Deformation of Solids – 2017

1. 9702/22/M/J/17/3

The Young modulus of the material of a wire can be determined using the apparatus shown in Fig. 3.1.

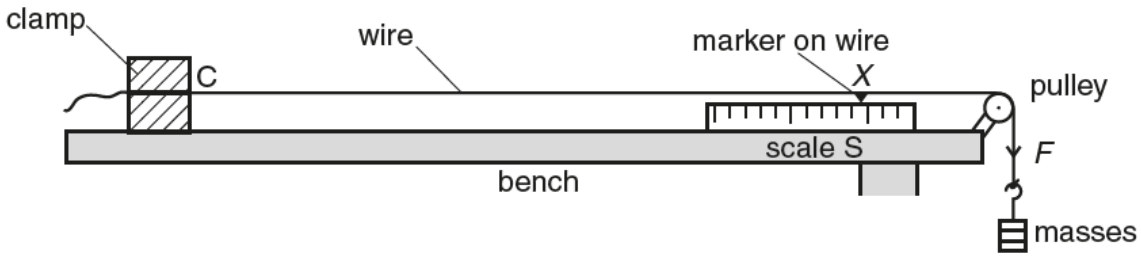

Fig. 3.1

One end of the wire is clamped at C and a marker is attached to the wire above a scale S. A force to extend the wire is applied by attaching masses to the other end of the wire.

The reading X of the marker on the scale S is determined for different forces F applied to the end of the wire. The variation with X of F is shown in Fig. 3.2.

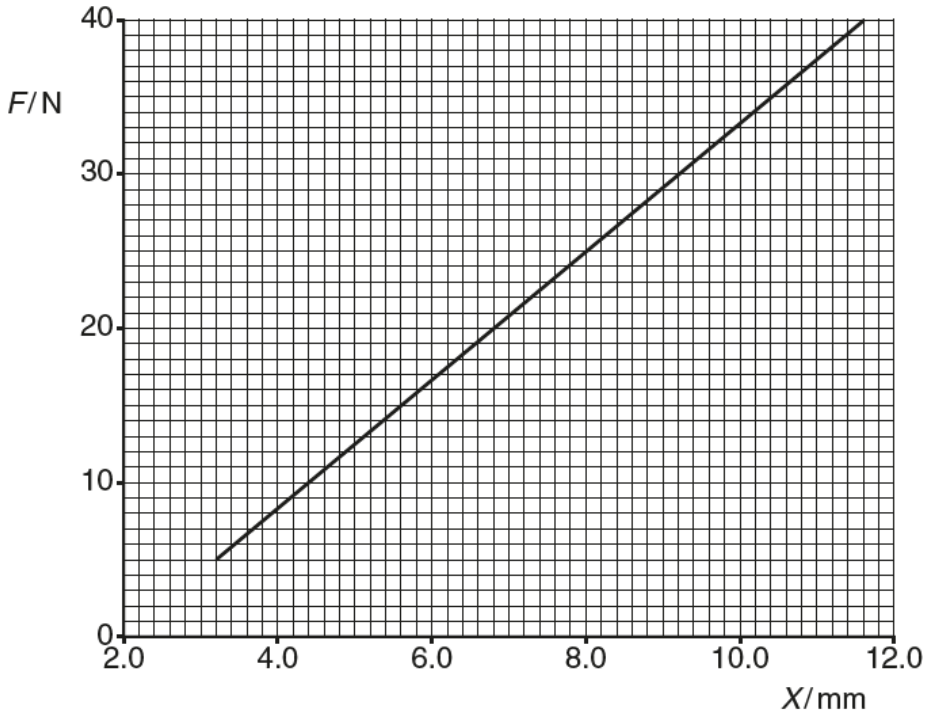

Fig. 3.2

(a) The length of the wire from C to the marker for $F = 0$ is 3.50 m. The diameter of the wire is 0.38 mm.

Use the gradient of the line in Fig. 3.2 to determine the Young modulus E of the material of the wire in TPa.

$E =$ ..... TPa [3]

(b) The experiment is repeated with a thicker wire of the same material and length.

State how the range of the force F must be changed to obtain the same range of scale readings as in Fig. 3.2.

.....

.....

.....[1]

[Total: 4]

2. 9702/23/M/J/17/4

A spring is supported so that it hangs vertically, as shown in Fig. 4.1.

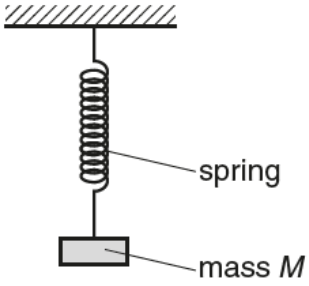

Fig. 4.1

Different masses are attached to the lower end of the spring. The extension x of the spring is measured for each mass M. The variation with x of M is shown in Fig. 4.2.

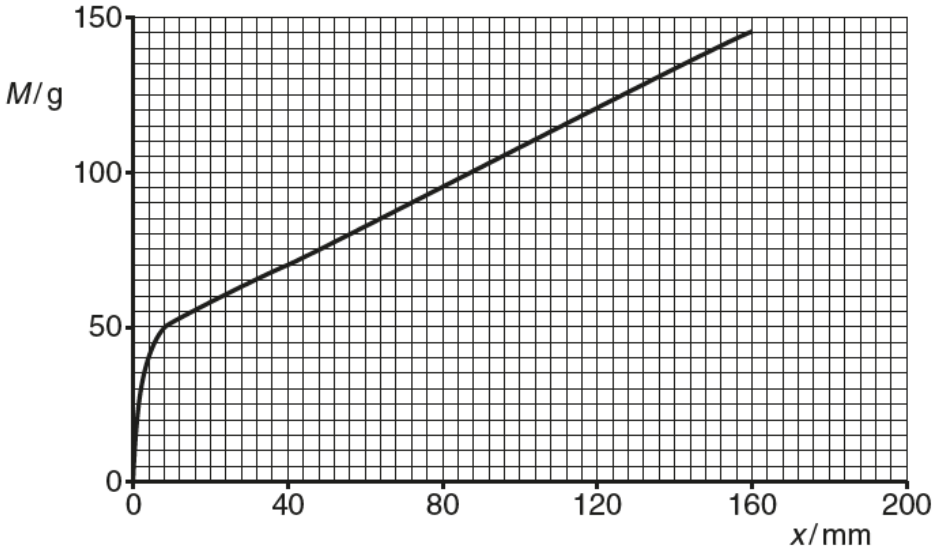

Fig. 4.2

(a) State and explain whether the spring obeys Hooke's law.

.....

.....[1]

(b) State the form of energy stored in the spring due to the addition of the masses.

.....[1]

(c) Describe how to determine whether the extension of the spring is elastic.

.....

.....[1]

(d) Calculate the work done on the spring as it is extended from $x = 40.0\,\text{mm}$ to $x = 160\,\text{mm}$.

work done = ...J [3]

[Total: 6]

3. 9702/21/O/N/17/4

(a) Define *strain*.

.....

.....[1]

(b) A wire is designed to ensure that its strain does not exceed 4.0×10^{-4} when a force of 8.0 kN is applied. The Young modulus of the metal of the wire is 2.1×10^{11} Pa. It may be assumed that the wire obeys Hooke's law.

For a force of 8.0 kN, calculate, for the wire,

(i) the maximum stress,

maximum stress = ... Pa [2]

(ii) the minimum cross-sectional area.

minimum cross-sectional area = ... m^2 [2]

[Total: 5]