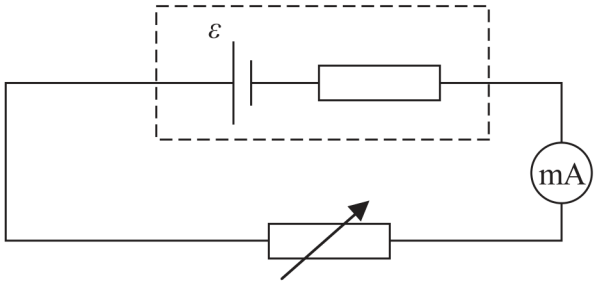
17 A cell of e.m.f. ε is connected in series with a variable resistor with resistance R as shown. The internal resistance of the cell is r.



When R is 12 Ω, the reading on the ammeter is 107 mA. The circuit is switched on for 300 seconds. In this time, 50 J of energy is transferred by the cell.

(a) Calculate r.

(5)

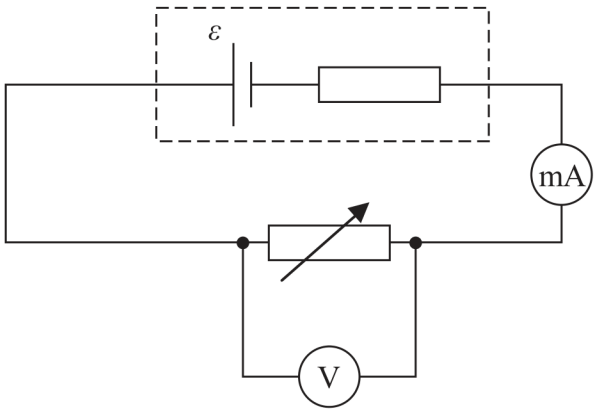
r = ...

(b) Increasing R would make the terminal potential difference value closer to ε.

Explain why, without further calculation.

(2)

(c) A voltmeter is added to the circuit as shown.



Explain how this circuit can be used to determine a value for r using a graphical method.

(4)

(Total for Question 17 = 11 marks)