Projectile Motion "SIN" Problems

85-5.

Δt (G)	Δy (N)
1	30
2	80
3	?

$\downarrow v_1$ $\downarrow a$ $\downarrow +y$

in general $\Delta y = v_1 \Delta t + \frac{1}{2} a \Delta t^2$

$\Delta t = 1G \rightarrow$ $30N = v_1 \cdot (1G) + \frac{a}{2}(1G)^2 \rightarrow 30 = v_1 + \frac{a}{2}$ — (1)

$\Delta t = 2G \rightarrow$ $80N = v_1(2G) + \frac{a}{2}(2G)^2 \rightarrow 80 = 2v_1 + 2a$ — (2)

Solve for a: [(2) − 2×(1)]:

$$80 = 2v_1 + 2a$$
$$-[60 = 2v_1 + a]$$
$$20 = a$$
$$\therefore a = 20 \frac{N}{G^2}$$

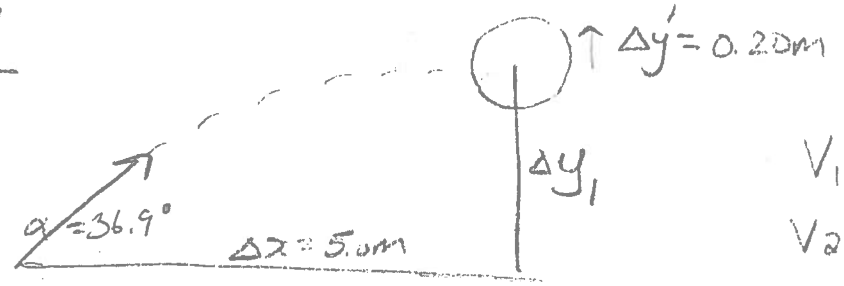
Solve for v_1 From Eq (1):

$$v_1 = 30 - \frac{a}{2}$$
$$v_1 = 30 - \frac{20}{2} = 20 \frac{N}{G}$$

Δy_{Total} at $\Delta t = 3G$?

$$\Delta y = v_1 \Delta t_3 + \frac{1}{2} a \Delta t_3^2$$
$$= (20 \tfrac{N}{G})(3G) + \tfrac{1}{2}(20 \tfrac{N}{G^2})(3G)^2$$
$$= 60N + 90N$$
$$= 150 N$$

91-11



$V_1 = 9.0\,m/s$

$V_2 = ?$

Solve for time of flight:

$$\Delta t = \frac{\Delta x}{V_{1x}} = \frac{5.0\,m}{9.0\,m/s \cdot \cos 36.9^\circ} = 0.6947\,s$$

Solve for original vertical displacement Δy_1:

$$\Delta y_1 = V_{1y}\Delta t - \frac{1}{2} g \Delta t^2$$

$$\Delta y_1 = (9.0\,m/s)(\sin 36.9^\circ)(0.6947\,s) - \frac{9.8\,m/s^2 (0.6947\,s)^2}{2}$$

$$= 1.3892\,m$$

Second vertical displacement $\Delta y_2 = \Delta y_1 + 0.20m = 1.59m$

Second time of flight $\Delta t_2 = \frac{\Delta x}{V_2 \cos\theta} = \frac{5.0\,m}{V_2 \cdot \cos 36.9^\circ}$

Solve for V_2:

$$\Delta y_2 = V_{2y}\Delta t - \frac{1}{2} g \Delta t^2$$

$$1.59m = \cancel{V_2} \sin 36.9^\circ \left(\frac{5.0\,m}{\cancel{V_2} \cos 36.9^\circ}\right) - \frac{9.8\,m/s^2}{2}\left(\frac{5.0\,m}{V_2 \cos 36.9^\circ}\right)^2$$

$$1.59m = 3.754m - \frac{191.557\,m^3/s^2}{V_2^2}$$

$$-2.164m = -\frac{191.557\,m^3/s^2}{V^2}$$

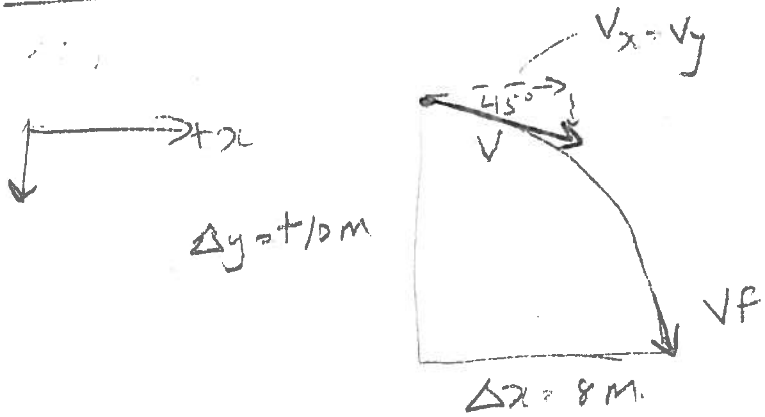
$$V_2 = 9.409\,m/s$$

$$\%\ \text{increase} = \frac{V_2 - V_1}{V_1} \times 100\%$$

$$= \frac{9.409 - 9.0}{9.0} \times 100\%$$

$$= 4.5\,\%$$

94-21



* by symmetry final Velocity is the same as initial velocity

$$\Delta y = v_y \Delta t + \frac{1}{2} g \Delta t^2 \quad \text{— (1)}$$

$$\Delta x = V_x \Delta t \quad \text{— (2)}$$

but $V_x = V_y$ at that point

$$\therefore \Delta t = \frac{\Delta x}{V_x} = \frac{\Delta x}{V_y} \longrightarrow (2b)$$

Substitute (2b) into (1) to solve for Δt:

$$\Delta y = V_y \Delta t + \frac{1}{2} g \Delta t^2$$

$$\Delta y = \cancel{V_y} \cdot \frac{\Delta x}{\cancel{V_y}} + \frac{1}{2} g \Delta t^2$$

$$10m = 8m + \frac{1}{2}(9.8\tfrac{m}{s^2})\Delta t^2$$

$$2m = 4.9\tfrac{m}{s^2} \cdot \Delta t^2$$

$$\Delta t = 0.639s$$

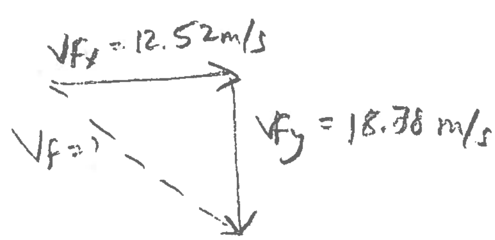
Solve for V_x + V_y:

$$V_x = \frac{\Delta x}{\Delta t} = \frac{8m}{0.639s} = 12.52\ m/s \qquad V_y = V_x = 12.52\ m/s$$

Solve for V_f:

$$V_{fy} = V_y + g\Delta t = 12.52\ m/s + (9.8\tfrac{m}{s^2})(0.639s) = 18.78\ m/s$$

$$V_{fx} = V_x = 12.52\ m/s$$



$$V_f = \sqrt{12.52^2 + 18.78^2} = 22.6\ m/s$$