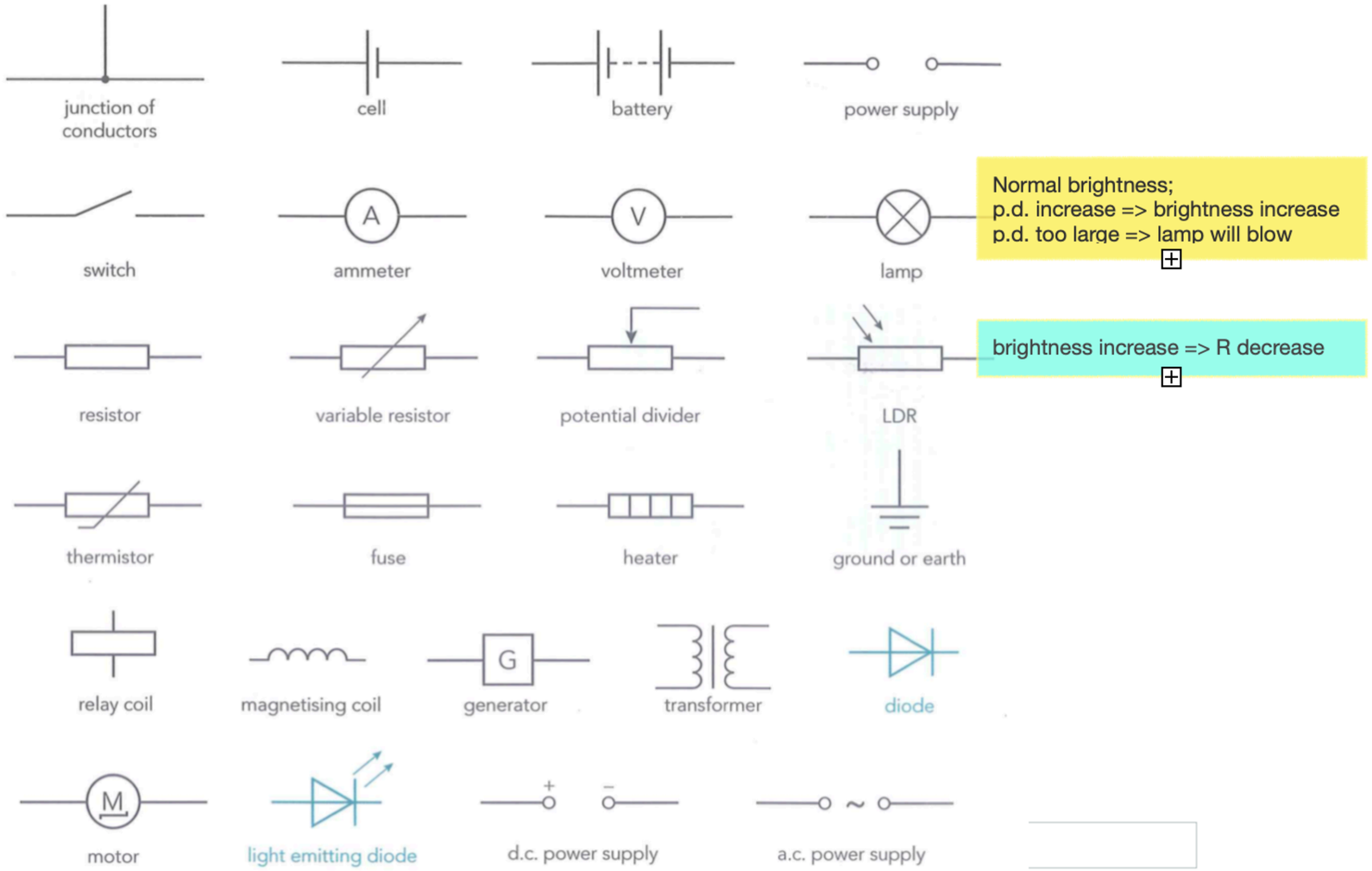
Chapter 19.
Electrical Circuits

New Words

Short/open/closed circuit; mains supply/electricity; graphite; blow; coil;
Fuse Junction generator motor transformer relay

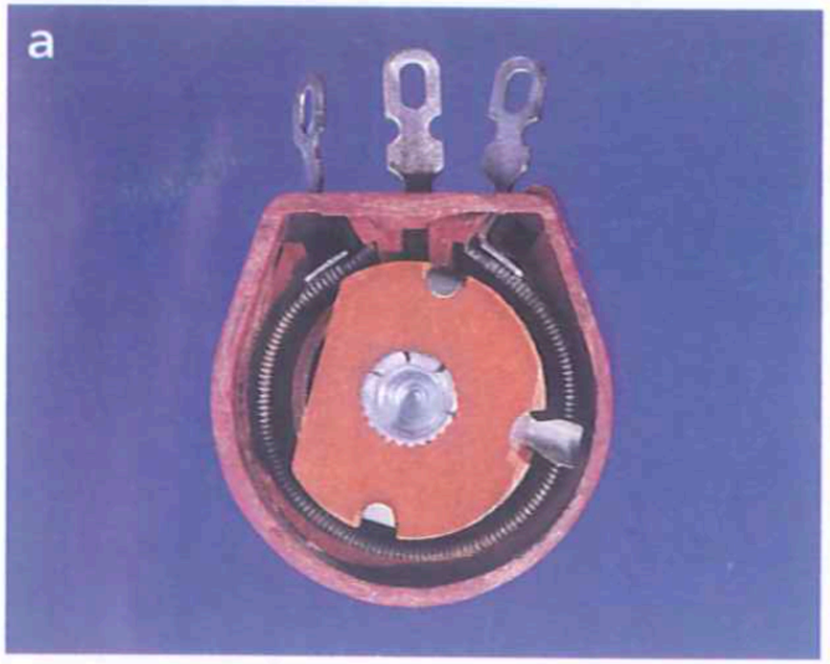
Circuit Component

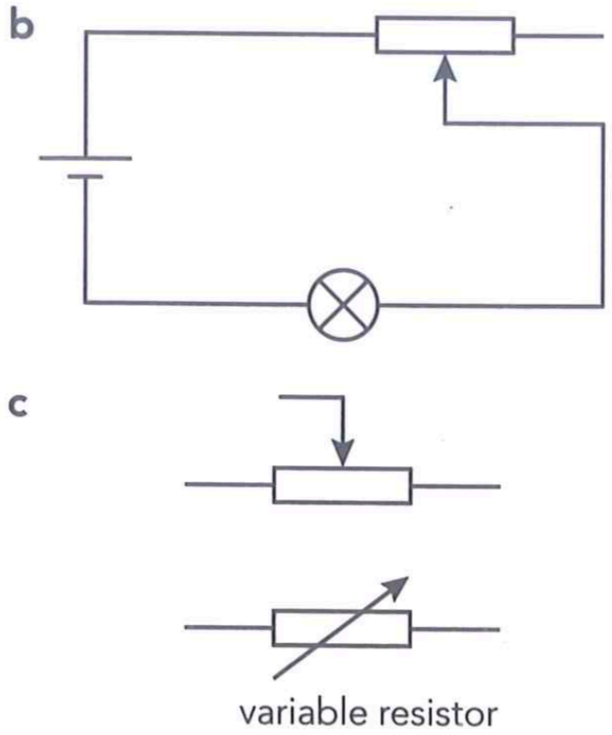


Resistors & variable resistor

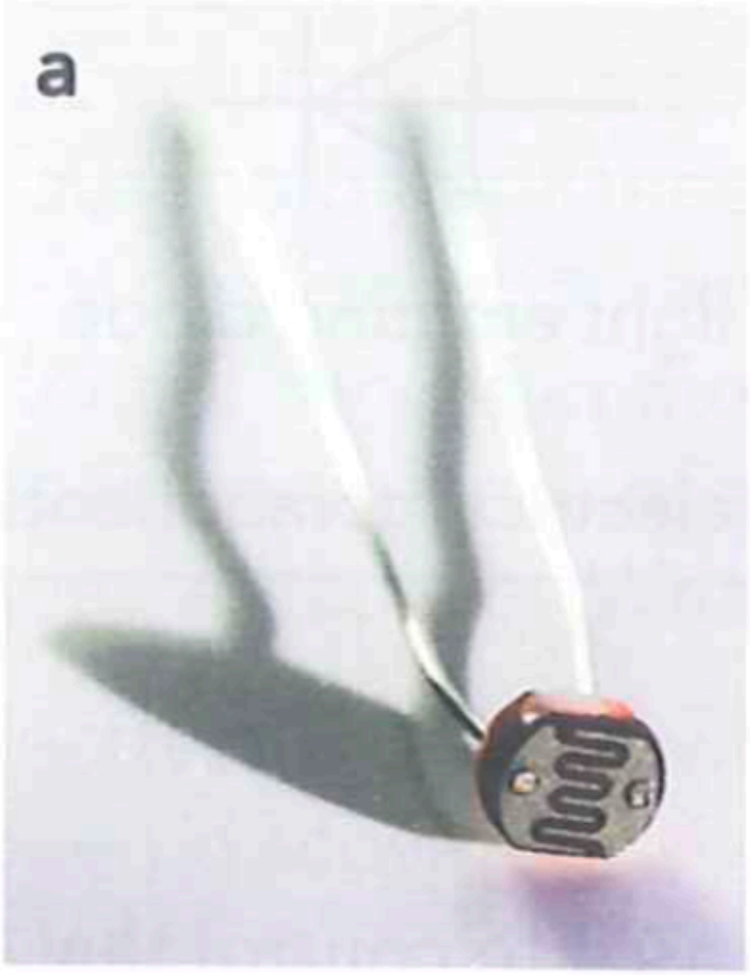
Resistor material:
Metal(aluminum, copper, etc.), graphite

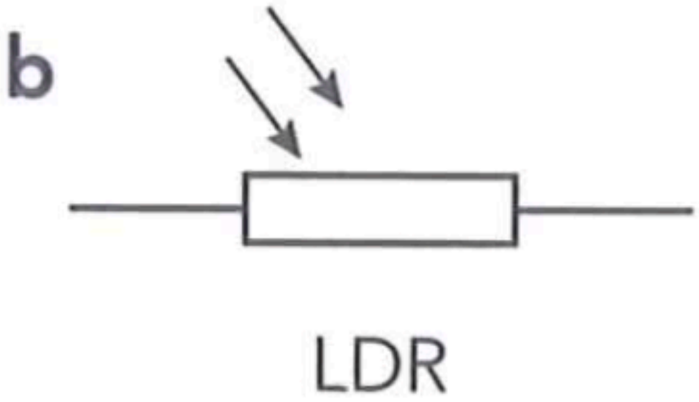
Resistors & variable resistor



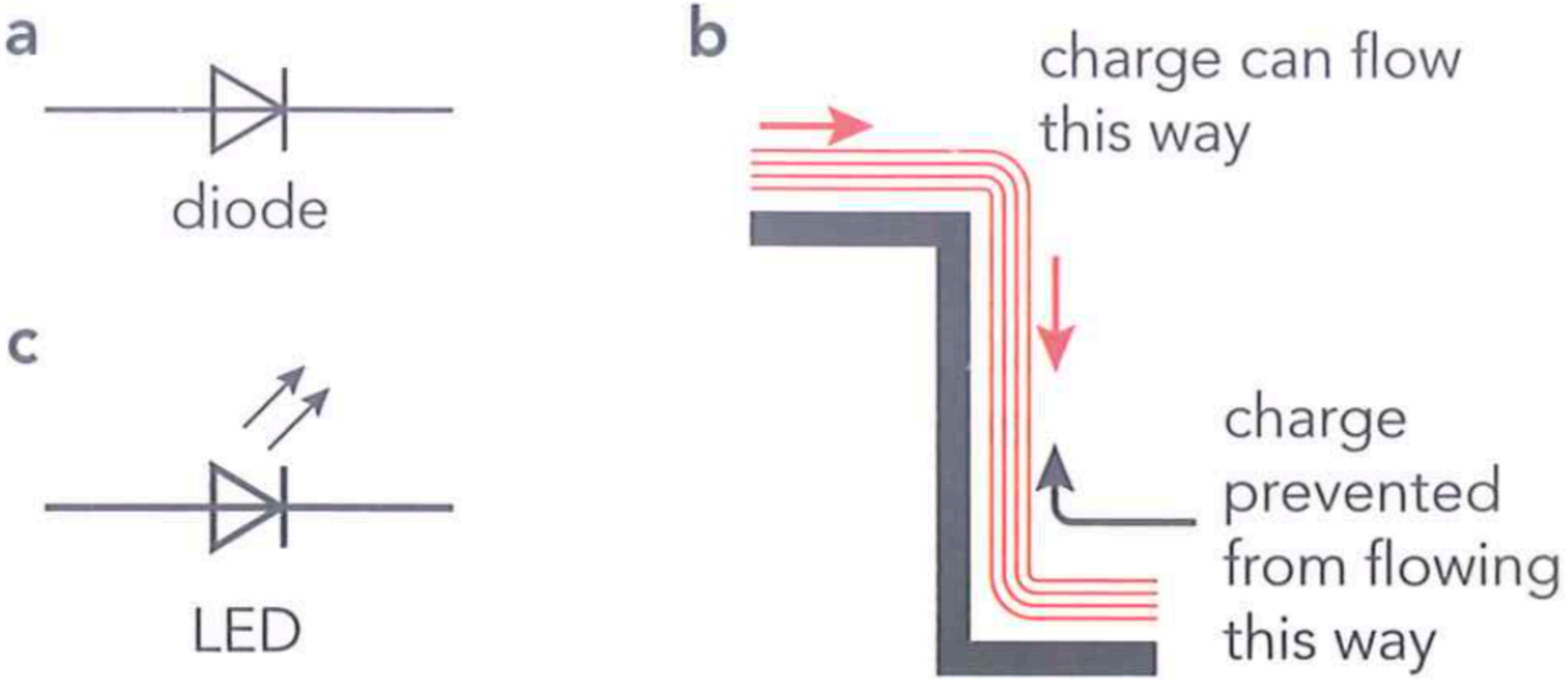


light-dependent resistor (LDR)





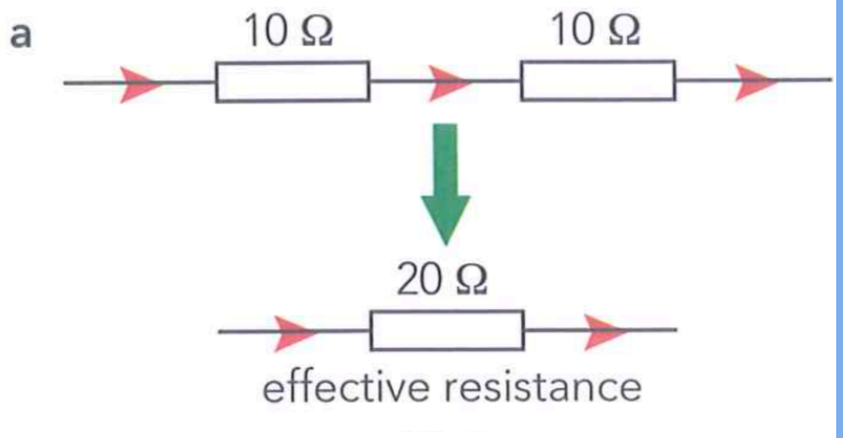
Diode & light-emitting diode (LED)



Resistors in series

Effective resistance: 等效电阻

Resistors in series:



$I = I_1 = I_2$ **(charge conservation)**

$V = V_1 + V_2$ **(energy conservation)**

$R = R_1 + R_2$ **(proof see below)**

$$V_1 = \frac{R_1}{R_1 + R_2} V$$

$$P = P_1 + P_2$$

Characteristics

- Always switched on/off at the **same time;**
- One breaks, others **won't work**;
- Share voltage

Proof: $IR = V = V_1 + V_2 = IR_1 + IR_2 \rightarrow R = R_1 + R_2$

Exercise:

One 4 ohms resistor and one 6 ohms resistor are connected in a series circuit with a

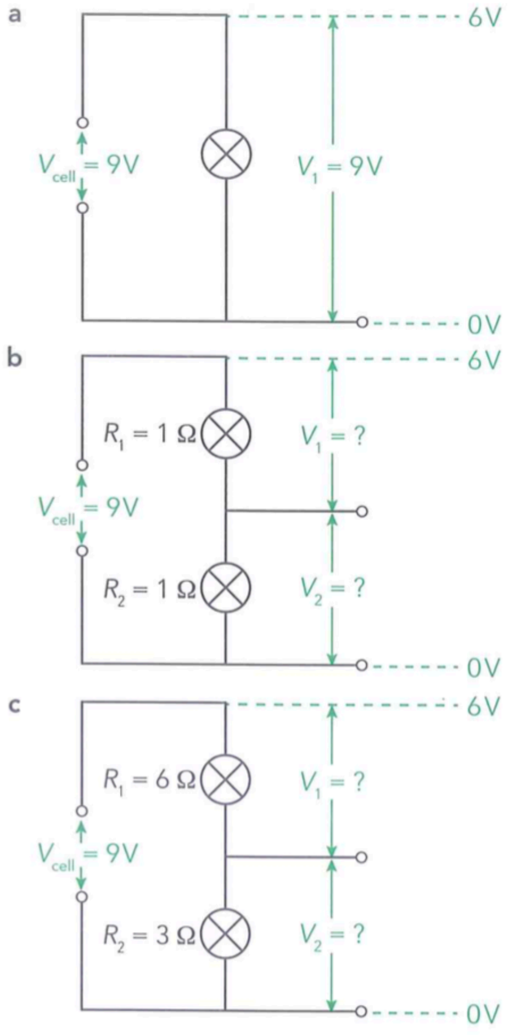
6 V power supply. Calculate:

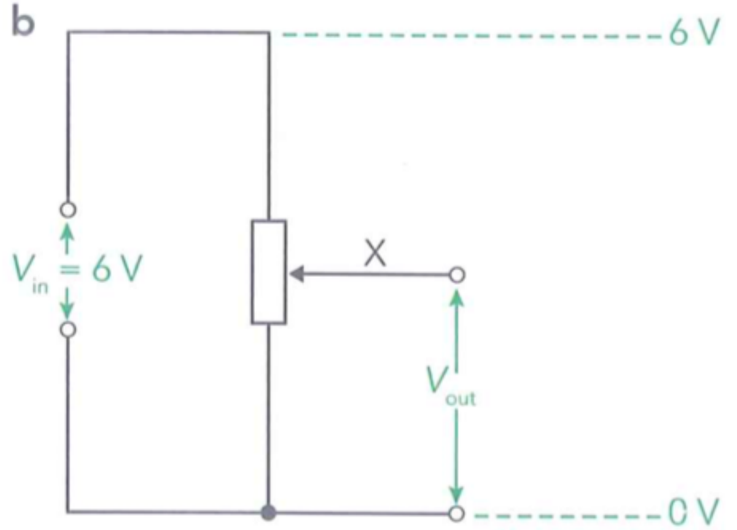
1, The combined resistance of the two resistors

2, The current that flows in the circuit

3, The p.d. across each resistor

Potential divider circuit



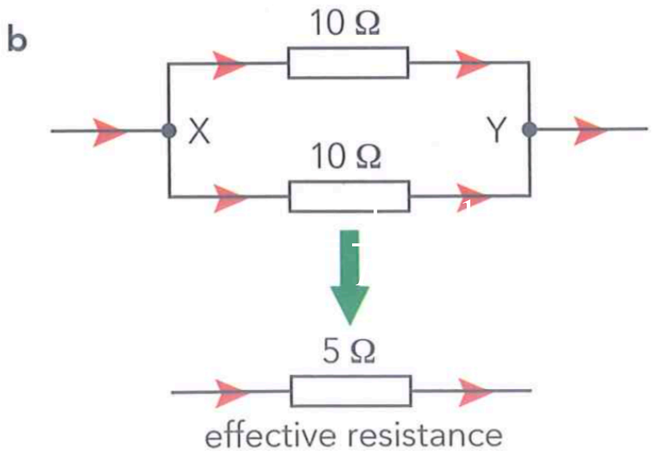


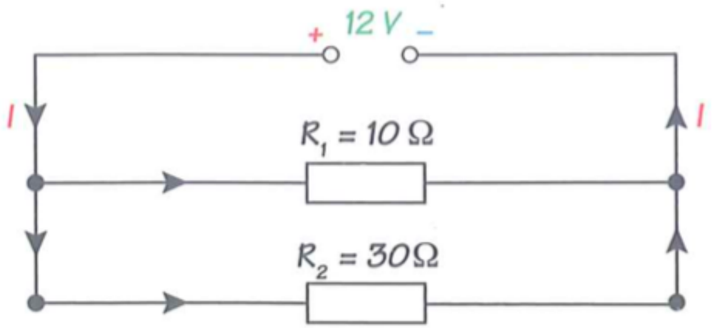
$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

Exercise:

A potential divider circuit is required to produce an output voltage of 8V across a resistor, R1, of 600 ohms. The supply voltage is 12V. What is the required value of the series resistor, R2?

Resistors in parallel:





$$I = I_1 + I_2$$

$$V = V_1 = V_2$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

$$P = P_1 + P_2$$

Characteristics

- Can be switched on/ off **separately**
- One breaks, others **still work**
- Can have **full voltage**

Proof: $I = I_1 + I_2 => \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} => \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

Resistors in parallel:

in particular: N resistors in parallel:

$$R_{tot} = \frac{R}{n}$$

Putting it all together:

Work out the current through, and the voltage across, each lamp in the circuit.

Summarize your result in the table below.

$$V_{AB} = e.m.f. = 9.0V = V_{CE}$$

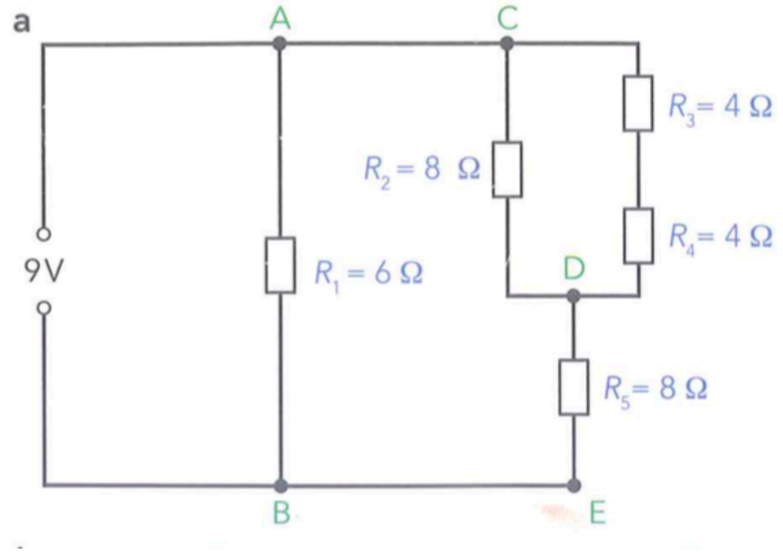
$$I_{AB} = \frac{V_{AB}}{R_1} = 1.5A$$

$$R_{34} = R_3 + R_4 = 8\,\Omega$$

$$R_{CD} = 4\,\Omega$$

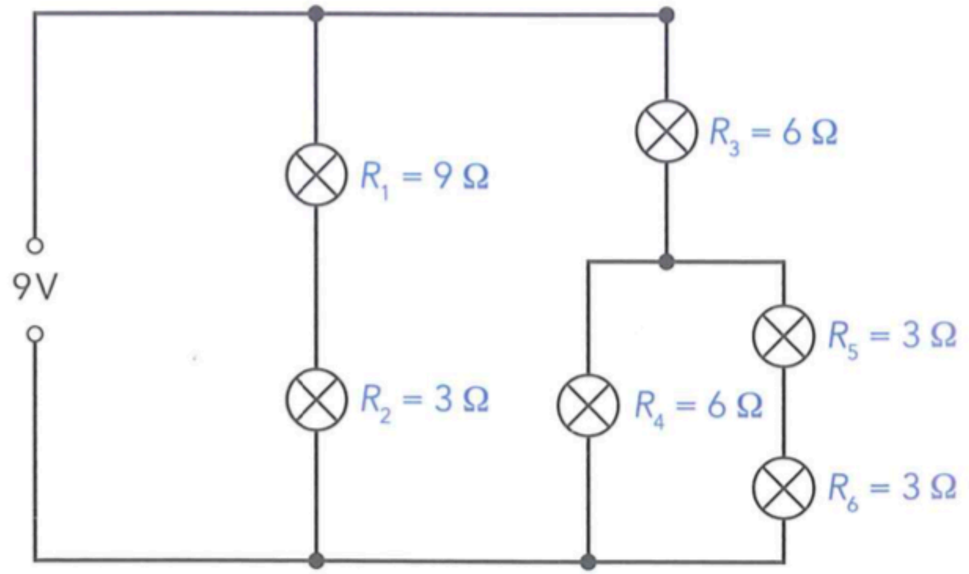
$$R_{CE} = 12\,\Omega \quad V_{CE} = 9.0\,V \quad I_{CE} = \frac{V_{CE}}{R_{CE}} = 0.75\,A = I_{DE}$$

$$I_2 = I_3 = I_4 = \frac{I_{DE}}{2} = 0.375\,A$$



Resistor	Source	1	2	3	4	5
Voltage	9.0V	9.0V	3.0V	1.5V	1.5V	6.0V
Current	2.25A	1.5A	0.375A	0.375A	0.375A	0.75A

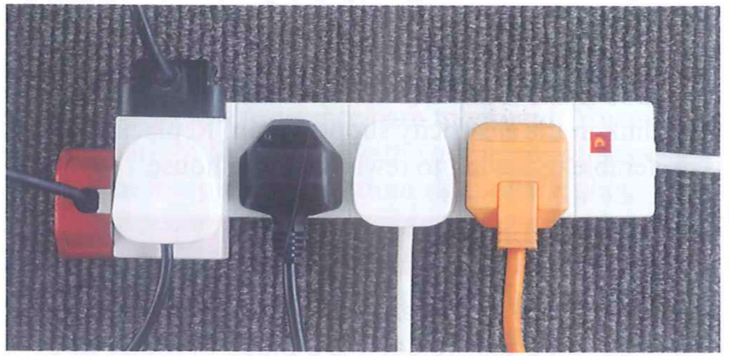
Exercise



Resistor	Source	1	2	3	4	5	6
Voltage							
Current							

Electrical safety

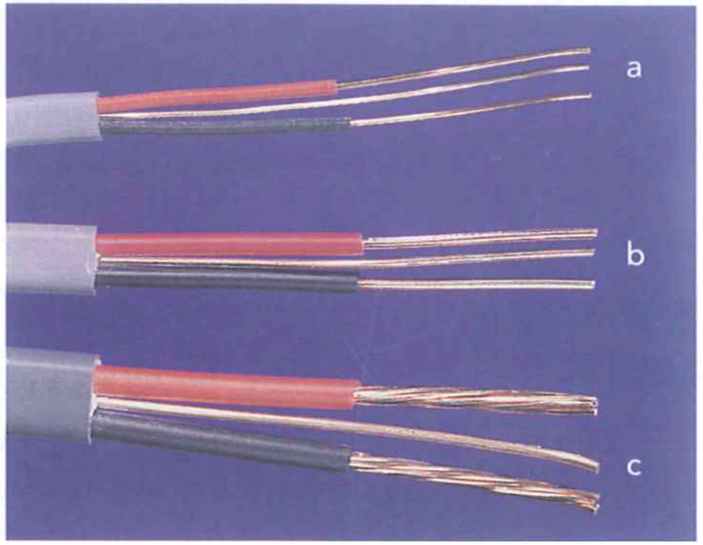
Electrical hazards

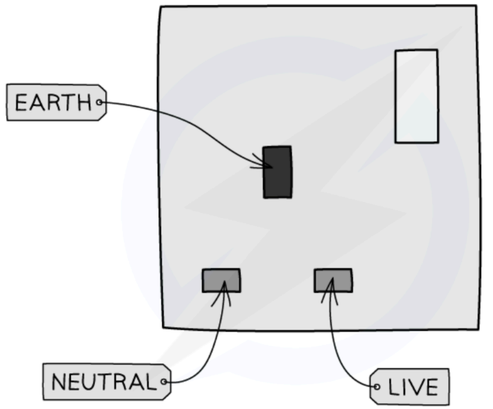


Fire <= Overheating of wire, Excess current from overloading

Electrical shock <= Damaged insulation, Damp condition

Damp conditions – water can conduct a current so wet electrical equipment can cause an electric shock.

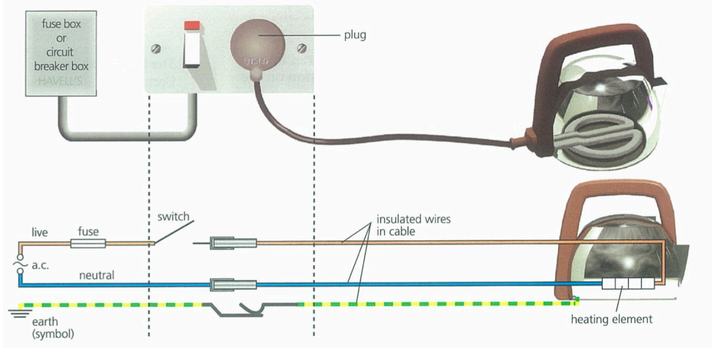


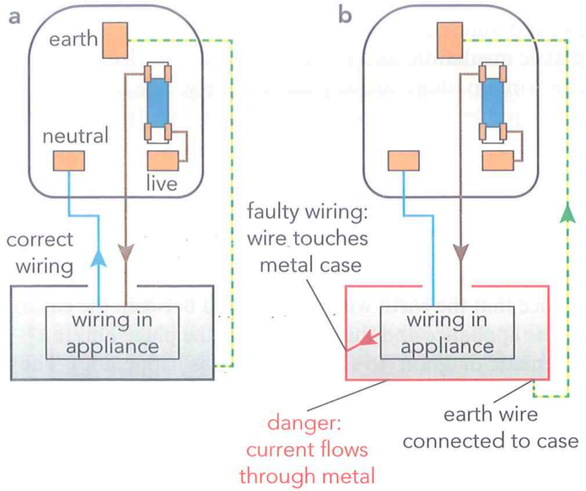


Electrical safety

solutions

Earthing





Use fuse / trip switch

Double insulation