

- 3 Lightning occurs when charge builds up in the atmosphere, creating a potential difference between the ground and the atmosphere.

During a lightning strike there is an average current of  $3.3 \times 10^4 \text{ A}$  for a time of  $2.6 \times 10^{-5} \text{ s}$ .

- (a) Calculate the charge transferred during the lightning strike.

$$\text{charge} = \dots \text{ C} [2]$$

- (b) The potential difference between the ground and the atmosphere is  $3.0 \times 10^7 \text{ V}$ .

Calculate the average power, in GW, transferred during the lightning strike.

$$\text{power} = \dots \text{ GW} [2]$$

- (c) A lightning rod is attached to a tall building to conduct charge safely to the ground. The lightning rod is modelled as a uniform cylindrical copper cable of total length 95 m that runs from the ground to the top of the building, as shown in Fig. 3.1.

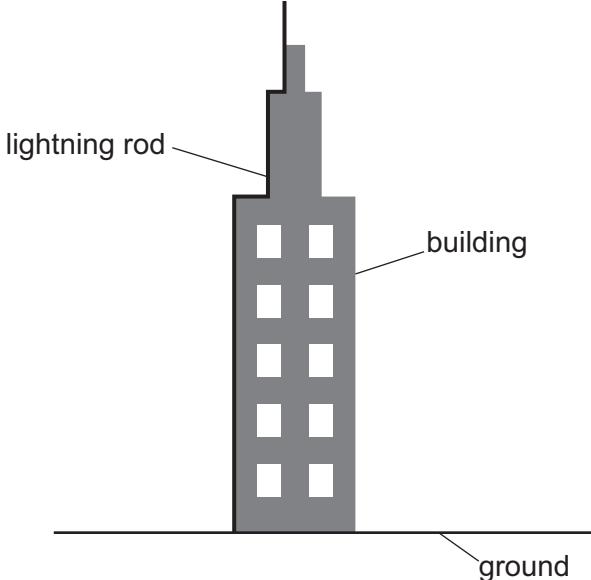


Fig. 3.1



- (i) The resistance of the lightning rod is  $9.6\ \Omega$ .  
The resistivity of copper is  $1.7 \times 10^{-8}\ \Omega \text{m}$ .

Determine the radius of the lightning rod.

$$\text{radius} = \dots \text{ m} [3]$$

- (ii) The radius of the copper lightning rod is doubled with no change to its length.

State the effect of this change on the resistance of the lightning rod.

$$\dots [1]$$

- (d) A section of the lightning rod of length 0.12 m is removed for testing. A tensile stress of  $1.9 \times 10^6\ \text{Pa}$  is applied, as shown in Fig. 3.2.

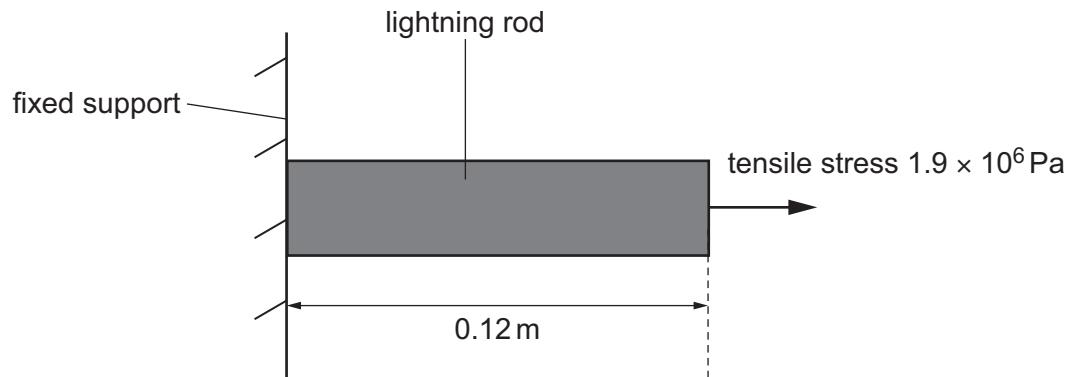


Fig. 3.2 (not to scale)

The section of the rod obeys Hooke's law. The Young modulus of copper is  $1.3 \times 10^{11}\ \text{Pa}$ .

Calculate the extension of the section.

$$\text{extension} = \dots \text{ m} [3]$$