isaac Physics. You work it out.

Electricity

A-level overview

isaacphysics.org
https://isaacphysics.org/pages/remote_learning

Electrical quantities and equations

Quantity	symbol	Unit	symbol	Definition
charge	Q	coulomb	C	'Amount of electrical stuff'
current through	I	amp	A	Rate of flow of charge. $I = dQ/dt$
energy	E	joule	J	Work done. $E = Fs$ (defined mechanically) Also $E=VIt$
power	P	watt	W	Rate of doing work. $P = E/t$. Also $P=IV$, I^2R, V^2/R
voltage across p.d. e.m.f.	V	volt	V	Energy transferred per unit charge. $V = E/q$ p.d. = electrical energy transferred to other forms per unit charge. e.m.f. = electrical energy increase per unit charge (in a battery or generator)
resistance	R	ohm	Ω	'obstruction to current flow' ratio between voltage across a component & current through it: $R = V/I$.

You try it…

Charge / C	Current / A	Energy / J	Power / W	Resistance / Ω	Time / s	Voltage / V
	13				30	230
		1 MJ		2.5		11 kV
46 MC				45		230
2 C	20 mA					7.5

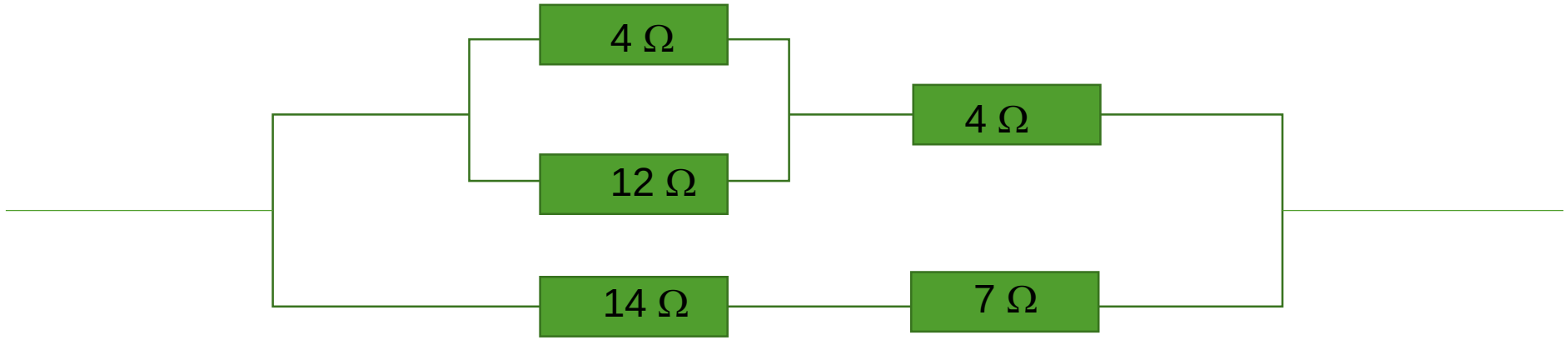
Charge carriers

- Electron and ions can carry charge in a circuit.
- How many electrons/s if the current is 3mA?

- You try it – what is the current if there are 4×10^{20} electrons/s?

Resistors in Series and Parallel

- Series – add them up (3 + 6 = 9)
- Parallel – add their reciprocals, then take the reciprocal (1/3 + 1/6 = ½, so resistance is 2).
- Work outwards from the middle – see example

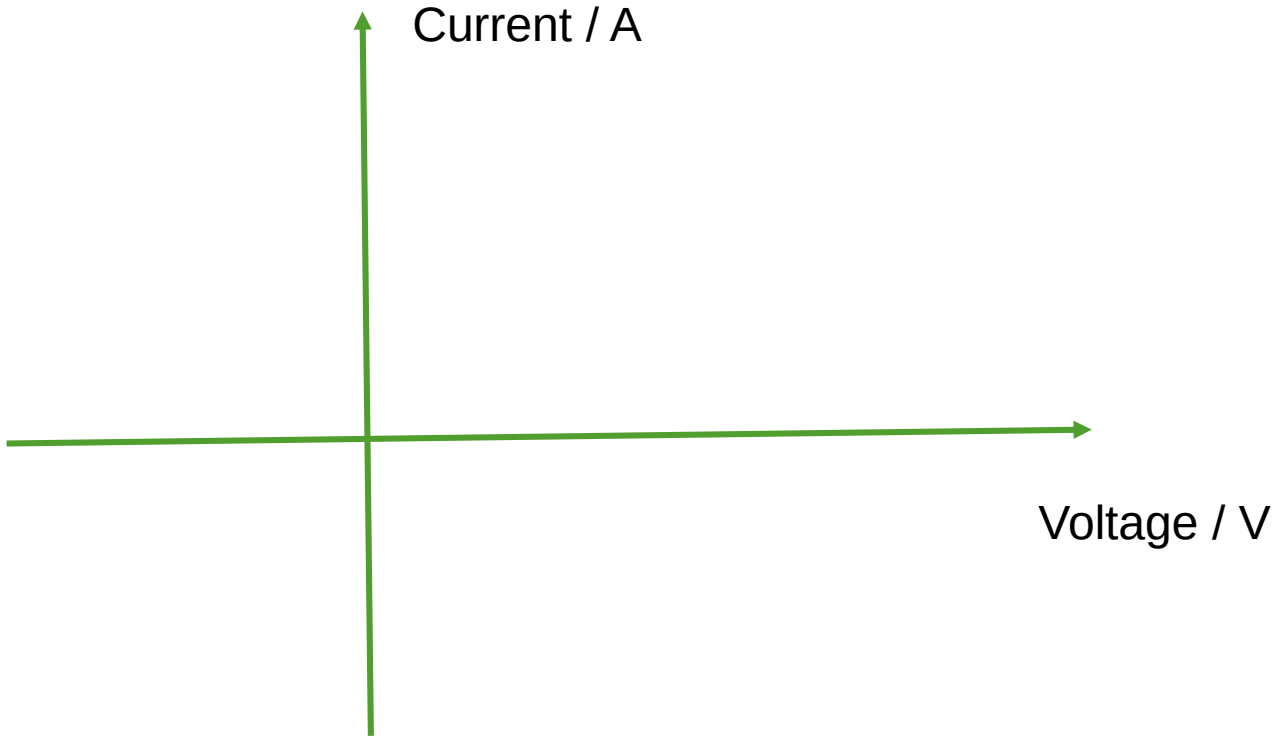


Resistivity – an intrinsic property

- $R = \rho L / A$
- measuring resistivity – micrometer in 3 places, check zero error
- work in metres (turn that 1.5mm diameter into a 0.75×10^{-3}m radius)
- remember $10^6 mm^2$ in one square metre…

- You try it – 2km of 6.0mm diameter cable made of copper (resistivity is 5.6×10^{-8} Ωm has a resistance of…

Component Characteristics



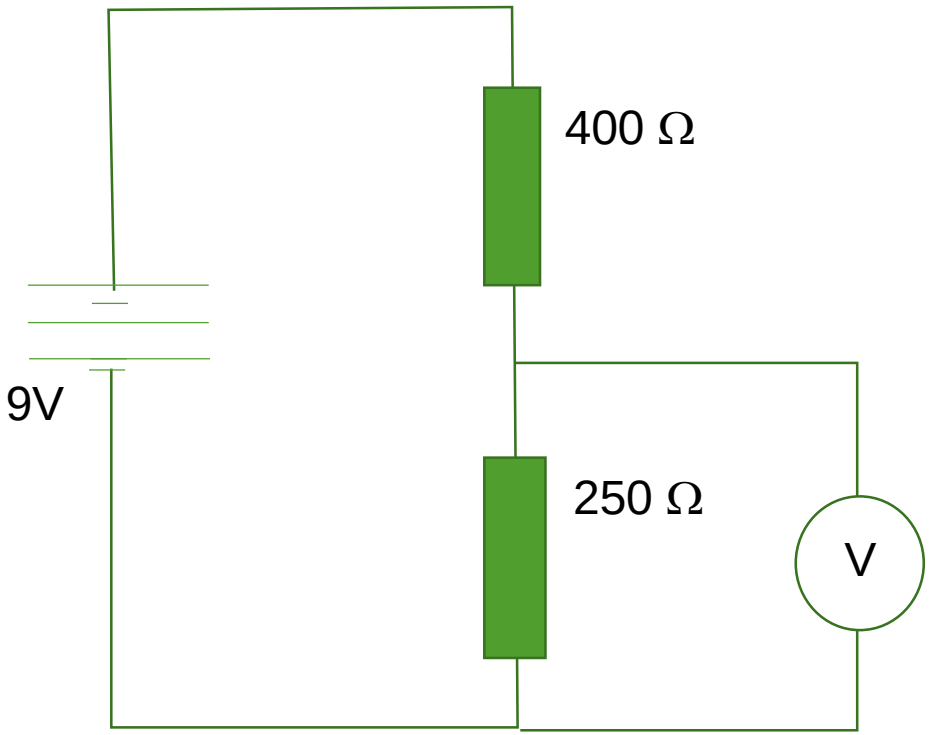
Draw a

- 2Ω resistor
- 4Ω resistor
- light bulb
- diode

Weird resistances

- Thermistor
  - resistance goes DOWN when temperature goes UP because…
- Light Dependent Resistor
  - resistance goes DOWN when light level goes UP because…
- Superconductor

Potential divider



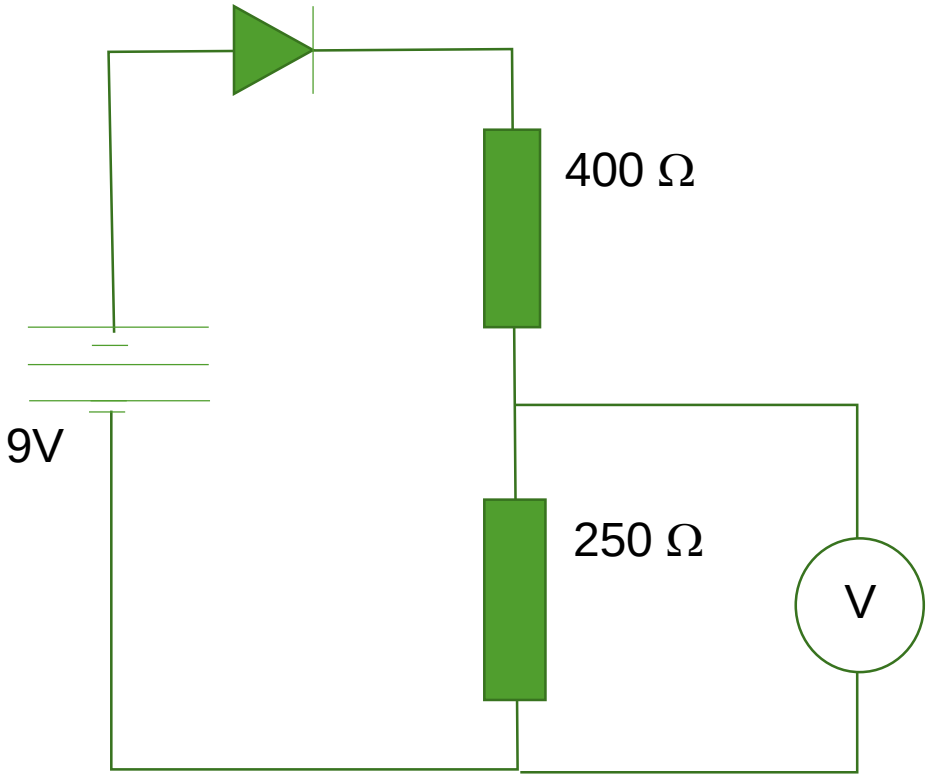
EITHER

Voltage shared in ratio of resistances

OR

Current same in series circuit, so V/R same

Potential divider 2



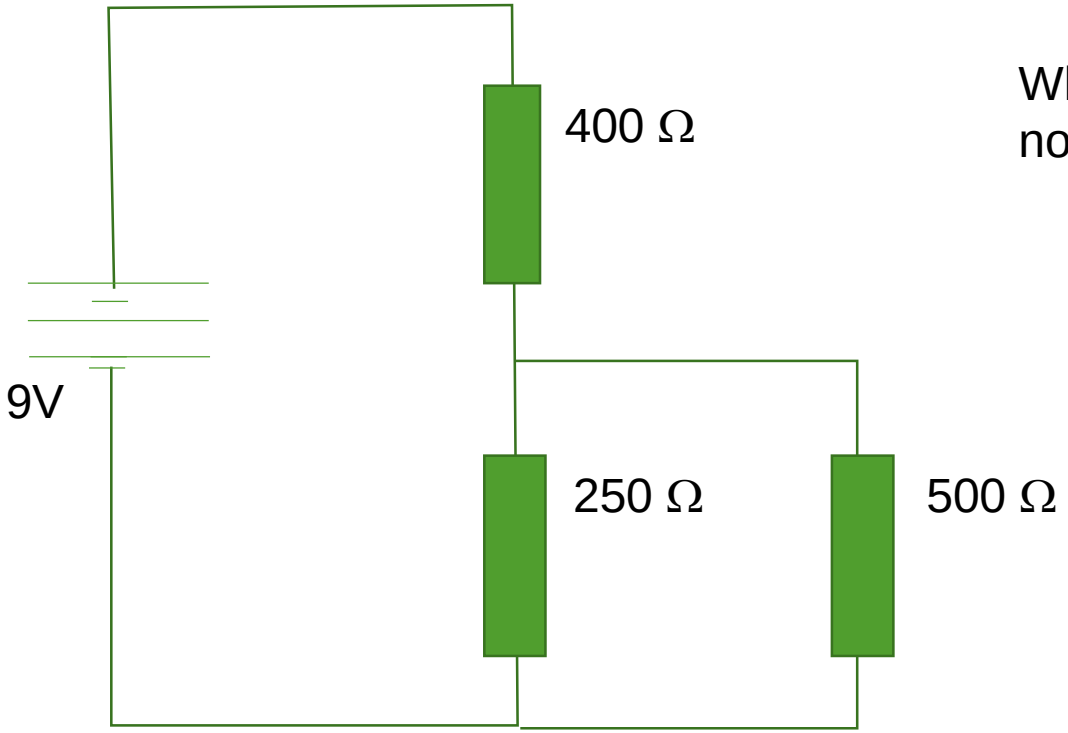
EITHER

Voltage shared in ratio of resistances

OR

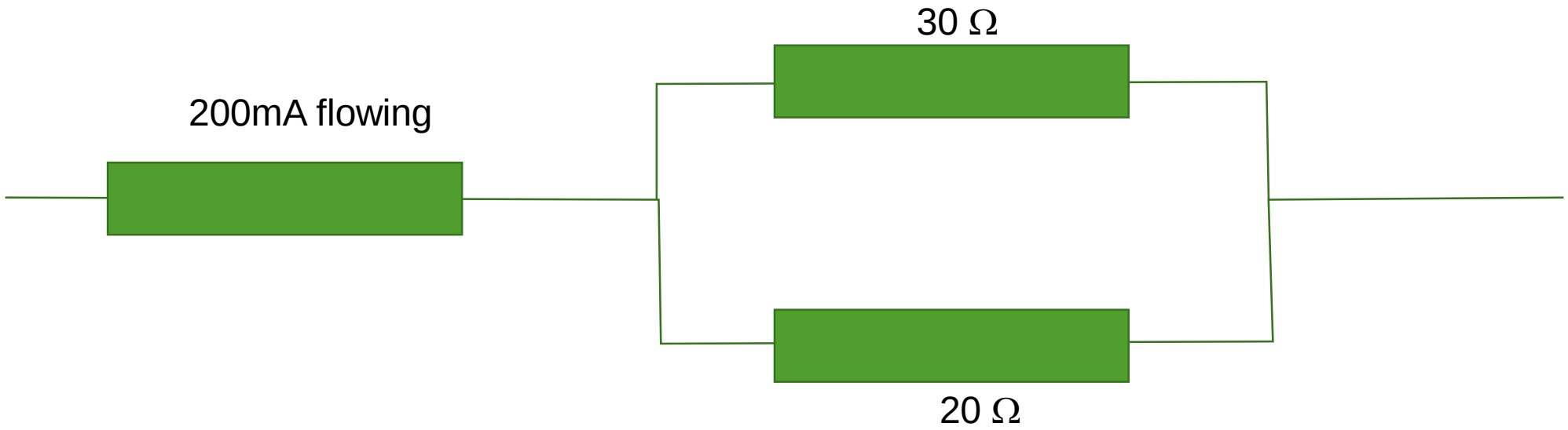
Current same in series circuit, so V/R same

Potential divider 3



What is the voltage across the 250Ω resistor now?

Sharing current



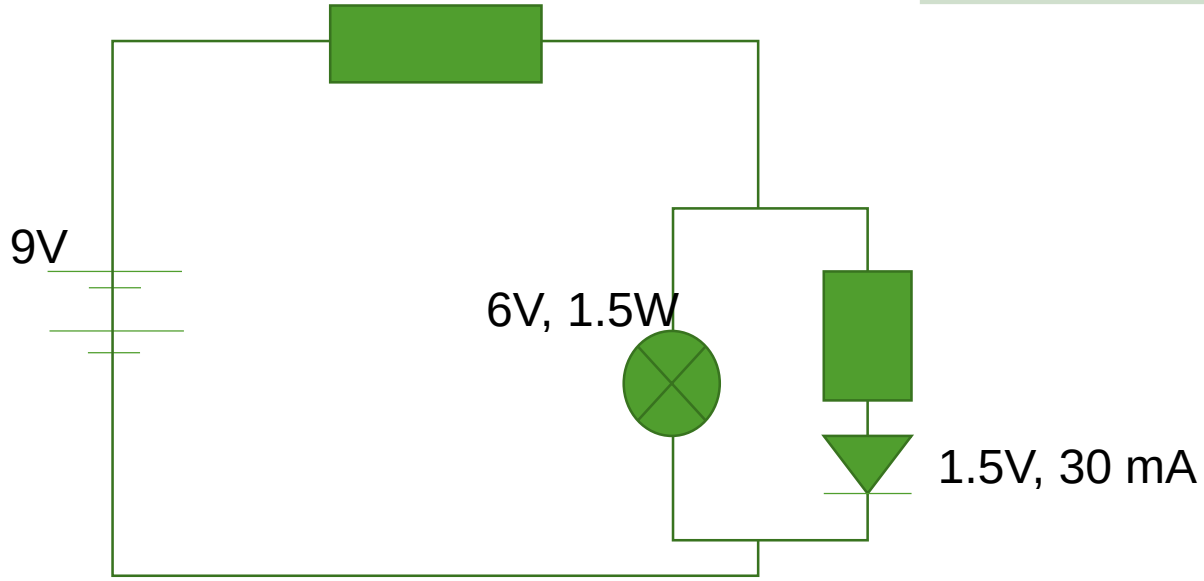
Circuit Rules

Parallel	Series
Voltage across components in parallel is the same	Components in series have the same current
Current at a junction splits	Voltage in circuit shared between components in series
Voltage at a junction stays the same	Current entering a component equals current leaving it

Kirchhoff's 1st Law	**Total current entering a junction = total current leaving it** **Equivalent to conservation of charge**
Kirchhoff's 2nd Law	Choose a loop in a circuit (at a junction, choose any one turning) Total of the p.d.s across components on that route = total of the e.m.f.s across components on that route Equivalent to conservation of energy

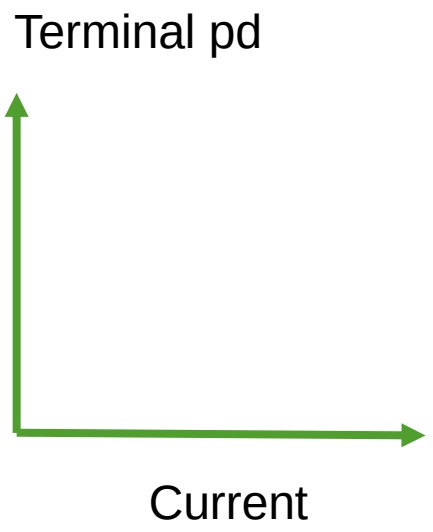
Solve the circuit

Parallel	Series
Voltage across components in parallel is the same	Components in series have the same current
Current at a junction splits	Voltage in circuit shared between components in series
Voltage at a junction stays the same	Current entering a component equals current leaving it



Internal resistance

$V = \varepsilon - Ir = IR$



Links

A Level Topic Revision

https://isaacphysics.org/pages/a_level_topic_index#a_level_revision

Consolidation Programme

https://isaacphysics.org/pages/summer_programmes_2021