

24 Resistance

Resistance measures how difficult it is for electric current to pass through a component (or through an object) for an applied voltage. A resistor is a circuit component that dissipates energy thermally when work is done in driving a current through it.

So an iron nail has **less** resistance than a plastic pen.

Resistance is measured in ohms (Ω – the upper case Greek letter “omega”).

Formula:

resistance (Ω) = voltage across component (V) / current through it (A)

$$R = V / I, \text{ so}$$

$$V = IR$$

24.1 Complete the table, where each row is a separate question:

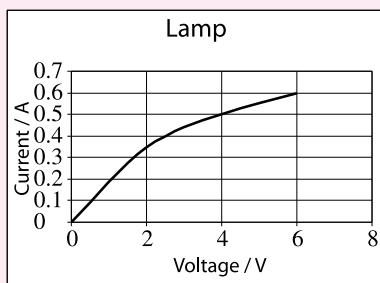
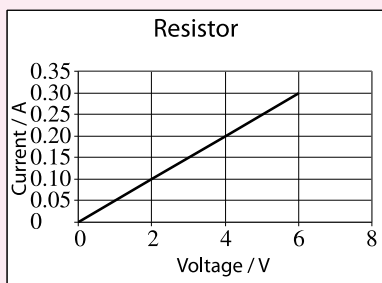
Voltage (V)	Current (A)	Resistance (Ω)
6.0	1.98	(a)
240	0.020	(b)
(c)	0.050	200
415	(d)	200

24.2 What is the resistance of the heating element in an electric oven which carries a current of 10 A when connected to 230 V mains?

24.3 What resistance is needed if you wish to have a 10 mA current and the supply voltage is 20 V?

Notice from your answer from Q24.3 that the equation $V = IR$ also works if you measure I in mA and R in $k\Omega$. This is useful as the mA and the $k\Omega$ are more convenient units in electronics than the amp and ohm.

- 24.4 A car headlamp bulb has a filament resistance of $6.0\ \Omega$. If the car battery is 13.2 volts, how much current does the bulb take from the battery when lit?
- 24.5 The heater of a toilet hand drier uses 9.0 amps from a 240 volt mains supply. What is the resistance of the heater's element?
- 24.6 (a) What is the voltage across a $0.33\ \text{k}\Omega$ resistor carrying 20 mA?
(b) A current of 3.33 mA flows through a $2.7\ \text{k}\Omega$ resistor. Calculate the potential difference across the resistor.
(c) In part of an electric circuit, the potential difference across a $12\ \Omega$ resistor is 16 V. What is the current through the resistor?
- 24.7 Some resistors are labelled with a red band. This shows that their true resistance will be within 2.0% of the value shown on the side. What is the largest current you would expect through a $15\ \text{k}\Omega$, 2.0% resistor when connected to a 5.0 V supply?
- 24.8 When both of a car's red tail lamps are lit, this 'draws' a current of 0.83 A from the battery. Given that a car battery has a voltage of 12 V, what is the resistance of each lamp? The lamps are wired in parallel.



- 24.9 Study the two graphs above, showing the current passing through a resistor and lamp for different supply voltages.
- (a) What is the resistance of the resistor when it is connected to a 6 V supply?
- (b) What is the resistance of the resistor when it is carrying 0.20 A?

- (c) What current would you expect to flow through the resistor if the voltage across it were 10 V?
- (d) What is the resistance of the lamp when it is connected to a 4 V supply?
- (e) If you wired the resistor and the lamp in parallel and connected them to a 6 V supply, how much current would be 'taken' in total from the supply?
- (f) [Harder] If you wired the resistor and the lamp in series, and connected this to a 14 V supply
- what would the current be?
 - what would be the voltage across the lamp?

24.10 [Harder] When a light emitting diode (LED) is connected into an electric circuit, it is wired in series with a resistor to ensure it doesn't get damaged by taking too much current. The voltage across a red LED is 1.5 V when it is lit. If you wish to supply it using a 9.0 V battery, what resistance of resistor is needed if a 30 mA current is needed?

