Total marks — 130

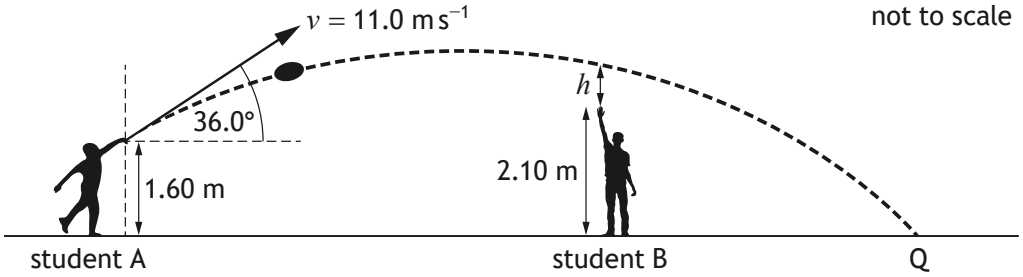
Attempt ALL questions

1. A Doppler ball consists of a loudspeaker and a battery-powered circuit board inside a foam ball.

Two students are throwing the ball to each other.

Student A throws the ball with a velocity of 11.0 m s^{-1} at an angle of 36.0° to the horizontal. The ball is released at a height of 1.60 m above the ground. The ball passes over the head of student B and lands on the ground at point Q.

The effects of air resistance can be ignored.



(a) (i) Calculate:

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

Space for working and answer

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

Space for working and answer

1. (a) (continued)

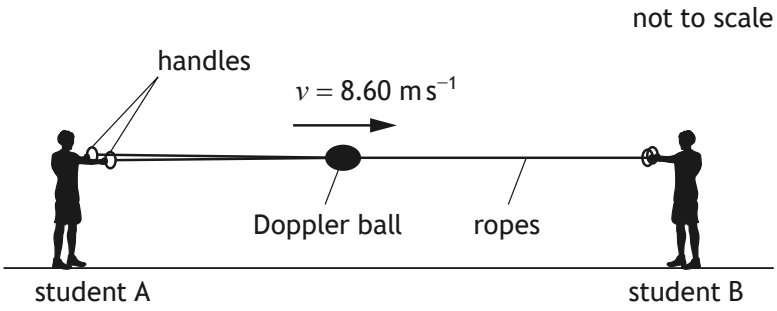
(ii) The ball takes 1.53 s to travel from student A to point Q.
Calculate the horizontal distance travelled by the ball. **3**
Space for working and answer

(iii) The ball was directly above student B 0.95 s after it was released.
Student B has a maximum reach of 2.10 m.
Determine the height h between student B and the ball. **4**
Space for working and answer

[Turn over

1. (continued)

(b) The Doppler ball is now threaded onto two ropes. There are handles at either end of the ropes.



The circuit in the Doppler ball is switched on. The loudspeaker produces a sound of frequency 622 Hz.

Student A pulls the ropes apart and the Doppler ball travels along the ropes towards student B.

The ball travels horizontally along the ropes at a constant velocity of $8.60\ \text{m s}^{-1}$.

(i) Calculate the frequency of the sound heard by student B as the Doppler ball approaches them. **3**

Space for working and answer

1. (b) (continued)

(ii) The foam Doppler ball collides with the handles at the end of the ropes held by student B and comes to rest.

Explain how the foam ball protects the circuit board during the collision. **2**

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