Total marks — 130

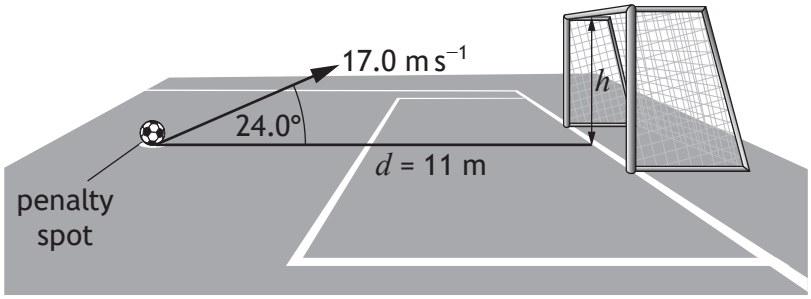
Attempt ALL questions

1. The crossbar challenge is a football contest in which competitors try and hit the crossbar of a goal by kicking a football from the penalty spot.

The horizontal distance between the penalty spot and the crossbar is 11 m.

One competitor kicks a football with an initial velocity of 17.0 m s^{-1} at an angle of 24.0° to the horizontal.

not to scale



The football hits the crossbar.

The effects of air resistance can be ignored.

(a) (i) Calculate:

(A) the horizontal component of the initial velocity of the football **1**

Space for working and answer

(B) the vertical component of the initial velocity of the football. **1**

Space for working and answer

1. (a) (continued)

(ii) Show that the time taken for the football to travel from the penalty spot to the crossbar is 0.71 s. **2**

Space for working and answer

(iii) The football is at the maximum height in its trajectory when it hits the crossbar.

Calculate the height h above the ground at which the football hits the crossbar. **3**

Space for working and answer

(b) The next time the competitor tries the challenge, they kick the football at the same angle with an initial speed less than 17.0 m s^{-1}.

State whether the football hits the crossbar, passes over the crossbar, or passes under the crossbar.

Justify your answer. **2**