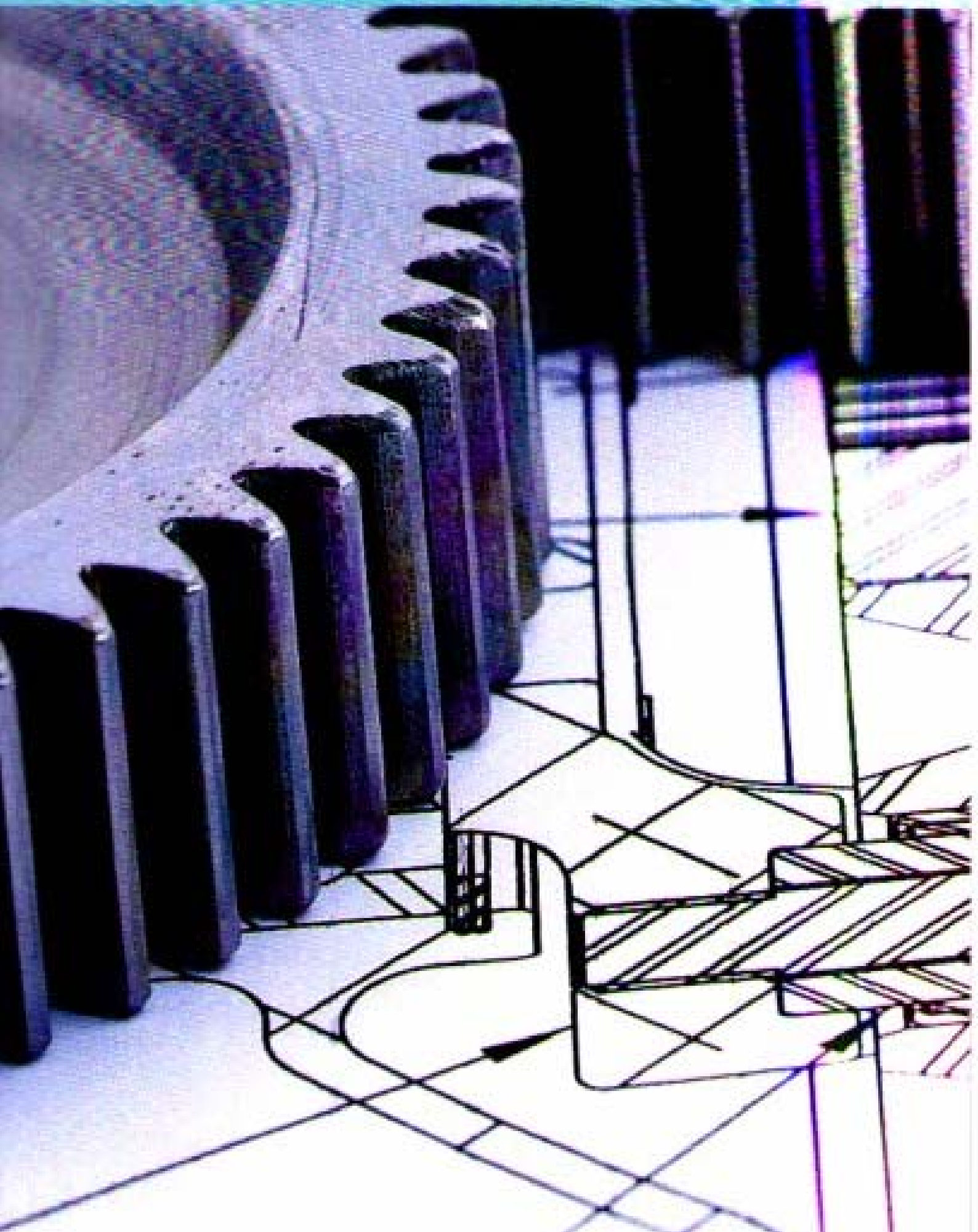
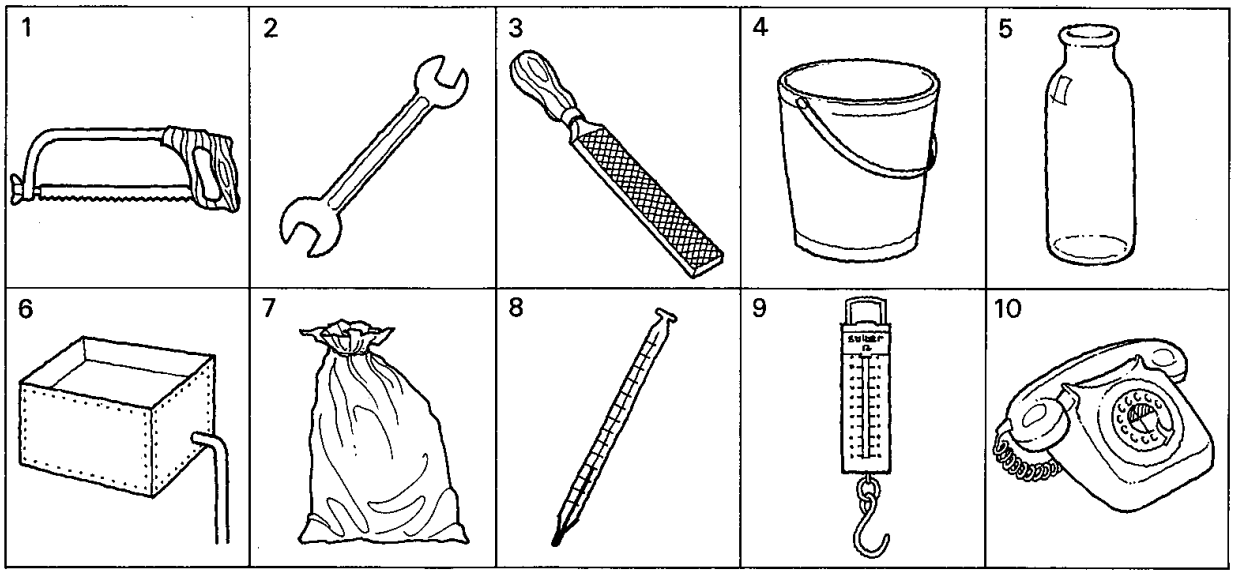
INGLÉS TÉCNICO



Contents

Entry Test

A. What is the English word for each of these objects?



What are the common names for these elements?
Note: They are all metals.

11. *Cu* 12. *Sn* 13. *Hg* 14. *Fe* 15. *Pb*

B. Listen to your teacher. Write down the amounts. There are ten items.

Now listen again. Follow the five instructions and complete the figure.

C. Complete each paragraph from the wordlist.

above	*gas*	*m.p.*
called	*its*	*range*
definite	*leaves*	*same*
example	*made*	*therefore*

There are three states of matter: the solid state, the liquid state and the gas state. At certain temperatures, every material changes from one state to another. For . . . . , pure water only remains liquid between 0°C and 100°C. . . . . 100°C, it becomes a gas. This gas is usually . . . . steam. Below 0°C, water becomes a solid. Water in . . . . solid state is called ice. Pure metals have a . . . . melting point, i.e. they always melt at exactly the . . . . temperature. Alloys, however, do not often have a definite . . . . . They slowly change from solid to liquid over a . . . . of temperatures.

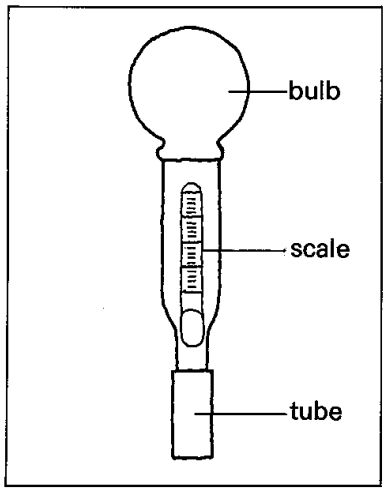
a	*is*
become	*or*
contains	*there*
has	*very*

In engineering, many different types of materials are used. Each material has different properties and these properties determine the use of a material. For example, concrete . . . . a very common material in construction work.

It is . . . . much cheaper material than most metals and it is . . . . durable, that is to say, it does not corrode . . . . decompose easily. Concrete is a heavy material but it . . . . comparatively good strength, both in tension and in compression.

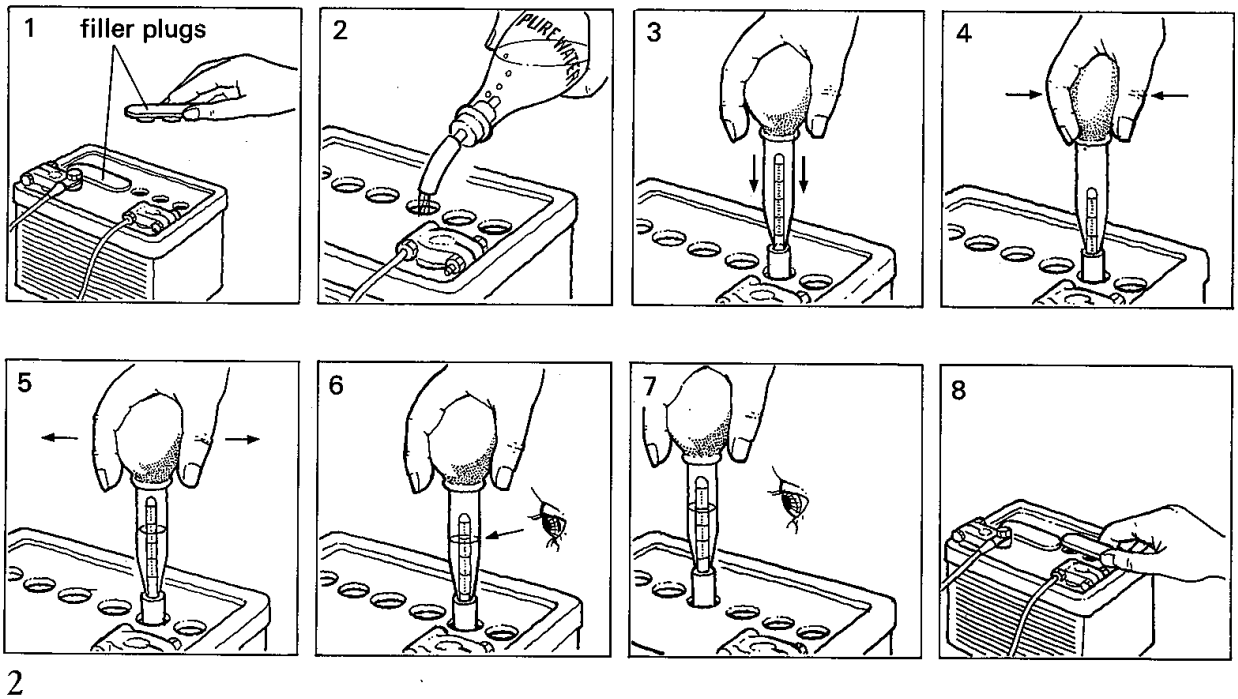
. . . . are several different types of concrete. However, it always . . . . a basic mixture of cement, aggregate (usually sand) and water.

D.



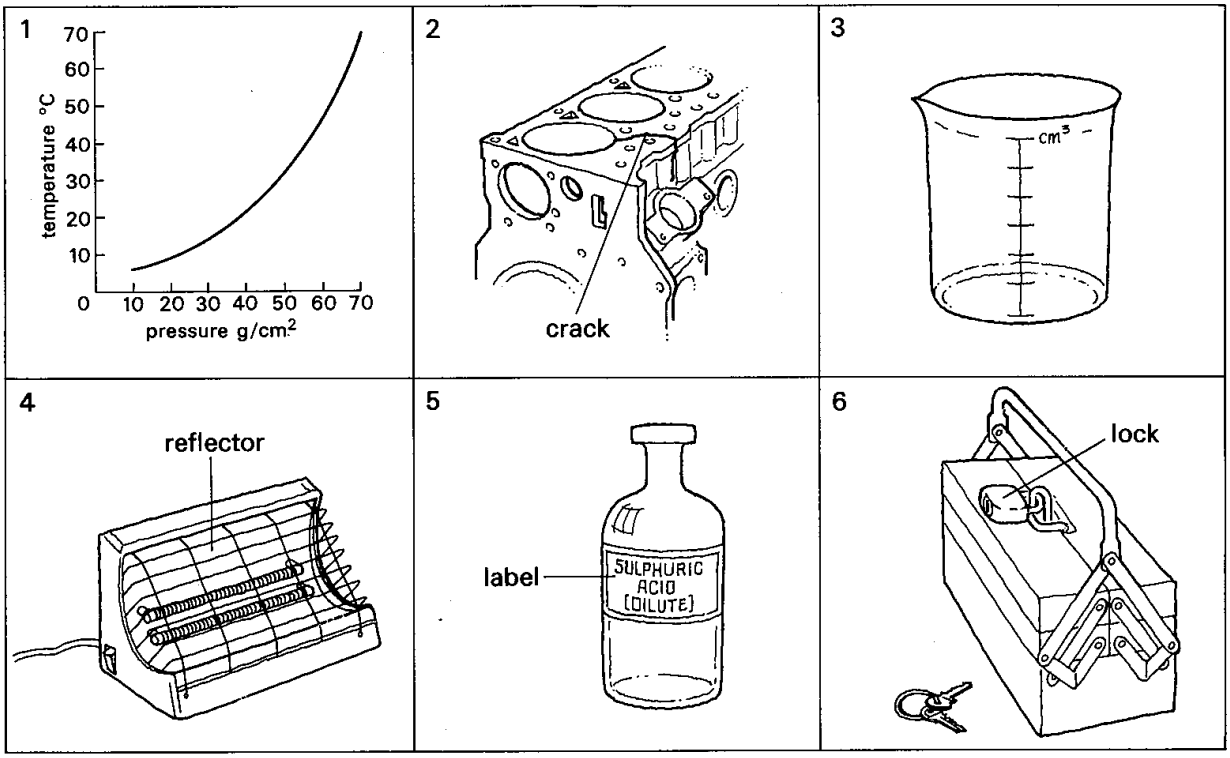
This instrument is a hydrometer. It is used for checking the specific gravity of the electrolyte in car batteries.
Look at the pictures below. Write a set of eight instructions from the pictures. Use one of the verbs in the list in each sentence.

check	*press*	*release*
fill	*read*	*replace*
place		*remove*



UNIT ONE Shapes and Conditions

SECTION A: EVERYDAY OBJECTS



The first picture shows a graph. The graph line is curved.

The next picture shows an engine block. The block is cracked.

The third picture shows a beaker. The beaker is calibrated.

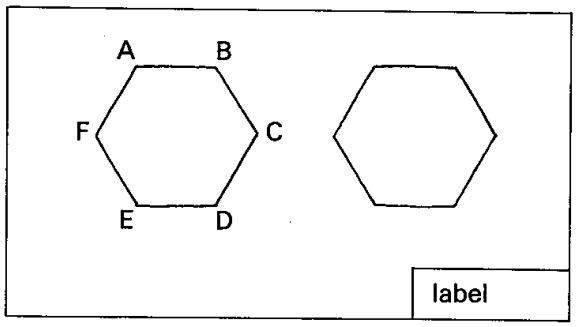
Exercise 1 Look at pictures four, five and six. Complete the sentences below.

The . . . . picture . . . . an electric fire.
The . . . . is curved.

The . . . . . shows a . . . . . acid.
The . . . . . (label).

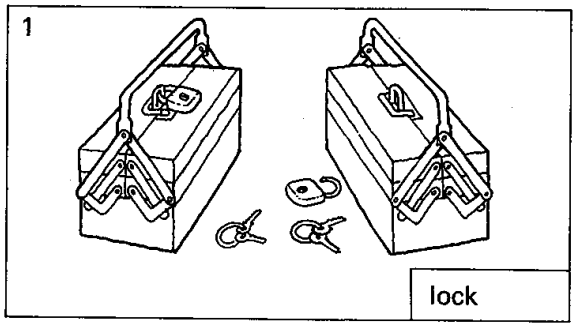
The . . . . . shows a toolbox.
. . . . . (lock).

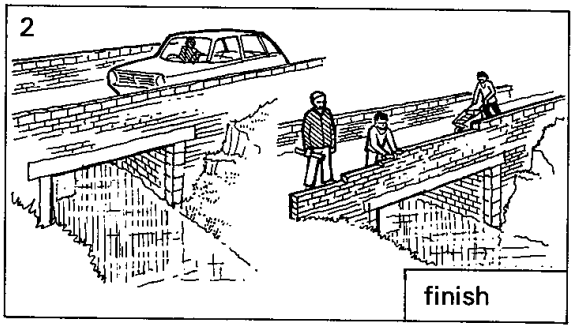
Exercise 2 Look at this example.

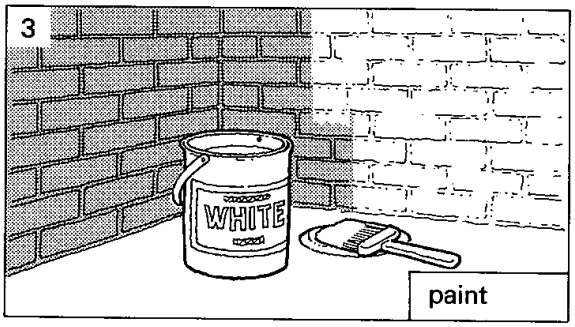


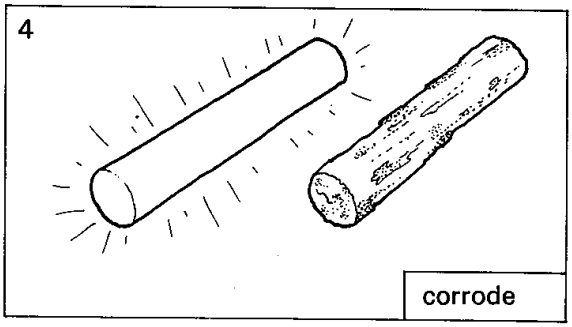
There are two hexagons in the picture. One hexagon is *labelled* and the other is *unlabelled*.

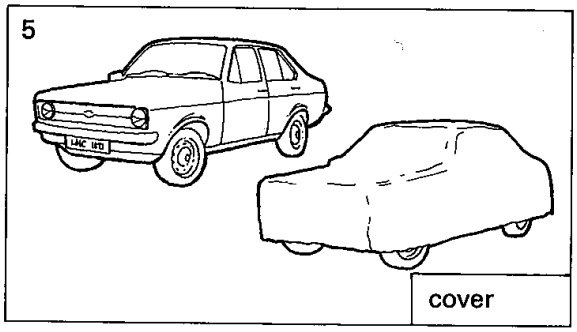
Describe these objects in the same way.

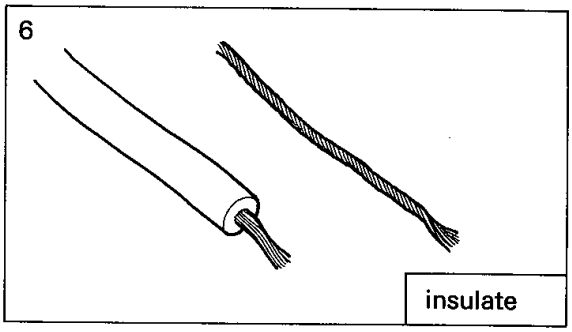


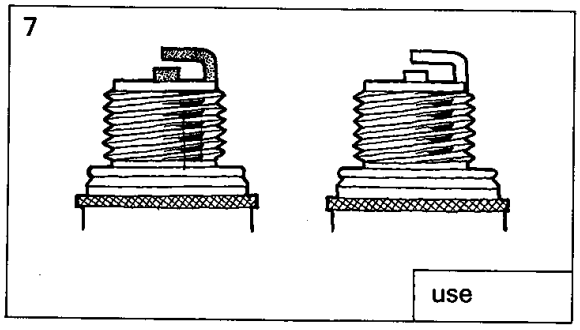


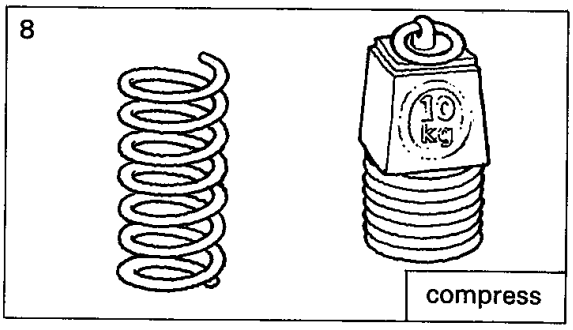




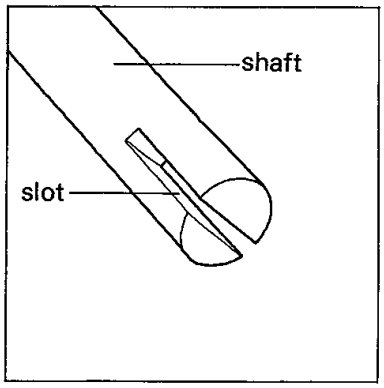




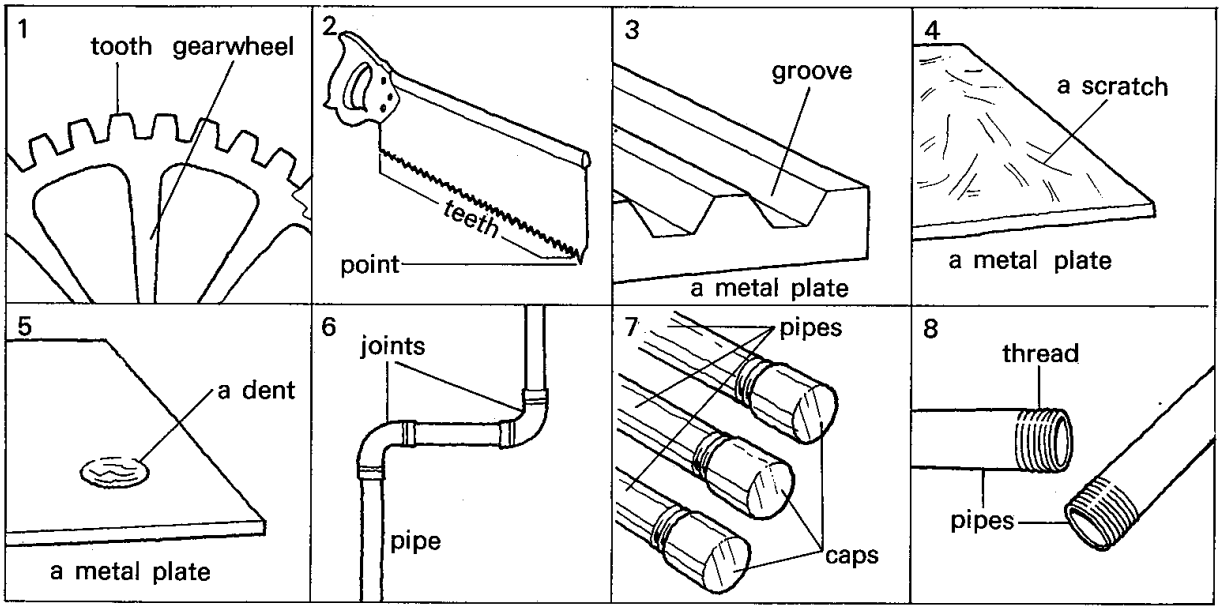




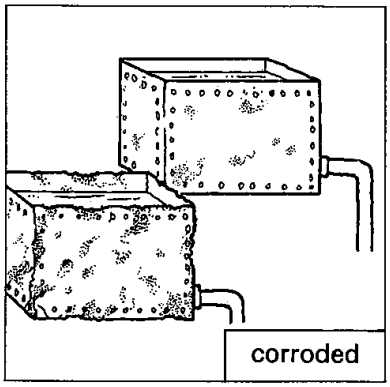
Exercise 3 Look at the example. Then describe the objects below in the same way.



This shaft is *slotted.*



Exercise 4 Look at this example.

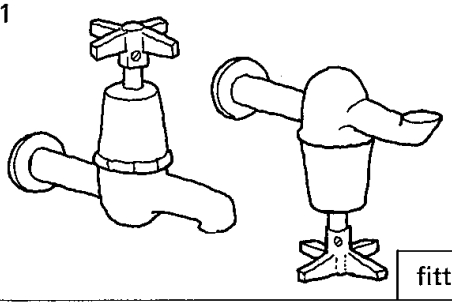


One water tank is *badly corroded.*
The other is *slightly corroded.*

Now describe each pair of objects in the same way. Use the words below. Use one pair of words for each picture.

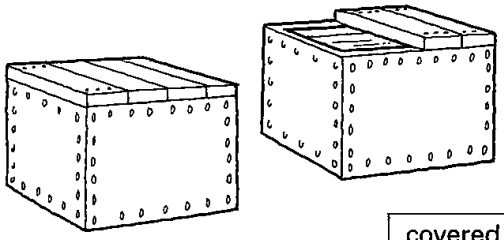
approximately exactly	poorly well	badly slightly
correctly incorrectly	half fully	too not ..... enough

1



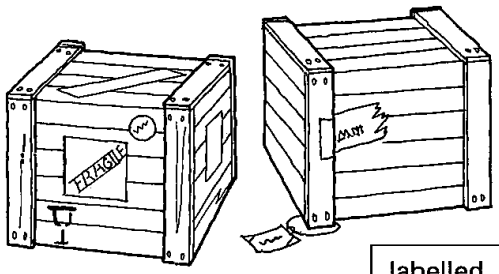
fitted

2



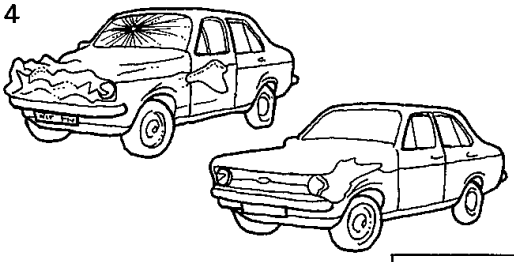
covered

3



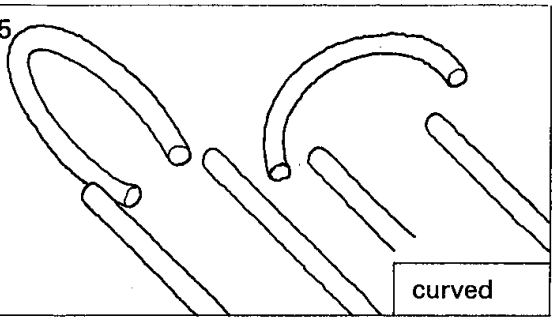
labelled

4



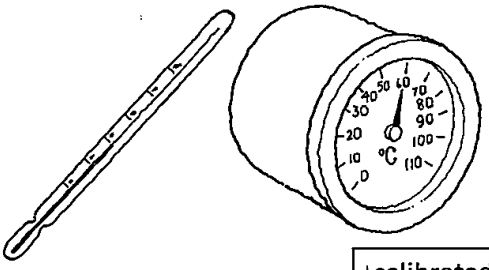
dented

5



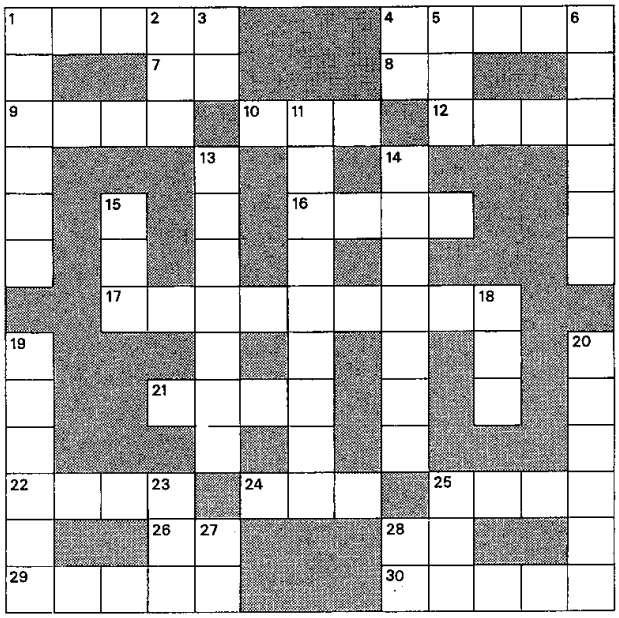
curved

6



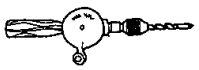
calibrated

Exercise 5 Complete this crossword.



ACROSS

1 Some solders set more . . . ly than others.

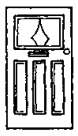
4 

7 Draw a line from A . . . . B.

8 'that is to say' = ...

9 An air-cooled engine always has . . . .

10 What is the opposite of *cold*?

12 

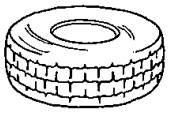
16 . . . . is to say

17 

21 13 = thir . . .

22 . . . . type of fire extinguisher has a different use.

24 . . . . the sides of a square are equal.

25 

26 The chemical symbol for calcium.

28 Is steel an element . . . . an alloy?

29 Wrenches, planes and mallets are . . . .

30 

DOWN

1 An angle of more than 180°.

2 A stiff material does not change . . . . shape easily.

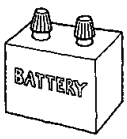
3 What electrolyte . . . . car batteries contain?

4 CO_2 = carbon . . .-oxide

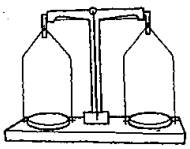
5 Type A fire extinguishers are usually . . . .

6 A lorry is . . . . than a car.

11 With eight sides.

13 

This battery is fully . . . .

14 

15 

ON/ . . . .

18 . . . . cells are a type of primary cell.

19 Lime and silica and alumina = ...

20 Under . . . . glass breaks easily.

23 The chemical formula for hydrochloric acid.

25 SO_3 = Sulphur . . .-oxide

27 Copper is not . . . . heavy . . . . gold.

28 The density . . . . water is 1 g/cm^3.

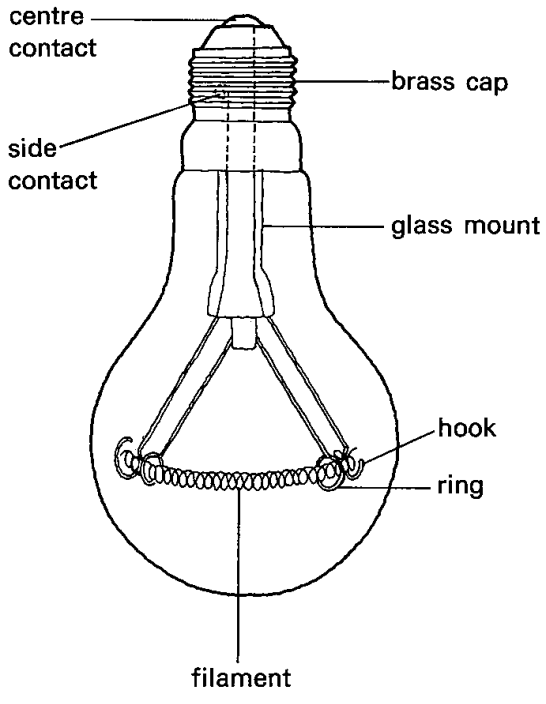
LANGUAGE NOTE 1
a tooth → teeth
a foot → feet

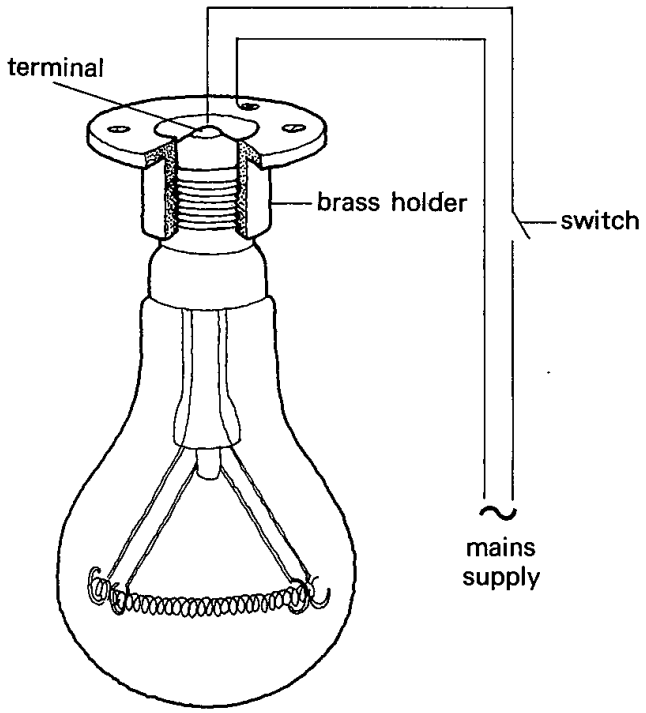
a shaft
a slot
a tooth
a groove
a scratch
a dent
a joint
a thread
a pair

calibrated
compressed
cracked
labelled
locked
painted
corroded
covered
used
insulated
finished
fitted

poorly
badly
(in)correctly
half

SECTION B: A LIGHT BULB AND SOCKET



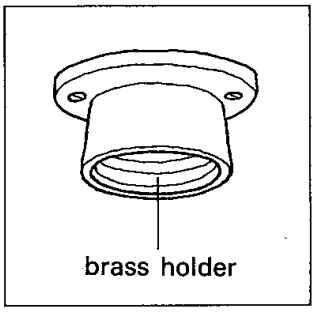


The filament is made of tungsten wire. The wire is coiled. The coil passes through two wire rings. Two conductors are hooked over the ends of the filament.

These conductors are insulated inside a glass mount. The filament, the conductors and the mount are covered with a glass bulb. All the air is removed and the bulb is filled with argon gas. It is sealed with a brass cap. The cap is fitted over the glass. One conductor is soldered to a contact at the bottom of the cap. The other conductor is soldered to the side of the cap. The cap is threaded.

The light bulb is screwed into a socket. The socket is lined with a brass holder. The centre contact is pressed against a terminal. The other contact is the brass cap. It is screwed into the brass holder. The socket is fixed onto the ceiling with two screws. The light is connected to the mains supply through a switch.

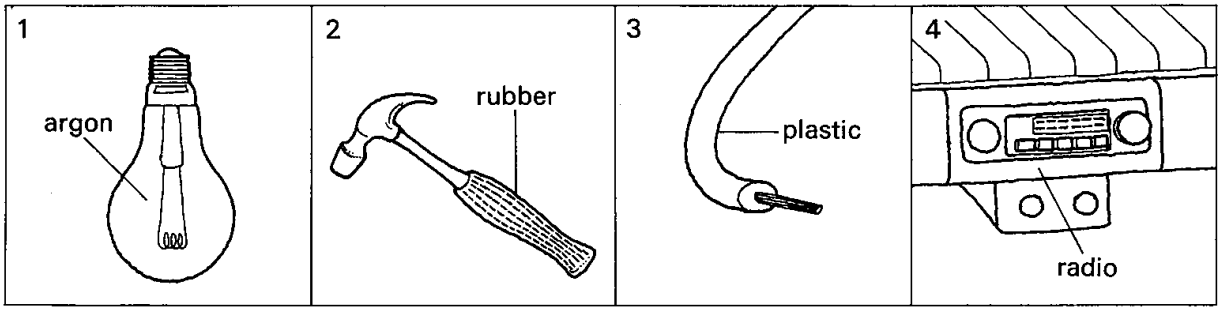
Exercise 6 Look at the example.

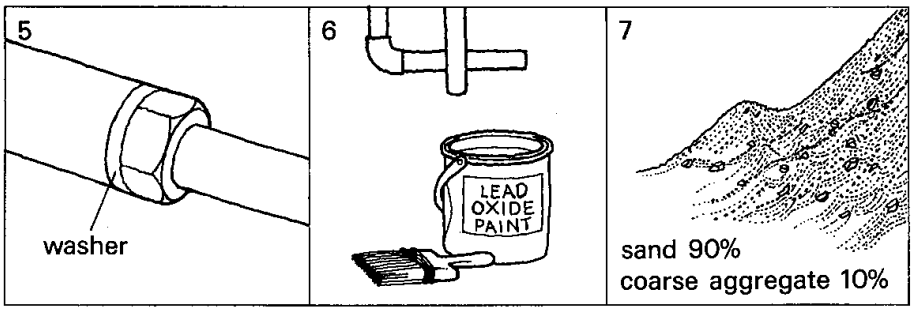


The socket is lined *with* a brass holder.

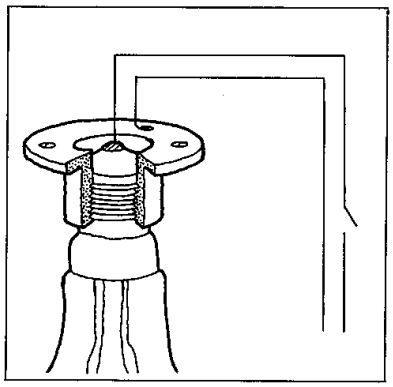
Make similar sentences from the pictures below. Use the words in the list.

covered	insulated	painted
filled	mixed	
fitted	sealed	

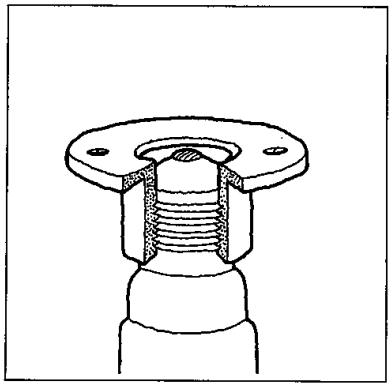




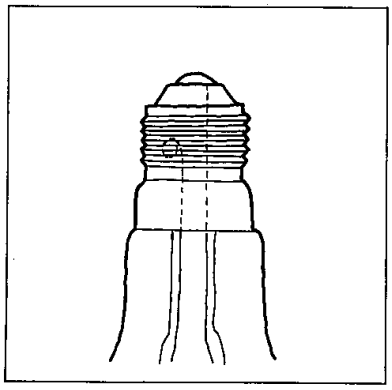
Exercise 7 Read the examples carefully.



The light is connected *to* the mains supply.



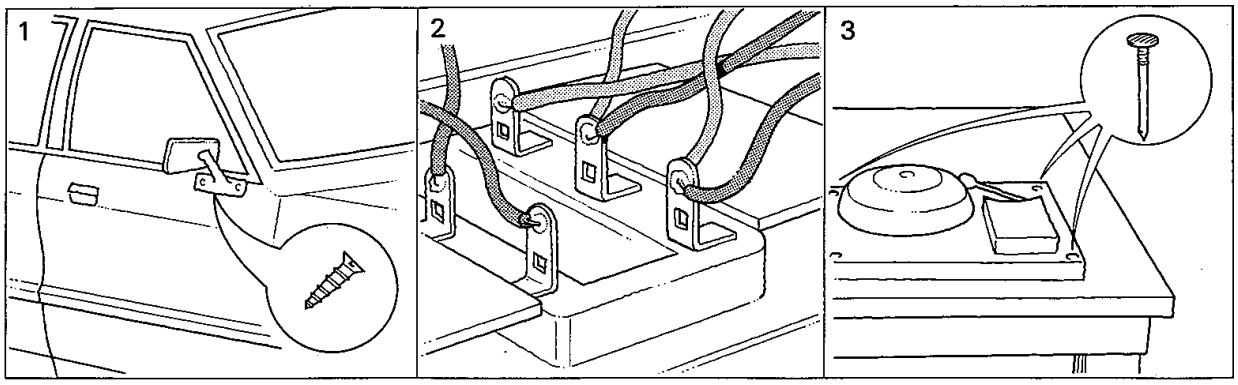
The light bulb is screwed *into* the socket.

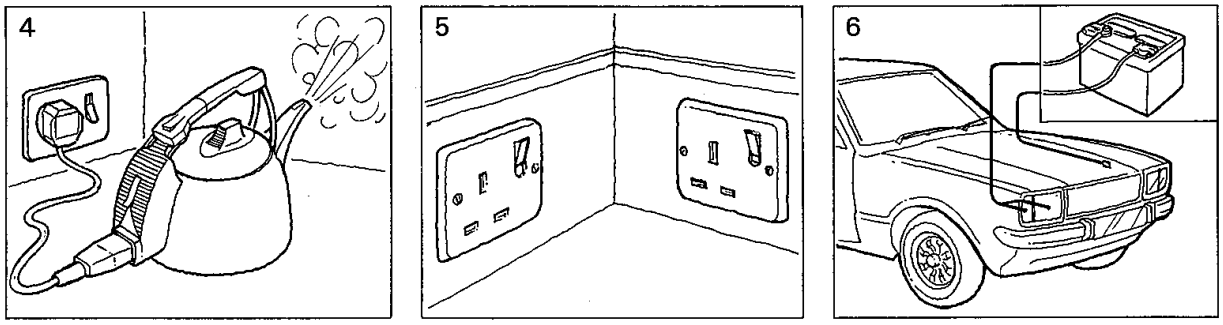


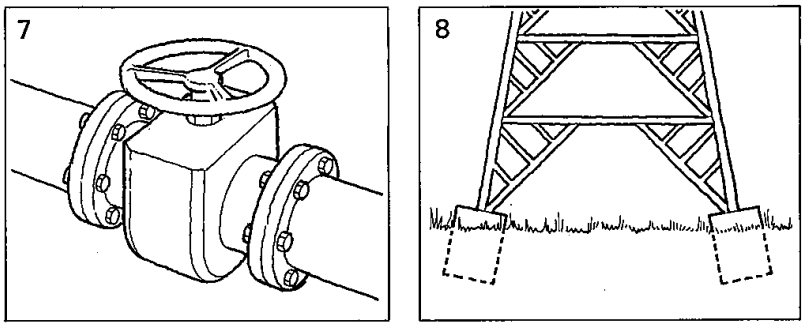
The conductor is soldered *onto* the cap.

Make eight similar sentences from the pictures and from this table.

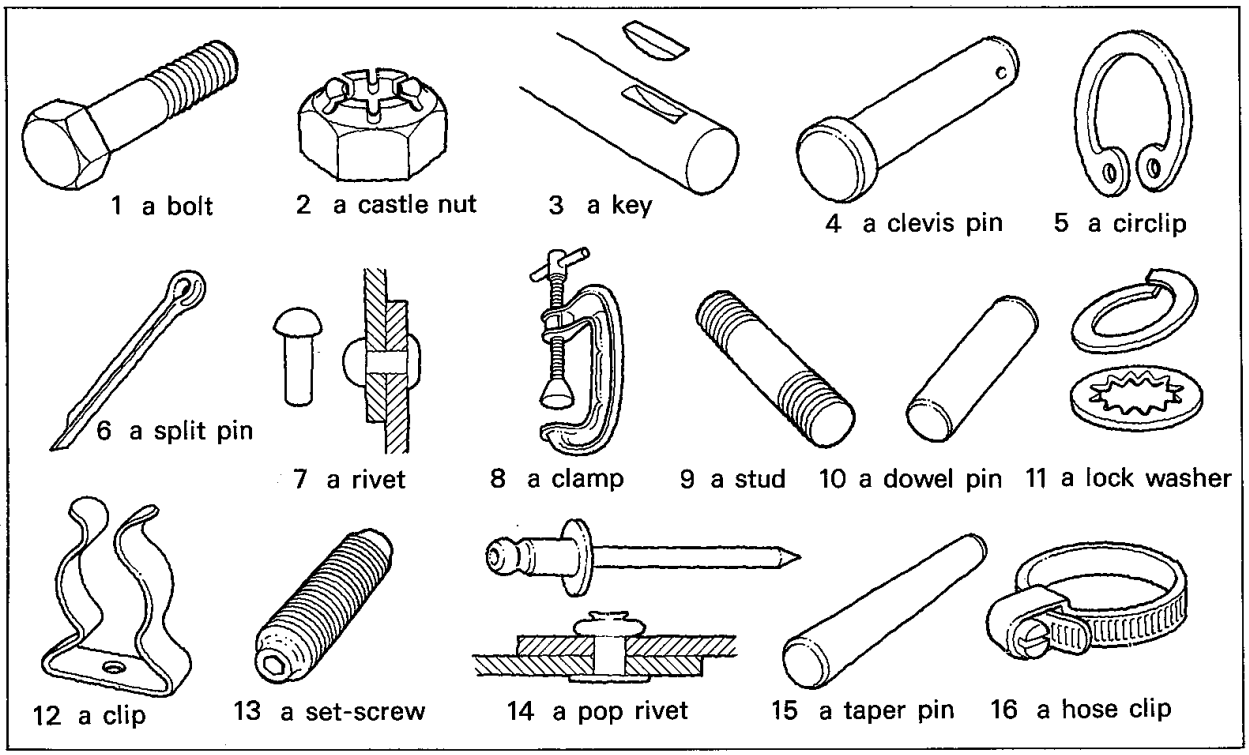
The	bell headlights kettle mirror pylon sockets valve wires	is are	bolted concreted fitted nailed plugged screwed soldered wired	to the into onto	battery. car. ground. pipe. socket. terminals. wall. workbench.

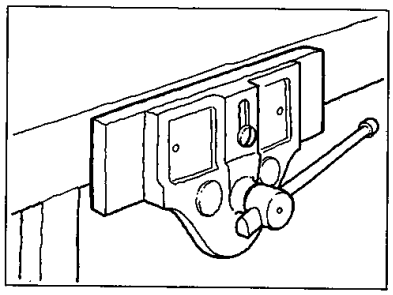






Exercise 8 Look at the illustrations below. What are these objects?



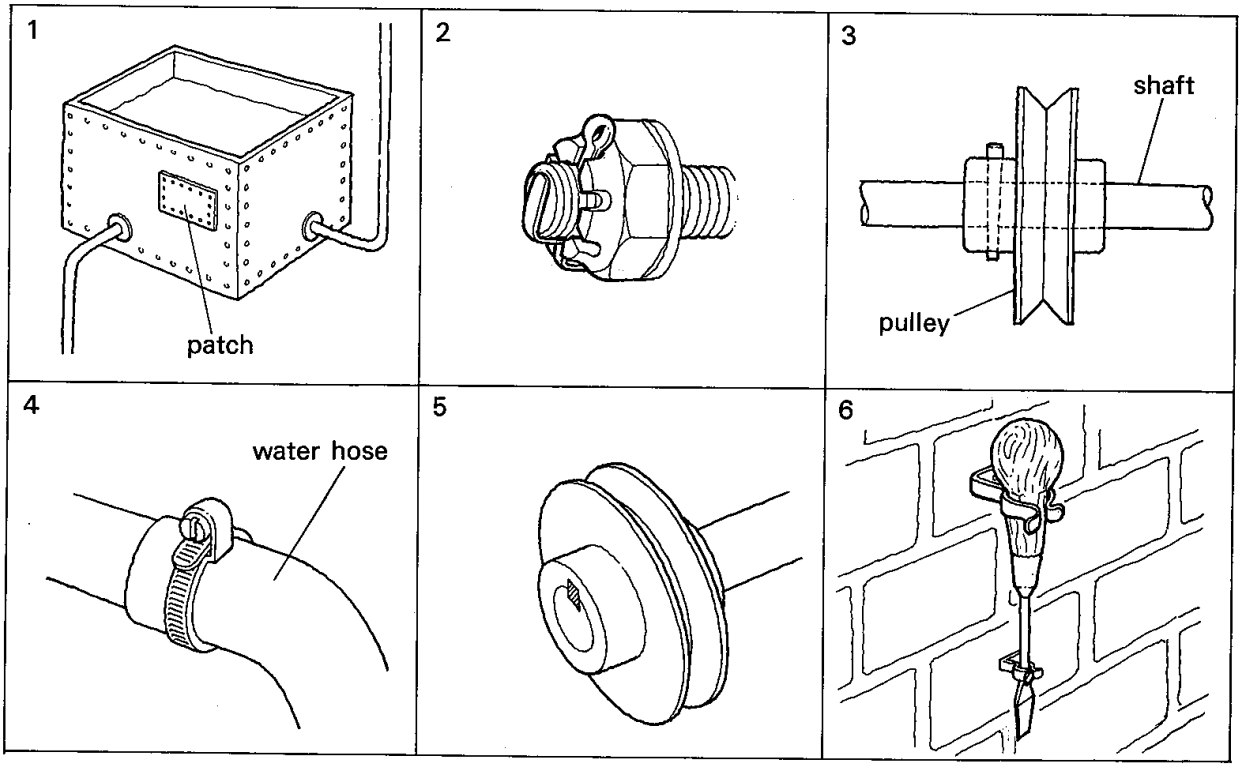


Look at the example.

The vice is bolted *onto* the workbench.

The vice is *fixed* (or *fitted*) onto the workbench *with* bolts.

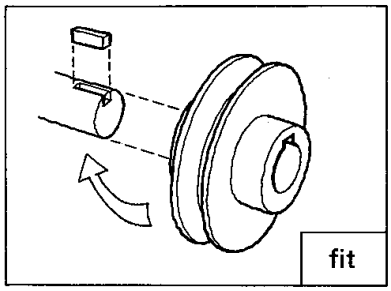
Now make two sentences in the same way from each picture.



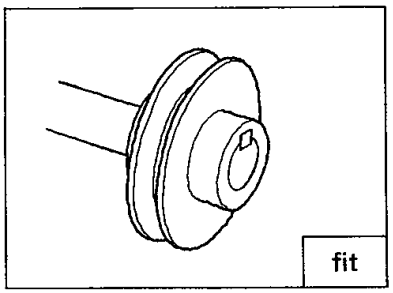
Exercise 9 Look at the diagram of the light bulb on page 8. How many true sentences can you make from this table?

The	filament conductors socket bulb cap light	is are	fixed filled screwed hooked fitted connected sealed insulated made	into inside over to of with	a glass mount. a brass cap. a tungsten wire. argon gas. the glass bulb. the filament. a socket. the ceiling. the mains supply.

Exercise 10 Look at these examples.

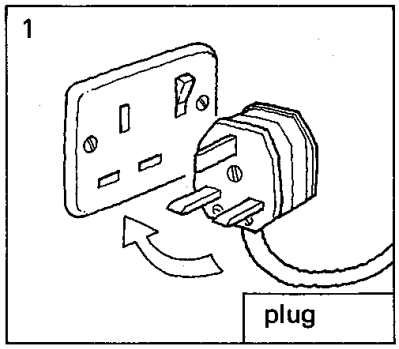


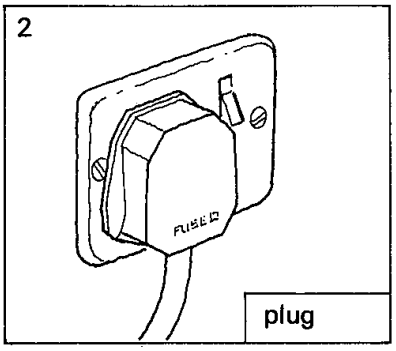
a) The pulley fits *onto* the shaft.

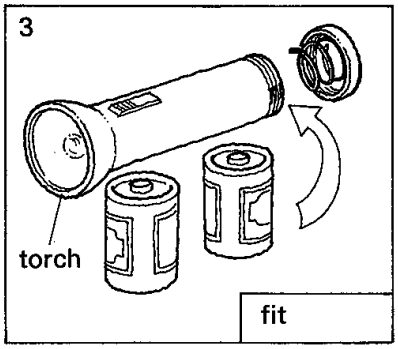


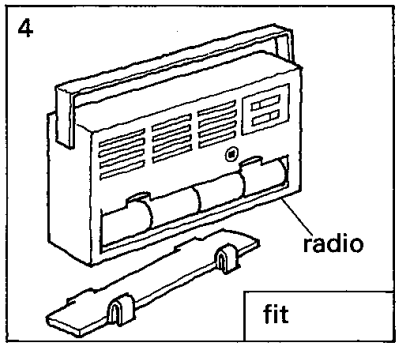
b) The pulley *is fitted* onto the shaft.

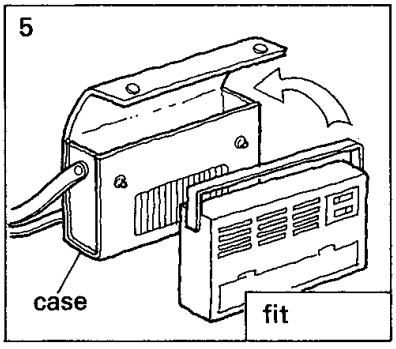
Make similar sentences, either like a) or like b), from these pictures.

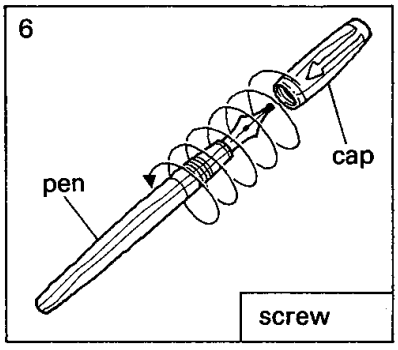


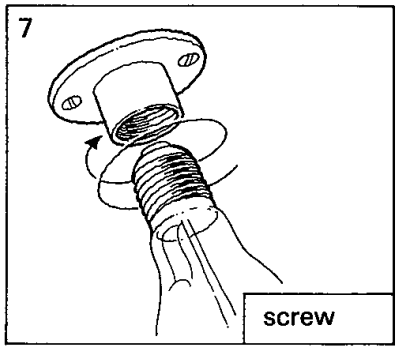


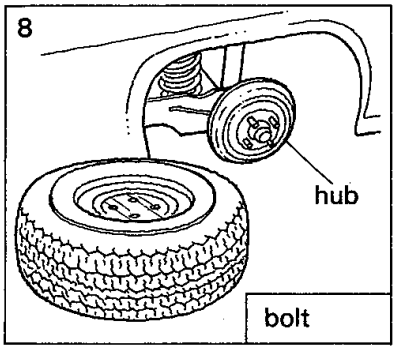


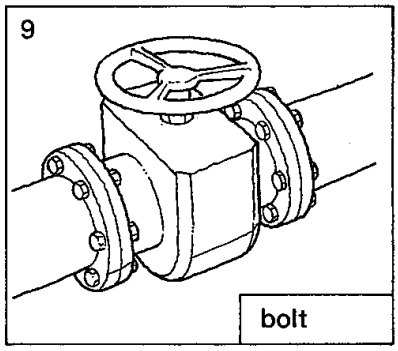


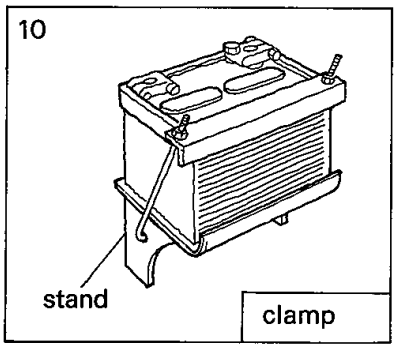


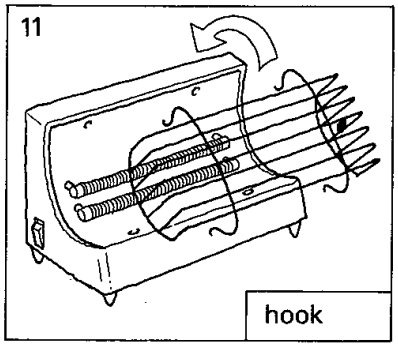


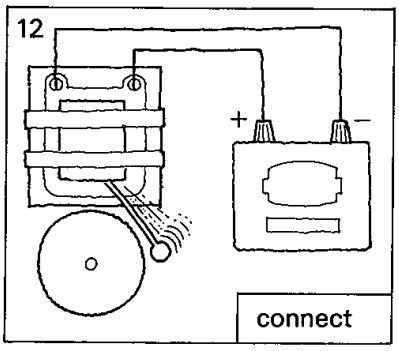












LANGUAGE NOTE 2

fit	→	fitted
slot	→	slotted
plug	→	plugged
cap	→	capped
pin	→	pinned
clip	→	clipped
label	→	labelled

BUT

rivet	→	riveted

a filament
a loop
a conductor
an insulator
a mount
a contact
a holder
a terminal
a stand
the ceiling

argon
tungsten
brass

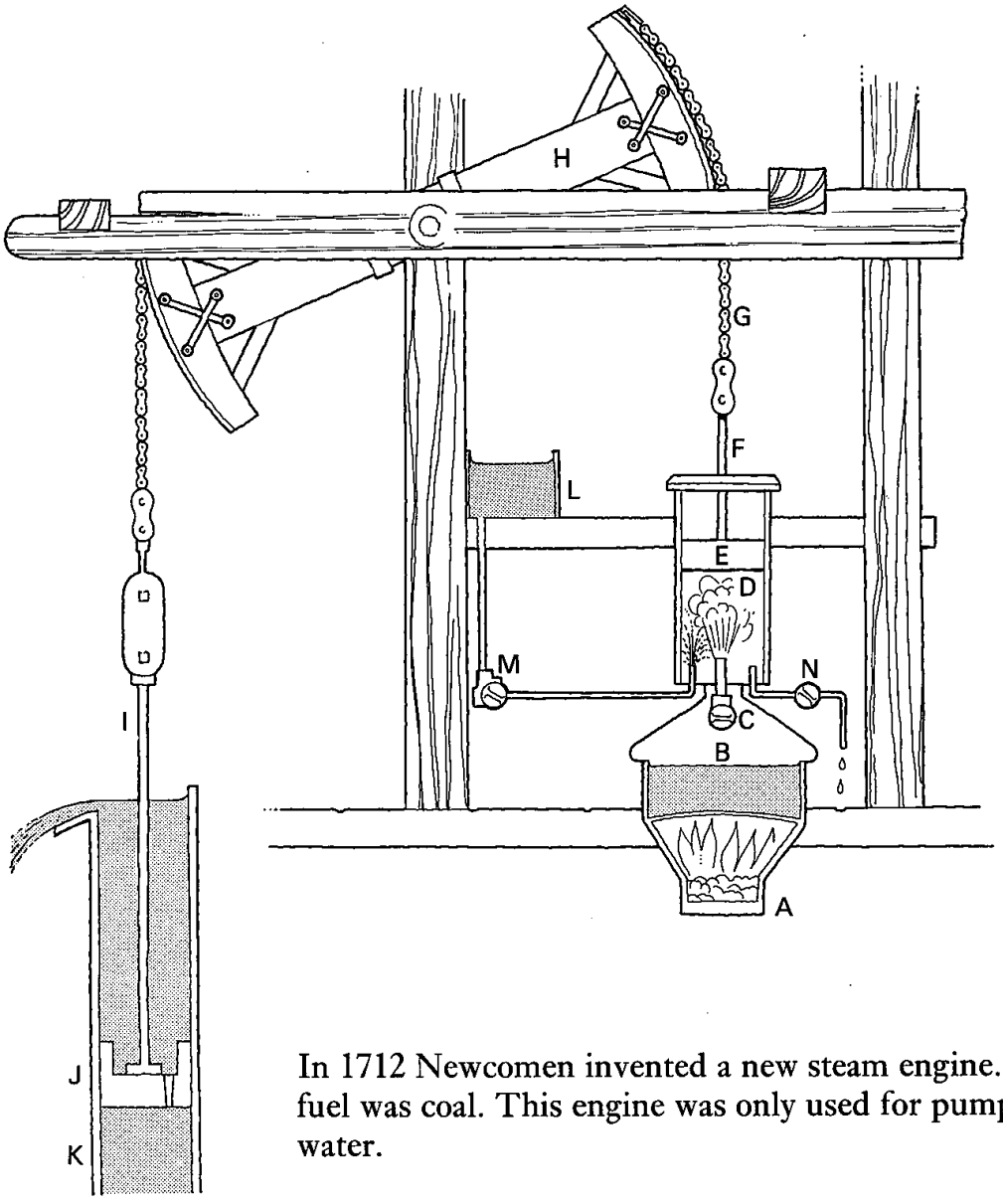
a holder
a washer
a patch
a pulley
a torch
a radio
a pen

coil
hook
connect
screw
line
fix
mix

inside
onto

UNIT TWO Steam Engines

SECTION A: NEWCOMEN'S ENGINE



In 1712 Newcomen invented a new steam engine. The fuel was coal. This engine was only used for pumping water.

The Up Stroke

A furnace (A) heated water in a copper boiler (B). The water evaporated into steam. The steam entered a cylinder (D) through a valve (C). Inside the cylinder the steam pressure forced the piston (E) to the top of the cylinder. A chain (G) connected the piston rod (F) to one end of a heavy beam (H). The beam turned on its centre point. A pump rod (I) lowered a bucket (J) into a well (K).

The Down Stroke

Water entered the cylinder from a tank (L) through a valve (M). The steam in the cylinder condensed. Therefore the pressure below the piston decreased considerably. The pressure above the piston (i.e. normal air pressure) was then much greater than the pressure below the piston. The air pressure forced the piston to the bottom of the cylinder. The water inside the cylinder escaped through a valve (N). The movement of the piston turned the beam and raised the other end. The pump rod raised the bucket from the well.

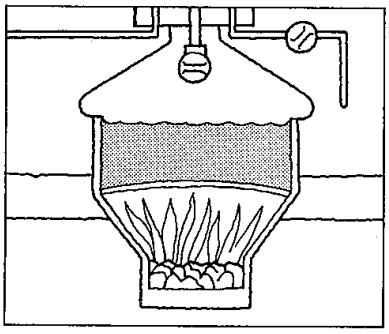
Rods (not shown in the diagram) connected the beam (H) to the valves (M, C and N) and opened and closed them at the right times.

Newcomen's engine worked at very low speed. It completed less than 15 strokes per minute.

Exercise 1 Are these statements true or false?

1. Newcomen's engine was used for raising water from a well.
2. In Newcomen's engine, the water boiled in a cylinder.
3. Steam entered the cylinder through a valve.
4. Steam pressure forced the piston to the top of the cylinder.
5. Water was used for decreasing the steam pressure inside the cylinder.
6. Steam pressure forced the piston to the bottom of the cylinder.
7. Two chains connected the piston rod and the pump rod to the beam.
8. Newcomen's engine was a high speed engine.

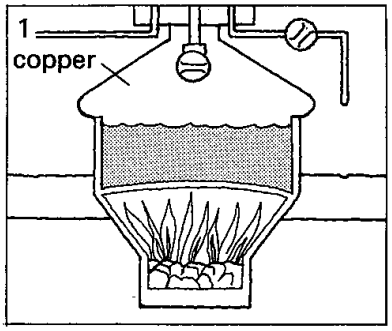
Exercise 2 Look at the example below.



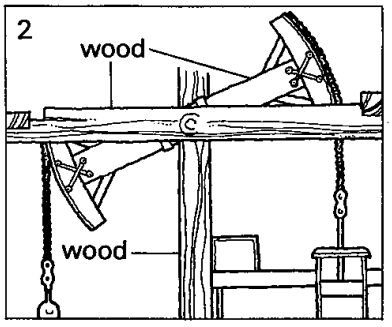
Nowadays a steam engine has a high pressure boiler.

Newcomen's engine had a low pressure boiler.

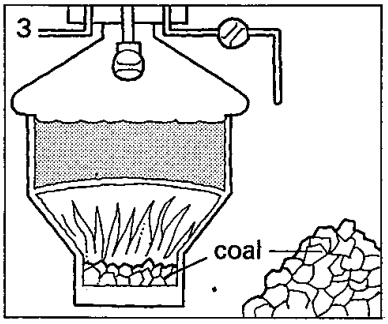
Now make a sentence about Newcomen's engine from each picture.



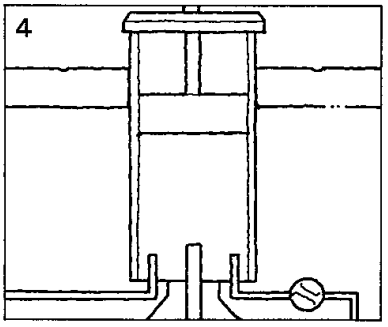
Nowadays an engine has a steel boiler.
Newcomen's . . . . . .



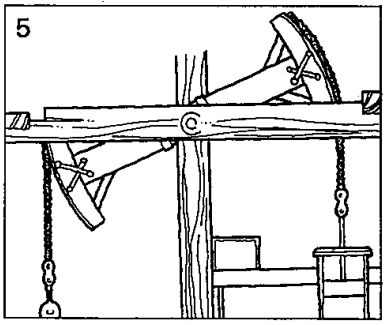
Nowadays an engine does not have wooden parts.
. . . . . .



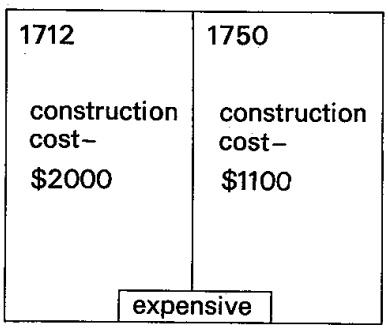
Nowadays steam engines generally have an oil furnace.
. . . . . .



Nowadays steam engines usually have more than one cylinder.
. . . . . .



Nowadays engines do not have a beam.
. . . . . .



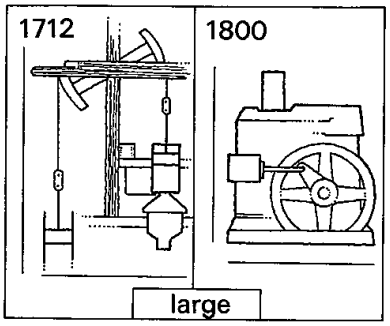
Look at the next example.

Newcomen's engine *was* expensive.

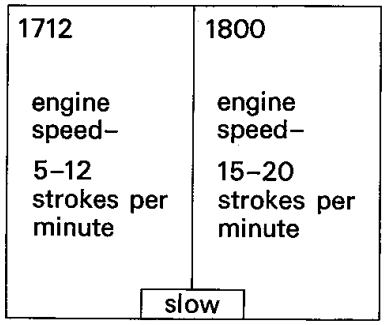
Later engines *were* not as expensive.

Now make sentences from these pictures in the same way.

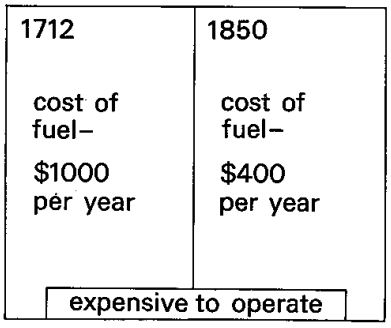
6



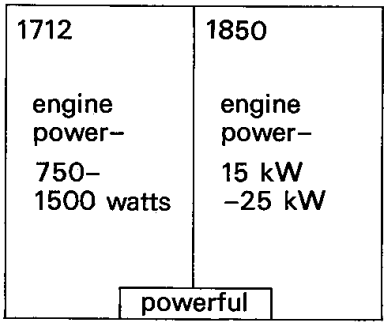
7



8



Now look at the final example.

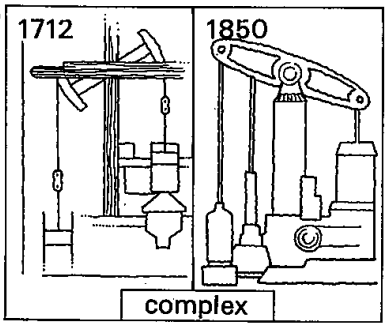


Newcomen's engine was *not very* powerful.

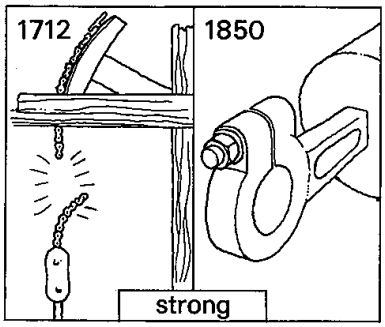
Later engines were *more* powerful.

Make sentences from these pictures in the same way.

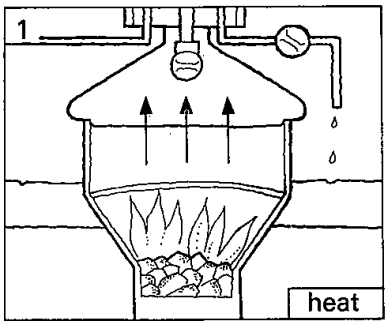
9



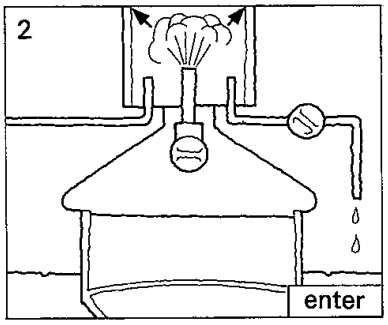
10



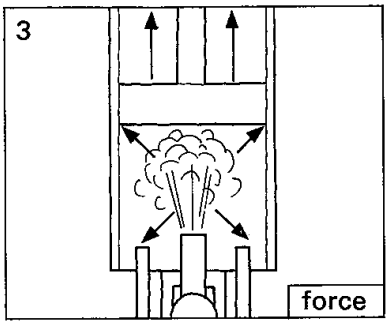
Exercise 3 Describe how Newcomen's engine worked from the pictures below. The first sentence has been done for you.



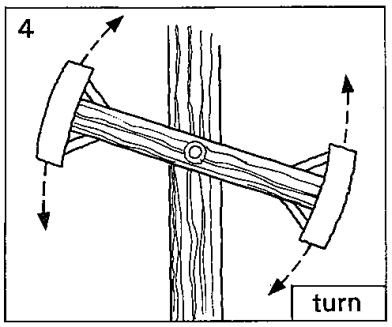
A furnace *heated the* water in the boiler.



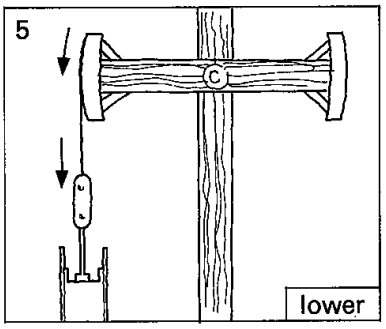
Steam . . . . . through a valve.



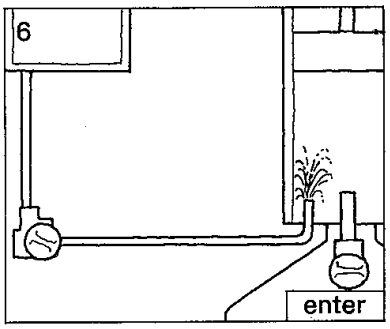
Steam pressure . . . . . up the cylinder.



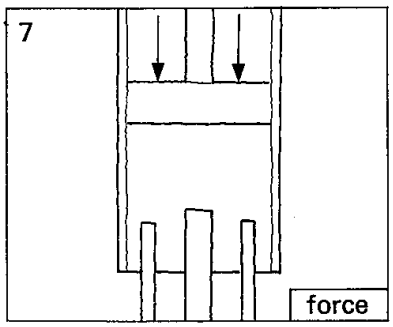
The beam . . . . . on its centre point.



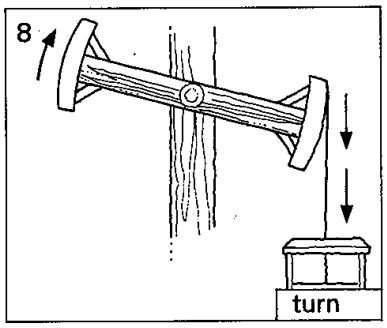
The movement of the beam . . . . . into a well.



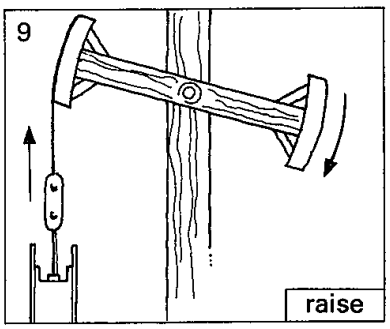
Water . . . . . through a valve.



The pressure . . . . . down the cylinder.

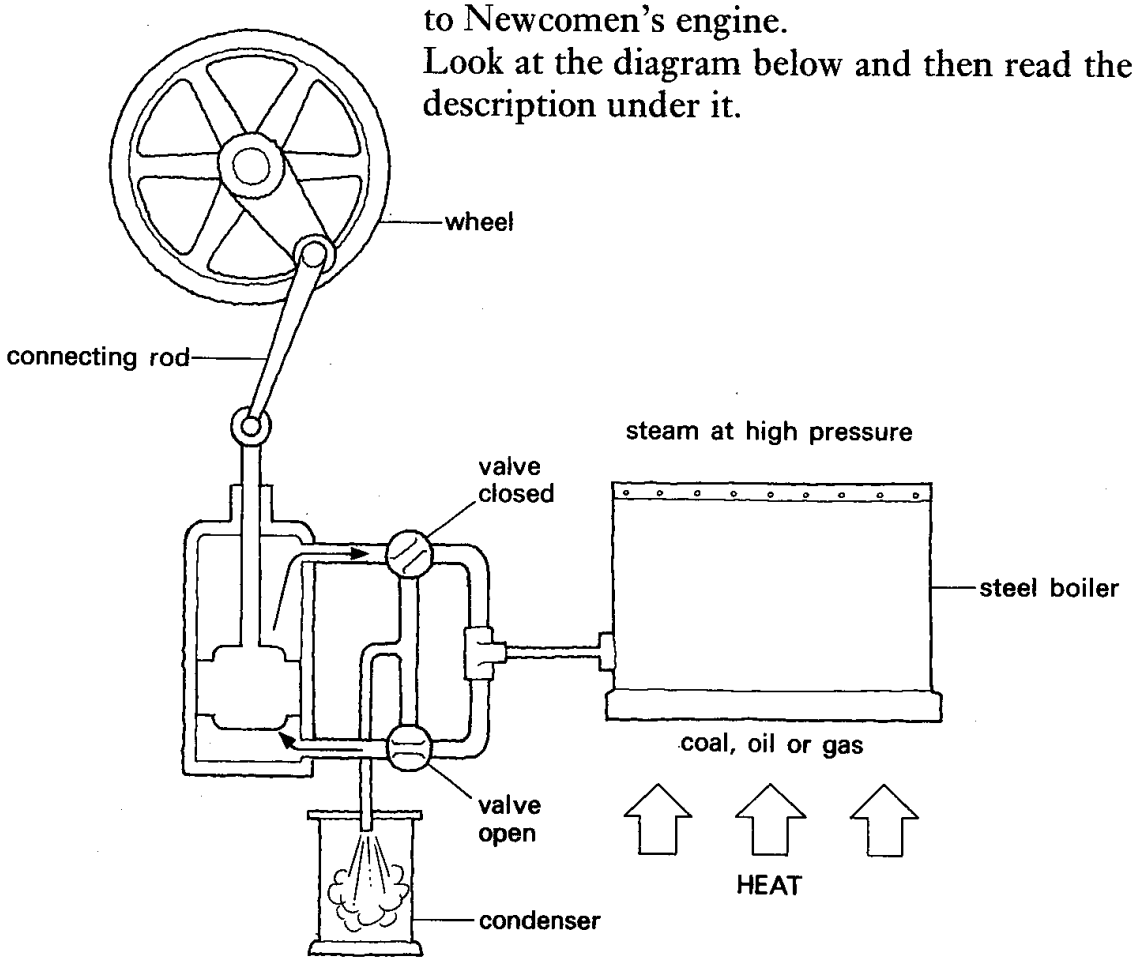


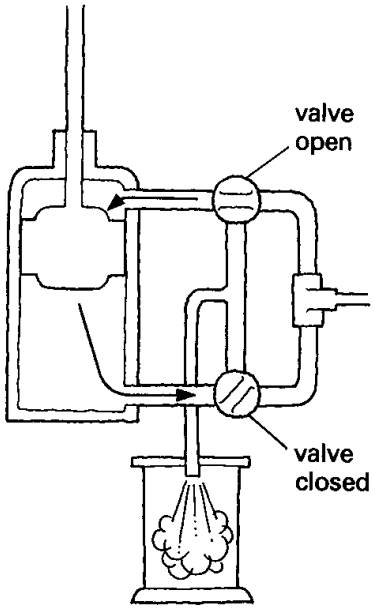
The movement of the piston . . . . . on its centre point.



The movement of the beam . . . . . from the well.

Exercise 4 Later steam engines worked in a very similar way to Newcomen's engine.
Look at the diagram below and then read the description under it.





1. The boiler is made of *steel.*
2. It has a *high* pressure boiler.
3. The fuel is coal, *oil or gas.*
4. A furnace heats the boiler.
5. The boiler provides the steam.
6. Steam pressure forces the piston up the cylinder.
7. *Steam pressure* forces the piston down the cylinder.
8. The steam *does not condense* inside the cylinder.
9. A *metal* rod connects the piston to a *wheel.*
10. The engine works at *quite high* speeds.

The words in *italics* show the differences between later steam engines and Newcomen's engine. Describe how Newcomen's engine worked. The first sentence has been done for you. Write nine more sentences.

Newcomen's First Steam Engine (1712)

1. The boiler *was* made of *copper.*

a boiler
a piston
a design
a centre
a movement
a minute
a year

coal
steam

invent
pump
enter
force
condense
decrease
complete

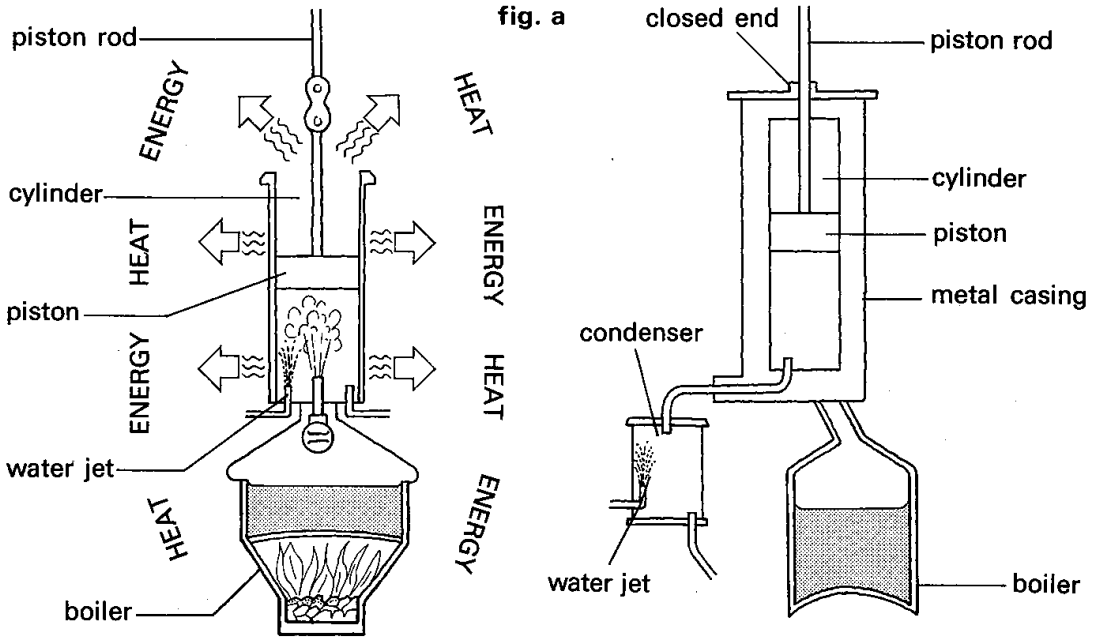
similar
complex
early
late(r)
powerful
slow

up
down

(the) top of . . . .
nowadays

SECTION B: WATT'S ENGINES

fig. a



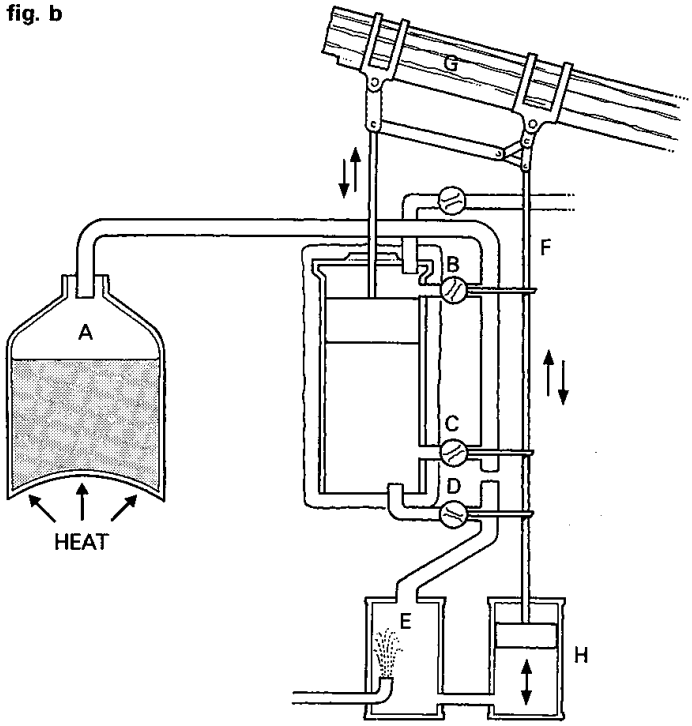
NEWCOMEN (1712)

WATT (1765)

In Newcomen's engine, the steam heated the cylinder and then the condensing water cooled it. Therefore heat energy escaped and the engine was not very efficient. In his engine, Watt fitted a steam jacket around the cylinder and so the cylinder remained hot. He also fitted a separate condenser to avoid spraying water into the cylinder.

In Newcomen's engine, a water jet condensed the steam inside the cylinder and so the temperature inside the cylinder went up and down over a wide range. Therefore a large amount of steam was used for raising the cylinder temperature at each up stroke. Watt fitted a separate condenser to his engines. Thus it was possible to condense the steam outside the cylinder and so the cylinder remained at a steady temperature.

fig. b



Watt designed his first engine in 1765. In 1787 he constructed the engine in **fig. (b)**. The boiler (A) supplied the steam to the cylinder through a long pipe. Two valves controlled the supply of steam to the cylinder. The first valve (B) opened and closed the inlet at the top of the cylinder. The second valve (C) controlled the steam supply to the bottom of the cylinder. Steam pressure now supplied the power for both the up and the down strokes and so the engine was more powerful.

A third valve (D) controlled the steam outlet to the condenser (E). The steam condensed very rapidly in the condenser and so the engine had a higher speed. A separate rod (F) connected the beam (G) to the piston of an air pump (H). This piston travelled up and down the air pump with the movement of the beam. The air pump emptied the water from the condenser on the up stroke. The same rod opened and closed the three valves.

This engine had an efficiency of about 4%. It was about four times as efficient as Newcomen's engine and so it used only 25% as much fuel.

Exercise 5 Answer these questions.

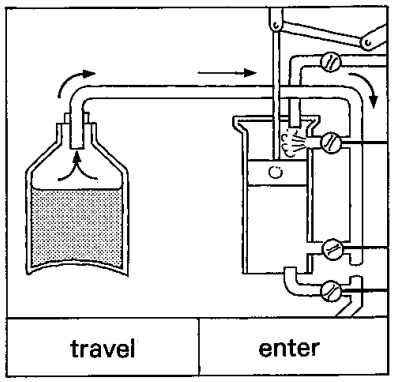
Newcomen's Engine

1. How did heat energy escape from the engine and decrease its efficiency?

Watt's Engines

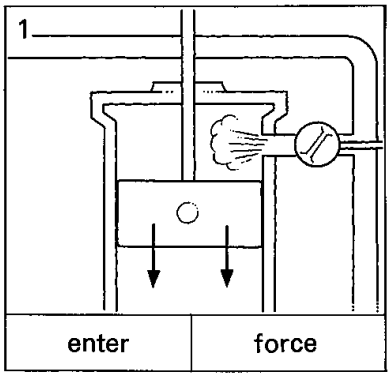
2. How did Watt improve the design of steam engines? (*Two answers.*)
3. How did Watt control the steam supply to the cylinder?
4. How did he make his engines more powerful?
5. How did the beam control the air pump?
6. How did the beam open and close the three valves?

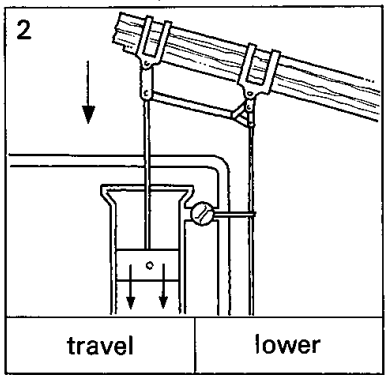
Exercise 6 Look at this example.

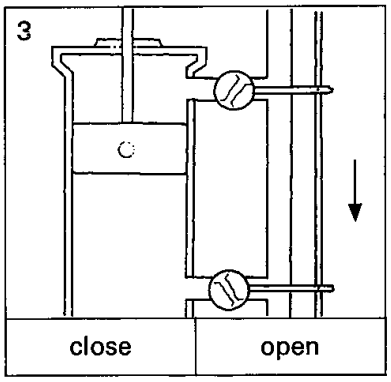


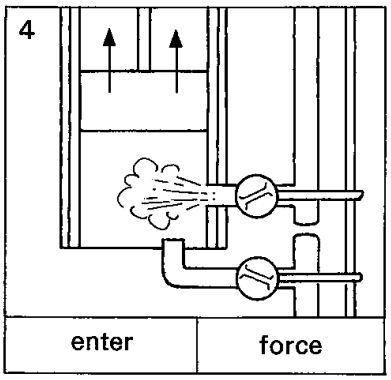
The steam *travelled* through a pipe and *entered* the cylinder.

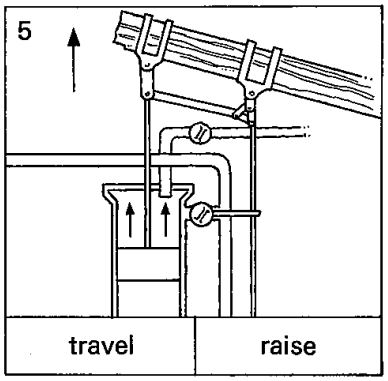
Now make a sentence about each picture in the same way.

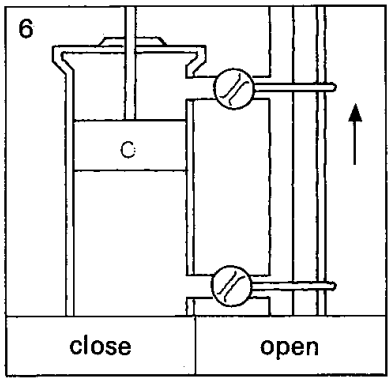


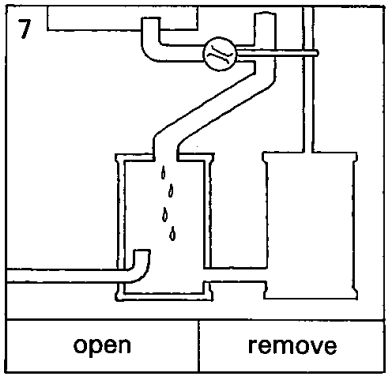


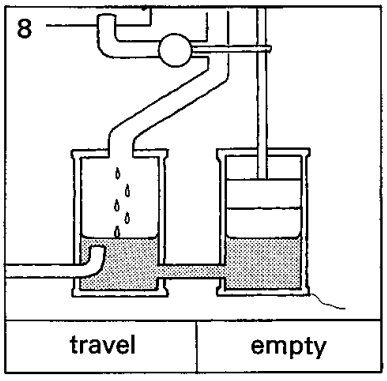












Exercise 7 Read the examples below.

Watt's engine was more efficient *because the furnace required less fuel.*

The furnace required less fuel and so Watt's engine was more efficient.

Reconstruct these sentences. Use *and so.*

1. Newcomen's engine had poor efficiency because the cylinder temperature varied.
2. The cylinder temperature varied because the steam condensed inside the cylinder.

Reconstruct these sentences. Use *because.*

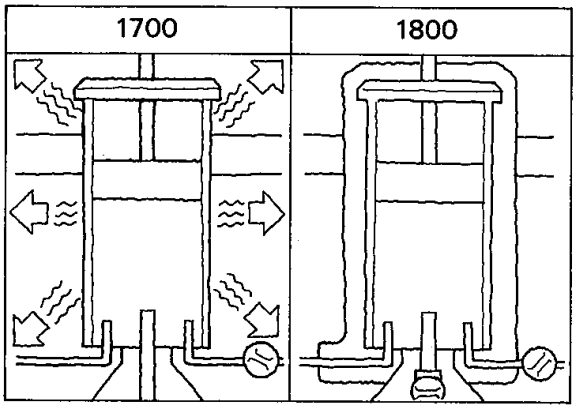
3. Steam escaped through the top of the cylinder and so the steam pressure was not high.
4. The cylinder temperature varied considerably and so a large amount of steam was used for raising the cylinder temperature.

Now construct one sentence from each pair of sentences. Use *because* or *and so.*

5. Watt's engines were more powerful.
   Steam pressure supplied the power for both the up and the down strokes.
6. The steam condensed rapidly in the condenser.
   Watt's engines had a higher speed.
7. The steam condensed outside the cylinder.
   The cylinder temperature remained stable.
8. The cylinder remained hot.
   There was a steam jacket around the cylinder.
9. Watt's engine was four times as efficient as Newcomen's engine.
   The furnace used only 25% as much fuel.

Exercise 8 How did steam engines change between 1700 and 1800? How did they improve?

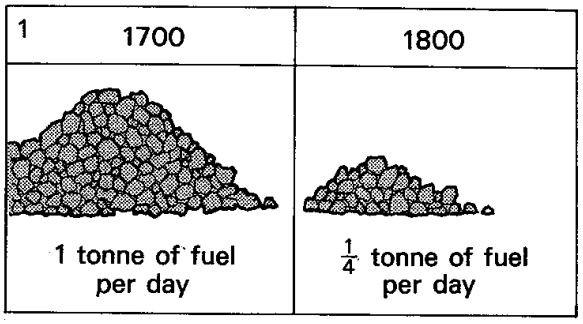
Look at the example.



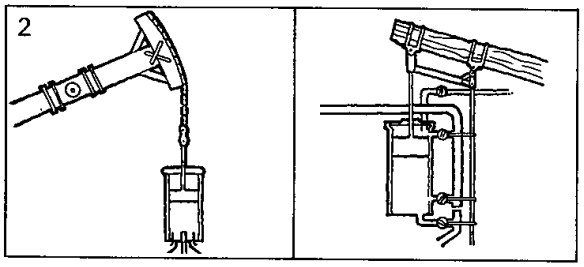
..... loss (small)

The heat loss was smaller.

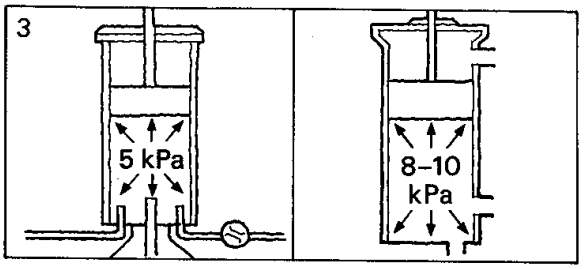
The loss of heat was smaller.



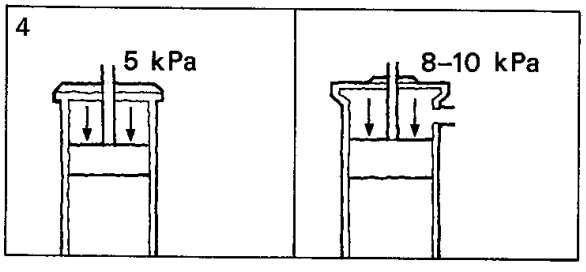
. . . . . consumption (small)



. . . . . design (complex)

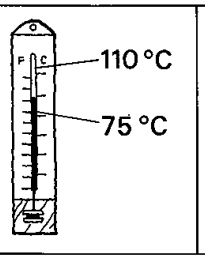


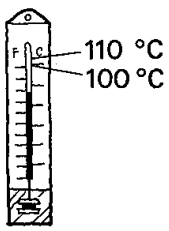
. . . . . pressure (high)



. . . . . stroke (powerful)

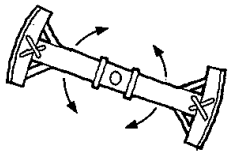
5



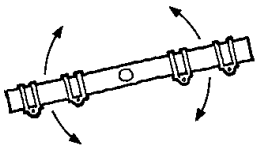


. . . . . temperature (stable)

6



5–12 strokes per minute



15–20 strokes per minute

. . . . . movement (rapid)

7

750 W – 3 kW

6 kW – 8 kW

. . . . . power (great)

8

1%

4%

. . . . . efficiency (great)

a supply
a day
a date
an invention

a pump
a condenser
an inlet
an outlet
a loss

energy
efficiency
consumption

improve
vary

design
construct
supply
control
empty

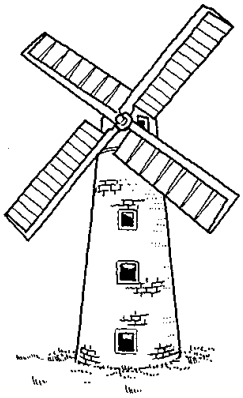
he/his

efficient
separate
rapid
steady
outside

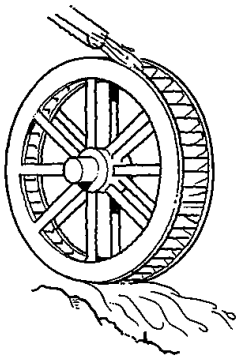
and so . . . . . .

SECTION C: PARSONS' TURBINE

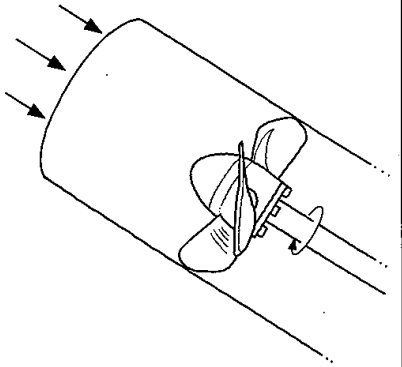
SIMPLE TURBINES



a windmill



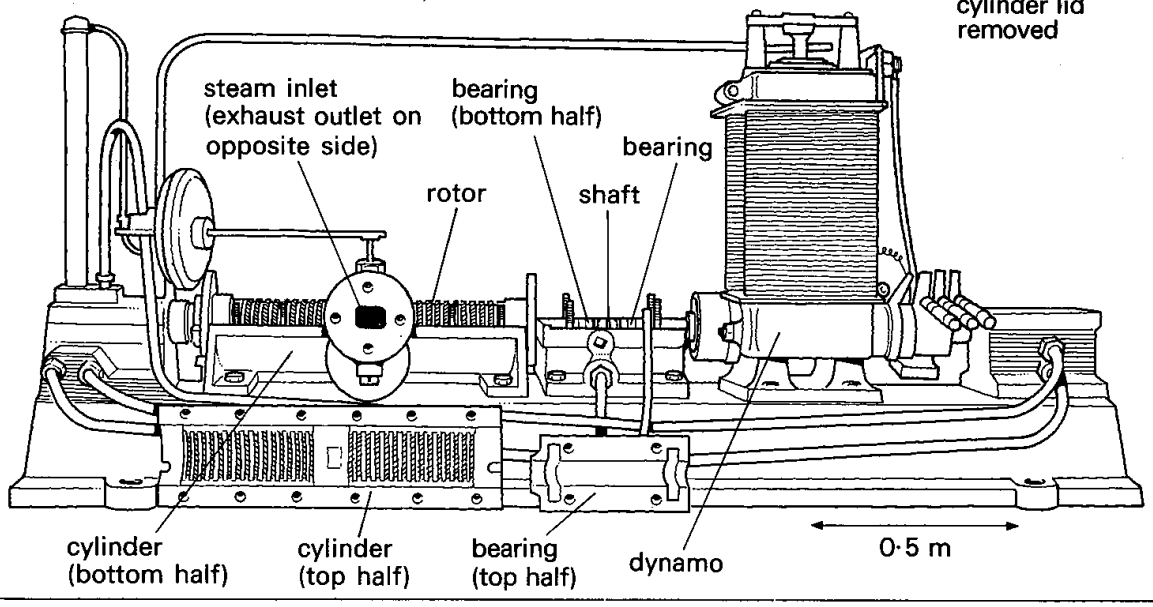
a water wheel



a simple water turbine

PARSONS' STEAM TURBINE AND DYNAMO 1884
Science Museum, London

Note The rotor is shown exposed with the cylinder lid removed



In Parsons' turbine, the boiler supplied the steam at a pressure of 550 kPa. The steam entered the engine casing at high speed. It then expanded rapidly in opposite directions along two cylinders. Parsons put seven rotors in each cylinder. These rotors consisted of thick metal rings around a central shaft. He cut slots at an angle of 45° in the rings. The slots sloped in opposite directions in the two cylinders.

The steam forced its way along the cylinders from the central steam inlet and travelled through the slots.

It pushed against the slot walls and turned all the rotors in the same direction.

Steam pressure became mechanical power in this simple way. The steam gave most of its energy to the rotors but it still came through the exhaust outlet under pressure. The fourteen rotors drove the central shaft at about 18 000 rpm. The shaft went from the turbine through two bearings directly into the dynamo. This high speed generator had no gearbox. Parsons did not use a gearbox for decreasing the engine speed and so the dynamo ran at the same speed as the turbine (18 000 rpm).

The generator produced a maximum voltage of 100 V. The power of the engine was 7.5 kW. However, it had a poor steam/energy ratio. It used 60 kg of steam per kilowatt hour. This was because the engine speed was too high and because the exhaust steam escaped directly into the atmosphere under pressure. Later turbines had steam condensers. In this way it was possible to convert all the steam energy into engine power. They also had larger rotors and larger dynamos. The shaft often connected the turbine to the dynamo through a gearbox. These improvements decreased the dynamo speed considerably.

With modern dynamos it is possible to have an efficiency of more than 90%. Nowadays, large electrical generators need only 2–5 kg of steam per kilowatt hour.

Exercise 9 Answer these questions from the text.

1. How many rotors did Parsons put in his turbine?
2. What did these rotors consist of?
3. Did all of the rotor slots slope at the same angle?
4. Did all of the rotors slope in the same direction?
5. What was the engine speed of Parsons' generator?
6. How did the steam turn the rotors?
7. Did the steam give all of its energy to the rotors?
8. How did the turbine drive the dynamo?
9. What voltage did Parsons' generator produce?
10. Why did the generator have a poor steam/energy ratio? (*Two answers*)
11. How did later designers improve the efficiency of steam generators? (*Two answers*)
12. What is the maximum efficiency of modern generators?

Exercise 10 Read the first three paragraphs of the text again.

'In Parsons' turbine . . . . . (18 000 rpm).'
The paragraphs contain ten *regular verbs* and nine *irregular verbs*. Irregular verbs do not generally have '*-ed*' endings in the past tense.

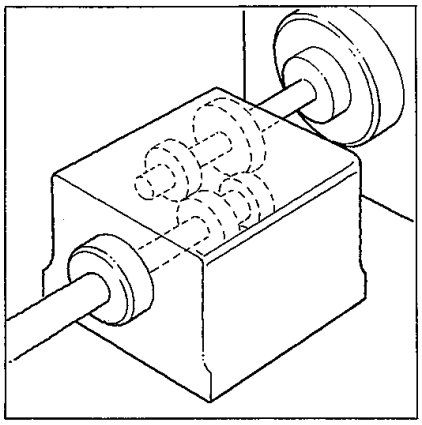
Make a list of the nineteen verbs in the two columns below.

One of each type has been done for you.

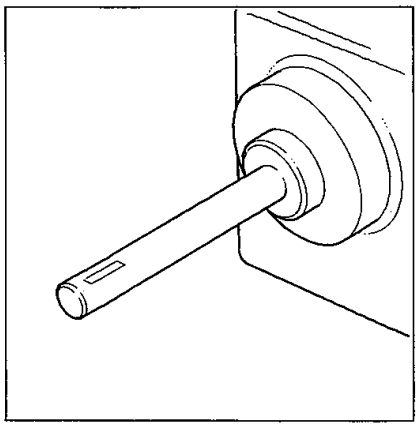
REGULAR VERBS (10)	IRREGULAR VERBS (9)
supply (supplied)	have (had)
. . . .	. . . .
. . . .	. . . .
. . . .	. . . .

Now use the nine irregular verbs to complete these sentences.

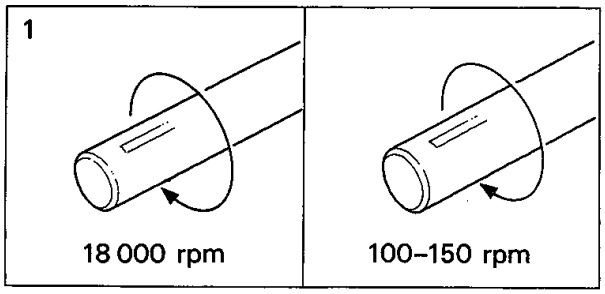
Example:



Later turbines often *had* a gearbox on the shaft.

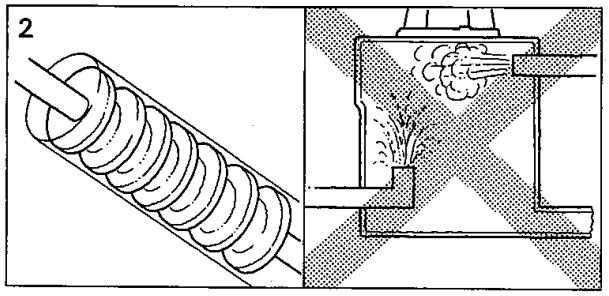


Parsons' turbine *did not have* a gearbox.



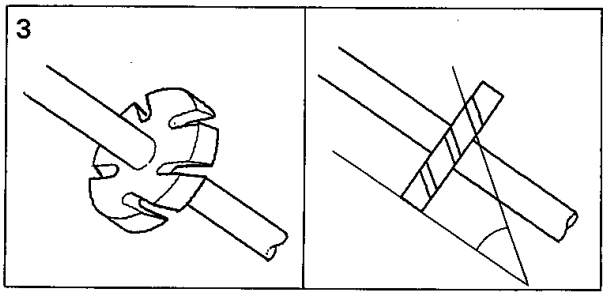
Parsons' turbine . . . . at very high speed.

Piston steam engines . . . . . at high speeds.



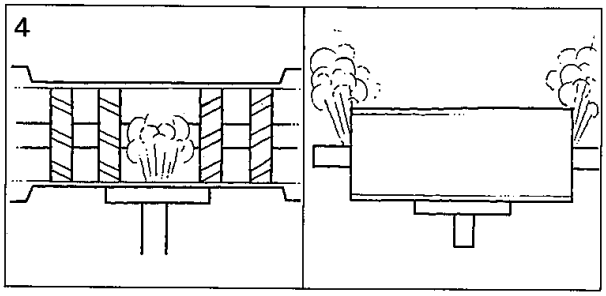
Parsons . . . . seven rotors in each cylinder.

He . . . . . a condenser in his turbine.



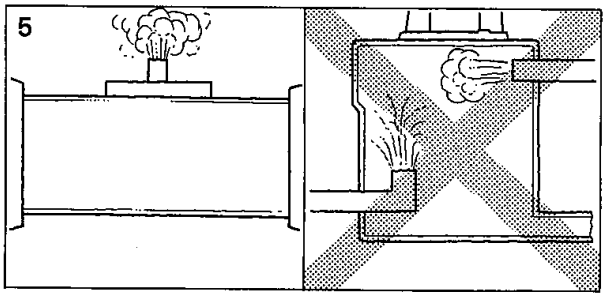
He . . . . slots in the outside of the rotors.

He . . . . . the slots parallel to the shaft.



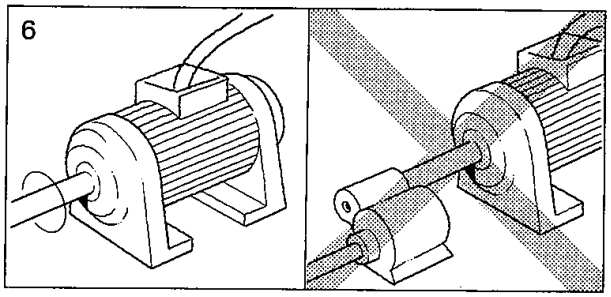
The steam . . . . its energy to the rotors.

However, it . . . . . all its energy to the rotors.



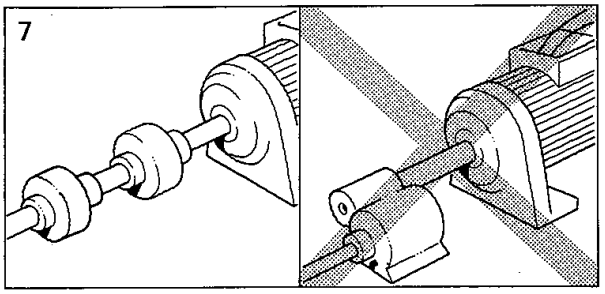
The steam . . . . through the exhaust outlet under pressure.

It . . . . . into a condenser.



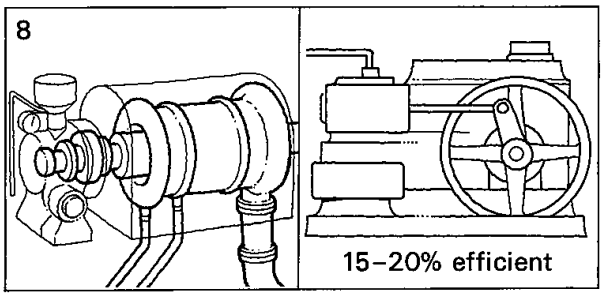
The shaft . . . . the dynamo at 18 000 rpm.

It . . . . . the dynamo through a gearbox.



The shaft . . . . from the turbine to the dynamo through two bearings.

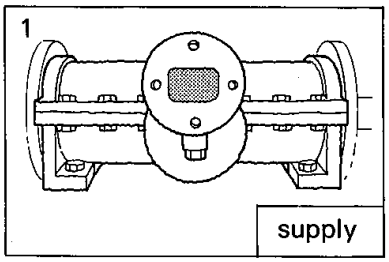
It . . . . . through a gearbox.



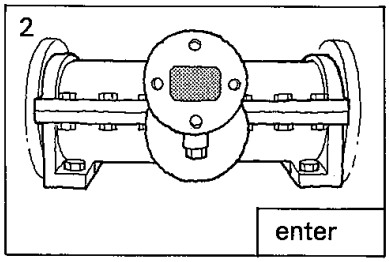
Later turbines . . . . much more efficient.

Piston steam engines . . . . . more than 15–20% efficient.

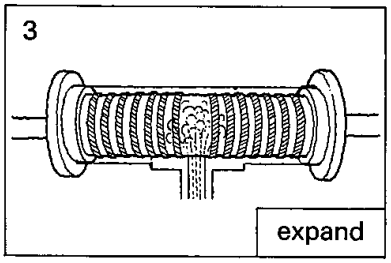
Exercise 11 Complete these sentences and describe how Parsons' turbine worked.



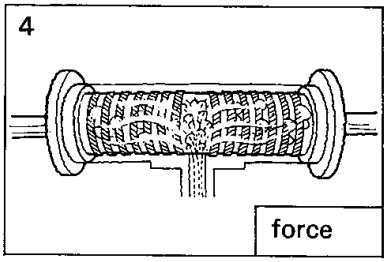
The boiler . . . . steam . . . . . 550 kPa.



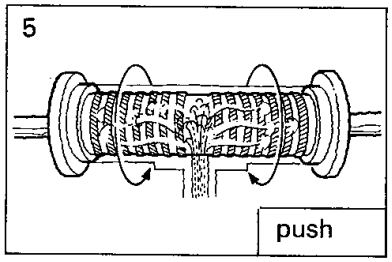
The steam . . . . the engine casing . . . . . speed.



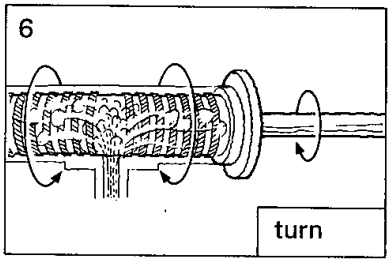
The steam . . . . rapidly . . . . . directions . . . . the two cylinders.



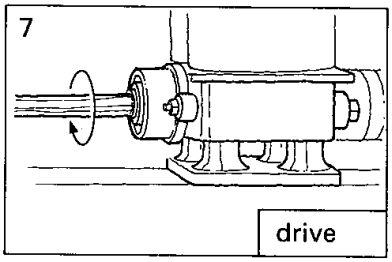
The steam . . . . its way . . . . . slots.



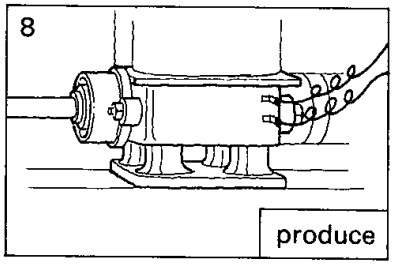
The steam . . . . all the rotors . . . . . direction.



The rotors . . . . the shaft . . . . . rpm.



The shaft . . . . the dynamo . . . . . speed.



The dynamo . . . . a voltage . . . . . 100 V.

Exercise 12 Look at the table below. Then look at the questions and the answers beside it.

Parsons' generator (1884)
MAIN PARTS
a. a boiler
b. the rotors
c. the shaft
d. the dynamo

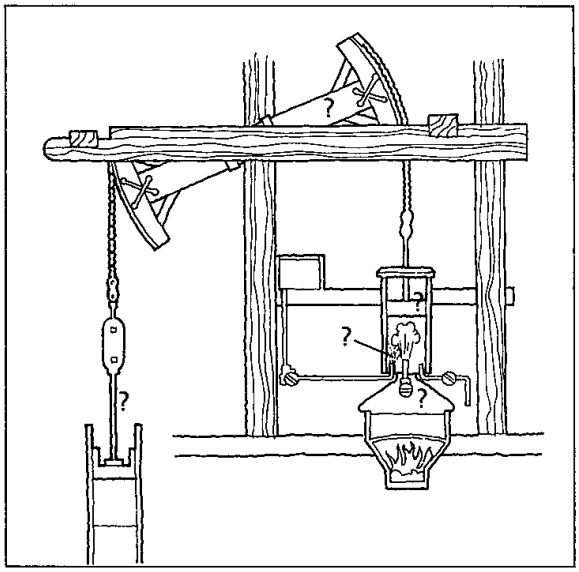
What did the boiler do?
It supplied the steam.

What did the rotors do?
They turned the shaft.

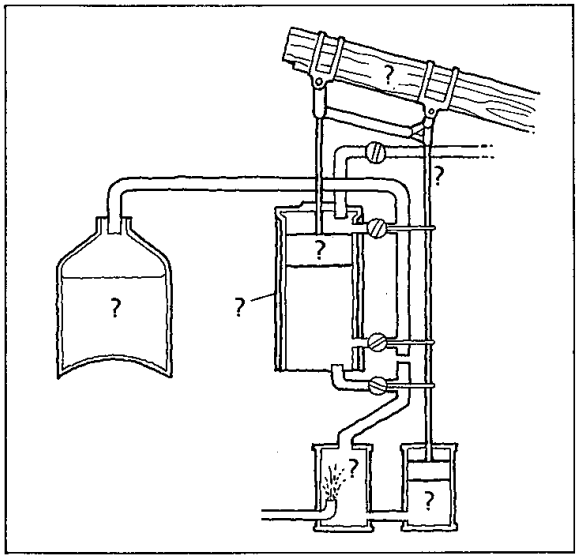
What did the shaft do?
It drove the dynamo.

What did the dynamo do?
It produced the electricity.

Now complete these two tables. Then make questions and answers from them in the same way.



Newcomen's engine (1712)
MAIN PARTS
a.
b.
c.
d.
e.



Watt's engine (1787)
MAIN PARTS
a.
b.
c.
d.
e.
f.
g.

LANGUAGE NOTE 3

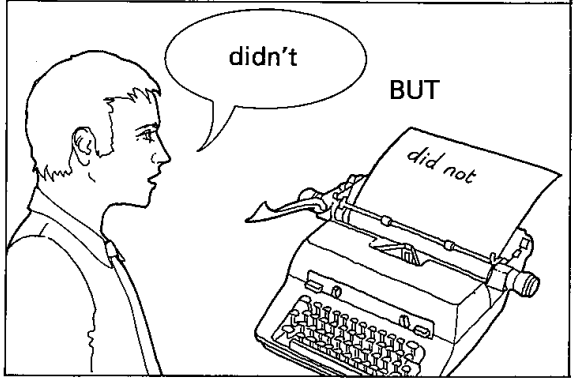
Newcomen's engine

Watt's engine

BUT

Parsons' generator

LANGUAGE NOTE 4



a generator
a turbine
a dynamo
a rotor
a ring
a bearing

a direction
an improvement
a voltage

exhaust

directly
still

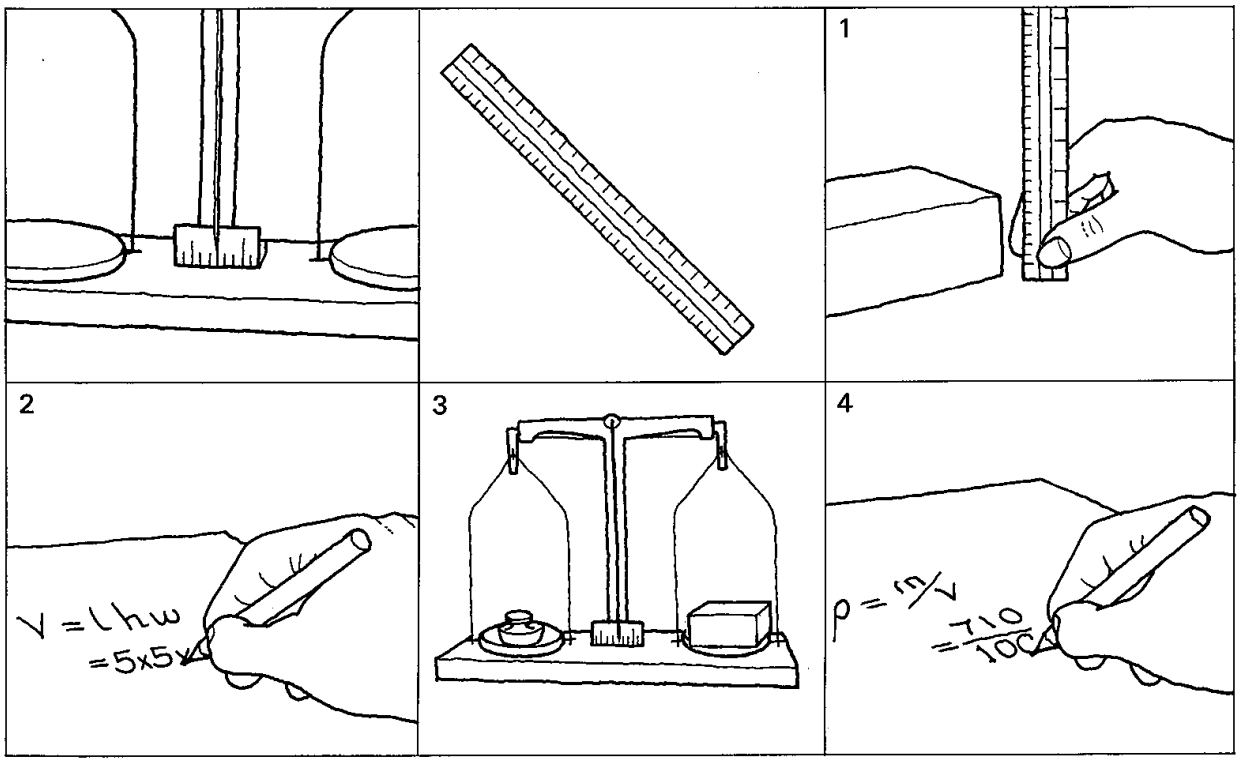
along

need
run
drive
cut
put
slope
push
come
go

rpm (revolutions per minute)

UNIT THREE Laboratory Experiments

SECTION A: CALCULATING DENSITY (i)



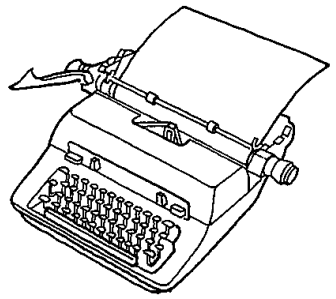
All matter, solid, liquid or gas, has density. The density of a material is its mass divided by its volume ($\frac{m}{v}$). Density is measured in g/cm^3 or in kg/m^3. Density is denoted by the Greek letter *rho* (ρ). The density of pure water at 4°C is exactly 1 g/cm^3.

Experiment 1

To calculate the density of a rectangular metal block.

We need a balance and a ruler for this experiment.

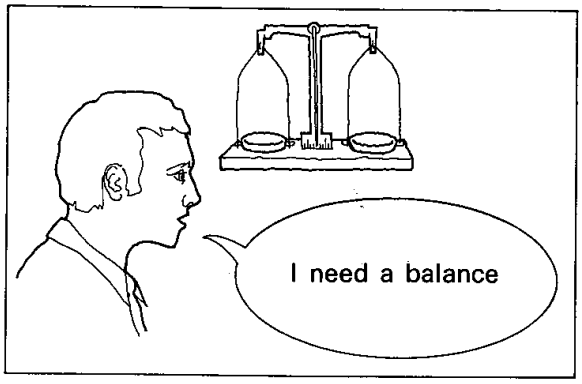
1. We measure the dimensions of the block.
2. We calculate the volume of the block with the formula *lwh* (length × width × height).
3. Next we weigh the block on the balance.
4. Then we calculate the density with the equation $\rho = \frac{m}{v}$.

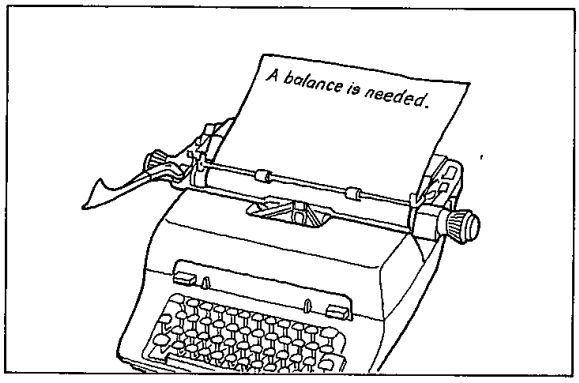


A balance and a ruler are needed for this experiment.

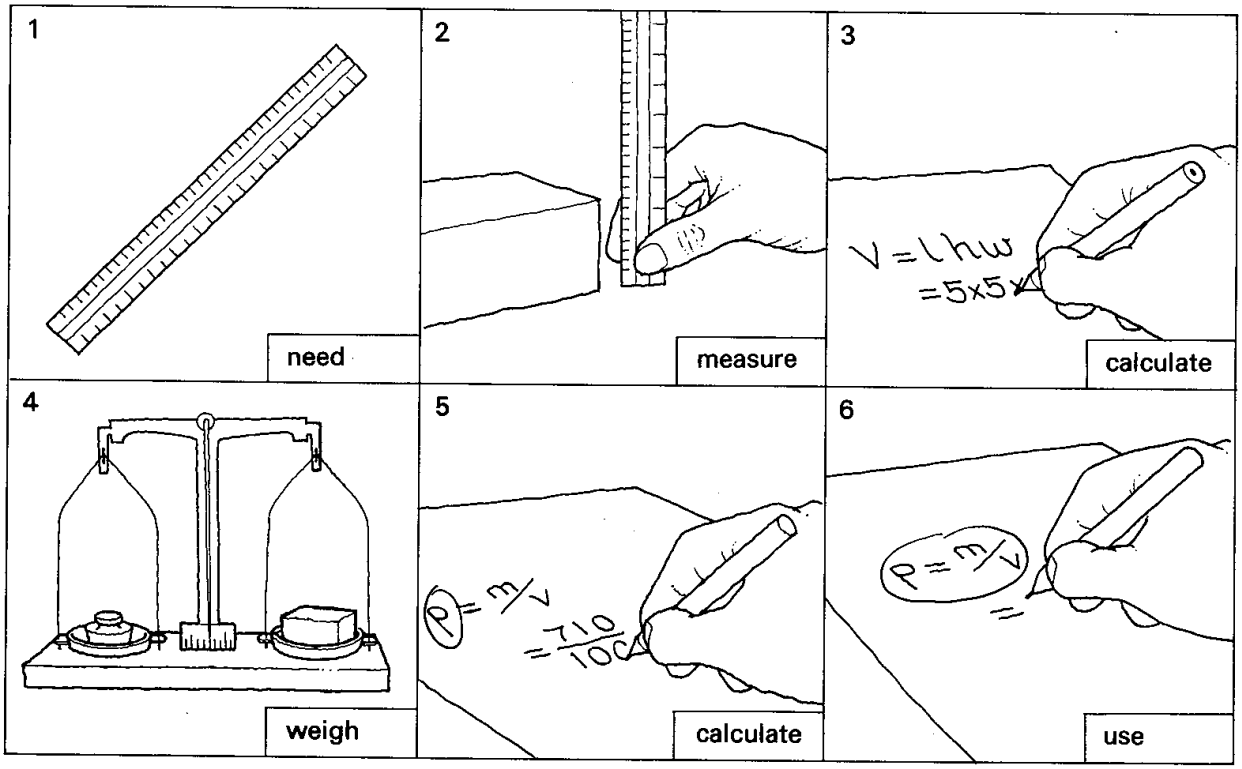
1. The dimensions of the block are measured (with a ruler).
2. The volume is calculated with the formula *lwh* (length × width × height).
3. Next the block is weighed. It is weighed on the balance.
4. Then the density is calculated. It is calculated with the equation $\rho = \frac{m}{v}$.

Exercise 1 Look at these examples.





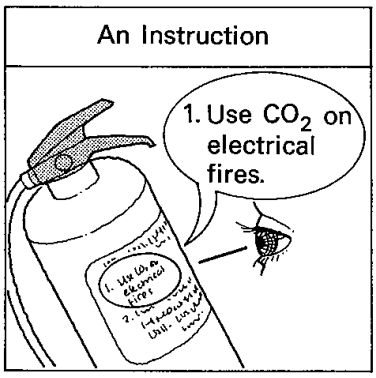
Now make two short sentences from each picture in the same way.

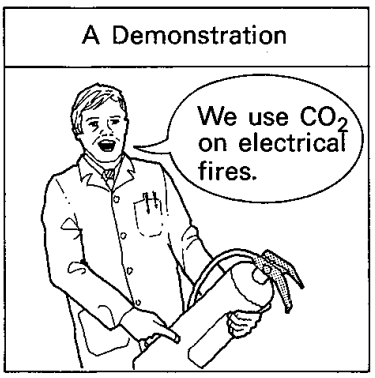


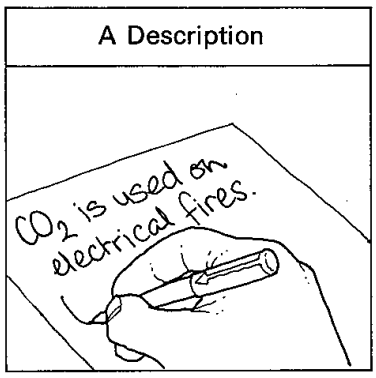
Now add one of the phrases below to each sentence.

. . . . . for this experiment.
. . . . . on the balance.
. . . . . with the equation $\rho = \frac{m}{v}$.
. . . . . with the formula *lwh*.
. . . . . with the ruler.
. . . . . for calculating density.

Exercise 2 Look at these three examples.







Now write a description of Experiment 1A from these instructions.

Experiment 1A

To calculate the density of aluminium.

1. Use a rectangular block of aluminium.
2. Measure the dimensions of the block.
3. Calculate its volume with the formula *lwh*.
4. Weigh the block on the balance.
5. Calculate its density with the equation $\rho = \frac{m}{v}$.

Exercise 3 Read this description of Experiment 1A.

A ruler and a balance are required for this experiment. A rectangular block of pure aluminium is also required.

First the dimensions of the block are measured. The block is 4 cm long, 3 cm wide and 2 cm high.

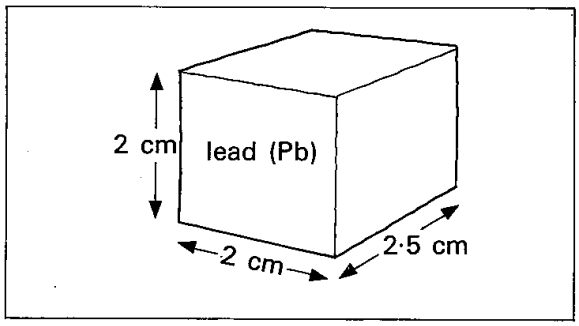
Then the formula *lwh* is used for calculating the volume of the block. Its volume is $4 \times 3 \times 2$ cm $= 24$ cm^3.

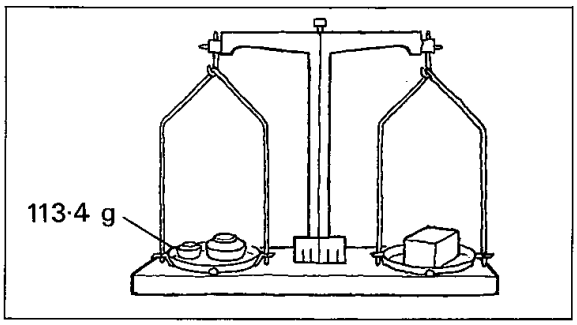
Next the block is weighed on the balance. Its mass is 64.8 g.

Finally its density is calculated with the equation $\rho = \frac{m}{v}$. The density of the block is $\frac{64.8}{24} = 2.7$ g/cm^3.

Therefore, the density of pure aluminium is approximately 2.7 g/cm^3.

Now describe a similar experiment in the same way. Use *first*, *then*, *next* and *finally*. In this experiment we calculate the density of lead.





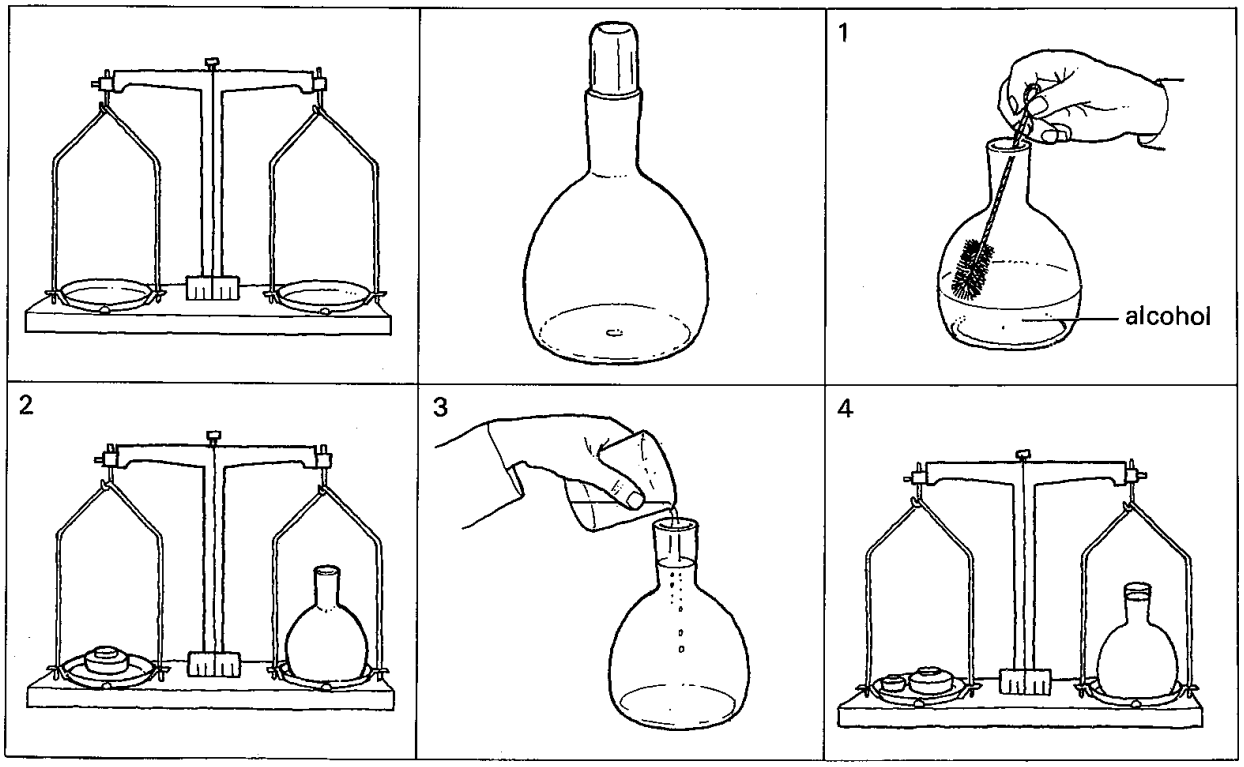
Start like this:

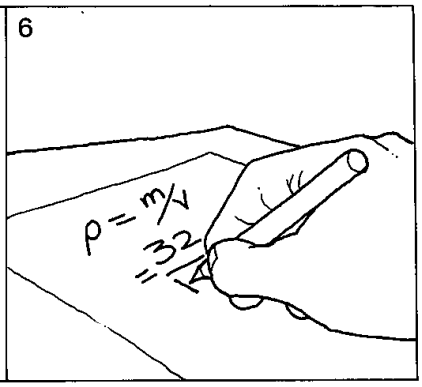
Experiment 1B

To calculate.....

Exercise 4 These pictures describe a different experiment. This experiment is used for finding the density of *a liquid*.
Study the pictures carefully.

Experiment 2A



5	6
mass of liquid = mass full bottle − mass of empty bottle. ($m_3 = m_2 - m_1$)	

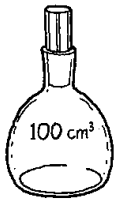
Now complete this description of the experiment from the pictures.

To calculate the density of a liquid.

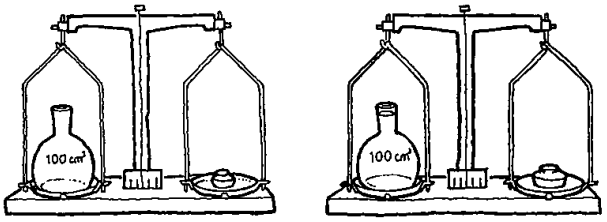
A balance is needed.
A . . . . is also required . . . . this experiment.

1. First the . . . . . washed with . . . . .
2. The empty bottle . . . . . .
3. Then . . . . . .
4. Next the full bottle . . . . . .
5. The mass . . . . . calculated with . . . . . .
6. Finally its density . . . . . .

Now describe a similar experiment to find the density of benzene (C_6H_6).



The density bottle has a volume of exactly 100 cm^3.



m_1 (empty) = 10 g. m_2 (full) = 100 g.

Start like this:

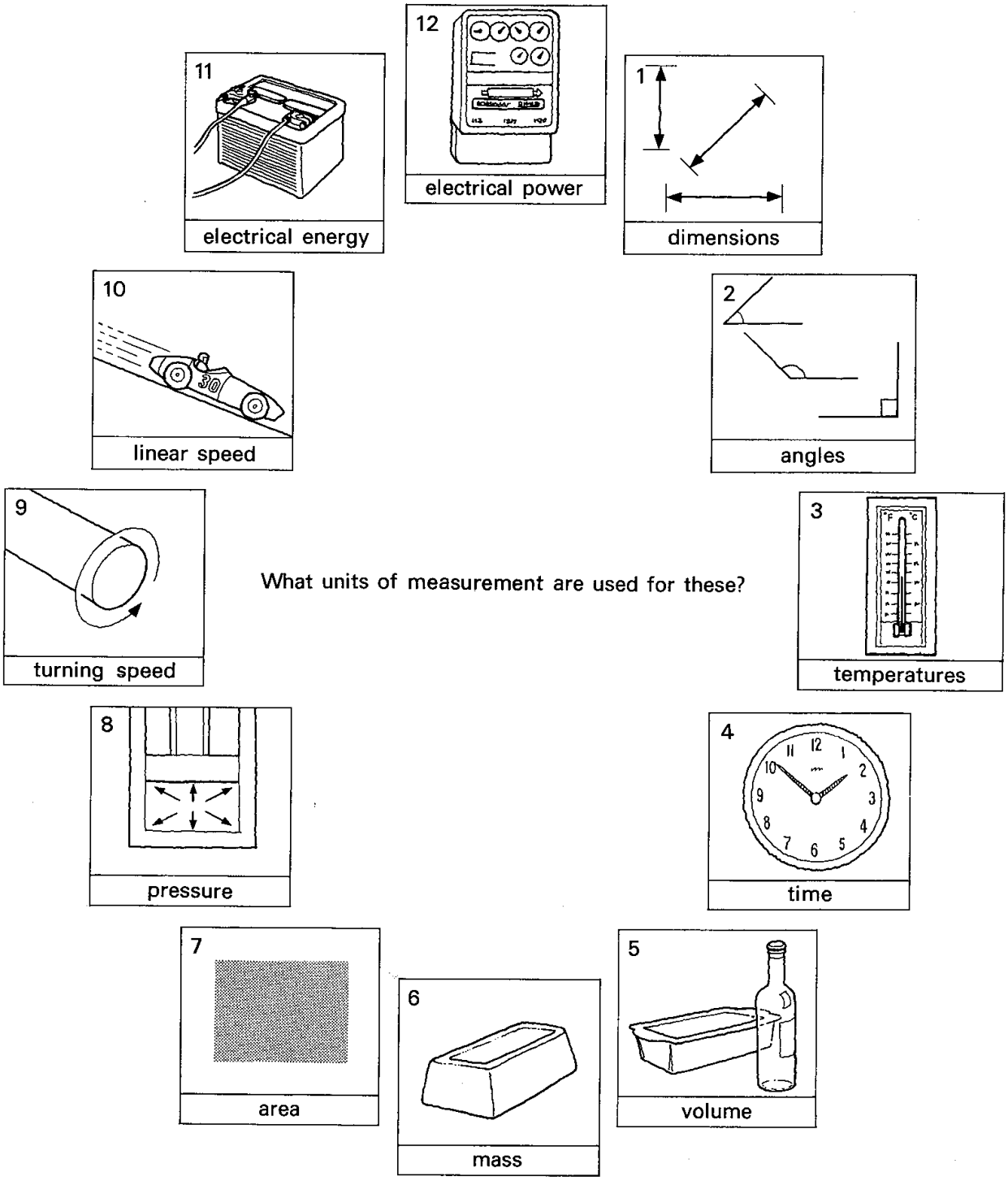
Experiment 2B

To calculate the density of benzene.
A balance.....

Does *benzene* have a greater density than *water*?

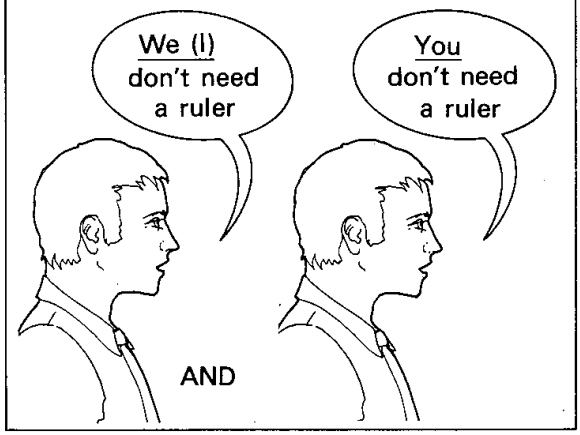
Exercise 5 Look at this example.

Density is measured in g/cm^3 or in kg/m^3.



LANGUAGE NOTE 5	
abbreviations	cm kg approx. etc.
symbols	Cu, Al, Pb, =, +
formulae	1wh, πr^2, H_2SO_4
equations	$\rho = {}^{m}/_{v}$, $m_3 = m_2 - m_1$, $3 \times (x - 1)^2 = 0$

LANGUAGE NOTE 6



a laboratory
an experiment
an equation
a demonstration
a description
a unit (of measurement)

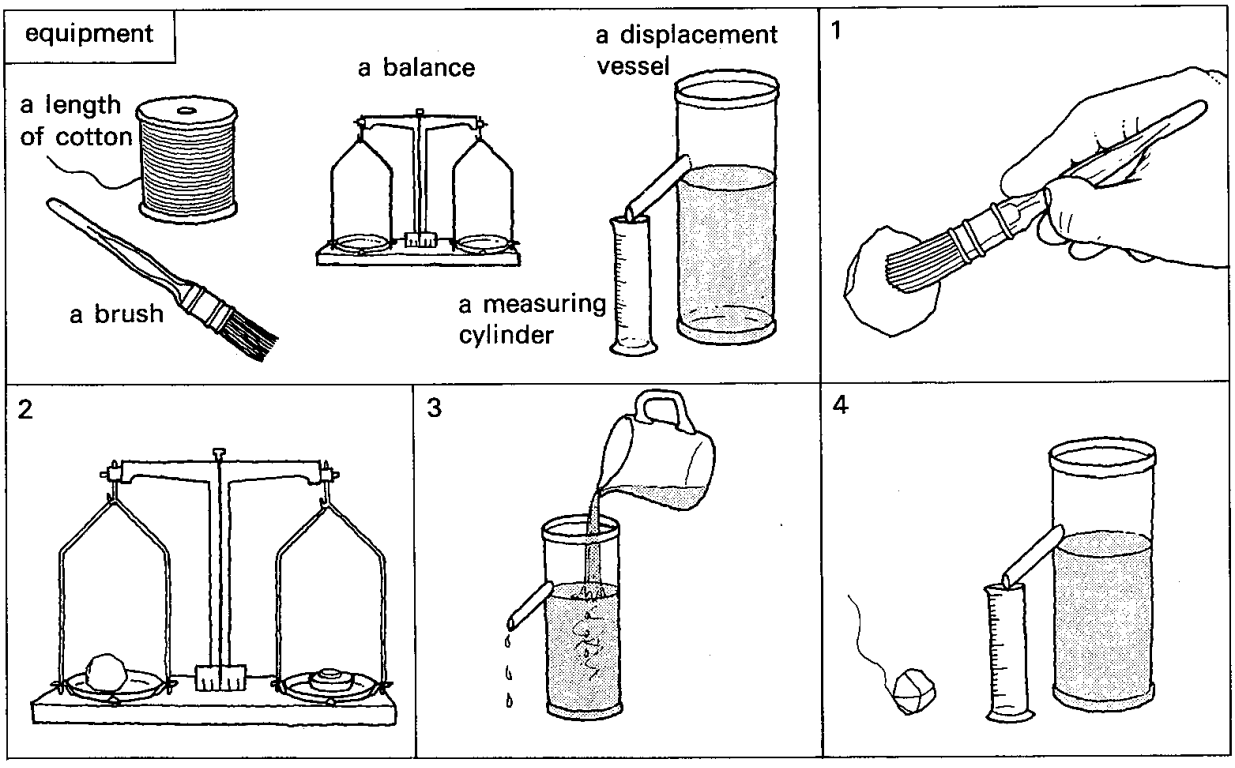
calculate
weigh
describe
wash

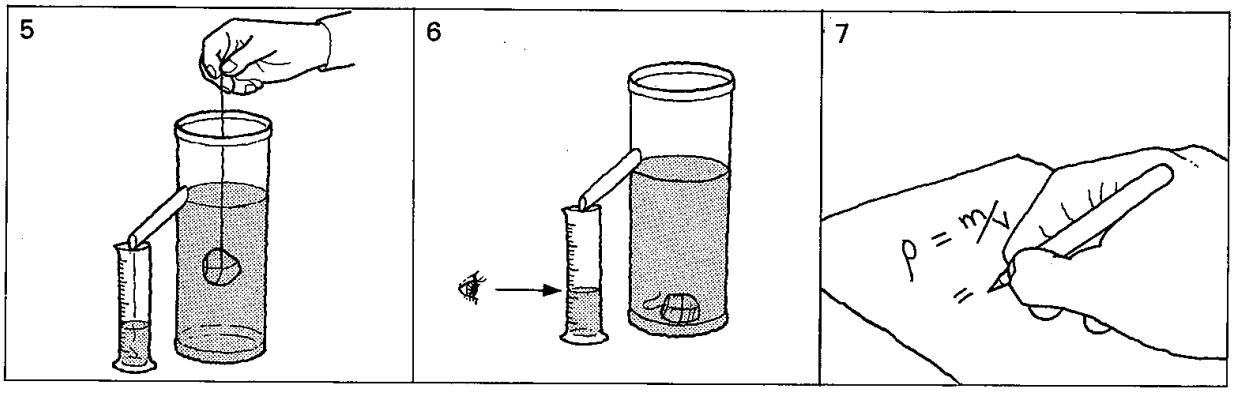
empty
full

first
finally

(a) mass
(a) time
alcohol

SECTION B: CALCULATING DENSITY (ii)





Experiment 3

Aim
To calculate the density of an *irregular* piece of metal.

Description of Procedure
1. First the solid is carefully cleaned. All oxides and dirt are removed with a stiff brush.
2. Then the solid is placed on the balance and its mass is accurately weighed.
3. The displacement vessel is then filled with water. The excess water is allowed to overflow through the the outlet pipe.
4. A length of cotton is now attached to the solid and the measuring cylinder is placed under the outlet pipe.
5. Next the solid is gently lowered into the vessel and allowed to sink slowly to the bottom.
6. A piece of metal displaces its own volume of water. The water is allowed to overflow into the cylinder. The volume of water in the cylinder is carefully noted.
7. Finally the density of the metal is calculated with the equation $\rho = \frac{m}{v}$.

Exercise 6 Answer these questions.

1. What is the aim of Experiment 3?
2. What equipment is required for this experiment?
3. Why is a ruler not required?
4. What is the brush used for?
5. What do you measure on the balance?
6. Is it possible to fill the displacement vessel completely?
7. Why do you need a measuring cylinder?
8. Why does water overflow into the cylinder?
9. How much water overflows into the cylinder?
10. How is the density of the metal finally calculated?

Exercise 7 Look at these examples.

DEMONSTRATIONS (or INSTRUCTIONS)	DESCRIPTIONS	REPORTS
You *normally measure* specific gravity with a hydrometer.	Specific gravity *is normally measured* with a hydrometer.	The specific gravity *was* measured with a hydrometer.
Lower the hydrometer *gently* into the cell and *let it sink.*	The hydrometer is *gently lowered* into the cell and *allowed to sink.*	The hydrometer *was* gently lowered into the cell and allowed to sink.

Now make sentences for a report about the following experiment.

Experiment 3A

Aim
To determine the composition of an irregular piece of ferrous metal.

DEMONSTRATION	REPORT
1. First you clean the piece of metal with a stiff brush.	. . . . .
2. Then measure its mass accurately on the balance.	. . . . .
3. Next fill the displacement vessel with water and let the excess water overflow.	. . . . .
4. Then you attach a length of cotton to the metal and you place the cylinder under the outlet pipe.	. . . . .
5. Lower the metal gently into the vessel and let it sink to the bottom.	. . . . .
6. Note the volume of displaced water carefully. Finally you calculate the density of the metal with the equation $\rho = \frac{m}{v}$.	. . . . .

Exercise 8 Now read this report of Experiment 3B. Note the headings carefully.

Experiment 3B Date: 18/9

Aim To determine the composition of an irregular piece of yellow metal.

Equipment a wire brush, a balance, a length of cotton, a displacement vessel, a measuring cylinder

Procedure

1 The metal was first cleaned with the wire brush. All oxides and dirt were completely removed.

2 The metal was then accurately measured on the balance. Its mass was 212·5 g.

3 The displacement vessel was filled with water and the excess water was allowed to overflow.

4 Next the cotton was attached to the piece of metal and it was gently lowered into the displacement vessel.

5 The displaced water was allowed to overflow into the cylinder and its volume was carefully noted. The volume of the displaced water was approx. 25 cm^3.

6 Finally the density of the metal was calculated with the equation:

$$\rho = \frac{m}{v}$$
$$= \frac{212 \cdot 5}{25}$$
$$= 8 \cdot 5 g/cm^3$$

Conclusion

The density of brass is normally 8·4 – 8·7 g/cm^3 and the density of bronze is normally 8·8 – 8·9 g/cm^3. Therefore, this piece of metal is probably brass.

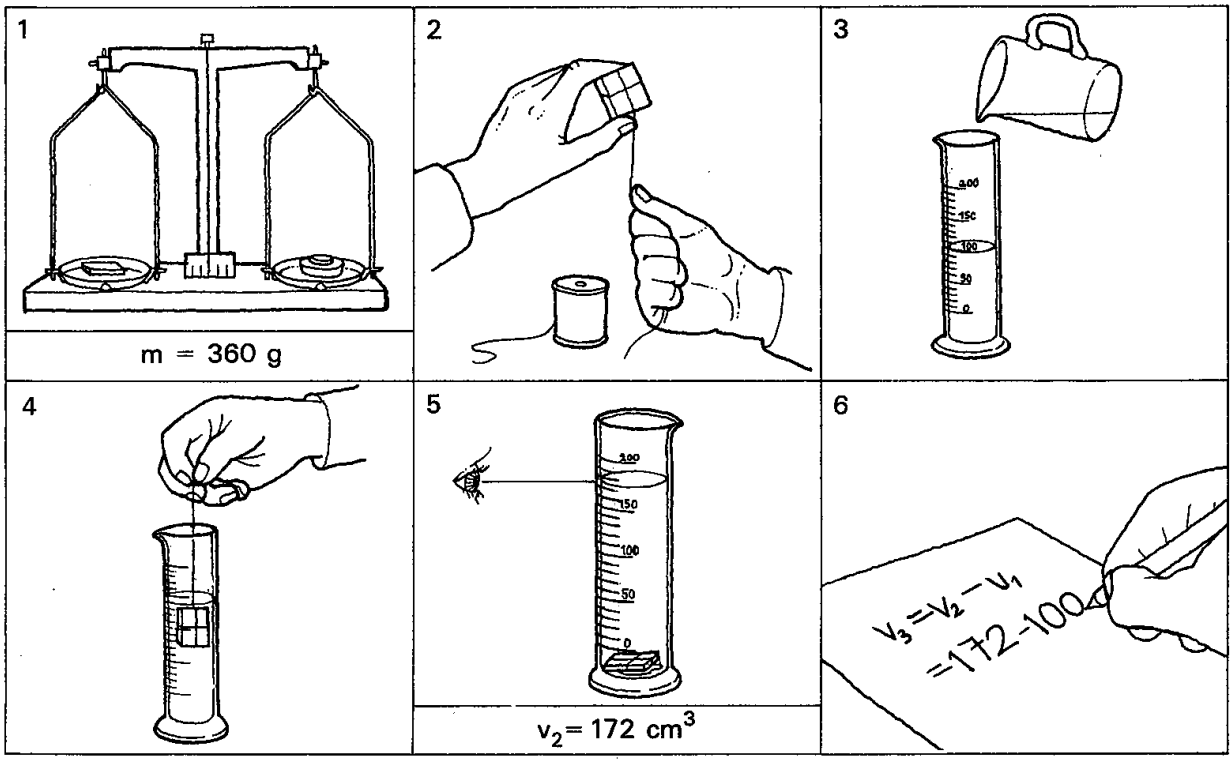
Now write a report of Experiment 3A (see Exercise 7) in the same way.

Mass of the piece of metal = 722 g

Volume of displaced water = 95 cm^3

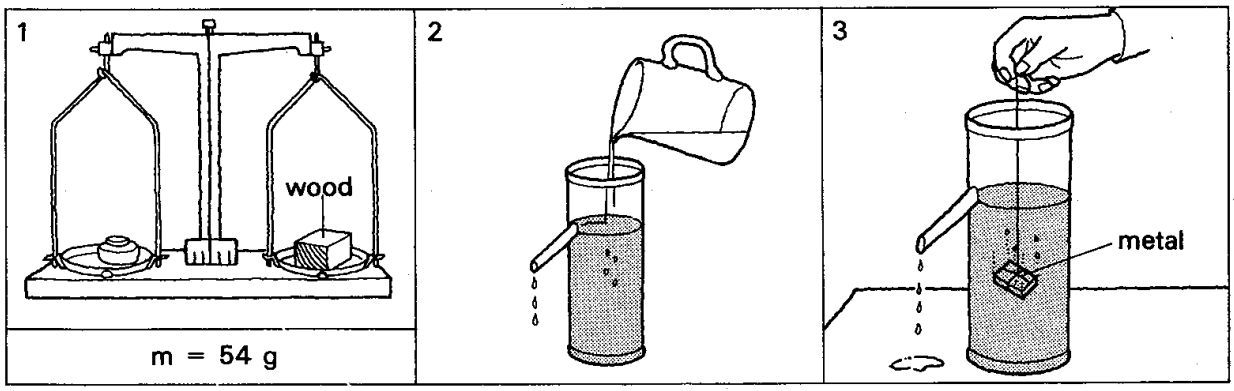
Density of common ferrous metals	
steels:	7·4 – 7·55 g/cm^3
cast iron:	approx 7·6 g/cm^3
wrought iron:	approx 7·85 g/cm^3

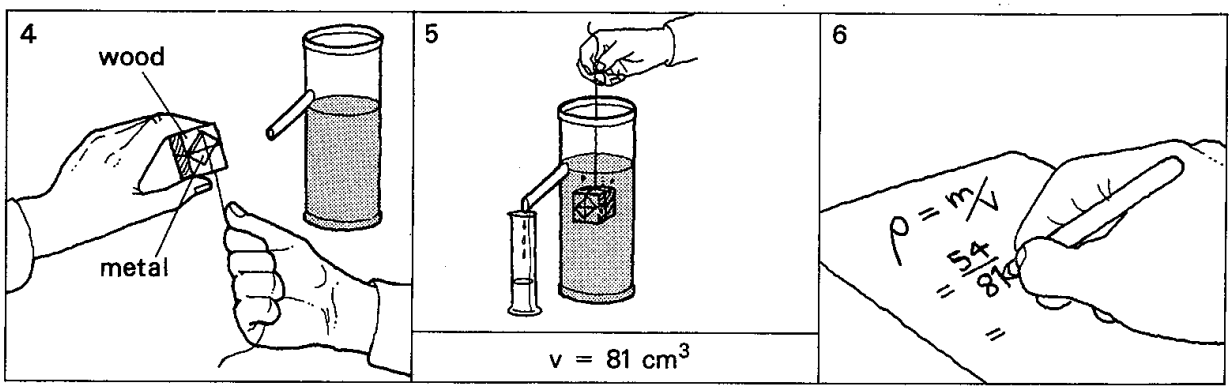
Exercise 9 Describe a procedure for calculating density without a displacement vessel.



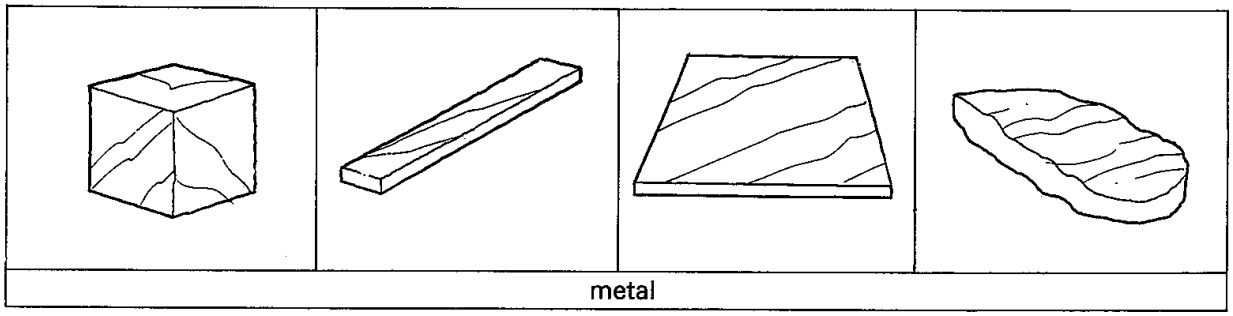
Now describe the procedure for calculating the density of an irregular piece of wood.

Wood does *not* sink in water.



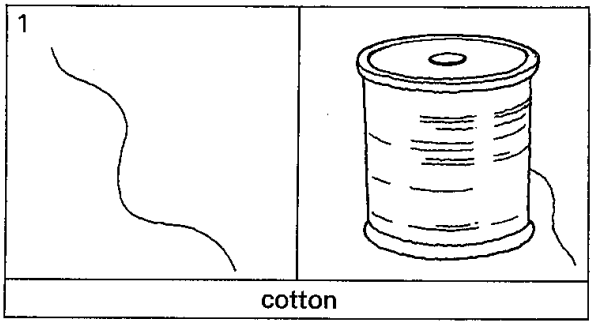


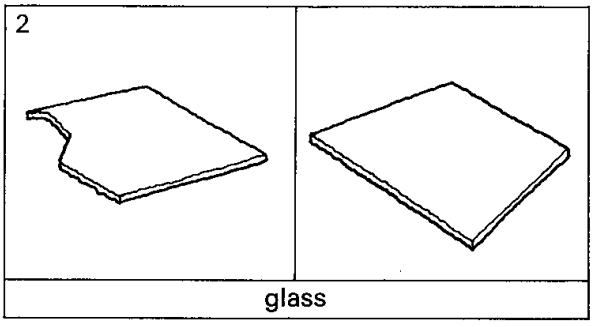
Exercise 10 Look at the examples.

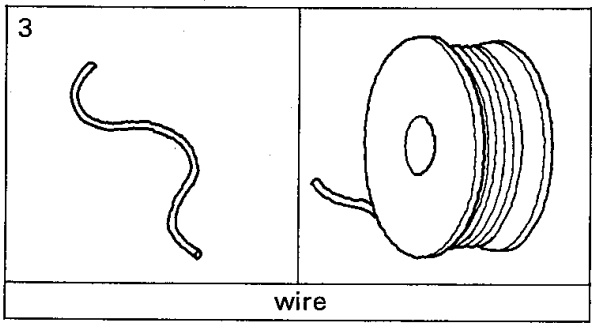


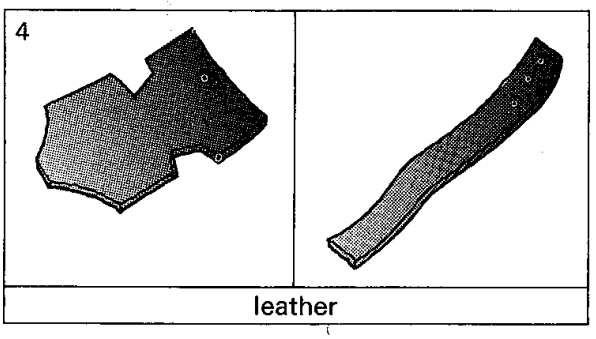
Now describe these objects. Use these words.

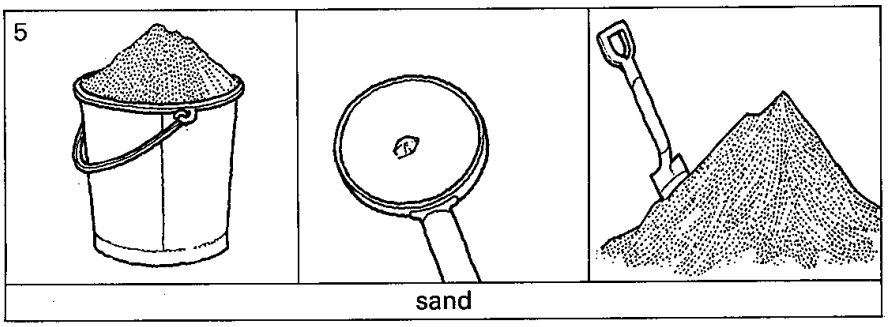
a bucket of . . . .
a grain of . . . .
a length of . . . .
a piece of . . . .
a pile of . . . .
a plank of . . . .
a sheet of . . . .
a reel of . . . .
a stack of . . . .
a strip of . . . .

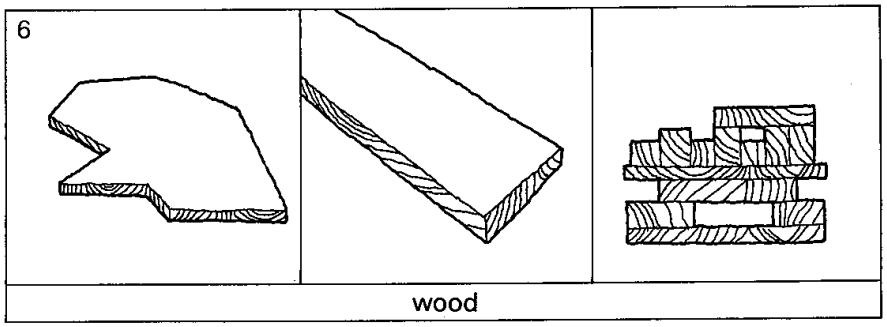


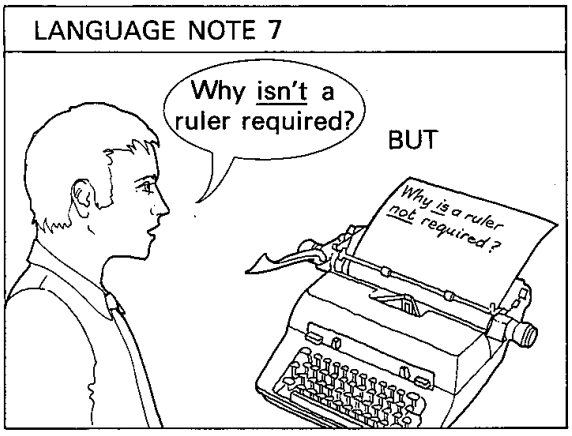












an aim
a procedure
a conclusion
a report
an oxide
a brush
a displacement vessel

dirt
cotton
a piece of . . . .

a grain
a pile
a plank
a reel
a stack
a strip

allow (let)
overflow
attach
sink
displace

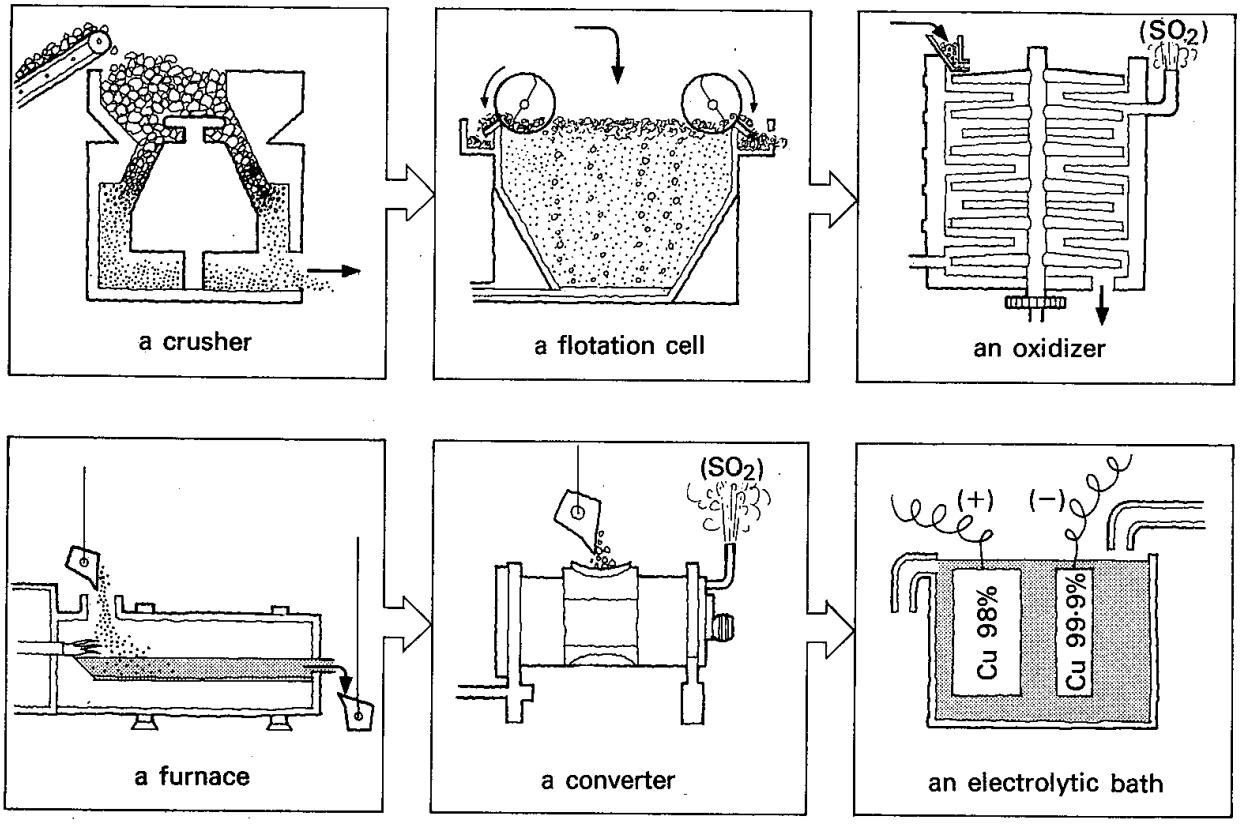
irregular
excess
own
displaced

carefully
accurately
gently

probably

UNIT FOUR Industrial Chemistry

SECTION A: THE PRODUCTION OF COPPER



Copper Sulphide (Cu_2S) Ores

The ore is first crushed. It is crushed into fine grains.

Next, the minerals are separated from the rock particles. They are separated in flotation cells. The rock particles sink to the bottom and the copper-rich grains are carried to the surface. This copper-rich ore is called concentrate.

The concentrate is now oxidized. Hot air is passed through the oxidizer. Some of the sulphur is transformed into sulphur dioxide gas (SO_2) and is allowed to escape.

The concentrate is then smelted in a furnace. Silica (SiO_2) is added to the mixture. More sulphur is transformed into gas (SO_2) and allowed to escape. Copper ore also contains iron sulphide (FeS). This is

transformed into iron silicate ($FeSiO_3$) and removed from the surface of what is now impure copper.

The impure copper is then transferred to a converter. Hot air is again passed through the mixture. Silica is again added. More iron is removed in this way. The copper sulphide plus oxygen is converted into pure copper plus sulphur dioxide gas:

$$Cu_2S + O_2 \longrightarrow 2Cu + SO_2$$

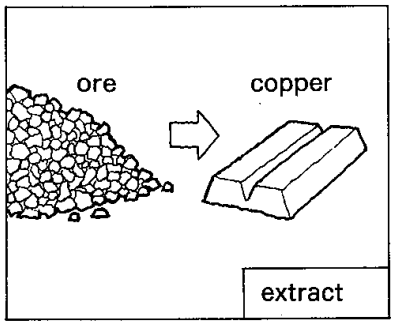
The copper is now 98% pure. It is removed from the converter and allowed to cool into blocks. The blocks are called anodes.

The copper anodes are refined in an electrolytic bath. The cathodes are pure copper and the electrolyte is usually copper sulphate ($CuSO_4$). An electric current is passed through the bath and the anodes slowly dissolve into the electrolyte. The copper molecules are eventually deposited on the cathodes. This copper is now 99.9% pure.

Exercise 1 Answer these questions.

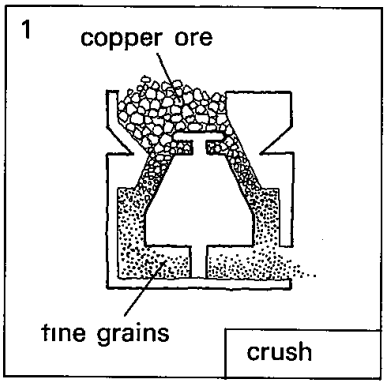
1. What happens to the ore in the crusher?
2. What happens to the ore in the flotation cells?
3. What happens to the concentrate in the oxidizer?
4. What happens to the concentrate in the furnace?
5. What happens to the iron sulphide in the furnace?
6. What happens to the copper sulphide in the converter?
7. What happens to the copper anodes in the electrolytic bath?
8. What happens to the copper molecules in the electrolyte?

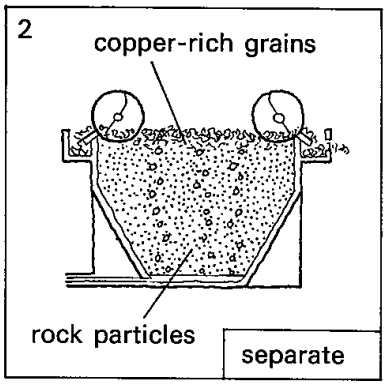
Exercise 2 Look at this example.

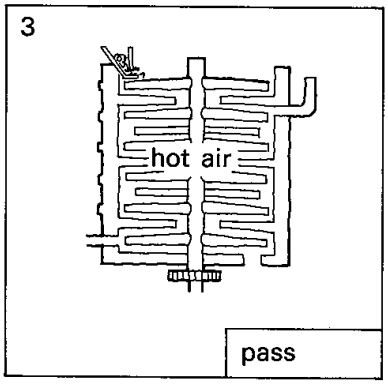


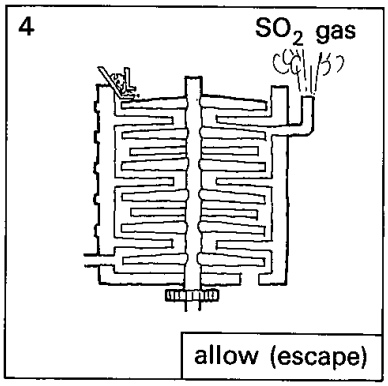
Copper is extracted from the ore.

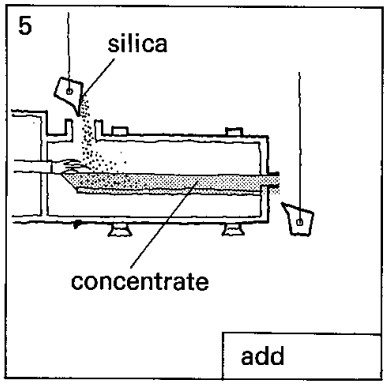
Now make sentences from these pictures in the same way.

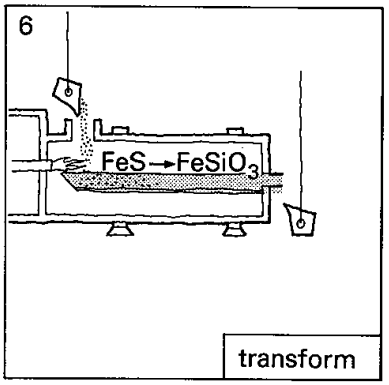


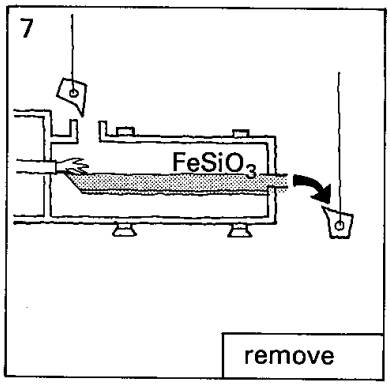


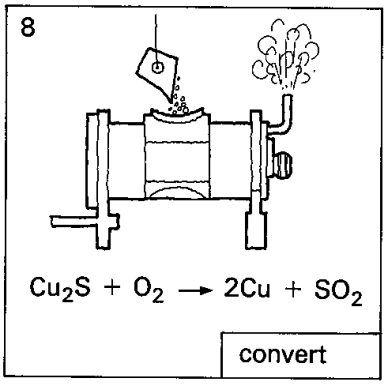


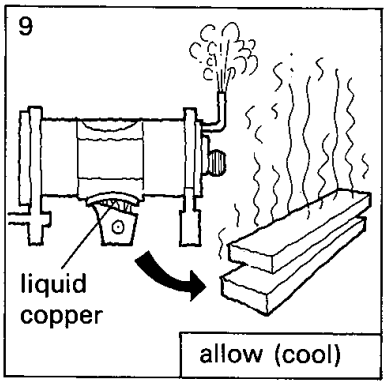


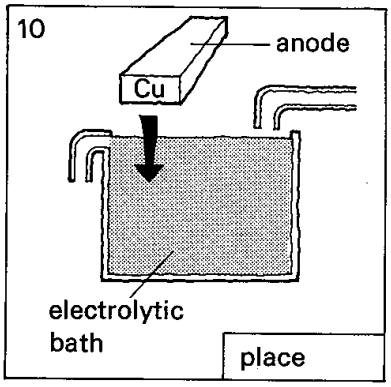


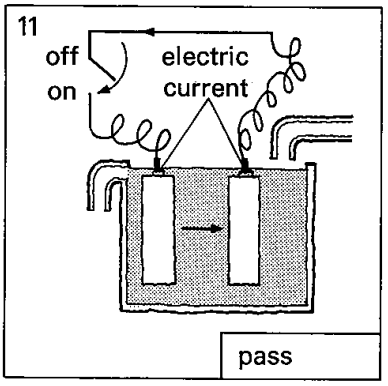


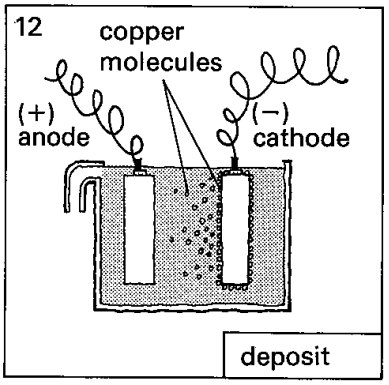






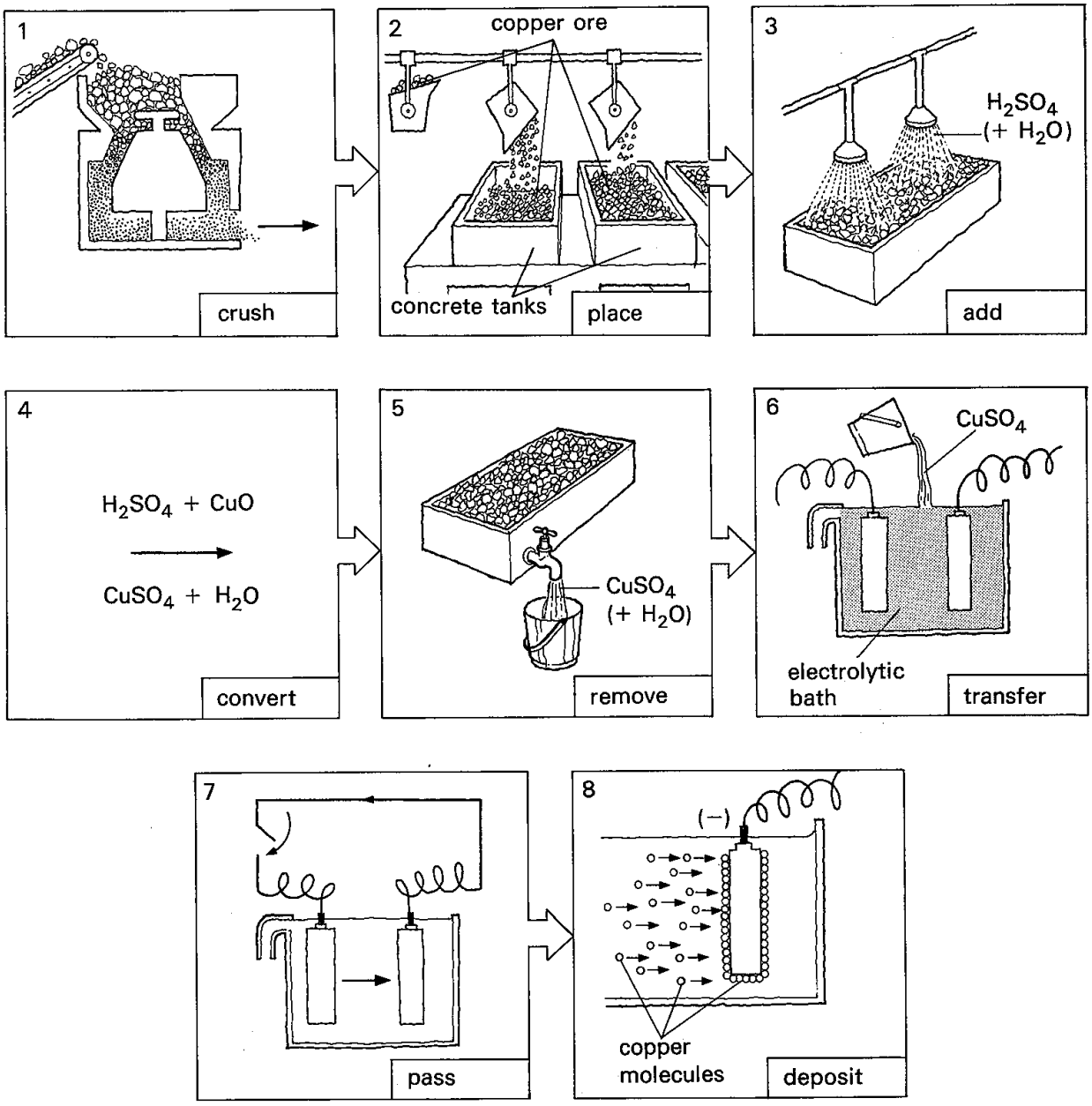




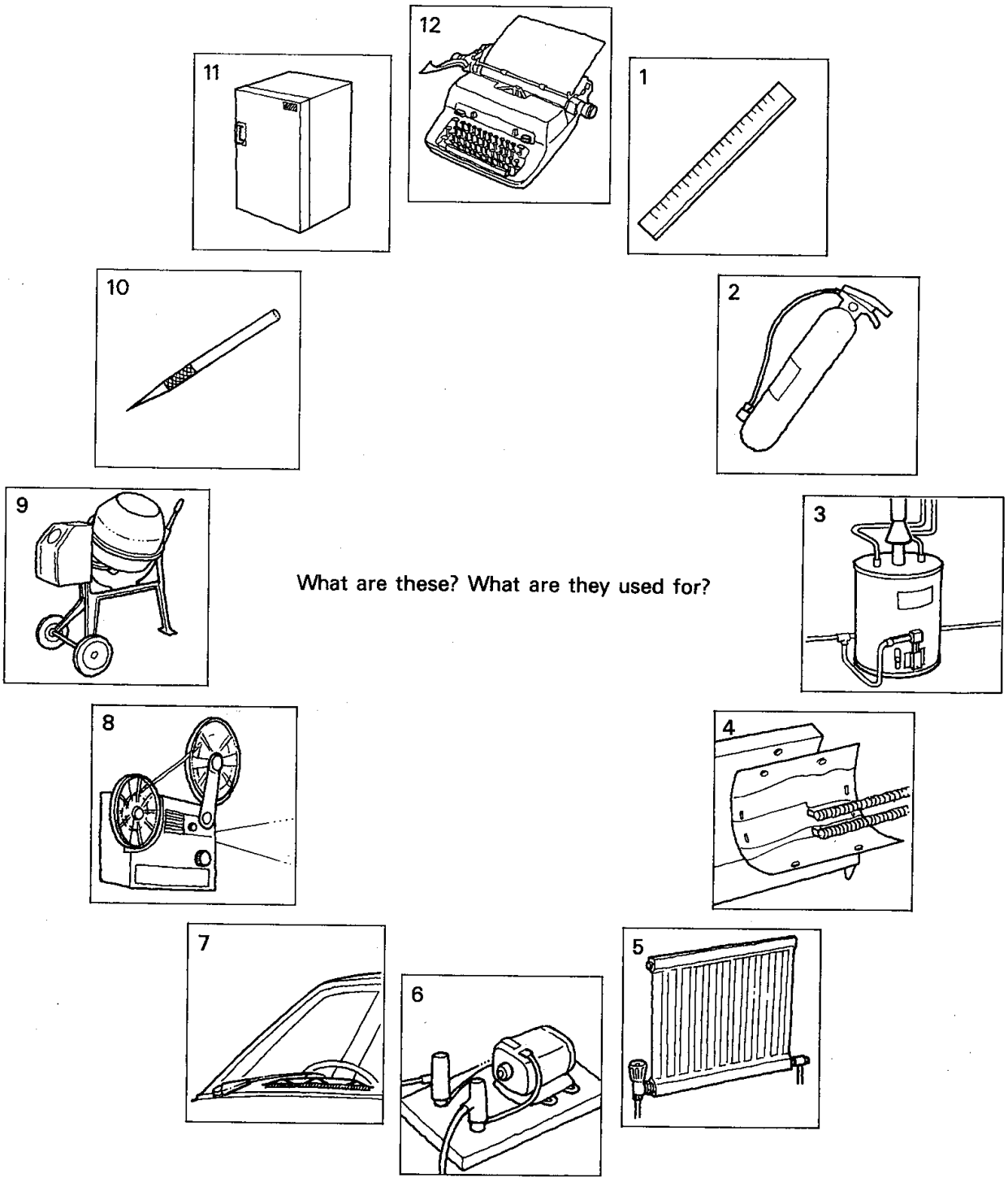


Exercise 3 Some copper ores do not contain copper sulphide. They contain *copper oxide* (CuO). Copper oxide ores are much simpler to purify.

Describe the process from these pictures.



Exercise 4 What are these?
What are they used for?



Example: This is a ruler.
It is used for measuring dimensions.

LANGUAGE NOTE 8

crusher	condenser
oxidizer	container
typewriter	mixer
converter	scriber

BUT

conductor	insulator
refrigerator	projector
radiator	generator

LANGUAGE NOTE 9

deposit → deposited

BUT

transfer → transferred

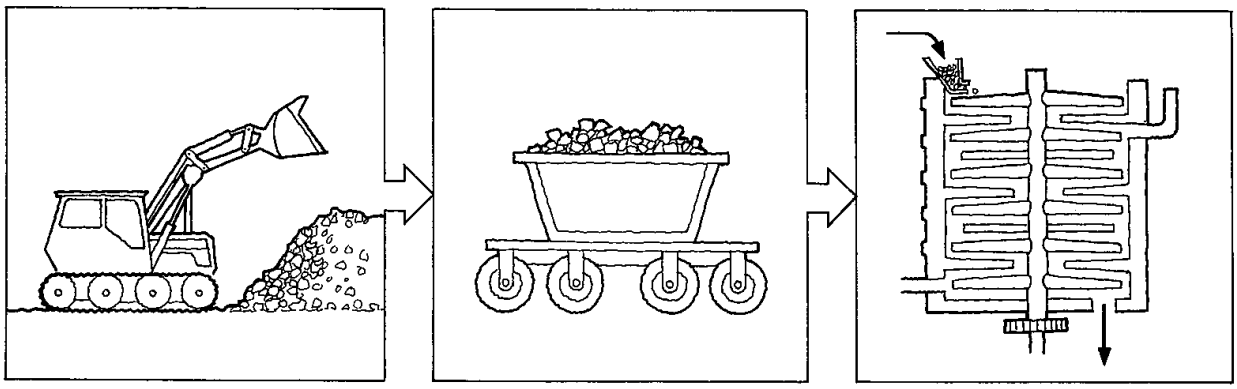
an ore
a mineral
a concentrate
a bath
a crusher
a flotation cell
an oxidizer
a converter
a projector
a mixer
a scriber
a refrigerator
a typewriter

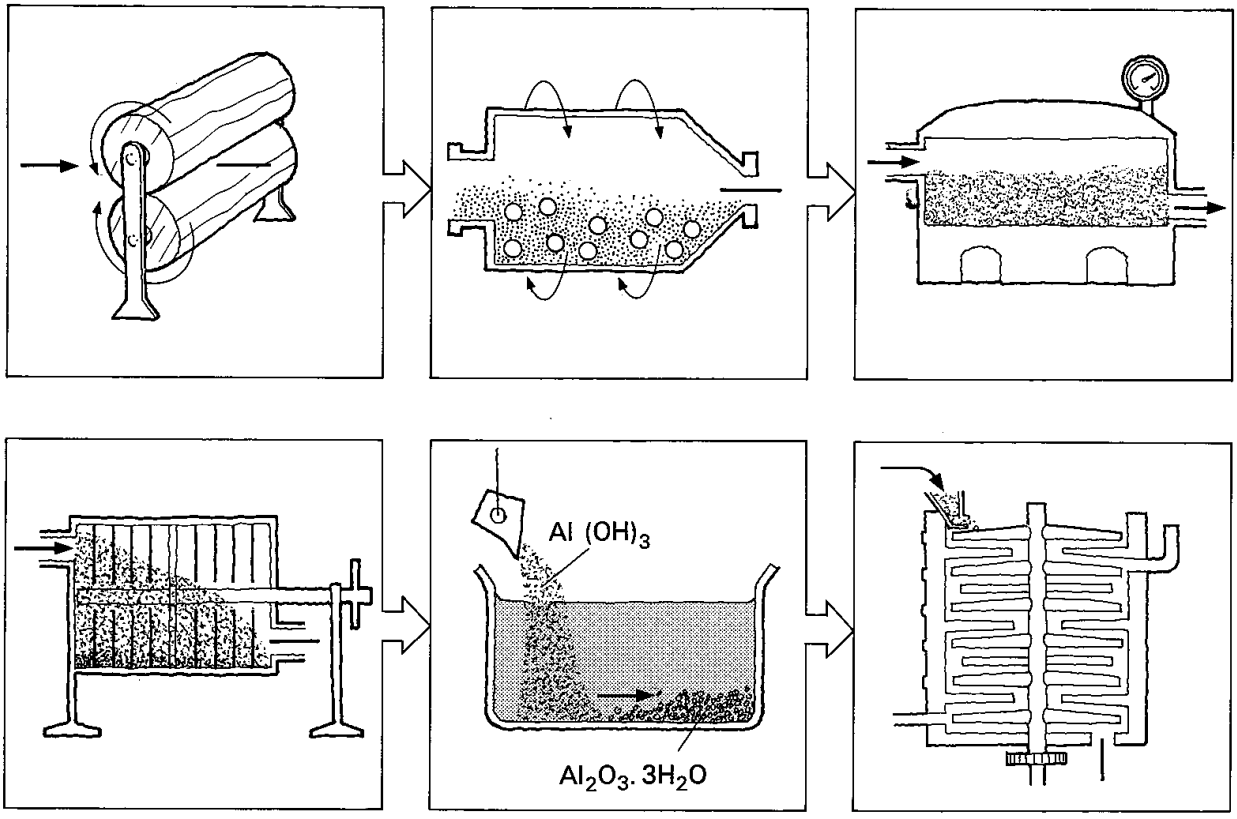
crush
separate
oxidize
smelt
transform
transfer
refine
deposit
extract

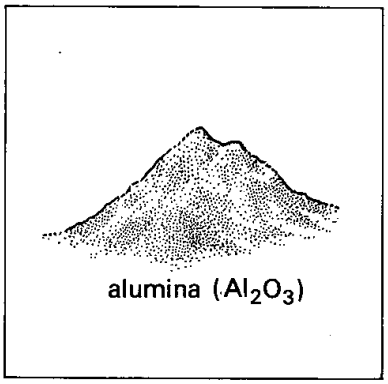
industrial
rich
impure

again
eventually

SECTION B: THE PRODUCTION OF ALUMINIUM







Treating the ore

Aluminium is produced from bauxite. Bauxite is generally found near the surface and so it is comparatively cheap to mine. The ore is then taken to a refinery in its natural state. At the refinery it is heated and dried. The water content is extracted in this way. The dried bauxite is then crushed between rollers. Finally, it is powdered with heavy steel balls.

Purifying the ore

The powdered ore is now mixed with heated sodium hydroxide (NaOH) in a pressurized bath. The aluminium oxide (Al_2O_3) in the ore is dissolved in the sodium hydroxide and converted into sodium aluminate:

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

The solution is then passed through a filter. This filter allows the dissolved sodium aluminate to pass through it, but the undissolved impurities are left inside the filter.

The filtered solution is left to cool and crystals of aluminium hydroxide ($Al(OH)_3$) are added to it. Larger crystals of aluminium oxide are formed from the aluminium hydroxide crystals. These larger crystals are a

combination of aluminium oxide and water ($Al_2O_3.3H_2O$).

Finally, the crystallized aluminium oxide is put into another drier. At a temperature of more than 1000°C the water is allowed to escape in the form of steam. Pure alumina now remains in the form of a white powder.

Exercise 5 Irregular verbs do not usually have forms ending in *-ed*. How many irregular verbs are used in this text? Find their different forms in Appendix One.

Are these statements true or false? Rewrite the untrue statements.

1. Bauxite is a type of aluminium ore.
2. Bauxite is comparatively cheap to mine because it is found near the surface.
3. Bauxite is treated at a refinery.
4. Bauxite does not contain water.
5. Sodium hydroxide dissolves aluminium oxide and converts it into sodium aluminate.
6. The sodium hydroxide bath is heated and pressurized.
7. Sodium aluminate does not dissolve.
8. The undissolved impurities pass through the filter.
9. Aluminium oxide crystals are a combination of aluminium oxide and water.
10. The drier converts aluminium oxide crystals into powdered aluminium and steam.

Exercise 6 Read the example below.

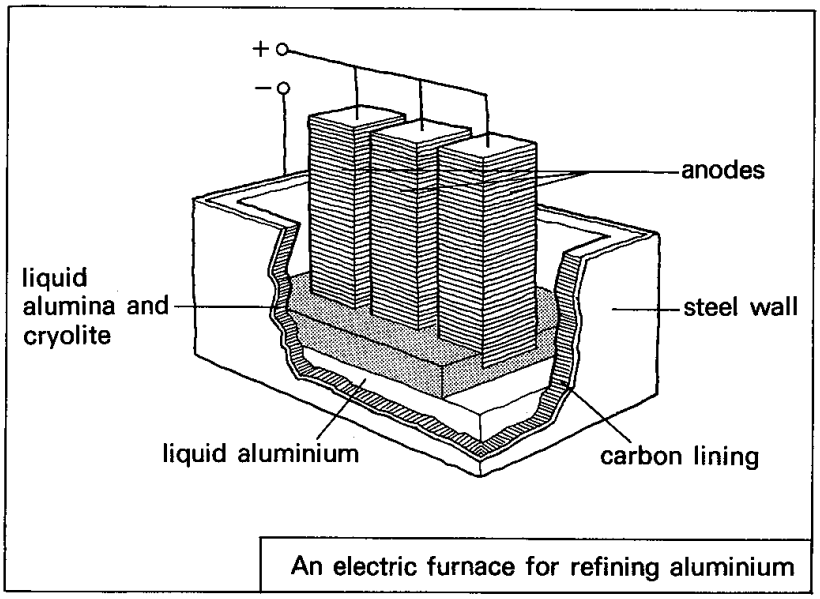
Lorries take the ore to a refinery. (in)
The ore *is taken* to the refinery *in lorries.*

Now convert these sentences in the same way.

1. Rollers crush the bauxite. (between)
2. Heavy steel balls powder the bauxite. (with)
3. Sodium hydroxide dissolves the aluminium oxide. (in)
4. The filter removes the undissolved impurities. (in)
5. The aluminium hydroxide crystals form larger aluminium oxide crystals. (from)
6. The drier converts the crystals into pure alumina. (in)

Exercise 7 Complete these paragraphs from the wordlist below.

affected	*electric*	*point*
are	*eventually*	*separates*
blocks	*into*	*sinks*
bottom	*furnaces*	*solidify*
combination	*lining*	*than*
converting		*transformed*



An electric furnace for refining aluminium

Refining the alumina

An electrolytic process is used for . . . . the alumina powder into aluminium. The alumina is liquefied inside a furnace and a strong . . . . current is passed through it. The current . . . . the alumina into aluminium and oxygen molecules:

$$2Al_2O_3 \longrightarrow 4Al + 3O_2$$

The pure aluminium . . . . to the bottom of the furnace. It is allowed to run into containers and is then left to . . . . into blocks. The oxygen molecules . . . . attracted to the carbon anodes in the furnace. These anodes are slowly oxidized and . . . . into carbon monoxide gas (CO). They are . . . . replaced with new anodes.

These electric . . . . are generally rectangular steel containers. The sides and the bottom have a thick . . . . of carbon. This forms the cathode. The anodes are large . . . . of carbon. The electrolyte is a mixture of alumina and cryolite. Cryolite is a chemical . . . . of aluminium, sodium and fluorine. It is used to lower the melting . . . . of the alumina from approximately 2000°C to about

1000°C. The cryolite is not . . . . by the electric current but the alumina is converted . . . . aluminium and oxygen. The pure aluminium is heavier . . . . the cryolite mixture and so it sinks to the . . . . of the furnace. More alumina is added to the mixture and the refined aluminium is removed.

Exercise 8 Convert these verbs into adjectives and then add them to the sentences below.

Example:

solder

A . . . . joint is often stronger than the metal around it.

A *soldered* joint is often stronger than the metal around it.

crystallize	*heat*	*powder*
dissolve	*liquefy*	*pressurize*
dry	*oxidize*	*purify*
filter		

1. The . . . . bauxite is crushed between rollers.
2. The . . . . ore is transferred to a bath of . . . . sodium hydroxide.
3. This . . . . bath converts the aluminium oxide into sodium aluminate.
4. The . . . . sodium aluminate is passed through a filter.
5. The . . . . impurities are left inside the filter.
6. The . . . . solution is left to cool.
7. . . . . aluminium oxide is put into a drier.
8. The . . . . aluminium oxide is in the form of white powder.
9. In the furnace the . . . . alumina separates into aluminium and oxygen molecules.
10. The . . . . anodes are replaced with new anodes.

LANGUAGE NOTE 10

noun	verb
powder	powder
filter	filter
solder	solder
hammer	hammer
BUT	
oxide	oxidize
pressure	pressurize
crystal	crystallize
anode	anodize

LANGUAGE NOTE 11

alumina = aluminium oxide = Al_2O_3

caustic soda = sodium hydroxide = NaOH

silica = silicon dioxide = SiO_2

lime = calcium oxide = CaO

a refinery
a roller
a ball
a solution
a filter
an impurity
a crystal
a combination
a powder

a drier
bauxite
cryolite
fluorine

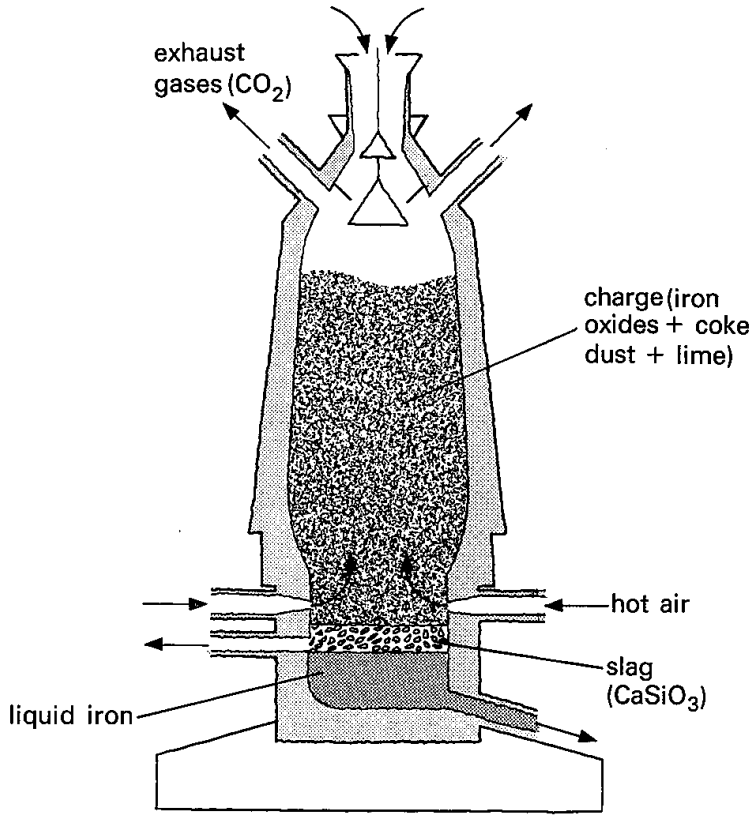
treat
find
mine
dry
powder
pressurize
leave
cool
form
crystallize

natural

SECTION C: THE PRODUCTION OF IRON

Iron became an important engineering material at a very early date. Simple furnaces were used for producing iron thousands of years ago. The modern blast furnace was invented around 1800. Early blast furnaces burnt coal or charcoal. Cold air was used for the blast.

Nowadays, blast furnaces are much more efficient. The charge contains coke instead of coal, and hot air is used instead of cold air. A hundred years ago, the production of one tonne of iron required two or three tonnes of coke. Nowadays, only about half a tonne of coke is needed. Other types of modern furnace, for example electric furnaces, use little or no coke at all. They burn gases or oils instead of coke.



a blast furnace

Iron oxides are found in two main ores. These are magnetite (Fe_3O_4) and haematite (Fe_2O_3). They are usually mined in the form of rock. The ores are first processed by a crusher. The large pieces of rock are broken into smaller pieces. Large unbroken pieces are removed by a filter. The ore is then ground into a fine powder. The powdered ore is mixed with coke dust and lime (CaO). The mixture is then heated. This process causes it to form into small lumps.

The charge is fed into the top of the furnace. Hot air is blown into the bottom of the furnace at great pressure. The coke is rapidly oxidized by this blast of air and very high temperatures are produced. The burnt coke produces carbon monoxide (CO) gas. The iron oxide is reduced to pure iron by the hot gas.

$$FeO + CO \longrightarrow Fe + CO_2$$

At the same time, the lime transforms the silica impurities into calcium silicate slag.

$$CaO + SiO_2 \longrightarrow CaSiO_3$$

The iron and the slag both fall to the bottom of the furnace in liquid form. The slag is less dense than the iron and so it remains on the surface of the melted iron.

The two liquids are removed separately. The slag is left to cool and then used to make cement, etc. The iron is either cast into long bars or it is taken in liquid form to another furnace and converted into steel.

Exercise 9 Answer these questions.

1. When was the modern blast furnace invented?
2. What fuels were used in early blast furnaces?
3. Why are blast furnaces more efficient nowadays?
4. Are there other types of furnace for purifying iron?
5. What are magnetite and haematite?
6. How is iron ore treated?
7. What does the charge consist of?
8. What causes the coke to burn in the furnace?
9. Describe the reduction process in chemical terms.
10. How is the slag formed?
11. Why does the slag separate from the melted iron?
12. What happens to the pure iron from the furnace?

Exercise 10 Complete each sentence with the correct form of one of the verbs in the wordlist.

blow	*cast*	*grind*
break	*feed*	*leave*
burn	*find*	*take*

1. Coal or charcoal . . . . . in early blast furnaces.
2. Normally, iron ores . . . . . in the form of rock.
3. Large pieces of rock . . . . . into smaller pieces in a crusher.
4. The ore . . . . . into a fine powder.
5. The charge . . . . . into the top of the furnace.
6. Hot air . . . . . into the bottom of the furnace at great pressure.
7. The liquid slag . . . . . to cool into large blocks.
8. Sometimes, the pure iron . . . . . into long bars.
9. Sometimes, the iron . . . . . to another furnace and converted into steel.

Exercise 11 Read these examples.

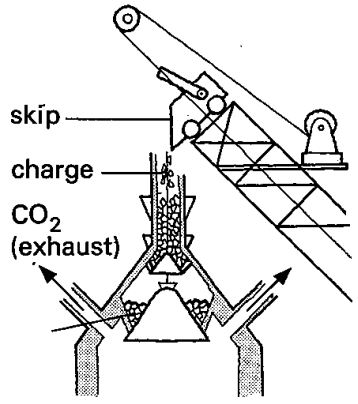
First, make eight true sentences (Type A) from the table. Then transform each sentence into another (Type B) sentence.

Examples:

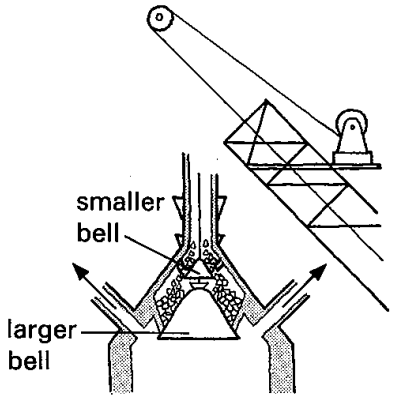
A.	A crusher <u>processes</u> the ore.
B.	The ore <u>is processed by</u> a crusher.

1.	A crusher	breaks	the rock into smaller pieces.
2.	A filter	converts	large unbroken pieces.
3.	A hot blast of air	melts	the coke.
4.	Heated carbon monoxide	oxidizes	iron into steel.
5.	The lime	produces	the iron and the slag.
6.	The heat of the furnace	reduces	the iron oxide to pure iron.
7.	A large blast furnace	removes	3000 tonnes of iron per day.
8.	A separate furnace	transforms	the silica impurities to calcium silicate.

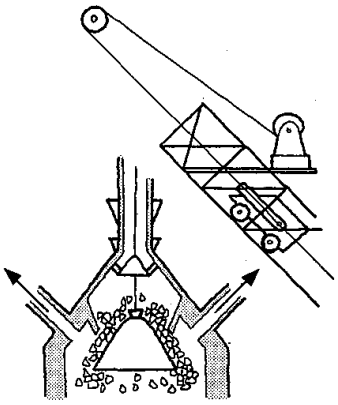
Exercise 12 Complete the following paragraphs from the word-list. First, look at the diagrams carefully.



both bells raised



smaller bell lowered



larger bell lowered

allowed	*fall*	*through*
by	*into*	*top*
caused	*never*	*transferred*
charge	*sealed*	*under*
exhaust		

In a blast furnace, large amounts of CO_2 gas are . . . . by the reduction process. These . . . . gases are extremely hot. The exhaust outlets are near the . . . . of the furnace. The gases are removed . . . . pressure and are used to heat the air blast of the furnace. The gases are not . . . . to escape into the atmosphere through the top of the furnace. The furnace top is sealed . . . . two *bells* (*see diagram*).

The charge is . . . . to the top of the furnace in *skips*. These skips are emptied . . . . the furnace top. The smaller bell is then lowered and the charge is allowed to . . . . onto the larger bell. The furnace is still . . . . because the larger bell is raised. Then the smaller bell is raised again. Finally, the larger bell is lowered and the . . . . is allowed to fall into the furnace. The two bells are . . . . lowered at the same time. In this way, the furnace top is completely sealed and the exhaust gases never escape . . . . it.

LANGUAGE NOTE 12

in the form of a liquid = in liquid form
in the form of a powder = in powder form
in the form of a rock = in rock form

BUT

in the form of a gas = in gaseous form
in the form of steam ~~in steam form~~

a blast
a lump
a skip

reduction

charcoal
coke
dust
magnetite
haematite
slag

grind
cause
feed
blow
reduce
cast
see

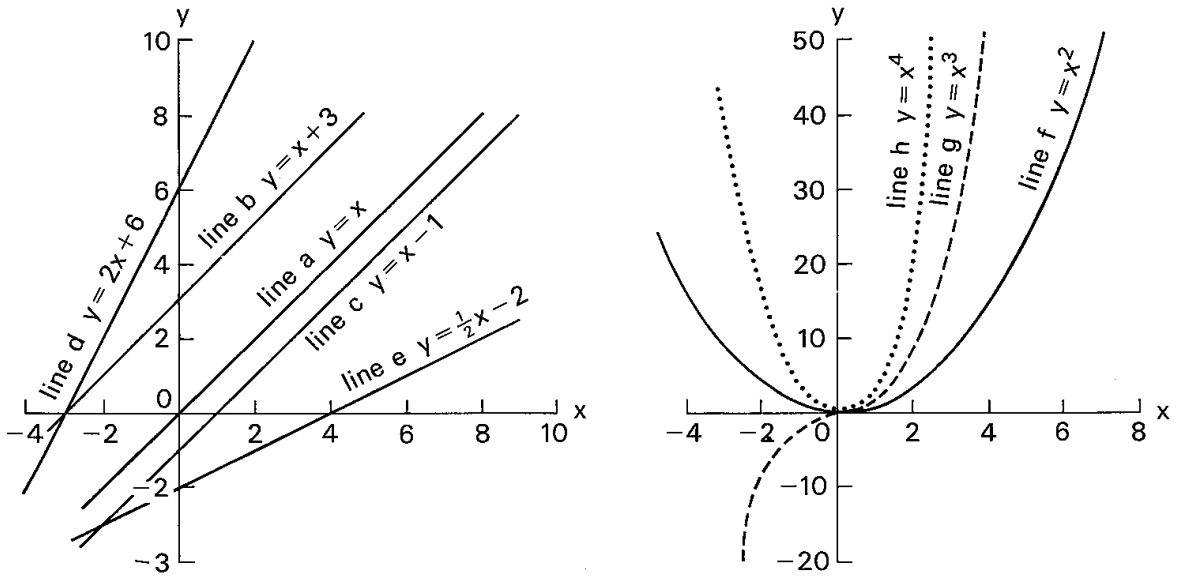
instead of

ago

separately

UNIT FIVE Graphs

SECTION A: MATHEMATICAL EQUATIONS



Mathematical equations contain variables. If there are only two variables, it is possible to show their relationship on a graph.

The simplest equation is y = x. The graph of y = x is a straight line. In this equation, the values of x and y always remain equal. (If x = 1, then y = 1; if x = −3, then y = −3, etc.) This graph line (line a) passes through the *origin* of the graph.

Sometimes the equation of a straight line contains a *constant*. For example, in the equation y = x+3, x and y are the two *variables* and 3 is the constant. If an equation contains a constant then the graph line does not pass through the origin. Look at lines b and c. If the constant is positive, then the line cuts the y *axis* above the origin. If the constant is negative, then the line cuts the y axis below the origin.

Lines a, b and c all have the same *gradient*. That is to say they all slope at the same angle to the x axis. Now look at lines d and e. Line d has a higher gradient and line e has

a lower gradient. This is because the *coefficients* of x are different in these equations. In equations a, b and c, x has a coefficient of 1. That is why the graph lines all have the same gradient. However, in equation d the coefficient of x is 2 and in equation e the coefficient is $\frac{1}{2}$. If the coefficient of x is high, the gradient is high. Similarly, if the coefficient is low, the gradient is low.

These five lines are all straight. However, if a graph equation contains x^2, x^3, etc., the graph becomes curved.

Because equation f contains x^2, the graph line is curved. Line f does not pass below the origin because the values of y never become negative. A squared number never has a negative value. (If $x = -2$, $x^2 = 4$; if $x = -3$, $x^2 = 9$, etc.) Similarly, equation h contains x^4 and so the y values never become negative. (If $x = -2$, $x^4 = 16$; if $x = -3$, $x^4 = 81$, etc.) However, equation g contains x^3, and so it gives both positive and negative values for y. (If $x = 2$, $y = 8$; if $x = -2$, $y = -8$ and so on.) That is why the graph line stretches above and below the origin.

Exercise 1 Are these statements true or false? If they are false, write corrected statements.

1. $y = x$ (line a)

a) If $x = 10$, $y = 10$.
b) The graph line passes through the origin.
c) The equation contains a constant.

2. $y = x+3$ (line b)

a) If $x = 4$, then $y = 7$.
b) The graph line passes through the origin.
c) The equation contains a negative constant.
d) Lines a and b have the same gradient.

3. $y = x-1$ (line c)

a) if $x = -2$, $y = 0$.
b) The graph line cuts the y axis below the origin.
c) The equation contains a negative constant.
d) The coefficient of x is 2.

4. $y = 2x+6$ (line d)

a) If $x = 0$, $y = 6$.
b) The graph line has the highest gradient.
c) The equation contains the constant 2.

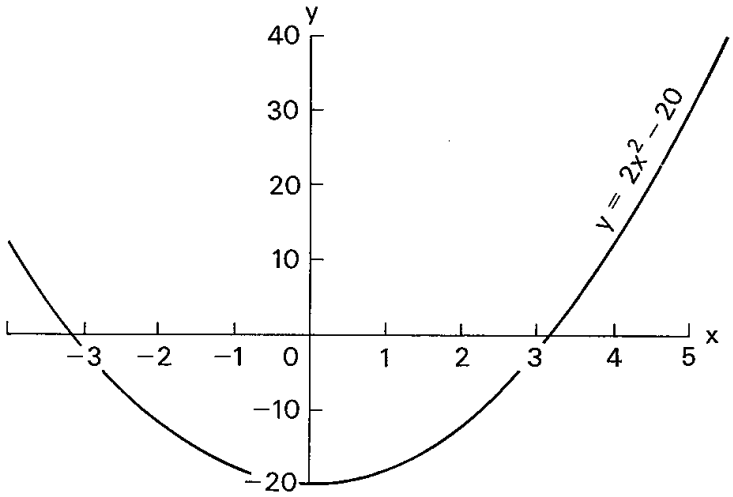
5. $y = \frac{1}{2}x - 2$ (line e)

a) If $x = 4$, $y = -2$.
b) Line e has a lower gradient because the coefficient of x is low.
c) The line cuts the y axis above the origin.
d) The equation contains the constant $\frac{1}{2}$.

6. $y = x^2$, $y = x^3$, $y = x^4$ (lines f, g, h)

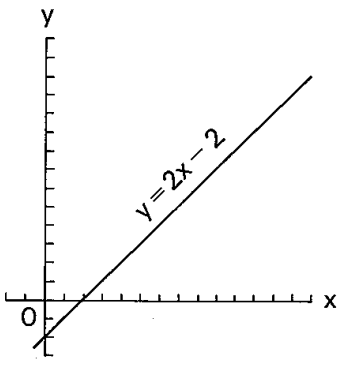
a) In all three graphs, if $x = 1$, $y = 1$.
b) The three graph lines are all curved.
c) All three lines pass through the origin.
d) The lines all stretch above and below the origin.
e) x^2, x^3 and x^4 never have negative values.

Exercise 2 Examine this graph and then answer the questions.



1. Is the graph line curved?
2. Does y have both positive and negative values?
3. Where does the graph line cut the y axis?
4. How many times does the graph line cut the x axis?
5. What is the equation?
6. If there is a constant in the equation, what is its value?
7. If x has a coefficient, what value does it have?
8. If $x = 1$ what does y equal?
   If $x = -2$ what does y equal?
   If $x = 4$ what does y equal?
   If $x = 5$ what does y equal?

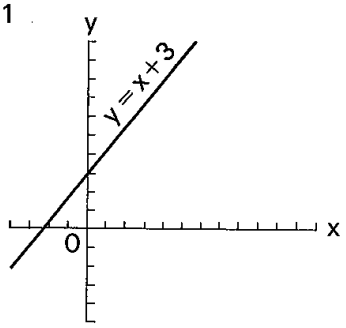
Exercise 3 Make sentences from the pictures. Look at the example first.



equation/constant/line/ origin

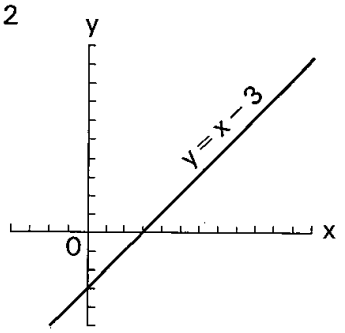
If the *equation* contains a *constant*, the *line* does not pass through the *origin*.

1



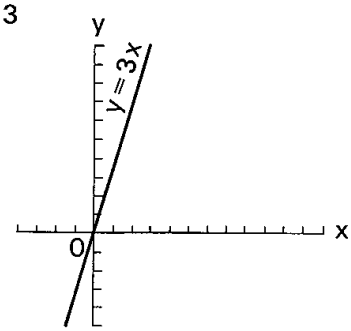
constant/positive/line/ above/origin

2



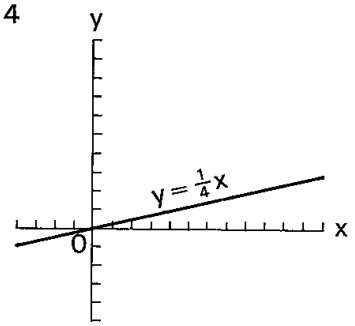
constant/negative/line/ below/origin

3



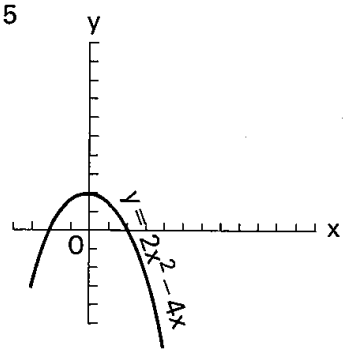
x/high coefficient/gradient/ high

4



x/low coefficient/gradient/ low

5



equation/x^2/graph/curved

6

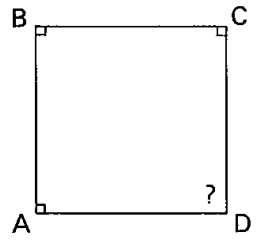
$x = -1, x^4 = 1$

$x = -2, x^4 = 16$

$x = -3, x^4 = 91$

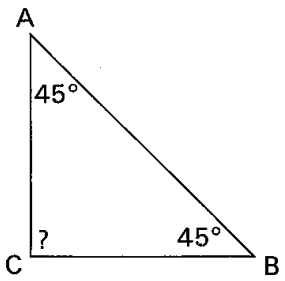
x/negative/x^4/positive

7



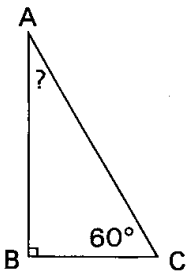
angles A, B, C/right angles/
angle D = ?

8



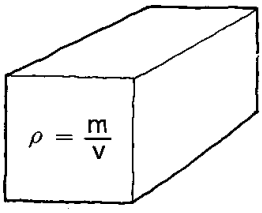
angles A, B = 45°/
angle C = ?

9



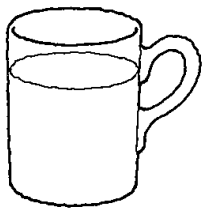
angle B = 90°, angle
C = 60°/angle A = ?

10



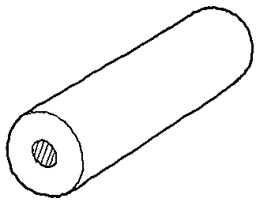
ρ = ? g/cm^3
m = 500 g
v = 100 cm^3

11



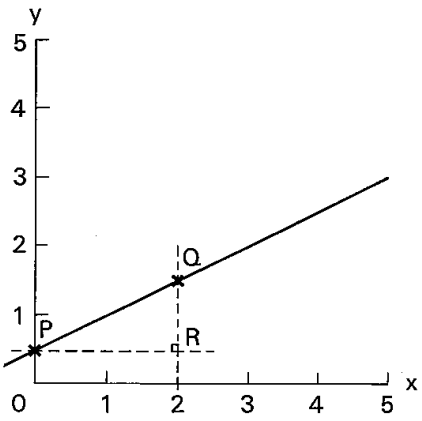
ρ = 2 g/cm^3
m = ? g
v = 16 cm^3

12



ρ = 9 g/cm^3
m = 900 g
v = ? cm^3

Exercise 4 Examine the graph on the left and read the instructions under it.



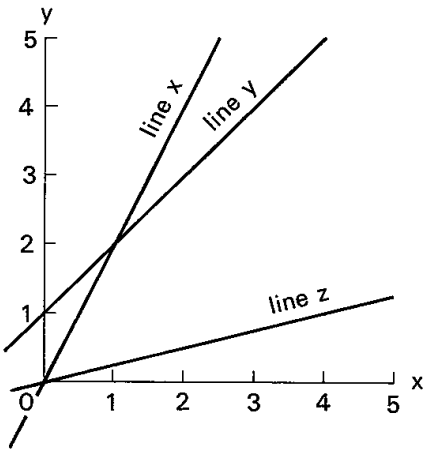
To calculate the gradient of a straight line.

1. Find the two points on the line x = 0 and x = 2.
2. Mark the two points with your pencil and then label them P and Q.
3. Construct a right-angled triangle PQR. First draw a line parallel to the y axis through Q. Label the third point of the triangle R.
4. Measure the lines QR and PR. (QR = 1; PR = 2)
5. The gradient is calculated with the formula $\frac{QR}{PR}$.
   Therefore, the gradient is $\frac{1}{2}$.

Finally, write a short report. Start like this:

To calculate the gradient of a graph line.

1. First, the two points x = 0 and x = 2 were .....



Calculate the gradients of the three lines on the left. Follow the same instructions.

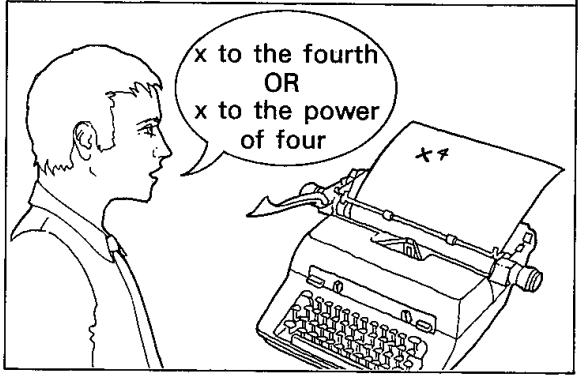
LANGUAGE NOTE 13

one axis

BUT

two axes

LANGUAGE NOTE 14



a number
a value
a variable
a constant
a coefficient
a gradient
an origin
an axis

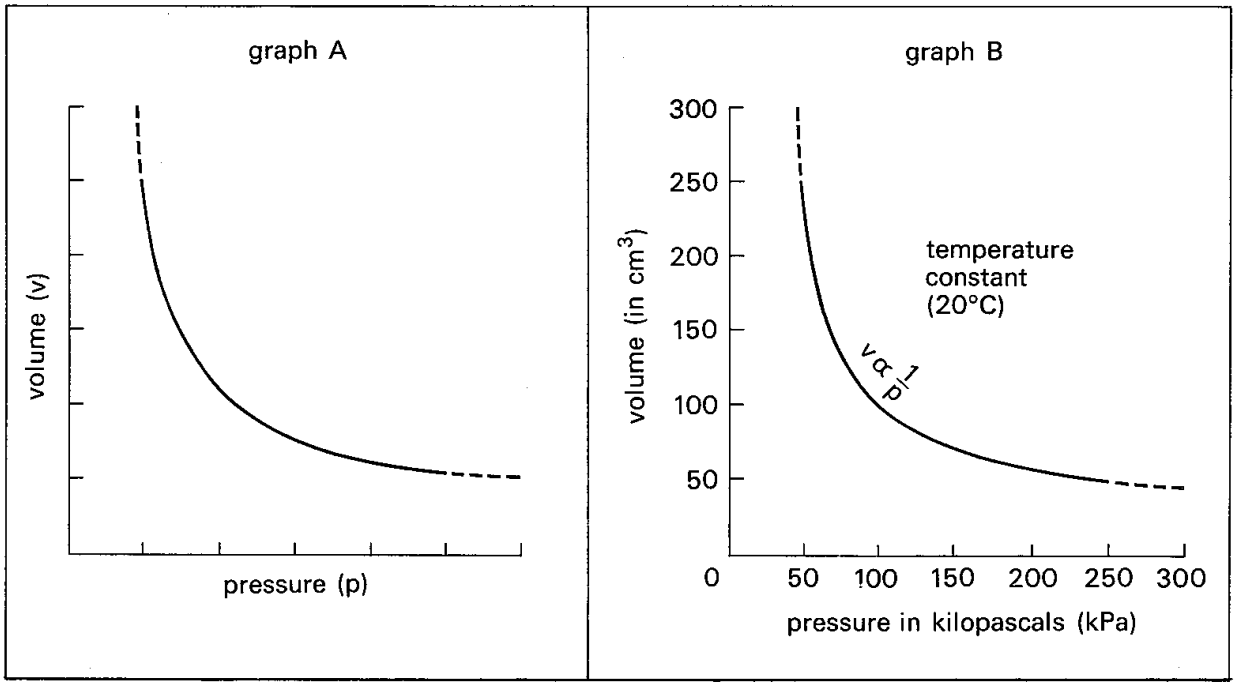
if . . . . . then . . . . . .

similarly

right-angled

SECTION B: BOYLE'S LAW

The two graphs on page 69 give the relationship between the pressure of a gas and its volume. This relationship is called Boyle's Law. As the pressure of a gas increases, so its volume decreases. Conversely, as the pressure decreases, so the volume increases. In other words, the pressure of a gas varies in inverse proportion to its volume ($v \propto \frac{1}{p}$).



Although both the graphs give this information, graph A is incomplete. Although the axes are labelled, the units of measurement are not given. Similarly, the graph equation is not given although the graph line is correctly drawn.

Moreover, although the axes are labelled correctly, the values of p and v are not shown. It is impossible to use the graph unless the values of p and v are given. Unless the values are shown, the graph provides no numerical information at all.

Furthermore, the graph is inaccurate unless it includes the words 'Temperature Constant'. The volume of a gas is affected by temperature. The volume varies in direct proportion to the temperature. In other words, the volume of a gas decreases as its temperature decreases. Conversely, as the temperature increases, the volume also increases. Therefore, the equation $v \propto \frac{1}{p}$ is inaccurate unless the temperature remains constant, and the graph shown is correct only when $T = 20°C$.

Exercise 5 Study the text and then complete the sentences.

A. Describe *Boyle's Law* in one sentence.
Boyle's Law: The pressure of . . . . . proportion . . . . . .

Explain the law in another way. (Two sentences)

As . . . . . , so . . . . . .
Conversely, as . . . . . , so . . . . . .

The relationship between the volume of a gas and its temperature is also given in the text. This relationship is called *Charles' Law.*

Charles' Law: The volume . . . . . proportion . . . . . .
In other words, the volume . . . . . .
Conversely . . . . . .

B. How is graph A incomplete?

1. It does not give . . . . . .
2. It does not give . . . . . .
3. It does not show . . . . . .
4. It does not include . . . . . .

Complete sentences 5, 6, 7 and 8 with the information from sentences 1, 2, 3 and 4. Use the word *unless.*

5. It is impossible to use the graph unless . . . . . given.
6. The graph is incomplete . . . . . .
7. The graph provides no numerical information . . . . . .
8. The graph is inaccurate . . . . . .

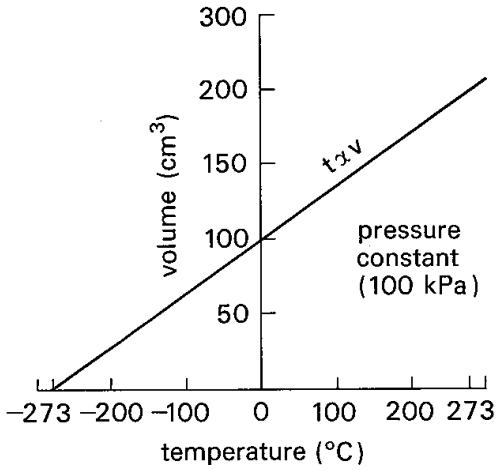
Exercise 6 Join these sentences to make one sentence. Use the word *although.*

1. Both graphs show Boyle's Law.
   One graph is incomplete.
2. Graph A gives some information.
   It is incomplete.
3. The axes are labelled.
   The units of measurement are not given.
4. The graph equation is not given.
   The graph line is correctly drawn.
5. The values of p and v are not shown.
   The axes are correctly labelled.

Join these sentences to make one sentence. Use the words *because*, *as* or *unless*.

6. The equation $v \propto \frac{1}{p}$ is inaccurate.
   The temperature of a gas remains constant.
7. The graph line becomes less curved.
   The pressure increases.
8. The graph line does not cut the axes.
   p and v never have negative values.
9. A straight-line equation contains a constant.
   The graph line passes through the origin.
10. The temperature of a gas increases.
    Its molecules move more rapidly.

Exercise 7 Complete the paragraphs from the wordlist.



above	*decreases*	*Law*
Although	*direct*	*marked*
Conversely	*impossible*	*negative*
	increases	*relationship*
		to
		words

The graph shows the . . . . between the temperature of a gas and its volume. This relationship is called Charles' . . . . . The temperature of a gas is in . . . . proportion to its volume. In other . . . . , as the temperature . . . . , so the volume also increases. . . . . , as the temperature decreases, the volume of the gas . . . . .

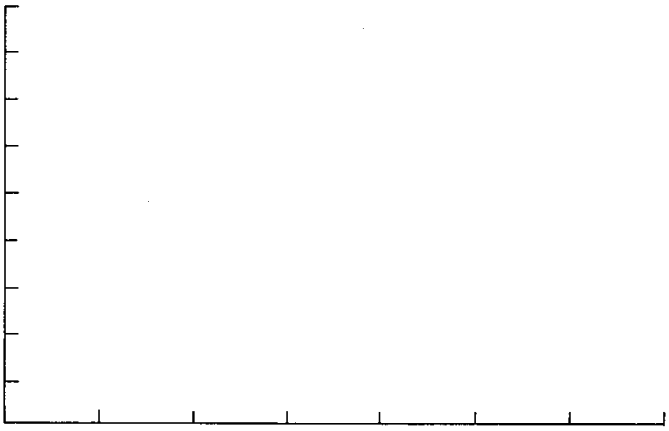
The vertical axis has no . . . . values. . . . . it is possible to

have negative values for temperature, it is . . . . to have a negative value for volume. The temperature values are . . . . along the horizontal axis from −273°C . . . . +273°C. At higher temperatures (i.e. . . . . 273°C) Charles' Law is no longer very accurate.

Exercise 8 Fill in the table.

	days of the week	abbreviations
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Now listen to the teacher and follow his instructions.

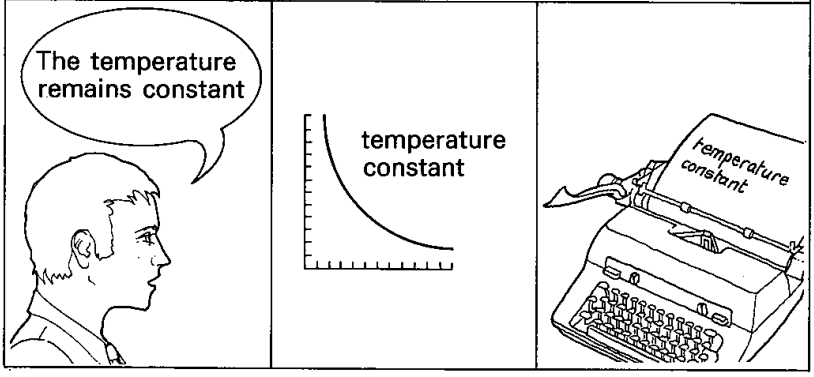


LANGUAGE NOTE 15

$v \propto t$: in direct proportion to

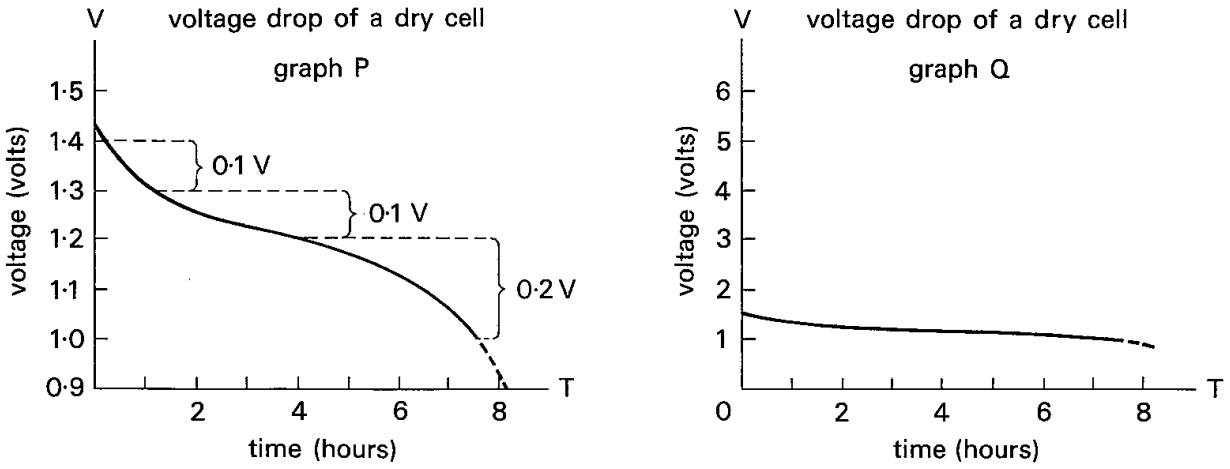
$v \propto \frac{1}{p}$: in inverse proportion to

LANGUAGE NOTE 16



a relationship	moreover	numerical
a law	furthermore	(in)complete
a week		(in)accurate
	in direct/inverse proportion	
as . . . . . (so)	to	conversely
unless		
although	in other words	include

SECTION C: TIME GRAPHS



Graphs P and Q both show the voltage drop in the same dry cell. The cell was in continuous use for eight hours. When the cell was new, the voltage was approximately 1.4 V. As the cell was used, the voltage decreased. When the voltage decreased to less than 1.0 V, the current became very weak. After eight hours the voltage was no longer strong enough to provide much power.

It is important to use suitable scales in a graph. In graph Q, the voltage scale is unsuitable. The scale shows values from 0 V to 5 V. It is only necessary to show values from 0.9 V to 1.5 V. Moreover, the voltage scale is too small. It is difficult to take any accurate measurements from graph Q. In graph P, only the necessary voltage values are given. It is much easier to measure the voltage drop when the scale is larger.

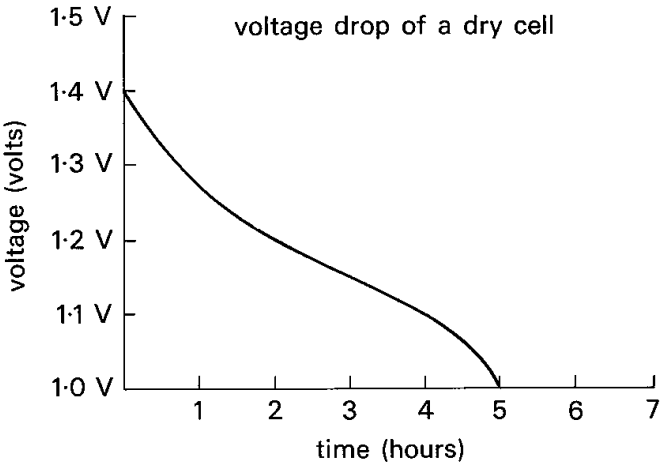
The voltage decreased quite rapidly in the first hour. It decreased from approximately 1.4 V to 1.3 V. In other words, it decreased by 0.1 V in one hour. In the next three hours, the decrease was much slower. It decreased from 1.3 V to 1.2 V. In other words, it only decreased by 0.1 V in three hours. In the next two and a half hours it decreased more rapidly again. It decreased by 0.2 V in two and a half hours. The dry cell became useless when it was used continuously for more than eight hours.

The graphs do not include one necessary piece of information. Although they give measurements of the voltage drop, they do not give any information about the use of the cell. We do not know if the cell was used in a torch or in a radio, for example. A torch bulb uses much more current than a radio and so needs more power. Unless we know the use of the cell, the graph is not very useful.

Exercise 9 Are these statements true or false? If they are false, write a true statement.

1. Graphs P and Q both give the same information.
3. The voltage of a dry cell increases slowly as it is used.
3. After continuous use for eight hours, the cell still provided a little power.
4. Graph P has a more suitable voltage scale than graph Q.
5. In graph Q, the voltage scale is too small.
6. In graph P, the voltage scale is too large.
7. It is easy to take voltage measurements from graph P.
8. It is easy to take accurate measurements from graph Q.
9. The graphs include information about the use of the cell.
10. This cell was used in a radio.

Exercise 10 This cell was used in a large torch. Examine the graph and the example under it.

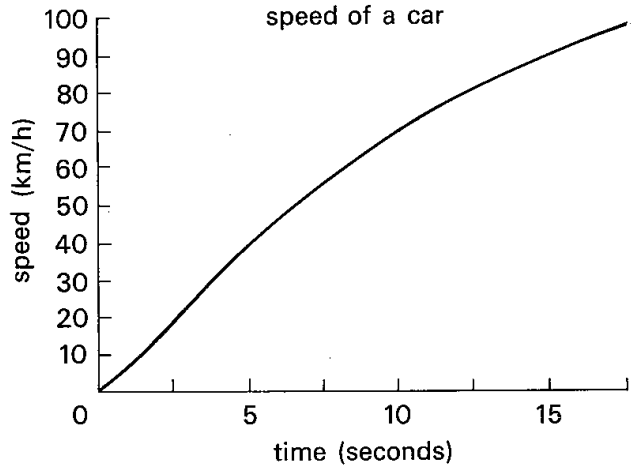


In the first two hours, the voltage decreased from 1.4 V to 1.2 V. It decreased by 0.2 V in two hours.

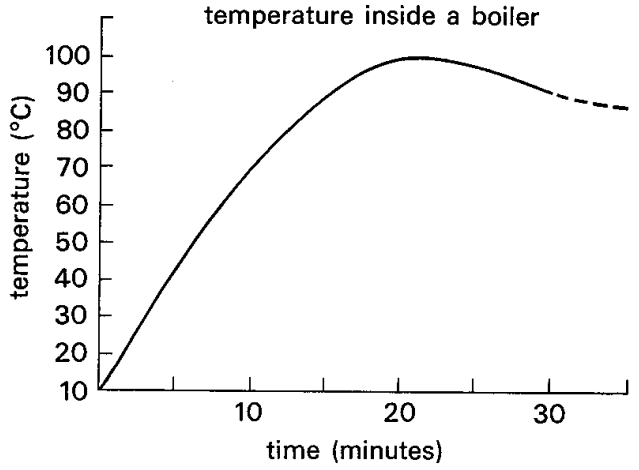
Complete these sentences in the same way.

1. In the next two hours, ...
   It decreased by . . . . . .
2. In the last hour, ...
   It . . . . . .

Now look at these graphs and complete the sentences below them in the same way.



3. In the first five seconds, ...
   It . . . . . .
4. In the next . . . . . .
   It . . . . . .
5. In the last . . . . . .
   It . . . . . .



6. In the first . . . . . .
   It . . . . . .
7. In . . . . . .
   It . . . . . .
8. In . . . . . .
   It . . . . . .

Exercise 11 Read these examples carefully.

a) Watt increased the efficiency of his engine.
b) He added a condenser.

Watt increased the efficiency of his engine *when* he added a condenser.

a) We do not know.
b) The cell was used in a torch.

We do not know *if* the cell was used in a torch.

a) $x = 4$
b) $x^2 = 16$

If $x = 4$, $x^2 = 16$
OR
When $x = 4$, $x^2 = 16$
OR
$x = 4$ if (or when) $x^2 = 16$

Join a) and b) below with *if* or *when* or both.

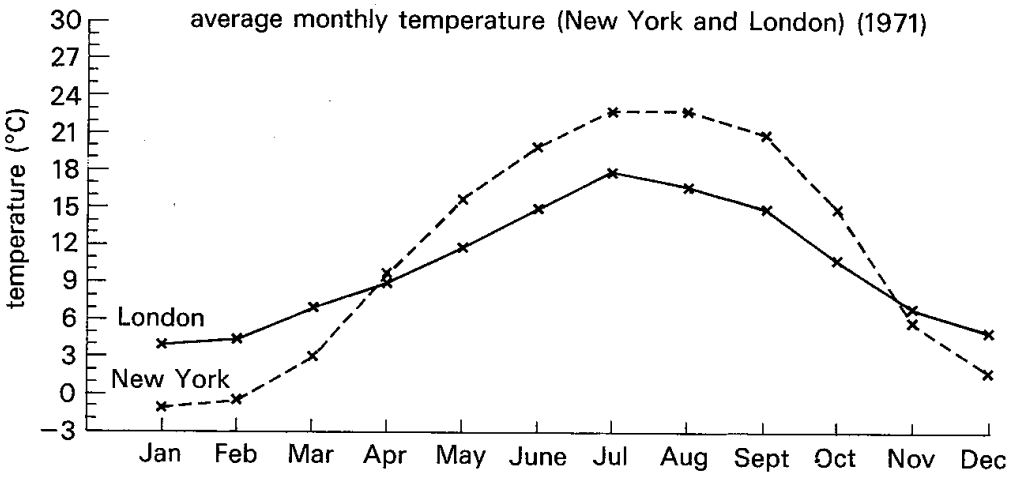
1. a) the voltage was approximately 1.4 V
   b) the dry cell was new
2. a) the current became very weak
   b) the cell was used for more than seven and a half hours
3. a) the equation contains a constant
   b) the graph line does not pass through the origin
4. a) the coefficient of x is low
   b) the gradient of the line is also low
5. a) the graph line becomes curved
   b) the graph equation contains x^2
6. a) engine efficiency increased rapidly
   b) turbines first appeared in 1884
7. a) it is important to know
   b) the carbon content of steel is high or low
8. a) the equation $v \propto \frac{1}{p}$ is inaccurate
   b) the temperature is allowed to vary

Exercise 12 Complete this table.

	months of the year	abbreviations
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

Below there is a discontinuous time graph. It gives information about the average monthly temperatures in New York and in London.

Study the graph and listen to your teacher.



How long did the temperature stay $\begin{matrix}\text{above}\\\text{below}\end{matrix}$ . . . . °C?

How far did the temperature $\begin{matrix}\text{rise}\\\text{fall}\end{matrix}$ between . . . . and . . . .?

What was the temperature difference between London and New York in . . . .?

LANGUAGE NOTE 17		
in 1884		on Monday
in July	BUT	on July 21st
in the first hour		on the third day

a drop
a second
a month
a difference

(an) acceleration

rise
stay

(dis)continuous
(un)suitable
(un)necessary

average

useful
useless

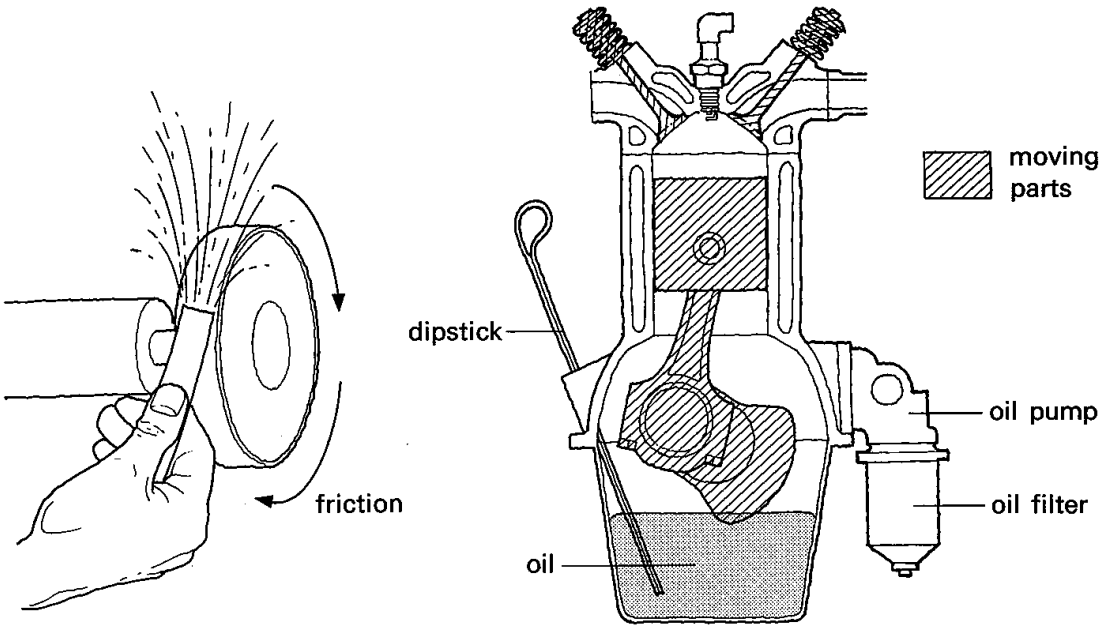
continuously

any

how long . . . .?
how far . . . .?

UNIT SIX Motor Vehicle Maintenance

SECTION A: LUBRICATION



Friction causes heat and wear. In an engine, oil lubricates the moving parts and reduces the heat and the wear. The oil also collects any small particles of dirt or metal and carries them to the oil filter.

Some of the oil will leak out of the engine when it is used. The amount of oil in the engine will need checking regularly. The dipstick is used for checking the amount of oil. If there is not enough oil in the engine, friction between the moving parts will increase and the engine will quickly become damaged.

The oil in the engine will need changing about once every 5000 km. If it is not changed, it will become thin and full of impurities and it will not lubricate efficiently. The oil filter will also need changing regularly. If it is not changed, it will become blocked by particles of dirt and metal. If the filter becomes blocked, the oil will not flow around the engine and heat and wear will increase very rapidly.

Some parts of a car need greasing – usually about once every six months. Fifty years ago cars needed greasing every week. Modern vehicles need much less greasing. They only need greasing about twice a year. Cars in the future will probably need no greasing.

Exercise 1 Are these statements true or false? Rewrite them if they are false.

1. Oil lubricates and collects dirt.
2. The oil filter is used for changing the oil.
3. Particles of dirt and metal will damage the moving parts of an engine.
4. The amount of oil in an engine does not change.
5. If the amount of oil in an engine decreases, the friction will increase.
6. The dipstick shows the amount of damage in an engine.
7. The oil in an engine needs changing regularly but the oil filter does not need changing.
8. Grease lubricates.
9. Early cars needed more greasing than modern cars.
10. Cars in the future will need more greasing.

Exercise 2 Often, *will* does not refer to the future but indicates something that always happens. For example: *Friction will cause heat and wear.*

Rewrite this paragraph using *will* in each sentence.

Friction causes heat and wear. In an engine, oil lubricates the moving parts and reduces heat and wear. The oil also collects any small particles of dirt and metal and carries them to the oil filter.

Now rewrite these sentences using *will.*

1. At normal pressure, water boils at 100°C. It freezes at 0°C.
2. Lead melts at 327°C.
3. An electric current flows from negative to positive.
4. Non-ferrous metals do not corrode easily.
5. A hacksaw cuts metal.
6. Low pressure decreases the boiling point of water.
7. In an open container, a liquid evaporates slowly.
8. A dry cell supplies 1.5 V.

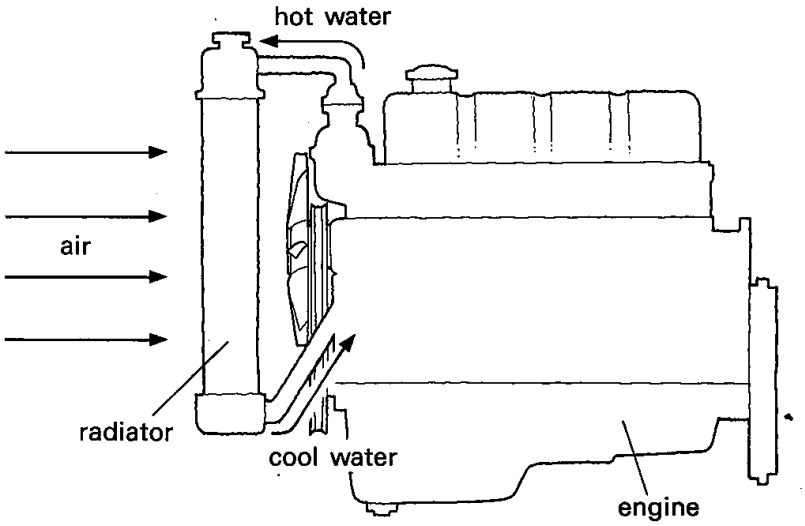
Exercise 3 Look at this example:

a) Modern cars need greasing twice a year.
b) Modern cars need greasing once every six months.

Now rewrite these sentences in the same way.

1. Early cars needed greasing four times a month.
2. The amount of oil in an engine needs checking seven times a week.
3. The amount of liquid in a fire extinguisher needs checking at least four times a year.
4. In some early steam engines, the boiler needed filling four times an hour.
5. In these steam engines, the piston moved only twenty times a minute.
6. The windscreen wipers on most modern cars operate approximately sixty times a minute.
7. In modern vehicles, the water in the radiator only needs checking about twice a month.

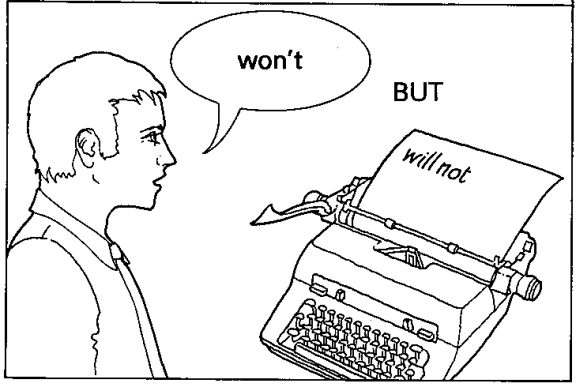
Exercise 4 Look at the diagram below and then complete the paragraph from the wordlist.



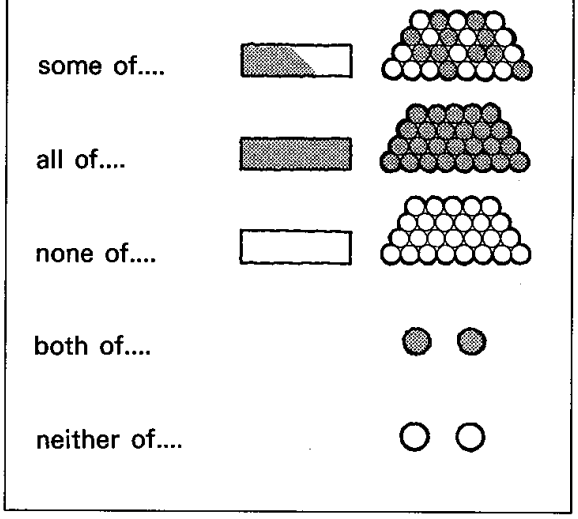
air	*cooled*	*out of*
amount	*flows*	*radiator*
below	*leak*	*reduces*
boil	*needs*	*stroke*
causes		*unless*
checking		*will*

The friction inside an engine . . . . heat. Too much heat . . . . damage the engine and so it . . . . cooling. Generally, engines are . . . . by water but some engines are . . . .-cooled. Four-. . . . engines are usually water-cooled. The water . . . . around the inside of the engine and . . . . the temperature. The water then flows to the . . . . and is cooled by the air flow. Then it comes . . . . the radiator and runs through the engine again. Some of the water will . . . . out of the engine when it is used. The heat of the engine will sometimes cause the water to . . . . and evaporate into steam. Therefore, the . . . . of water in the radiator will need . . . .regularly. In cold conditions (. . . . 0°C), the water in the radiator will freeze . . . . *anti-freeze* is added to it.

LANGUAGE NOTE 18



LANGUAGE NOTE 19



a dipstick
a moving part

friction
wear
damage
lubrication
grease

the future
anti-freeze

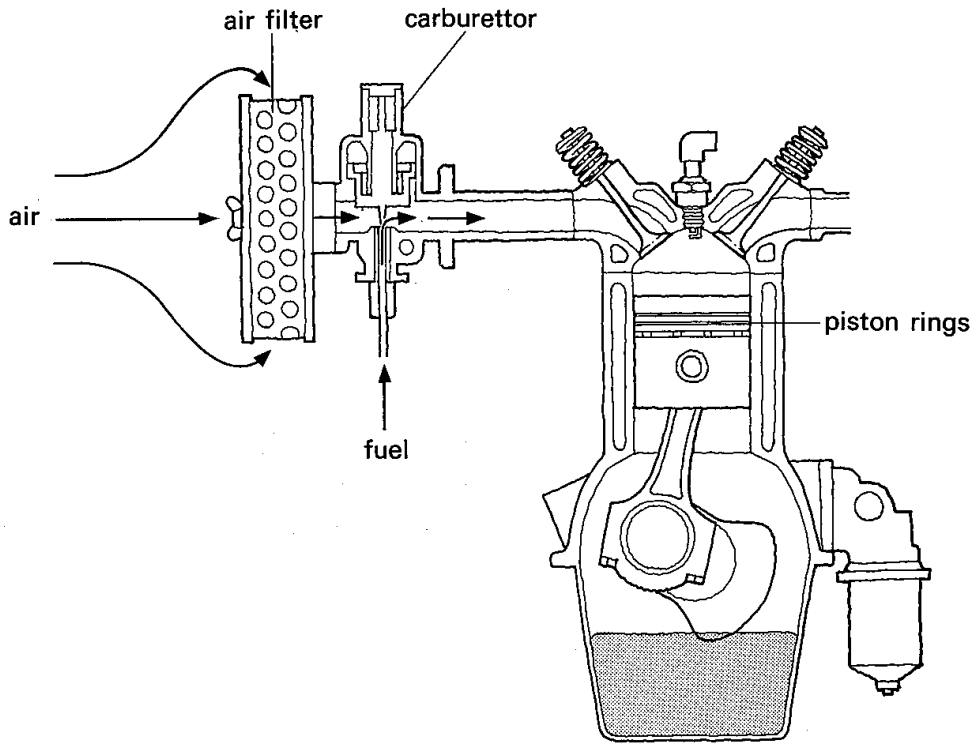
collect
leak
damage
block
flow
grease
lubricate

future
every

regularly
efficiently
once

out of

SECTION B: FILTERS



Although it is very simple, the air filter is a very important part of an engine. It may be made of paper or it may contain oil. A paper filter will need changing regularly. An oil filter will not need changing but it will need cleaning and the oil will need changing. Filters will become blocked unless they are cleaned or changed. If they become blocked, the engine may be damaged.

Air passes through the air filter before it goes into the carburettor. The filter removes dirt, dust and other impurities from the air. In the carburettor, the air is mixed with fuel (usually in the ratio of about 10:1) and this mixture passes to the cylinders. If the air filter becomes blocked, the air flow to the carburettor will be decreased. If the air flow decreases, the amount of fuel in the mixture will increase. The amount of fuel in the mixture may increase by 30% or 40%. Then the engine will not operate efficiently and considerable damage may be caused inside the cylinders.

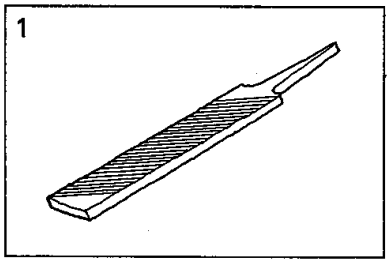
Never operate an engine if the air filter is not in place. Dust and dirt may enter the engine and damage the cylinders, pistons and piston rings. If the piston rings become damaged, oil from the sump will flow past the pistons and will enter the cylinders above the pistons.

This oil may cover the spark plugs. The spark plugs will not give a spark if they are covered with oil and the engine will stop.

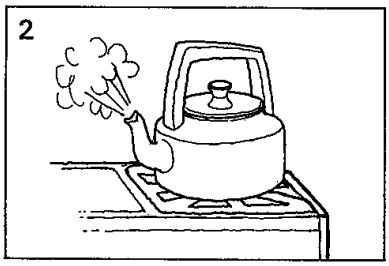
Exercise 5 Answer these questions.

1. What happens when air passes through an air filter?
2. What happens when this air passes to the carburettor?
3. What happens if the air flow is decreased?
4. What happens if the amount of fuel in the mixture is increased?
5. What happens if an engine is operated without an air filter?
6. What happens if the piston rings become damaged?
7. What happens if oil enters the cylinders?
8. What happens if the spark plugs become covered with oil?

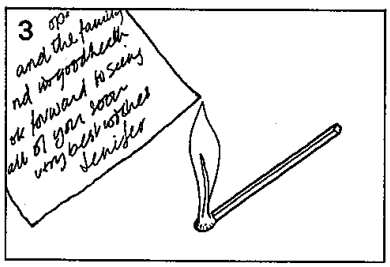
Exercise 6 Complete these sentences. Use *will* or *may*.



If a file has no handle you . . . . damage your hand.

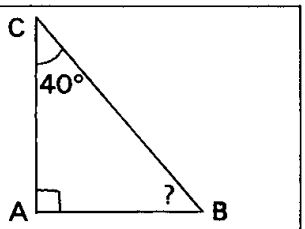


If the pressure is normal, the water . . . . boil at 100°C.



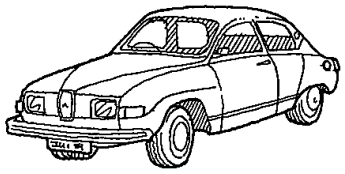
If the paper enters the flame, it . . . . burn.

4



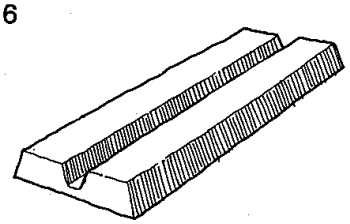
If the angle ACB is 40°, the angle ABC . . . . be 50°.

5



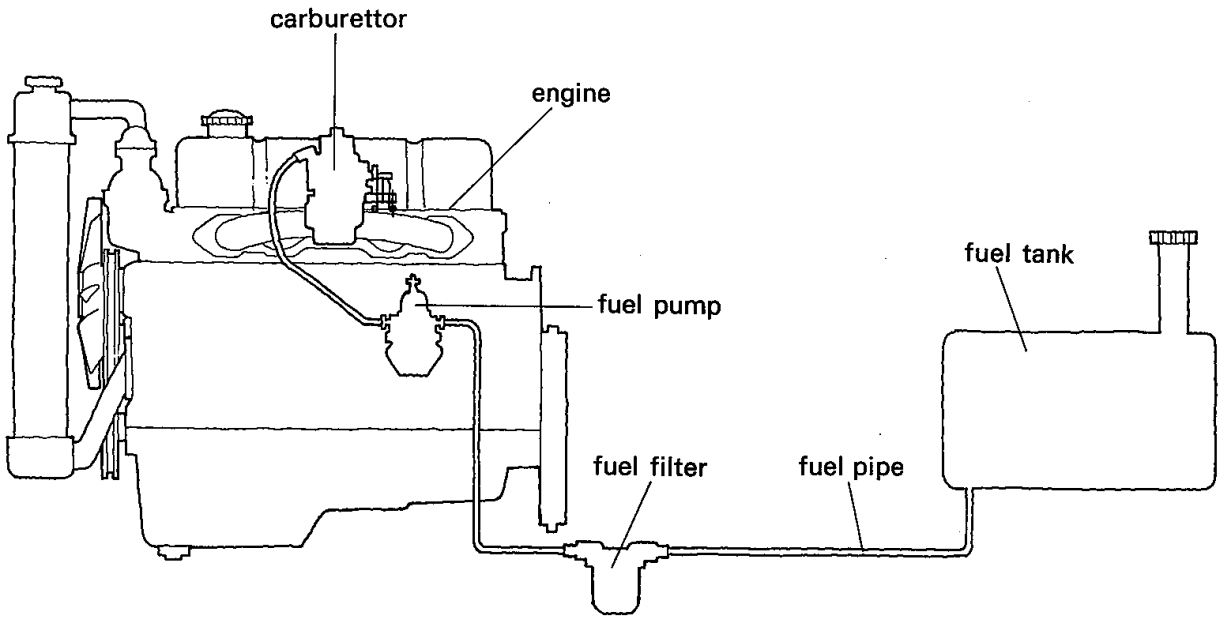
If this car has a two-stroke engine the fuel . . . . contain oil.

6



If this alloy contains copper, it . . . . be brass or it . . . . be bronze.

Exercise 7 Study the diagram below carefully. Then complete the three paragraphs on the next page from the wordlist.



becomes	*contains*	*pump*
between	*from*	*needs*
blocked	*fuel*	*remove*
cause	*impurities*	*stop*
clean	*particles*	
collect	*passes*	

Every petrol engine needs a . . . . filter. As the petrol flows . . . . the fuel tank to the carburettor, it . . . . through a filter. This filter removes any . . . . of dirt, dust, etc. in the fuel. Unless these . . . . are collected in the filter, they may eventually block the carburettor or enter the engine and . . . . considerable damage.

The fuel filter . . . . cleaning regularly. If it is not cleaned, it may become . . . . . If it . . . . blocked, the fuel will not flow to the carburettor and the engine will . . . . .

. . . . the carburettor and the filter, there is always a fuel pump. This pump usually . . . . another small filter. The filter in the fuel . . . . is usually made of wire. It will only . . . . comparatively large particles of dirt. It is possible to . . . . the filter from the pump and to . . . . it with a stiff brush.

Exercise 8 Look at this example:

Dirt and dust in the air may damage an engine.
An engine may be damaged by dirt and dust in the air.

Now change these sentences in the same way.

1. Dirt in the cylinders will damage the pistons and the piston rings.
2. Oil from the cylinders may cover the spark plugs.
3. A blocked air filter will increase the amount of fuel in the mixture.
4. Too much fuel in the mixture may cause considerable damage to an engine.
5. Lubrication will decrease friction between moving parts.
6. Impurities will change the density of a liquid.

Now look at this example:

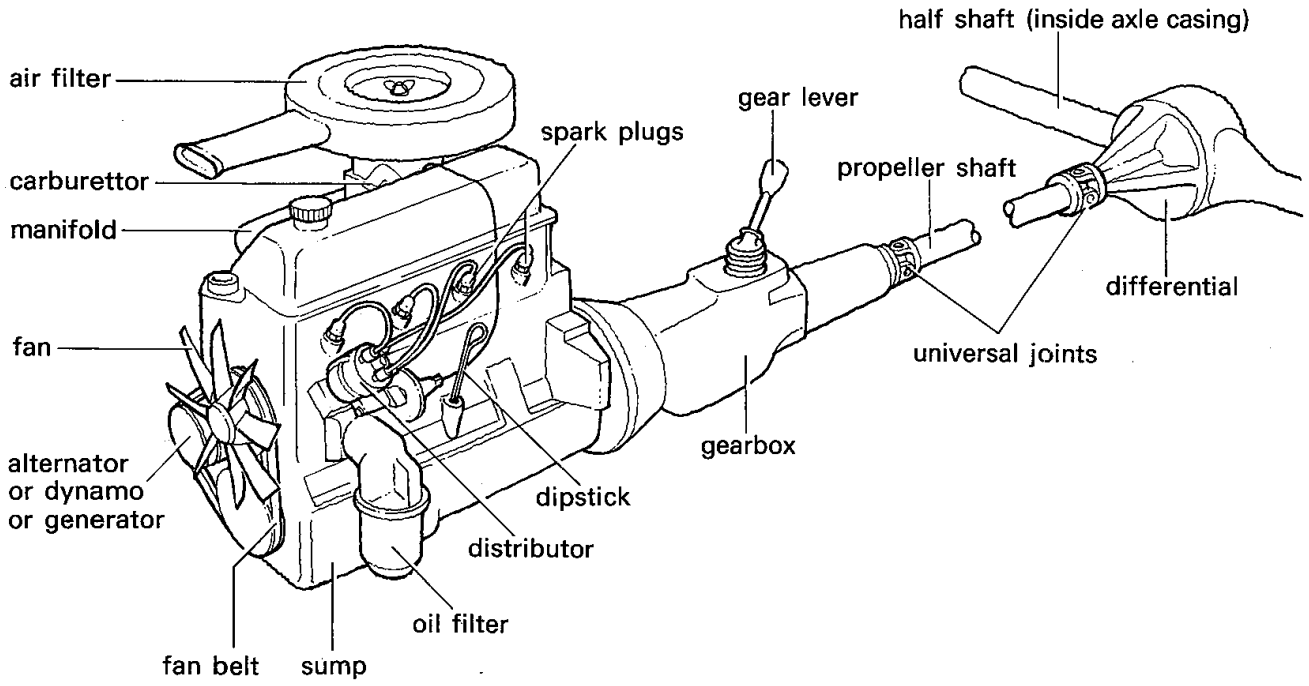
An engine may *be* damaged if the filters *become* blocked.

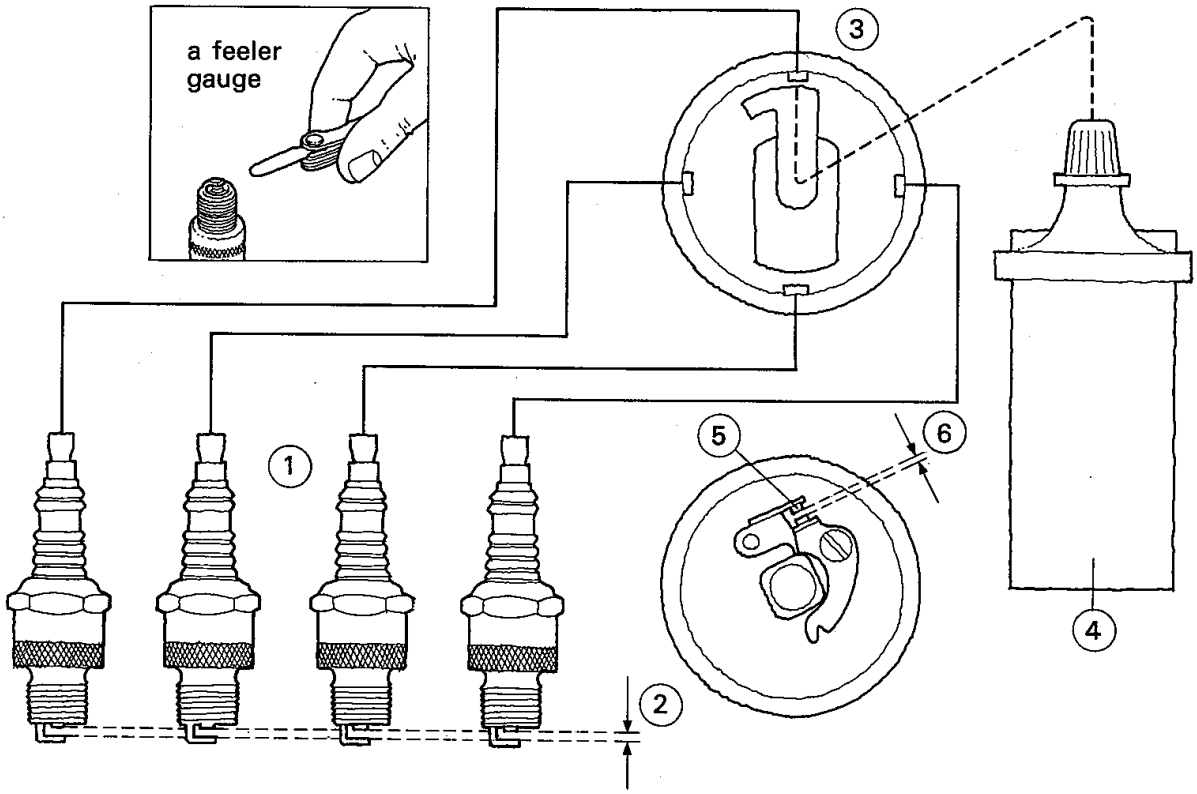
Now complete these sentences using *be* and *become*.

7. If an air filter . . . . blocked, the air flow will . . . . – decreased.
8. If an oil filter . . . . blocked, the flow of oil around the engine will . . . . considerably decreased.
9. If there is not enough oil in an engine, the friction between moving parts will . . . . increased and they will quickly . . . . damaged.
10. The lubrication of the moving parts will also . . . . decreased if the oil in the engine . . . . thin and impure.

the carburettor	operate	considerable
a piston ring		
a spark		in place
a flame		

MOTOR VEHICLE TERMINOLOGY (1) EXTERNAL PARTS





Modern motor vehicles can be very reliable. They can also be very unreliable unless they are serviced regularly. Most vehicles need servicing every 10 000 km. If they are not serviced, faults can occur and the vehicle will become unreliable.

The spark plugs (1) will need regular checking. As the plugs become worn, the gap (2) between the electrodes will increase. This gap can increase by 0.1 mm every 5000 km. The electrodes can also become dirty. If they are dirty, or if the gap is too large, the spark between the electrodes will be weak and the engine will operate badly. The electrodes can be cleaned with a small file and then adjusted to the correct gap. A feeler gauge is generally used to check the gap.

Electricity is supplied to the spark plugs by the distributor. The rotor arm (3) rotates and supplies high voltage from the coil (4) to each spark plug in turn. As the rotor arm rotates, the distributor points (5) open and close. These points will need checking because the gap (6) between them can change. If the gap is not correct, the engine will not run well. The gap can be adjusted with a

screwdriver but the points cannot normally be cleaned. If the points are in poor condition, they will need changing. Some modern cars have electronic distributors and have no points.

The electrolyte in the battery consists of a mixture of distilled water and sulphuric acid. As the vehicle is used, some of the water in the electrolyte will evaporate. This can be replaced with distilled water. Never use acid to replace electrolyte. Never use tap water either. Tap water contains impurities and can damage the lead plates inside the battery.

Exercise 9 Look at these instructions. Are they correct or incorrect?

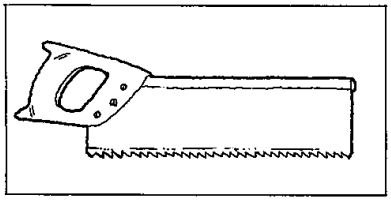
Every 10 000 km:

1. Check the spark plugs.
2. Clean the plugs with a small file.
3. Clean the points with a small file.
4. Check the gap between the points.
5. Fill the battery with tap water or acid.
6. Change the oil in the radiator.
7. Change the paper air filter.
8. Check the oil in the sump but do not change it.

Now rewrite a correct set of servicing instructions.

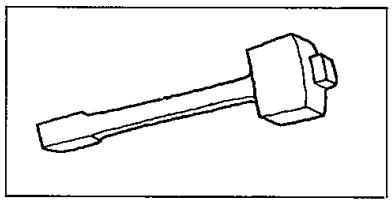
Exercise 10 Look at these examples:

1



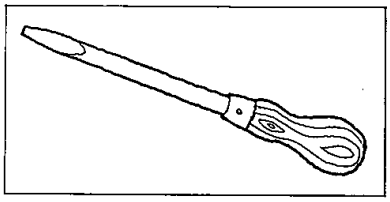
This tool can be used for cutting wood.

2

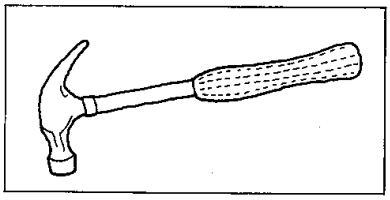


This tool can't be used for cutting metal.

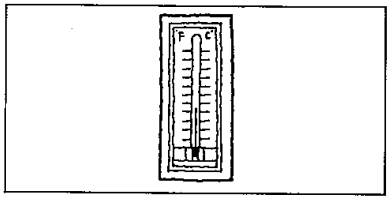
Now complete these sentences in the same way. Use *can be used* or *can't be used.*

1 

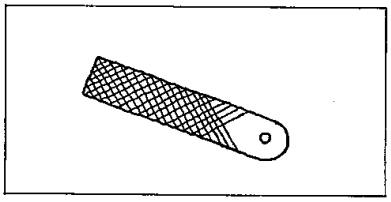
This tool . . . . . for turning screws.

2 

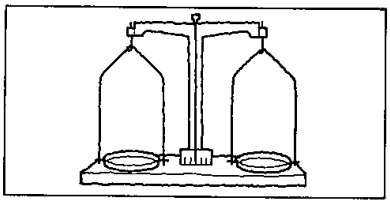
This tool . . . . . for turning bolts.

3 

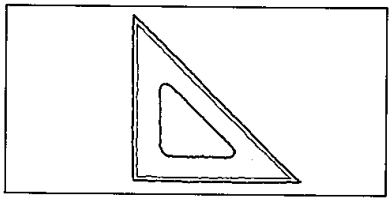
This instrument . . . . . for measuring pressure.

4 

This file . . . . . for cleaning spark plugs.

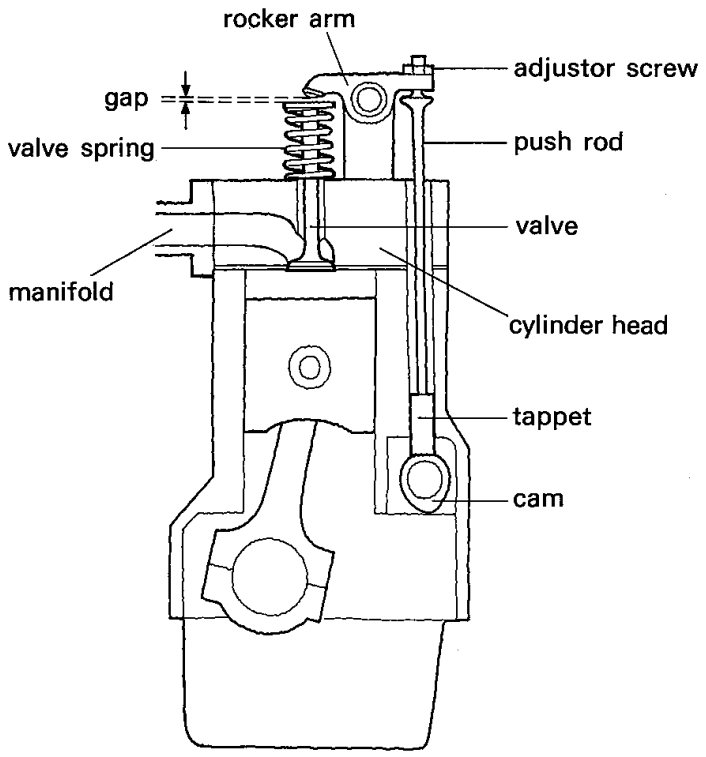
5 

This instrument . . . . . for measuring weight.

6 

This instrument . . . . . for drawing circles.

Exercise 11 Study the diagram below and then complete the two paragraphs from the wordlist.

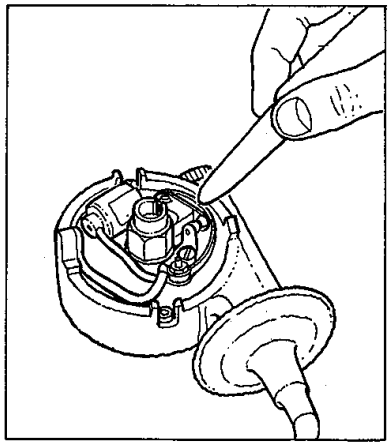


adjusting	*each*	*valves*
be	*efficient*	*worn*
because	*eight*	
cannot	*less*	
check	*may*	

A car engine . . . . have four, six or even eight cylinders. Eight-cylinder engines are not very common . . . . they are expensive to make. Most modern cars only have four cylinders but these smaller engines are much more . . . . than earlier, larger engines.

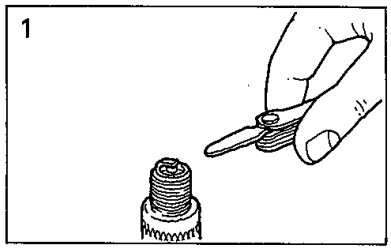
In most four-stroke engines there are two valves in . . . . cylinder. Therefore, a four-cylinder engine has . . . . valves. After a long time the valves may become . . . . . You . . . . change one or two valves. *All* the . . . . will need changing at the same time. The gap between the valve and the rocker arm will also need . . . . . It can . . . . adjusted easily with a spanner and a screwdriver. Also . . . . the condition of the valve springs. After continuous use, they may become . . . . elastic or they may break.

Exercise 12 When servicing a motor vehicle there are many things to check; for example:

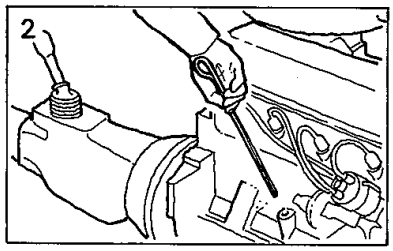


Check the gap between the distributor points.

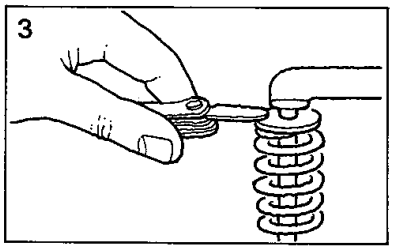
Study these pictures carefully and then complete the instructions for servicing a motor vehicle.



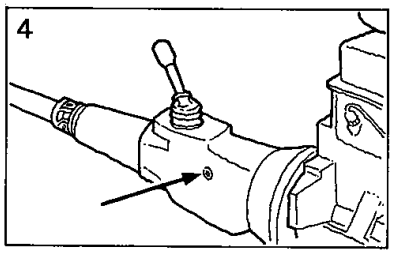
Check the . . . . between the . . . . . .



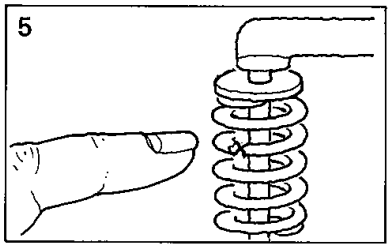
Check the amount . . . . . the sump.



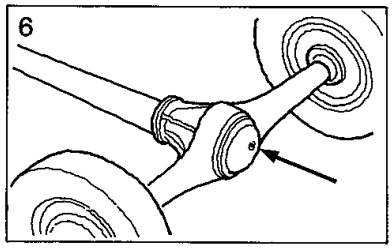
Check . . . . . between the . . . . and the . . . . . .



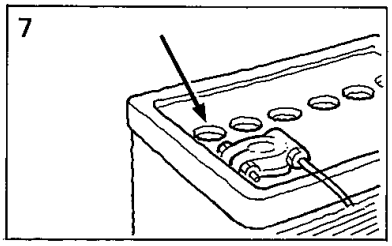
Check the . . . . of oil in the . . . .



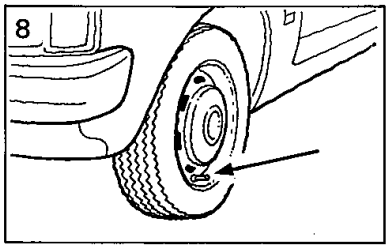
. . . . the condition of . . . . . .



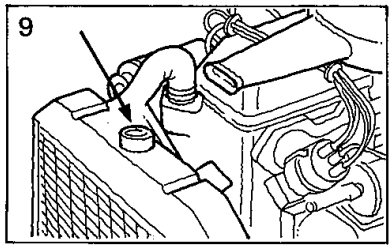
. . . . . oil . . . . . differential.



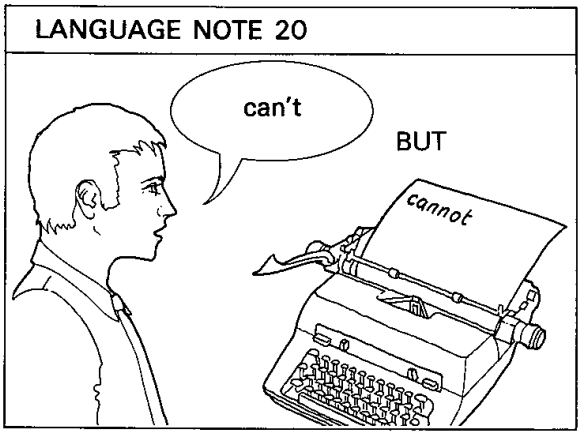
. . . . . amount . . . . . battery.

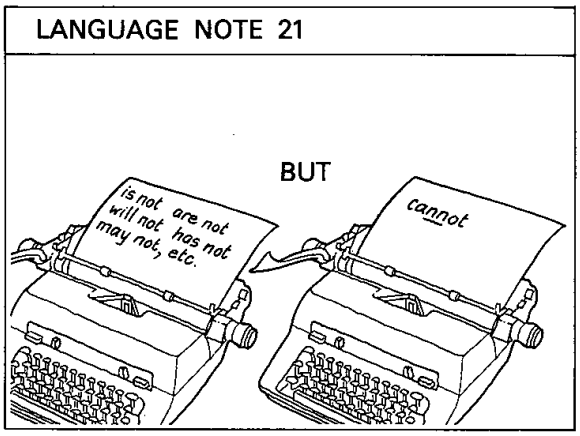


. . . . . pressure . . . . . .



. . . . . .





servicing

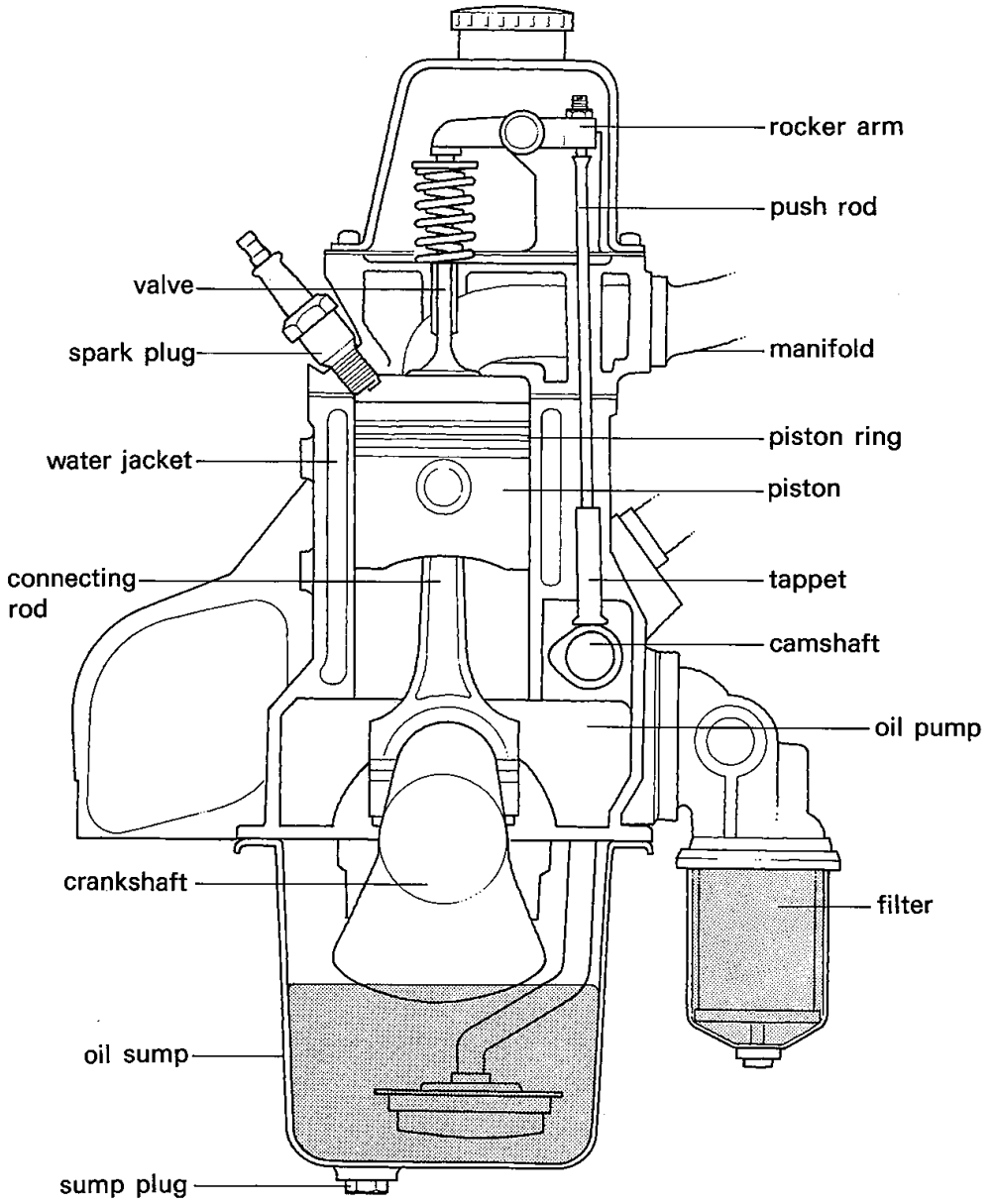
a fault
a distributor
a rotor arm
a rocker arm
an adjuster screw
a push rod
a tappet
a cam

the coil
the points of a vehicle

service
occur
rotate
adjust

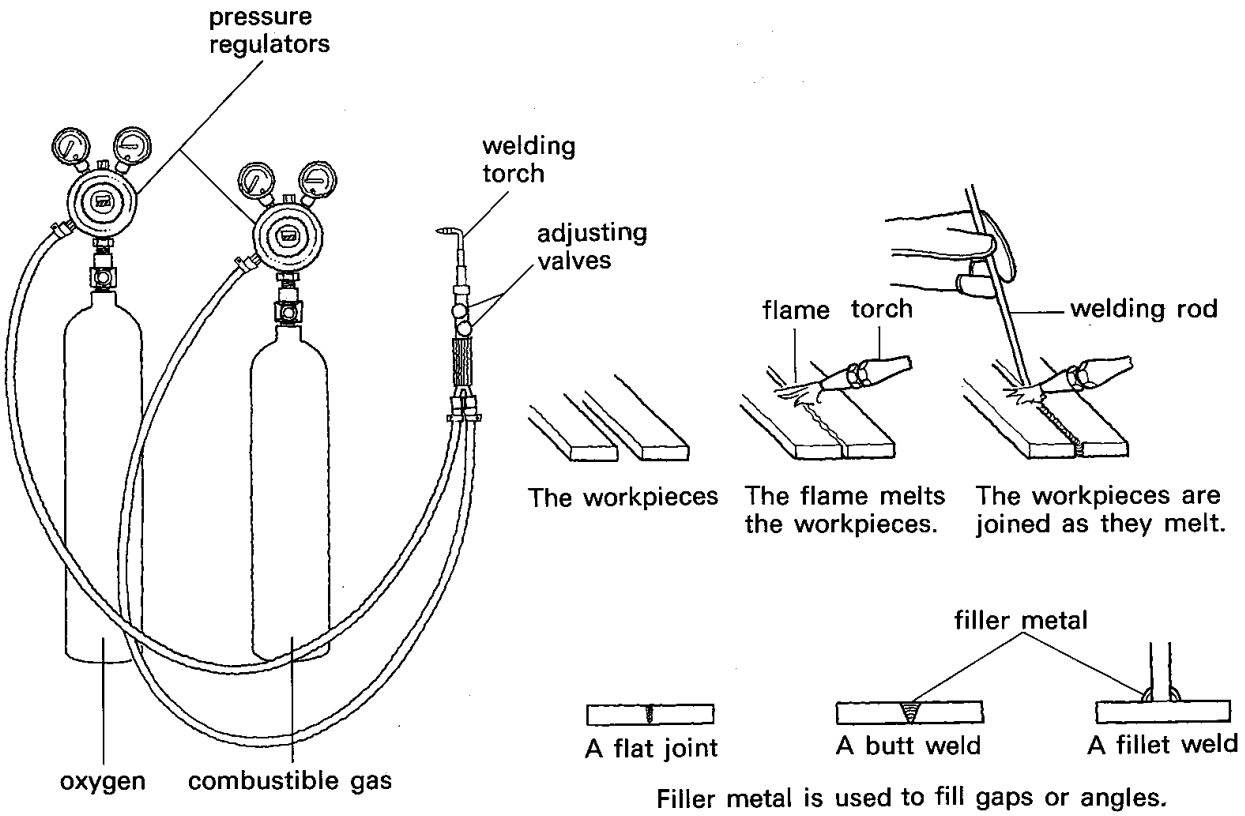
(un)reliable
worn
dirty
frequent
distilled
electronic
in turn
in poor condition

MOTOR VEHICLE TERMINOLOGY (2) INTERNAL PARTS



UNIT SEVEN Welding

SECTION A: GAS WELDING



Filler metal is used to fill gaps or angles.

In gas welding, it is necessary to use a mixture of two gases. To create a hot enough flame, a combustible gas must be mixed with oxygen. Although acetylene (C_2H_2) is normally used, the combustible gas need not be acetylene. Hydrogen or petroleum gases (propane, for example) can also be used.

Oxygen can be stored at very high pressure (120 atmospheres). It is dangerous to compress gaseous acetylene in the same way and so it is dissolved under pressure in liquid acetone but at a much lower pressure than oxygen (about 15 atmospheres). To create a suitable flame, the gases must be supplied to the welding torch at low pressure. Pressure regulators are therefore used to regulate the gas flow from the cylinders. They are screwed into the top of each cylinder.

Gas welding is normally used to join steel to steel. To make a very strong joint, the workpieces must be composed of the same metal. Welding rods are used to provide filler metal. In gas welding, these rods are generally composed of steel. Bronze or brass rods may sometimes be used. When bronze or brass filler metal is used the process is called brazing.

CAUTION: To light the welding torch, the combustible gas must be turned on first. The oxygen must not be turned on before the flame is lit. The oxygen supply must be adjusted to give the correct flame.

Exercise 1 Are these statements true or false? If they are false, write a true statement.

1. Acetylene must be used in gas welding.
2. To create a hot enough flame, acetylene must be mixed with hydrogen or a petroleum gas.
3. Petroleum gases are combustible.
4. Oxygen and acetylene can be stored at high pressure.
5. High gas pressures must be used for gas welding.
6. Pressure regulators are used to regulate gas pressures.
7. Welding rods must be composed of the same metal as the workpieces.
8. Steel welding rods are used for brazing.
9. To light the welding torch, the combustible gas must be turned on before the oxygen.
10. The acetylene supply is adjusted to give the correct flame.

Exercise 2 Make eight true sentences from this table.

In gas welding,	two gases a combustible gas oxygen acetylene pressure regulators steel welding rods low pressures high pressures	must must not need not	be used.

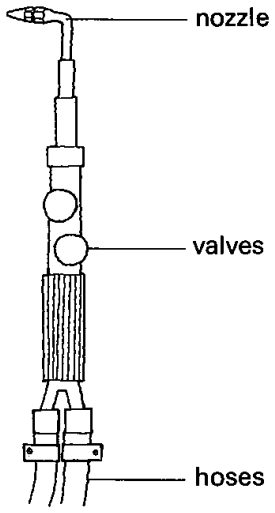
Exercise 3 Make six true sentences from this table.

A welding torch Gas welding Oxygen Pressure regulators Adjusting valves Welding rods	is are	used to	adjust the welding flame. join steel to steel. melt the workpieces. provide a hot enough flame. regulate the gas pressures. supply filler metal.

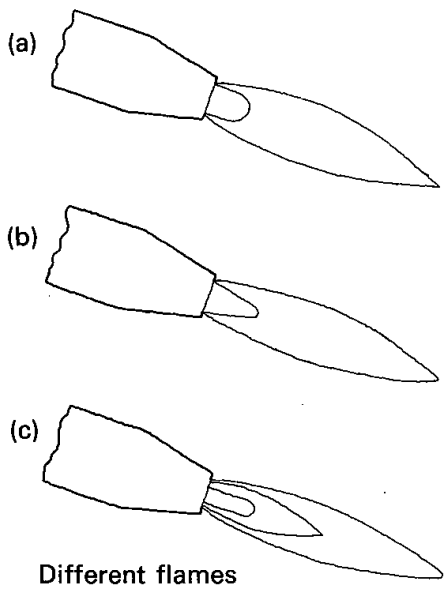
And now make five true sentences from the following table.

To adjust the welding flame, To create the welding flame, To compress acetylene, To light the welding torch, To make a very strong joint,	it is dissolved in acetone. it is necessary to mix two gases. the combustible gas must be turned on first. the oxygen pressure can be adjusted. the workpieces must be composed of the same metal.

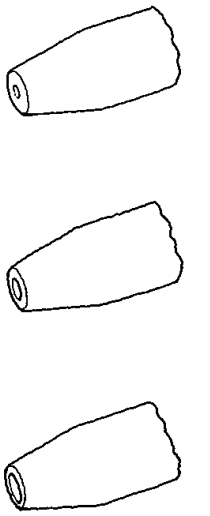
Exercise 4 Study the diagrams below carefully and then complete the paragraphs from the wordlist.



A welding torch



Different flames



Different nozzles

contains *larger* *types*
created *mixture* *to*
determines *necessary* *welded*
different *regulate* *welding*
flame *supplied* *work*

The welding gases are supplied . . . . the blowpipe through separate hoses. The blowpipe has two valves to . . . . the flow of each gas to the nozzle. In gas welding, three different . . . . of flame may be used:

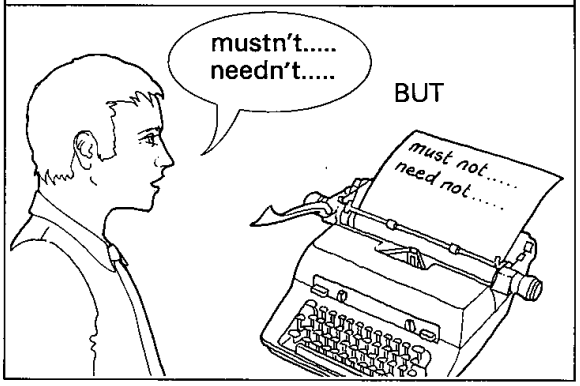
a) a *neutral* flame – a neutral flame is . . . . by a mixture of equal amounts of oxygen and acetylene. This type of flame is used in most construction . . . . .

b) an *oxidizing* flame – this is caused by an excess of oxygen in the gas . . . . . An oxidizing flame is generally used for . . . . brass or copper workpieces.

c) a *carburizing* flame – when the gas mixture . . . . an excess of acetylene, a carburizing flame is produced. The excess of acetylene produces molecules of carbon in the . . . . joint. This type of . . . . is only used for welding high carbon steels.

Welding torches are . . . . with several different nozzles. These nozzles have . . . . diameters. The diameter . . . . the length and the width of the flame. It is . . . . to fit the correct nozzle before welding. The thicker the workpieces, the . . . . the required nozzle.

LANGUAGE NOTE 22



WELDING TERMINOLOGY

a welding torch
a regulator
a cylinder
a valve
a hose
a nozzle

a workpiece
a flat joint
a butt weld
a fillet weld
filler metal

neutral
oxidizing
carburizing
brazing

acetylene
propane
acetone

a flow
an excess

petroleum

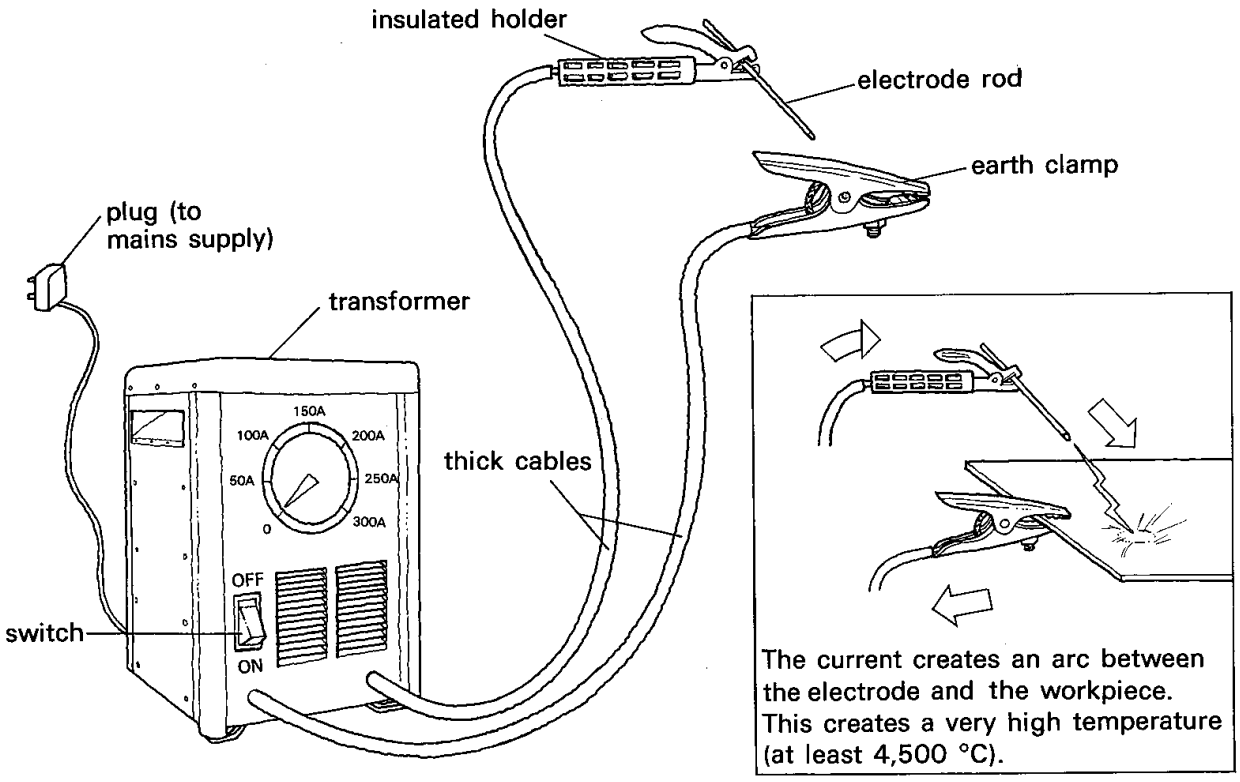
caution

an atmosphere
(unit of pressure)

create
compress
regulate
light

combustible
gaseous

SECTION B: ARC WELDING



In arc welding the workpieces are not melted by a flame. They are melted by an electric arc. In order to create the arc, a powerful electric current must be provided. The current must be at least 60 A or else the arc will not create enough heat. For thicker workpieces, the current may be 250 A or more. (*Note*: An electric light bulb operates at a maximum of 1 A.) In order to carry this current, the cables from the transformer must be quite thick or else they will overheat. In order to protect the operator, the electrode holder and the cables must be well insulated. The welding current must be provided at a low voltage in order to prevent the danger of electrocution.

A transformer is used to supply the necessary current. An earth clamp must be used in order to complete the electric circuit. The earth clamp must be attached to the workpiece or else the current cannot flow around the circuit and the arc will not appear. It must be securely attached or else an arc will appear between the clamp and the workpiece.

To strike the arc, the transformer must be switched on first. The electrode holder must contain an electrode rod in order to provide the filler metal to join the workpieces. When the arc is struck the electrode must brush against the workpiece or the current cannot flow. The electrode must then be withdrawn or it will become attached to the workpiece. It must not be withdrawn too far or the arc will disappear again. It must be held approximately 4 mm from the surface of the workpiece.

As the current flows between the electrode and the workpiece, the tip of the electrode will melt and fall onto the workpiece. If the electrode is left too long in the same position, it will become attached to the workpiece. It must be moved across the joint continuously. However, if it is moved too quickly, neither the electrode nor the workpiece will melt.

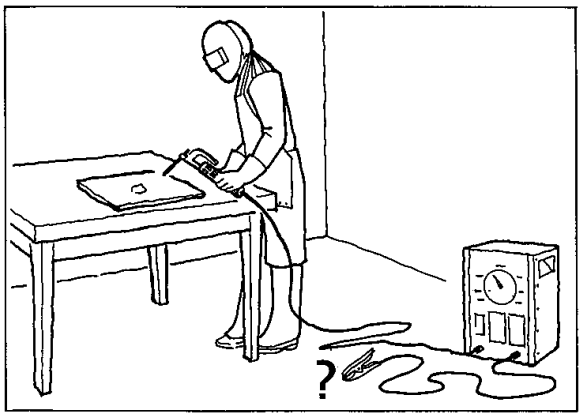
Exercise 5 Answer these questions.

1. How are the workpieces melted in arc welding?
2. How is the arc created?
3. Does an electric light bulb need a powerful current?
4. Why must thick cables be used?
5. Why must the electrode holder be well insulated?
6. What is the electrode rod for?
7. What is the transformer for?
8. What is the earth clamp for?
9. What will happen if the earth clamp is not securely attached?
10. Describe how to strike an arc and how to use the electrode correctly. (There are at least *five* points to remember.)

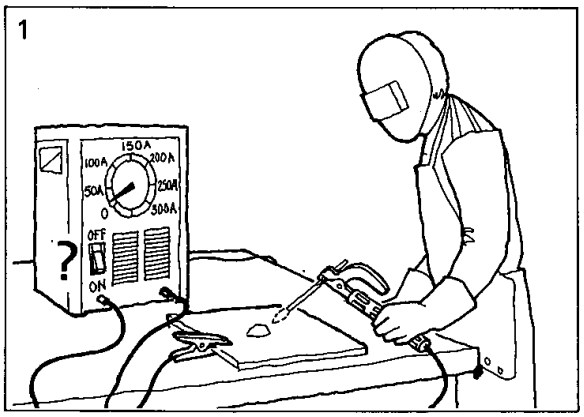
Exercise 6 Make eight true sentences from the following table.

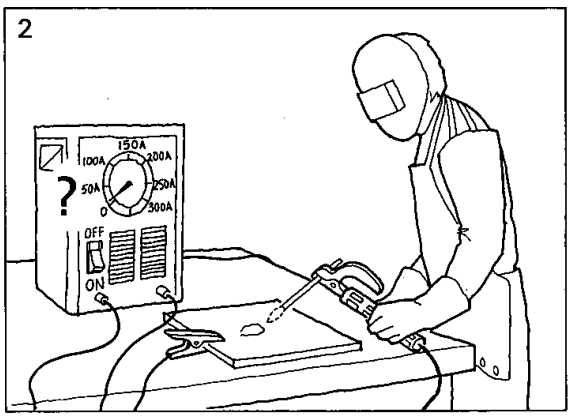
The current must be above 60 A		they will overheat.
The cables must be thick		the current will not flow.
The electrode must not be moved too quickly		arcs will appear in the wrong place.
An earth clamp must be attached to the workpiece	or else	the electrode will not melt.
The clamp must be attached securely		there is a danger of electrocution.
The welding current must be at a low voltage		the arc will not be strong enough.
The electrode must not be withdrawn too far		it will become attached to the workpiece.
The electrode must be moved across the joint continuously		the arc will disappear.

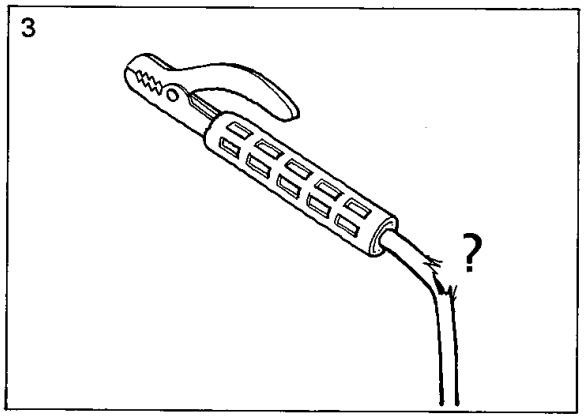
Exercise 7 Look at the drawings and make sentences like the examples.

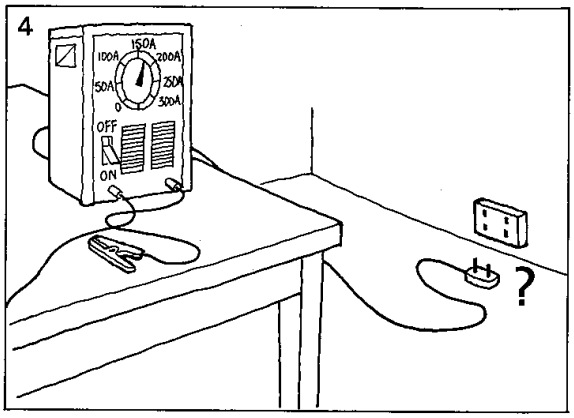


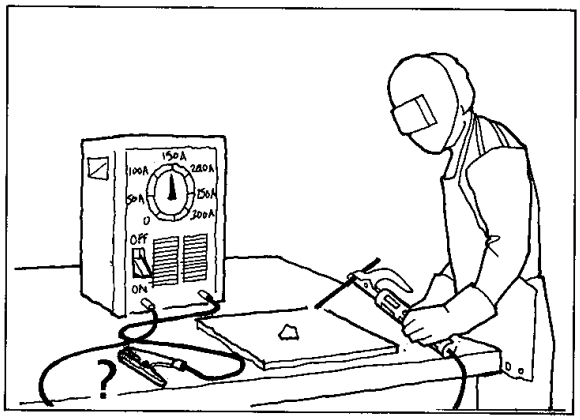
The earth clamp must be attached to the workpiece (*in order*) *to* complete the circuit.



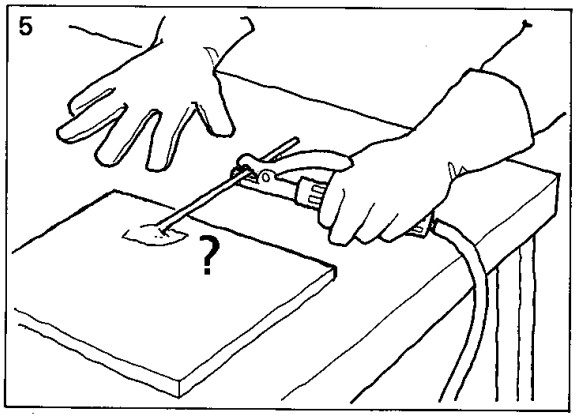


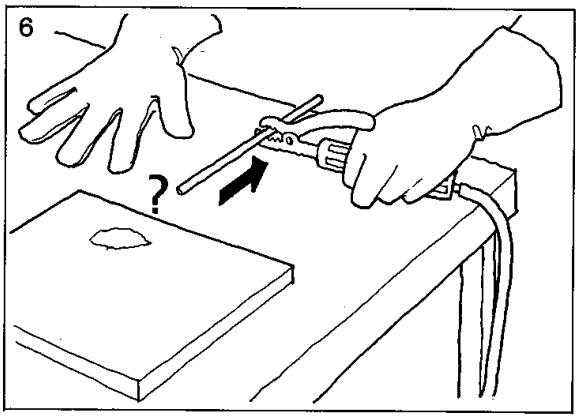


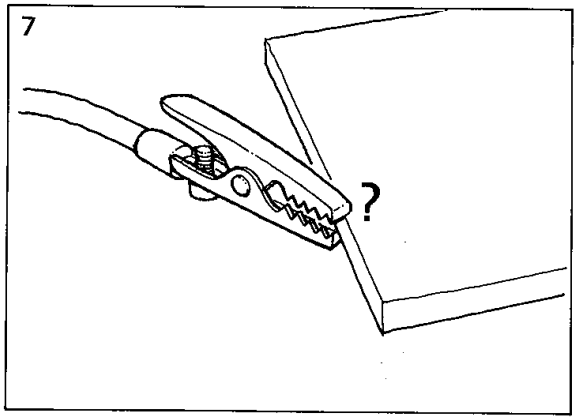


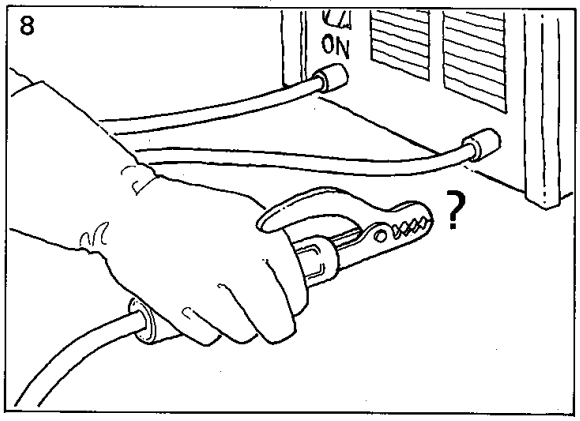


The earth clamp must be attached to the workpiece *or* (*else*) the current cannot flow.

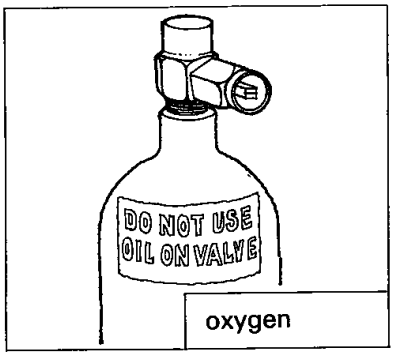




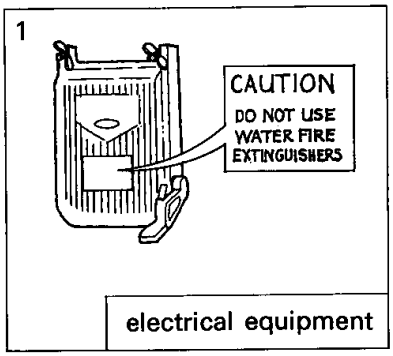


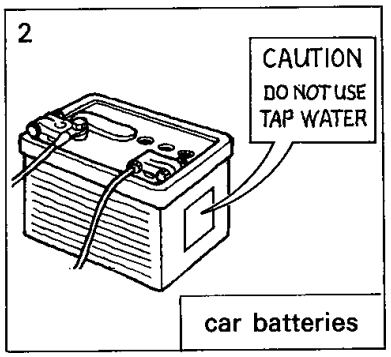


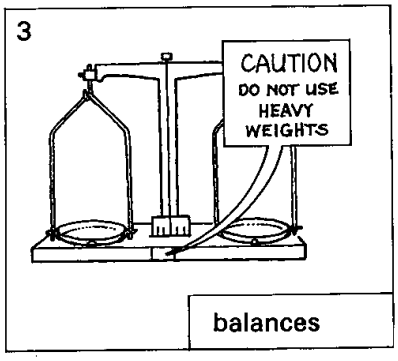
Exercise 8 Look at the examples and then make similar sentences from the drawings.

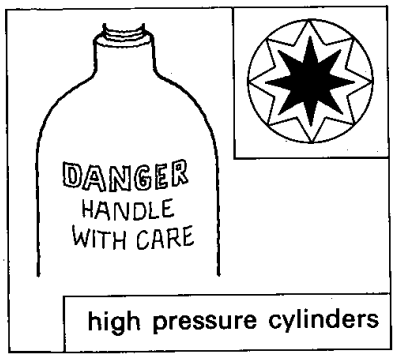


Oil *must not be used* with oxygen.

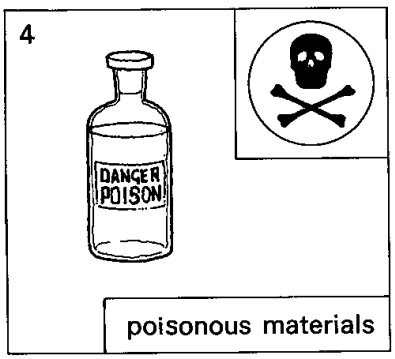


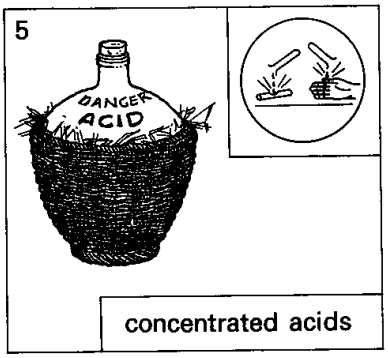


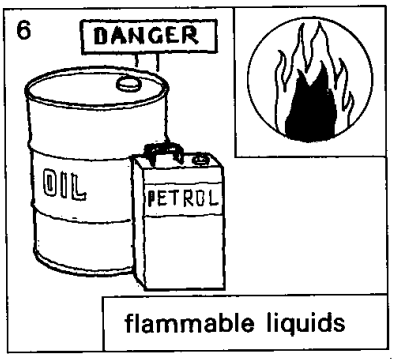




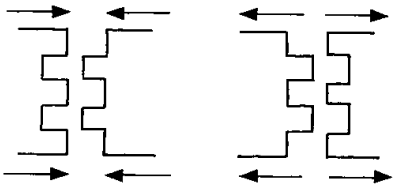
High pressure cylinders are *dangerous* and *must be handled with care.*







LANGUAGE NOTE 23	
volt (V)	amp(ere) (A)
voltage	amperage
voltmeter	ammeter

LANGUAGE NOTE 24	
overheat	
overflow	attach detach

ELECTRICAL TERMINOLOGY
an amp(ere)
an arc
a cable
a transformer
(an) earth
a circuit

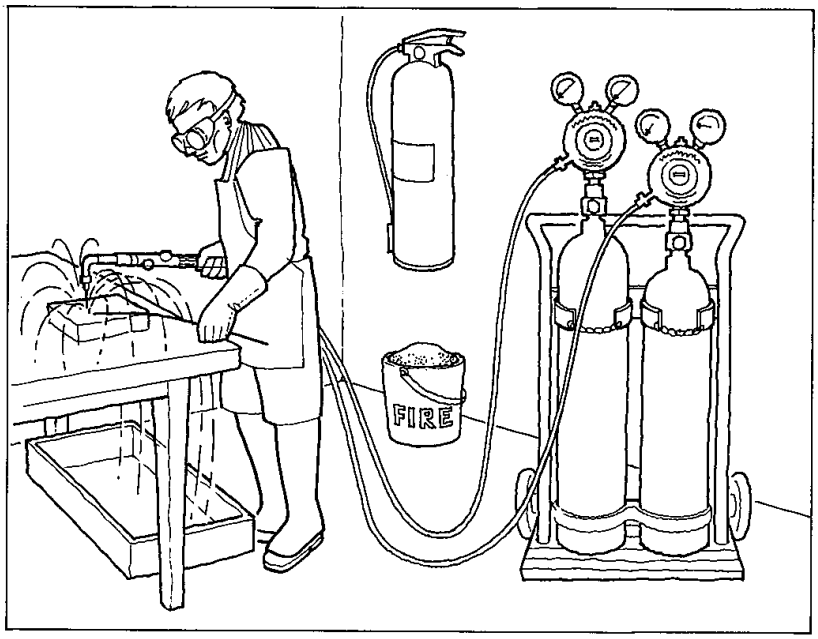
an operator
(an) injury
a tip
a sign
a drawing

electrocution
danger
poison

poisonous
concentrated
securely

in order to
or else

carry
overheat
protect
prevent
detach
injure
strike
brush
withdraw
disappear
mean
handle



Gas Welding

You must wear goggles to protect your eyes.

Gas cylinders should be used in a vertical position.

Your clothes should not be oily or greasy. Oxygen can combine with oil or grease to cause an explosion.

You should wear long sleeves so that you do not burn your arms.

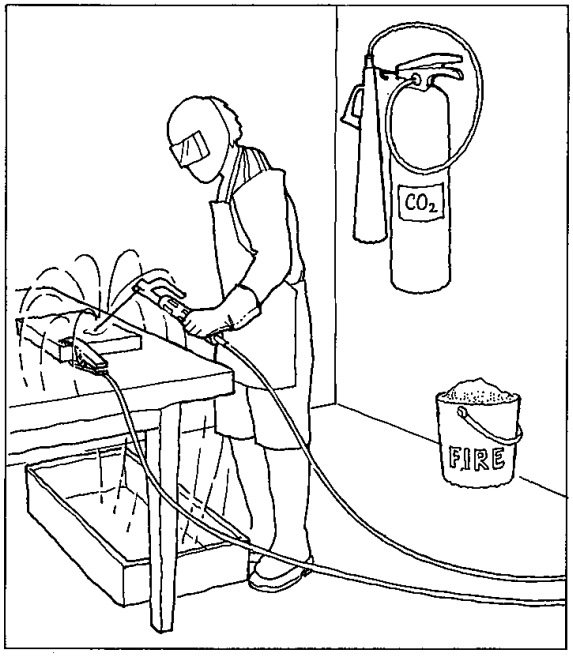
You should wear thick shoes so that you will not burn your feet.

You should wear gloves so that the sparks will not burn your hands.

Allow the sparks to fall into a metal container so that they don't burn the floor.

There must be fire extinguishers in the workshop so that any fires can be extinguished immediately.

After welding, turn off all valves so that no gases can escape.



Arc Welding

A face mask must be used or your face and eyes will not be protected.

The workshop floor should be dry and clean so that it cannot conduct electricity.

The floor should be made of concrete so that it cannot be burnt.

Your clothes should be dry and clean so that they cannot conduct electricity.

Overalls with long sleeves should be worn.

Thick shoes should be worn to protect your feet.

Welding gloves should be worn so that your hands are protected from sparks.

Allow the sparks to fall into a metal container so that they don't burn the floor.

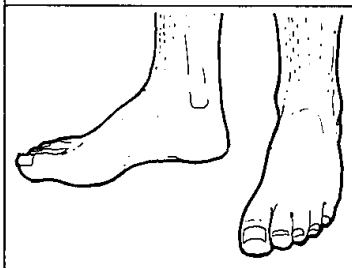
CO_2 fire extinguishers should be provided in the workshop so that any electrical fires can be immediately extinguished.

After welding, all switches must be turned off to prevent accidents.

Exercise 9 Study the first example.

thick shoes

WHY?



feet

You should / must wear thick shoes.

OR

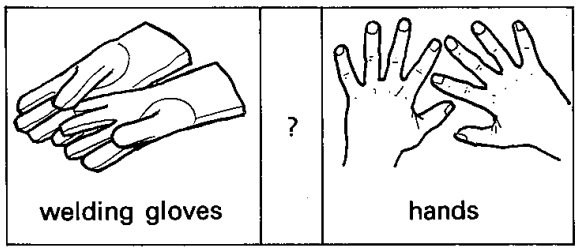
Thick shoes should / must be worn.

To protect your feet.

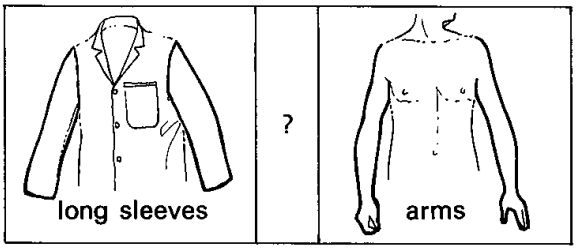
OR

So that your feet are protected.

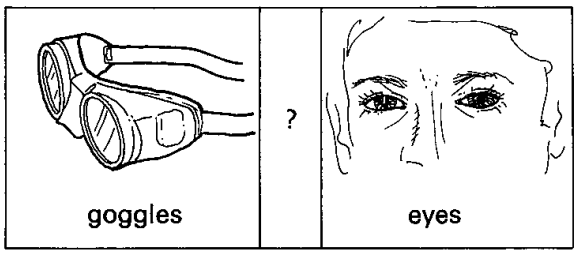
Make similar sentences from the pictures below.



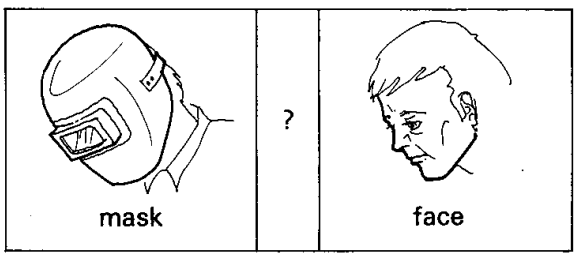
welding gloves ? hands



long sleeves ? arms

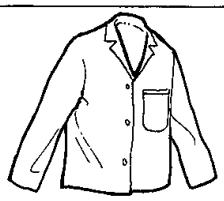


goggles ? eyes



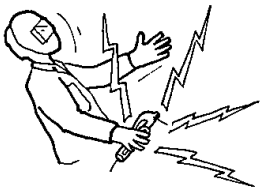
mask ? face

Now study the second example.



clean and dry

WHY?



electric shocks

Your clothes should be clean and dry.

To prevent electric shocks.

OR

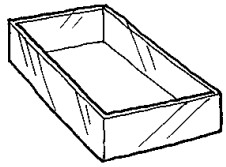
So that electric shocks are prevented.

Make similar sentences from the pictures below.

oily or greasy

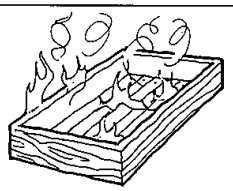
?

explosions

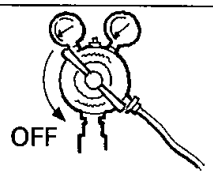


container/provided

?

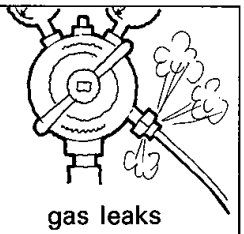


fires

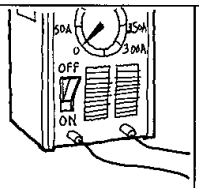


valve turned off

?



gas leaks



switches turned off

?

accidents

Exercise 10 Read the example carefully.

STATEMENT
Long sleeves will protect your arms from burns.
PRECAUTION
Long sleeves should be worn *to* protect your arms from burns. *so that* your arms are protected from burns.

Make similar PRECAUTION sentences from the following STATEMENTS. Use *to* or *so that*.

1. Thick shoes will protect your feet from sparks.
2. Goggles will protect your eyes from sparks.
3. Dry clothes will prevent injuries from electrical equipment.
4. A face mask will protect your eyes from the arc light.
5. A metal container will protect the floor from burns.
6. CO_2 extinguishers will prevent damage from electrical fires.

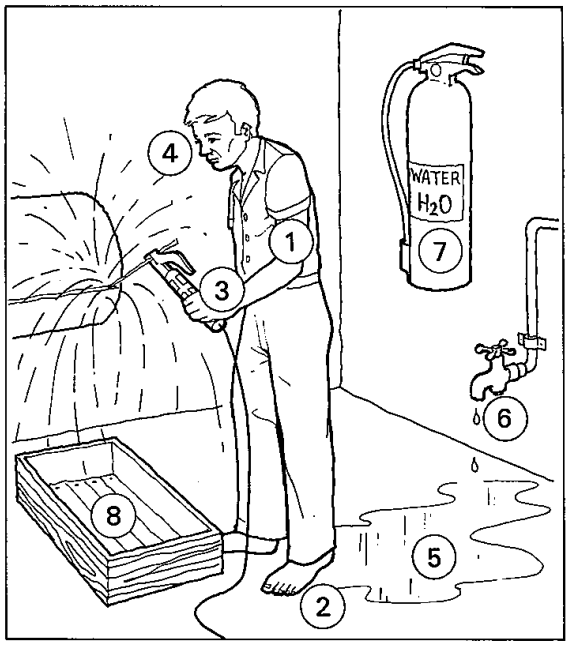
Now read the next example:

metal container/used/fires
a) A metal container should be used *to prevent fires.* b) A metal container should be used *or fires may be caused.*

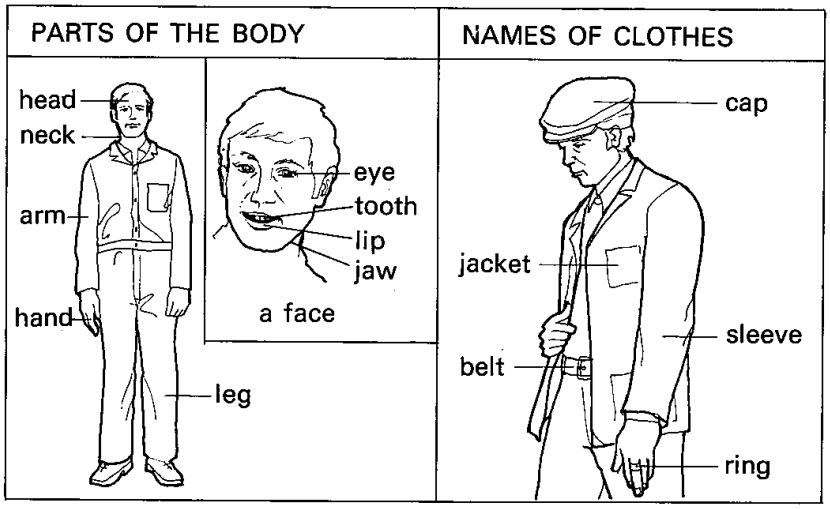
Make similar a) and b) sentences from the words below.

7. all valves/turned off/gas leaks
8. clean clothes/worn/an explosion
9. all switches/turned off/accidents
10. the correct precautions/followed/injuries

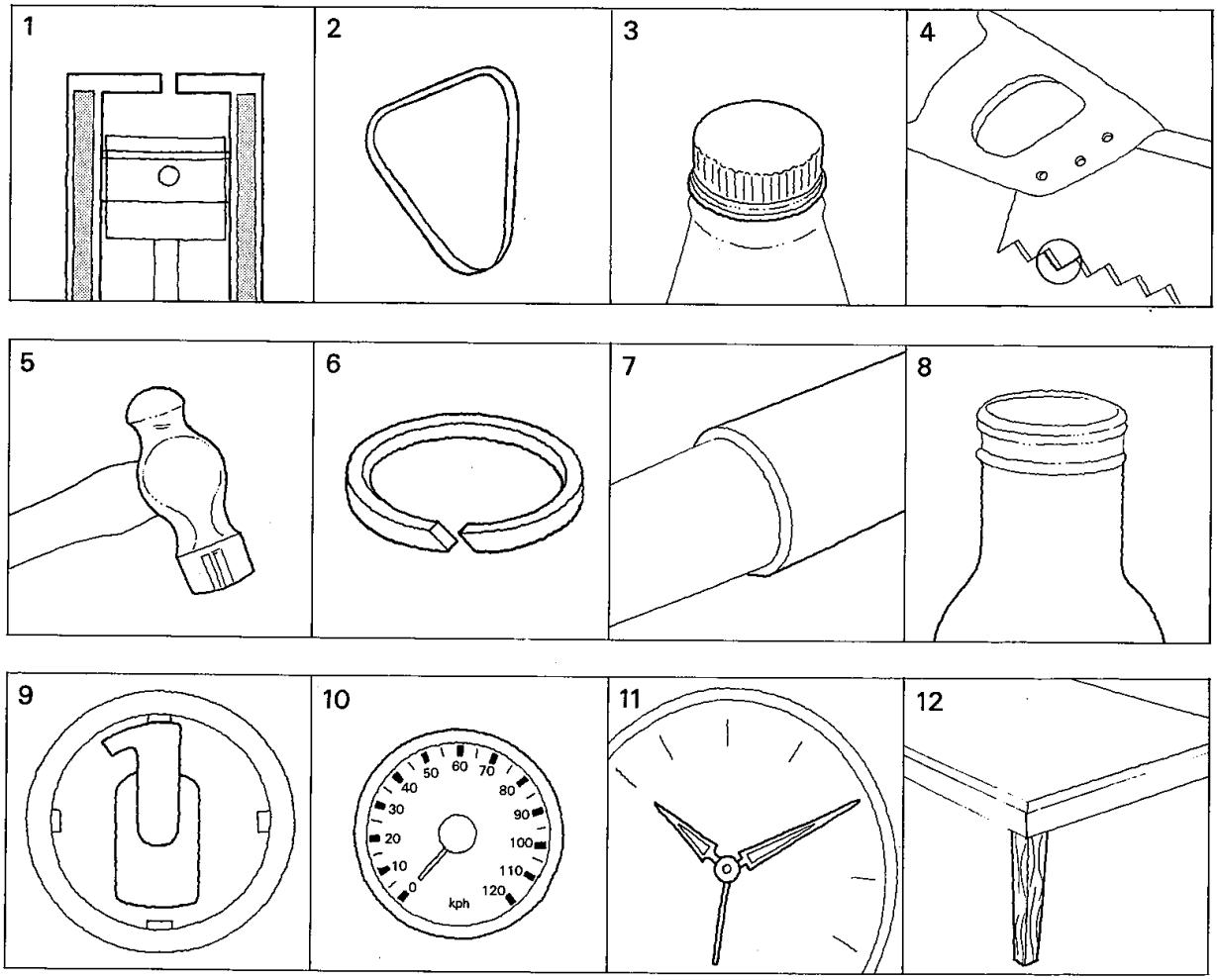
Exercise 11 This welder does not know the safety precautions for arc welding. Write eight instructions for him.

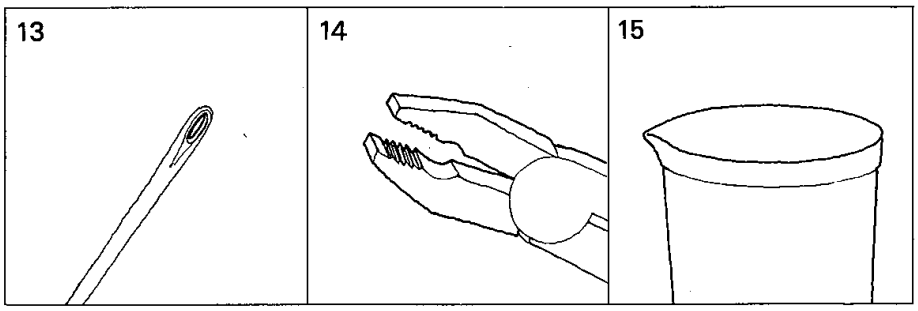


Exercise 12 PARTS OF THE BODY and NAMES OF CLOTHES are often used to describe different objects in engineering. Look at these two diagrams.

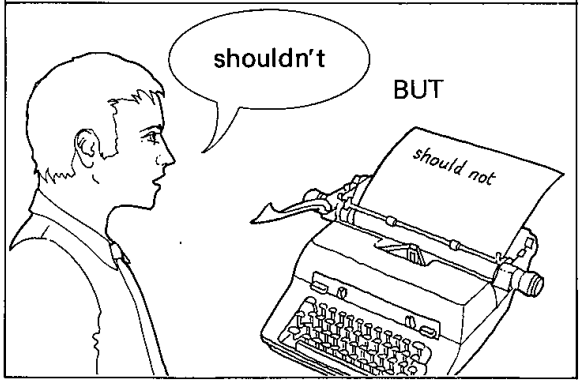


Use the fifteen words above (ten *parts of the body* and five *names of clothes*) to describe the fifteen objects below.





LANGUAGE NOTE 25



LANGUAGE NOTE 26

oil	→	oily
grease	→	greasy
dirt	→	dirty
sand	→	sandy
dust	→	dusty

clothes
goggles
overalls

a sleeve
a shoe
a glove
a mask

an arm
a foot
an eye
a face
a lip
a jaw
a neck
a leg

a burn
an explosion
a floor
an accident
an electric shock
a leak
a statement
a precaution

so that

oily
greasy
clean

immediately

wear
follow
combine

UNIT EIGHT Electrical Instruments

SECTION A: THE INSTRUMENTS IN A CAR

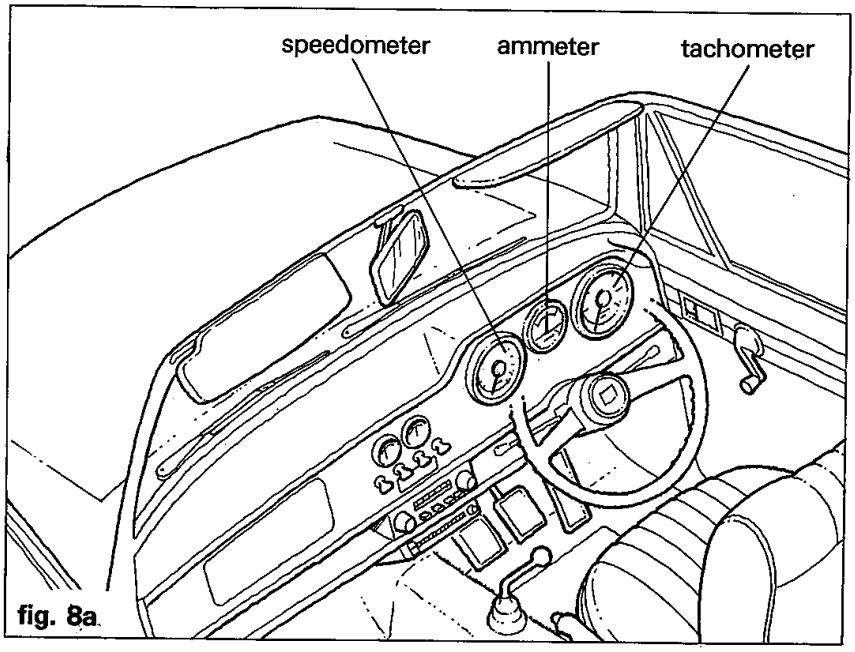


fig. 8a

All vehicles require certain instruments to provide information for the driver. For instance, every car has a speedometer to indicate its speed. It also has a fuel gauge to indicate the amount of fuel in the petrol tank. Many cars also have a tachometer (or revolution counter) to indicate the engine speed (in rpm). They may also have an ammeter to indicate if the battery is charging or discharging.

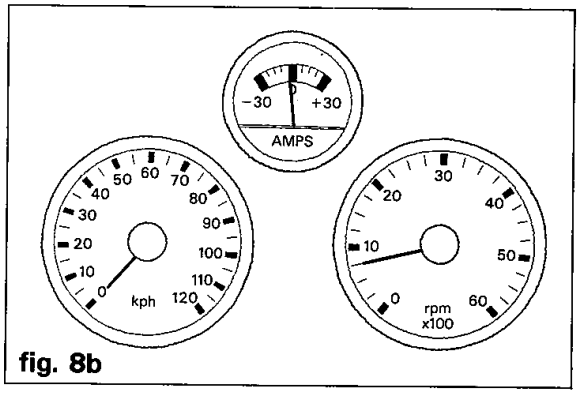


fig. 8b

Fig. 8b shows an instrument panel. What information does it provide for the driver?

The speedometer is indicating zero kph. The car is not moving. The engine is turning at minimum speed (approximately 750 rpm). As the engine is only turning slowly, the alternator is also turning slowly. It is not producing enough current for the engine. Therefore, the battery must supply some of the necessary current. The battery is discharging and so the ammeter is indicating about −5 A.

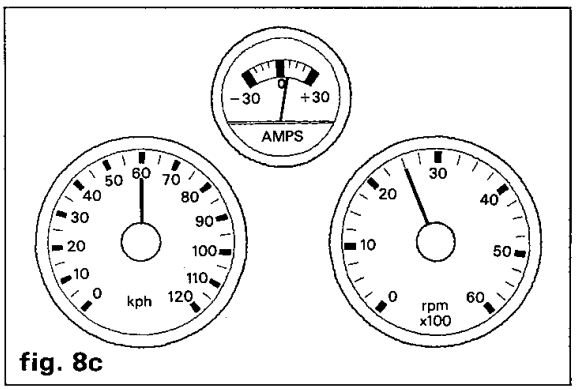


fig. 8c

Fig. 8c provides the driver with different information. The car is now moving at 60 kph. The engine is turning at 2500 rpm and so the alternator is turning quite fast. It is producing a strong current for the engine and so the battery is no longer needed to supply current. The battery is now recharging from the alternator and so the ammeter is indicating +10 A. After a short time, the battery will be fully charged again.

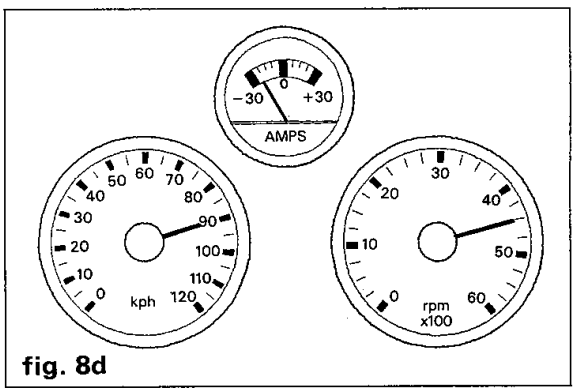


fig. 8d

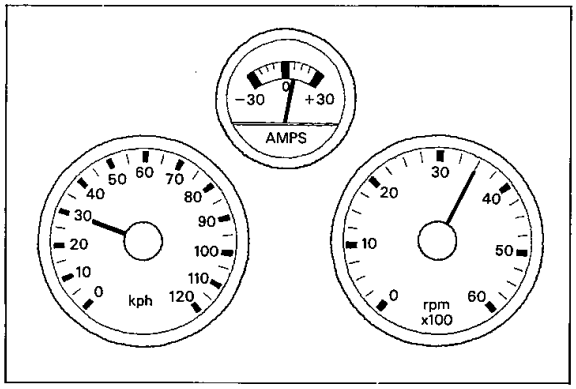
Fig. 8d indicates a fault. The car is now moving at 90 kph. The engine is turning at a speed of 4500 rpm. However, the alternator is not producing any current. The ammeter is indicating −20 A. In other words, the battery is discharging rapidly although the engine is turning at high speed. Therefore, the alternator is not producing any power and the battery is discharging at

20 A. So, unless the fault is put right or the engine stopped, the battery will soon become completely discharged. The electrical items, such as the headlights, should be switched off as soon as possible. When they are switched off and the engine is stopped the ammeter will read zero and the needle will point vertically.

Exercise 1 Check the following statements from the text. If they are false, rewrite them.

1. All cars have a speedometer and a fuel gauge.
2. All cars have a tachometer and an ammeter.
3. A tachometer indicates the speed of the engine.
4. When the car is not moving, the tachometer will always indicate zero (see **fig. 8b**).
5. When the ammeter is indicating —5 A, the battery is supplying current to the engine (see **fig. 8b**).
6. The battery is now fully charged (**fig. 8c**).
7. The battery is now completely discharged (**fig. 8d**).
8. The battery recharges the alternator.
9. The engine speed determines the speed of the alternator.
10. Only one of the instrument panels above indicates a fault.

Exercise 2 Look at the instrument panel below.



Road Speed
The car is travelling at 30 kph.

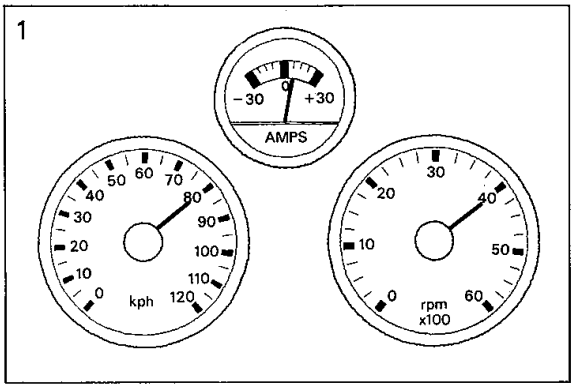
Engine Speed
The engine is turning at 3500 rpm.

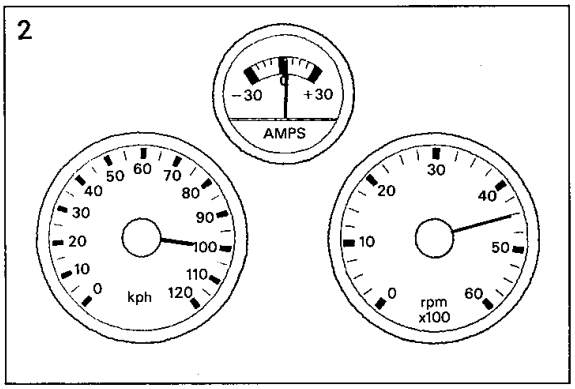
Alternator
The alternator is supplying current to the battery and to the engine.

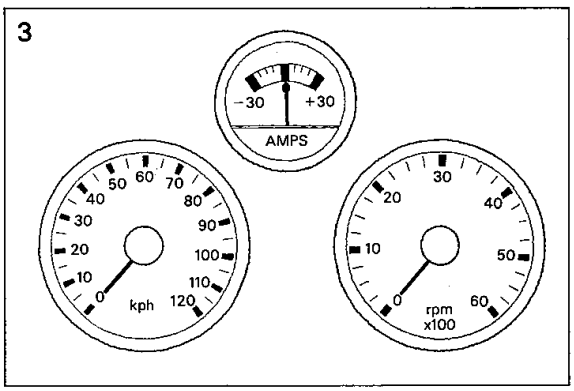
Ammeter and Battery
The ammeter is indicating +5 A and so the battery is charging.

What information do these instrument panels give the driver?
Write one sentence under each heading.

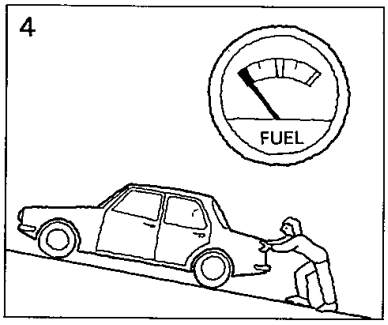
Road Speed
Engine Speed
Alternator
Ammeter and Battery



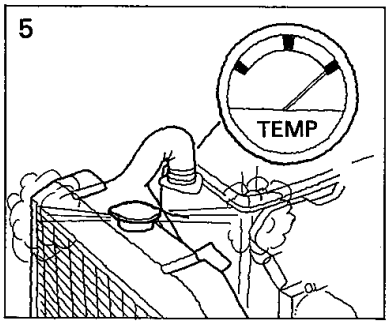




What is happening in these drawings?
Use the verbs in brackets.

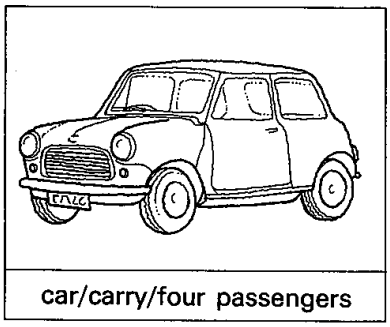


The engine . . . . . (turn)
The driver . . . . . (push)
The car . . . . . (move)



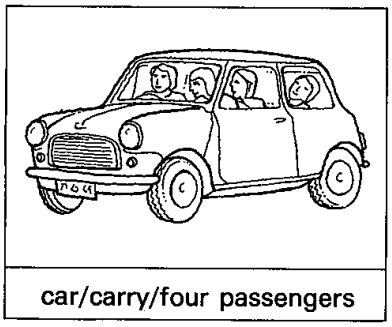
The engine . . . . . (overheat)
The water . . . . . (boil)
Steam . . . . . (escape)

Exercise 3 Study the two examples. Different verb forms are used.



car/carry/four passengers

This car carries (OR can carry) four passengers.

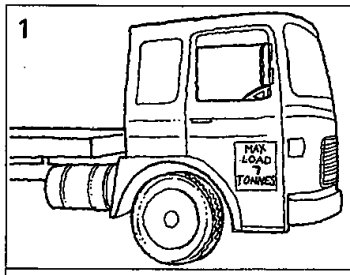


car/carry/four passengers

This car *is carrying* four passengers.

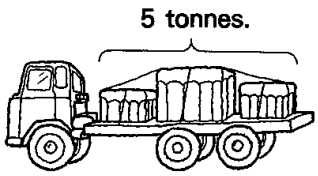
Make similar sentences from the drawings below.
Use the correct verb form.

1



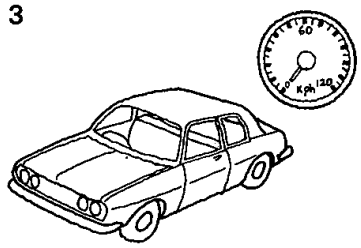
lorry/carry/7 tonnes

2



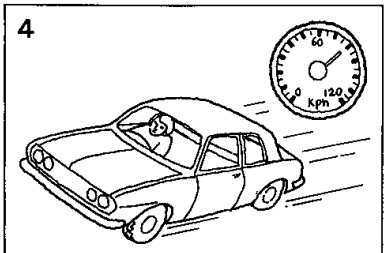
lorry/carry/5 tonnes

3



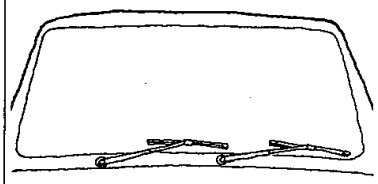
car/travel/120 kph

4



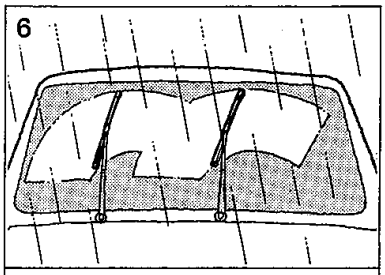
car/travel/80 kph

5



wipers/clean/windscreen

6

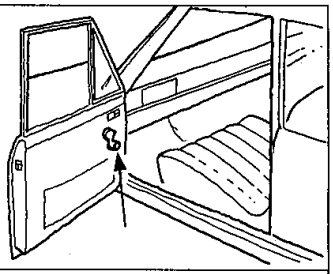


wiper/clean/windscreen

7

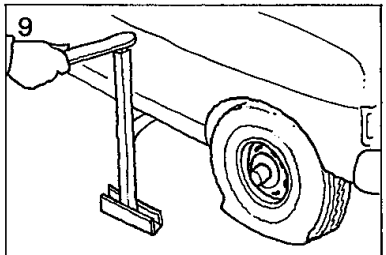
lorry/pull/trailer

8



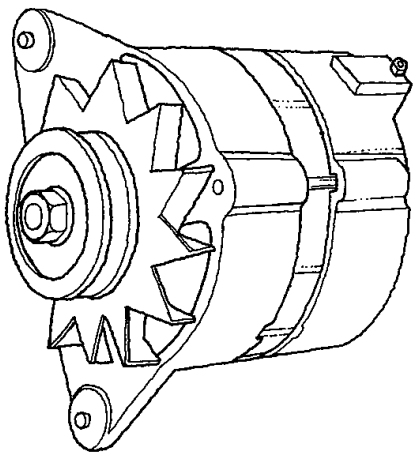
handle/operate/car window

9



jack/raise/car wheel

Exercise 4 Complete the following paragraphs from the wordlist.



An alternator

because	*efficient*	*instance*	*soon*
although	*either*	*charge*	*still*
convert	*generate*	*require*	*supply*

The battery in a car can only provide enough electricity to . . . . the engine for a short time. If the headlights are switched on when the engine is not running, the battery will . . . . become completely discharged.

Every car requires a separate electrical device to . . . . electricity, both to supply the engine and to . . . . the battery. This electrical generator may be . . . . an alternator or a dynamo. Most modern cars now have an alternator but a few cars . . . . have dynamos.

Modern cars . . . . much more electrical power than earlier vehicles. Alternators were fitted into most new cars after about 1965 . . . . they are much cheaper than dynamos. For . . . . , alternators provide a much stronger current at low engine speeds. Dynamos are not very . . . . when they are only turning slowly. However, alternators generate Alternating Current . . . . car engines and batteries require Direct Current. If a car has an alternator, a separate device must also be fitted to . . . . a.c. into d.c. This device is called a rectifier.

LANGUAGE NOTE 27

indicate → indicating
charge → charging
produce → producing

AND

travel → travelling
run → running
fit → fitting

a tachometer	a trailer	indicate	fast
a rev(olution) counter	a window	clean	soon
an ammeter	a rectifier	pull	for instance
a driver	an item	discharge	after
a panel	Alternating Current (a.c.)	travel	
a passenger	Direct Current (d.c.)		

SECTION B: THE MULTIMETER

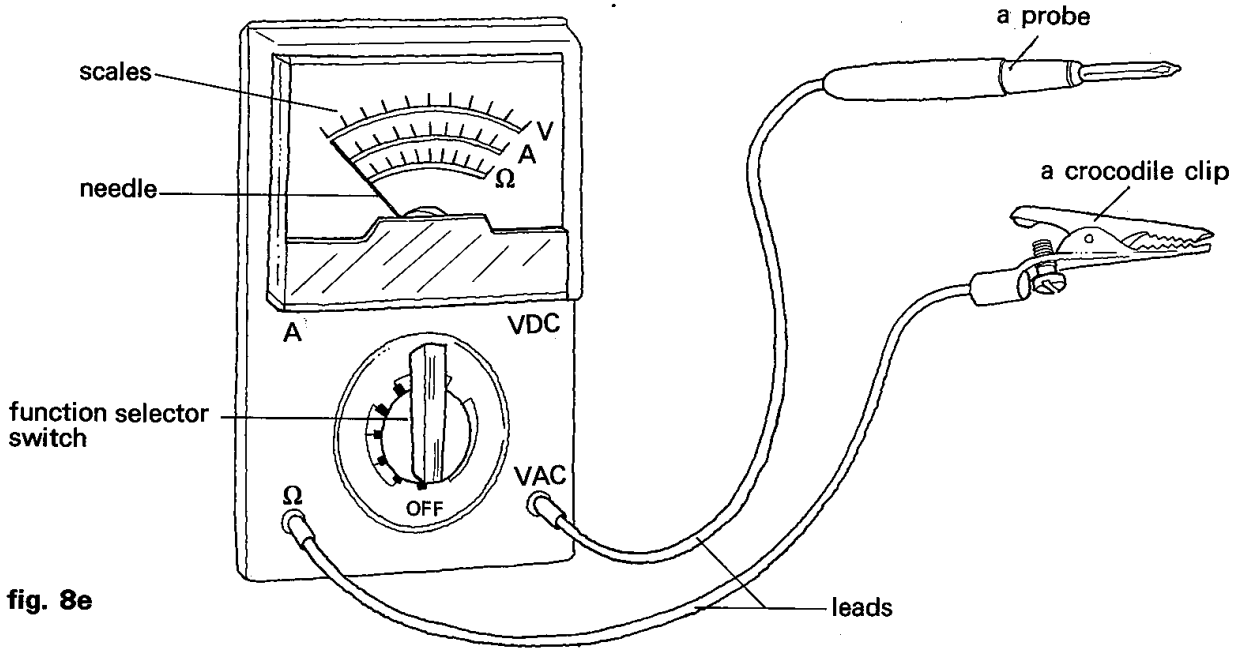


fig. 8e

A multimeter measures three types of electrical units. It can be used to measure voltage, current and resistance. The multimeter in **fig. 8e** has four different ranges. It can be used for voltage (d.c.), voltage (a.c.), resistance (measured in ohms) and current (measured in amperes). Before a multimeter is used, the function selector switch must be turned to the correct range.

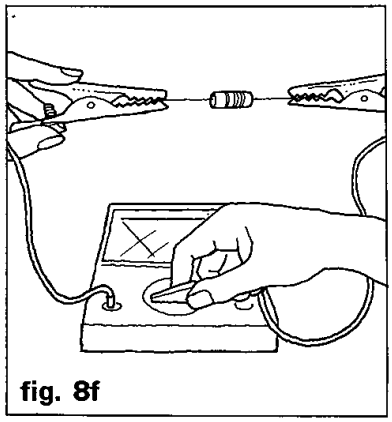


fig. 8f

In **fig. 8f**, the multimeter is being used to measure the value of a resistor. The two leads are being connected to the resistor. Two small crocodile clips are being used to make a good connection between the meter and the resistor. The function selector switch is being turned to the resistance range. The needle will indicate the value of the resistor on the ohm scale.

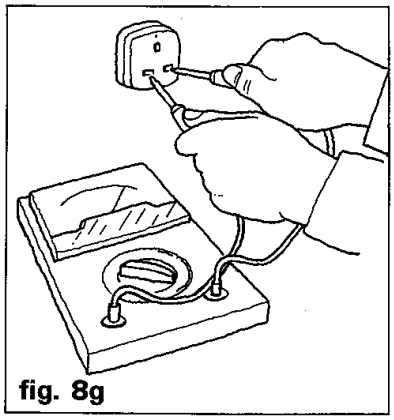


fig. 8g

In **fig. 8g**, the same meter is now being used to check a mains socket in the wall. Mains electricity is a.c., so the function selector switch is on the Va.c. (Voltage – Alternating Current) range. The two probes are being inserted into the two terminals of the socket. When a.c. voltage is being checked, the negative probe can be inserted into either terminal.

CAUTION: Hold the insulated part of the probes. Do not touch the metal part when checking mains voltage.

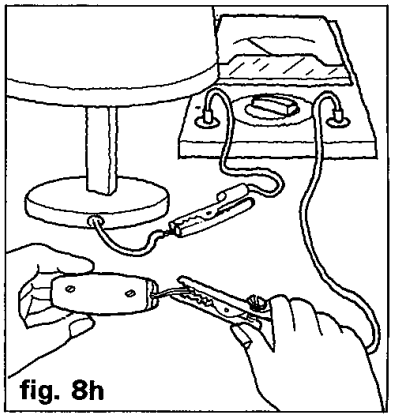


fig. 8h

The same meter may also be used to measure amperage. In **fig. 8h**, the current to a table lamp is being measured. The plastic switch is being disconnected and the meter is being connected instead of the switch. Crocodile clips are being used.

CAUTION: Before connecting crocodile clips to mains voltage, make sure the mains supply is turned off. After connecting the meter, the supply may be turned on again.

When using a multimeter, these two points should be remembered:

1. Before using the meter, always make sure the selector switch is in the correct position.
2. After using the meter, make sure the selector switch is in the 'OFF' position.

Exercise 5 After reading the example, complete the sentences.

the reading text
a multimeter (*describe*) .....
In the reading text a multimeter *is being described.*

1. **Fig. 8f** – the value of a resistor (*measure*) .....
2. **Fig. 8f** – crocodile clips (*use*) .....
3. **Fig. 8f** – the function selector switch (*turn*) ..... to the resistance range
4. **Fig. 8g** – two probes (*insert*) ..... into the mains socket
5. **Fig. 8g** – crocodile clips (*use*) .....
6. **Fig. 8g** – the mains socket (*check*) .....
7. **Fig. 8h** – the amperage of a table light (*check*) .....

8. **Fig. 8h** – the switch (*disconnect*) . . . . . and the meter (*connect*) . . . . . .

Now complete the following paragraph.

Note: The verbs are *not* all in the same tense.

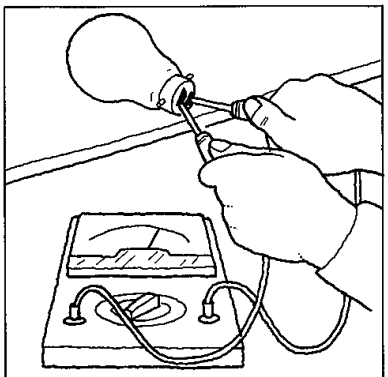


fig. 8x

The multimeter (*use*) . . . . . to measure the resistance of a light bulb. Two probes (*hold*) . . . . . against the bulb terminals. The function selector switch (*turn*) . . . . . to the resistance range. The needle (*indicate*) . . . . . the resistance of the bulb on the ohms scale.

Finally, write four sentences to describe the use of a multimeter for measuring the voltage of a dry cell (**fig. 8y**). Use the words below to make a paragraph like the one above.

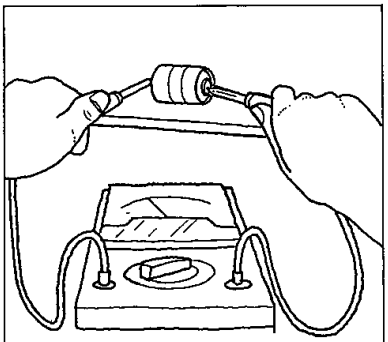
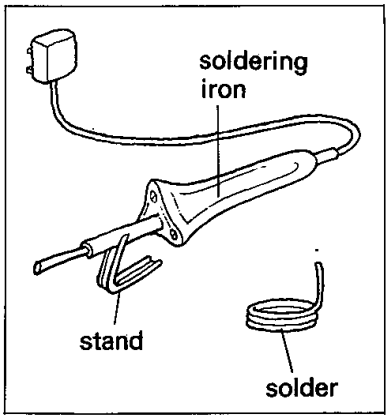


fig. 8y

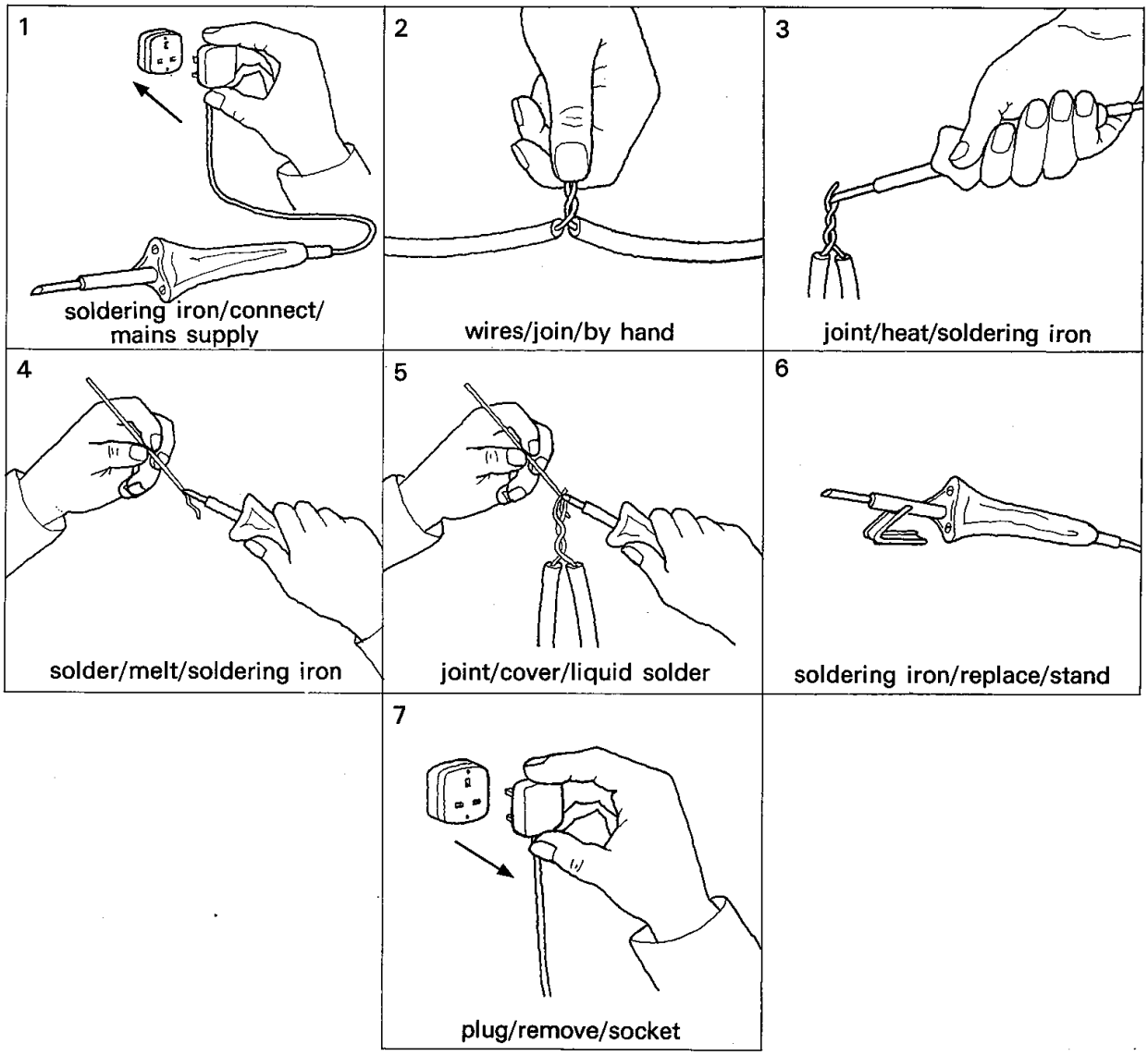
The multimeter (*use*) . . . . . to measure the voltage of . . . . . .

Two probes/hold/the cell terminals.
The function selector switch/the Vd.c. range.
The needle/voltage scale.

Exercise 6



This equipment is normally required for soldering. In the following pictures, the equipment is being used to join two pieces of electrical wire. Make one sentence about each picture.



Exercise 7 When completing the sentences below, use the words *when*, *after* or *before*.

Example: A small file can be used . . . . (*clean*) . . . . spark plugs.

A small file can be used *when cleaning* spark plugs.

1. Do not touch the metal part of the probes . . . . (*check*) . . . . mains voltage.
2. The negative probe can be inserted into either terminal . . . . (*measure*) . . . . a.c. voltage.
3. Make sure the mains supply is turned off . . . . (*connect*) . . . . crocodile clips to mains voltage.

4. . . . . (*connect*) the meter, the supply can be turned on again.
5. Make sure the function selector switch is in the correct position . . . . . (*use*) the meter.
6. . . . . (*use*) the meter, make sure the selector switch is in the 'OFF' position.
7. . . . . (*test*) a light bulb, the selector switch is turned to the resistance range.
8. . . . . (*check*) a dry cell, the negative probe should be held against the negative terminal.

Exercise 8 Complete these paragraphs from the wordlist.

being	*function*	*provides*
connecting	*instance*	*red*
current	*insulated*	*terminal*
damage	*may*	*than*
direct	*or else*	*turn*
disconnected	*points*	

A multimeter has two terminals below the . . . . selector switch. The two leads from these terminals are . . . . with red and black plastic. The red lead is connected to the positive . . . . and the black lead to the negative one.

When measuring amperage or voltage these two . . . . should always be remembered:

1. When . . . . the meter to the circuit, ... the function selector switch to the highest range first. If the circuit current is higher . . . . the multimeter range, you may . . . . the meter. For . . . . , if the selector is on the 0–12 Va.c. range and the measured . . . . is 220 V, the meter will probably be damaged.

2. When measuring . . . . current (d.c.), the positive lead (. . . .) must be connected to the positive terminal . . . . the meter will not give a correct measurement. If the current is quite strong, the meter . . . . again be damaged.

While the meter is . . . . used to measure a resistor, one end of the resistor should be . . . . from the circuit first. A battery inside the meter . . . . the necessary current to give a resistance measurement.

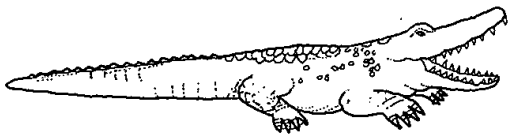
LANGUAGE NOTE 28

Glass is not a conductor of electricity.
Wood is not a conductor either.

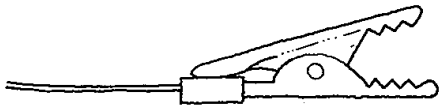
An electric current may be either a.c. or d.c.

The probe can be inserted into either terminal.

LANGUAGE NOTE 29



a crocodile



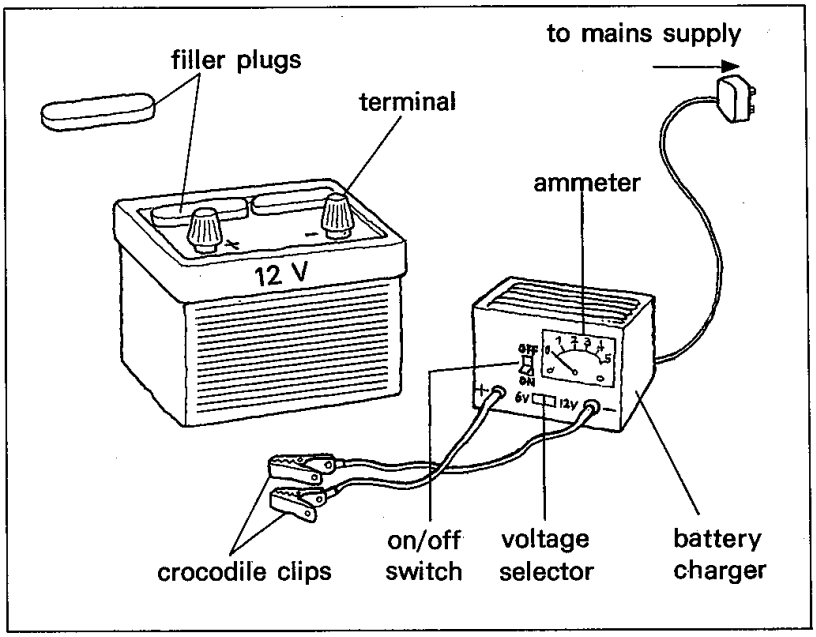
a crocodile clip

a multimeter
an ohm (Ω)
a function selector switch
a resistor
a lead
a crocodile clip
a connection
a probe
a point
a soldering iron

when
before

insert
disconnect
remember
touch
make sure

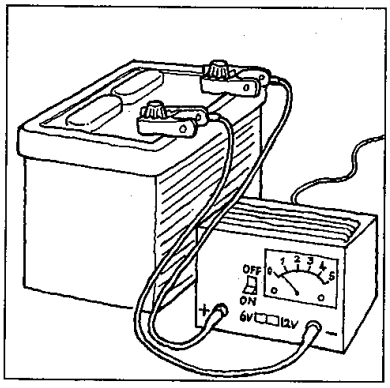
SECTION C: BATTERY CHARGERS



A car battery can easily become discharged if there is an electrical fault in the car. If the fan belt is broken, for example, the battery may become discharged in quite a short time. If the lights are left on while the car is not in use, the battery will also become discharged.

A battery (d.c.) cannot be recharged directly from the mains (a.c.). A battery charger is needed to rectify the a.c. to d.c. and to reduce the voltage to 12 V. Before charging the battery, remove all the filler plugs. While the battery is charging, hydrogen will be produced. This gas cannot escape easily from the battery if the filler plugs are not removed.

When connecting the crocodile clips to the battery, check the connections. The positive clip *must* be connected to the positive terminal and the negative clip to the negative terminal. Make sure the clips are connected before switching on the charger. After charging, switch off the charger before disconnecting the clips.



Below, there is a description of a battery as it is charging.

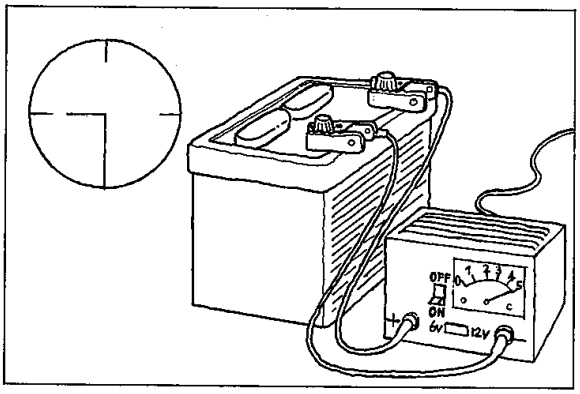
Charging started eight hours ago. During the first hour, the ammeter needle was indicating 5 A (i.e. the battery was being charged at the maximum rate). During the second and third hours, the ammeter was indicating about 4.5 A (i.e. the rate of charging was decreasing slowly). During the next two hours, the charging rate was decreasing more rapidly. After five hours, the rate was only 2 A. After eight hours, the ammeter is now indicating 0.5 A. The battery is almost fully charged. It will be fully charged in about an hour from now.

Note: While a battery is being charged it will 'gas', i.e. hydrogen will be produced in the electrolyte. Hydrogen is a highly flammable gas. Do not smoke near a battery while it is being charged.

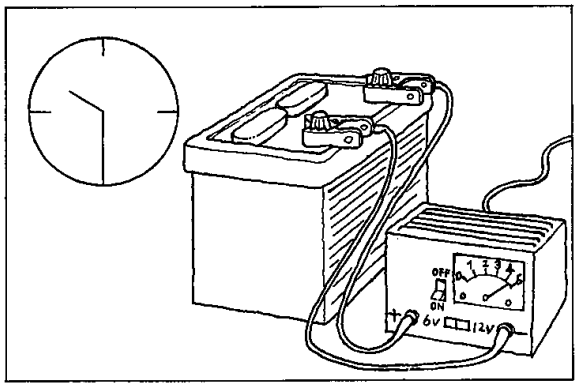
Exercise 9 Answer these questions with short explanations or some examples. You should use more than one sentence to answer each question.

1. Can a car battery be charged directly from the mains?
2. How can a car battery become discharged? Give examples.
3. You should remember *three* important things about connecting a battery to a charger. What are they?
4. Does a car battery always charge at the same rate? Give examples.
5. Why should you not smoke while a battery is being charged?

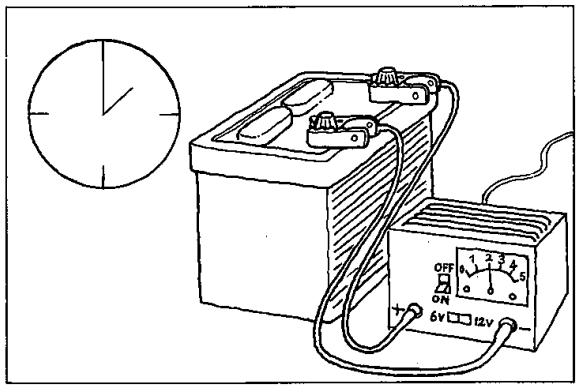
Exercise 10 In the example below, charging started at 09.00 hrs. Complete these short paragraphs. Each paragraph contains two sentences.



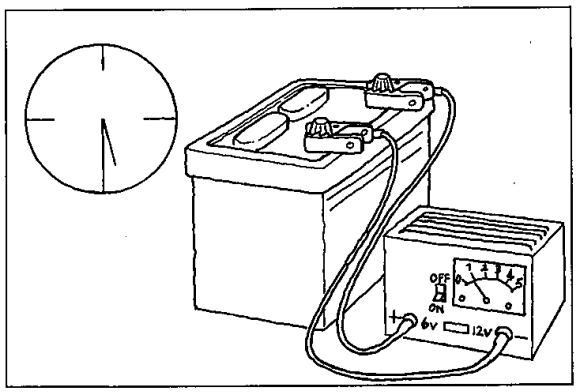
1. At 09.30 hrs, the battery . . . . . maximum rate.
   The ammeter . . . . . 5 A.



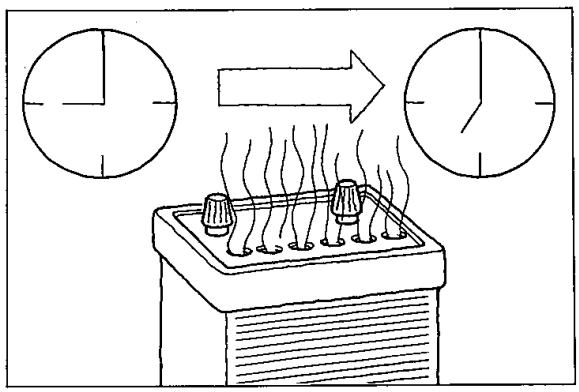
2. At . . . . . .
The ammeter . . . . . .



3. At . . . . . .
. . . . . .



4. At . . . . . .
. . . . . .



5. From . . . . to . . . . hrs, hydrogen . . . . . in the electrolyte. A battery always . . . . hydrogen while . . . . . .

Exercise 11 The eight sentences below describe the correct procedure for charging a car battery. Complete the instructions from the wordlist.

battery	*disconnecting*	*charging*
check	*make sure*	*replace*
connecting	*making*	*switching*
correct	*near*	*to*
crocodile	*plugs*	

1. Before . . . . any connections, remove the filler . . . . from the battery.
2. Connect the charger . . . . the battery before . . . . it to the mains.
3. When connecting the . . . . clips, ... the connections carefully.
4. Before . . . . on the mains, make sure the voltage selector is in the . . . . position.
5. Do not smoke . . . . a battery while . . . . it.
6. Before . . . . the clips from the battery, switch off the charger.
7. Remember to . . . . the filler plugs after recharging the . . . . .
8. When storing the charger, ... it is disconnected from the mains.

Now look at this example:

Check the specific gravity of the electrolyte when
servicing a battery.
you service a battery.

Transform each of the instructions above in the same way.

Exercise 12 This is a time sheet for an electrical technician. First, read it carefully.

Name: G. J. Williams			Date: 14/8
	From	To	
Work Period 1	8·00	8·50	Checked a Sanyo Mk 48 radio.
	8·50	9·10	Collected spare parts from the storeroom.
	9·10	10·00	Repaired the Sanyo radio.
Rest Period 1 (Tea break) 10·00 — 10·30			
Work Period 2	10·30	11·30	Tested a Philips amplifier.
	11·30	12·00	Replaced two transistors in —··—
Rest Period 2 (Lunch break) 12·00 — 1·00			
Work Period 3	1·00	2·20	Cleaned and serviced a National tape recorder.
	2·20	3·30	Replaced the motor in a Sony tape recorder.
	3·30	4·10	Adjusted the amplifier in —··—
	4·10	4·30	Cleaned my tools and workbench.
Signed: G. J. Williams Checked: M Walters Approved: LA Jones			

Now look at the examples and then make similar questions and answers from the time sheet in the same way.

How long was the technician checking the radio?

He was checking the radio from 8.00 to 8.50.
for fifty minutes.

What was he doing in the first work period?

He was checking the radio (and . . . . .).

What was he doing at 8.30/9.00/9.30?

. . . . . .

LANGUAGE NOTE 30

What time is it? It's

three o'clock	=	15.00
a quarter past three		15.15
twenty past three		15.20
half-past three		15.30
twenty to four		15.40
a quarter to four		15.45

a battery charger
a filler plug
a rate
a period
a break
a time sheet
a technician
an amplifier
a transistor
a tape recorder

an explanation

rectify
repair
sign
approve

almost
highly

rest
tea
lunch

while

during

Appendix One

Irregular Verbs

This list contains 77 useful English irregular verbs. The verbs are divided into groups according to their type of irregularity. Verbs which have been used in this course (Books 1 and 2) are printed in *italics*.

Group 1

bend	bent	bent
build	built	built
burn	*burnt*	*burnt*
learn	learnt	learnt
send	sent	sent

Group 2

bring	brought	brought
buy	bought	bought
hear	heard	heard
keep	kept	kept
leave	*left*	*left*
lose	lost	lost
mean	*meant*	*meant*
say	said	said
sell	sold	sold
teach	taught	taught

Group 3

burst	burst	burst
cast	*cast*	*cast*
cost	cost	cost
cut	*cut*	*cut*
hit	hit	hit
let	*let*	*let*
put	*put*	*put*
set	*set*	*set*
shut	shut	shut
split	split	split
spread	spread	spread

Group 4

bind	bound	bound
dig	dug	dug
feed	*fed*	*fed*
find	*found*	*found*

grind	*ground*	*ground*
hang	hung	hung
have	*had*	*had*
hold	*held*	*held*
lead	led	led
light	*lit*	*lit*
meet	met	met
make	*made*	*made*
read	*read**	*read**
shine	shone	shone
slide	slid	slid
spin	spun	spun
stand	stood	stood
stick	stuck	stuck
strike	*struck*	*struck*
understand	understood	understood
withstand	*withstood*	*withstood*

Group 5

saw	*sawed*	*sawn*
show	*showed*	*shown*

Group 6

blow	*blew*	*blown*
break	*broke*	*broken*
choose	chose	chosen
draw	*drew*	*drawn*
drive	*drove*	*driven*
fall	*fell*	*fallen*
fly	flew	flown
freeze	*froze*	*frozen*
give	*gave*	*given*
know	*knew*	*known*
lie	lay	lain
rise	*rose*	*risen*
see	*saw*	*seen*
shake	shook	shaken
speak	spoke	spoken
take	*took*	*taken*
tear	tore	torn
throw	*threw*	*thrown*
wear	*wore*	*worn*
withdraw	*withdrew*	*withdrawn*
write	*wrote*	*written*

Group 7

become	*became*	*become*
begin	began	begun
come	*came*	*come*
do	*did*	*done*
go	*went*	*gone*
run	*ran*	*run*
sink	*sank*	*sunk*

**read* is pronounced *red* here.

Appendix Two

SI Units of Measurement

Many different systems of measurement are still used. However, most scientists now use the SI (Système Internationale) system.

The SI system has seven *basic units*. Here are the five most common units.

Quantity and Symbol	Basic SI Unit	SI Abbreviation
length (l)	metre	m
mass (m)	kilogram	kg
time (t)	second	s
electric current (I)	ampere	A
temperature (T)	kelvin	K*

* The Kelvin scale and the Celsius scale are related. The Kelvin temperature equals the Celsius temperature plus 273.16°. (0°C = 273.16°K: 100°C = 373.16°K, etc.)

All other SI units are *derived* from the basic units.

For example:

Quantity and Symbol	Derived Unit	SI Abbreviation
volume (V)	cubic metre	m^3
area (A or S)	square metre	m^2

Most derived units are combinations of the basic units.

For example:

Quantity and Symbol	Combination	SI Abbreviation
density (ρ)	m/V	kg/m^3 *or* kgm^{-3}
velocity (u *or* v)	l/t	m/s *or* ms^{-1}

Some derived units have special names.

For example:

Quantity and Symbol	SI Abbreviation	Name and Symbol
frequency (ν *or* f)	s^{-1}	hertz (Hz)
force (F)	$kg\ m\ s^{-2}$	newton (N)

Common derived SI Units

Quantity and Symbol	SI Abbreviation	Name and Symbol
area (A *or* S)	m^2	
volume (V)	m^3	
density (ρ)	$kg\ m^{-3}$	
velocity (u *or* v)	$m\ s^{-1}$	
acceleration (a)	$m\ s^{-2}$	
frequency (ν *or* f)	s^{-1}	hertz (Hz)
force (F)	$kg\ m\ s^{-2}$	newton (N)
pressure (p)	$kg\ m^{-1}\ s^{-2}$ *or* $N\ m^{-2}$	pascal (Pa)
energy (E)	$kg\ m^2\ s^{-2}$	joule (J)
power (P)	$kg\ m^2\ s^{-3}$ *or* $J\ s^{-1}$	watt (W)

Multiples of both base and derived units

Multiple or sub-multiple	Prefix	Symbol
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ

Vocabulary List for Book Two

GRAMMATICAL TERMINOLOGY AND ABBREVIATIONS

adjective (*adj*)	preposition (*prep*)
adverb (*adv*)	pronoun (*pron*)
conjunction (*conj*)	verb (*v*)
count noun (*n.c.*)	irregular verb (*v. irreg*)
mass noun (*n.m.*)	plural (*pl*)

The *number* and *letter* after each word refer to the *unit* and *section* in which the word first appears. Words which have already appeared in Book 1 do *not* appear in this list.

accident (*n.c.*) 7C
accurate (*adj*) 5B
accurately (*adv*) 3B
acetone (*n.m.*) 7A
acetylene (*n.m.*) 7A
adjust (*v*) 6C
adjuster screw (*n.c.*) 6C
aerial (*n.c.*) 1A
after (*prep*) 8A
again (*adv*) 4A
against (*prep*) 1B
ago (*adv*) 4C
aim (*n.c.*) 3B
alcohol (*n.m.*) 3A
allow (*v*) 3B
almost (*adv*) 8C
along (*prep*) 2C
alternating current (*n.m.*) 8A
alternator (*n.c.*) 6B
although (*conj*) 5B
ammeter (*n.c.*) 8A
ampere (*n.c.*) 7B
amplifier (*n.c.*) 8C
and so (*conj*) 2B
anti-freeze (*n.m.*) 6A
any (*adj*) 5C
approve (*v*) 8C
arm (*n.c.*) 7C
argon (*n.m.*) 1B
as . . . (so) (*conj*) 5B
atmosphere (*n.c.*) 7A
attach (*v*) 3B
average (*adj*) 5C
axis (pl. axes) (*n.c.*) 5A

badly (*adv*) 1A
ball (*n.c.*) 4B
bath (*n.c.*) 4A
battery charger (*n.c.*) 8C
bauxite (*n.m.*) 4B
bearing (*n.c.*) 2C
before (*prep*) 8B
blast (*n.c.*) 4C
block (*v*) 6A
blow (*v. irreg*) 4C
boiler (*n.c.*) 2A
brass (*n.m.*) 1B
brazing (*n.m. & adj*) 7A
break (*n.c.*) 8C
brush (*n.c.*) 3B
brush (*v*) 7B
burn (*n.c.*) 7C
butt weld (*n.c.*) 7A

cable (*n.c.*) 7B
calculate (*v*) 3A
calibrated (*adj*) 1A
cam (*n.c.*) 6C
camshaft (*n.c.*) 6C
carburettor (*n.c.*) 6B
carburizing (*adj*) 7A
carefully (*adv*) 3B
carry (*v*) 7B
casing (*n.c.*) 2C
cast (*v. irreg*) 4C
castle nut (*n.c.*) 1B
cause (*v*) 4C
caution (*n.m.*) 7A
ceiling (*n.c.*) 1B
centre (*n.c.*) 2A
charcoal (*n.m.*) 4C
charge (*n.c.*) 4C
chemistry (*n.m.*) 4A
circlip (*n.c.*) 1B
circuit (*n.c.*) 7B
clamp (*n.c.*) 1B
clean (*adj*) 7C
clean (*v*) 8A
clevis pin (*n.c.*) 1B
clip (*n.c.*) 1B
clock (*n.c.*) 7C
clothes (*n.m.*) 7C
coal (*n.m.*) 2A
coefficient (*n.c.*) 5A
coil (*v*) 1B
coke (*n.m.*) 4C

collect (*v*) 6A
combination (*n.c.*) 4B
combine (*v*) 7C
combustible (*adj*) 7A
come (*v. irreg*) 2C
complete (*v*) 2A
complete (*adj*) 5B
completed (*adj*) 1A
complex (*adj*) 2A
compress (*v*) 7A
compressed (*adj*) 1A
concentrate (*n.c.*) 4A
concentrated (*adj*) 7B
conclusion (*n.c.*) 3B
condense (*v*) 2A
condenser (*n.c.*) 2B
conductor (*n.c.*) 1B
connect (*v*) 1B
connecting rod (*n.c.*) 6C
connection (*n.c.*) 8B
connector (*n.c.*) 8B
considerable (*adj*) 6B
constant (*n.c.*) 5A
construct (*v*) 2B
consumption (*n.c. & n.m.*) 2B
contact (*n.c.*) 1B
continuous (*adj*) 5C
continuously (*adv*) 5C
control (*v*) 2B
conversely (*adj*) 5B
contact (*n.c.*) 1B
continuous (*adj*) 5C
continuously (*adv*) 5C
control (*v*) 2B
conversely (*adj*) 5B
converter (*n.c.*) 4A
cool (*v*) 4B
correctly (*adv*) 1A
corroded (*adj*) 1A
cotton (*n.m.*) 3B
covered (*adj*) 1A
cracked (*adj*) 1A
crankshaft (*n.c.*) 6C
create (*v*) 7A
crocodile clip (*n.c.*) 8B
crush (*v*) 4A
crusher (*n.c.*) 4A
cryolite (*n.m.*) 4B
crystal (*n.c.*) 4B
crystallize (*v*) 4B
cut (*v. irreg*) 2C

damage (*n.m. & v*) 6A
danger (*n.m.*) 7B
date (*n.c.*) 2B
day (*n.c.*) 2B
decrease (*v*) 2A
demonstration (*n.c.*) 3A
dent (*n.c.*) 1A
deposit (*v*) 4A
describe (*v*) 3A
description (*n.c.*) 3A
design (*n.c.*) 2A
design (*v*) 2B
detach (*v*) 7B
difference (*n.c.*) 5C
differential (*n.c.*) 6B
dipstick (*n.c.*) 6A
direct (*adj*) 5B
direct current (*n.m.*) 8A
direction (*n.c.*) 2C
directly (*adv*) 2C
dirt (*n.m.*) 3B
dirty (*adj*) 6C
disappear (*v*) 7B
discharge (*v*) 8A
disconnect (*v*) 8B
displace (*v*) 3B
displaced (*adj*) 3B
displacement vessel (*n.c.*) 3B
distilled (*adj*) 6C
distributor (*n.c.*) 6B
dowel pin (*n.c.*) 1B
down (*prep*) 2A
drawing (*n.c.*) 7B
drier (*n.c.*) 4B
drive (*v. irreg*) 2C
driver (*n.c.*) 8A
drop (*n.c.*) 5C
dry (*v*) 4B
during (*prep*) 8C
dust (*n.m.*) 4C
dynamo (*n.c.*) 2C

early (*adj*) 2A
earth (*n.m.*) 7B
efficiency (*n.c. & n.m.*) 2B
efficient (*adj*) 2B
efficiently (*adv*) 6A
electric shock (*n.c.*) 7C
electrocution (*n.m.*) 7B
electrolyte (*n.c.*) 6C
electronic (*adj*) 6C
empty (*v*) 2B
empty (*adj*) 3A
energy (*n.m.*) 2B
enter (*v*) 2A
equation (*n.c.*) 3A
eventually (*adv*) 4A
every (*adj*) 6A
excess (*adj*) 3B
excess (*n.c.*) 7A
exhaust (*n.m.*) 2C
experiment (*n.c.*) 3A
explanation (*n.c.*) 8C
explosion (*n.c.*) 7C
extract (*v*) 4A
eye (*n.c.*) 7C

face (*n.c.*) 7C
fan belt (*n.c.*) 6B
fast (*adj*) 8A
fault (*n.c.*) 6C
feed (*v. irreg*) 4C
filament (*n.c.*) 1B
filler metal (*n.m.*) 7A
filler plug (*n.c.*) 8C
fillet weld (*n.c.*) 7A
filter (*n.c.*) 4B
finally (*adv*) 3A
find (*v. irreg*) 4B
finish (*v*) 1A
first (*adv*) 3A
fit (*v*) 1B
fitted (*adj*) 1A
fix (*v*) 1B
flame (*n.c.*) 6B
flat joint (*n.c.*) 7A
floor (*n.c.*) 7C

flotation cell (*n.c.*) 4A
flow (*v*) 6A
flow (*n.c.* & *n.m.*) 7A
fluorine (*n.m.*) 4B
follow (*v*) 7C
foot (*n.c.*) 7C
force (*v*) 2A
form (*v*) 4B
frequent (*adj*) 6C
friction (*n.m.*) 6A
full (*adj*) 3A
function selector switch (*n.c.*) 8B
furthermore (*conj*) 5B
future (*n.m.*) 6A

gaseous (*adj*) 7A
gear lever (*n.c.*) 6B
gearbox (*n.c.*) 6B
generator (*n.c.*) 2C
gently (*adv*) 3B
glove (*n.c.*) 7C
go (*v. irreg*) 2C
goggles (*n.c.*) 7C
gradient (*n.c.*) 5A
grain (*n.c.*) 3B
grease (*n.m.* & *v*) 6A
greasy (*adj*) 7C
grind (*v. irreg*) 4C
groove (*n.c.*) 1A
ground (*n.m.*) 1B

haematite (*n.m.*) 4C
half shaft (*n.c.*) 6B
handle (*v*) 7B
have (*v. irreg*) 2C
he (*pron*) 2B
highly (*adv*) 8C
his (*adj*) 2B
holder (*n.c.*) 1B
hook (*v*) 1B
horsepower (*n.c.*) 2A
hose clip (*n.c.*) 1B
how far . . . ? 5C
how long . . . ? 5C

if . . . (then) (*conj*) 5A
immediately (*adv*) 7C
improve (*v*) 2B
improvement (*n.c.*) 2C
impure (*adj*) 4A
impurity (*n.c.*) 4B
in order to (*conj*) 7B
in place (*adj* & *adv*) 6B
in poor condition (*adj*) 6C
in turn (*adv*) 6C
include (*v*) 5B
indicate (*v*) 8A
industrial (*adj*) 4A
injure (*v*) 7B
injury (*n.c.*) 7B
inlet (*n.c.*) 2B
insert (*v*) 8B
inside (*prep*) 1B
instead of 4C
insulated (*adj*) 1A
insulator (*n.c.*) 1B
invent (*v*) 2A
invention (*n.c.*) 2B
inverse (*adj*) 5B
irregular (*adj*) 3B
item (*n.c.*) 8A

jaw (*n.c.*) 7C
jet (*n.c.*) 2B
joint (*n.c.*) 1A

key (*n.c.*) 1B

labelled (*adj*) 1A
laboratory (*n.c.*) 3A
later (*adj*) 2A
law (*n.c.*) 5B
lead (*n.c.*) 8B
leak (*n.c.*) 7C
leak (*v*) 6A
leave (*v. irreg*) 4B
leg (*n.c.*) 7C
let (*v. irreg*) 3B
light (*v. irrreg*) 7A
like 1A
line (*v*) 1B
lip (*n.c.*) 7C
lock washer (*n.c.*) 1B
locked (*adj*) 1A
loop (*n.c.*) 1B
loss (*n.c.* & *n.m.*) 2B
lubricate (*v*) 6A
lubrication (*n.m.*) 6A
lump (*n.c.*) 4C
lunch (*n.c.*) 8C

magnetite (*n.m.*) 4C
make sure (*v. irreg*) 8B
manifold (*n.c.*) 6B
mask (*n.c.*) 7C
mass (*n.c.* & *n.m.*) 3A
mean (*v. irreg*) 7B
measuring cylinder (*n.c.*) 1A
mine (*v*) 4B
mineral (*n.c.* & *n.m.*) 4A
minute (*n.c.*) 2A
mix (*v*) 1B
mixer (*n.c.*) 4A
modern (*adj*) 2A
month (*n.c.*) 5C
moreover (*conj*) 5B
motor (*n.c.*) 8C
mount (*n.c.*) 1B
mouth (*n.c.*) 5C
movement (*n.c.*) 2A
moving part (*n.c.*) 6A
multimeter (*n.c.*) 8B

natural (*adj*) 4B
necessary (*adj*) 5C
neck (*n.c.*) 7C
need (*v*) 2C
needle (*n.c.*) 7C
neutral (*adj*) 7A
nowadays (*adv*) 2A
number (*n.c.*) 5A
numerical (*adj*) 5B

occur (*v*) 6C
ohm (*n.c.*) 8B
oily (*adj*) 7C
once (*adv*) 6A
onto (*prep*) 1B

operate (*v*) 6B
operator (*n.c.*) 7B
or else (*conj*) 7B
ore (*n.m.* & *n.c.*) 4A
origin (*n.c.*) 5A
out of (*prep*) 6A
outlet (*n.c.*) 2B
outside (*prep*) 2B
overalls (*n.c.*) 7C
overflow (*v*) 3B
overheat (*v*) 7B
own (*adj*) 3B
oxide (*n.c.*) 3B
oxidize (*v*) 4A
oxidizer (*n.c.*) 4A
oxidizing (*adj*) 7A

painted (*adj*) 1A
pair (*n.c.*) 1A
panel (*n.c.*) 8A
passenger (*n.c.*) 8A
patch (*n.c.*) 1B
pen (*n.c.*) 1B
pencil (*n.c.*) 1A
period (*n.c.*) 8C
petroleum (*n.m.*) 7A
piece (*n.c.*) 3B
pile (*n.c.*) 3B
piston (*n.c.*) 2A
piston ring (*n.c.*) 6B
plank (*n.c.*) 3B
point (*n.c.*) 8B
points (*n.c.*) 6C
poison (*n.c.* & *n.m.*) 7B
poisonous (*adj*) 7B
poorly (*adv*) 1A
pop rivet (*n.c.*) 1B
powder (*n.c.* & *n.m.*) 4B
powder (*v*) 4B
power (*n.m.*) 2C
powerful (*adj*) 2A
precaution (*n.c.*) 7C
pressurize (*v*) 4B
prevent (*v*) 7B
probably (*adv*) 3B
probe (*n.c.*) 8B
procedure (*n.c.*) 3B
process (*v*) 4C
projector (*n.c.*) 4A
propane (*n.m.*) 7A
propeller shaft (*n.c.*) 6B
proportion (*n.c.*) 5B
protect (*v*) 7B
pull (*v*) 8A
pulley (*n.c.*) 1B
pump (*n.c.*) 2B
pump (*v*) 2A
push (*v*) 2C
push rod (*n.c.*) 6C
put (*v. irreg*) 2C

radio (*n.c.*) 1B
rapid (*adj*) 2B
rate (*n.c.*) 8C
reduce (*v*) 4C
reduction (*n.c.* & *n.m.*) 4C
rectifier (*n.c.*) 8A
rectify (*v*) 8C
reel (*n.c.*) 3B
refine (*v*) 4A
refinery (*n.c.*) 4B
refrigerator (*n.c.*) 4A
regularly (*adv*) 6A
regulate (*v*) 7A
regulator (*n.c.*) 7A
relationship (*n.c.*) 5B
reliable (*adj*) 6C
remember (*v*) 8B
repair (*v*) 8C
report (*n.c.*) 3B
resistor (*n.c.*) 8B
rest (*n.c.*) 8C
revolution (*n.c.*) 2C
revolution counter (*n.c.*) 8A
rich (*adj*) 4A
right-angled (*adj*) 5A
ring (*n.c.*) 2C
rise (*v. irreg*) 5C
rivet (*n.c.*) 1B
rocker arm (*n.c.*) 6C
roller (*n.c.*) 4B
rotate (*v*) 6C
rotor (*n.c.*) 2C
rotor arm (*n.c.*) 6C
run (*v. irreg*) 2C

scratch (*n.c.*) 1A
screw (*v*) 1B
scriber (*n.c.*) 4A
seal (*v*) 1B
second (*n.c.*) 5C
securely (*adv*) 7B
see (*v. irreg*) 4C
separate (*adj*) 2B
separate (*v*) 4A
separately (*adv*) 4C
service (*n.c.* & *v*) 6C
servicing (*n.m.*) 6C
set-screw (*n.c.*) 1B
shaft (*n.c.*) 1A
shoe (*n.c.*) 7C
sign (*n.c.*) 7B
sign (*v*) 8C
similar (*adj*) 2A
similarly (*adv*) 5A
sink (*v. irreg*) 3B
skip (*n.c.*) 4C
slag (*n.m.*) 4C
sleeve (*n.c.*) 7C
slope (*v*) 2C
slot (*n.c.*) 1A
slow (*adj*) 2A
smelt (*v*) 4A
so that (*conj*) 7C
soldering iron (*n.c.*) 8B
solution (*n.c.*) 4B
soon (*adv*) 8A
spark (*n.c.*) 6B
split pin (*n.c.*) 1B
stack (*n.c.*) 3B
stand (*n.c.*) 1B
statement (*n.c.*) 7C
stay (*v*) 5C
steady (*adj*) 2B
steam (*n.m.*) 2A
still (*adv*) 2C
strike (*v. irreg*) 7B
strip (*n.c.*) 3B
stud (*n.c.*) 1B
suitable (*adj*) 5C
sump plug (*n.c.*) 6C

supply (*n.c.*) 2B
supply (*v*) 2B
switch (*n.c.*) 1B

tachometer (*n.c.*) 8A
tape recorder (*n.c.*) 8C
taper pin (*n.c.*) 1B
tappet (*n.c.*) 6C
tea (*n.m.*) 8C
technician (*n.c.*) 8C
terminal (*n.c.*) 1B
thread (*n.c.*) 1A
time (*n.c. & n.m.*) 3A
time sheet (*n.c.*) 8C
tip (*n.c.*) 7B
tooth (pl. teeth) (*n.c.*) 1A
top (*n.c.*) 2A
torch (*n.c.*) 1B
touch (*v*) 8B
trailer (*n.c.*) 8A
transfer (*v*) 4A
transform (*v*) 4A
transformer (*n.c.*) 7B
transistor (*n.c.*) 8C
travel (*v*) 8A
treat (*v*) 4B
tungsten (*n.m.*) 1B
turbine (*n.c.*) 2C
typewriter (*n.c.*) 4A

unit (*n.c.*) 3A
universal joint (*n.c.*) 6B
unless (*conj*) 5B
up (*prep*) 2A
used (*adj*) 1A
useful (*adj*) 5C
useless (*adj*) 5C

value (*n.c.*) 5A
variable (*n.c.*) 5A
vary (*v*) 2B
vice (*n.c.*) 1B
voltage (*n.c. & n.m.*) 2C

wash (*v*) 3A
washer (*n.c.*) 1B
wear (*n.m.*) 6A
wear (*v. irreg*) 7C
wedge (*n.c.*) 1A
week (*n.c.*) 5B
weigh (*v*) 3A
welding torch (*n.c.*) 7A
when (*conj*) 8B
while (*conj*) 8C
window (*n.c.*) 8A
withdraw (*v. irreg*) 7B
word (*n.c.*) 5B
workpiece (*n.c.*) 7A
worn (*adj*) 6C

year (*n.c.*) 2A