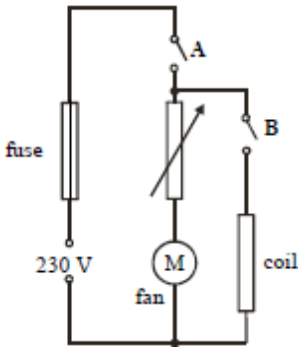
State Examination Commission – Physics Higher Level, 2010

Question 8

A hair dryer with a plastic casing uses a coiled wire as a heat source.
When an electric current flows through the coiled wire, the air around it heats up and a motorised fan blows the hot air out.
What is an electric current?
Heating is one effect of an electric current.
Give two other effects of an electric current. (12)
The diagram shows a basic electrical circuit for a hair dryer.
(i) Describe what happens:
(*a*) when switch **A** is closed and the rheostat is adjusted
(*b*) when switch **A** and switch **B** are closed. (9)
(ii) The maximum power generated in the heating coil is 2 kW.
(*a*) What is the initial resistance of the coil?
(*b*) Calculate the current that flows through the coil when the dryer is turned on. (9)
(iii) A length of nichrome wire of diameter 0.17 mm is used for the coil. Calculate the length of the coil of wire. (18)
(iv) Explain why the current through the coil would decrease if the fan developed a fault and stopped working. (8)



(resistivity of nichrome = 1.1×10^{-6} Ω m)

What is an electric current?

A flow of electric charge

Heating is one effect of an electric current. Give two other effects of an electric current. (12)

Chemical and magnetic

The diagram shows a basic electrical circuit for a hair dryer.
(i) Describe what happens:
(*a*) when switch **A** is closed and the rheostat is adjusted

The fan twirls and its speed of rotation increases as the resistance of the rheostat decreases

(*b*) when switch **A** and switch **B** are closed. (9)

Current flows through the coil, it gives out heat and the the fan blows air over it.

(ii) The maximum power generated in the heating coil is 2 kW.
(*a*) What is the initial resistance of the coil?

$P = VI = V(V/R) = V^2/R$
$2000 = 230^2/R$
$R = 26.5\ \Omega$

(*b*) Calculate the current that flows through the coil when the dryer is turned on. (9)

$I = P/V = 2000/230 = 8.7$ A

(iii) A length of nichrome wire of diameter 0.17 mm is used for the coil. Calculate the length of the coil of wire. (18)

$$\rho = \frac{RA}{l} = \frac{R\pi d^2}{4l}$$

$$\Rightarrow l = \frac{R\pi d^2}{4\rho} = \frac{26.5 \text{x} \pi x (1.7 x 10^{-4})^2}{4 x 1.1 \times 10^{-6}} = 0.547\, m$$

(iv) Explain why the current through the coil would decrease if the fan developed a fault and stopped working. (8)

If the fan stopped blowing air over the coil, its temperature would increase, and hence its resistance would also increase. This would lead to a smaller current through the coil. (Any back emf generated by the motor would have negligible effect on the pd across the coil)