2 A rigid uniform beam of weight W is connected to a fixed support by a hinge, as shown in Fig. 2.1.

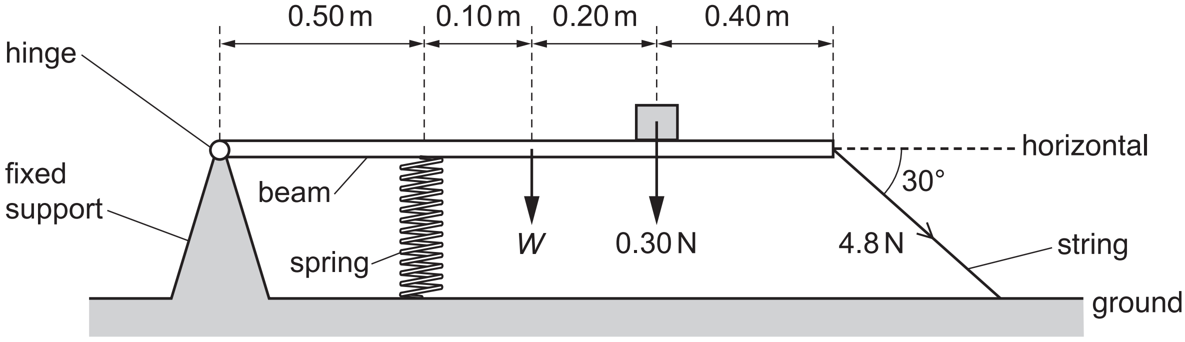

Fig. 2.1 (not to scale)

A compressed spring exerts a total force of 8.2 N vertically upwards on the horizontal beam. A block of weight 0.30 N rests on the beam. The right-hand end of the beam is connected to the ground by a string at an angle of 30° to the horizontal. The tension in the string is 4.8 N. The distances along the beam are shown in Fig. 2.1.

The beam is in equilibrium. Assume that the hinge is frictionless.

(a) **(i)** Show that the vertical component of the tension in the string is 2.4 N.

[1]

(ii) By taking moments about the hinge, determine the weight W of the beam.

W = ... N [3]

(iii) Calculate the horizontal component of the force exerted on the beam by the hinge.

force = ... N [1]

(b) The spring obeys Hooke's law and has an elastic potential energy of 0.32 J.

Calculate the compression of the spring.

compression = ... m [2]

(c) The string is cut so that the spring extends upwards. This causes the beam to rotate and launch the block into the air. The block reaches its maximum height and then falls back to the ground.

Fig. 2.2 shows part of the path of the block in the air shortly before it hits the horizontal ground.

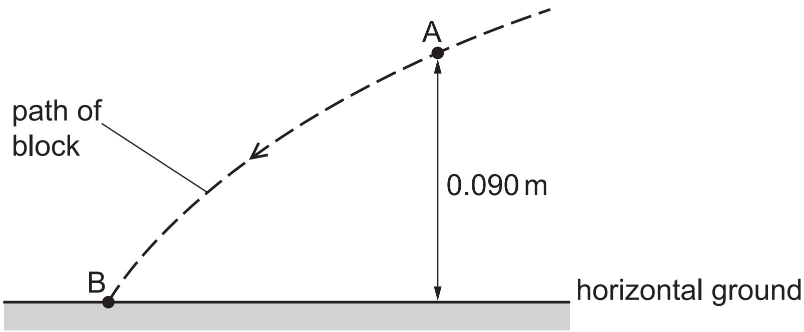

Fig. 2.2 (not to scale)

The block is at a height of 0.090 m above the ground when it passes through point A. The block has a kinetic energy of 0.044 J when it hits the ground at point B.
Air resistance is negligible.

(i) Calculate the decrease in the gravitational potential energy of the block for its movement from A to B.

decrease in gravitational potential energy = ... J [2]

(ii) Use your answer in **(c)(i)** and conservation of energy to determine the speed of the block at point A.

speed = ... $m s^{-1}$ [3]

(iii) By reference to the force on the block, explain why the horizontal component of the velocity of the block remains constant as it moves from A to B.

....

.... [1]

(iv) The block passes through point A at time t_A and arrives at point B at time t_B.

On Fig. 2.3, sketch a graph to show the variation of the magnitude of the vertical component v_Y of the velocity of the block with time t from $t = t_A$ to $t = t_B$.
Numerical values of v_Y are not required.

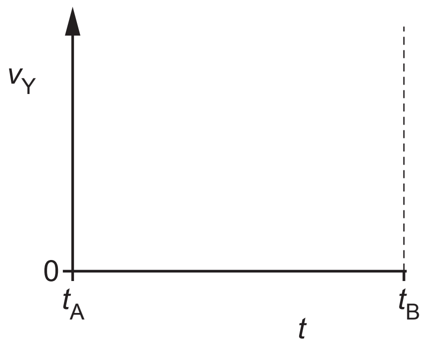

Fig. 2.3

[1]

[Total: 14]