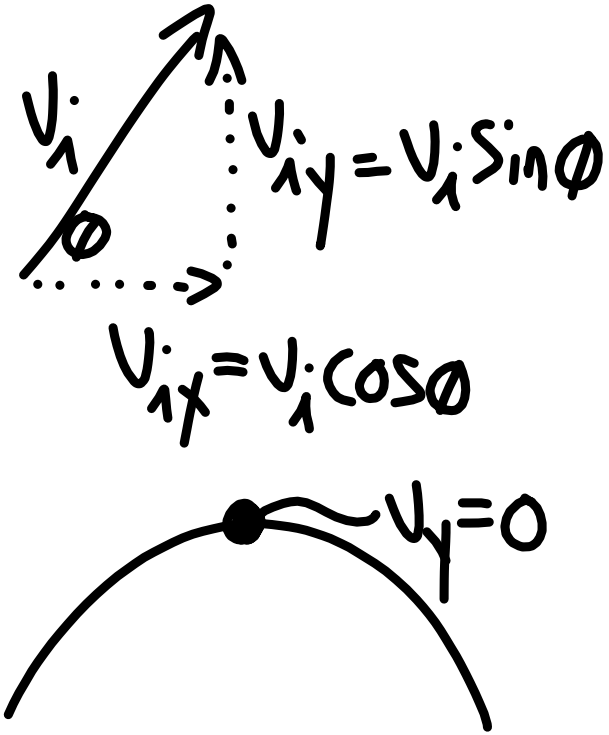


y-direction

$$v_f = v_i + at$$

$$0 = v_i \sin\phi + at$$

$$+v_i \sin\phi = gt \quad (1)$$

X-direction

$$d = v_i t + \frac{1}{2} a t^2$$ (the $\frac{1}{2}at^2$ term is crossed out and labeled 0)

$$d_x = v_i t$$

$$d_x = v_i \cos\theta t$$ (2)

$$\frac{d_x}{v_i \cos\theta} = t$$

$$\frac{V_1 \sin\phi}{V_1 \cos\phi} = \frac{g d_x}{V_1 \cos\phi}$$

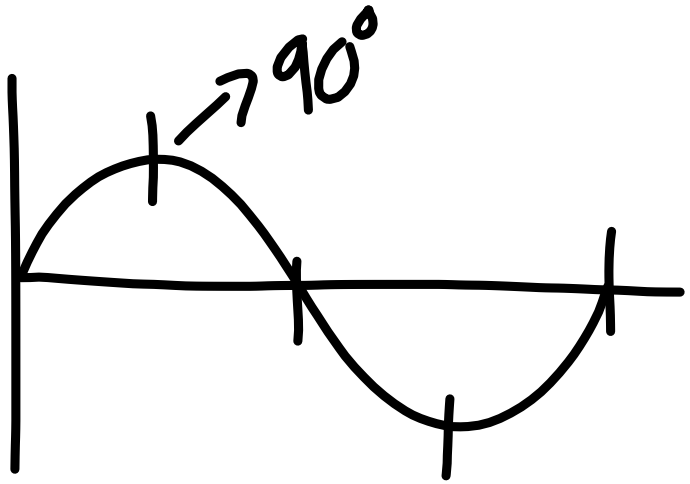
$$V_1 \sin\phi \, V_1 \cos\phi = g d_x$$

$$\frac{V_1^2 \sin\phi \cos\phi}{g} = d_x$$

$$\frac{V_1^2 2 \sin\phi \cos\phi}{g} = d_x$$

$2 \times 45^\circ = 90^\circ$ (max)

$$\frac{V_1^2 \sin 2\phi}{g} = d_x$$


90°