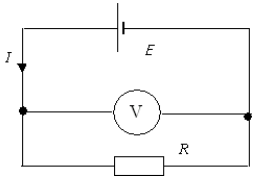
Resistors

Definitions

Internal Resistance



The internal resistance, r, of a power source affects circuits. The internal resistance of the power source should be included in any voltage or current calculations.

$$E = V + Ir$$

where **E**= EMF, **V** = Terminal p.d. and **Ir** is the lost volts.

- When R is very large, I is very small, so r has no effect and V = E
- When R is very small, I is relatively large, so r has effect and V < E
- When R = r, this is impedance matching and the maximum power is gained from the voltage source

Kirchhoff's law 1: The sum of the potential differences in any loop is zero.

$$\Sigma V = 0$$

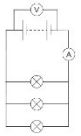
Kirchhoff's law 2: The sum of the currents entering a junction = The sum of the currents leaving a junction.

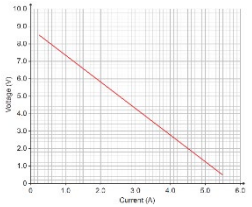
$$\Sigma I = 0$$

Equations

$R_T = R_1 + R_2 + \ldots$	Resistance	R	Ω
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	Resistance	R	Ω
$V = IR$	Voltage	V	V
	Current	I	A
	Resistance	R	Ω
$P = VI$	Power	P	W
	Voltage	V	V
	Current	I	A

Questions





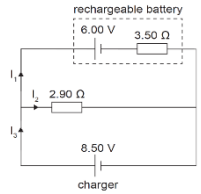
BATTERIES (2021,3)

Joel is measuring the terminal voltage across a battery and the current drawn from the battery while adding lamps in parallel. The terminal voltage decreases as he adds more lamps in parallel. He plots a graph of terminal voltage across the battery against circuit current.

(a) State the physical meaning of the term emf.

(b) Using the graph, determine the emf of the battery and the internal resistance of the battery.

(c) Explain why the terminal voltage of the battery decreases as more lamps are added in parallel.



(d) Joel repeats his experiment using a different battery, but it becomes flat before he has finished. He recharges it using the circuit shown. Using the information in the circuit, calculate the current in each of the three branches using Kirchhoff's laws. Begin your answer by writing a current equation for I_1, I_2, and I_3.

Terms

Tips

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Answers

(a) The voltage across the battery when no current is drawn.

(b) *y*-axis intercept = emf = about 9.0 V; Gradient of graph = internal resistance = 1.5 Ω

(c) As more lamps are added in parallel, there are more pathways for the current to flow, (resistance decreases), so that current from the battery increases. Since there is more current passing through the battery, there will be a greater potential drop across the internal resistance, so less available to the external circuit.

(d)

$$I_1 + I_2 = I_3$$
$$-6.00 - 3.50I_1 + 2.90I_2 = 0$$
$$8.50 - 2.90I_2 = 0$$
$$I_2 = \frac{8.50}{2.90} = 2.93\,\text{A}$$
$$-6.00 - 3.50I_1 + 2.90 \times 2.93 = 0$$
$$I_1 = \frac{2.50}{3.50} = 0.714\,\text{A}$$
$$I_3 = 2.93 + 0.714 = 3.65\,\text{A}$$