4 **(a)** State Hooke's Law.

.....

.....[1]

(b) A spring is compressed by applying a force. The variation with compression x of the force F is shown in Fig. 4.1.

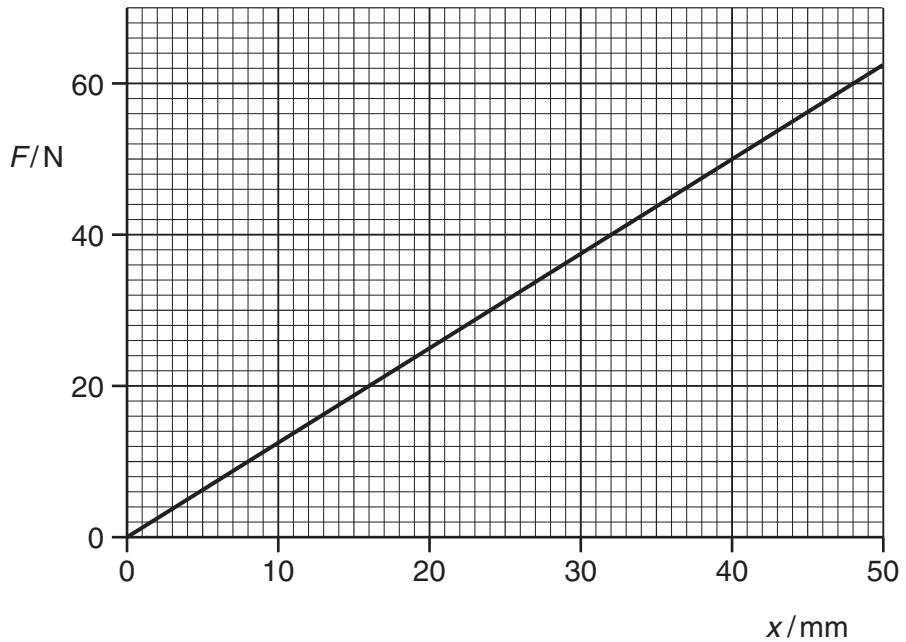

Fig. 4.1

(i) Calculate the spring constant.

spring constant = ... $N\,m^{-1}$ [1]

(ii) Show that the work done in compressing the spring by 36 mm is 0.81 J.

[2]

For Examiner's Use

(c) A child's toy uses the spring in **(b)** to shoot a small ball vertically upwards. The ball has a mass of 25 g. The toy is shown in Fig. 4.2.

For Examiner's Use

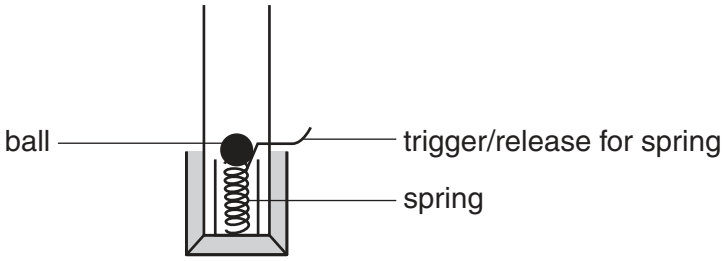

Fig. 4.2

(i) The spring in the toy is compressed by 36 mm. The spring is released.
Assume all the strain energy in the spring is converted to kinetic energy of the ball.
Using the result in **(b)(ii)**, calculate the speed with which the ball leaves the spring.

speed = ... $m\,s^{-1}$ [2]

(ii) Determine the compression of the spring required for the ball to leave the spring with twice the speed determined in **(i)**.

compression = ... mm [2]

(iii) Determine the ratio

$$\frac{\text{maximum possible height for compression in (i)}}{\text{maximum possible height for compression in (ii)}}.$$

ratio = ... [2]