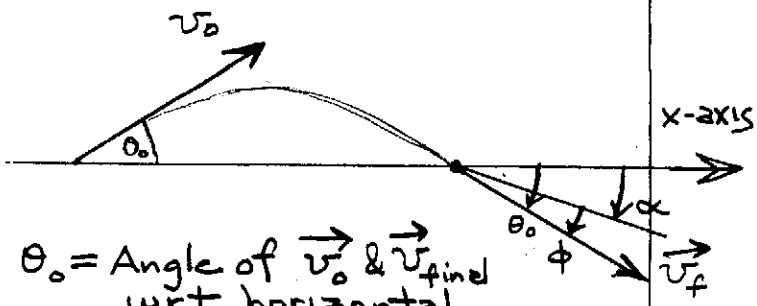
STAEDTLER® No. 937 811E Engineer's Computation Pad

•••49 A skilled skier knows to jump upward before reaching a downward slope. Consider a jump in which the launch speed is $v_0 = 10$ m/s, the launch angle is $\theta_0 = 9.0°$, the initial course is approximately flat, and the steeper track has a slope of 11.3°. Figure 4-45*a* shows a *prejump* that allows the skier to land on the top portion of the steeper track. Figure 4-45*b* shows a jump at the edge of the steeper track. In Fig. 4-45*a*, the skier lands at approximately the launch level. (a) In the landing, what is the angle ϕ between the skier's path and the slope? In Fig. 4-45*b*, (b) how far below the launch level does the skier land and (c) what is ϕ? (The greater fall and greater ϕ can result in loss of control in the landing.)



FIG. 4-45 Problem 49.



θ_0 = Angle of $\vec{v}_0$ & $\vec{v}_{final}$ wrt horizontal

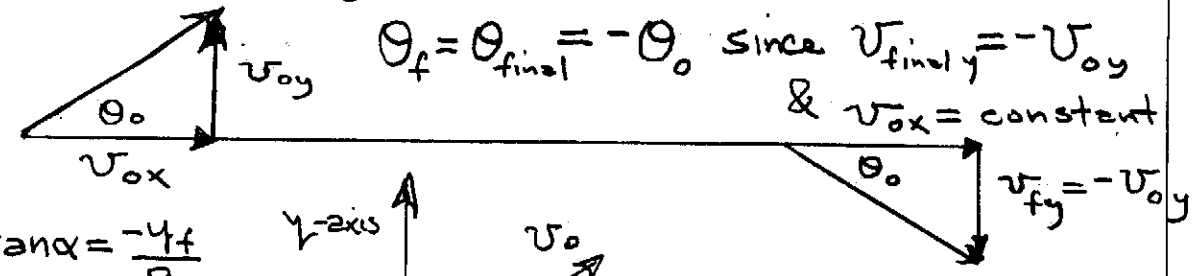
α = Angle of Slope wrt Horizontal

ϕ = Angle between Slope & $\vec{v}_{final}$

⇒ The Author of this Problem must have meant $\theta_0 = 11.3°$ & $\alpha = 9.0°$ since ...

a) ... $\theta_0 > \alpha$ must $\Rightarrow \phi = \theta_0 - \alpha = 11.3 - 9.0 = 2.3°$

Only under these conditions will the skier be able to land in the "top portion of the steeper track" If $\theta_0 < \alpha$, Then he would not "touch down" in the "top portion of the speeper track" because relative to the sloping ground his velocity would be inclined above above it by an amount $\phi = \theta_0 - \alpha$.



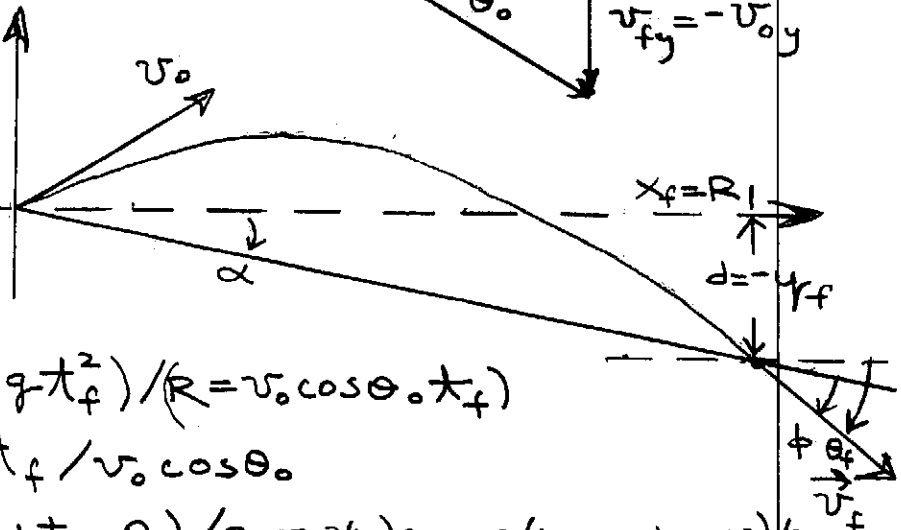
$\theta_f = \theta_{final} = -\theta_0$ since $v_{final\,y} = -v_{oy}$ & v_{ox} = constant

NOTE: $\tan\alpha = \frac{-y_f}{R}$

$-y_f = -\left(y_0 + v_{oy}t_f - \frac{1}{2}gt_f^2\right)$

$x_f = R = x_0 + v_{ox}t_f$

$\Rightarrow t_f = R/v_{ox} = R/v_0\cos\theta_0$



$\frac{-y_f}{x_f} = \tan\alpha = (-v_0\sin\theta_0 t_f + \frac{1}{2}gt_f^2)/(R = v_0\cos\theta_0 t_f)$

$\tan\alpha = -\tan\theta_0 + \frac{1}{2}gt_f/v_0\cos\theta_0$

$\Rightarrow t_f = 2v_0\cos\theta_0(\tan\alpha + \tan\theta_0)/g = 2(10)\cos 11.3(\tan 9 + \tan 11.3)/9.8$

$= 0.717$ sec

$v_{yf} = v_{oy} - gt_f = v_0\sin\theta_0 - 9.8(0.717) = 10\sin 11.3 - 9.8(0.717) = -5.07$ m/s

$v_{xf} = v_{x0} = v_0\cos\theta_0 \Rightarrow \tan\theta_f = \frac{|v_{fy}|}{|v_{fx}|} = \frac{|-5.071|}{9.81} = 0.517$

$= 10\cos 11.3 = 9.81$

$\Rightarrow \theta_f = 27.3°$

c) $\Rightarrow \phi = \theta_f - \alpha = 27.3 - 9.0 = 18.3° \Rightarrow$ WHAM

b) $|y_f| = R\tan\alpha = v_0\cos\theta_0 t_f \tan\alpha = 10\cos 11.3(0.717)\tan 9 = 1.1$ m