Non-Ideal Meters

IB PHYSICS | ELECTRICITY

The Observer Effect

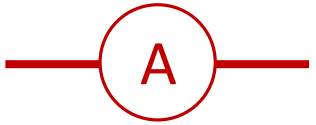
When taking any scientific measurement, there is always the possibility that the act of taking the measurement will change what is being measured

The Observer Effect

When we measure **voltage** or **current** in a circuit, we want to make sure to minimize an effect that our tool has on the circuit so that we get the most accurate results

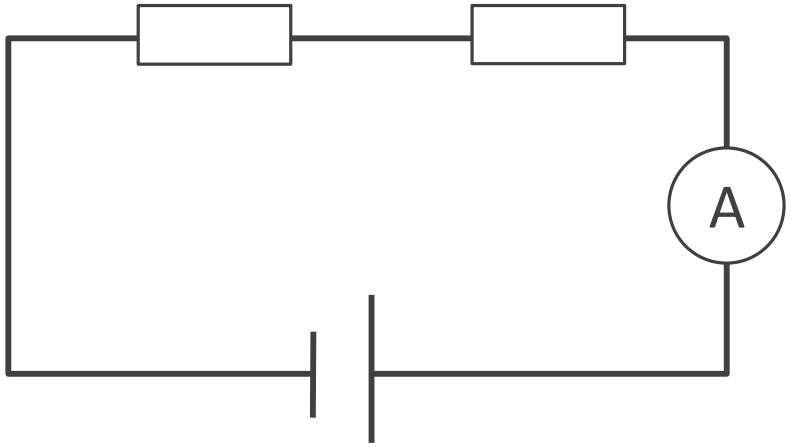
Voltmeter

Ammeter



Ammeter

Hooked up in **series** with the component being measured

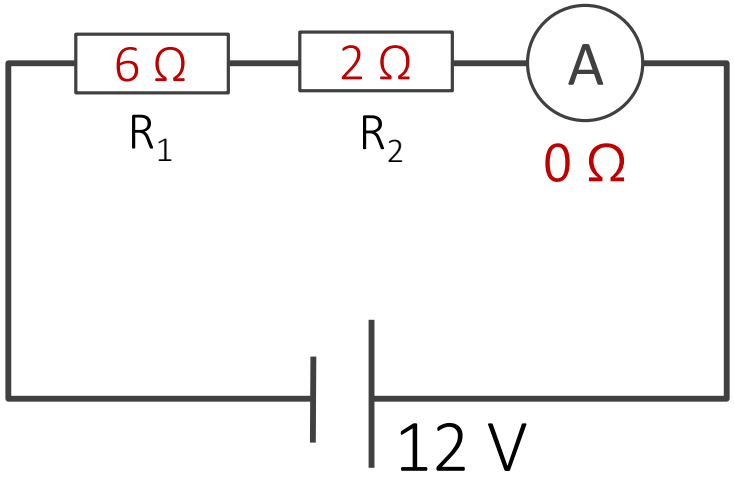


Ideal Ammeter:

$[R = 0\ \Omega]$

Measuring the Current

What is the reading for the current flowing through this ideal ammeter?



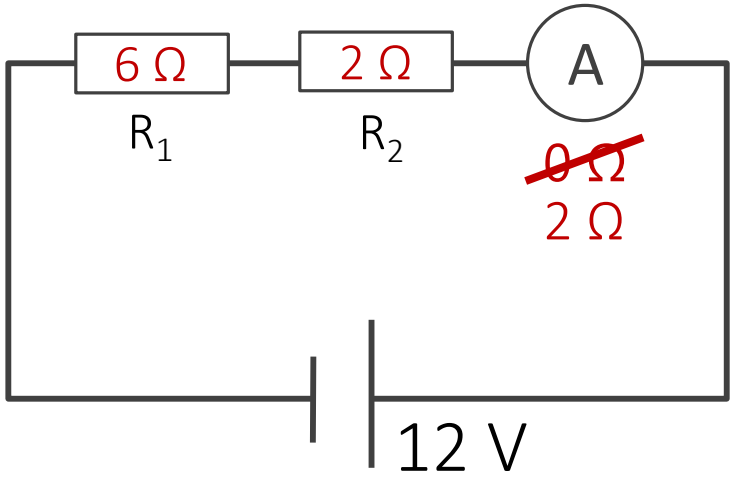
$$R_T = 8\ \Omega$$

$$I = \frac{V}{R} = \frac{12}{8} = \mathbf{1.5\ A}$$

The ammeter has no effect on the current that it's measuring

What if Ammeter isn't ideal?

What is the reading for the current flowing through this ~~ideal~~ 2 Ω ammeter?

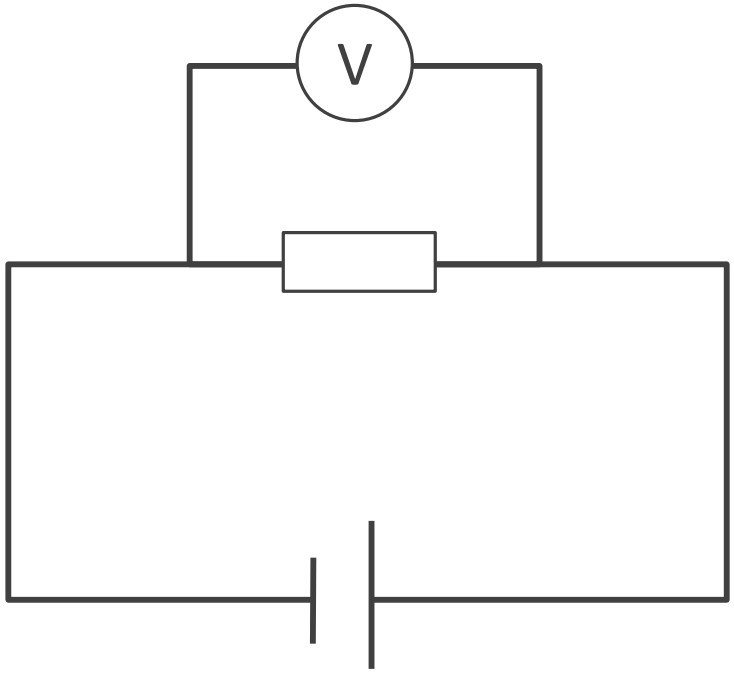


$$R_T = \cancel{8\ \Omega}\ 10\ \Omega$$

$$I = \frac{V}{R} = \frac{12}{\cancel{8}\ 10} = \cancel{1.5\ \text{A}}\ 1.2\ \text{A}$$

The non-ideal ammeter's resistance slows down the current that it's measuring

Voltmeter

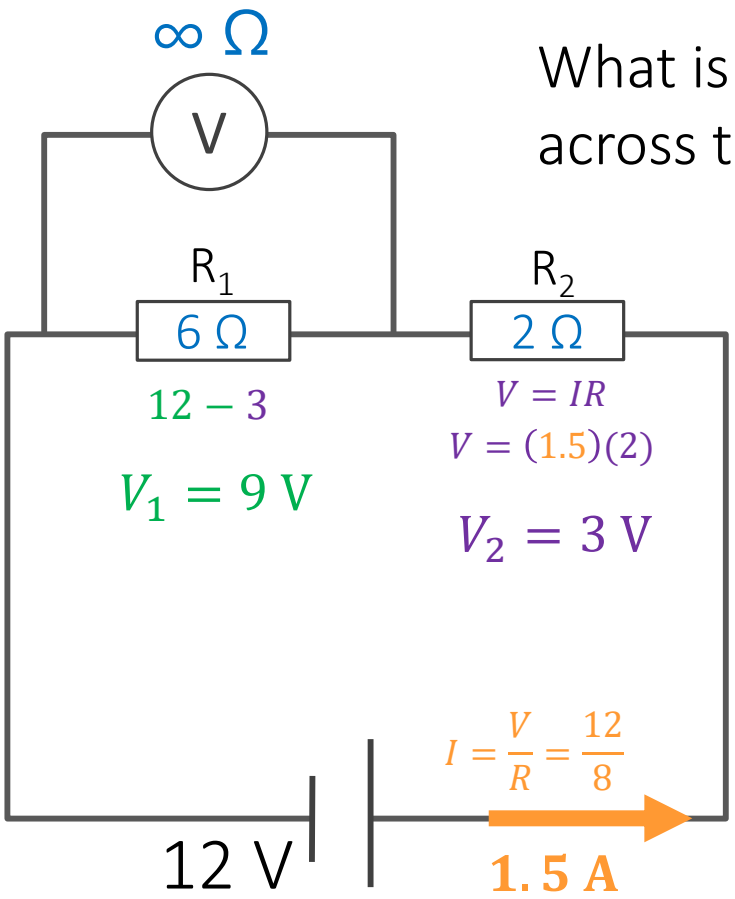


Hooked up in **parallel** with the component being measured

Ideal Voltmeter:

$$[R = \infty\ \Omega]$$

Measuring the Voltage



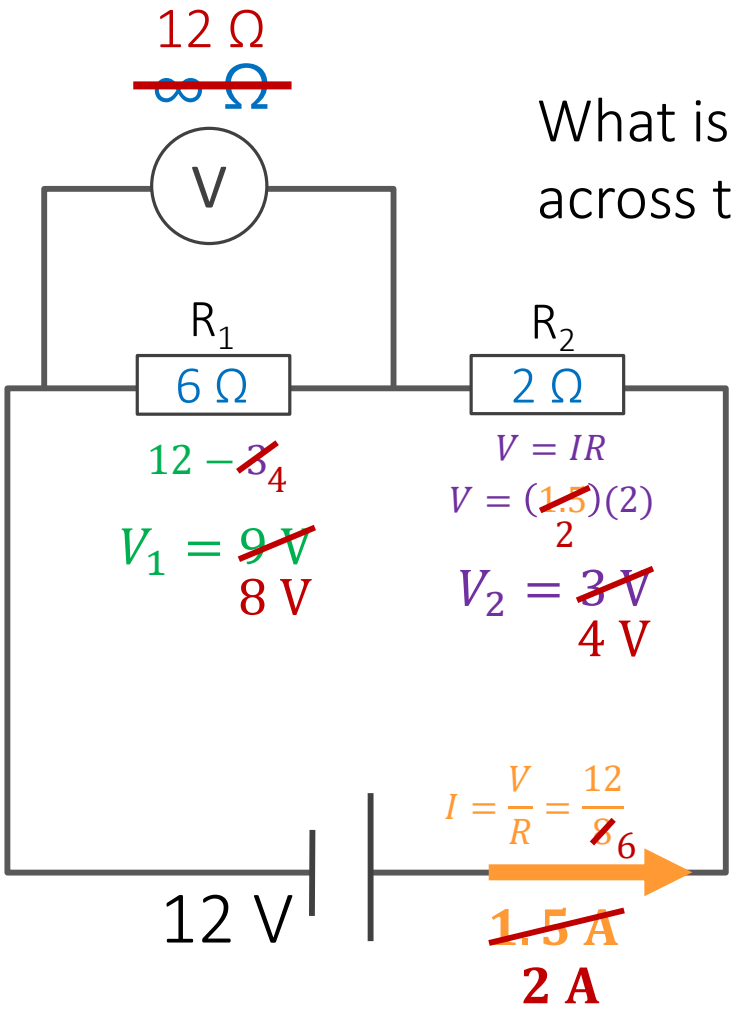
What is the reading for the ideal voltmeter across the resistor R_1?

$$R_T = \frac{1}{\frac{1}{6} + \frac{1}{\infty}} + 2$$

$\frac{1}{\infty} \rightarrow \mathbf{0}$

$$R_T = 6 + 2 = \mathbf{8\ \Omega}$$

Measuring the Voltage



What is the reading for the ideal voltmeter across the resistor R_1?

12 Ω

$$R_T = \frac{1}{\frac{1}{6} + \frac{1}{\infty}} + 2$$

12

$$R_T = \frac{6}{4} + 2 = 8\ \Omega$$

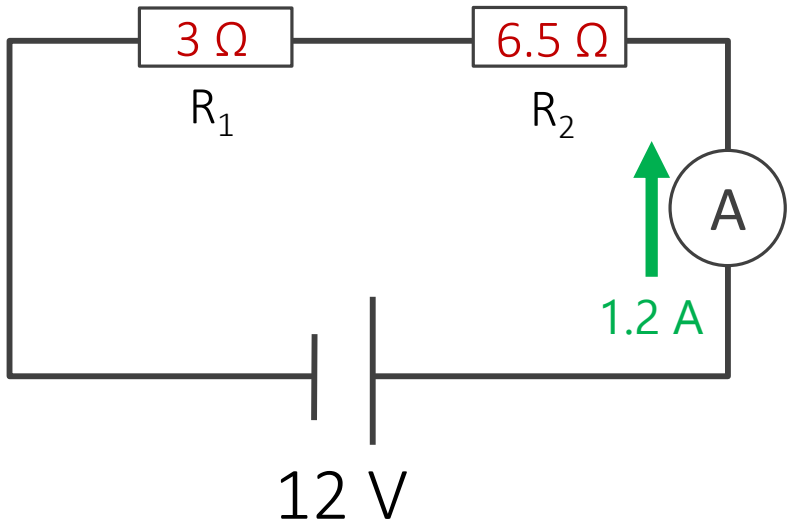
6 Ω

Try This

Calculate the resistance of this non-ideal meter:

Ammeter Reading	1.2 A

- Current is the same for all components
- Calculate total resistance from voltage and current
- Calculate ammeter resistance



$$R = \frac{V}{I} = \frac{12}{1.2} = 10\ \Omega$$

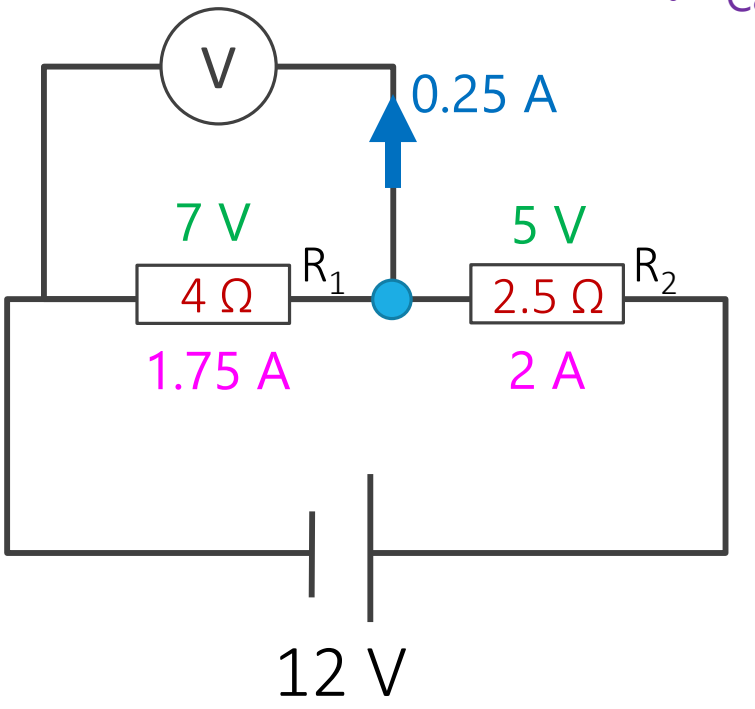
$$R_T = 10\ \Omega = 3 + 6.5 + A$$

$$A = \mathbf{0.5\ \Omega}$$

Try This

Calculate the resistance of this non-ideal meter:

Voltmeter Reading	7 V

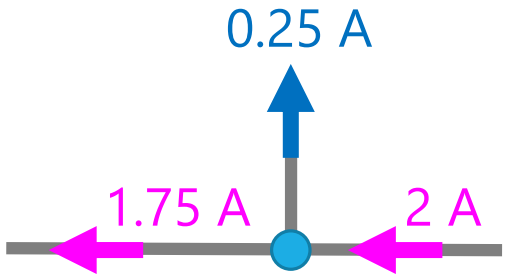


- Use voltage loops to calculate voltage for R_1 and R_2
- Calculate current for R_1 and R_2
- Use current junction to find current through meter
- Calculate resistance of voltmeter

$$I = \frac{V}{R}$$

$$R = \frac{V}{I} = \frac{7}{0.25}$$

$$R = \mathbf{28\ \Omega}$$



Lesson Takeaways

- ❑ I can connect a meter to measure current or voltage
- ❑ I can describe the conditions required for an ideal ammeter or voltmeter
- ❑ I can calculate for a situation when the meter isn't ideal