3 One end of a spring is fixed to a support. A block is attached to the other end of the spring and gently lowered to its equilibrium position, as shown in Fig. 3.1.

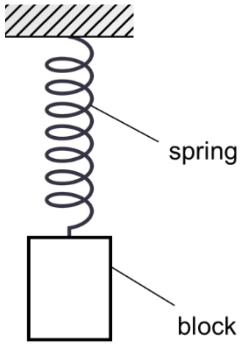

Fig. 3.1

Using two fingers, a student pushes down sharply on the block.

This immediately imparts some downward momentum to the block, causing it to oscillate.

(a) Theory suggests that the vertical acceleration *a* of the block is related to its vertical displacement *y* by the expression

$$a = -\frac{k}{m}y$$

where *k* is the spring constant and *m* is the mass of the block.

Explain why this expression leads to the conclusion that the block is performing simple harmonic motion.

………

………

………

……… [2]

(b) Fig. 3.2. shows some measurements obtained by the student.

Spring constant k / N m^{-1}	25
Mass of block / kg	0.15

Fig. 3.2

(i) Determine the angular frequency ω of the oscillation.

ω = ………………………….. rad s^{-1} [1]

(ii) The block has a maximum speed of 0.31 m s^{-1}. Damping effects can be neglected. **Using your result in (b)(i)**, calculate the amplitude y_0 of the oscillation.

y_0 = ………………………….. m [1]

(iii) Using your answers in **(b)(i)** and **(b)(ii)**, sketch on Fig. 3.3 the variation of velocity v of the oscillating system with the displacement y.

Indicate on your graph when the mass is at the start of its motion and when it first comes to rest. Label these points A and B respectively.

Take downwards as positive displacement.

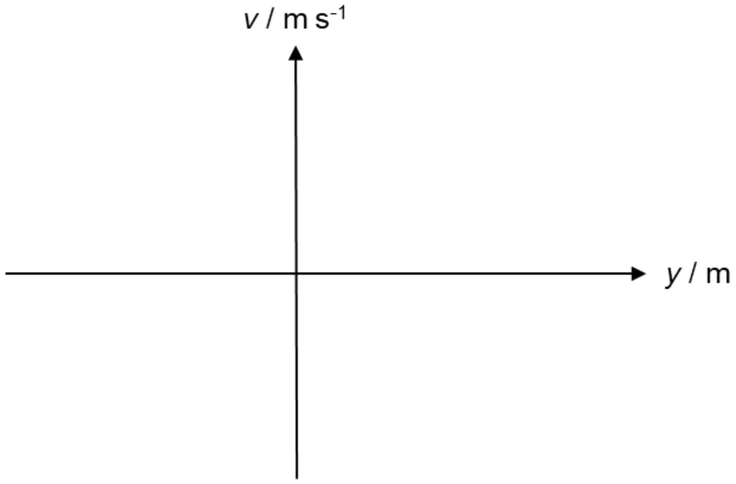

Fig. 3.3 [3]

(iv) Sketch two graphs on Fig. 3.4 to show the variation of kinetic energy (KE) and elastic potential energy (EPE) of the oscillating system as the block moves between the equilibrium position and the lowest position. Label each graph clearly.

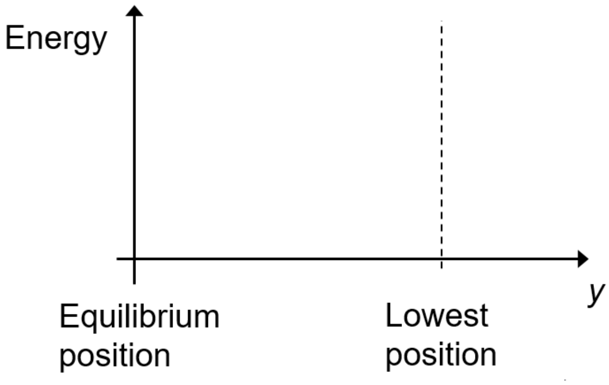

Fig. 3.4 [2]

[Total: 9]