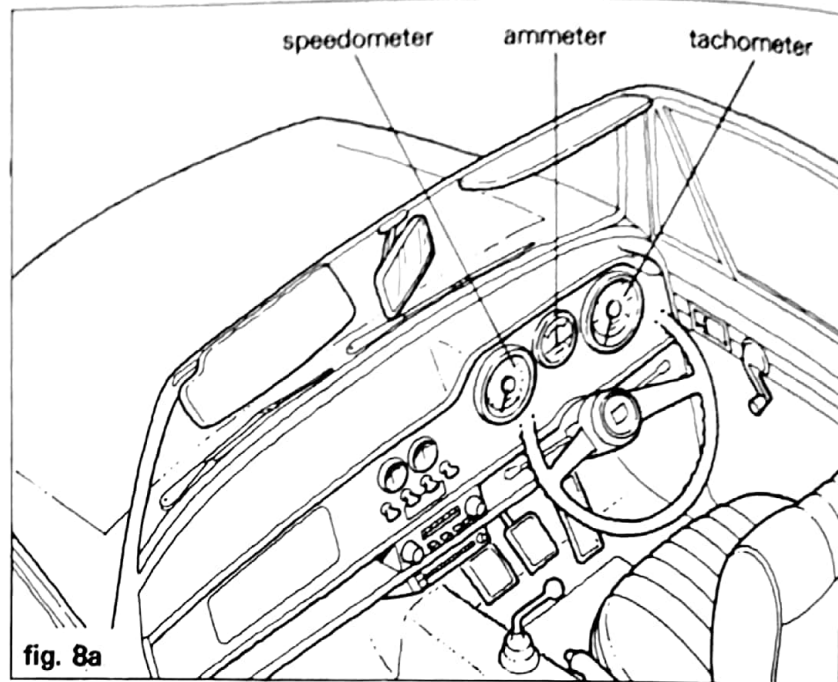


# UNIT EIGHT

## Electrical Instruments

### SECTION A: THE INSTRUMENTS IN A CAR



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.

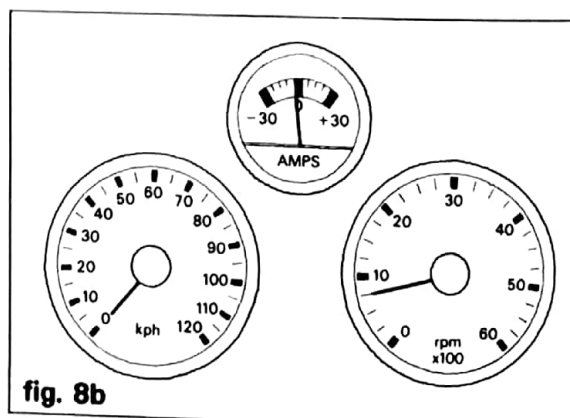


Fig. 8b shows an instrument panel. What information does it provide for the driver?

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  $-5\text{ A}$ .

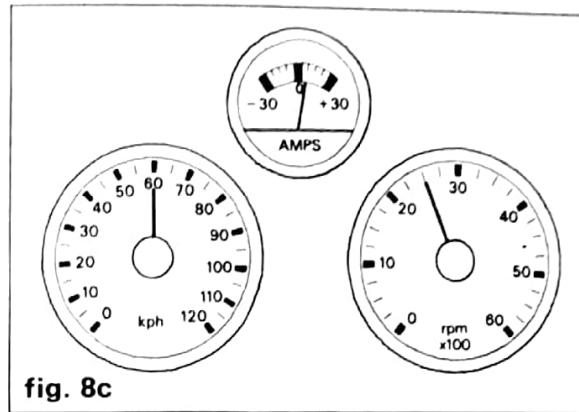


Fig. 8c provides the driver with different information. The car is now moving at 60 kph. The engine is turning at 2500 rpm and so the alternator is turning quite fast. It is producing a strong current for the engine and so the battery is no longer needed to supply current. The battery is now recharging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

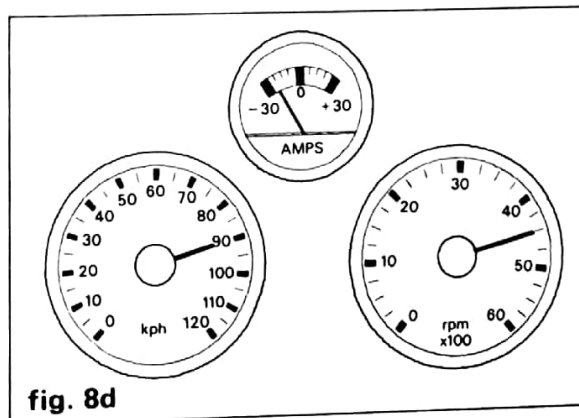


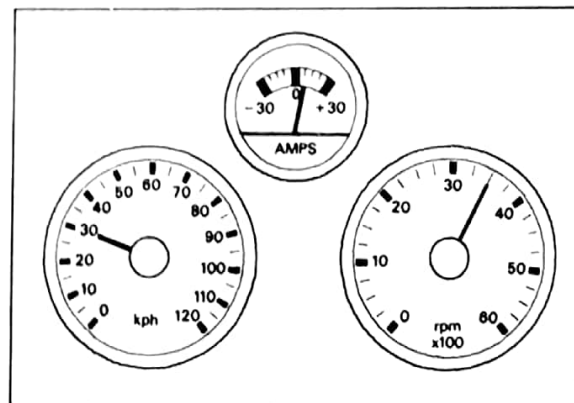
Fig. 8d indicates a fault. The car is now moving at 90 kph. The engine is turning at a speed of 4500 rpm. However, the alternator is not producing any current. The ammeter is indicating  $-20\text{ A}$ . In other words, the battery is discharging rapidly although the engine is turning at high speed. 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?

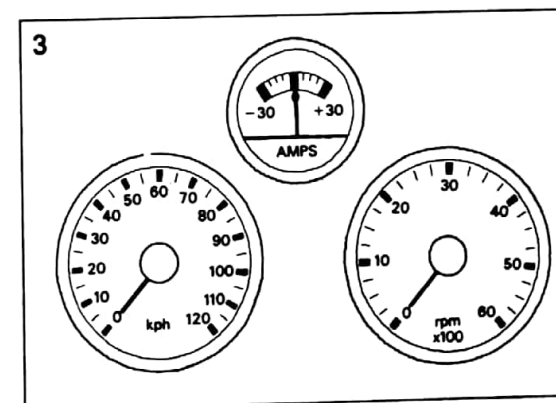
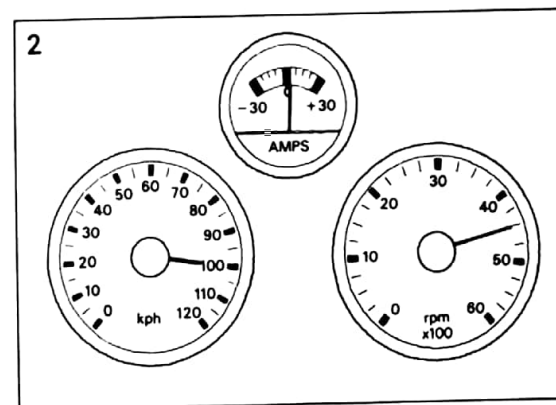
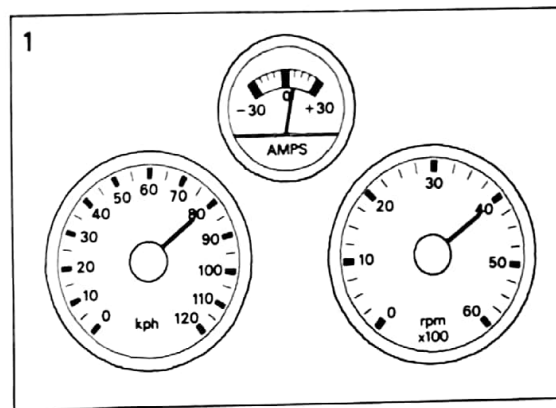
Write one sentence under each heading.

*Road Speed*

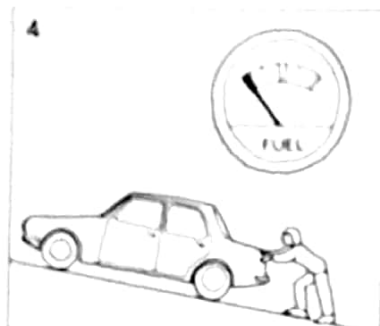
*Engine Speed*

*Alternator*

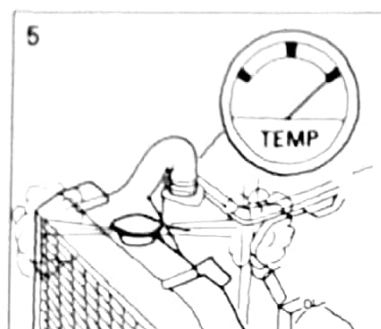
*Ammeter and Battery*



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

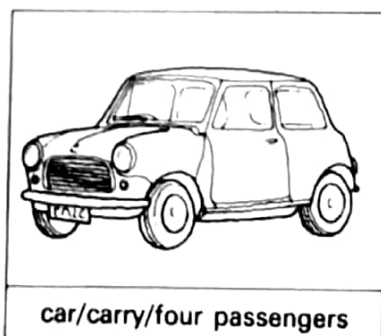


The engine . . . . . (turn)  
The driver . . . . . (push)  
The car . . . . . (move)

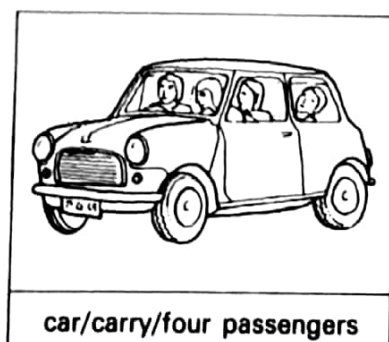


The engine . . . . . (overheat)  
The water . . . . . (boil)  
Steam . . . . . (escape)

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

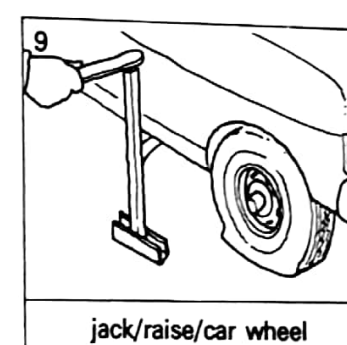
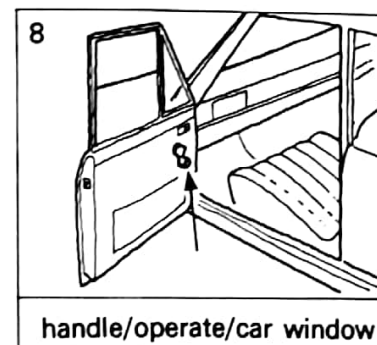
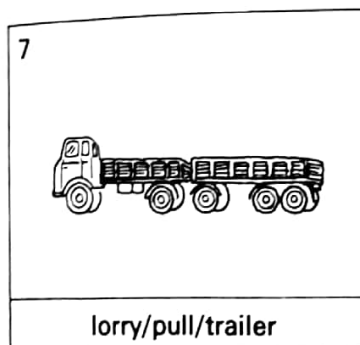
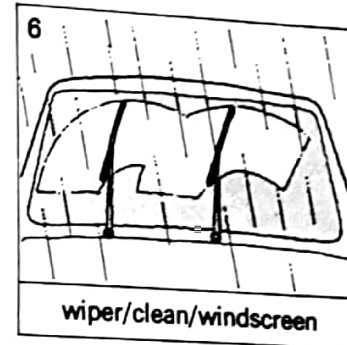
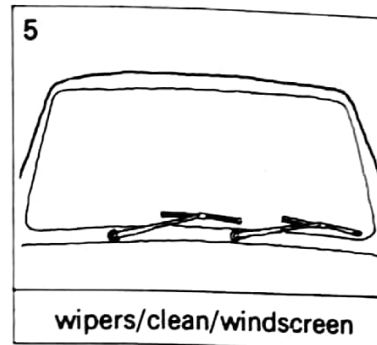
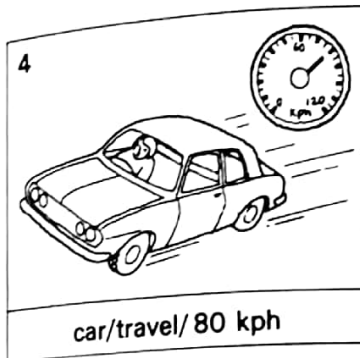
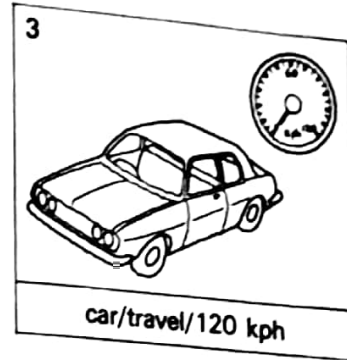
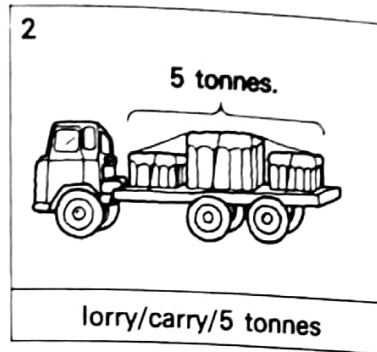
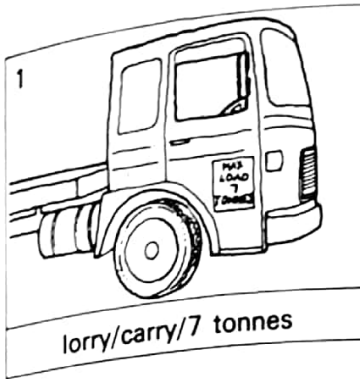


This car carries (OR can carry) four passengers.

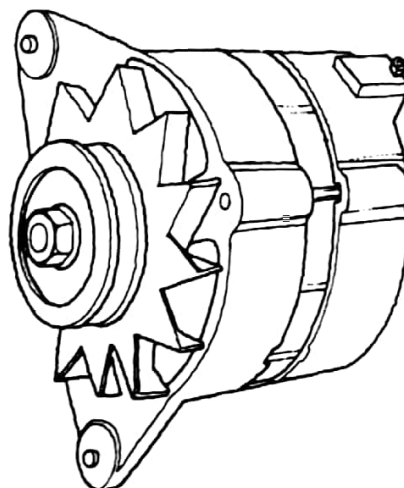


This car *is carrying* four passengers.

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



**Exercise 4** Complete the following paragraphs from the wordlist.



An alternator

because  
although  
convert

efficient  
either  
generate

instance  
charge  
require

soon  
still  
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 rev(olution) counter  
an ammeter  
a driver  
a panel  
a passenger

a trailer  
a window  
a rectifier  
an item  
Alternating Current (a.c.)  
Direct Current (d.c.)

indicate  
clean  
pull  
discharge  
travel

fast  
soon  
for instance  
after

## SECTION B: THE MULTIMETER

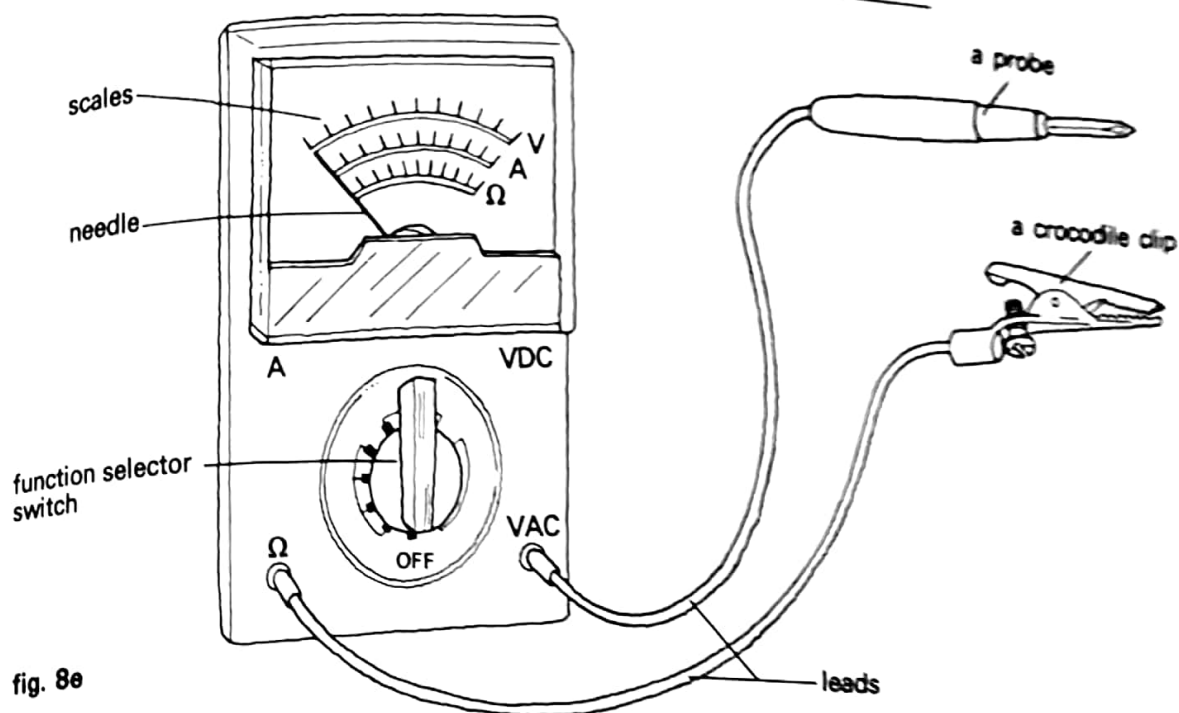


fig. 8e

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.

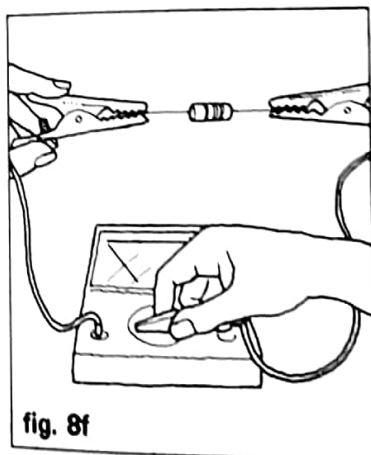


fig. 8f

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.

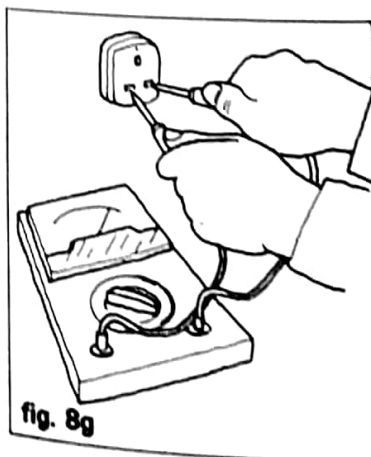
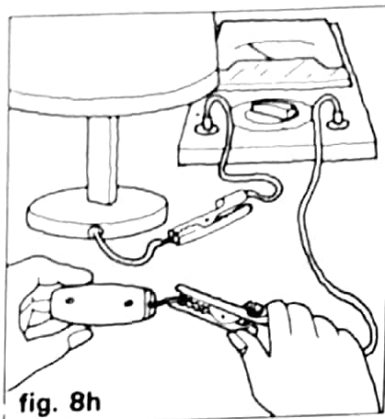


fig. 8g

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 V.a.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.





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)* .....

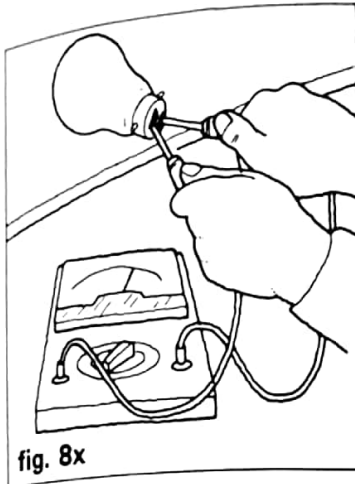
*In the reading text a multimeter is being described.*

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*) .....

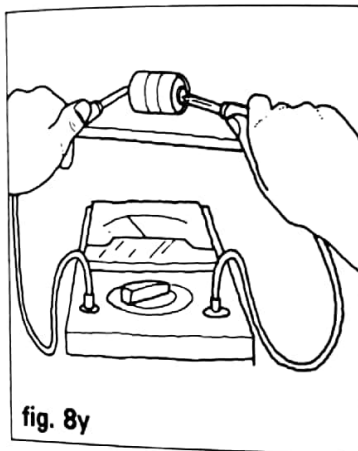
Now complete the following paragraph.

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



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.

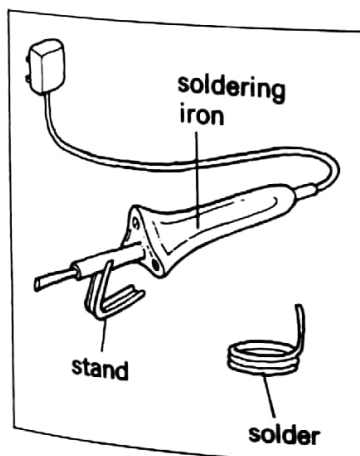
Finally, write four sentences to describe the use of a  
 multimeter for measuring the voltage of a dry cell  
 (fig. 8y). Use the words below to make a paragraph  
 like the one above.



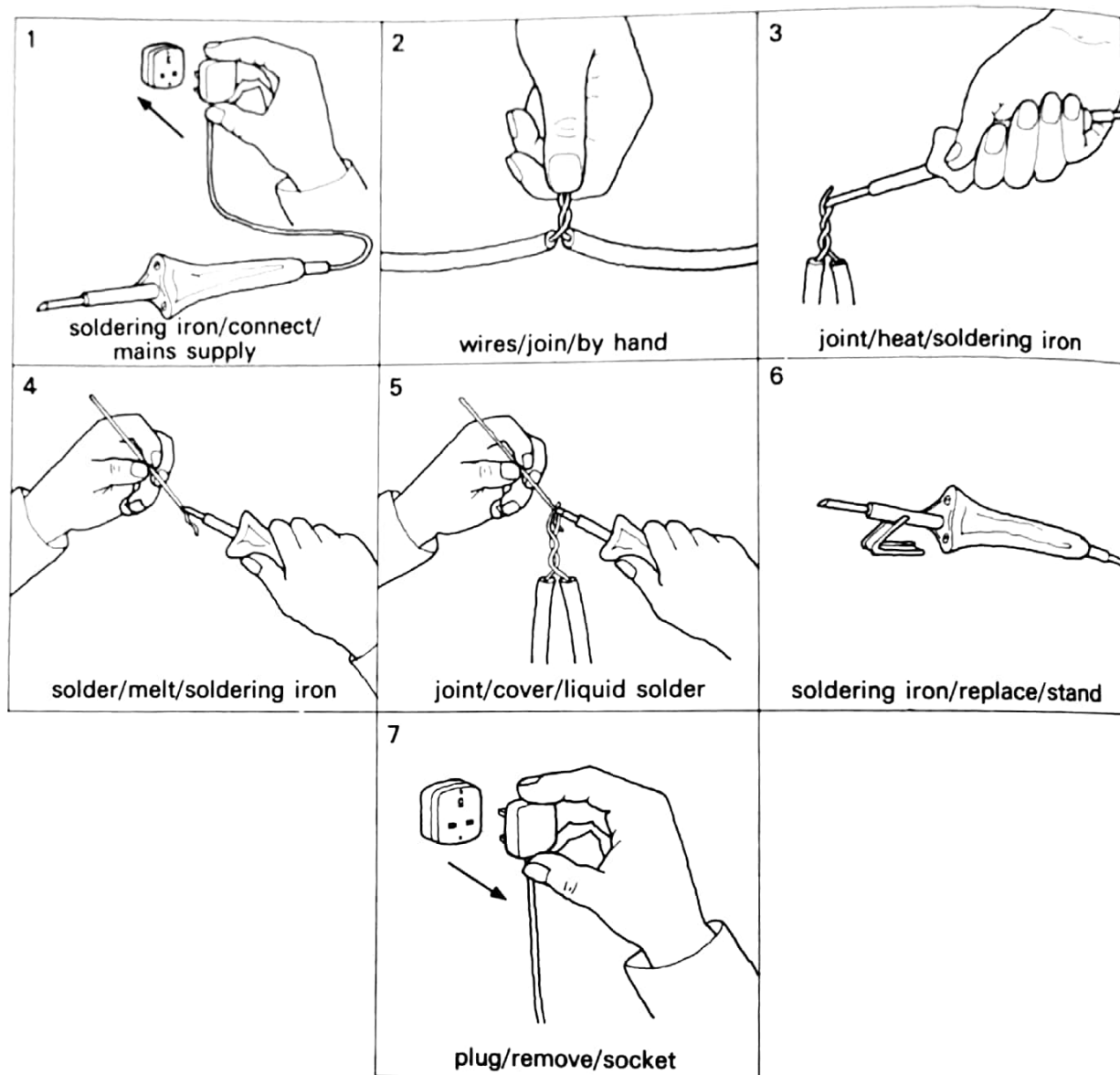
The multimeter (*use*) ..... to measure  
 the voltage of .....

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 . . . . . <sup>(clean)</sup> spark plugs.  
A small file can be used *when cleaning* spark plugs.

1. Do not touch the metal part of the probes . . . . . <sup>when</sup>  
(check) . . . . . mains voltage.
2. The negative probe can be inserted into either  
terminal . . . . . <sup>(measure)</sup> 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.

*Hint:*

<i>being</i>	<i>function</i>	<i>provides</i>
<i>connecting</i>	<i>instance</i>	<i>red</i>
<i>current</i>	<i>insulated</i>	<i>terminal</i>
<i>damage</i>	<i>may</i>	<i>than</i>
<i>direct</i>	<i>or else</i>	<i>turn</i>
<i>disconnected</i>	<i>points</i>	

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 V.a.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.

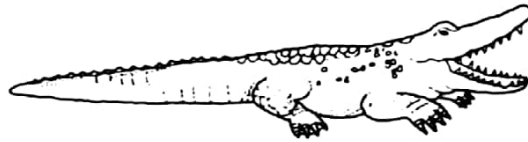
#### LANGUAGE NOTE 28

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

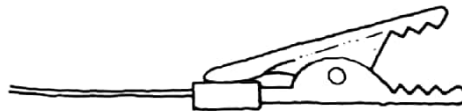
An electric current may be either a.c. or d.c.

The probe can be inserted into either terminal.

#### LANGUAGE NOTE 29



a crocodile



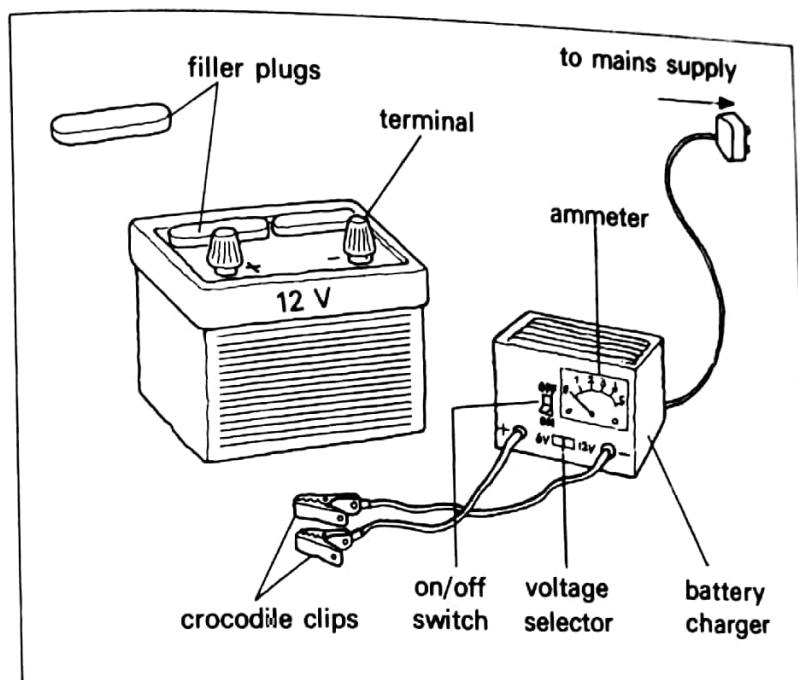
a crocodile clip

a multimeter  
an ohm ( $\Omega$ )  
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

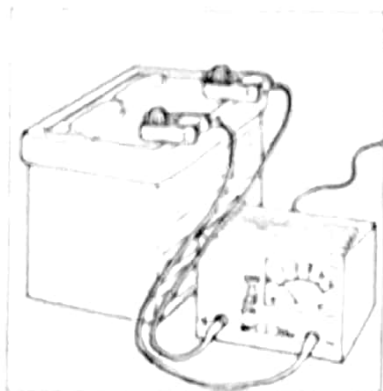
## SECTION C: BATTERY CHARGERS



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

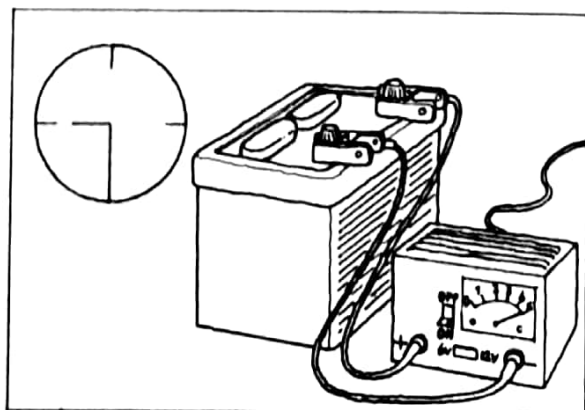
Charging started eight hours ago. During the first hour, the ammeter needle was indicating 5 A (i.e. the battery was being charged at the maximum rate). During the second and third hours, the ammeter was indicating about 4.5 A (i.e. the rate of charging was decreasing slowly). During the next two hours, 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.

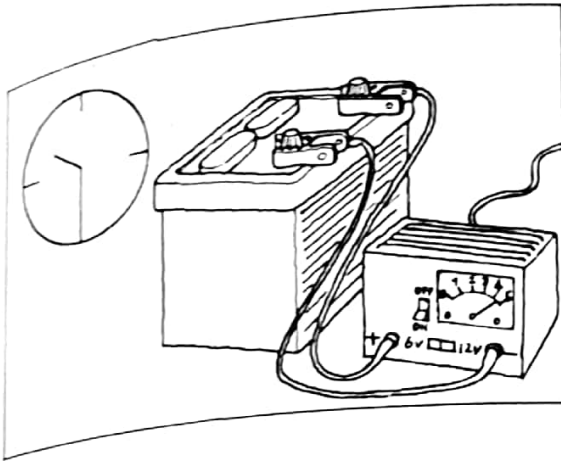
**Exercise 9** Answer these questions with short explanations or some examples. You should use more than one sentence to answer each question.

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?

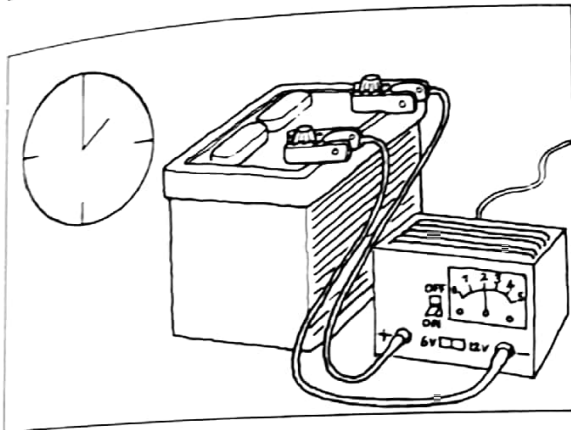
**Exercise 10** In the example below, charging started at 09.00 hrs. Complete these short paragraphs. Each paragraph contains two sentences.



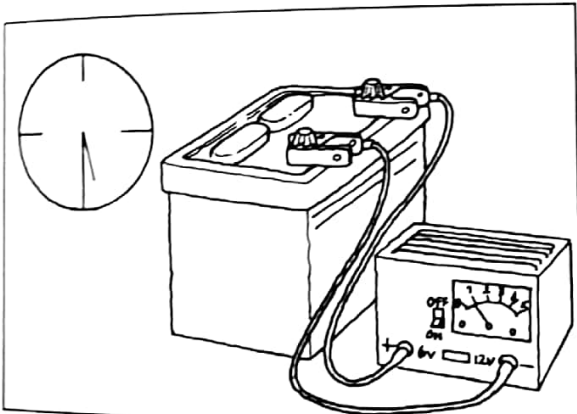
1. At 09.30 hrs, the battery .....  
maximum rate.  
The ammeter ..... 5 A.



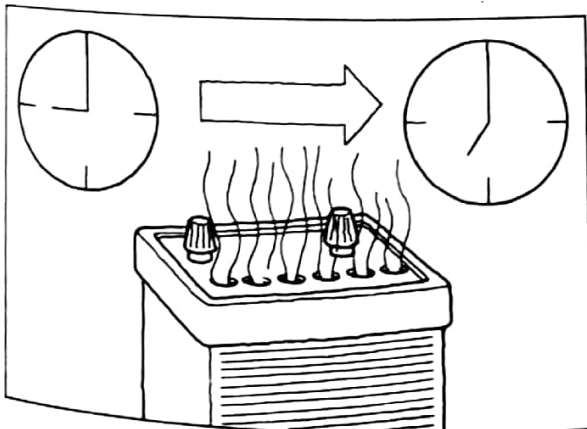
2. At .....  
The ammeter .....



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.

<i>battery</i>	<i>disconnecting</i>	<i>charging</i>
<i>check</i>	<i>make sure</i>	<i>replace</i>
<i>connecting</i>	<i>making</i>	<i>switching</i>
<i>correct</i>	<i>near</i>	<i>to</i>
<i>crocodile</i>	<i>plugs</i>	

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: 14/5	
Work Period 1	From	To	
	8.00	8.50	Checked a Sanyo Mk 45 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. Walker Approved: L. A. 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?

. . . . .



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