1. (a)(i) Figure 1.1 shows how the velocity $v/(\mathrm{ms}^{-1})$ varies with the displacement x/m for a particle undergoing simple harmonic motion.

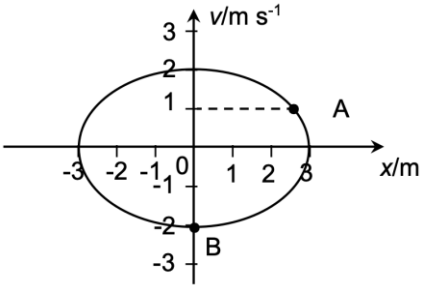

Figure 1.1

Determine the period of the motion. [2 marks]

(a)(ii) Calculate the time taken for the particle to move from the state represented by the point A to the state represented by the point B. [2 marks]

(b)(i) By using the expression $v = \pm\omega\sqrt{x_0^2 - x^2}$, show that the potential energy E of a particle of mass m undergoing simple harmonic motion of angular frequency ω is given by $E = \frac{1}{2}m\omega^2x^2$. [3 marks]

(b)(ii) Figure 1.2 shows a pendulum bob of mass m suspended from a string of length L.

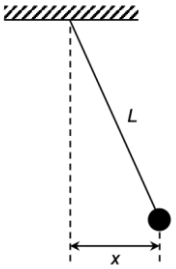

Figure 1.2

Show that the potential energy E of the pendulum is given by (with respect to the equilibrium position, $E = mgL - mg\sqrt{L^2 - x^2}$. [1 mark]

(b)(iii) By combining the results of **(b)(i)** and **(b)(ii)**, show that the period of a pendulum of length L is $2\pi\sqrt{\frac{L}{g}}$ for small-angle oscillations. [2 marks]