On electrical components

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Questions 4 and 5 are taked from *Success in Electronics*, Tom Duncan. Questions 6 and 7 are from *Advanced level physics*, Nelkon & Parker.

Warm-up problems

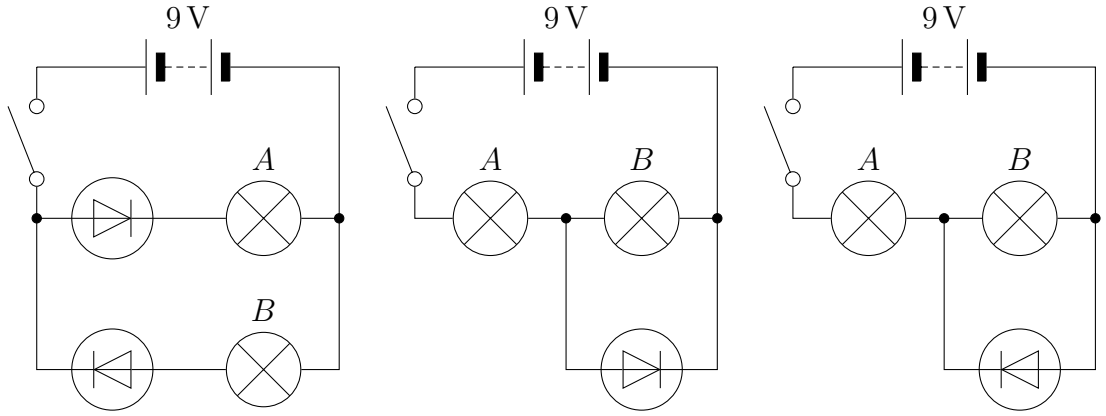
1. Sketch the *current–voltage* characteristics for an ohmic conductor, a filament lamp and a semiconductor diode.

2. Explain why an $I - V$ plot for a filament lamp is a curve.

3. Descibe in simple terms the action of a diode in the forward and reverse bias directions.

Regular problems

4. In the circuits below, say which of the 6 V, 60 mA lamps are bright, dim or off.



(a) (b) (b)

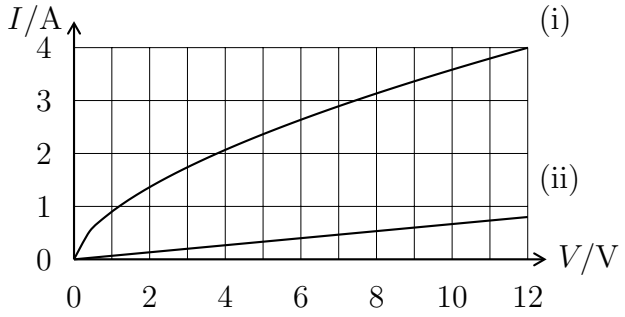
5. From the data given below for a semiconductor diode:

Forward voltage / V	0.0	0.2	0.4	0.6	0.8
Forward current / mA	0.00	0.00	0.02	1.00	100.0

   (a) Plot its $I - V$ characteristic.

   (b) What value and power of resistor should be connected in series with is to limit the forward current to 100 mA on a 3.0 V supply?

6. The graph below shows how the current varies with applied voltage across (i) a 12 V, 36 W filament lamp, and (ii) a metre length of nichrome wire of cross-section 0.08 mm^2.



   (a) Using the graph, find the ratio of the values of the electrical resistance of the filament lamp to the nichrome wire

      i. when the potential difference across them is 12 V,

      ii. when the potenrial difference across them is 0.5 V.

   (b) How does the resistance of the filament lamp change as the current increases? Suggest a physical explanation for this change.

   (c) The resistivity of copper is about $1.8 \times 10^{-8}\,\Omega\,\mathrm{m}$ at 20 °C. Show, using the information above, that the resistivity of nichrome is approximately 60 times this value.

Extension problems

7. A semiconductor diode and a resistor of constant resistance are connected in some way inside a box having two external terminals. When a potential difference of 1.0 V is applied across the terminals, the ammeter reads 25 mA. If the same potential difference is applied in the reverse direction, the ammeter reads 50 mA.

   What is the most likely arrangement of the diode and the resistor? Explain your deduction. Calculate the resistance of the resistor and the forward resistance of the diode.

8. It is said that switching a filament lamp on and off repeatedly shortens its life. How do you think the current in such a light varies with time after it is switched on? Explain your reasoning. What is the cause of lightbulb failure?