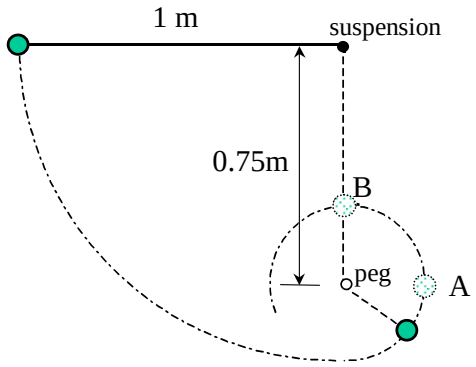
1. (2000-1 SFCC F.6 1st Exam I)

A mass attached to a string of length 1.0 m is released from the horizontal position, as shown in the figure. A distance 0.75 m directly below the suspension is a peg so that once the string swings beyond the vertical position, the mass of 0.25 kg follows a circular path of radius 0.25 m.



(a) (i) Determine the speed of the mass when it passes through point A so that the end portion of the string becomes horizontal. (Hint : consider mechanical energy conservation.)

(ii) Hence determine the horizontal acceleration of the mass at A and the tension in string at that moment.

(6 marks)

(b) (i) and (ii) Repeat part (a) for point B being directly above the peg. (6 marks)

2. (2000-1 SFCC F.6 Final Exam I)

A bobsleigh rises up the side of an ice track when it follows a horizontal circular path at speed. Figure 1 shows a cross-section of the ice track (the bobsleigh is moving out of paper instantaneously in figure 1) and figure 2 is a free body diagram showing the forces which act on the bobsleigh at the same instant.

Figure 1

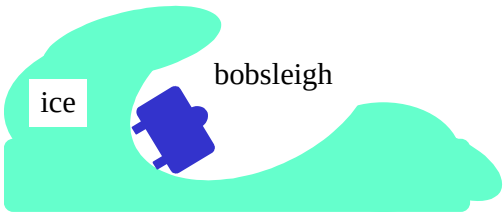
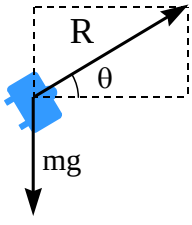


Figure 2



(a) Explain why the kinetic energy of the bobsleigh is conserved but not its linear momentum.

(3 marks)

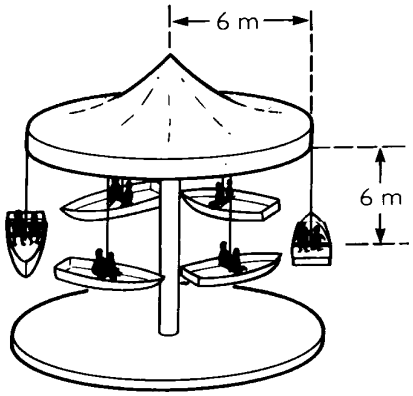
(b) What effect does the horizontal component of the push, R, of the ice track on the bobsleigh have on the motion of the bobsleigh? (2 marks)

(c) Calculate the value of tan θ for a speed of 25 m s^{-1} if the radius of the circular path the bobsleigh follows is 20 m.

(3 marks)

3. (2000-1 SFCC F.6 Final Exam I)

One ride in a fairground consists of `boats' hanging on lengths of wire 6 m long, on a rim of radius 6 m. The rim revolves round its centre, and the `boats' fly outwards. See figures (a) and (b).



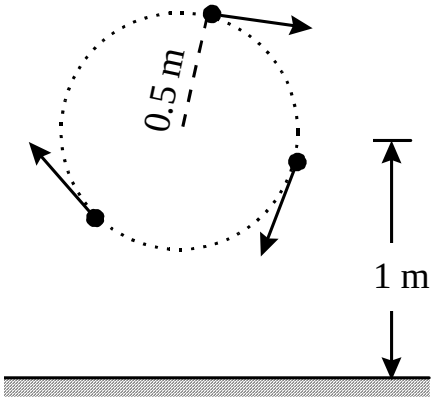
At its fastest rate of rotation, the wires are at angles of 50° to the vertical. Calculate

(a) the acceleration of the boats, (2 marks)

(b) the rate of rotation of the rim in rad s^{-1}, (2 marks)

(c) the factor by which the tension in the cables has been increased, compared to when the ride was stationary. (2 marks)

4. (1995-6 SFCC F.7 Mock Exam I)



A stone of mass 0.5 kg is attached to a string of length 0.5 m which will break if the tension in it exceeds 20 N. The stone is whirled in a vertical circle, the axis of rotation being at a height of 1 m above the ground. The angular speed is very slowly increased until the string breaks.

(a) In what position is this break most likely to occur, and at what angular speed?

(4 marks)

(b) What is the direction and magnitude of the velocity of the stone when the string just breaks?

(3 marks)

(c) Where will the stone hit the ground?

(3 marks)