4 A ball of mass m is attached to one end of a light inextensible string of length L. The other end of the string is attached to a fixed point O.

(a) The ball is swung around in a vertical circle, as shown in Fig. 4.1. The speeds of the ball at the top and bottom of the vertical circle are v_T and v_B respectively.

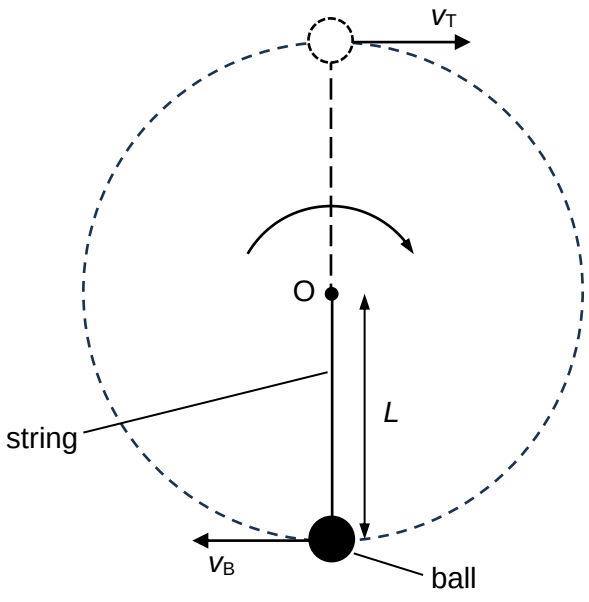

Fig. 4.1

(i) Show that for the ball to just complete the vertical circle, $v_T = \sqrt{gL}$.
Explain your working.

[2]

(ii) Explain why the ratio $\frac{v_B}{v_T}$ must be greater than 1 for the ball to complete the vertical circle.

.....

.....

..... [1]

(iii) A student wishes to swing the ball in a vertical circle such that $\frac{V_B}{V_T} = 3$.

With appropriate calculations, state and explain if this ratio is achievable.

.....

.....

..... [3]

(b) The ball is now swung in a horizontal circle around the fixed point O, as shown in Fig. 4.2.

When the ball is swinging around with angular velocity ω, the string is at an angle θ from the vertical and the tension in the string is *T*.

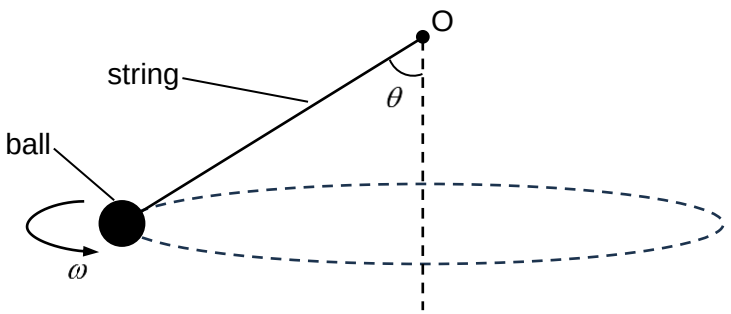

Fig. 4.2

Determine the tension in the string, in terms of *T*, when the angular velocity of the ball is doubled.

tension = ... [2]

[Total: 8]