8 **(a)** State the conditions required for a body to be in equilibrium.

……

……

…… [2]

(b) A pendulum bob of mass *m* is held in static equilibrium by a light inelastic string and a horizontal spring with an extension of 5.0 cm. The string makes an angle of 36° with the vertical as shown in Fig. 8.1.

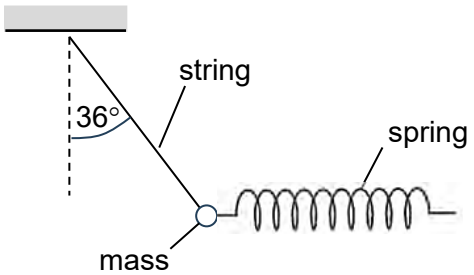

Fig. 8.1

(i) The tension *T* in the string is measured to be 2.5 N.

Calculate the force constant *k* of the spring.

force constant *k* = …… N m^{-1} [2]

(ii) Determine the mass m of the bob.

mass m = …….. kg [2]

(iii) Calculate the elastic potential energy stored in the spring.

elastic potential energy = …….. J [2]

(c) The spring is detached from the pendulum bob.

The bob is then slightly displaced to an angular displacement θ of 10.0° and released to undergo simple harmonic motion as shown in Fig. 8.2. The inelastic string is 15.0 cm in length.

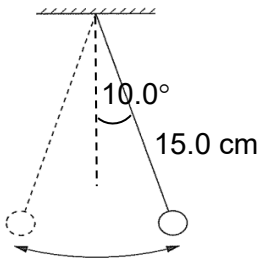

Fig. 8.2

(i) Define simple harmonic motion.

……

……

…… [2]

(ii) Assuming air resistance is negligible, when the bob is at the bottom of its swing,

1. show that the speed of the bob is 0.21 m s^{-1},

[2]

2. compare the tension T in the string with the weight W of the bob. Explain your reasoning qualitatively.

……

……

…… [1]

3. Hence or otherwise, calculate the tension in the string at the bottom of its swing.

tension = …….. N [2]

(d) Assuming **air resistance is not negligible.**

(i) Sketch in Fig. 8.3, the variation with displacement x of the velocity v of the bob for 1 period of oscillation.

Label the axes with appropriate values.

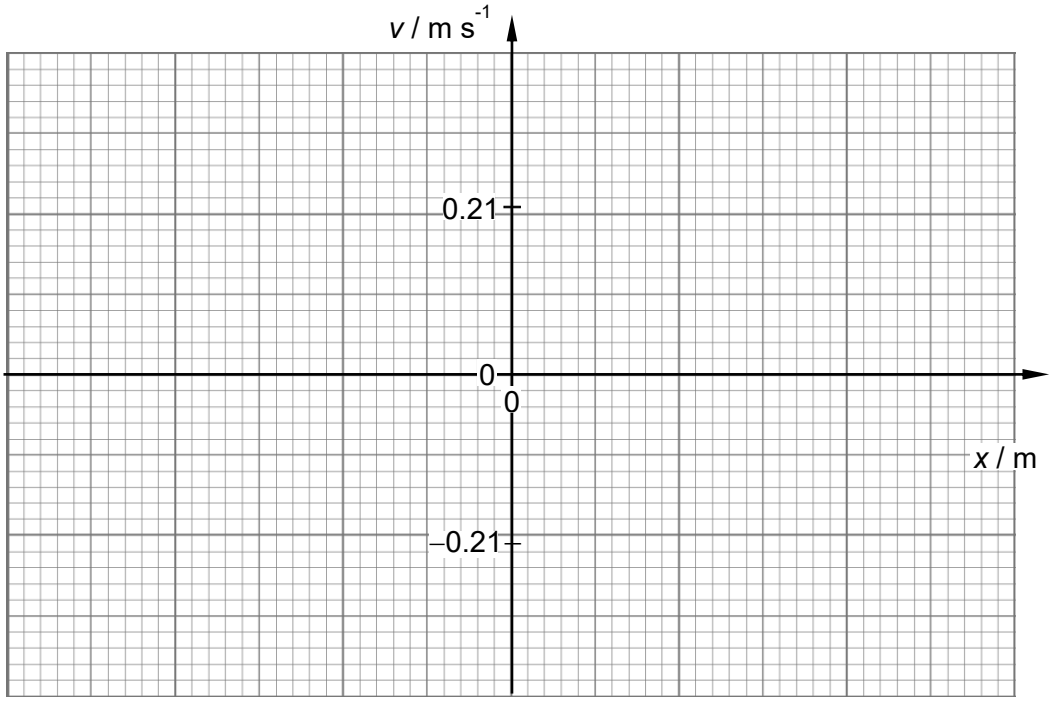

Fig. 8.3

[2]

(ii) Sketch in Fig. 8.4, the variation with time *t* of

1. the potential energy (label the graph *U*) and
2. the kinetic energy (label the graph *K*) of the pendulum bob for 1 period of oscillation.

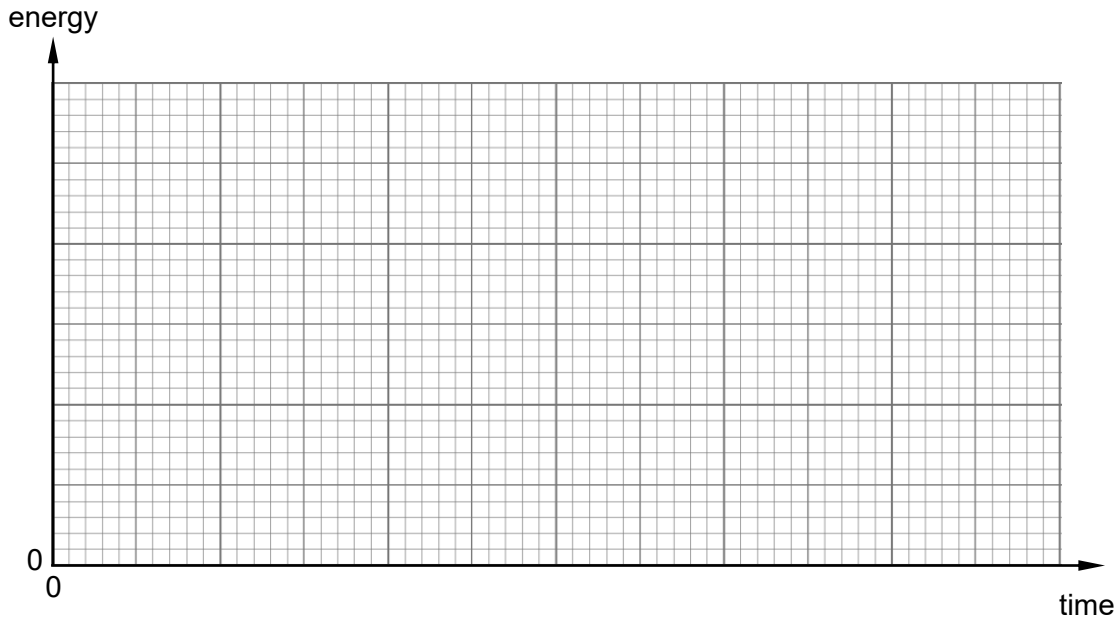

Fig. 8.4

[3]

[Total: 20 marks]