

## STEP II, 2008, Q9

9 In this question, use  $g = 10 \text{ m s}^{-2}$ .

In cricket, a fast bowler projects a ball at  $40 \text{ m s}^{-1}$  from a point  $h$  m above the ground, which is horizontal, and at an angle  $\alpha$  above the horizontal. The trajectory is such that the ball will strike the stumps at ground level a horizontal distance of 20 m from the point of projection.

(i) Determine, in terms of  $h$ , the two possible values of  $\tan \alpha$ .

Explain which of these two values is the more appropriate one, and deduce that the ball hits the stumps after approximately half a second.

(ii) State the range of values of  $h$  for which the bowler projects the ball below the horizontal.

(iii) In the case  $h = 2.5$ , give an approximate value in degrees, correct to two significant figures, for  $\alpha$ . You need not justify the accuracy of your approximation.

[You may use the small-angle approximations  $\cos \theta \approx 1$  and  $\sin \theta \approx \theta$ .]



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