2 In the circus, there is an act called the Wheel of Steel. The apparatus consists of two rigid steel circular cages welded to a long steel truss. Two acrobats perform on this apparatus while it is rotating about its centre. The circular cages are 2.0 m in diameter and the truss is 4.0 m long. The acrobats are both 1.8 m tall and have a mass of 80 kg each. We assume that the centre of mass of each of the the acrobats is 0.90 m from the bottom of their feet.

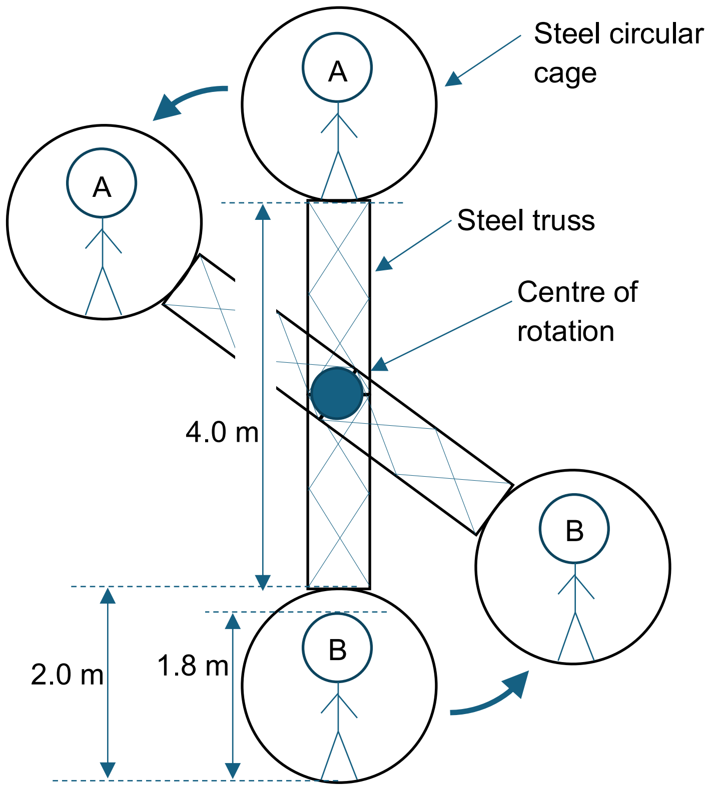

Fig. 2.1

(a) In the preparation phase, both acrobats A and B stay within the wheel, while the apparatus rotates at an increasing rate. At one point in the performance, the apparatus rotates with an angular velocity of 1.29 rad s^{-1} when acrobat B is at the bottom position. Calculate the tangential velocity of B at this instant.

Tangential velocity of B = ………………….. m s^{-1} [2]

(b)

(i) In the first trick, the apparatus rotates fast enough until the acrobat A just loses contact with the floor of the cage and seems to be momentarily “weightless” with respect to the cage. (see Fig. 2.2)

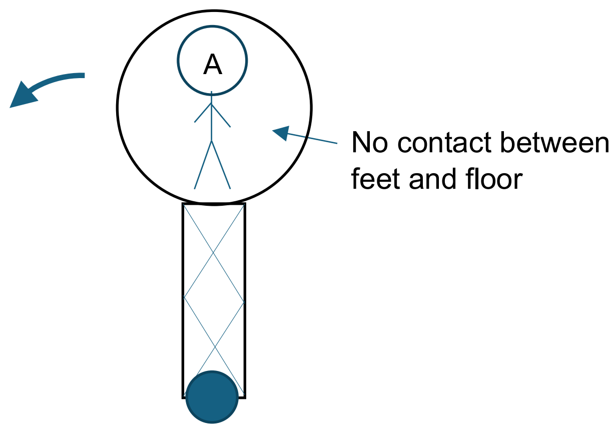

Fig. 2.2

Calculate the velocity of acrobat A when this happens.

Velocity of A = ………………………….. m s^{-1} [3]

(ii) Calculate the velocity of acrobat B when acrobat A just loses contact with the cage.

Velocity of B = ………………………….. m s^{-1} [1]

(c) In the second trick, the apparatus is spun so fast that acrobat A can stand upside down and be in contact with the top part of the cage. (see Fig. 2.3)

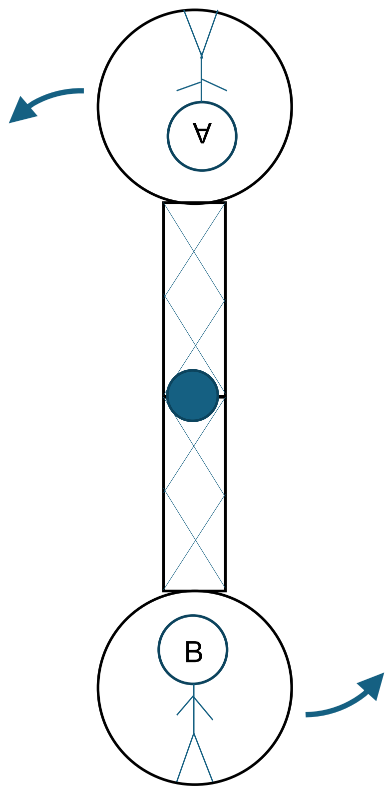

Fig. 2.3

Calculate the minimum velocity of acrobat A to accomplish this.

Minimum velocity required = …………………….. m s^{-1} [2]

(d) Fig. 2.4 shows the apparatus in a horizontal position during its rotation. The apparatus is rotating at a constant angular velocity.

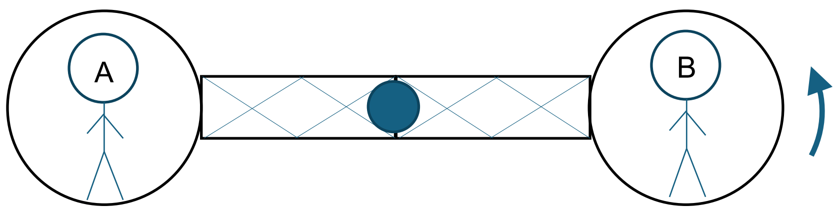

Fig. 2.4

In the space below, sketch and label the forces acting on acrobat A.

[2]

[Total: 10]