7 The National Electrical Code (NEC), is an adoptable standard for the safe installation of electrical wiring and equipment in some countries. It is part of the National Fire Codes series published by the National Fire Protection Association (NFPA), a private trade association. Despite the use of the term "national", it is not a federal law. It is typically adopted by states and municipalities in an effort to standardize their enforcement of safe electrical practices. In some cases, the NEC is amended, altered and may even be rejected in lieu of regional regulations as voted on by local governing bodies. The "authority having jurisdiction" inspects for compliance with these minimum standards.

A type of wire used for interior wiring of houses, hotels, office buildings, and industrial plants, is referred to as wire “A”. Wire “A” is permitted to carry no more than a specified maximum amount of current. The “wire gauge” is a standard method used to describe the diameter of wires.

Table 7.1 shows the diameter d and resistance R of a constant length L of the wire for various wire gauges. The constant length L for this set of data is 1.00 m.

Table. 7.1

Wire Gauge	d / mm	R / mΩ
14	0.27	19.0
12	0.32	13.9
10	0.38	9.70
8	0.46	6.60
6	0.56	4.40
5	0.91	1.68

I_{max} is the maximum amount of current that can flow in wire “A” of 1.00 m before it overheats. The graph of I_{max} against the diameter of the gauge d is plotted in Fig. 7.1 below.

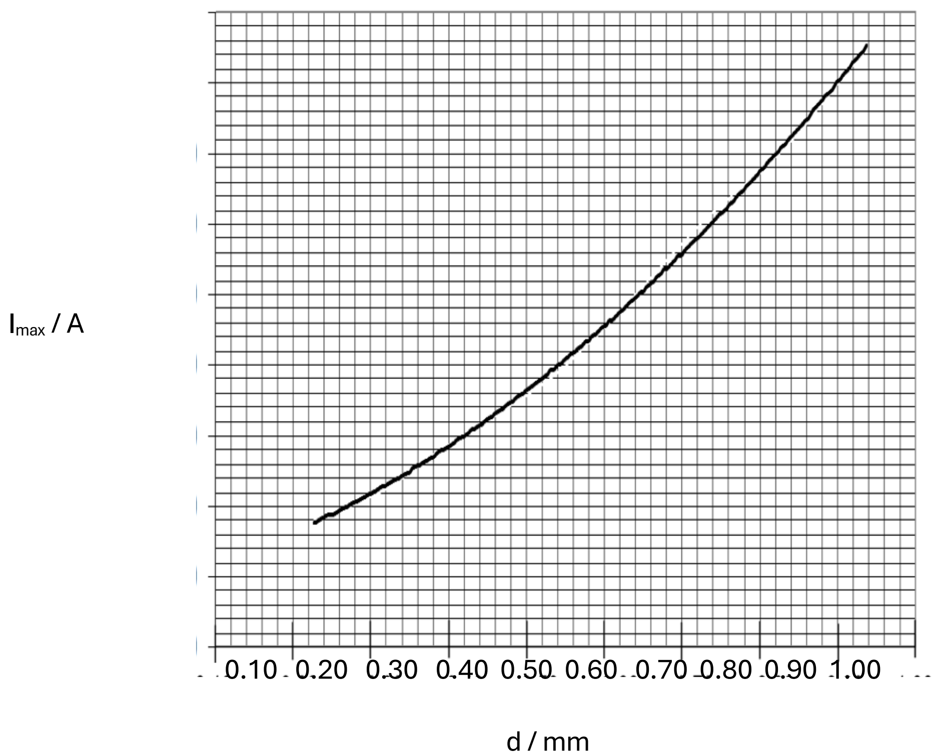

Fig. 7.1

A student, who is investigating how the resistance of wire “A” depends on the diameter of the wire, believes that resistance R of wire “A” is related to diameter d by the following equation:

$$R = kd^n$$

where k and n are constants.

The student uses Table. 7.1 to compute the data in Table 7.2 so that he can test his hypothesis.

Table. 7.2

ln (d / mm)	lg (R / mΩ)
-0.57	1.28
-0.49	1.14
-0.42	0.987
-0.33	0.820
-0.25	0.643

-0.041	0.225

The student then plots the variation of lg (d / mm) with lg (R / mΩ) on a graph. The graph is shown in Fig. 7.2.

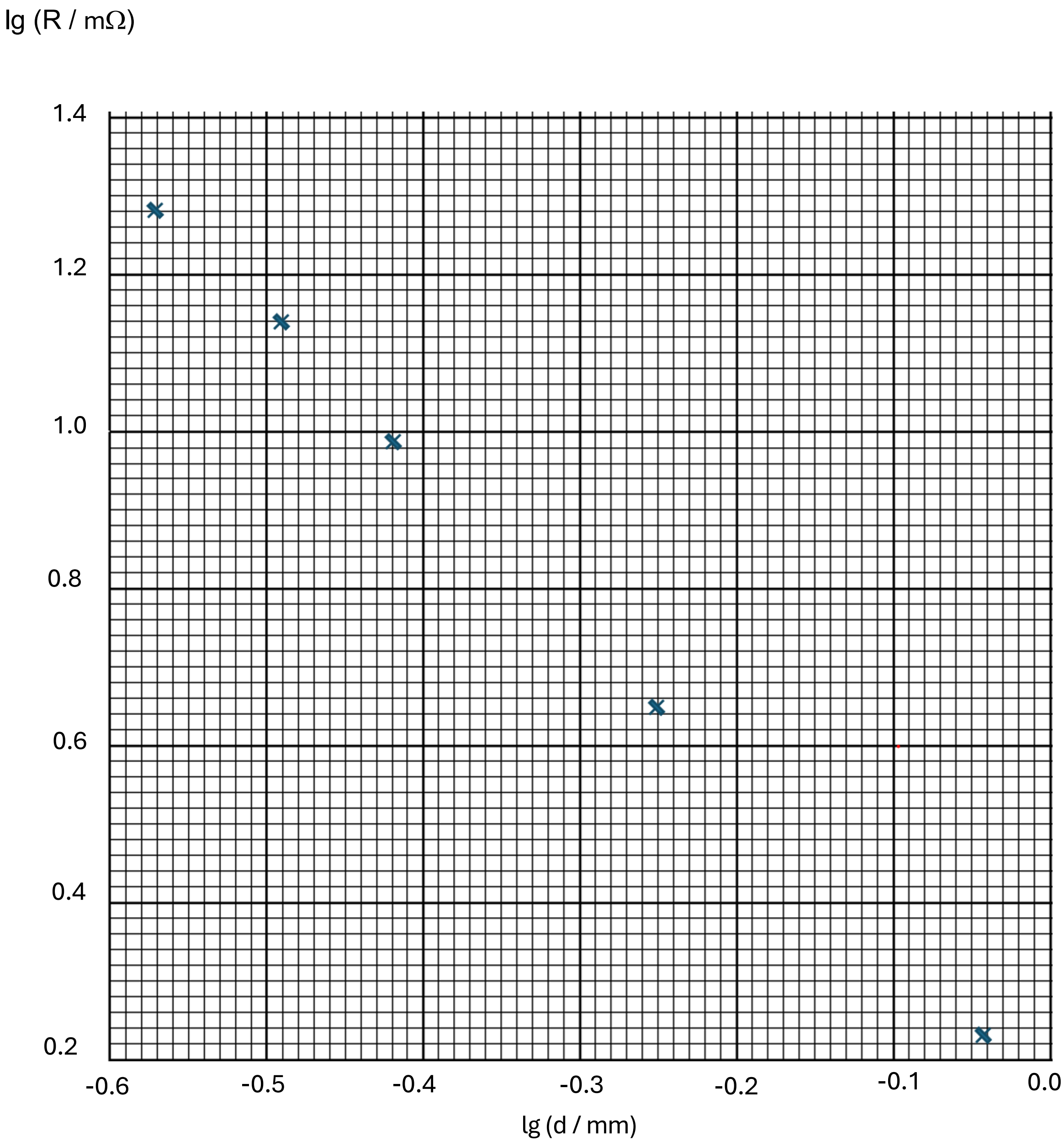

Fig. 7.2

(a) **(i)** Use Table 7.1 to suggest qualitatively the relationship between diameter (and resistance R.

……………..………………………………………………………………………….…………….....

……………..………………………………………………………………………….…………….....

……………………………………………………………………………………….…………................ [1]

(ii) Explain why the graph of Fig. 7.2 supports the student's hypothesis.

……………..………………………………………………………………………….…………….....

……………..………………………………………………………………………….…………….....

……………..………………………………………………………………………….…………….....

……………………………………………………………………………………….…………................ [2]

(b) **(i)** Plot the point for d = 0.46 mm on Fig. 7.2. [1]

(ii) Complete Fig. 7.2 by drawing the line of best fit. [1]

(iii) Determine the value of n from your line.

n = ……………………….. [2]

(c) Use Fig. 7.2 to find the resistance R of wire “A” with diameter 0.73 mm.

R = ……………………………. Ω [3]

(d) If $k = 4\rho L / \pi$, determine the value of ρ, where L is the length of the wire. Include an appropriate unit for ρ.

ρ = ... [4]

(e) A boiler, with resistance of 6.0 kΩ and rated at 5.4 MW is to be connected to two wire "A"s of length 1.00 m each as shown in Fig. 7.3 below.

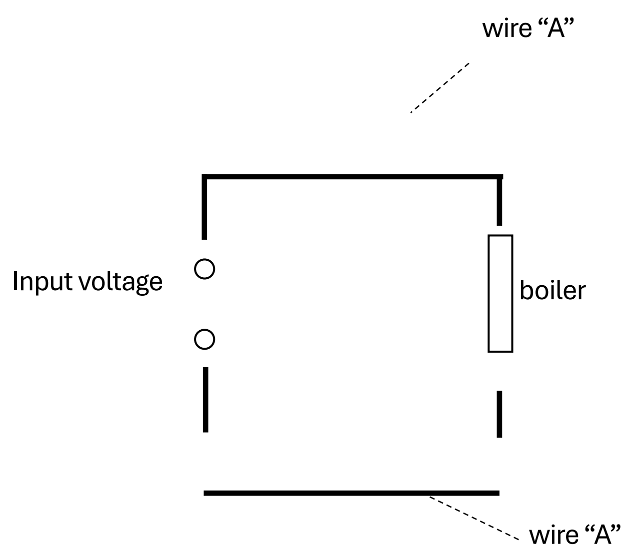

Fig. 7.3

(i) Determine the thinnest permissible wire that can be used with the boiler. Choose a suitable gauge from Table 7.1 and explain your choice.

....

.... [3]

(ii) Suggest a reason why a manufacturer would use the thinnest possible wire.

....

.... [1]

(iii) State and explain an advantage of using a thicker wire for this boiler.

……

……

……… [2]

(iv) Calculate the potential difference across each of the 1.00 m wires for the gauge selected in **(e)(i)**.

potential difference = ... V [2]

[Total: 22]