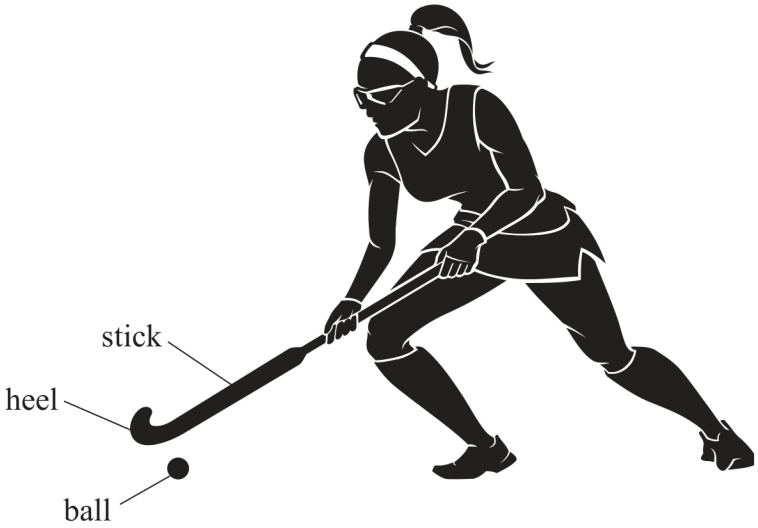
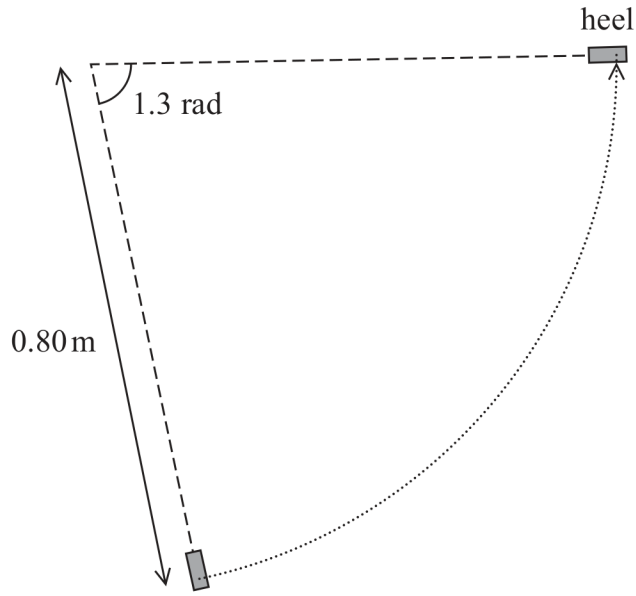
16 Hockey is a sport played with a stick and a ball. The player tries to hit the ball with part of the stick called the 'heel', as shown.



(Source: © Studio77 FX vector/Shutterstock)

(a) The player swings her stick so that the heel moves horizontally in a circle of radius 0.80 m across the ground, as shown below.



Plan view

Not to scale

It takes a time of 0.22 s for the heel to move through an angle of 1.3 radians.

Calculate the speed of the heel.

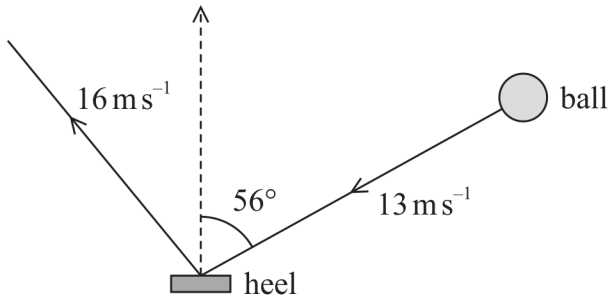
(3)

Speed of heel = ...

(b) A ball has a speed of $13\,m\,s^{-1}$. The heel has a momentum p_{heel} of $3.0\,N\,s$, in the direction of the dashed line, as shown.

The heel collides with the ball and stops.

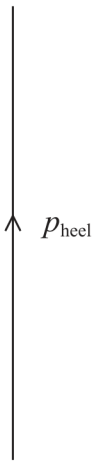
The speed of the ball after being hit by the heel is $16\,m\,s^{-1}$.



(i) Deduce whether momentum is conserved for this collision by completing the vector diagram below. A scaled line representing p_{heel} is shown.

mass of ball = 160 g

(5)



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(ii) Deduce whether the collision is elastic.

speed of heel before collision = $5.0\,m\,s^{-1}$

(4)

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(Total for Question 16 = 12 marks)