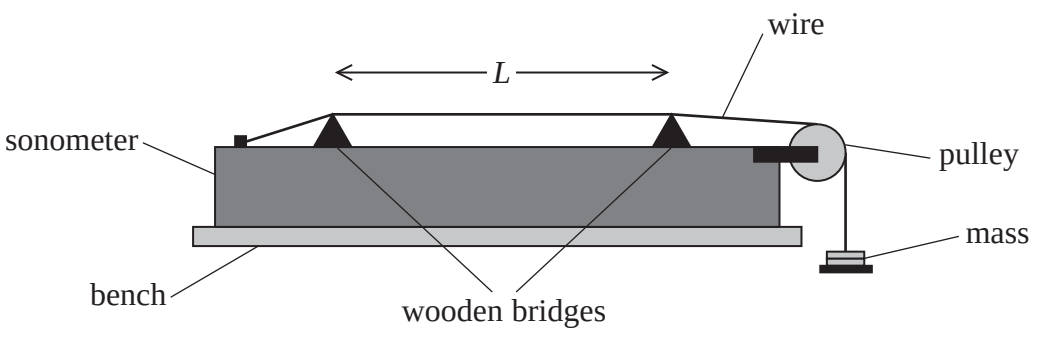
13 A student used a sonometer to investigate the properties of a stretched wire. The sonometer is a long hollow wooden box.

A steel wire is attached to one end of the box and rests on two wooden bridges. The wire is placed under tension T by hanging a mass from the end of the wire, as shown.



The student placed the base of a vibrating tuning fork in contact with the wire, at one of the bridges. This set the wire into oscillation. He adjusted the position of the other bridge until a single-loop standing wave was produced on the wire between the bridges.

(a) Explain how an antinode is produced at the mid-point of the wire between the bridges.

(3)

(b) The student repeated this for a series of tuning forks with different frequencies f. For each fork he measured the distance L between the bridges.

The steel wire, of mass per unit length μ, was placed under tension T by hanging a mass of 2.10 kg from the end of the wire.

(i) State one safety precaution that should be taken when carrying out the investigation.

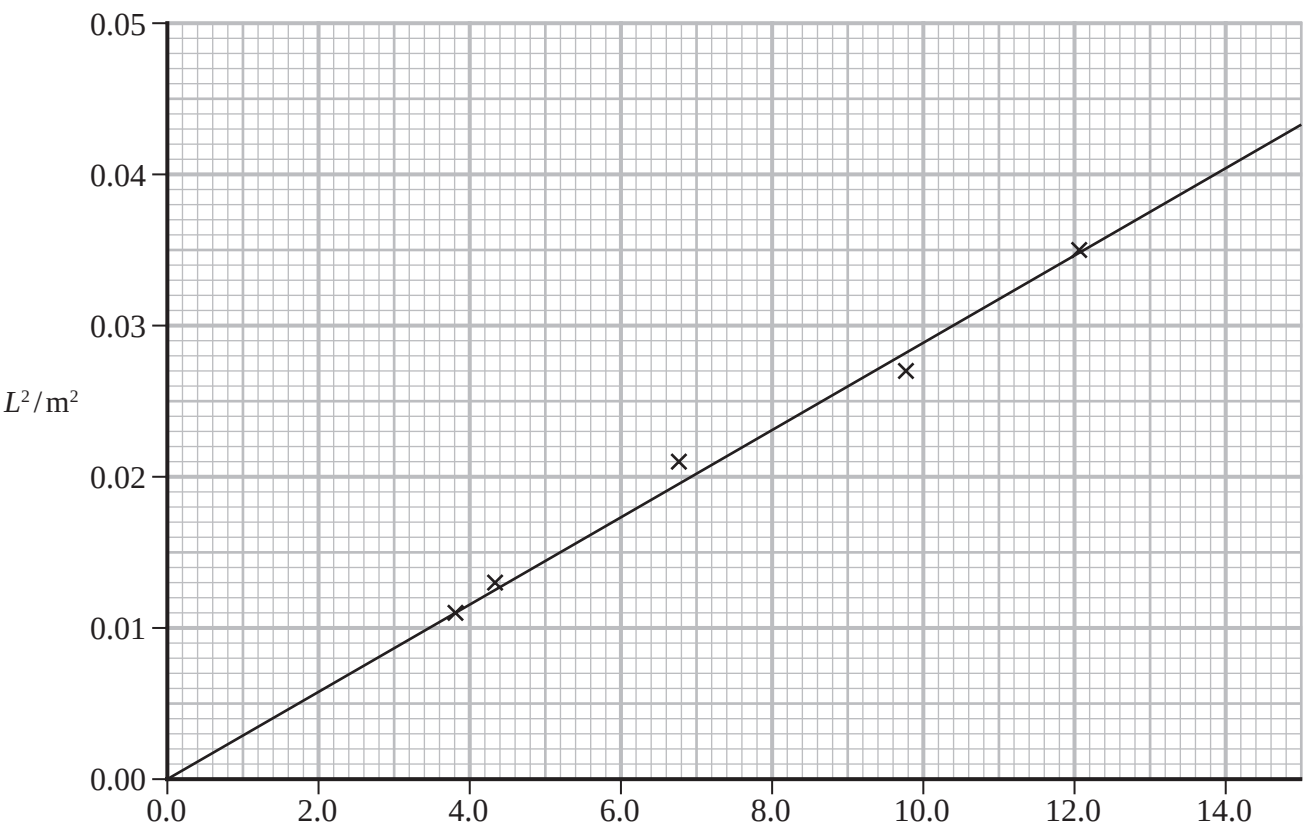
(1)

(ii) The student plotted a graph of L^2 against $1/f^2$.

Show that the gradient of this graph is equal to $\frac{T}{4\mu}$

(3)

(iii) The student's graph is shown below.



The value of μ for different standard wire gauge (SWG) steel wire is shown in the table.

SWG	μ/g m^{-1}
22	3.15
24	1.95
26	1.31

Deduce which wire the student used in the investigation.

(4)

(c) The student then found a value of μ for a brass wire, using a different method.

(i) He measured the diameter d of the wire using a micrometer.

Explain one technique the student should use when measuring d.

(2)

(ii) The student obtained the following data.

d/mm			
0.55	0.59	0.57	0.58

The stated value of μ for the brass wire used by the student was 2.14×10^{-3} kg m^{-1}.

Deduce whether the student's data supports this value for μ.

density of brass = 8700 kg m^{-3} ± 200 kg m^{-3}

(6)

(Total for Question 13 = 19 marks)