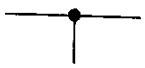
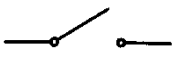
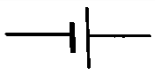
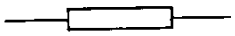
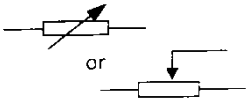
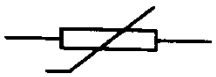
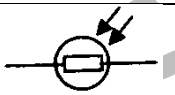
15 D.C. Circuits

Practical Circuits

Common electrical symbols used in circuit diagrams:

Junction of conductors	Switch
	
Earth or ground connector	Cell
	
Fixed resistor	Variable resistor
	
Bulb	Ammeter
	
Voltmeter	Galvanometer
	
Thermistor	Light dependent resistor
	

Series and Parallel Arrangements

Combined (Effective) Resistance

Resistors in series:

In general, $R_{eff} = R_1 + R_2 + \ldots$ (given)

Resistors in parallel:

In general, $\frac{1}{R_{eff}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ (given)

Current

Total current through e.m.f. is given by $\frac{e.m.f.}{total\ circuit\ resistance}$. Current in **series** arrangement stays constant, while current in **parallel** arrangement splits, with larger current towards smaller resistance.

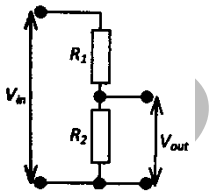
Potential Difference

Across any path in a circuit, **total** p.d. V of resistors always add up to total e.m.f.

In **series** arrangement, p.d. across resistor R according to $V = IR$. Potential divider principle: in series circuit, $V \propto R$. In **parallel** arrangement, p.d. across each path is identical.

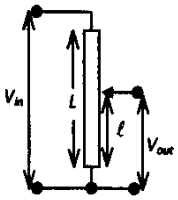
Potential Divider

A potential divider consists of two or more resistors connected in series across a fixed voltage source. It can be shown that



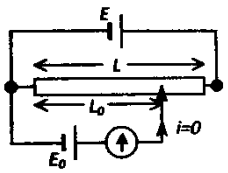
$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

By varying the values of R_1 and R_2, one can obtain the desired value of V_{out}.

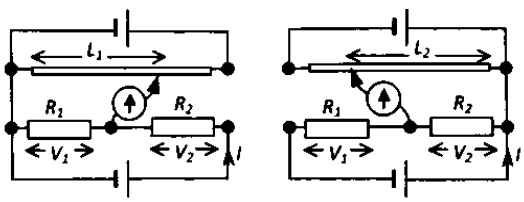


In practice, a long linear-varying resistor and sliding contact is used. It can be shown that $\frac{V_{out}}{V_{in}} = \frac{\ell}{L}$

Balanced Potentials



In the potentiometer setup shown, balance length L_0 is when the galvanometer shows a **null-deflection**. If p.d. across wire L is E, then $\frac{E}{E_0} = \frac{L}{L_0}$.



Connecting across R_1/R_2, $V_1/V_2 = IR_1/IR_2 \propto L_1/L_2$.

Taking ratio, $\frac{R_1}{R_2} = \frac{L_1}{L_2}$.