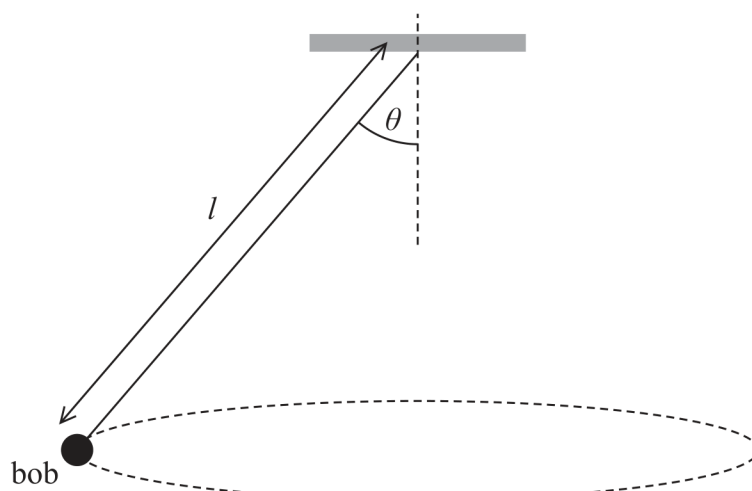12 18th century clocks sometimes used a conical pendulum to measure regular periods of time. A conical pendulum consists of a bob of mass m fixed to the end of a wire of length l as shown. The bob is set to follow a circular path in the horizontal plane. The wire makes an angle θ with the vertical.

(a) Add to the diagram to show the two forces acting on the bob.

(2)

(b) (i) Derive the following equation for the angular velocity ω of the bob.

$$\omega = \sqrt{\frac{g}{l \cos\theta}}$$

(4)

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(ii) A clock requires the period of the bob to be 5.0 s.

$l = 6.4$ m
$\theta = 13.9°$

Deduce whether this arrangement leads to the required period.

(3)

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(Total for Question 12 = 9 marks)