

Answer on Question # 76089, Physics -Mechanics- Relativity:

Question: A body is projected with a velocity U at an angle α with horizontal. The velocity of the body will become perpendicular to the velocity of the projector after a time T which is given by?

Solution: A body is projected with initial velocity U by making angle α with the horizontal. Then after time T (consider at point P) it's direction is perpendicular to U .

Magnitude of velocity at this point (P) is given by $v = U \cot \alpha$

Vertical component of initial velocity $v_i = U \sin \alpha$

Final velocity at point P is (v_f) = $-v \cos \alpha = -U \cot \alpha \cos \alpha$

Time of flight up to point P is T .

Now we know, $v_f = v_i - gT$ (considering vertical motion)

$$\text{Or, } -U \cot \alpha \cos \alpha = U \sin \alpha - gT \quad [\text{Plug } v_f \text{ and } v_i \text{ value}]$$

$$\text{Or, } T = \frac{U \sin \alpha + U \cot \alpha \cos \alpha}{g} = \frac{U \operatorname{cosec} \alpha}{g}$$

Answer: $T = \frac{U \operatorname{cosec} \alpha}{g}$

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