5 **(a)** A metal wire has an unstretched length L and area of cross-section A. When the wire supports a load F, the wire extends by an amount ΔL. The wire obeys Hooke's law.

Write down expressions, in terms of L, A, F and ΔL, for

(i) the applied stress,

.....

(ii) the tensile strain in the wire,

.....

(iii) the Young modulus of the material of the wire.

.....

[3]

(b) A steel wire of uniform cross-sectional area 7.9×10^{-7} m^2 is heated to a temperature of 650 K. It is then clamped between two rigid supports, as shown in Fig. 5.1.

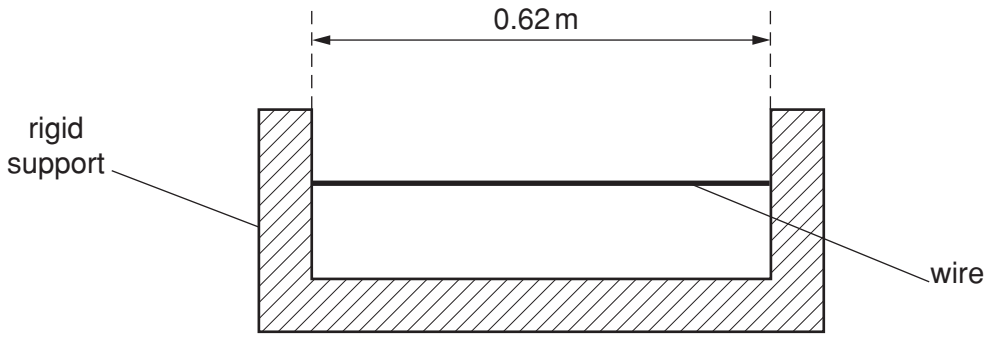

Fig. 5.1

The wire is straight but not under tension and the length between the supports is 0.62 m. The wire is then allowed to cool to 300 K.

When the wire is allowed to contract freely, a 1.00 m length of the wire decreases in length by 0.012 mm for every 1 K decrease in temperature.

(i) Show that the change in length of the wire, if it were allowed to contract as it cools from 650 K to 300 K, would be 2.6 mm.

[2]

(ii) The Young modulus of steel is 2.0×10^{11} Pa. Calculate the tension in the wire at 300 K, assuming that the wire obeys Hooke's law.

For Examiner's Use

tension = ... N [2]

(iii) The ultimate tensile stress of steel is 250 MPa. Use this information and your answer in **(ii)** to suggest whether the wire will, in practice, break as it cools.

.....

..... [3]