3 **(a)** The variation of stress with strain for a metal P is shown in Fig. 3.1.

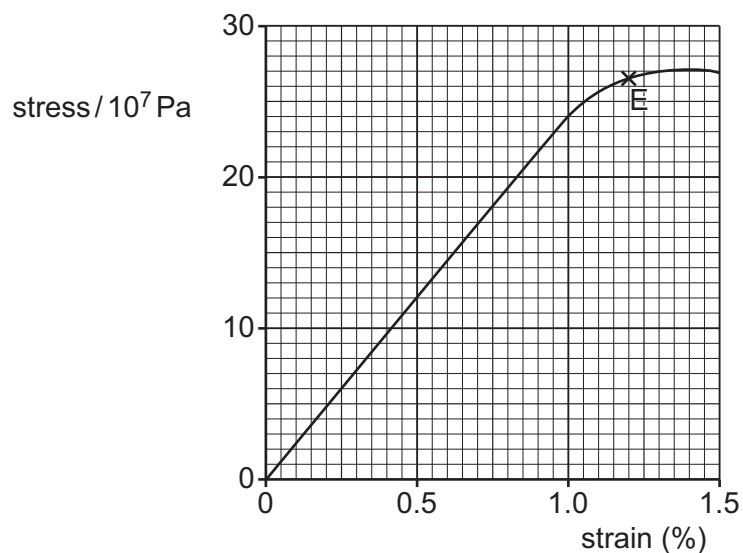
Fig. 3.1

Point E is the elastic limit of the metal.

(i) Use Fig. 3.1 to determine the Young modulus for P.

Young modulus = ... Pa [2]

(ii) On the line in Fig. 3.1, draw a cross (×) to show the limit of proportionality.
Label this point Q. [1]

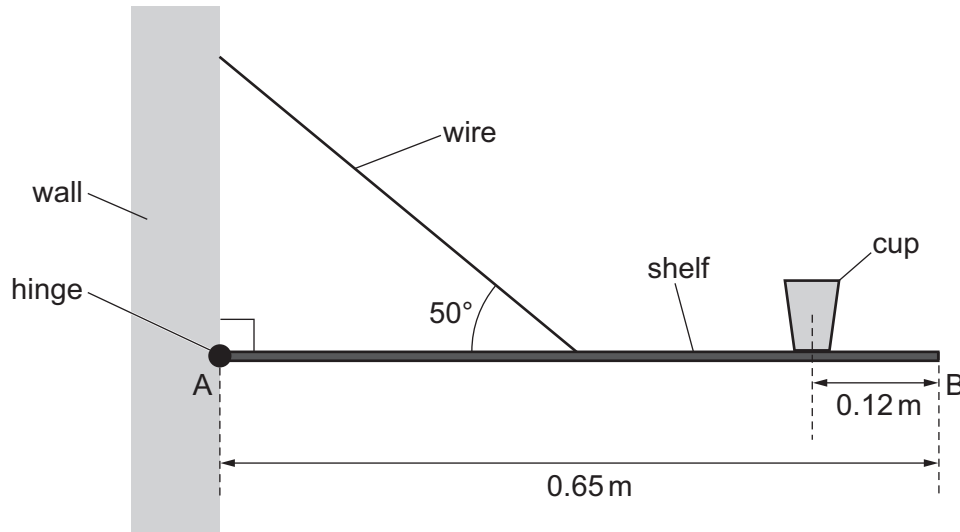**(b)** State the conditions necessary for an object to be in equilibrium.

....

....

.... [2]

(c) A wire is used to hold a uniform shelf AB horizontally in equilibrium as shown in Fig. 3.2.

Fig. 3.2 (not to scale)

The wire is connected to the midpoint of shelf AB at an angle of 50° to the horizontal. The shelf is attached to a wall by a hinge at A. The length of shelf AB is 0.65 m and its weight is 33 N.

A cup of weight 1.5 N rests on the shelf with its centre of gravity at a horizontal distance of 0.12 m from B.

(i) By taking moments about A, determine the tension in the wire.

tension = ... N [3]

(ii) The stress in the wire is $1.5 \times 10^7\,Pa$.

Determine the radius of the wire.

radius = ... m [2]

(iii) More items are added to the shelf, doubling the stress in the wire. The wire is made of the metal P from **(a)**.

Use Fig. 3.1 to state and explain whether the wire will behave plastically or elastically as the stress doubles.

....

....

....

....

.... [2]

[Total: 12]