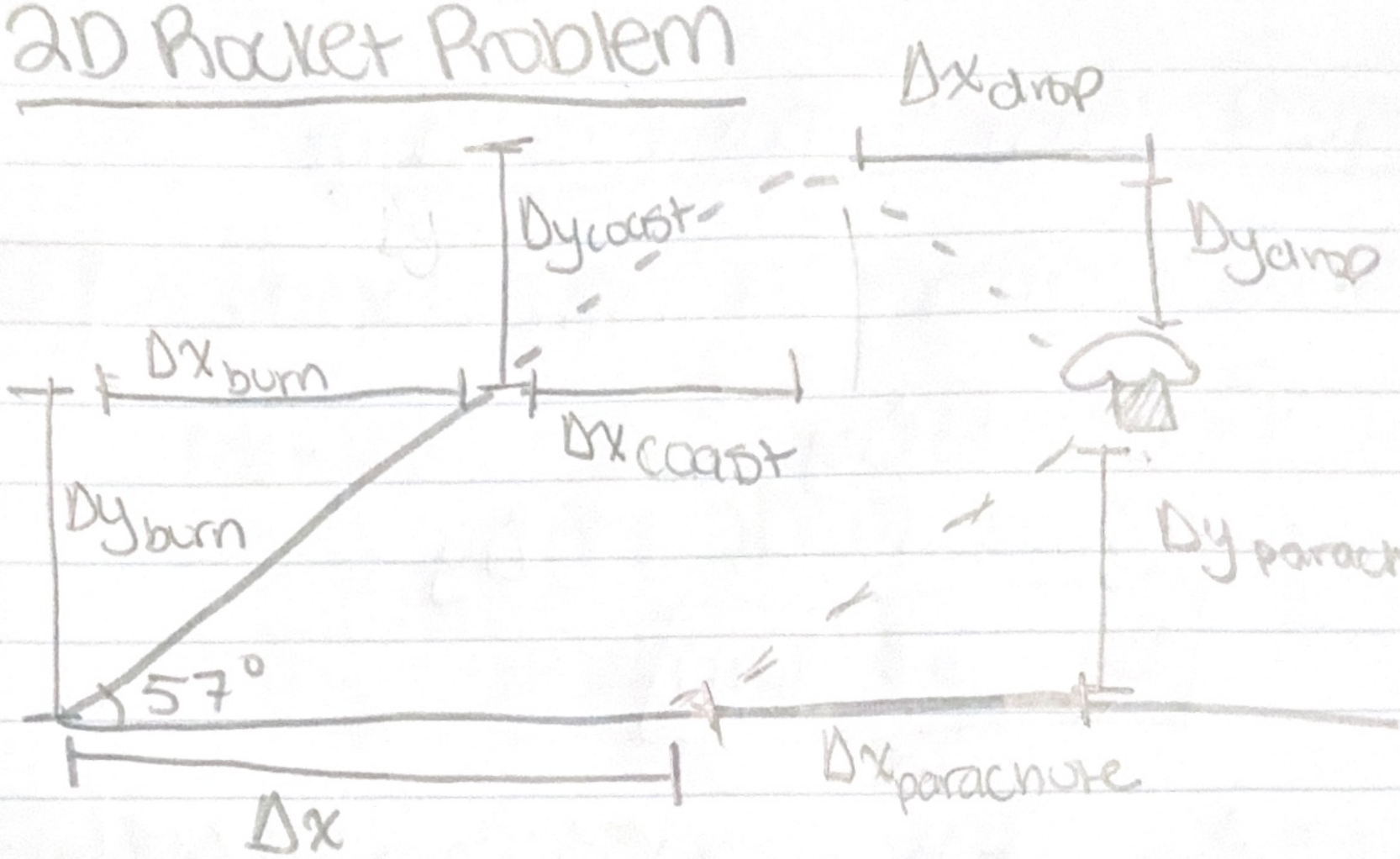
2D Rocket Problem



Stage 1: Engine Burn

① Distance traveled during burn

$$d = v_0 t + \frac{1}{2} a t^2 \leftarrow v_0 = 0$$
$$d = \frac{1}{2} a t^2$$
$$d = \frac{1}{2}(5.2)(8.4^2) = \boxed{183.46\text{m}}$$

② Break into horizontal and vertical

$$d_x = 183.46 \cos(57°) = \boxed{99.92\text{m}}$$
$$d_y = 183.46 \sin(57°) = \boxed{153.86\text{m}}$$

③ Velocity at the end of the burn

$$v = at \rightarrow v = (5.2)(8.4) = 43.68\text{m/s}$$
$$v_x = 43.68\text{m/s} \cos(57) = \boxed{23.79\text{m/s}}$$
$$v_y = 43.68 \sin(57) = \boxed{36.63\text{m/s}}$$

Stage 2: Coast to maximum Height

① max Height

$$V^2 = V_0^2 + 2a\Delta y$$

$$0 = (36.63)^2 + 2(-9.8)\Delta y$$

$$\boxed{\Delta y = 68.46\text{m}}$$

$$H_{max} = H_{engine} + H_{coast} = 153.86\text{m} + 68.46\text{m} =$$

$$\boxed{222.32\text{m}} \star$$

② Time in this stage

$$V = V_0 + at$$

$$0 = 36.63 + (-9.8)t$$

$$\boxed{t = 3.74\text{sec}} \star$$

③ Find horizontal Distance

$$V_x \cdot t = d_x$$

$$23.79 \cdot 3.74 = \boxed{88.97\text{m}} \star$$

Stage 3: Drop 70m down to parachute opening

① Find time in this stage

$$\Delta x = v_0 t - \frac{1}{2} a t^2$$

$$-70m = -\frac{1}{2}(9.8) t^2$$

$$\boxed{t = 3.78 sec} \star$$

② Horizontal Distance Traveled

$$V_x \cdot t = 23.8 \cdot 3.78 = \boxed{89.96m} \star$$

③ Height when Parachute opens

$$222.32m - 70m = \boxed{152.32m} \star$$

222.32m: max height

70m: height fallen

Stage 4: Parachute Descent

① Time in this stage

$$v = \frac{d}{t} \rightarrow t = \frac{d}{v} \rightarrow t = \frac{152.3m}{\underbrace{6m/s}_{\text{constant vertical speed!}}} = \boxed{25.38 sec} \star$$

② Horizontal Drift (west at 16m/s)

$$\underbrace{\frac{16}{1}}_{\text{Horizontal speed}} \times \underbrace{\frac{25.38}{1}}_{\text{time}} = \boxed{406.08m \text{ west}}$$

Final Position

East → 99.92m + 88.97m + 89.96m = 278.85m

Stage 1 Stage 2 Stage 3

West → 406.08m

→ Stage 4

Total Δx = 278.85m − 406.08m $\overset{*}{=}$ −127.23m

OR

127.23m west of the launch point.