14 A firework is launched into the air and explodes once it reaches a maximum height.

(a) The firework is designed to explode at a maximum height of 350 m.

(i) Show that the vertical component of the velocity at launch is about 80 m s^{-1}.

(2)

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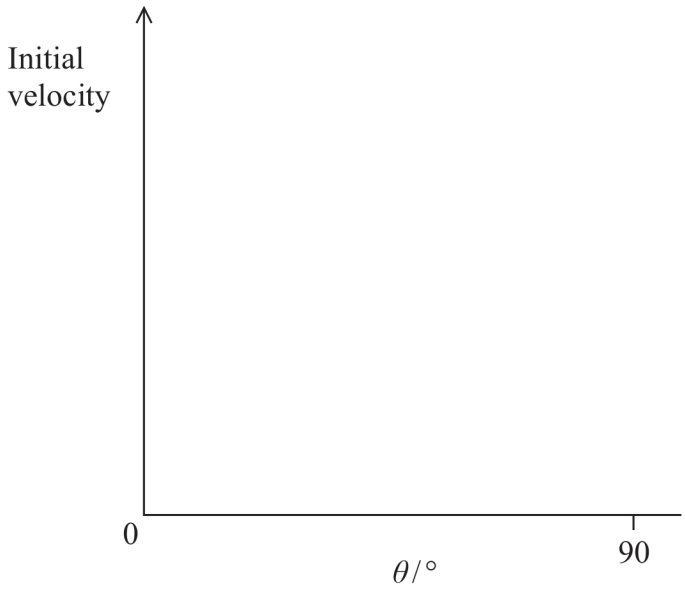
(ii) The vertical component of the velocity at launch depends on both the initial velocity of the firework and θ, the angle between the initial velocity and the horizontal.

Sketch a graph showing how the initial velocity required for the firework to reach the maximum height of 350 m varies with θ for the firework.

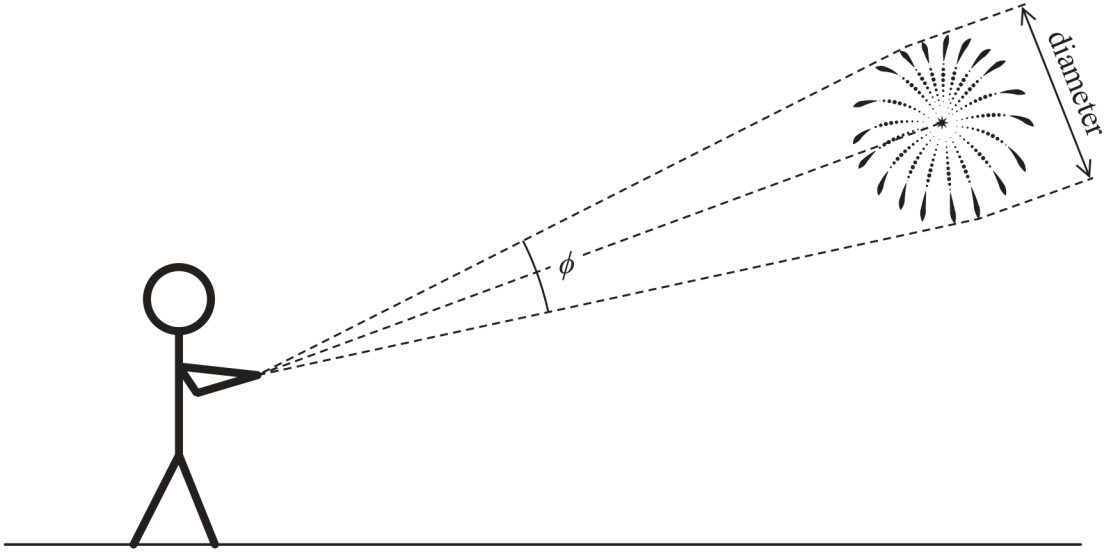
(4)



(b) A student wanted to estimate the maximum diameter of the firework after exploding.

The student estimated:

- the time taken between seeing the firework explode and hearing the firework explode
- the angle ϕ from the top to the bottom of the firework



Describe how the student could determine the maximum diameter of the exploded firework using the estimated data.

(2)

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(Total for Question 14 = 8 marks)