2 **(a)** **(i)** State the principle of moments.

.....

.....

.....

..... [2]

(ii) State what is meant by the centre of gravity of an object.

.....

..... [1]

(b) A spring with force constant k is suspended from a fixed point. The extension of the spring is x when the spring supports a load.

The spring obeys Hooke's law.

(i) Use the area under a force–extension graph to show that the energy W stored in a stretched spring is given by:

$$W = \frac{1}{2}kx^2.$$

[2]

(ii) When the extension x of the spring is 81 mm, the energy W stored in the spring is 0.16 J.

Determine the force constant k.

k = ... $\mathrm{N\,m^{-1}}$ [1]

(c) The spring in **(b)** is used to support a uniform rod. The top of the spring is attached to a fixed point on a vertical wall. The rod is hinged at the wall and is horizontal, as shown in Fig. 2.1.

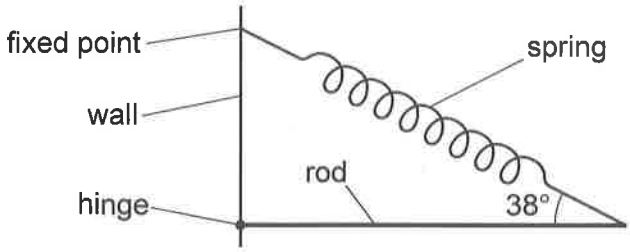

Fig. 2.1 (not to scale)

The angle between the spring and the rod is 38°. The extension of the spring is 0.12 m. The spring is of negligible mass. The spring obeys Hooke's law.

(i) Determine the mass m of the rod.

m = ... kg [2]

(ii) The spring is replaced by a wire of negligible mass. A force H at the hinge acts as shown in Fig. 2.2.

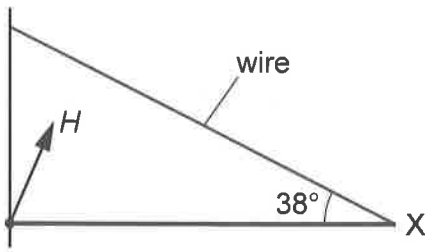

Fig. 2.2 (not to scale)

A load is added to the rod at X. The rod remains horizontal.

State and explain what happens to the magnitude and direction of H.

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..... [3]

[Total: 11]