



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 |



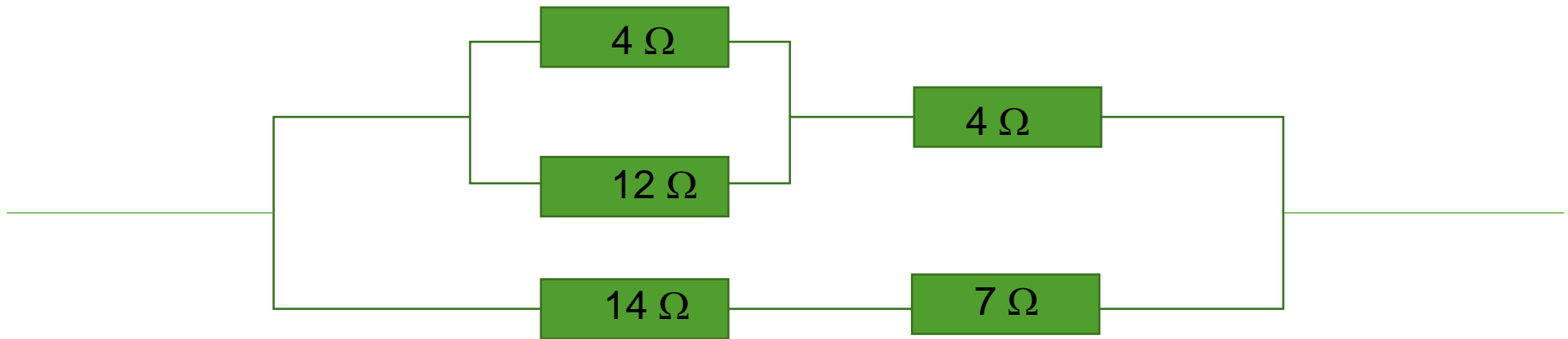
Charge carriers

- › 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 ($1/3 + 1/6 = 1/2$, so resistance is 2).
- › Work outwards from the middle – see example

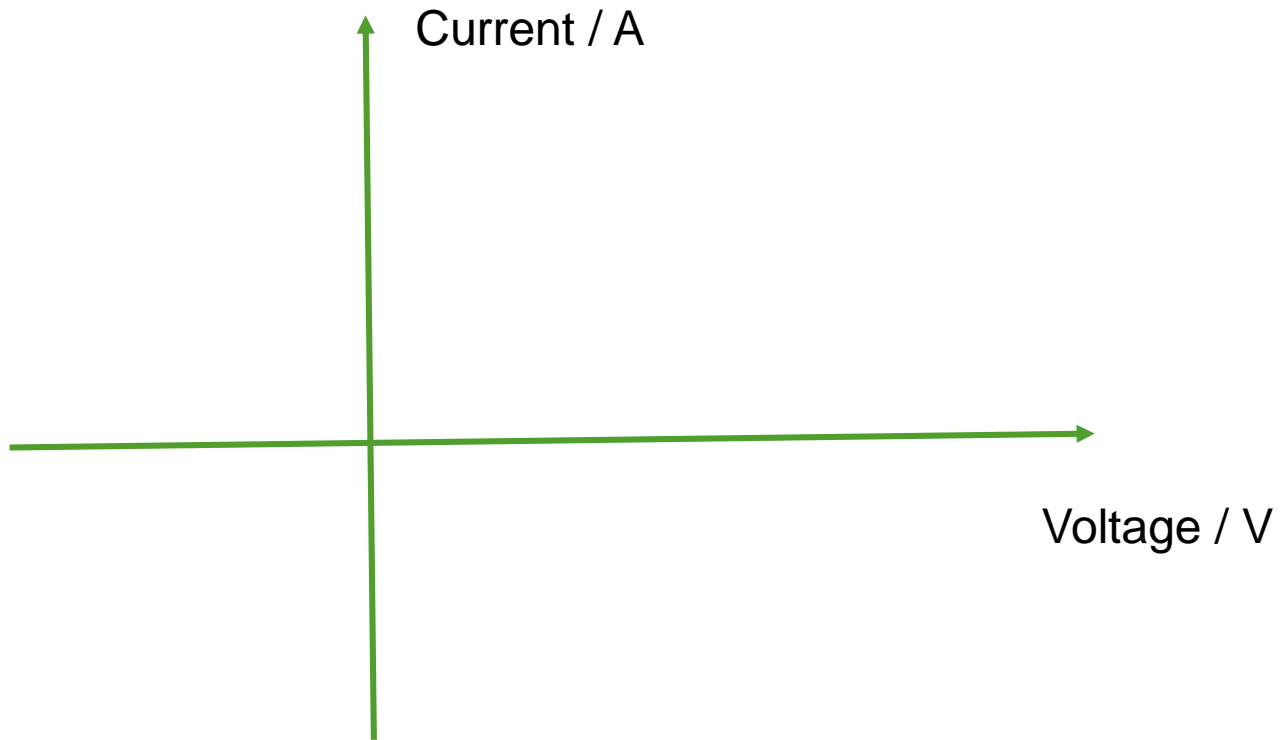




Resistivity – an intrinsic property

- › $R = \rho L / A$
- › measuring resistivity – micrometer in 3 places, check zero error
- › work in metres (turn that 1.5mm diameter into a $0.75 \times 10^{-3} \text{m}$ radius)
- › remember 10^6mm^2 in one square metre...
- › You try it – 2km of 6.0mm diameter cable made of copper (resistivity is $5.6 \times 10^{-8} \Omega \text{m}$ 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...

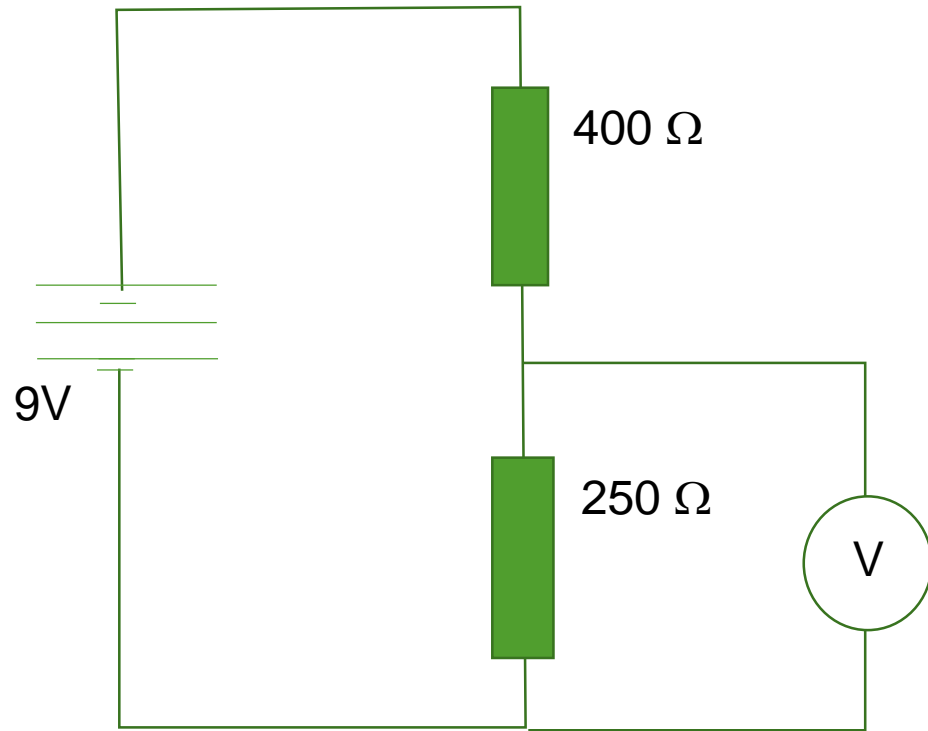
- › **Light Dependent Resistor**

- resistance goes DOWN when light level goes UP because...

- › **Superconductor**



Potential divider



EITHER

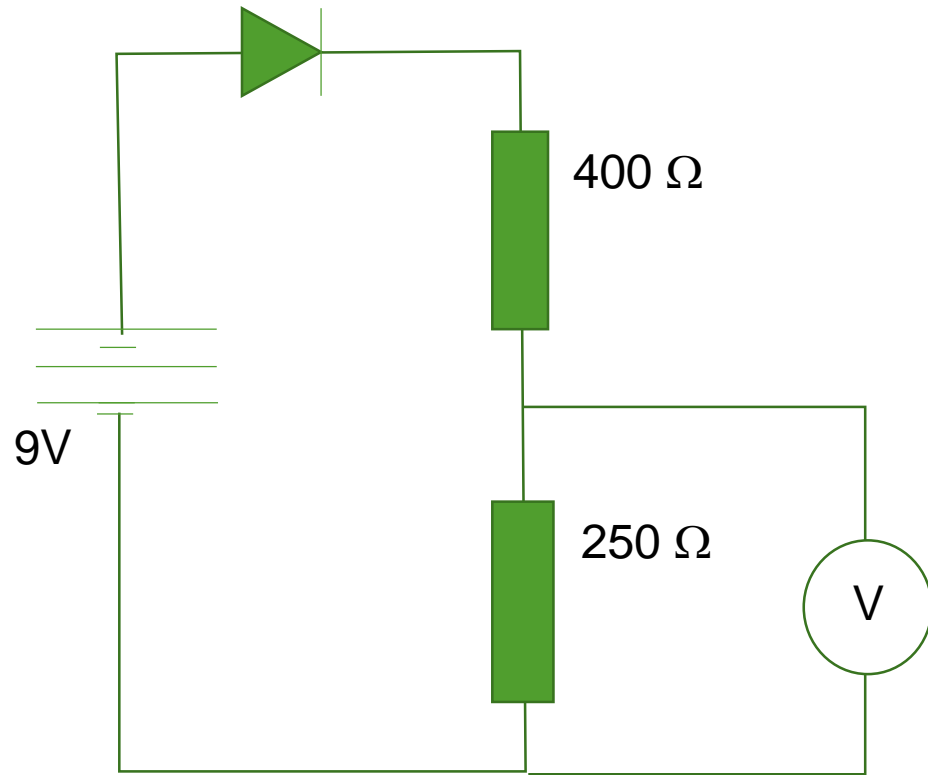
Voltage shared in ratio of resistances

OR

Current same in series circuit, so V/R same



Potential divider 2



EITHER

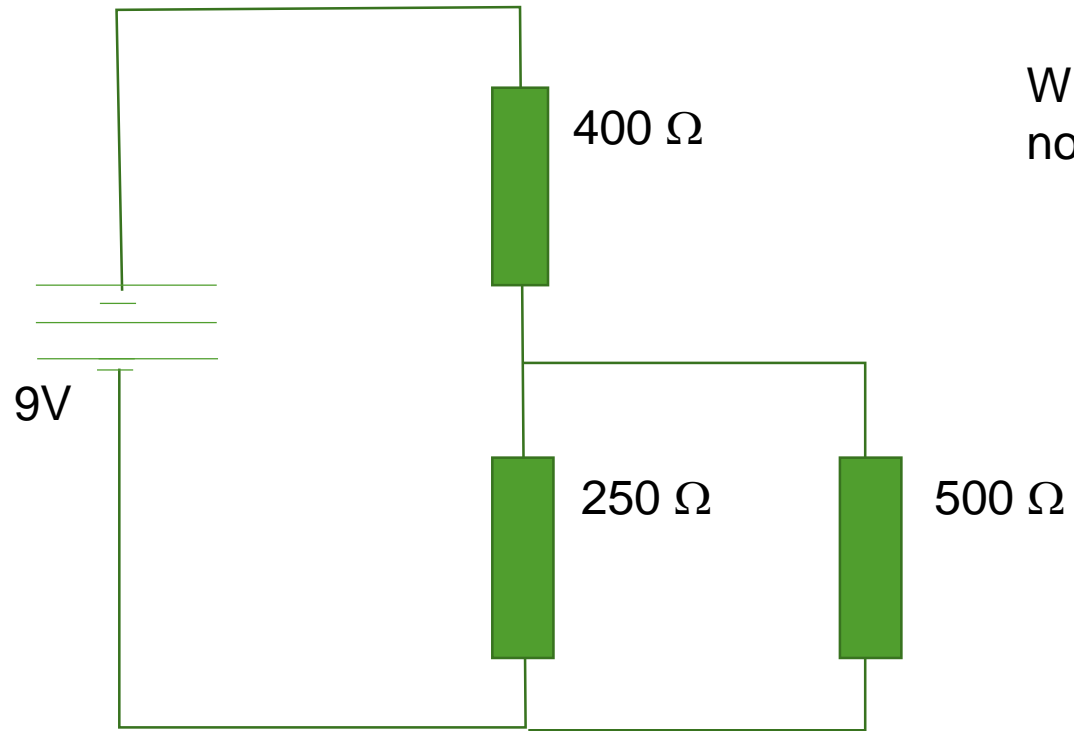
Voltage shared in ratio of resistances

OR

Current same in series circuit, so V/R same



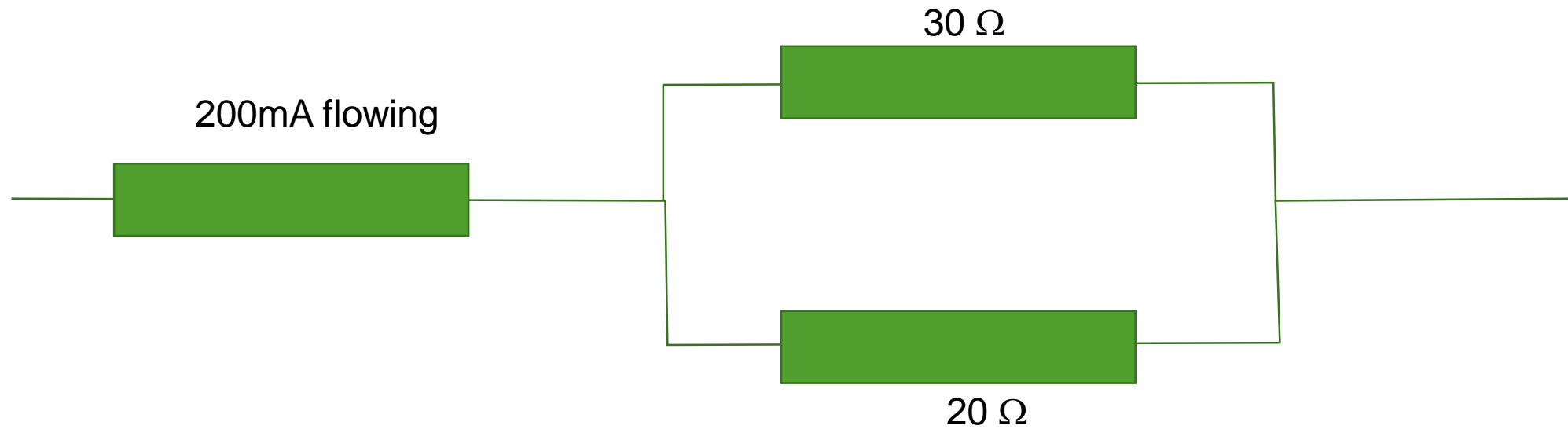
Potential divider 3



What is the voltage across the 250Ω resistor now?



Sharing current





Circuit Rules

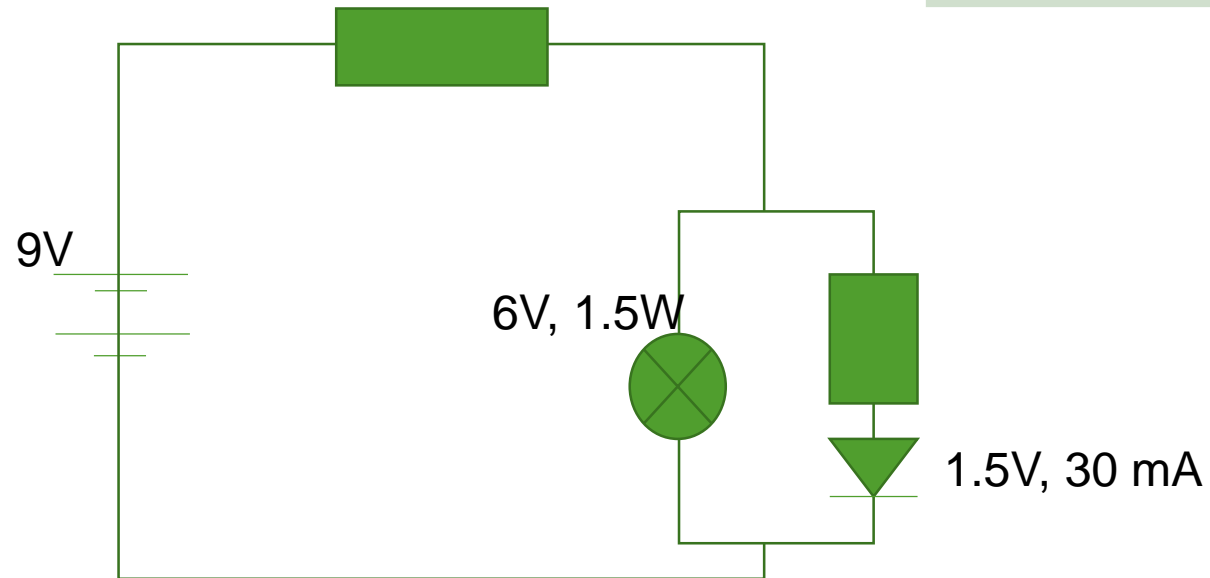
| Parallel | Series |
|---|--|
| Voltage across components in parallel is the same | Components in series have the same current |
| Current at a junction splits | Voltage in circuit shared between components in series |
| Voltage at a junction stays the same | Current entering a component equals current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

| | |
|---|--|
| Kirchhoff's 1st Law | Total current entering a junction = total current leaving it Equivalent to conservation of charge |
| Kirchhoff's 2 nd 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 |

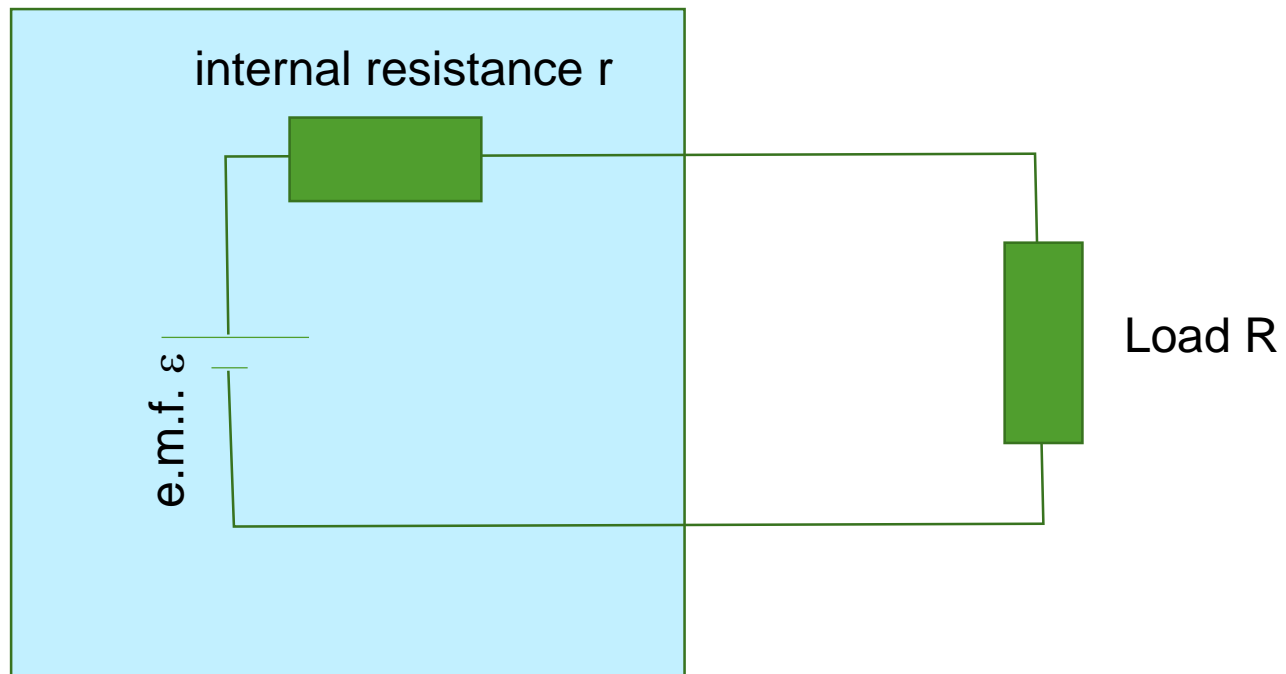


Solve the circuit

| Parallel | Series |
|---|--|
| Voltage across components in parallel is the same | Components in series have the same current |
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Internal resistance



$$V = \varepsilon - Ir = IR$$

Terminal pd

Current



Links

A Level Topic Revision



[https://isaacphysics.org/pages/
a_level_topic_index#a_level_revision](https://isaacphysics.org/pages/a_level_topic_index#a_level_revision)

Consolidation Programme



[https://isaacphysics.org/pages/
summer_programmes_2021](https://isaacphysics.org/pages/summer_programmes_2021)