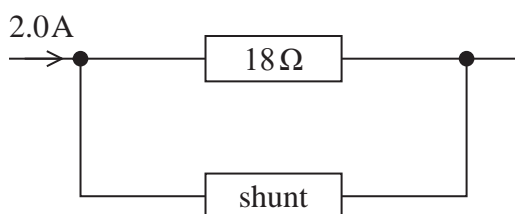


- 12** Analogue ammeters were used before digital meters became widely available.  
The analogue ammeter shown will measure a maximum current of  $1.0\text{ mA}$  and has a resistance of  $18\,\Omega$ .



(Source: © David J. Green/Alamy Stock Photo)

The analogue ammeter can be adapted to measure a larger current by adding a resistor, known as a shunt, in parallel with the ammeter. The arrangement is shown below.  
The analogue ammeter is represented by the  $18\,\Omega$  resistor.



The maximum current through the  $18\,\Omega$  resistor remains as  $1.0\text{ mA}$ .

- (a) Show that the shunt would need to have a resistance of about  $0.01\,\Omega$  to adapt this ammeter to read up to a maximum current of  $2.0\text{ A}$ .

(3)

- (b) A shunt of this resistance was usually made from Manganin wire.

Calculate the length of Manganin wire of radius  $0.95\text{ mm}$  required to make this shunt.

resistivity of Manganin =  $4.55 \times 10^{-7}\,\Omega\text{ m}$

(3)

Length = .....

(Total for Question 12 = 6 marks)