.g. coolant) that is pumped through it	
spoilers	moveable panels on aircraft wings which increase drag and reduce lift; used to slow aircraft when descending and on landing	
starter motor	electric motor in an engine used to turn the engine in order to start it running	
suspension	moveable connection between a vehicle's chassis and its wheels, consisting of springs and dampers	
tank	container for storing liquid	
throttle	accelerator control on an engine	
turbine	transforms a flow of fluid (liquid or gas) into rotary movement, e.g. a wind turbine	
valve	mechanism for opening/closing/restricting the flow of gas or liquid along a pipe	
Unit 6		
beam	long, narrow horizontal component in a structure	
core drill	hole-saw for drilling through thick materials	
crane	machine for lifting heavy objects, able to reach significant heights and distances; includes mobile cranes (which wheel), tower cranes (which are supported by a fixed tower) and gantry cranes (which run along beams)	
dynamic	related to movement, e.g. a dynamic load (= a load generated by a moving object)	
G-force	force of acceleration or deceleration: 1 G is equivalent to the force of acceleration exerted by gravity	
jib	moveable arm of a crane	
lifting eye	ring fixed to a heavy object allowing a hook (e.g. of a crane) to be attached to enable lifting	
low-loader	truck with a low, flat trailer, used for transporting large heavy vehicles, especially construction plant	
slings	flat straps which can be attached to crane hooks and placed under objects in order to lift them	
thrust	pushing force, e.g. generated by expanding gases exiting a rocket	
Unit 7		
air inlet	point where air enters a device or process – the opposite is air outlet	
arc	electrical current travelling a short distance through the air to flow between two conductors	
blower	pump-like mechanism which generates airflow	
circuit breaker	electrical device which instantly breaks a circuit (switches off the power supply) as a safety measure if a variation in current is detected	
extinguisher (fire extinguisher)	device used for putting out fires; usually a metal container with a hose or nozzle containing water, CO_2, powder or foam	
gas bottle	metal container which contains compressed gas, often in liquefied form	
guardrail	safety rail designed to prevent people falling from high places	
handrail	(as guardrail, above)	
load-bearing	describes a part of a structure or assembly that is designed to resist/transmit force	
moisture-sensitive	can be damaged by water	
off-cuts	waste pieces left over after cutting	
shot-blasting	firing small metal balls propelled by compressed air as an abrasive cleaning process	
silo	large container for storing bulk granular materials such as grain	
strain	change in size/shape of a component (e.g. stretching) due to force	
switchboard	control panel containing several switches for all the individual circuits of an electrical installation	
switchgear	collective term for switching equipment	
transformer	electrical device for modifying current and voltage – a step-up transformer increases voltage and reduces current, a step-down transformer decreases voltage and increases current	
Unit 8		
AC	Alternating Current	
automation	automatic control of a system, device or process	
CAD	Computer Aided Design – computer software for producing engineering drawings	
conveyor belt	moving belt which transports objects horizontally; often used in manufacturing processes and warehouses	
downstream	further down the direction of flow (e.g. in a river); used in engineering to describe industrial processes and the flow of liquid/air in pipe/duct networks (opposite = upstream)	
electric utility	company which generates electricity at power stations	

Word	Definition	Translation
electrical charge	stored electricity (potential electrical energy)	
exothermic reaction	chemical reaction which produces heat (opposite = endothermic reaction, which absorbs heat)	
flow	movement of a substance, usually a liquid or gas (e.g. along a pipe)	
gizmo	slang term for a technical device, usually electronic – suggests the device is complex	
hydroelectric power	electricity generated using water pressure (hydrostatic pressure)	
mains electricity	domestic electricity supply system	
manual	controlled by a person – the opposite is automatic	
refrigeration	process of cooling to temperatures below atmospheric temperature	
reservoir	man-made lake for storing water, usually for drinking water or hydroelectric power	
standby (on standby)	when a device is ready to operate immediately, e.g. a TV that is ready to switch on when it receives a remote control signal	
vessel	closed tank which can hold a pressure greater than the atmospheric pressure outside it	
Unit 9		
aerodynamics	study of airflow, e.g. over moving vehicles and aircraft	
aeronautical	related to the design and construction of aircraft	
centre of gravity	theoretical point on the cross-section of an object from which the object's mass is transmitted vertically downwards due to gravity	
compressor	device for pressurising gas (usually air) inside a vessel or network of pipes/hoses	
data gathering	collecting and recording the results of tests for later analysis	
deformable	can change shape	
deploy	release/eject/open, e.g. when skydivers pull the cord of their parachute, the parachute is deployed	
destructible	can be / is designed to be broken/destroyed	
DIY store	*Do It Yourself* store – hardware / home improvements store selling building materials and tools to consumers	
pressure gauge	device which shows a pressure reading, e.g. in bar or psi (pounds per square inch)	
turbulence	disturbed airflow – i.e. air not flowing smoothly around an object	
vacuum	volume containing no gas, e.g. space	
windshield	glass at front of a vehicle or aircraft which the driver or pilot looks through, also called a windscreen in British English	
Unit 10		
bodywork	the external skin of a vehicle; usually consists of several panels	
camber	angle that is inclined from horizontal, usually at 90 degrees to the direction of travel, e.g. the camber of a road (the slope of the road across its width)	
catenary	downward curved line of a cable when suspended between two supports	
coastal defences	large walls, blocks, etc., constructed to protect the coast from sea/ocean erosion	
corrode	degrade as a result of a chemical reaction, e.g. iron turning to iron oxide (rust) when exposed to water and air	
corrosion	result of material corroding (see above)	
derail	come off the rails, e.g. trains can be derailed	
detonate	trigger an explosion	
fail-safe	cannot fail / go wrong – often used to describe safety systems	
horsepower	historic unit of power, has been replaced by Watts but still used to describe power output from engines	
inaxial	not in a straight line	
opposing forces	forces acting in opposite directions	
oscillation	wave pattern	
reverse thrust	thrust directed in the opposite direction to that which a vehicle/aircraft is travelling in, intended to slow the vehicle/aircraft	
rpm	revolutions per minute, used to measure the speed of rotary motion	
sled	vehicle that slides along (i.e. does not have wheels), e.g. a sled designed to travel over snow	
stress	the force(s) exerted on an object, e.g. tensile stress in a cable that is being pulled in opposite directions	
superstructure	the part of a structure that is above ground level – the opposite is the substructure	

Cambridge English for
Engineering

Mark Ibbotson
Series Editor: Jeremy Day

Cambridge English for Engineering is for intermediate to upper-intermediate level (B1-B2) learners of English who need to use English in an engineering environment. The course is particularly suitable for civil, mechanical and electrical engineers and can be used in the classroom or for self-study.

Cambridge English for Engineering is designed to improve the communication skills and specialist language knowledge of engineers, enabling them to work more confidently and effectively. With an emphasis on listening and speaking, the ten standalone units cover topics common to all fields of engineering such as monitoring and control, procedures and precautions, and engineering design. Authentic activities based on everyday engineering situations - from describing technical problems and solutions to working with drawings - make the course practical and motivating.

In addition, a set of case studies available online provide problem-solving practice in authentic engineering scenarios.

The online Teacher's Book has extensive background information for the non-specialist teacher, useful web links and extra printable activities.

The course comprises:

- Student's Book with 2 Audio CDs
- Engineering case studies online
- Teacher's Book online

For more information visit:
www.cambridge.org/elt/englishforengineering

Cambridge English for ... is a new series of short courses for different areas of English for Specific Purposes. Written for professionals by professionals they combine the best in ELT methodology with real professional practice.

CAMBRIDGE
UNIVERSITY PRESS
www.cambridge.org

ISBN 978-0-521-71518-8
9 780521 715188