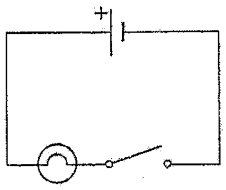
D.C. Circuits

1) Basic components of a Circuit

The diagram below shows a simple circuit. The current flows in one direction in the circuit. It is therefore called a Direct Current. Circuits with direct current are called D.C. circuits.

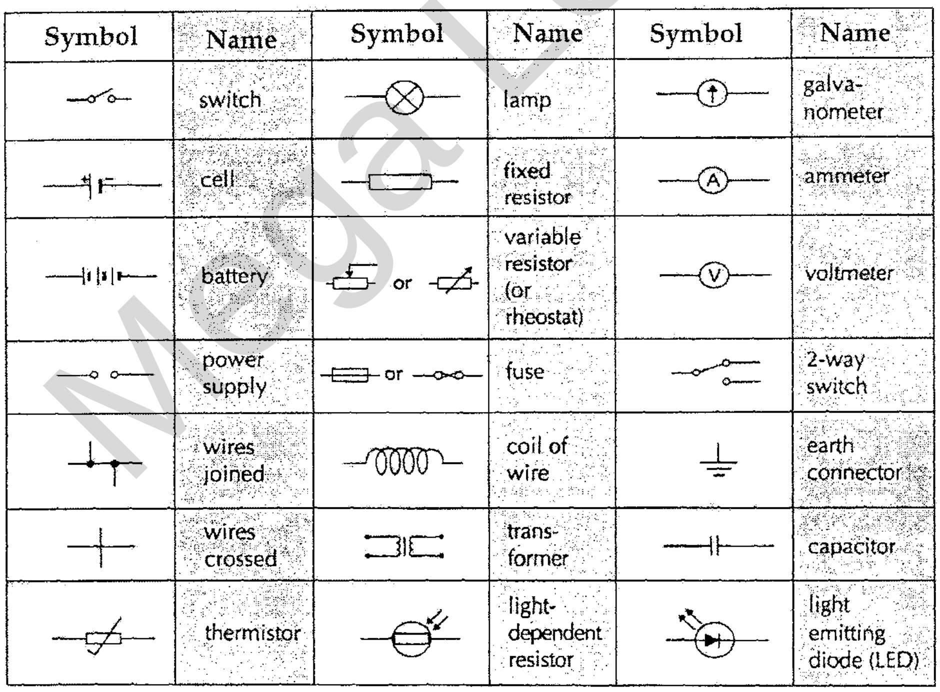


There are FOUR basic components in a circuit.

1. Power supply (battery)
2. Connecting wire
3. Switch
4. Electrical device (e.g. lamp, motor, electric kettle)

Circuit Symbols of components

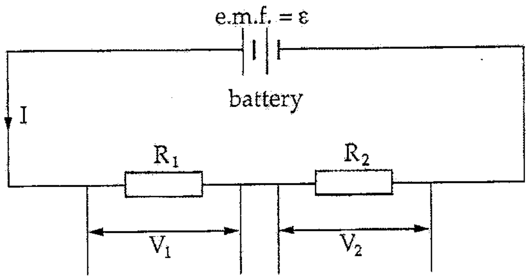
When we draw diagrams of circuits, we often use symbols for each component. The table shows the symbols commonly used in drawing circuits.



Symbol	Name	Symbol	Name	Symbol	Name
	switch		lamp		galva-nometer
	cell		fixed resistor		ammeter
	battery	or	variable resistor (or rheostat)		voltmeter
	power supply	or	fuse		2-way switch
	wires joined		coil of wire		earth connector
	wires crossed		trans-former		capacitor
	thermistor		light-dependent resistor		light emitting diode (LED)

2) Current and Potential Difference in Circuits

The figure shows a simple circuit consisting of a battery with emf, ε, and two resistors R_1 and R_2 in series.



I, R, V_1 and V_2 represent the total current, total resistance, voltage across R_1 and voltage across R_2 respectively.

We apply the equation V = IR to the individual resistor R_1 and R_2.

$$V_1 = IR_1$$
$$V_2 = IR_2$$

The e.m.f., ε, is equal to the total potential difference of the circuit. Thus we have

$$\varepsilon = IR$$

Since total resistance $R = R_1 + R_2$, we obtain

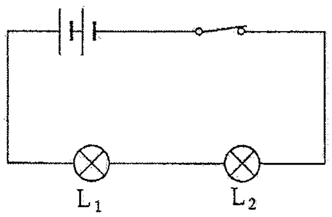
$$\boxed{\varepsilon = I(R_1 + R_2)}$$

Exam Tips:

- Total current I is the same at every point in the circuit.
- Total potential difference across all resistors must be equal to the emf.
- The equation V = RI can be applied to the whole circuit or individual resistor.

3) Series Circuits

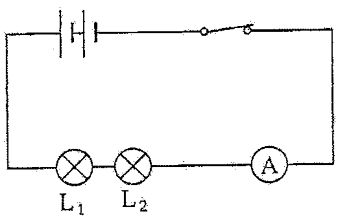
Consider a circuit which has 2 lamps connecting to a cell.



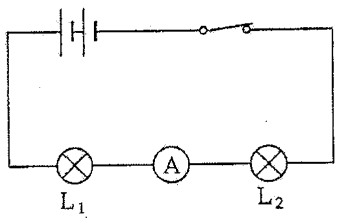
All the electrons that go through one lamp must go through the other. We say that the lamps are connected IN SERIES.

Current:

Now, we add an ammeter to the above circuit. Move the ammeter o different positions in the series circuit.



(a)



(b)

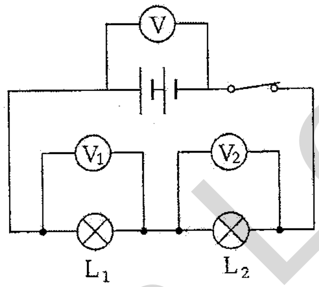
It is noticed that the same current flows through each point of a series circuit.

If you unscrew one lamp in the circuit, the other lamp will not light up. There is no current if there is a break anywhere in the circuit.

Conclusion:

The current flow is the same throughout a series circuit.

Potential Difference:



Now, we add three voltmeters to the circuit. Voltmeter V shows the potential difference across the battery, while voltmeters V_1 and V_2 show the potential differences across lamps L_1 and L_2 respectively.

From the readings of the voltmeters, we can draw the conclusion that

$$V = V_1 + V_2$$

Conclusion:

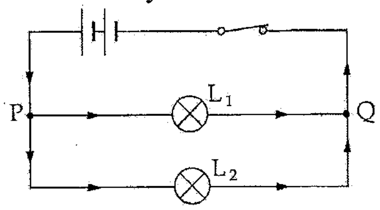
Sum of the potential differences across individual components in a series circuit is equal to the potential difference across the whole circuit.

Exam Tips:

For a series circuit, the component (resistor) with the highest resistance has the highest potential difference across it.

4) Parallel Circuits

Connect a battery to two lamps in the way shown below.



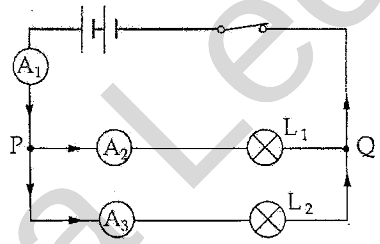
We say these two lamps are connected in PARALLEL. There is more the one path in which the electrons can flow in the circuit.

Current:

Each lamp has its own branch of the circuit. When the switch is closed, the current flows through the circuit and splits up at junction P. Both lamps lights up. The currents join together at junction Q.

Now connect three ammeters to the circuit as shown.

Ammeter A_1 measures the total current of the circuit. Ammeter A_2 and A_3 measure the current through lamps L_1 and L_2 respectively.



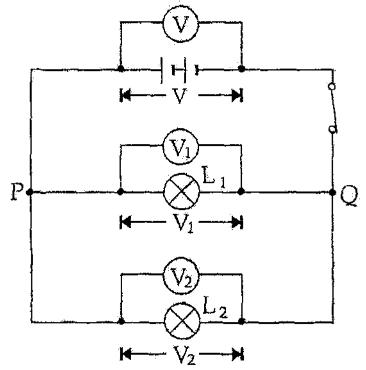
From the reading of the ammeter, we can draw the conclusion that

$I_1 = I_2 + I_3$

Conclusion:

The current in the main circuit is the sum of the current in the separate branches.

Potential Difference:



Now, we connect three voltmeters to the circuit as shown. Voltmeter V measures the potential difference across the battery while voltmeters V_1 and V_2 measure the potential differences across the lamps L_1 and L_2 respectively.

From the readings of the voltmeters, we can draw the conclusion that

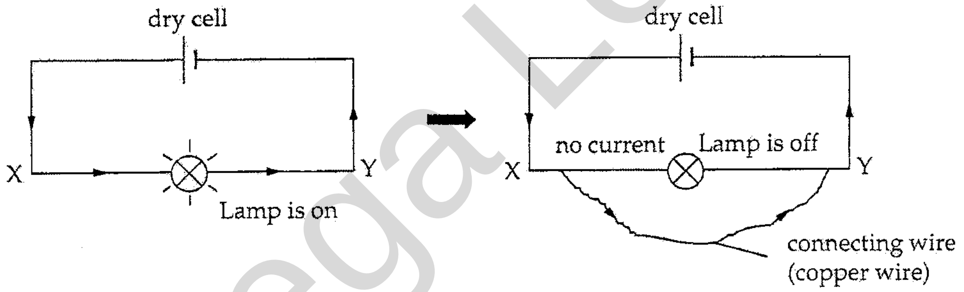
$$V = V_1 = V_2$$

Conclusion:

Each component (resistor) connected in parallel has the same potential difference across it.

5) Short Circuit

Connect a dry cell to a lamp as shown in the figure. Use a length of thick copper wire to connect one side of the lamp to the other side for just a second.



What happens to the lamp? The lamp will go off.

Actually, the copper wire has shorted the lamp or caused a *SHORT CIRCUIT*. The copper wire has less resistance to the flow of electrons than the lamp. So the current flows through the copper wire instead of the lamp.

Electricity travels by the easiest path (the one with lowest resistance), not necessarily the shortest path.