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Oxford English for Electrical and Mechanical Engineering

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1 Engineering – what's it all about?

Tuning-in

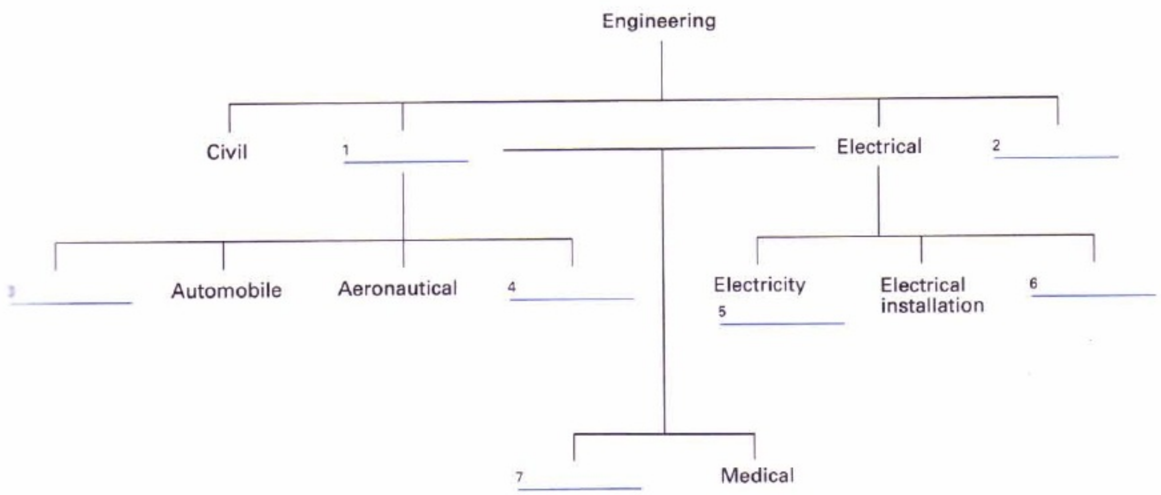
Task 1

List the main branches of engineering. Combine your list with others in your group. Then read this text to find out how many of the branches listed are mentioned.

> Engineering is largely a practical activity. It is about putting ideas into action. Civil engineering is concerned with making bridges, roads, airports, etc. Mechanical engineering deals with the design and manufacture of tools and machines. Electrical engineering is about the generation and distribution of electricity and its many applications. Electronic engineering is concerned with developing components and equipment for communications, computing, and so on.
>
> Mechanical engineering includes marine, automobile, aeronautical, heating and ventilating, and others. Electrical engineering includes electricity generating, electrical installation, lighting, etc. Mining and medical engineering belong partly to mechanical and partly to electrical.

Task 2

Complete the blanks in this diagram using information from the text.

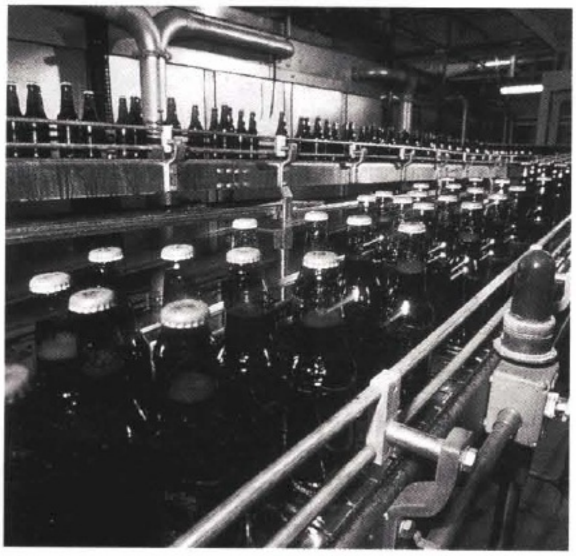


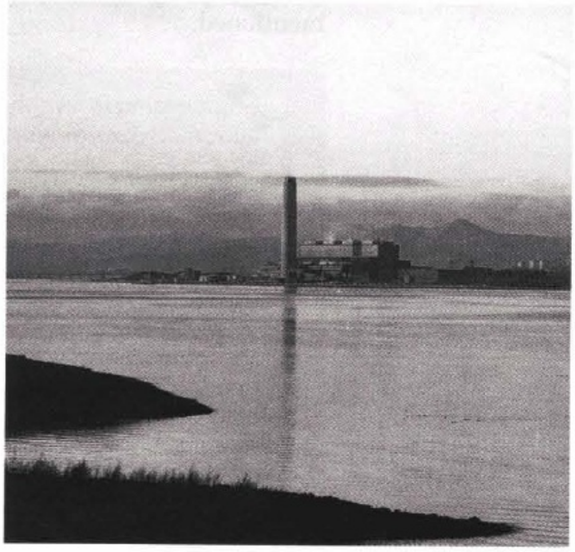
Reading *Introduction*

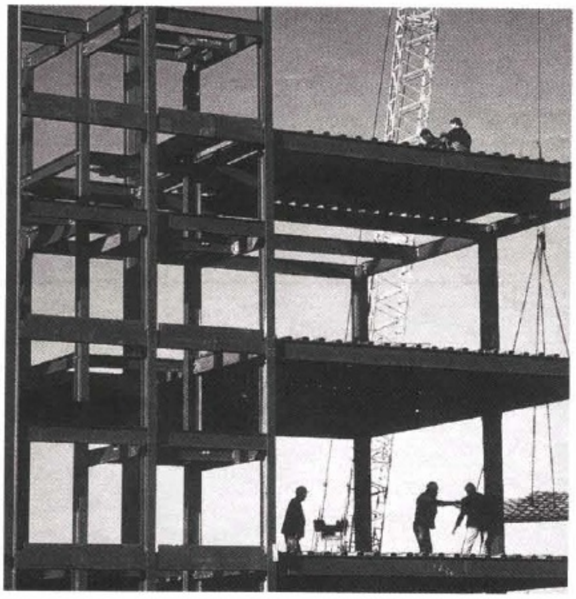
In your study and work, it is important to think about what you are going to read before you read. This helps you to link old and new knowledge and to make guesses about the meaning of the text. It is also important to have a clear purpose so that you choose the best way to read. In this book, you will find tasks to make you think before you read and tasks to help you to have a clear purpose when you read.

Task 3

Study these illustrations. They show some of the areas in which engineers work. Can you identify them? What kinds of engineers are concerned with these areas – electrical, mechanical, or both?







Task 4

Now read the following texts to check your answers to Task 3. Match each text to one of the illustrations above.

Transport: Cars, trains, ships, and planes are all products of mechanical engineering. Mechanical engineers are also involved in support services such as roads, rail track, harbours, and bridges.

Food processing: Mechanical engineers design, develop, and make the machines and the processing equipment for harvesting, preparing and preserving the foods and drinks that fill the supermarkets.

Medical engineering: Body scanners, X-ray machines, life-support systems, and other high tech equipment result from mechanical and electrical engineers combining with medical experts to convert ideas into life-saving and life-preserving products.

Building services: Electrical engineers provide all the services we need in our homes and places of work, including lighting, heating, ventilation, air-conditioning, refrigeration, and lifts.

Energy and power: Electrical engineers are concerned with the production and distribution of electricity to homes, offices, industry, hospitals, colleges and schools, and the installation and maintenance of the equipment involved in these processes.

Source: Adapted from *Turning ideas into action*, Institution of Mechanical Engineers, and *Engineering a Career*, Institution of Electronics and Electrical Incorporated Engineers.

Language study *deals/is concerned with*

What is the link between column **A** and column **B**?

A	**B**
mechanical	machines
electrical	electricity

Column **A** lists a branch of engineering or a type of engineer. Column **B** lists things they are concerned with. We can show the link between them in a number of ways:

1. *Mechanical engineering* ***deals with*** *machines.*
2. *Mechanical engineers* ***deal with*** *machines.*
3. *Mechanical engineering* ***is concerned with*** *machines.*
4. *Mechanical engineers* ***are concerned with*** *machines.*
5. *Machines* ***are the concern of*** *mechanical engineers.*

Task 5

Match each item in column **A** with an appropriate item from column **B** and link the two in a sentence.

	A		**B**
1	marine	**a**	air-conditioning
2	aeronautical	**b**	roads and bridges
3	heating and ventilating	**c**	body scanners
4	electricity generating	**d**	cables and switchgear
5	automobile	**e**	communications and equipment
6	civil	**f**	ships
7	electronic	**g**	planes
8	electrical installation	**h**	cars and trucks
9	medical	**i**	power stations

Word study *Word stress*

Words are divided into syllables. For example:

engine en.gine
engineer en.gin.eer
engineering en.gin.eer.ing

Each syllable is pronounced separately, but normally only one syllable is stressed. That means it is said more slowly and clearly than the other syllables. We say *'engine* but *engin'eer*. A good dictionary will show the stressed syllables.

Task 6

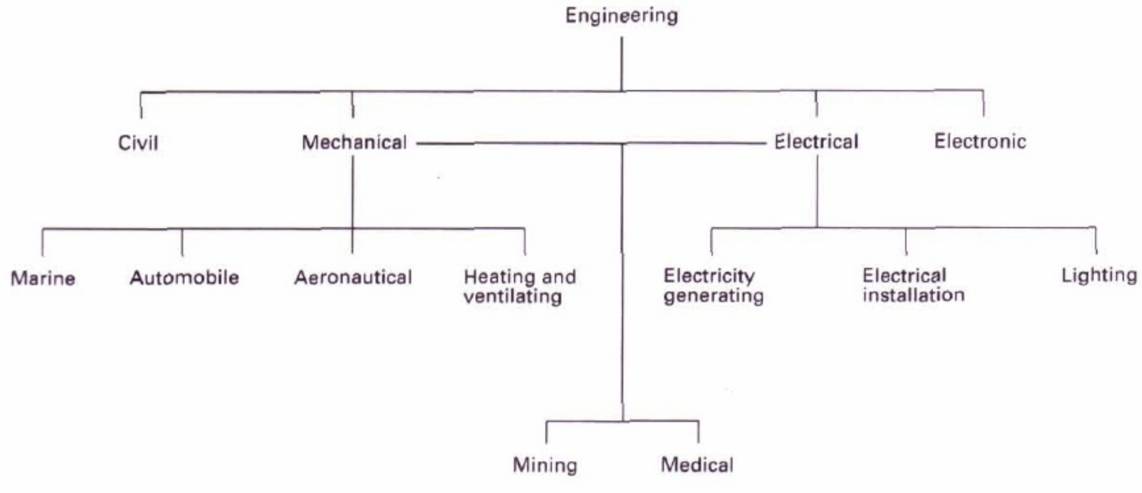
Listen to these words. Try to mark the stressed syllables.

1 machinery
2 mechanical
3 machine
4 install
5 installation
6 electricity
7 electrical
8 electronics
9 aeronautical
10 ventilation

Writing

Task 7

Fill in the gaps in the following description of the different branches of engineering using information from this diagram and language you have studied in this unit.



The main branches of engineering are civil, [1] ________, [2] ________, and electronic. Mechanical engineering is [3] ________ [4] ________ machinery of all kinds. This branch of engineering includes [5] ________, automobile, [6] ________, and heating and ventilating. The first three are concerned with transport: [7] ________, cars and planes. The last [8] ________ with air-conditioning, refrigeration, etc.

Electrical engineering deals with [9] ________ from generation to use. Electricity generating is concerned with [10] ________ stations. Electrical installation deals [11] ________ cables, switchgear, and connecting up electrical equipment.

Two branches of engineering include both [12] ________ and [13] ________ engineers. These are mining and [14] ________ engineering. The former deals with mines and mining equipment, the latter with hospital [15] ________ of all kinds.

Listening

Task 8

Listen to these short extracts. To which branch of engineering do these engineers belong?

Task 9

Listen again. This time note the words which helped you decide on your answers.

2 Central heating

Tuning-in

Task 1

How can you heat a house in cold weather? List the possible ways.

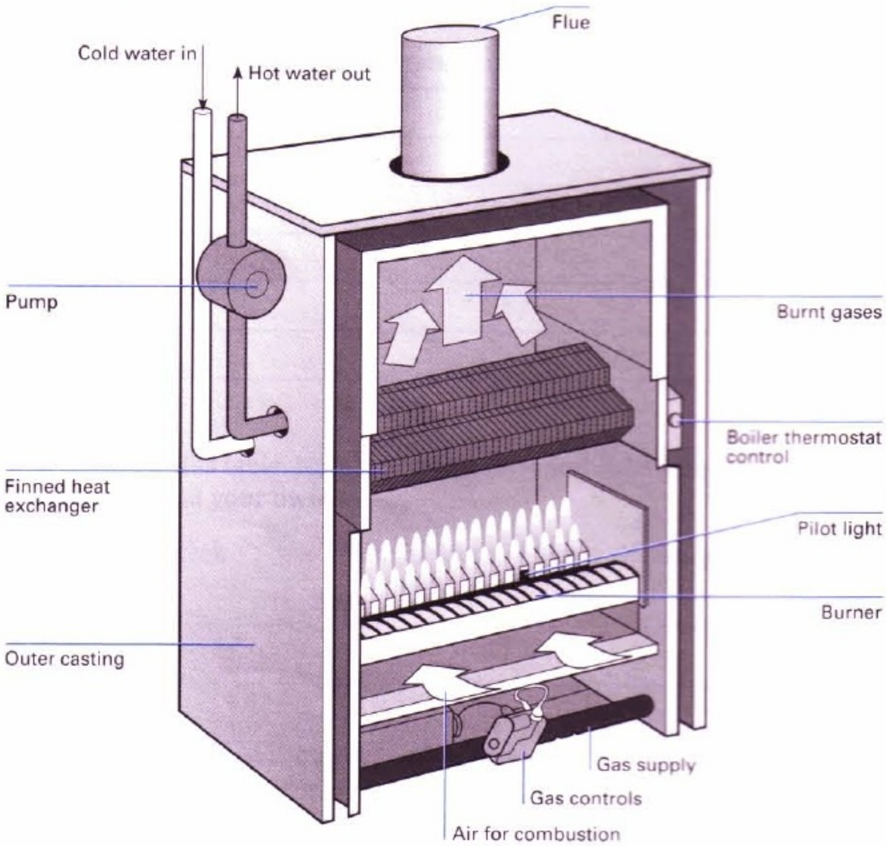
Reading *Predicting*

In Unit 5 we learnt how using the title can help us to predict the contents of a text. Diagrams are also very useful in helping the reader to make the right guesses about what a text will contain. Before you read a text, read the title and look at any diagrams it contains.

Task 2

Using the diagram, try to explain the function of these components:

1 the pilot light
2 the heat exchanger fins
3 the flue
4 the thermostat
5 the pump



Task 3

Scan this text quickly to check the explanations you made in Task 2. You may not find all the information you want.

Gas central heating

Most gas central heating works on the 'wet' system of heat transfer between water flowing through pipes. A typical system includes a boiler, a network of pipes, a feed, and expansion tank, radiators, and a hot water storage system.

In conventional boilers, water is heated by gas burners. It is then pumped around the central heating system and the hot water storage cylinder. The flow of gas to the burner is controlled by a valve (or valves) which can be operated by a time switch or by a boiler thermostat, hot water cylinder thermostat, or by a thermostat located in one of the rooms.

Air is necessary for complete combustion and is supplied to the burners either from inside the house, when adequate ventilation must be ensured, or directly from outside through a balanced flue.

Water is circulated through a heat exchanger above the burner. The heat exchanger is made of tubes of cast iron or copper, which resist corrosion. Both types use fins to increase the surface area in contact with water, which improves the transfer of heat. A thermostat located in the boiler causes the gas control valve to shut off when the water temperature reaches the pre-set level.

After being pumped through a diverter or priority valve, water circulates around either one of two loops of pipework, which act as heat exchangers. One loop passes through the inside of the hot water storage cylinder in a coil arrangement. Heat is transferred to the surrounding water, which can then be drawn off from this cylinder from various hot taps in the house when required. The loop then returns to the boiler for re-heating.

The other loop of the circuit passes to the radiators, which provide room heating. Several radiators are generally connected, where one pipe provides the hot water input and the other carries the cold water back to the boiler. In this way, all radiators receive hot water directly from the boiler.

Source: 'Inside out: Central Heating', *Education Guardian*

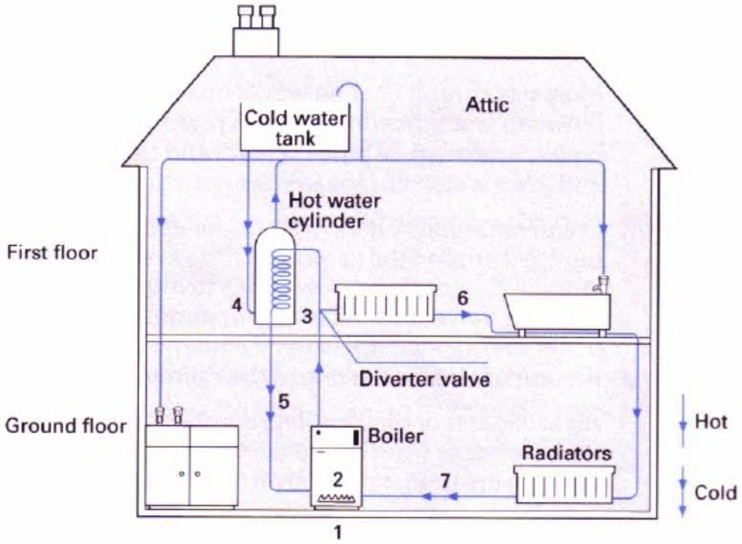
Task 4

Put these statements in the correct sequence. The first and last have been done for you.

a	Water is circulated through a heat exchanger.	*1*
b	The loop returns to the boiler for re-heating.	____
c	One loop passes through the inside of the hot water storage cylinder in a coil of pipes.	____
d	Water is heated by gas burners.	____
e	The hot water is pumped through a diverter valve.	____
f	The other loop of the circuit passes to the radiators.	____
g	Cold water from the radiators returns to the boiler.	*7*

Task 5

Use the statements in Task 4 to label the stages shown in this diagram of a heating system.



Language study *Time clauses*

What is the relationship between these pairs of actions? How can we link each pair to show this relationship?

1 Cold water passes through a heat exchanger.
The water is heated.

2 The water is heated.
It reaches a pre-set temperature.

3 The water is heated.
It is pumped to a diverter valve.

4 The water temperature reaches the right level.
The gas control valve shuts off.

We can show how actions are linked in time by using time clauses.

We can use *as* to link two connected actions happening at the same time. For example:

1 ***As*** *cold water passes through a heat exchanger, the water is heated.*

We can use *until* to link an action and the limit of that action. For example:

2 *The water is heated* ***until*** *it reaches a pre-set temperature.*

Note that *until* normally comes between the stages.

We can use *after* to show that one action is followed by another action. For example:

3 ***After*** *the water is heated, it is pumped to a diverter valve.*

We can use *when* to show that one action happens immediately after another. For example:

4 ***When*** *the water temperature reaches the right level, the gas control valve shuts off.*

Note that when the time word comes first in the sentence, a comma (,) is used after the time clause.

Task 6

Link these sets of actions with appropriate time words.

1 The system is switched on.
Cold water passes through a heat exchanger in the boiler.

2 The water passes through the heat exchanger.
The water becomes hotter and hotter.
The water reaches a pre-set level.

3 The water temperature reaches the pre-set level.
A thermostat causes the gas control valve to shut off.

4 The water is pumped to a diverter valve.
The water goes to the hot water cylinder or the radiators.

5 Hot water passes through the inside of the hot water storage cylinder in a coil arrangement.
Heat is transferred to the surrounding water.

6 The hot water flows through the radiators.
The hot water loses heat.

7 The water passes through the radiators.
The water returns to the boiler.

Word study

Task 7

The words listed in the first column of this table are common in descriptions of technical plant. They describe how substances are moved from one stage of the process to the next. Some of these words can be used for any substance: others are more specific. Write an X under Solids, Liquids, or Gases if the word on the left can be used to talk about them. The first example has been done for you.

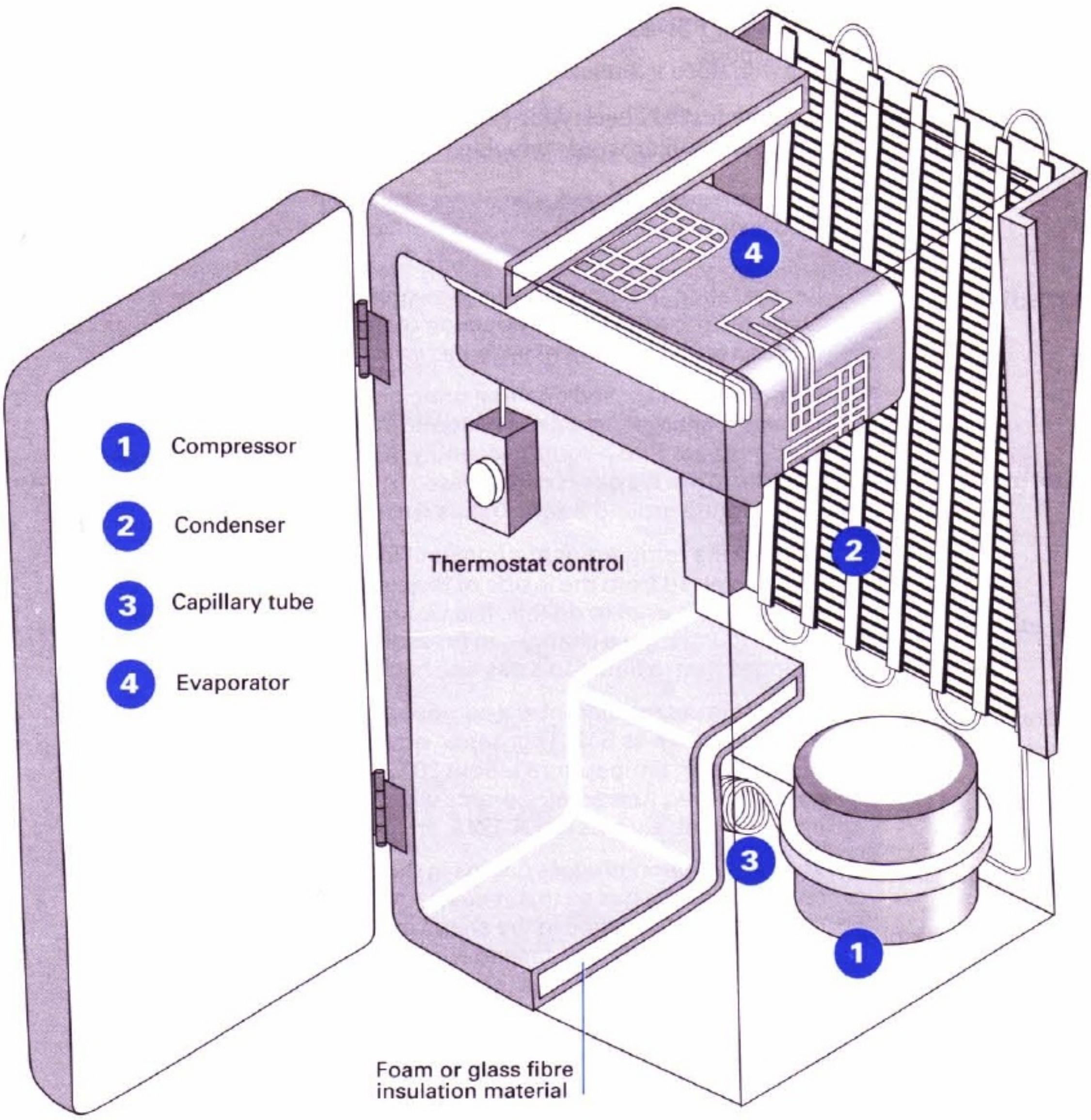
	Solids	Liquids	Gases
carried	X	X	X
circulated			
conveyed			
distributed			
fed			
piped			
pumped			
supplied			

3 Refrigerator

Tuning-in

Task 1

Study this diagram. It explains how a refrigerator works. In your group try to work out the function of each of the numbered components using the information in the diagram.



Reading *Dealing with unfamiliar words, 1*

You are going to read a text about refrigerators. Your purpose is to find out how they operate. Read the first paragraph of the text below. Underline any words which are unfamiliar to you.

> Refrigeration preserves food by lowering its temperature. It slows down the growth and reproduction of micro-organisms such as bacteria and the action of enzymes which cause food to rot.

You may have underlined words like *micro-organisms*, *bacteria*, or *enzymes*. These are words which are uncommon in engineering. Before you look them up in a dictionary or try to find translations in your own language, think! Do you need to know the meaning of these words to understand how refrigerators operate?

You can ignore unfamiliar words which do not help you to achieve your reading purpose.

Task 2

Now read the text to check your explanation of how a refrigerator works. Ignore any unfamiliar words which will not help you to achieve this purpose.

Fridge

para

Refrigeration preserves food by lowering its temperature. It slows down the growth and reproduction of micro-organisms such as bacteria and the action of enzymes which cause food to rot. *1*

Refrigeration is based on three principles. Firstly, if a liquid is heated, it changes to a gas or vapour. When this gas is cooled, it changes back into a liquid. Secondly, if a gas is allowed to expand, it cools down. If a gas is compressed, it heats up. Thirdly, lowering the pressure around a liquid helps it to boil. *2*

To keep the refrigerator at a constant low temperature, heat must be transferred from the inside of the cabinet to the outside. A refrigerant is used to do this. It is circulated around the fridge, where it undergoes changes in pressure and temperature and changes from a liquid to a gas and back again. *3*

One common refrigerant is a compound of carbon, chlorine, and fluorine known as R12. This has a very low boiling point: –29°C. At normal room temperature (about 20°C) the liquid quickly turns into gas. However, newer refrigerants which are less harmful to the environment, such as KLEA 134a, are gradually replacing R12. *4*

The refrigeration process begins in the compressor. This compresses the gas so that it heats up. It then pumps the gas into a condenser, a long tube in the shape of a zigzag. As the warm gas passes through the condenser, it heats the surroundings and cools down. By the time it leaves the condenser, it has condensed back into a liquid. *5*

Liquid leaving the condenser has to flow down a very narrow tube (a capillary tube). This prevents liquid from leaving the condenser too quickly, and keeps it at a high pressure. *6*

►

As the liquid passes from the narrow capillary tube to the larger tubes of the evaporator, the pressure quickly drops. The liquid turns to vapour, which expands and cools. The cold vapour absorbs heat from the fridge. It is then sucked back into the compressor and the process begins again. 7

The compressor is switched on and off by a thermostat, a device that regulates temperature, so that the food is not over-frozen. 8

Source: 'Inside out: Fridge', *Education Guardian*

Language study *Principles and laws*

Study these extracts from the text above. What kind of statements are they?

1 If a liquid is heated, it changes to a gas or vapour.

2 If a gas is allowed to expand, it cools down.

3 If a gas is compressed, it heats up.

Each consists of an action followed by a result. For example:

Action	*Result*
a liquid is heated	it changes to a gas or vapour

These statements are principles. They describe things in science and engineering which are always true. The action is always followed by the same result.

Principles have this form:

If/When (action – present tense), (result – present tense).

Task 3

Link each action in column **A** with a result from column **B** to describe an important engineering principle.

A Action

1 a liquid is heated
2 a gas is cooled
3 a gas expands
4 a gas is compressed
5 a force is applied to a body
6 a current passes through a wire
7 a wire cuts a magnetic field
8 pressure is applied to the surface of an enclosed fluid
9 a force is applied to a spring fixed at one end

B Result

a it heats up
b there is an equal and opposite reaction
c it changes to a gas
d it extends in proportion to the force
e it is transmitted equally throughout the fluid
f a current is induced in the wire
g it cools down
h it sets up a magnetic field around the wire
i it changes to a liquid

Word study *Verbs and related nouns*

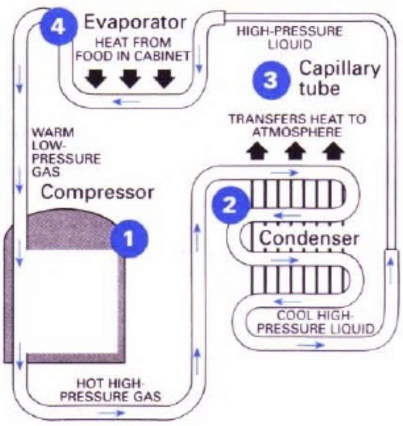
Task 4

Each of the verbs in column **A** has a related noun ending in *-er* or *-or* in column **B**. Complete the blanks. You have studied these words in this and earlier units. Use a dictionary to check any spellings which you are not certain about.

	A Verbs	**B Nouns**
	For example: refrigerate	refrigerator
1	condense	________
2	________	evaporator
3	compress	________
4	resist	________
5	________	charger
6	generate	________
7	conduct	________
8	________	exchanger
9	radiate	________
10	control	________

Writing *Describing a process, 2: location*

Study this diagram. It describes the refrigeration process.



In Unit 13 we learnt that when we write about a process, we have to:

1 Sequence the stages
2 Locate the stages
3 Describe what happens at each stage
4 Explain what happens at each stage

For example:

sequence location *description*
The refrigeration process begins in the compressor. This compresses the gas
explanation
so that it heats up.

In this unit we will study ways to locate the stages.

Task 5

Put these stages in the refrigeration process in the correct sequence with the help of the diagram above. The first one has been done for you.

a The liquid enters the evaporator. ____
b The gas condenses back into a liquid. ____
c The vapour is sucked back into the compressor. ____
d The gas is compressed. *1*
e The liquid turns into a vapour. ____
f The gas passes through the condenser. ____
g The liquid passes through a capillary tube. ____
h The high pressure is maintained. ____

There are two ways to locate a stage in a process.

1 Using a preposition + noun phrase. For example:

The liquid turns to vapour ***in the evaporator***.
The gas cools down ***in the condenser***.

2 Using a *where*-clause, a relative clause with *where* rather than *which* or *who*, to link a stage, its location and what happens there. For example:

The warm gas passes through the condenser, ***where it heats the surroundings and cools down***.
The refrigerant circulates around the fridge, ***where it undergoes changes in pressure and temperature***.

Task 6

Complete each of these statements.

1 The gas passes through the compressor, where ____________.
2 It passes through the condenser, where ____________.
3 The liquid passes through a capillary tube, where ____________.
4 The liquid enters the evaporator, where ____________.
5 The cold vapour is sucked back into the compressor, where ____________.

Task 7

Add sequence expressions to your statements to show the correct order of events. For example:

First the gas passes through the condenser ...

Make your statements into a paragraph adding extra information from the text in Task 2 if you wish. Then compare your paragraph with paragraphs 6, 7, and 8 from the text.

4 Washing machine

Tuning-in

Task 1

Many items found in the home contain control systems. The washing machine is one of the most complex. List some of the factors the control system of a washing machine must handle. This diagram may help you.

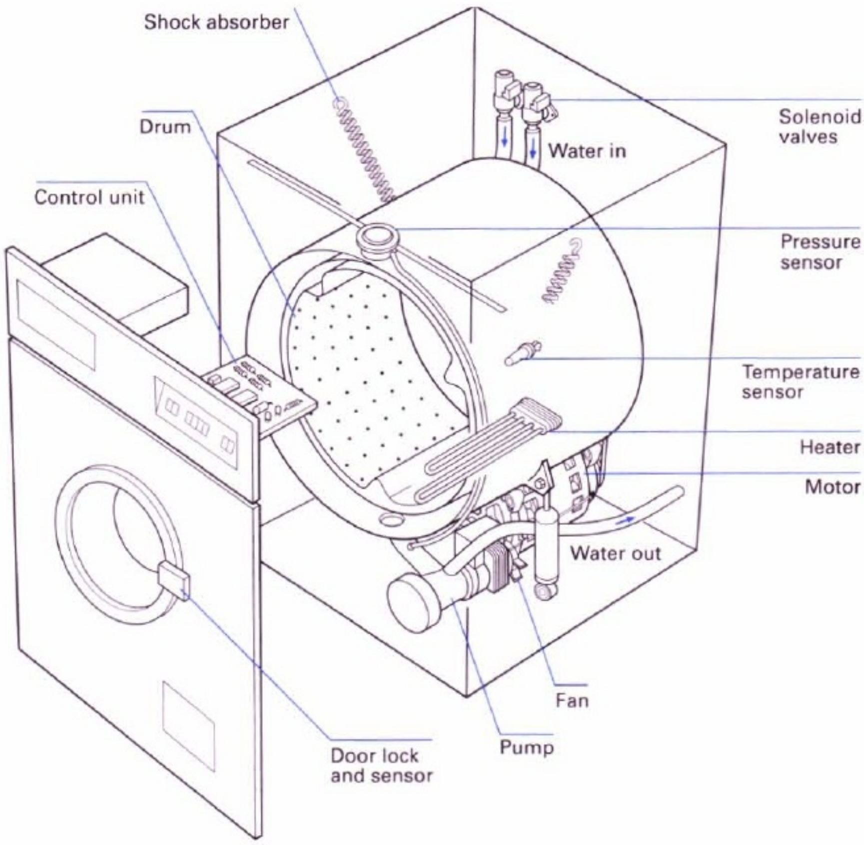


Fig. 1 Cross-section through a washing machine

Reading *Reading diagrams*

In engineering, diagrams carry a great deal of information. They can also help you to understand the accompanying text. For this reason, it is helpful to try to understand any diagram before reading the text.

Task 2

Study the diagram again. Try to explain the function of each of these items.

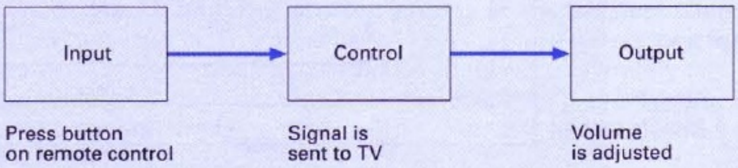
1 Pump
2 Motor

3. Shock absorber
4. Solenoid valves
5. Heater
6. Pressure sensor
7. Door lock and sensor
8. Temperature sensor
9. Fan

Task 3 Read this text to check your answers to Task 1.

Control systems in the home

Most devices in the home have some sort of control. For example, you can control the volume of a TV by using a remote control. The building blocks of a control system are:



The input can be any movement or any change in the environment. For example, a drop in temperature may cause a heating system to come on.

The control may change the size of the output (for example, adjusting the sound of a TV). Often this involves changing one kind of input into a different kind of output. For example, opening a window may set off a burglar alarm.

Outputs can be of many kinds. An alarm system may ring a bell, flash lights, and send a telephone message to the police.

Most control systems are closed loops. That means they incorporate a way of checking that the output is correct. In other words, they have feedback. The thermostat in a central heating system (Fig. 2) provides constant feedback to the control unit.

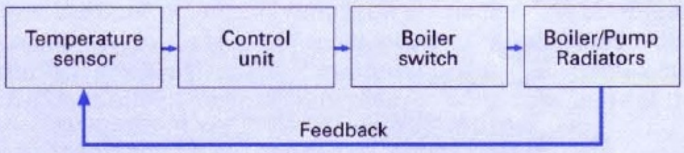


Fig. 2

The control system of a modern washing machine has to take into account several different factors. These are door position, water level, water temperature, wash and spin times, and drum speeds. Most of them are decided when you select which washing program to use.

Fig. 3 shows a block diagram of a washing machine control system. You can see that this is quite a complex closed loop system using feedback to keep a check on water level, water temperature, and drum speeds.

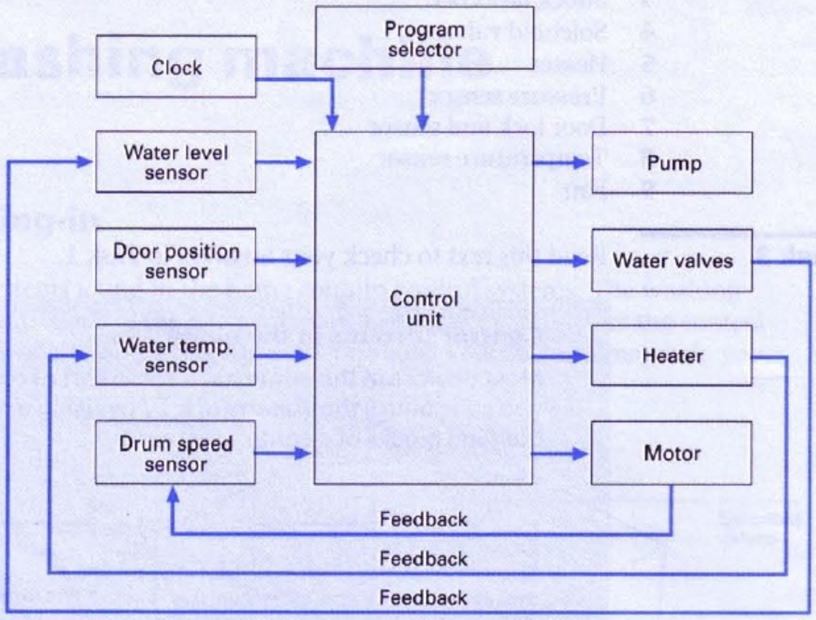


Fig. 3

The control unit is the heart of the system. It receives and sends out signals which control all the activities of the machine. It is also capable of diagnosing faults which may occur, stopping the program, and informing the service engineer what is wrong. It is a small, dedicated computer which, like other computers, uses the language of logic.

Source: P. Fowler and M. Horsley, 'Control systems in the home', *CDT: Technology*

Task 4

Read the following text to find the answers to these questions:

1. What device is used to lock the door?
2. What provides feedback to the control unit about the door position?

Text 1

Door position

The machine will not start any program unless the door is fully closed and locked. When the door is closed, it completes an electrical circuit which heats up a heat-sensitive pellet. This expands as it gets hot, pushing a mechanical lock into place and closing a switch. The switch signals the control unit that the door is closed and locked. Only when it has received this signal will the control unit start the wash program.

Now work in pairs, **A** and **B**.

Student A: Read Texts 2 and 3.
Student B: Read Texts 4 and 5.

Complete your section of the table opposite. Then exchange information with your partner to complete the whole table.

	Control factor	Operating device	Feedback by
1	Door position	heat-sensitive pellet	switch
2	Water level		
3	Water temperature		
4	Wash and spin times		—
5	Drum speeds		

Text 2

Water level

When a wash program first starts it has to open the valves which allow the water in. There are usually two of these valves, one for hot water and one for cold. Each must be controlled separately depending on the water temperature needed for that program. The valves are solenoid operated, i.e. they are opened and closed electrically.

The rising water level is checked by the water level sensor. This is a pressure sensor. The pressure of the air in the plastic tube rises as it is compressed by the rising water. The pressure sensor keeps the control unit informed as to the pressure reached and the control unit uses the information to decide when to close the water inlet valves.

Text 3

Water temperature

The temperature sensor, a type of thermometer which fits inside the washer drum, measures the water temperature and signals it to the control unit. The control unit compares it with the temperature needed for the program being used. If the water temperature is too low, the control unit will switch on the heater. The temperature sensor continues to check the temperature and keep the control unit informed. Once the correct temperature is reached, the control unit switches off the heater and moves on to the next stage of the program.

Text 4

Clock

The control unit includes a memory which tells it how long each stage of a program should last. The times may be different for each program. The electronic clock built into the control unit keeps the memory of the control unit informed so that each stage of each program is timed correctly.

Text 5

Drum speed

During the washing and spinning cycles of the program, the drum has to spin at various speeds. Most machines use three different speeds: 53 rpm for washing; 83 rpm for distributing the load before spinning; 100 rpm for spinning.

The control unit signals the motor to produce these speeds. The motor starts up slowly, then gradually increases speed. The speed sensor, a tachogenerator, keeps the control unit informed as to the speed that has been reached. The control unit uses the information to control the power to the motor and so controls the speed of the drum at all times.

Language study *If/Unless sentences*

Task 5

Fill in the blanks in this table using the information in Fig. 3 and the texts in Task 4.

Sensor	Condition	Control unit action
Water	level low	open inlet valves
	level high enough	______
Water temperature	______	switch on heater
	high enough	______
Drum speed	______	______
	______	decrease motor speed

The conditions which the sensors report determine the action of the control unit. We can link each condition and action like this:

> ***If** the water level is low, the inlet valves are opened.*

Task 6

Write similar sentences for the other five conditions given.

Now study this example:

Sensor	Condition	Control unit action
Door	Door open	Machine cannot start
	Door closed	Machine can start

We can link these conditions and actions as follows:

1. ***If** the door is open, the machine cannot start.*
2. ***If** the door is closed, the machine can start.*
3. ***Unless** the door is closed, the machine cannot start.*

We use *unless* when an action cannot or will not happen if a prior condition is not true. In example 3, *Unless* means *If ... not*. We can rewrite 3 as:

> ***If** the door is **not** closed, the machine cannot start.*

Task 7

Complete these sentences using *Unless* and your knowledge of engineering.

1 Unless the ignition is switched on, a car cannot ____________.

2 Unless the pilot light is on, gas central heating will not ____________.

3 Unless the diverter valve is switched to central heating, the radiators will not ____________.

4 Unless there is current flowing in the primary coil of a transformer, there will be no current in the ____________ coil.

5 Unless there is ____________ in the cylinders, a petrol engine will not start.

6 Unless the doors are ____________, a lift will not operate.

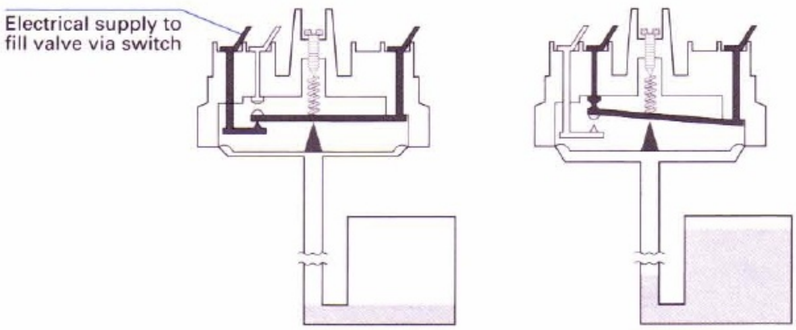
7 Unless mild steel is painted, it will ____________.

8 Unless electrical equipment is earthed, it may be ____________.

Writing *Explaining a diagram*

Task 8

Study this diagram of a pressure sensor. Explain how it works by linking each pair of actions with appropriate time words.



1 A wash programme first starts.
It opens the valves to allow the water in.
2 The water level in the drum rises.
The air in the plastic tube is compressed.
3 The pressure rises.
The diaphragm moves upwards.
4 This continues.
The switch contacts are separated.
5 This happens.
The fill valves are closed.

Task 9

Join the following groups of statements to make longer sentences. Use the words printed in *italics* above each group. You may omit words and make whatever changes you think are necessary in the word order and punctuation of the sentences. Join the sentences to make a paragraph.

1 *which*
The temperature sensor measures the water temperature.
The temperature sensor is a type of thermometer.

2 *and*
The temperature sensor fits inside the washer drum.
The temperature sensor signals the water temperature to the control unit.

3 *which*
The control unit compares the water temperature with the temperature.
The temperature is needed for the programme being used.

4 *If*
The water temperature is too low.
The control unit will switch on the heater.

5 *and*
The temperature sensor continues to check the temperature.
The temperature sensor keeps the control unit informed.

6 *When ... and*
The correct temperature is reached.
The control unit switches off the heater.
The control unit moves on to the next stage of the programme.

5 HEAT TRANSFER

5.1. Demonstration: *Thermodynamics*

Task 1: *Read the demonstration and give some examples deal with the first law of thermodynamics:*

Thermodynamics is that branch of science dealing with the mechanical action of heat. There are certain fundamental principles of nature, often called laws of thermodynamics, which govern our existence here on Earth, several of which are basic in the study of refrigeration.
The first and most important of these laws is the fact that energy can neither be created nor destroyed, but can be converted from one type to another. A study of thermodynamic theory is beyond the scope of this manual, but the examples that follow will illustrate the practical application of the energy law.

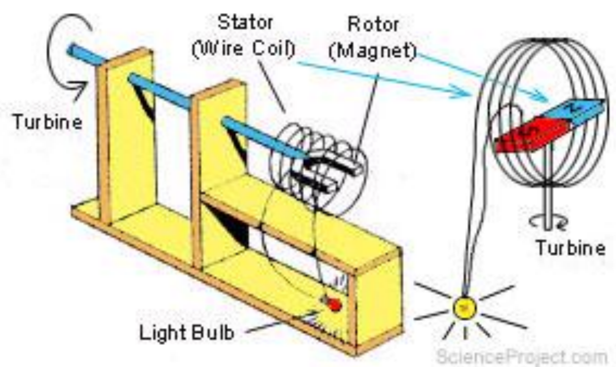


Fig.5.1

5.2. The second law of thermodynamics:

There are three mechanisms by which thermal energy is transported. What are they? Now read the text:

The second important law of thermodynamics is that heat always travels from a warm object to a colder one. The rate of heat travel is in direct proportion to the temperature difference between the two bodies.

Assume that two steel balls are side by side in a perfectly insulated box. One ball weighs one pound and has a temperature of 400^0 F., while the second ball weighs 1,000 pounds and has a temperature of 390^0 F. The heat content of the larger ball is tremendously greater than the small one, but because of the temperature difference, heat will travel from the small ball to the large one until the temperatures equalize.

Heat can travel in any of three ways: radiation, conduction, or convection.

-

Radiation is the transfer of heat by waves similar to light waves or radio waves. For example, the sun's energy is transferred to the Earth by radiation. One need only step from the shade into direct sunlight to feel the impact of the heat waves, even though the temperature of the surrounding air is identical in both places. There is little radiation at low temperatures, and at small temperature differences, so radiation is of little importance in the actual refrigeration process. However, radiation to the refrigerated space or product from the outside environment, particularly the sun, may be a major factor in the refrigeration load.

Fig.5.2

Conduction is the flow of heat through a substance. Actual physical' contact is required for heat transfer to take place between two bodies by this means. Conduction is a highly efficient means of heat transfer as any service-man who has touched a piece of hot metal can testify.

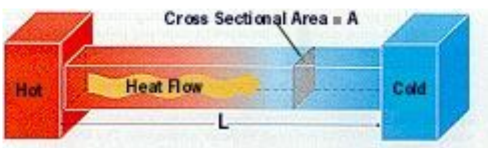


Fig.5.3

Convection is the flow of heat by means of a fluid medium, either gas or liquid, normally air or water. Air may be heated by a furnace, and then discharged into a room to heat objects in the room by convection.

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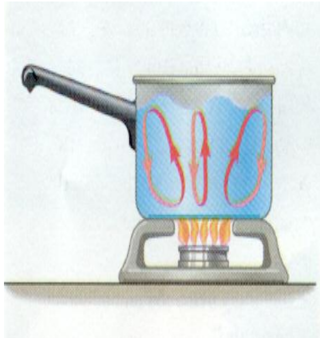

Fig. 5.4

In a typical refrigeration application, heat normally will travel by a combination of processes, and the ability of a piece of equipment to transfer heat is referred to as the overall rate of heat transfer. While heat transfer cannot take place without a temperature difference, different materials vary in their ability to conduct heat. Metal is a very good heat conductor, while asbestos has so much resistance to heat flow it can be used as insulation.

5.3. Answer the questions

Task 2: *1. Answer the questions:*

1/ What is thermodynamics?

2/ What is the first law of energy?

3/ In the second law of thermodynamics, how does heat travel ?

4/ Name three ways in which heat can travel.

2. True or false:

1/ Thermodynamics concerns the mechanical action of heat.

2/ Study of refrigeration is not in thermodynamics.

3/ Laws of thermodynamics do not govern our existence here on Earth.

4/ Energy can neither be created or destroyed.

5/ Heat will travel from the hotter small ball to the colder large one until the temperatures equalize.

6/ The sun's energy is transferred to the Earth by wave radio.

7/ Conduction is the flow of heat through a substance

8/ Convection is the flow of heat by means of air or water.

9/ Metal does not transfer heat better than asbestos.

5.4. Language study *Active or Passive*

Task 3: *Review some grammartical points about active and passive voice:*

We use passive forms for reasons of style and of clarity, as well as of meaning. Mostly the rules of passive formation are straightforward. Subject of an active verb can be the agent of a passive verb. We often don't mention the agent in the passive, but if we do it is introduced with *by*:

-

Ex: 1, They established an insductrial area in the zone last year.

=> An insductrial area was established in the zone last year **by them**.

2, A furnace may heat air.

=>Air may be heated **by a furnace.**

We thw passive form of verbs in all tenses by using *be* in the appropriate tense plus the past participle of the main verb:

Ex: 3, The sun's energy is transferred to the earth by radiation.

4, Hot piston cylinders in automobile engine are cooled by water forced around them.

Form of Passive:

Subject + finite form of *to be* + Past Participle (3rd column of irregular verbs)

	Active	**Passive**
Simple Present	Mr Smith *writes* the delivery notes.	The delivery notes *are written* (by Mr Smith).
Present Progressive	Mr Smith *is writing* the delivery notes.	The delivery notes *are being written* (by Mr Smith).
Simple Past	Mr Smith *wrote* the delivery notes.	The delivery notes *were written* (by Mr Smith).
Present Perfect	Mr Smith *has written* the delivery notes.	The delivery notes *have been written* (by Mr Smith).
Past Perfect	Mr Smith *had written* the delivery notes.	The delivery notes *had been written* (by Mr Smith).
Future	Mr Smith *will write* the delivery notes.	The delivery notes *will be written* (by Mr Smith).
Auxiliary Verbs	Mr Smith *must write* the delivery notes.	The delivery notes *must be written* (by Mr Smith).

When rewriting active sentences in passive voice, note the following:

- the object of the active sentence becomes the subject of the passive sentence
- the finite form of the verb is changed (*to be* + past participle)
- the subject of the active sentence becomes the object of the passive sentence (or is dropped)

-

5.5. Practice *Sentences*

Task 4: *Match*

Match the each picture with its sentence or name about the heat transfer. And say how they can transfer heat.

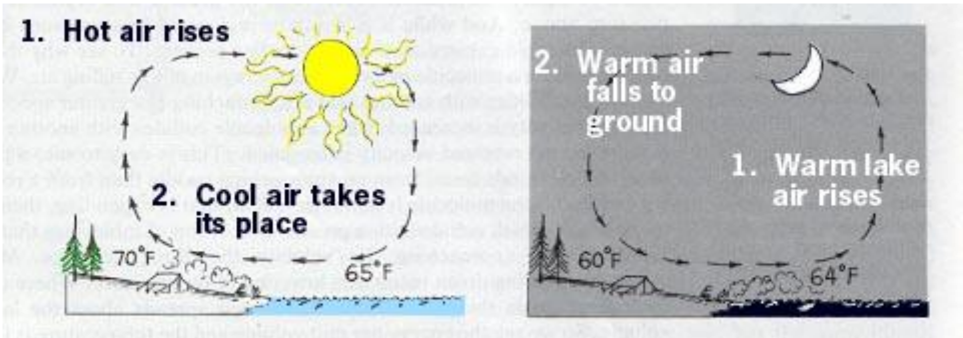

Fig. 5.5

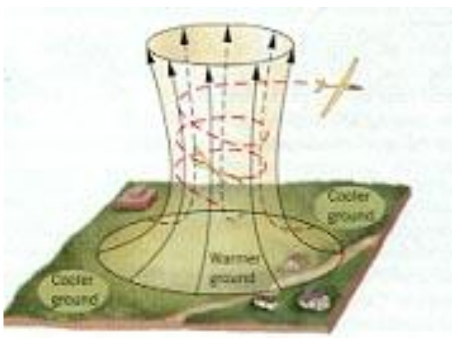

Fig. 5.6

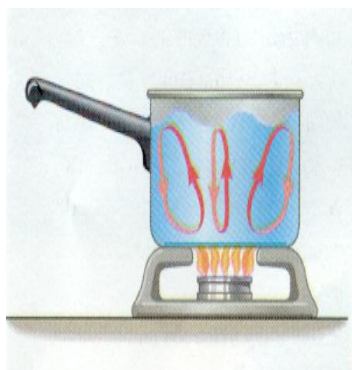

Fig5.7

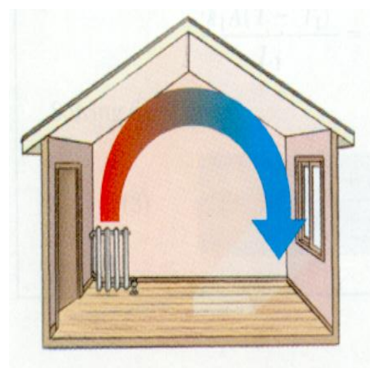

Fig.5.8

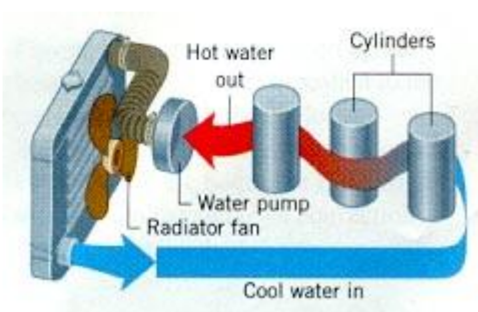

Fig.5.9

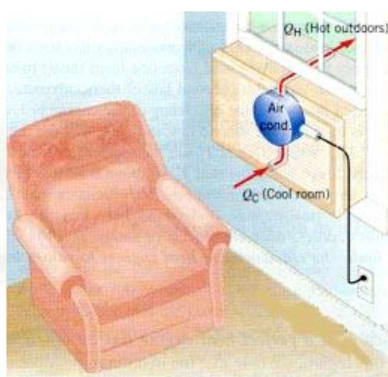

Fig.5.10

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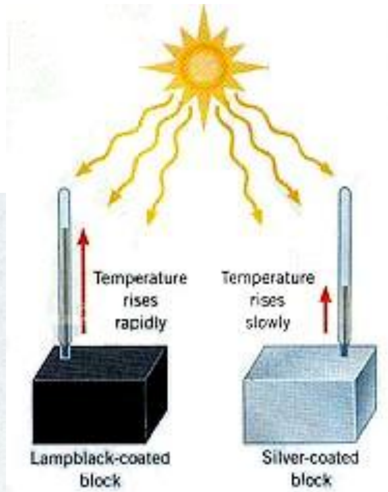

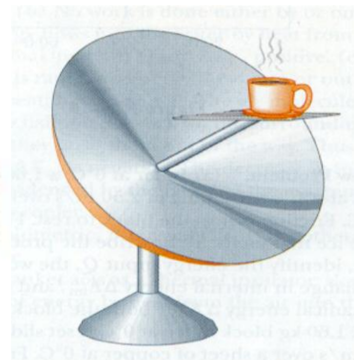

Fig. 5.11 Fig.5.12 Fig. 5.13

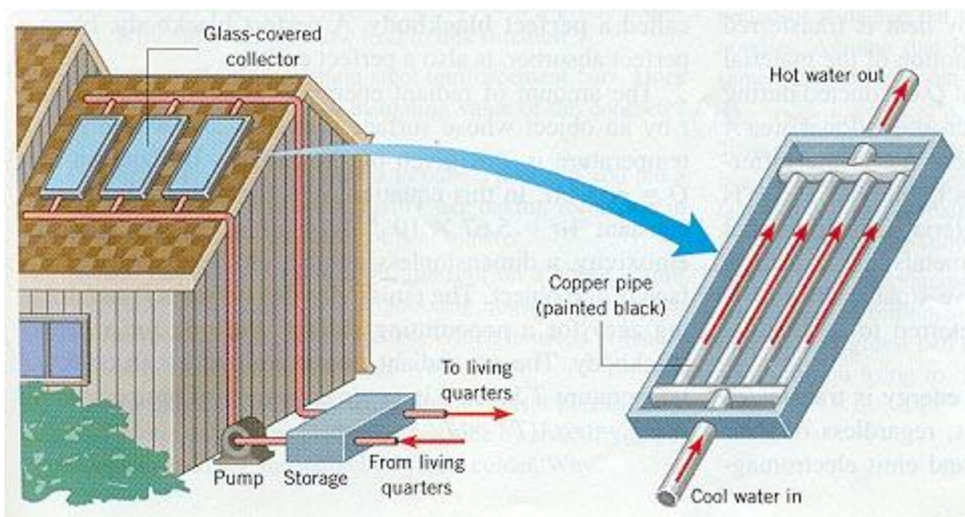

Fig. 5.14

A/ Air above warmer ground rises.
B/ Heated air rises, cools, then falls. Air near heater is replaced by cooler air, and the cycle repeats
C/ Warm land is cooled during the day, while cooler land is warmed at night
D/ Hot water rises, cools, and falls.
E/ Hot room air is forced outside, while cooler air replaces it.
F/ Water at the bottom of the drops is evaporated and provides insulation against further evaporation. Pan must be very hot.
G/ Solar cooker.
H/ Pipes in Solar Panels are painted black
I/ Summer clothing: white reflects radiant energy better than black.
J/ Hot piston cylinders in automobile engine are cooled by water forced around them.

-

5.6. More reading

Temperature

Temperature is the scale used to measure the intensity of heat, the indicator that determines which way the heat energy will move. In the United States, temperature is normally measured in degrees Fahrenheit, but the Centigrade scale (sometimes termed Celsius) is widely used in other parts of the world. Both scales have two basic points in common, the freezing point of water, and the boiling point of water at sea level. Water freezes at 32^0 F. and O^0 C., and water boils at sea level at 212^0 F. and 100^0 C. On the Fahrenheit scale, the temperature difference between these two points is divided into 180 equal increments or degrees F., while on the Centigrade scale the temperature difference is divided into 100 equal increments or degrees C, The relation between Fahrenheit and Centigrade scales can always be established by the following formulas:

Fahrenheit 9/5 (Centigrade + 32^0)

Centigrade 5/9 (Fahrenheit – 32^0)

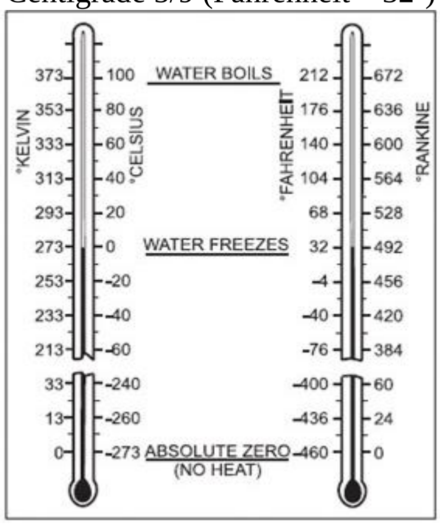

Fig. 5.15

5.7. Exercise

I/ Rewrite the passive sentences into active sentences

1/ In the United States, temperature is normally measured in degrees Fahrenheit.

⇨ ____

2/ Air may be heated by a furnace.

⇨ ____

3/ The sun's energy is transferred to the Earth by radiation.

⇨ ____

-

4/ The relation between Fahrenheit and Centigrade scales can always be established by the following formulas.

⇨ ____

5/ Ice was harvested in the winter to be used in the summer.

⇨ ____

II/ Rewrite the sentences in passive voice.

1. I confirm the reservation.
2. We will deliver the goods immediately.
3. We arranged a meeting.
4. You can cancel the contract within five business days.
5. They execute all orders carefully.
6. You have made a mistake.
7. We are processing your order.
8. Jane had booked a flight.
9. He has not answered our letter.
10. She did not sign the contract

***III/ Decide whether to use simple present, simple past, present perfect, conjunctive or passive voice. Use the** long forms*

The Fellowship of the Ring (be)__________ the first book of J.R.R. Tolkien's The Lord of the Rings trilogy, which (set)____________in a fictive world, Middle Earth. It (tell)_____________the story of Frodo, a hobbit, and a magic ring.

As the story (begin)_______________, Frodo (give)______________a magic ring. The wizard Gandalf then (tell)________________him of the Rings of Power and of Sauron, the Dark Lord, who (make)______________the Master Ring to rule all other Rings. Gandalf (advise)___________Frodo to leave home and keep the ring out of Sauron's hands who already (send)_____________his Black Riders in search for it. Frodo's ring (give)_____________Sauron the power to enslave Middle Earth.

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Glossary of engineering terms and abbreviations

The definitions in this glossary refer to words only as they are used in this book. The meanings of certain words will vary according to context. As the texts in this book are authentic and come from a variety of sources, some inconsistency in hyphenation and spelling is inevitable.

The unit and task numbers indicate where the word first appears.

Abbreviations used in the text

R = Reading section
SP = Speaking practice
T = Task
TS = Tapescript
U = Unit
W = Writing section

n = noun
adj = adjective
v = verb

A

A-frame /ˈeɪ freɪm/ *n* [U10, T5] a structural frame in the shape of the letter A

ac /eɪ ˈsiː/ *n* [U23, T6] alternating current

aerodynamic /ˌeərəʊdaɪˈnæmɪk/ *adj* [U12, T3] designed to reduce wind resistance

air classifier /ˈeə ˌklæsɪfaɪə(r)/ *n* [U27, T3] a machine which uses air to segregate materials by size and weight

alarm /əˈlɑːm/ *n* [U11, T3] a means of attracting attention utilizing either sound or vision

alloy /ˈælɔɪ/ *n* [U12, T3] a metal formed by mixing together other metals and elements

alternator /ˈɔːltəneɪtə(r)/ *n* [U17, T3] a type of generator producing alternating current

amplifier /ˈæmplɪfaɪə(r)/ *n* [U16, T8] an electronic device which converts small signal changes to large

anthropomorphic /ˌænθrəpəˈmɔːfɪk/ *n* [U28, T3] of human-like form

armature /ˈɑːmətʃə(r)/ *n* [U6, T2] the moving part of an electric motor which comprises a piece of iron with loops of wire running round it; the current through the wire is reversed to provide the changes in magnetic fields required to make the motor run

B

bearing /ˈbeərɪŋ/ *n* [U2, T4] a device to reduce friction and wear between a rotating shaft and a stationary part; may contain balls or rollers

bimetallic corrosion /ˌbaɪmətælɪk kəˈrəʊʒn/ *n* [U22, T6] *see* galvanic corrosion

block diagram /ˈblɒk ˌdaɪəgræm/ *n* [U11, T3] schematic drawing showing different functions in a system or stages in a process

body scanner /ˈbɒdi ˌskænə(r)/ *n* [U1, T4] a medical electronic device for building up an image of the internal organs of a patient

brittle /ˈbrɪtl/ *adj* [U3, T2] describes a material which tends to break easily, e.g. glass

brushes /ˈbrʌʃɪz/ *n* [U6, T2] spring-loaded carbon blocks which carry the electric current to the commutator of an electric motor

buoyancy /ˈbɔɪənsɪ/ *n* [U5, T3] the upthrust exerted by a fluid

buzzer /ˈbʌzə(r)/ *n* [U7, T5 TS] a device which uses an electric signal to produce a buzzing sound

C

CAD /kæd/ *n* [U20, T1] computer-aided design

CAM /kæm/ *n* [U20, T2] computer-aided manufacture

cam /kæm/ *n* [U4, T7] a specially profiled part which is fitted to a rotating shaft to produce linear motion

capillary tube /kəˈpɪlərɪ ˌtju:b/ *n* [U15, T2] a tube with a very small diameter bore

CAPP /kæp/ *n* [U20, T2] computer-aided process planning

carbon fibre /ˈkɑ:bn ˌfaɪbə(r)/ *n* [U25, T5] high-strength fibre made from carbon atoms

carburettor /ˌkɑ:bəˈretə(r)/ *n* [U17, T3] a device where air and petrol are mixed in an internal combustion engine

Cartesian co-ordinates /kɑ:ˌti:ʒn kəʊˈɔ:dɪnəts/ *n* [U28, T5] information about the position of a body in space using distances measured from three intersecting planes

chain wheel /ˈtʃeɪn wi:l/ *n* [U12, T1] a toothed pulley or sprocket used for transmitting torque by a chain

charger /ˈtʃɑ:dʒə(r)/ *n* [U15, T4] a device which contains a unit for converting mains power to direct current at a suitable voltage for charging batteries

chisel /ˈtʃɪzl/ *n* [U18, T3] a steel tool with one end formed into a cutting edge

CIM /sɪm/ *n* [U20, T1] computer-integrated manufacturing: describes a series of processes or activities co-ordinated by using a computer

circuit breaker /ˈsɜ:kɪt ˌbreɪkə(r)/ *n* [U21, T6] an electrical switch fitted with an overload protection cut out

closed loop /ˌkləʊzdˈlu:p/ *n* [U11, T3] a system where part of the output of a system is fed back into the input to modify the output

commutator /ˈkɒmju:ˌteɪtə(r)/ *n* [U6, T2] the part of the armature of an electric motor which is in contact with the brushes: it reverses the flow of current through the armature

compact disc /ˌkɒmpækt ˈdɪsk/ *n* [U13, T2] plastic disc used to store high quality sound recordings or computer data on its surface

component evaluation /kəmˌpəʊnənt ɪvæljʊˈeɪʃn/ *n* [U30, T4] the testing of a component to ensure it conforms to specifications

composite /ˈkɒmpəzɪt/ *n* [U25, T4] a fibre-reinforced plastic material

compressed air /kəmˌprestˈeə(r)/ *n* [U18, T1] air at higher than atmospheric pressure: used to power pneumatic devices such as drills

compression /kəmˈpreʃn/ *n* [U4, T4] the effect of forces which act to squash a structure

computer model /kəmˈpju:tə ˌmɒdl/ *n* [U24, T7] a representation of a design created in 3D on a computer using a CAD programme

computer-based /kəmˈpju:tə ˌbeɪst/ *adj* [U30, T3] describes a system which relies on the use of a computer

condenser /kənˈdensə(r)/ *n* [U15, T2] a unit where vapour is converted back into a liquid

conductor /kənˈdʌktə(r)/ *n* [U3, T3] a material which will transmit electricity or heat

constraint /kənˈstreɪnt/ *n* [U28, T6] limit imposed by the nature of a mechanism

cooling duct /ˈku:lɪŋ dʌkt/ *n* [U23, T9] a passageway to allow air to pass to a hot surface, for example, in a motor

corrosion-resistant /kəˈrəʊʒn rɪˌzɪstənt/ *adj* [U3, T3] describes a material which can be used in environments where long-term strength or appearance is important, e.g. stainless steel

corrosive /kəˈrəʊsɪv/ *adj* [U9, T1] describes a substance which corrodes (eats or wears away), usually by chemical action

crankshaft /ˈkræŋkʃɑ:ft/ *n* [U4, T2] the main shaft of an engine which carries the cranks for the pistons

crevice corrosion /ˈkrevɪs kəˌrəʊʒn/ *n* [U22, T6] corrosion in cracks or crevices in pipes carrying liquids

cylinder head /ˈsɪlɪndə ˌhed/ *n* [U3, W] a plate which seals the ends of cylinders on internal combustion engines: it contains the valves

D

damper /ˈdæmpə(r)/ *n* [U23, T2] a device fitted between the chassis and axle of a vehicle to remove spring effects and smooth travel

database /ˈdeɪtəbeɪs/ *n* [U20, T2] a bank of information stored in a computer for easy access

dc /diː ˈsiː/ *n* [U6, T5] direct current

debug /ˌdiːˈbʌg/ vt [U29, T2] detect, locate and correct faults

degrees of freedom /dɪˌgriːz əv ˈfriːdəm/ *n* [U28, T4] the movements achievable by a robot in three-dimensional space

desalination /ˌdiːsælɪˈneɪʃn/n [U29, T5] production of fresh water from sea water

die /daɪ/ *n* [U13, T7] a specially shaped block of metal used as a mould for other materials

die-cast /ˈdaɪkɑːst/ *adj* [U12, T6] produced from moulds

disc brakes /ˈdɪsk breɪks/ *n* [U19, T2] brakes in which a caliper clamps brake pads onto a disc connected to the wheel of the vehicle

diverter valve /daɪˈvɜːtə ˌvælv/ *n* [U8, T6] a valve used in central heating to redirect the flow of hot water from radiators to water heating and vice versa

documentation /ˌdɒkjʊmenˈteɪʃn/ *n* [U30, T9] the complete description of a product in words and drawings at every stage in its manufacture

ductile /ˈdʌktaɪl/ *adj* [U3, T3] describes a material which can be stretched and yet retain its strength, e.g. copper

ductility /dʌkˈtɪlɪtɪ/ *n* [U26, T9] quality of being ductile

E

EDM /ˌiː diː ˈem/ *n* [U20, T2] engineering data management

elastic limit /ɪˈlæstɪk ˌlɪmɪt/ *n* [U26, T6] the point at which a material will no longer return to its original shape after tensile forces are released

elasticity /ɪlæsˈtɪsɪtɪ/ *n* [U5, T3] the property of a material to stretch and then return to its original state

encapsulation /ɪŋˌkæpsjʊˈleɪʃn/ *n* [U3, T3] the process of completely embedding a component in a resin as protection from the environment

engine /ˈendʒɪn/ *n* [U3, W] a device which coverts fuel into work

equilibrium /ˌekwɪˈlɪbrɪəm/ *n* [U5, T3] balance (a structure is in equilibrium when all the forces on it are stable and there is no movement)

escalator /ˈeskəleɪtə(r)/ *n* [U4, T2] moving stairs

evaporator /ɪˈvæpəreɪtə(r)/ *n* [U15, T2] a unit in which a liquid is converted into a vapour

exfoliate corrosion /eksˈfəʊlɪət kəˌrəʊʒn/ *n* [U22, T6] when flakes of metal are displaced due to corrosion

extrusion /ɪkˈstruːʒn/ *n* [U13, T7] a manufacturing process whereby a material in its plastic state is forced through a die, e.g. to make plastic pipes

F

feedback /ˈfiːdbæk/ *n* [U11, T3] a signal responding to the output of a system which is returned to the input to modify the output

field magnet /ˈfiːld ˌmægnət/ *n* [U6, T2] a magnet for producing and maintaining the magnetic field in a generator or electric motor

friction /ˈfrɪkʃn/ *n* [U5, T2] the resistance experienced when two bodies rub against each other

fuel cell /ˈfjʊəl sel/ *n* [U25, T4] a cell which converts the chemical energy of a fuel to electrical energy

fulcrum /ˈfʊlkrəm/ *n* [U5, T6] the pivot point of a system of levers, e.g. the screw in a pair of scissors

G

galvanic corrosion /gælˈvænɪk kəˌrəʊʒn/ *n* [U22, T6] the corrosion which results when two dissimilar metals are connected in the presence of moisture

gears /gɪəz/ *n* [U12, T1] an arrangement of toothed wheels which mesh together to change the speed or direction of movement

goggles /ˈgɒgəlz/ *n* [U9, T7] protective eye wear completely surrounding the eyes

granules /ˈgrænjʊəlz/ *n* [U13, T7] material, e.g. plastic, in the form of small grains

grinder /'graɪndə(r)/ *n* 1 [U9, T3] a machine with a rotating disc of abrasive material used for sharpening tools and removing rough edges [U29 SP (A)] a grinding machine operator

guard /gɑ:d/ *n* [U9, T3] a device to safeguard the operators of moving machinery

H

hammer mill /'hæmə mɪl/ *n* [U27, T3] a crushing machine using impacts from rotating arms

hazard /'hæzəd/ *n* [U9, T2] danger

heat exchanger /'hi:t ɪks,tʃeɪndʒə(r)/ *n* [U8, T3] the part of a boiler where the water is heated

heat-resistant /'hi:t rɪ,zɪstənt/ *adj* [U3, T3] describes a material which will withstand exposure to high temperature

hinge /hɪndʒ/ *n* [U5, T6] a flexible mounting for doors and lids

hydraulic /haɪ'drɔ:lɪk/ *adj* [U19, T2] describes a system using cylinders and pistons and driven by a fluid

I

ignition /ɪg'nɪʃn/ *n* [U28, T9] the circuit which allows high-tension current to pass to the sparking plugs in an internal combustion engine

insulator /'ɪnsjʊ,leɪtə(r)/ *n* [U3, T3] a substance which will not transmit electricity or heat

interface /'ɪntəfeɪs/ *n* [U28, T2] hardware and software to enable a computer to communicate with the device to be controlled

intergranular corrosion /,ɪntəgrænjʊlə kə'rəʊʒn/ *n* [U22, T6] corrosion at the boundaries of the crystal grains of a material

IT /aɪ 'ti:/ *n* [U20, T1] information technology

J

jig /dʒɪg/ *n* [U29 SP (A)] a work-holding device made for a specific component, e.g. to hold it for drilling

JIT /,dʒeɪ aɪ 'ti:/ *n* [U20, T2] just-in-time manufacturing

L

laser /'leɪzə(r)/ *n* [U13, T2] Light Amplification by Stimulated Emission of Radiation

LCD /,el si: 'di:/ *n* [U16, T6] liquid crystal display

load cell /'ləʊd sel/ *n* [U16, T5] a load-measuring element using an electrical strain gauge as the measuring device

M

malleable /'mælɪəbl/ *adj* [U3, T3] describes a material which can be stretched without breaking apart, e.g. copper

manipulator /mə'nɪpjʊ,leɪtə(r)/ *n* [U28, T2] the part of a robot which carries out the work

methods engineer /'meθədz endʒɪ,nɪə(r)/ *n* [U29, T7] someone concerned with establishing the best production method and equipment for making an article

micrometer /maɪ'krɒmɪtə(r)/ *n* [U29, T2] a U-shaped gauge used for precise measurement of thicknesses: the gap between the measuring faces is adjusted by rotating a screw thread encased in a graduated sleeve

microprocessor /,maɪkrəʊ'prəʊsesə(r)/ *n* [U16, T5] integrated circuit chip at the centre of a computer for controlling the system and processing the data

mill /mɪl/ *n* [U29, SP (B)] a milling machine: uses multi-toothed cutters to shape metals and plastics

miller /'mɪlə(r)/ *n* [U29, SP (A)] a milling machine operator

MRP /,em ɑ: 'pi:/ *n* [U20, T2] materials requirement planning

P

pedal /'ped(ə)l/ *n* [U12, T1] foot-operated lever, e.g. the accelerator pedal of a car

pendulum /'pendjʊləm/ *n* [U4, T2] the swinging weight used for time control in some clocks

pilot light /'paɪlət laɪt/ *n* [U8, T2] a small flame used to ignite the main burners in a gas-fired heating boiler

pitch /pɪtʃ/ *n* [U28, T8] angular displacement along the lateral axis

pitting /'pɪtɪŋ/ *n* [U22, T6] corrosion due to localized chemical reaction

plant /plɑ:nt/ *n* [U8, T7] the machines in a factory and all the buildings

PLC /,pi: el 'si:/ *n* [U20, T2] programmable logic control/controller: the system/device by which a microprocessor controls a stage in a process automatically

pneumatic drill /nju:,mætɪk 'drɪl/ *n* [U18, T3] a drilling machine using compressed air for power

pressure regulator /'preʃə ,regjʊleɪtə(r)/ *n* [U21, T6] a device for adjusting or maintaining pressure levels

prototype /'prəʊtə,taɪp/ *n* [U10, T2 TS] the first working model

pulley /'pʊlɪ/ *n* [U10, T5] a grooved wheel over which a rope passes

R

reaction /riːˈækʃn/ *n* [U5, T3] the force which opposes an applied force

reamer /riːmə(r)/ *n* [U19, T6] a tool for enlarging a drilled hole to a precise diameter

recycling /ˌriːˈsaɪklɪŋ/ *n* [U27, T1] extracting from waste all materials that can be reprocessed to be used again

refrigerant /rɪˈfrɪdʒərənt/ *n* [U15, T2] a substance which changes easily from a liquid to a gas and which can be used in refrigeration to remove heat energy and transfer it to the surroundings

regenerative braking /rɪˈdʒenərətɪv ˌbreɪkɪŋ/ *n* [U25, T5] a method of braking electric motors where the motor becomes a generator converting the energy of the slowing wheels into electricity

remote control /rɪˌməʊt kənˈtrəʊl/ *n* [U11, T3] a device for controlling something from a distance

respirator /ˈrespəˌreɪtə(r)/ *n* [U9, T7] a mask worn over the nose and mouth to filter air

resultant /rɪˈzʌltənt/ *n* [U5, T2] the single outcome of a number of different vectors

revolve /rɪˈvɒlv/ *vi* [U5, T7 TS] turn, rotate

robotics /rəʊˈbɒtɪks/ *n* [U28] the study or production of machines which perform tasks in a manner similar to humans

roll /rəʊl/ *n* [U28, T8] angular rotation about a longitudinal axis

rotor /ˈrəʊtə(r)/ *n* [U17, T2] rotating part of a generator

S

scallop /ˈskɒləp/ *n* [U28, T6] fan-shaped curve

scratch-resistant /ˈskrætʃ rɪˌzɪstənt/ *adj* [U3, T3] describes a material which retains its appearance when exposed to abrasion

sensing device /ˈsensɪŋ dɪˌvaɪs/ *n* [U7, T5 TS] a device which monitors the operating environment and is sensitive to change

shock absorber /ˈʃɒk əbˌzɔːbə(r)/ *n* [U11, T2] a device for absorbing shocks and vibrations

signal generator /ˈsɪgnəl ˌdʒenəreɪtə(r)/ *n* [U21, T6] electronic device which produces various signals used in tests and measurements

solenoid /ˈsəʊlənɔɪd/ *n* [U11, T2] a coil with an iron core which is pulled into the coil by a current passing through the coil

solenoid valve /ˈsəʊlənɔɪd ˌvælv/ *n* [U11, T2] a valve operated by a solenoid

spanner /ˈspænə(r)/ *n* [U5, T7 TS] a tool, or level, for applying force to nuts and bolts

speed governor /ˈspiːd ˌgʌvənə(r)/ *n* [U21, T6] a device fitted to an engine to limit its speed to a pre-set level

spring balance /ˌsprɪŋ ˈbæləns/ *n* [U5, T3] a measuring device in which the force applied is calculated by the extension of a spring

sprocket /ˈsprɒkɪt/ *n* [U12, T10] a toothed wheel over which a chain passes

stator /ˈsteɪtə(r)/ *n* [U17, T2] stationary part of a generator

strain gauge /ˈstreɪn geɪdʒ/ *n* [U16, T5] a device for measuring strain in a structure

switchgear /ˈswɪtʃgɪə(r)/ *n* [U1, T5] switches and associated equipment for controlling large electrical currents

systems analyst /ˈsɪstəmz ˌænəlɪst/ *n* [U29, T7] someone responsible for examining a problem to see whether it is suitable for a computer application

T

tachogenerator /ˈtækəʊˌdʒenəreɪtə(r)/ *n* [U11, T4] a sensor for measuring the speed of rotation

TEFC /ˌtiː iː ef ˈsiː/ *adj* [U23, T9] totally-enclosed fan-cooled (motor)

tension /ˈtenʃn/ *n* [U4, T4] the effect of a pulling force which tends to stretch a body

thermoplastic /ˈθɜːməʊˌplæstɪk/ *n* [U3, T1] a plastic which softens when heated and hardens when cooled

thermosetting plastic /ˌθɜːməʊsetɪŋ ˈplæstɪk/ *n* [U3, T3] a plastic which retains its shape and rigidity at high temperatures

thermostat /ˈθɜːməstæt/ *n* [U8, T3] a control device which operates at a pre-set temperature

throttle /ˈθrɒtl/ *n* [U18, T3] a valve for controlling the supply of a gas or liquid (e.g. fuel) to an engine

thrust /θrʌst/ *n* [U12, T6] force of propulsion

tooling /ˈtu:lɪŋ/ *n* [U13, T10] all manufacturing equipment required for the manufacture of a product

toxic /ˈtɒksɪk/ *adj* [U9, T1] poisonous

transformer /ˌtrænsˈfɔ:mə(r)/ *n* [U6, T6] a device for stepping up or down the voltage of an alternating current

treadle /tredl/ *n* [U4, T6] a linkage used to convert oscillating into rotary movement and vice versa

turbine /ˈtɜ:baɪn/ *n* [U17, T9] a machine which produces power when steam, gas or water is passed over the blades attached to the rotating drive output shaft

turbulence /ˈtɜ:bjʊləns/ *n* [U12, T6] violent or uneven movement of air

turner /ˈtɜ:nə(r)/ *n* [U29, SP (A)] a lathe operator

U

undercarriage /ˈʌndəˌkærɪdʒ/ *n* [U23, R2] the supporting framework of a vehicle comprising wheels, axles, suspension, etc.

V

vapour /ˈveɪpə(r)/ *n* [U15, T2] a gas that can be liquefied by increasing its pressure

vernier /ˈvɜ:nɪə(r)/ *n* [U29, T2] a measuring gauge fitted with an auxiliary scale which allows the operator to read the main scale with an accuracy of one tenth of a division

W

waisting /ˈweɪstɪŋ/ *n* [U26, T7] deformation which brings about narrowing of the section of a rod or material under tension

wave power /ˈweɪv ˌpaʊə(r)/ *n* [U17, T9] a method of generating electricity by using the movement of waves in water

work volume /ˈwɜ:k ˌvɒlju:m/ *n* [U28, T4] the space volume into which the manipulator of a robot can be positioned; hence the volume where useful work can be done

Y

yaw /jɔ:/ *n* [U28, T8] angular rotation about a vertical axis

yield point /ˈji:ld pɔɪnt/ *n* [U26, T7] the point where the elastic limit is reached