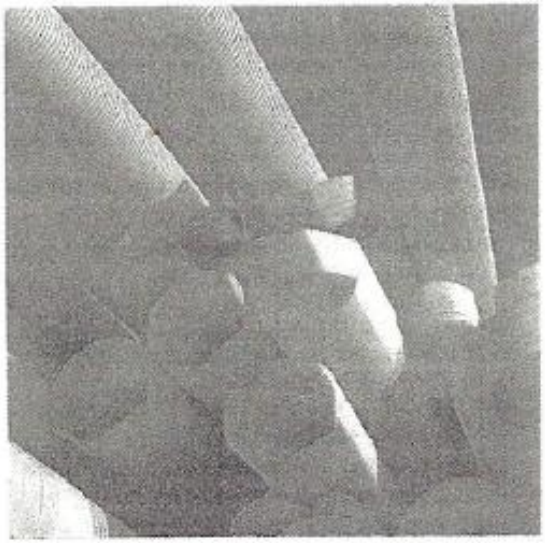
# 3 Engineering materials



*Ribbed plastic pipes stacked near a road construction site where they will be laid for drainage along the sides of a new section of motorway.*

## Tuning-in

**Task 1**

List the materials you know which are used in engineering. Combine your list with the others in your group and classify the materials as metals, thermoplastics, etc.

## Reading *Scanning tables*

In engineering it is important to practise reading tables, charts, diagrams, and graphs because so much information is presented in these ways. We will start in this unit with a table.

Scanning is the best strategy for finding information in a table. With scanning, you know before you read what sort of information you are searching for. To scan a table, you move your eyes up and down the columns until you find the word or words you want. To scan quickly, you must learn to ignore any information which will not help you with your task.

**Task 2**

Scan the table which follows to find a material which is:

1. soft
2. ductile
3. malleable
4. tough
5. scratch-resistant
6. conductive and malleable
7. durable and hard
8. stiff and brittle
9. ductile and corrosion-resistant
10. heat-resistant and chemical-resistant

| Materials | Properties | Uses |
|---|---|---|
| **Metals** | | |
| Aluminium | Light, soft, ductile, highly conductive, corrosion-resistant. | Aircraft, engine components, foil, cooking utensils |
| Copper | Very malleable, tough and ductile, highly conductive, corrosion-resistant. | Electric wiring, PCBs, tubing |
| Brass (65% copper, 35% zinc) | Very corrosion-resistant. Casts well, easily machined. Can be work hardened. Good conductor. | Valves, taps castings, ship fittings, electrical contacts |
| Mild steel (iron with 0.15% to 0.3% carbon) | High strength, ductile, tough, fairly malleable. Cannot be hardened and tempered. Low cost. Poor corrosion resistance. | General purpose |
| High carbon steel (iron with 0.7% to 1.4% carbon) | Hardest of the carbon steels but less ductile and malleable. Can be hardened and tempered. | Cutting tools such as drills, files, saws |
| **Thermoplastics** | | |
| ABS | High impact strength and toughness, scratch-resistant, light and durable. | Safety helmets, car components, telephones, kitchenware |
| Acrylic | Stiff, hard, very durable, clear, can be polished easily. Can be formed easily. | Aircraft canopies, baths, double glazing |
| Nylon | Hard, tough, wear-resistant, self-lubricating. | Bearings, gears, casings for power tools |
| **Thermosetting plastics** | | |
| Epoxy resin | High strength when reinforced, good chemical and wear resistance. | Adhesives, encapsulation of electronic components |
| Polyester resin | Stiff, hard, brittle. Good chemical and heat resistance. | Moulding, boat and car bodies |
| Urea formaldehyde | Stiff, hard, strong, brittle, heat-resistant, and a good electrical insulator. | Electrical fittings, adhesives |

**Task 3** Scan the table to find:

1 A metal used to make aircraft
2 Plastics used for adhesives
3 Steel which can be hardened
4 An alloy suitable for castings
5 A plastic with very low friction
6 A material suitable for safety helmets
7 A metal suitable for a salt-water environment
8 A metal for general construction use but which should be protected from corrosion
9 A plastic for car bodies
10 The metal used for the conductors in printed circuit boards

## Language study *Making definitions*

Study these facts from the table about aluminium:

1 Aluminium is a light metal.
2 Aluminium is used to make aircraft.

We can link these facts to make a definition of aluminium:

1+2 *Aluminium is a light metal* ***which*** *is used to make aircraft.*

**Task 4** Use the table on the previous page to make definitions of each of the materials in column **A**. Choose the correct information in columns **B** and **C** to describe the materials in column **A**.

| A | B | C |
|---|---|---|
| 1 An alloy | | allows heat or current to flow easily |
| 2 A thermoplastic | | remains rigid at high temperatures |
| 3 Mild steel | | does not allow heat or current to flow easily |
| 4 A conductor | a metal | contains iron and 0.7% to 1.4% carbon |
| 5 An insulator | a material | becomes plastic when heated |
| 6 High carbon steel | an alloy | contains iron and 0.15% to 0.3% carbon |
| 7 Brass | | formed by mixing other metals or elements |
| 8 A thermosetting plastic | | consists of copper and zinc |

## Writing *Adding information to a text*

Study this text about aluminium.

Aluminium is used to make aircraft, engine components, and many items for the kitchen.

We can add extra information to the text like this:

> Aluminium, **which is light, soft, and ductile**, is used to make aircraft, engine components – **for example, cylinder heads** – and many items for the kitchen, **such as pots**.

Note that the extra information is marked with commas or dashes:

*, which ... ,*
*– for example, ... –*
*, such as ... ,*

**Task 5** Add this extra information to the following text about plastics.

1 Plastics can be moulded into plates, car components, and medical aids.
2 Thermoplastics soften when heated again and again.
3 Thermosetting plastics set hard and do not alter if heated again.
4 ABS is used for safety helmets.
5 Nylon is self-lubricating.
6 Nylon is used for motorized drives in cameras.
7 Acrylic is a clear thermoplastic.
8 Acrylic is used for aircraft canopies and double glazing.
9 Polyester resin is used for boat and car bodies.
10 Polyester resin is hard and has good chemical and heat resistance.

Plastics are synthetic materials. They can be softened and moulded into useful articles. They have many applications in engineering. There are two types of plastics: thermoplastics and thermosetting plastics.

ABS is a thermoplastic which is tough and durable. Because it has high impact strength, it has applications where sudden loads may occur.

Nylon is a hard, tough thermoplastic. It is used where silent, low-friction operation is required.

Acrylic can be formed in several ways. It is hard, durable, and has many uses.

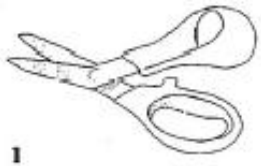
Polyester resin is a thermosetting plastic used for castings. It has a number of useful properties.

# 4 Mechanisms

## Tuning-in

**Task 1**

Identify these simple mechanisms. Try to explain the principles on which they operate.



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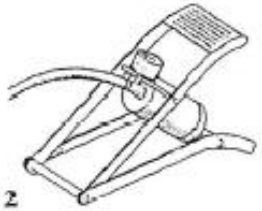

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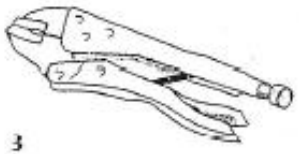

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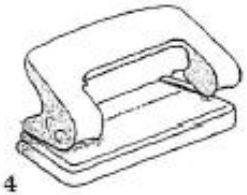

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## Reading *Scanning a text*

Scanning is the best strategy for searching for specific information in a text. Move your eyes up and down the text until you find the word or words you want. Again, try to ignore any information which will not help you with your task.

**Task 2**

Scan the text opposite quickly to find out which of these mechanisms are mentioned.

1 cam
2 tap
3 pendulum
4 foot pump
5 escalator

**Mechanisms**

Mechanisms are an important part of everyday life. They allow us to do simple things like switch on lights, turn taps, and open doors. They also make it possible to use escalators and lifts, travel in cars, and fly from continent to continent.

Mechanisms play a vital role in industry. While many industrial processes have electronic control systems, it is still mechanisms that deliver the power to do the work. They provide the forces to press steel sheets into car body panels, to lift large components from place to place, to force plastic through dies to make pipes.

All mechanisms involve some kind of motion. The four basic kinds of motion are:

Rotary: Wheels, gears, and rollers involve rotary movement.

Oscillating: The pendulum of a clock oscillates – it swings backwards and forwards.

Linear: The linear movement of a paper trimmer is used to cut the edge of the paper.

Reciprocating: The piston in a combustion engine reciprocates.

Many mechanisms involve changing one kind of motion into another type. For example, the reciprocating motion of a piston is changed into a rotary motion by the crankshaft, while a cam converts the rotary motion of the engine into the reciprocating motion required to operate the valves.

**Task 3**

Now read the text to find the answers to these questions.

1 What does a cam do?
2 What does oscillating mean?
3 How are plastic pipes formed?
4 What simple mechanisms in the home are mentioned directly or indirectly?
5 What is the function of a crankshaft?
6 Give an example of a device which can produce a linear movement.
7 How are car body panels formed?
8 What do mechanisms provide in industry?

## Writing *Ways of linking ideas, 1*

When we write, we may have to describe, explain, argue, persuade, complain, etc. In all these forms of writing, we use ideas. To make our writing effective, we have to make sure our readers can follow our ideas. One way of helping our readers is to make the links between the ideas in our writing.

What are the links between these pairs of ideas? What words can we use to mark the links?

1 Mechanisms are important to us.
2 They allow us to travel.

3 Mechanisms deliver the power to do work.
4 They play a vital role in industry.

5 Friction is sometimes a help.
6 It is often a hindrance.

Sentence 2 is a *reason* for sentence 1. We can link 1 and 2 like this:

*Mechanisms are important to us* ***because/since/as*** *they allow us to travel.*

Sentence 4 is the *result* of sentence 3. We can link 3 and 4 like this:

*Mechanisms deliver the power to do work* ***so*** *they play a vital role in industry.*

*Mechanisms deliver the power to do work;* ***therefore*** *they play a vital role in industry.*

Sentence 6 *contrasts* with sentence 5. We can link 5 and 6 like this:

*Friction is sometimes a help* ***but*** *it is often a hindrance.*

**Task 4**

Show the links between these sets of ideas using appropriate linking words.

1 Copper is highly conductive.
It is used for electric wiring.

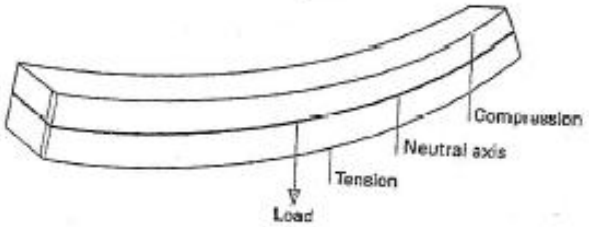
2 Weight is measured in newtons.
Mass is measured in kilograms.

3 Nylon is used for bearings.
It is self-lubricating.

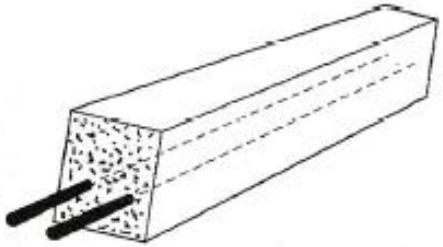
4 ABS has high impact strength.
It is used for safety helmets.

5 The foot pump is a class 2 lever.
The load is between the effort and the fulcrum.

6 Friction is essential in brakes.
Friction is a nuisance in an engine.




7 The upper surface of a beam is in compression.
The lower surface is in tension.



8 Concrete beams have steel rods near the lower surface.
Concrete is weak in tension.

## Language study *Dealing with technical terms*

One of the difficult things about the English of engineering is that there are many technical terms to learn. Newer terms may be the same, or almost the same, in your own language. But many terms will be quite different and you may not always remember them.

When this happens, you will have to use whatever English you know to make your meaning clear.

The same thing may happen in reverse when you know a technical term but the person you are communicating with does not recognize it. This may happen in the *Speaking practice* tasks in this book. Again, when this happens, you will have to make your meaning clear using other words.

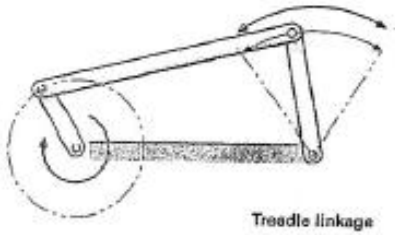
**Task 5**

The technical words in column **A** are similar in meaning to the more general English in column **B**. Match them.

| **A** | | **B** |
|---|---|---|
| 1 | oscillates | **a** changes |
| 2 | rotates | **b** large, thin, flat pieces |
| 3 | reciprocates | **c** moving stairs |
| 4 | has a linear motion | **d** goes round and round |
| 5 | converts | **e** movement |
| 6 | motion | **f** goes in a line |
| 7 | escalator | **g** swings backwards and forwards |
| 8 | sheets | **h** goes up and down |

**Task 6**

Try to explain how this simple mechanism operates using whatever English you know. Write your explanation down. Compare your explanation with the technical explanation given on page 4 of the Answer Book. Learn any technical terms which are unfamiliar to you.



Treadle linkage

## Speaking practice

**Task 7**

Work in pairs, **A** and **B**. Each of you has a diagram of a cam. Describe your diagram to your partner. Your partner should try to reproduce your diagram from the spoken description you provide.

**Student A:** Your diagram is on page 177.
**Student B:** Your diagram is on page 181.

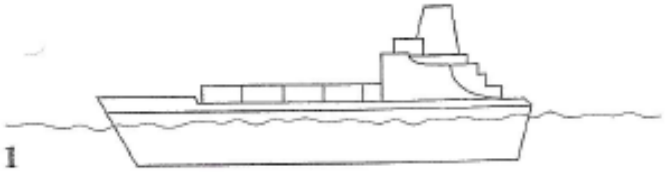
Thes text on the next page will help you with the vocabulary you need.

## Tuning-in

**Task 1**

Working in your group, try to explain these problems.

1 Why doesn't the ship sink?
2 What makes the spring stretch and what keeps the weight up?
3 Why doesn't the box slide down the slope?



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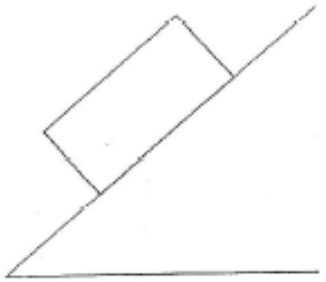

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## Reading 1 *Predicting*

As you learnt in Unit 1, it is important to think about what you are going to read before you read. Do not start to read a text immediately. One way to help your reading is to think about the words which might appear in the text. The title might help to focus your thoughts. Which words might appear in a text with the title *Forces in engineering*?

**Task 2**

The text you are going to read is called *Forces in engineering*. Here are some of the words it contains. Can you explain the link between each word and the title of the text?

| | | |
|---|---|---|
| weight | buoyancy | equilibrium |
| elasticity | magnitude | resultant |
| newton | gravity | |

**Task 3**

Now read the text. Use the information in the text to check the explanations you made in Task 1.

### Forces in engineering

To solve the ship problem, we must look at the forces on the ship (Fig. 1). The weight, W, acts downwards. That is the gravity force. The buoyancy force, B, acts upwards. Since the ship is in equilibrium, the resultant force is zero, so the magnitudes of B and W must be the same.

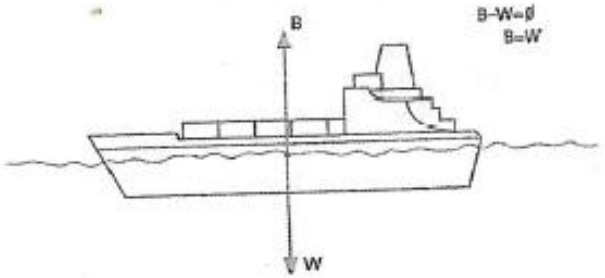



*Fig. 1*

Another very important force in engineering is the one caused by elasticity. A good example of this is a spring. Springs exert more force the more they are stretched. This property provides a way of measuring force. A spring balance can be calibrated in newtons, the unit of force. The block in Fig. 2 has a weight of 10 newtons. The weight on the balance pulls the spring down. To give equilibrium, the spring pulls up to oppose that weight. This upward force, F1, equals the weight of the block, W.


*Fig. 2*

It is important to get the distinction between mass and weight absolutely clear. Mass is the quantity of matter in an object. Weight is the force on that object due to gravity. Mass is measured in kilograms, whereas weight, being a force, is measured in newtons.

We have looked at buoyancy, elasticity, and gravity. There is a fourth force important in engineering, and that is friction. Friction is a help in some circumstances but a hindrance in others. Let us examine the forces on the box (Fig. 3). Firstly, there is its weight, W, the gravity force, then there is the reaction, R, normal to the plane. R and W have a resultant force trying to pull the box down the slope. It is the friction force, F, acting up the slope, that stops it sliding down.

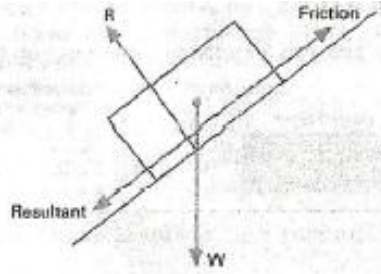



*Fig. 3*

## Reading 2 *Grammar links in texts*

One of the ways in which sentences in a text are held together is by grammar links. In this extract, note how each expression in italics links with an earlier expression.

> Another very important force in engineering is *the one* caused by elasticity. A good example of *this* is a spring. Springs exert more force the more *they* are stretched. *This* property provides a way of measuring force.

Sometimes these links cause problems for readers because they cannot make the right connection between words in different parts of a text.

Study these common grammar links:

1. A repeated noun becomes a pronoun.
   *Springs* becomes *they*.
2. A word replaces an earlier expression.
   *Force in engineering* becomes *one*.
3. A word replaces a whole sentence or clause.
   *Springs exert more force the more they are stretched* becomes *This property*.

**Task 4**

With which earlier expressions do the words in italics link? Join them as in the example above.

> Friction in machines is destructuve and wasteful. *It* causes the moving parts to wear and *it* produces heat where *it* is not wanted. Engineers reduce friction by using very highly polished materials and by lubricating *their* surfaces with oil and grease. *They* also use ball bearings and roller bearings because rolling objects cause less friction than sliding *ones*.
>
> Source: S. Larkin and L. Bernbaum (eds.): The Penguin Book of the Physical World

## Language study *The present passive*

Study these instructions for a simple experiment on friction.

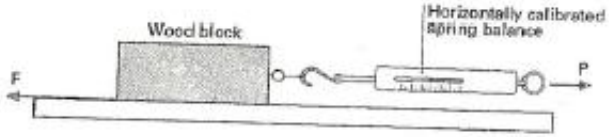



*Fig. 4*

1 Place a block of wood on a flat surface.
2 Attach a spring balance to one end of the block.
3 Apply a gradually increasing force to the balance.
4 Note the force at which the block just begins to move.
5 Pull the block along so that it moves at a steady speed.
6 Note the force required to maintain movement.
7 Compare the two forces.

When we describe this experiment, we write:

> A block of wood *is placed* on a flat surface. A spring balance *is attached* to one end of the block.

This description uses the present passive. We form the present passive using *is/are* + past participle.

**Task 5**

Complete this description of the experiment using the present passive.

A block of wood [1] _____ on a flat surface. A spring balance [2] _____ to one end of the block. A gradually increasing force [3] _____ to the balance. The force at which the block just begins to move [4] _____. The block [5] _____ along at a steady speed. The force required to maintain movement [6] _____. The two forces [7] _____. It is found that the first force is greater than the second.

What does this experiment show?

## Listening *Listening to lectures*

The listening passage you are going to hear is an extract from a typical engineering lecture. Here are some of the features of lectures.

1 Incomplete sentences: Spoken language is not divided neatly into sentences and paragraphs. For example:
*Now what I thought I might do today ... What we are going to talk of ...*

2 Repetition and rephrasing: Lecturers often say the same thing more than once and in more than one way. For example:
*It will turn, revolve.*

3 Signpost expressions: Lecturers often use expressions to help the students know what they are going to do next, what is important, etc. For example:
*What we are going to talk of is the extension of a force.*

**Task 6**

In the same way as when reading, it is helpful to think about the topic of a lecture before you listen. The topic here is *The Moment of a Force*. Can you explain the links between these words from the lecture and the topic? Use a dictionary to help you if necessary.

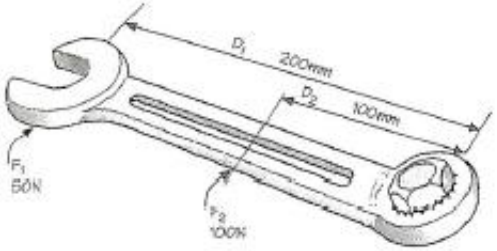
| | | |
|---|---|---|
| turning | distance | product |
| pivot | perpendicular | leverage |
| fulcrum | hinge | |

**Task 7**

Now listen to the lecture to check your explanations.

**Task 8**

During the lecture, the lecturer drew this diagram on the board. Which of the words in Task 6 can be used to talk about the diagram?




**Task 9**

Here are some signpost expressions from the lecture. What do you think the lecturer is indicating each time? Select from the labels below, **a** to **e**.

1 We're going to talk about the moment of a force.
2 If you can think of a spanner ...
3 But what you have to remember is ...
4 Something simple to illustrate.
5 I'm thinking of a practical job.
6 Why do we put a handle there on the door?
7 Is that understood? All right?
8 Well that is then a little explanation of how you calculate moments.

**a** Emphasizing an important point
**b** Showing that the lecture is over
**c** Checking that the students can follow him
**d** Introducing the topic of the lecture
**e** Giving examples to illustrate the points

**Task 10**

Listen to the tape again and answer these questions according to the information given by the lecturer.

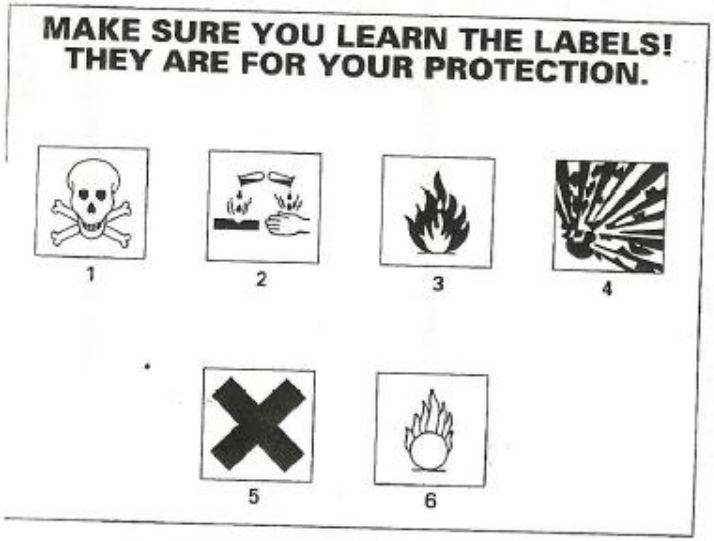
1 What advantage does a longer spanner offer in loosening a tight nut?
2 What is the formula for calculating the moment of a force?
3 Why is it sometimes difficult to apply a force at right angles in a motor car engine?
4 Why is the handle of a door at the edge?
5 Write down the formulae for calculating force and distance.

# Safety at work

## Tuning-in

What do these warning labels on chemicals mean? Match each label to the correct warning.

Highly flammable
Harmful
Explosive
Corrosive
Oxidizing
Toxic




**Task 2**

List some of the potential dangers in your laboratory, workshop, or place o work. How is the risk of these hazards reduced?

**Task 3**

Study the safety instructions from a workshop below, and then answer the questions.

**a** Who are the instructions for?
**b** Who wrote them?
**c** What was the writer's purpose?

1 Wear protective clothing at all times.
2 Always wear eye protection when operating lathes, cutters, and grinders and ensure the guard is in place.
3 Keep your workplace tidy.
4 The areas between benches and around machines must be kept clear.
5 Tools should be put away when not in use and any breakages and losses reported.
6 Machines should be cleaned after use.

## Reading *Understanding the writer's purpose*

Knowing what the writer's purpose is, who the writer is, and who the intend readers are can help us to understand a text. The safety instructions in Task 3 are clearly intended to encourage employees to be safety conscious and reduc the risk of accidents. The writer is perhaps a supervisor or the company safety officer, and the intended readers are machine operatives. Knowing these thin can help us to work out the meaning of any part of the text we may not understand.

**Task 4**

Study the company document on safety on the next page, and then answer these questions.

1 Who is this document for?
**a** machine operatives
**b** managers
**c** all employees
**d** injured employees

2 Who wrote this document?
**a** trade union representative
**b** technician
**c** manager
**d** medical staff

3 What is the writer's intention?
**a** to prevent accidents
**b** to ensure speedy help for injured employees
**c** to protect the company
**d** to warn about dangers

## Language study *Making safety rules*

What are the differences in meaning, if any, between these statements?

1 Wear protective clothing.
2 Always wear protective clothing.
3 Protective clothing must be worn.

We can make safety rules in these ways:

1 Using an imperative.

***Wear** protective clothing.*

***Do not wear** loose-fitting clothing.*

2 *Always/never* are used to emphasize that the rule holds in all cases.

***Always** wear protective clothing.*

***Never** wear loose-fitting clothing.*

3 We can use a modal verb for emphasis.

*Protective clothing **must** be worn.*

*Protective clothing **should** be worn.*

**Task 6**

Study this list of unsafe environmental conditions (hazards). Write safety rules to limit these hazards using the methods given above. For example:

inadequate lighting

*Lighting must be adequate.* or
*Lighting should be adequate.*

1 uneven floors
2 unguarded machinery
3 untidy workbenches
4 untidy workplaces
5 badly maintained machinery
6 carelessly stored dangerous materials
7 inadequate ventilation
8 damaged tools and equipment
9 machinery in poor condition
10 equipment used improperly
11 equipment operated by untrained personnel
12 apprentices working without supervision

## Writing *Ways of linking ideas, 2*

In Unit 4 we learnt that to make our writing effective, we have to make sure our readers can follow our ideas. We learnt how to mark reasons, results, and contrasts in our writing.

What are the links between these ideas? What words can we use to mark the links?

1 The accident happened.
2 The operator's carelessness.
3 The supervisor was not present.

# 17 Portable generator

## Tuning-in

**Task 1**

List the different ways in which electricity can be generated.

## Reading *Reading diagrams*

**Task 2**

Study the diagram below of a portable generator. Answer these questions using the diagram and your own knowledge of engineering.

1 What are its main parts?
2 What does the engine run on?
3 What are the four strokes called?
4 What is the function of the crankshaft?
5 What do both stator and rotor have?
6 What is the difference between stator and rotor?

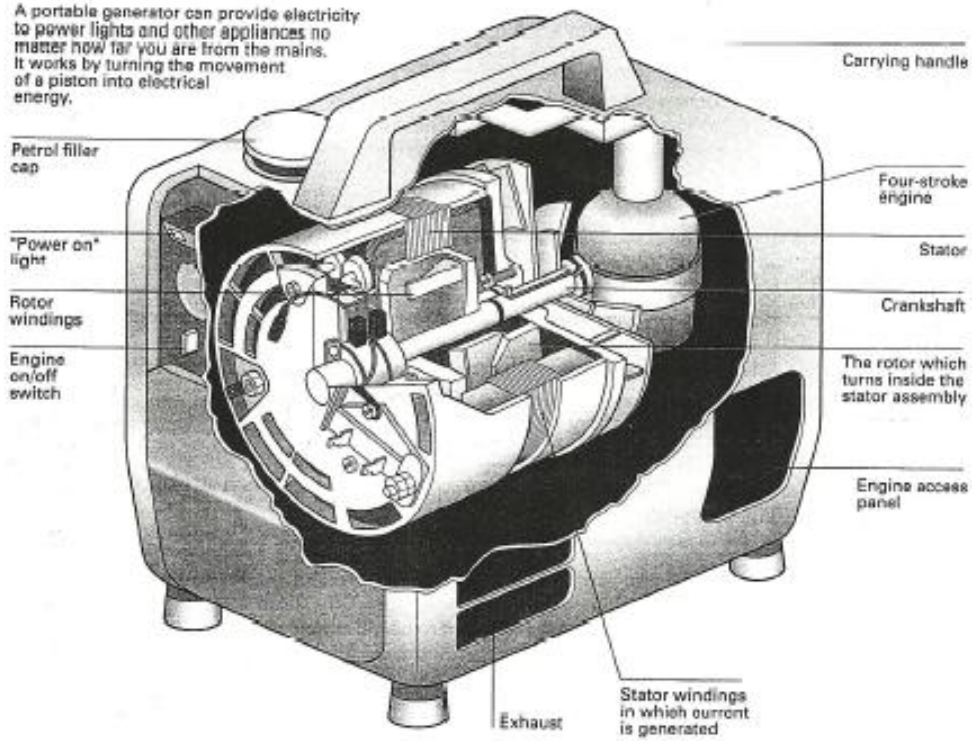



*Fig. 1*

Read this text to check as many of the answers as you can. You will not find complete answers to all of the questions.

**Portable generator**

Although most electricity comes from power stations, power can also be generated by far smaller means. Nowadays, electricity generators can be small enough to hold in the hand.

Portable generators are made up of two main parts: an engine, which powers the equipment, and an alternator, which converts motion into electricity.

The engine shown (Fig. 1) runs on petrol. It is started by pulling a cord. This creates a spark inside which ignites the fuel mixture.

In a typical four-stroke engine, when the piston descends, the air inlet valve opens and a mixture of air and petrol is sucked in through a carburettor.

The valve closes, the piston rises on the compression stroke and a spark within the upper chamber ignites the mixture. This mini-explosion pushes the piston back down, and as it rises again the fumes formed by the ignition are forced out through the exhaust valve.

This cycle is repeated many times per second. The moving piston makes the crankshaft rotate at great speed.

The crankshaft extends directly to an alternator, which consists of two main sets of windings – coils of insulated copper wire wound closely around an iron core. One set, called stator windings, is in a fixed position and shaped like a broad ring. The other set, the armature windings, is wound on the rotor which is fixed to the rotating crankshaft. The rotor makes about 3,000 revolutions per minute.

The rotor is magnetized and as it spins round, electricity is generated in the stator windings through the process of electromagnetic induction. The electric current is fed to the output terminals or sockets.

This type of generator can produce a 700 watt output, enough to operate lights, television, and some domestic appliances. Larger versions provide emergency power to hospitals and factories.

Source: Adapted from 'Inside out: Portable generator', *Education Guardian*

Study this text on the four-stroke cycle. Then label each stroke correctly in Fig. 2 opposite.

In the four-stroke cycle, the piston descends on the intake stroke, during which the inlet valve is open. The piston ascends on the compression stroke with both valves closed and ignition takes place at the top of the stroke. The power or expansion stroke follows. The gas generated by the burning fuel expands rapidly, driving the piston down, both valves remaining closed. The cycle is completed by the exhaust stroke, as the piston ascends once more, forcing the products of combustion out through the exhaust valve. The cycle then repeats itself.

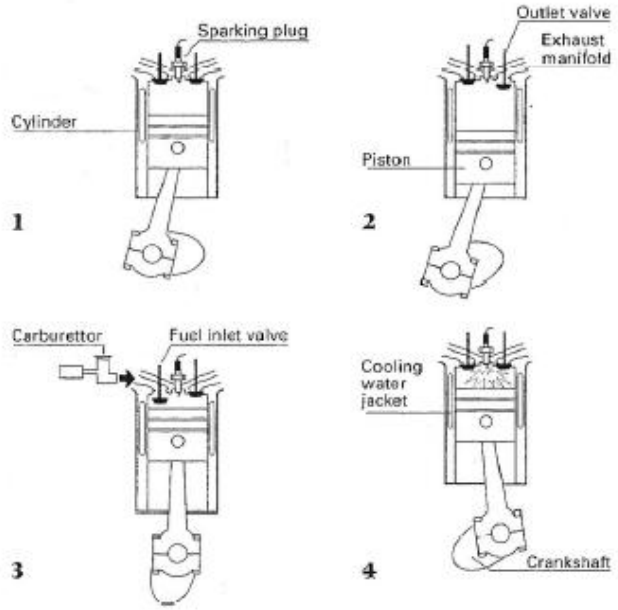



*Fig. 2*

## Language study *Cause and effect, 2*

Study these pairs of actions. What is the link between each pair?

1 The gas expands.
2 This drives the piston down.
3 The piston ascends.
4 This forces the products of combustion out.

There are two links between the actions:

They happen at the same time. We can show this using *As* (see Unit 8).

1+2 ***As*** *the gas expands, it drives the piston down.*
3+4 ***As*** *the piston ascends, it forces the products of combustion out.*

One is a cause and the other an effect.

1 Cause: The gas expands.
2 Effect: This drives the piston down.
3 Cause: The piston ascends.
4 Effect: This forces the products of combustion out.

We can show both the time link and the cause and effect link like this:

1+2 *The gas expands,* ***driving*** *the piston down.*
3+4 *The piston ascends,* ***forcing*** *the products of combustion out.*

# Road breaker

## Tuning-in

In your group, make a list of any devices you know which use compressed air.

List any advantages compressed-air devices have compared with electrical devices.

## Reading

Read the text below and the diagram opposite to check your answers to Tasks 1 and 2.

**Road breaker**

Air has considerable power when it is compressed. Compressed air is used to drive all sorts of machines, from construction tools to paint sprayers.

Pneumatic or air-driven machines all make use of the force exerted by air molecules striking a surface. Compressed air exerts a greater pressure than the air on the other side of the surface, which is at atmospheric pressure. The difference in pressure drives the machine.

Pneumatic drills, or road breakers, are powered by compressed air produced by a compressor. Compressed-air power is cheap and safe. An air device does not risk creating sparks in an explosive atmosphere and can be used under wet conditions without danger of electric shocks. Compressed air is therefore the only type of power used in some mining or construction operations.

A pneumatic drill works a little like an automatic hammer. The compressor pumps the compressed air to the drill through a hose. There it drives a piston up and down. The movement of the piston delivers repeated blows to the chisel that hammers into the road surface.

Pressing the throttle, or control lever, downwards releases the control valve. This allows compressed air to enter the drill. The air passes through the valve and down a chamber called a return chamber to the underside of the piston. The pressure forces the piston to rise up the cylinder. As the piston rises, it covers the exhaust, preventing the air from escaping. At the same time, the rising piston starts to compress the air trapped above it.

►

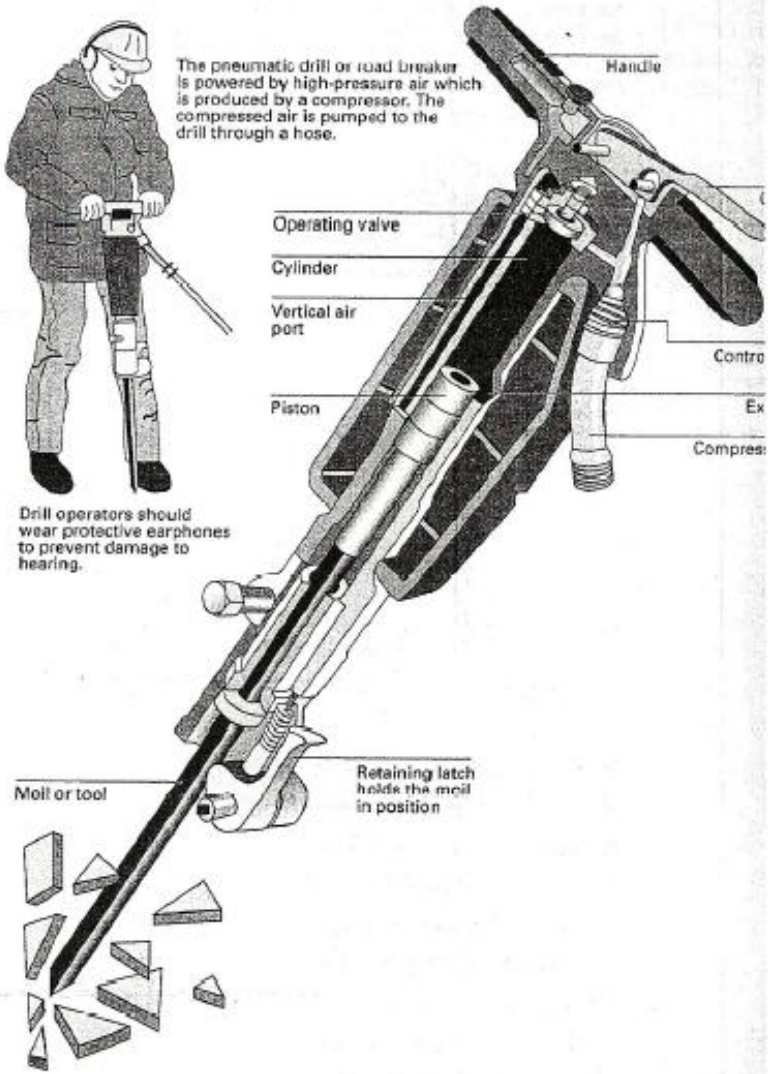



*Fig. 1*

The increase in pressure forces the operating valve to open, admitting air to the top of the chamber and closing off air in the return chamber. As the pressure in the chamber increases to 620 kPa (90 psi), it forces the piston to strike the chisel. When the piston passes the exhaust, the air is released into the atmosphere and the valve closes. This opens the return chamber again, which allows the air to pass to the underside of the piston and restarts the cycle.

Source: 'Inside out: Road breaker', *Education Guardian*

Put the following steps in the operation of the pneumatic drill in the correct sequence with the help of the diagrams. The first one has been done for you as an example.

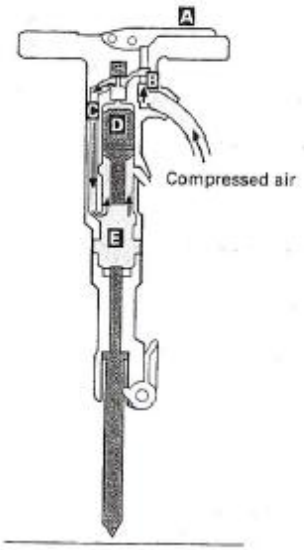



Fig. 2

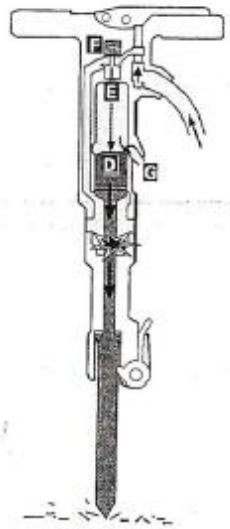



Fig. 3

| | | |
|---|---|---|
| a | The air passes through the valve and down the vertical air port. | ____ |
| b | This allows compressed air into the drill. | ____ |
| c | It forces the piston up the cylinder. | ____ |
| d | Pressing the control lever opens the control valve. | *1* |
| e | This admits compressed air to the top of the cylinder. | ____ |
| f | The operating valve closes and the cycle starts again. | ____ |
| g | The pressure of air on top of the piston opens the operating valve. | ____ |
| h | As the piston passes the exhaust, the air leaves the cylinder. | ____ |
| i | The air expands, forcing the piston down. | ____ |

Now label these components of the drill.

A _____

B _____

C _____

D _____

E _____

F _____

G _____

## Language study *Allow* and *prevent* links

**Task 6**

Fig. 4 shows the most basic components of a pneumatic system, a three-p valve (3PV) and a single acting cylinder (SAC). The steps below describe operation of the system when the push button of the valve is pressed. The step is **a**. Put the others in the correct sequence.

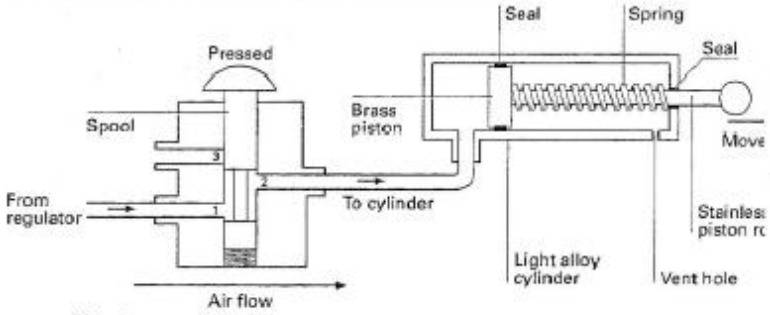



*Fig. 4*

| | | |
|---|---|---|
| **a** | The push button is pressed. | *1* |
| **b** | Port 3 is blocked. | ____ |
| **c** | Ports 1 and 2 are connected. | ____ |
| **d** | The piston compresses the spring. | ____ |
| **e** | The spool is pushed down. | ____ |
| **f** | Air cannot escape. | ____ |
| **g** | Compressed air flows through the valve to the SAC. | ____ |
| **h** | The compressed air pushes the piston along. | ____ |

Study these steps from the operation of the valve.

3 Ports 1 and 2 are connected.

4 Compressed air flows through the valve to the SAC.

5 Port 3 is blocked.

6 Air cannot escape.

What is the connection between Step 3 and Step 4?
What is the connection between Step 5 and Step 6?

Step 3 *allows* Step 4 to happen. We can link the steps in three ways like this:

a *Ports 1 and 2 are connected. This **allows** compressed air **to** flow throug the valve to the SAC.*

b *Ports 1 and 2 are connected. This **permits** compressed air **to** flow throu the valve to the SAC.*

c *Ports 1 and 2 are connected. This **lets** compressed air flow through the v to the SAC.*

Step 5 *prevents* something. We can link steps 5 and 6 like this:

*Port 3 is blocked. This **prevents** air **from** escaping.*

**Task 7**

Complete the blanks in this description of the operation of the valve with the button pressed.

[1] _____ the push button is pressed, the spool is pushed down,

[2] _____ ports 1 and 2. This [3] _____ compressed air to flow through the valve to the SAC. Port 3 is blocked which [4] _____ air from escaping.

The compressed air pushes the piston along, [5] _____ the spring.

**Task 8**

Fig. 5 shows the system with the push button of the valve released.

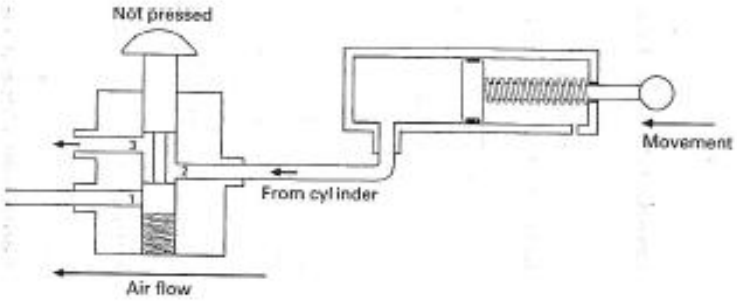



*Fig. 5*

These are the steps in the operation. Fill in the blanks in the steps.

**a** The push button is released.

**b** The valve spring [1] _____ up the spool.

**c** Ports 2 and 3 are [2] _____.

**d** Air from the SAC escapes through [3] _____.

**e** Port 1 is [4] _____.

**f** Compressed air cannot enter the [5] _____.

**g** The cylinder spring pushes the [6] _____ back in.

**Task 9**

Now write your own description of how the system operates when the push button is released.

# DESCRIPTION

of 2 process

Consider these stages in the operation of a washing machine.

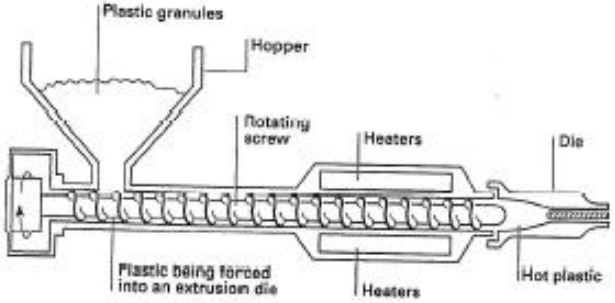
1 The drum is filled with water.
2 The water is heated to the right temperature.
3 Soap is added.
4 The drum is rotated slowly.
5 The dirty water is pumped out.
6 Clean water is added.
7 The drum is rotated much faster and the water pumped out.
8 The clean clothes are removed.

Instead of numbers, we can show the correct order using sequence words.

*First* the drum is filled with water.
*Then* the water is heated to the right temperature.
*Next* soap is added.
*After that*, the drum is rotated slowly.
*Next* the dirty water is pumped out.
*Then* clean water is added.
*After that*, the drum is rotated much faster and the water pumped out.
*Finally*, the clean clothes are removed.

**Task 7**

Study this diagram. It shows an extruder for forming plastic pipes. Describe the extruder.




**Task 8**

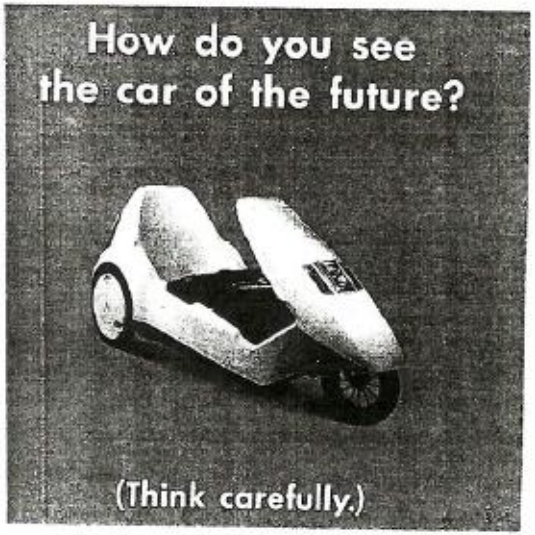
Now put these stages in the process in the correct sequence.

**a** The hot plastic is forced through the die to form a continuous length of pipe.
**b** The rotating screw forces the plastic past heaters.
**c** The plastic granules are mixed and placed in the hopper.
**d** The pipe is cooled and cut to suitable lengths.
**e** The plastic melts.

**Task 9**

Describe the correct order using sequence words. Add to your description of the process your description of the extruder from Task 7. Form your text into a paragraph.

# Supercar




## Tuning-in

Study the following recent Volkswagen survey on the car of the future. Decide in your group which developments in the survey are important to you. One person should report the group's views to the rest of the class.

**What changes would you like to see?**

We've suggested a few possible developments. Please think carefully about which ones would make a real difference to you and tick the boxes to let us know.

*Design*

- ☐ The opportunity to use alternative fuel sources like hybrid (petrol and diesel) or hydrogen power.
- ☐ A car that is an office away from work, with facilities such as a fax machine and video-conferencing.

*Safety*

- ☐ Speed limiters that vary to give you the safest possible drive for the weather and road conditions.
- ☐ A computer sensor to tell you if you're driving at a safe distance from the vehicle in front.
- ☐ Automatic engine and fuel supply cut-out in the unfortunate event of an accident.
- ☐ All-round airbags.

*Security*

- ☐ Engine immobilizer which makes it virtually impossible for anyone else to drive your car away.
- ☐ A tracking device which allows the car to be located fast if it is stolen.
- ☐ Audio systems built into the chassis or engine of the vehicle to prevent theft.

*Performance*

- ☐ Sports car performance combined with fuel economy.
- ☐ A computerized route finder which tells you the quickest way to get to your destination.
- ☐ Servicing by mobile units to save lengthy visits to a garage.

Source: V.A.G. (UK) Ltd

**Task 2**

What do you think will be different about cars in the next ten years? Think about the following points. Compare your ideas with other groups.

- materials
- design
- power
- fuel

**Task 3**

Read this title and introduction to a text. Try to guess the answers to the questions which follow.

**Supercar test for industry**

Matthew L. Wald on the technical issues the President's environmentally-friendly car faces ...

1 Who is the President?
2 Who is Matthew L. Wald?
3 How can a car be environmentally-friendly?
4 Why might a car be called a Supercar?
5 What test does industry face?

Now read the first paragraph of the text. Does it help you to answer the questions?

The 10-year co-operative project between government and Detroit for an environmentally-correct supercar will require radically new technologies for solving the car industry's problems: air pollution, over-reliance on imported oil, and loss of market share to imports.

## Reading *Predicting: using first sentences*

In earlier units we studied how reading the title and using diagrams can help you predict the contents of a text. As we saw above, reading the first paragraph can also be very helpful.

A final way to get a good idea of the contents of a text is to read the first sentence of each of the other paragraphs.

**Task 4**

Read these first sentences: then note down what you think the main points of the text are.

1 Some say it cannot be done but others say various components could be pulled together to do the job: electric motors with batteries, fuel cells or flywheels to deliver electricity, plus lightweight, aerodynamic car bodies.
2 Instead of steel, some other type of material would be necessary for the 'supercar' body, some kind of composite or carbon fibre.
3 Safety is another issue but lighter need not mean flimsier.
4 Reducing body weight and wind resistance will make any car more efficient.
5 Electronics can, however.
6 Four possible power sources are being investigated.
7 Another possibility is fuel cells, which combine oxygen from air with hydrogen to make electricity.
8 Yet another approach would be a flywheel, an electrical generator consisting of free-spinning wheels with magnets in the rims that can produce a current.
9 A fourth possible power source for the national supercar would be a small turbine engine, running on a clean fuel like natural gas.

**Task 5**

Read one of the following texts as your teacher directs: **A**, **B**, **C**, or **D**. Note in this table any information you find on solutions to the problems of designing the Supercar.

| Text | Solution | Reason(s) |
|---|---|---|
| 1 Materials | | |
| 2 Shape | | |
| 3 Power | | |
| 4 Power source | | |

| Problem |
|---|
| 1 |
| 2 |
| 3 |
| 4 |

Now share your information with others in your group to complete the table.

**Text A**

Some say it cannot be done but others say various components could be pulled together to do the job: electric motors with batteries, fuel cells or flywheels to deliver electricity, plus lightweight, aerodynamic car bodies.

Instead of steel, some other type of material would be necessary for the 'supercar' body, some kind of composite or carbon fibre. Such materials are available now, but are not considered cost competitive with steel. But a research centre in Colorado claims that composites can 'emerge from the mould virtually ready to use'. The result would be fewer parts and less labour than current car body construction and, therefore, less cost.

Safety is another issue but lighter need not mean flimsier. The centre points to Indy 500 drivers who routinely survive 230-mph crashes in composite vehicles.

**Text B**

Aerodynamic drag accounts for more and more of the energy required to move the car as speed rises. The car makers already know how to cut drag sharply. General Motors' *Impact* has about half the drag of a typical car. The *Impact* has a rounded front and a tapered back. It is also small to present less frontal surface to the wind.

**Text C**

Reducing body weight and wind resistance will make any car more efficient. But roughly equal to the wind in eating up the car's energy is braking, and internal combustion engines cannot do much about that.

Electronics can, however. Nearly all electric designs use regenerative braking. When the driver hits the brake the motors become generators, converting the mechanical energy of the slowing wheels into electricity. That capability virtually guarantees that a super-efficient car will have an electric motor.

**Text D**

Four possible power sources are being investigated. The simple one is batteries. But if a super-efficient car is to have an attractive cruising range, it cannot carry hundreds of pounds in batteries.

Another possibility is fuel cells, which combine oxygen from air with hydrogen to make electricity. But current fuel cells operate steadily, and a car cell would have to handle widely varying demand for energy: zero, while stopped at traffic lights, or several times that consumed by an average house, while accelerating.

Yet another approach would be a flywheel, an electrical generator consisting of free-spinning wheels with magnets in the rims that can produce a current. An early application of flywheels might be in a race car built for a twisting course, where frequent braking means high fuel consumption in conventional cars.

A fourth possible power source for the national supercar would be a small turbine engine, running on a clean fuel like natural gas. It would run at a constant speed, generating electricity for driving the vehicle or for feeding a bank of batteries, storing energy for later use.

**Task 6**

Read the whole text yourself. How much did the first paragraph and the f sentences of the other paragraphs help you to predict the main points of t whole text? Which first sentences were not very helpful? Why not?

## Language study *Certainty*

Study these statements. What is the difference between them? Can you put them in order of certainty?

1 *A supercar **will** have an electric motor.*

2 *A supercar **might** have a flywheel.*

3 *It **is likely** that a supercar will have a rounded front.*

The difference between the statements is how certain the writer is about each development. Study this list of certainty expressions.

| | Certain | Fairly certain | Uncertain |
|---|---|---|---|
| Yes | will | will probably | might |
| | | be + likely + vb | may |
| | | be + probable that | could |
| | | | will possibly |
| No | will not | be + unlikely to + vb | be possible that |

**Task 7**

Comment on how likely these predictions are for the next decade, using an appropriate expression from the table above. For example:

1 A human powered vehicle (hpv) will exceed 100 km/h.
*It is possible that an hpv will exceed 100 km/h.*

2 A perpetual motion machine will be invented.
*A perpetual motion machine will not be invented.*

3 More factories will be fully automated.
*It is likely that more factories will be fully automated.*

4 Driverless trains will link major cities.
*Driverless trains might link major cities.*

1 Electric cars will become common.
2 Most bicycles will have carbon fibre frames.
3 A more efficient petrol engine will be developed.
4 More people will travel by public transport.
5 Robots will be used in homes.
6 Fewer engineers will be required.
7 Diesel engines will replace petrol engines for cars.
8 Most waste materials will be recycled.
9 An ideal electric motor will be invented.
10 Physicists will reach absolute zero (-273°C).

Study these statements. Why is *will* used in the first sentence and *would* in the second?

1 *A supercar **will** have an electric motor.*

2 *A possible power source **would** be a turbine engine.*

In sentence 1 the writer feels certain this will happen. In sentence 2 the writer feels this is only a possibility because it depends on circumstances.

We use *would* to describe future events which can only happen if certain conditions are met. Study these examples from the text.

Another approach *would* be a flywheel. (*If a supercar were built.*)

The result *would* be fewer parts and less labour. (*If moulded composites were used.*)

**Task 8**

What would happen if these conditions were met?

1 If all cars were made of plastic _____.
2 If all cars had diesel engines _____.
3 If powerful, lightweight batteries were developed _____.
4 If all cars were fitted with flywheels _____.
5 If speed limits were reduced _____.

**Task 9**

What conditions are necessary for these events to happen?

1 All car parts would be recyclable.
2 Cars would travel 40 km/litre of fuel.
3 Cars would cost much less to produce.
4 Cars would not require painting.
5 Cars would not require lubricants.

## Writing *Summaries*

The best way to make a summary of a text is to write down the main points in note form and then link them clearly in your own words. If you are summarizing for others, make sure you do not over-summarize, that is, reduce the text to the point that no one but you can understand what it means.

**Task 10**

Study these notes which summarize the Supercar text.

| *Text* | **Solution** | **Reason(s)** |
|---|---|---|
| **A Materials** | Composite, carbon fibre | fewer parts, less labour |
| **B Shape** | rounded front, tapered back, small | reduce drag |
| **C Power** | electric motor | allows regenerative braking |
| **D Power source** | **Problem** | |
| 1 batteries | weight | |
| 2 fuel cells | cannot cope with varying demand | |
| 3 fly wheel | — | |
| 4 gas turbine with generator | — | |

Now convert each section of the notes into one or two sentences. Use the certainty expressions you studied in this unit. For example:

*The Supercar will have an electric motor because only electric motors allow regenerative braking.*

If you think that your reader will not understand particular terms, define them. For example:

*The Supercar will have an electric motor because only electric motors allow regenerative braking, that is, converting braking power back into electrical energy.*

Finally, link your sentences into paragraphs. You will need at least two.
– materials, shape, and power – possible power sources

You will also need to add a brief introductory paragraph stating the objectives of the Supercar project.

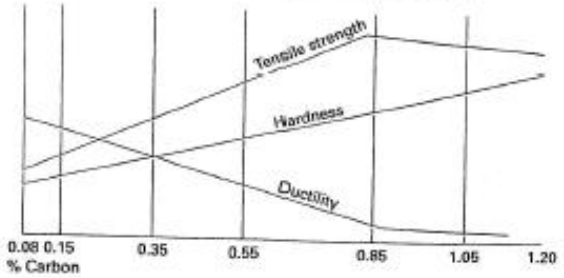
# GRAPHS

## Technical reading *Properties and applications of carbon steels*

**Task 9**

Study the diagram below which shows how tensile strength, hardness, and ductility vary with the percentage of carbon in carbon steels. Answer these questions:

1 What percentage of carbon gives the greatest tensile strength?
2 What happens to ductility between 0.08% and 0.87% carbon?
3 How does increased carbon affect hardness?
4 What is the effect on tensile strength of increasing carbon beyond 0.84%?
5 What happens to ductility beyond 0.87% carbon?

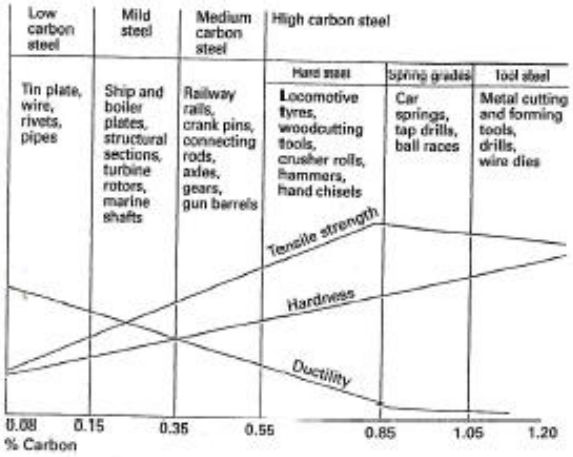



**Properties of carbon steels**

**Task 10**

Now study the diagram below for extra information and answer these questions.

1 What is high carbon steel?
2 How much carbon does tool steel contain?
3 Compare the properties of mild steel and hard steel.
4 What kind of steel is tin plate made from?
5 What kind of steel are car springs made from?




**Properties and applications of carbon steels**