

Circuit rules, power and mains safety

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

Does the power in a resistor really grow with the square of the current? In this lab you measure voltage and current for a $10\ \Omega$ resistor, calculate the power two ways and use a graph to find the resistance from the gradient. It takes about 30 minutes with standard school equipment.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P2, HS-PS3-3

Aim

To measure the power in a fixed resistor at different currents, and to show that $P = VI$ and that P is proportional to I^2 .

Equipment

- variable DC power supply, 0–6 V (or a battery pack with a rheostat)
- $10\ \Omega$ wire-wound resistor rated 5 W
- digital ammeter, 0–1 A, resolution 0.01 A
- digital voltmeter, 0–10 V
- switch and six connecting leads
- graph paper or a spreadsheet

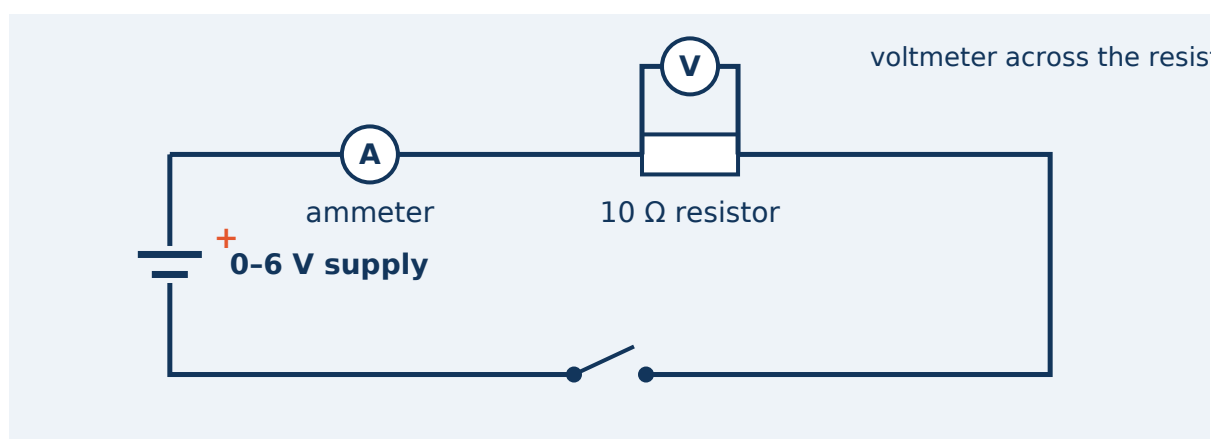
Safety

Safety

The resistor becomes hot at the highest current, so do not touch it and keep the switch open between readings. Never go above 6 V. Check all leads for damaged insulation.

Method

1. Build the circuit shown, with the ammeter in series and the voltmeter across the resistor. Keep the switch open.
2. Set the supply to 1.0 V, close the switch and read the ammeter.
3. Record V and I , then open the switch.
4. Repeat for 2.0 V, 3.0 V, 4.0 V, 5.0 V and 6.0 V.
5. Calculate $P = VI$ and I^2 for each row.



Lab set-up: the ammeter is in series with the 10 Ω resistor, the voltmeter is across it.

Results

Sample measurements from one group:

V (V)	I (A)	P = V I (W)	I ² (A ²)
1.0	0.10	0.10	0.010
2.0	0.20	0.40	0.040
3.0	0.29	0.87	0.084
4.0	0.39	1.56	0.152
5.0	0.49	2.45	0.240
6.0	0.59	3.54	0.348

Analysis questions

Question 1 Planning the readings

Name what you change on the supply, what you calculate from the meters, and two things that must stay fixed for a fair set of readings.

Question 2 Check one row

For the row with $V = 4.0$ V, check the power $P = V I$. Then calculate $I^2 R$ using $R = 10 \Omega$ and find the percentage difference between the two powers.

Question 3 Plot and gradient

Plot P (y-axis) against I^2 (x-axis) and draw the best-fit line. Use the first and last points to calculate the gradient, with its unit.

Question 4 Resistance from $V \div I$

Calculate $V \div I$ for each row and find the mean. Compare this value with the gradient.

Question 5 Heating effect

Explain why the switch should be opened between readings and why the resistance might rise slightly at 6.0 V.

Question 6 Uncertainty

The ammeter resolution is 0.01 A. Calculate the percentage uncertainty in the current at 0.10 A and at 0.59 A. Which readings are more reliable?

Question 7 Improve the lab

Suggest two improvements that would make the value of the resistance more precise.