

STEP II, 2020, Q9

- 9 Point A is a distance h above ground level and point N is directly below A at ground level. Point B is also at ground level, a distance d horizontally from N . The angle of elevation of A from B is β . A particle is projected horizontally from A , with initial speed V . A second particle is projected from B with speed U at an acute angle θ above the horizontal. The horizontal components of the velocities of the two particles are in opposite directions. The two particles are projected simultaneously, in the vertical plane through A , N and B .

Given that the two particles collide, show that

$$d \sin \theta - h \cos \theta = \frac{Vh}{U}$$

and also that

(i) $\theta > \beta$;

(ii) $U \sin \theta \geq \sqrt{\frac{gh}{2}}$;

(iii) $\frac{U}{V} > \sin \beta$.

Show that the particles collide at a height greater than $\frac{1}{2}h$ if and only if the particle projected from B is moving upwards at the time of collision.



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