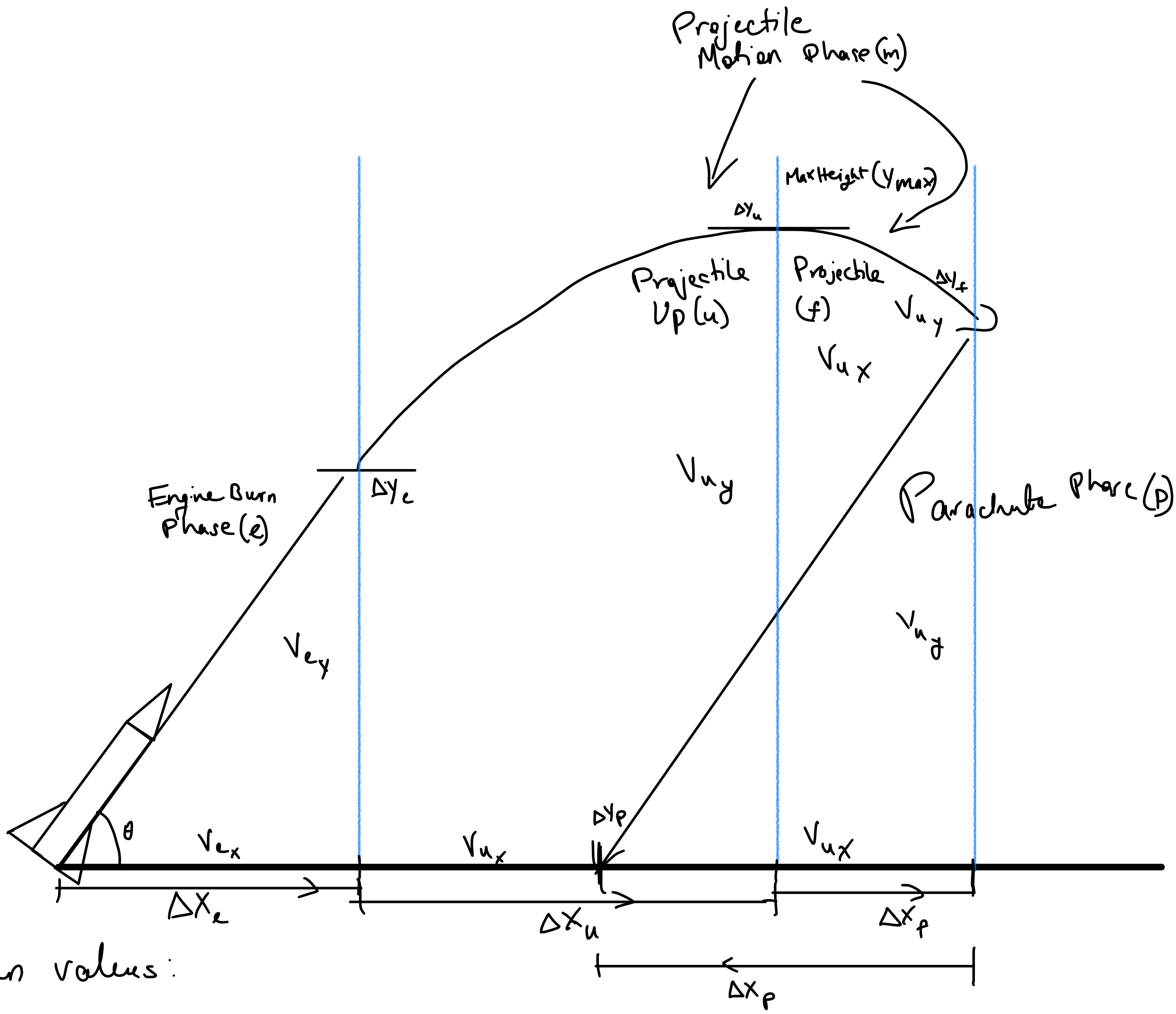
Diagram Rohan Gulati Section: B



Given values:

Launch angle $= \theta = 46°$

Engine Burn Time $= t_e = 7.0$ sec

Net accleration of rocket while engine burns $= a_e = 7.0\,m/s^2$

Distance rocket falls before parachute opens $= \Delta y_f = -76m$

Rocket with parachute constant vertical speed $= V_{p_y} = -11 m/s$

Wind + Rocket with parachute constant horizontal speed $= V_{p_x} = -12 m/s$

Engine Burn Phase (e)

$\theta = 46^\circ$
$t_e = 7.0 \text{ sec}$
$a_e = 7.0 \text{ m/s}^2$
$v_{0e} = 0 \text{ m/s}$
$V_x = ?$
$V_y = ?$
$\Delta x_e = ?$
$\Delta y_e = ?$

a) $a_{e_x} = a_e \cos(\theta)$
$= 7.0 \text{ m/s}^2 \cdot \cos(46^\circ)$
$= 4.863 \text{ m/s}^2$

b) $a_{e_y} = a_e \sin(\theta)$
$= 7.0 \text{ m/s}^2 \cdot \sin(46)$
$= 5.035 \text{ m/s}^2$

c) $V_{e_x} = a_{e_x} \cdot t_e$
$= 4.863 \text{ m/s}^2 \cdot 7.0 \text{ s}$
$= 34.04 \text{ m/s}$

d) $V_{e_y} = a_{e_y} \cdot t_e$
$= 5.035 \text{ m/s}^2 \cdot 7 \text{ sec}$
$= 35.25 \text{ m/s}$

e) $\Delta x_e = \frac{1}{2} a_{e_x} \cdot (t_e)^2$
$= \frac{1}{2} \cdot 4.863 \text{ m/s}^2 \cdot (7.0 \text{ s})^2$
$= 119.14 \text{ m}$

f) $\Delta y_e = \frac{1}{2} \cdot a_{e_y} (t_e)^2$
$= \frac{1}{2} \cdot 5.035 \text{ m/s}^2 \cdot (7.0 \text{ s})^2$
$= 123.36 \text{ m}$

So,
$V_{e_x} = 34.04 \text{ m/s}$
$V_{e_y} = 35.25 \text{ m/s}$
$\Delta x_e = 119.14 \text{ m}$
$\Delta y_e = 123.36 \text{ m}$

Projectile Motion Phase (m)

Let's divide this phase up into 2 parts, Projectile up (u) and projectile fall (f)

Projectile Up (u)

$V_{u0_x} = V_{e_x} = 34.04 \text{ m/s}$
$V_{u0_y} = V_{e_y} = 35.25 \text{ m/s}$
$a_{u_y} = -9.8 \text{ m/s}^2$
$\Delta y_u = ?$
$\Delta x_u = ?$
$y_{max} = ?$
$t_u = ?$

a) $(V_{u_y})^2 = (V_{u0_y})^2 + 2 \cdot a_{u_y} \cdot \Delta y_u$
$0 = (35.25 \text{ m/s})^2 + 2 \cdot (-9.8 \text{ m/s}^2) \cdot \Delta y_u$
$-19.6 \text{ m/s}^2 \, \Delta y_u = -1242.56 \text{ m}^2/\text{s}^2$
$\Delta y_u = 63.40 \text{ m}$

b) $y_{max} = \Delta y_e + \Delta y_u$
$= 123.36 \text{ m} + 63.40 \text{ m}$
$= 186.76 \text{ m}$

c) $V_{u_y} = V_{u0_y} + a_{u_y} \cdot t_u$
$0 = 35.25 \text{ m/s} + (-9.8 \text{ m/s}^2) \cdot t_u$
$t_u = 3.60 \text{ s}$

d) $\Delta x_u = t_u \cdot V_{u0_x}$
$= 3.60 \text{ s} \cdot 34.04 \text{ m/s}$
$= 122.54 \text{ m}$

So,
$\Delta y_u = 63.40 \text{ m}$
$\Delta x_u = 122.54 \text{ m}$
$y_{max} = 186.76 \text{ m}$
$t_u = 3.60 \text{ s}$

Projectile Fall (f)

$\Delta y_f = -76 \text{ m}$
$a_{u_y} = -9.8 \text{ m/s}^2$
$V_{f0_x} = V_{u0_x} = 34.04 \text{ m/s}$
$t_f = ?$
$\Delta x_f = ?$

a) $\Delta y_f = \frac{1}{2} \cdot a_{u_y} \cdot (t_f)^2$
$-76 \text{ m} = \frac{1}{2} \cdot (-9.8 \text{ m/s}^2) \cdot (t_f)^2$
$(t_f)^2 = 15.51 \text{ s}^2$
$t_f = 3.94 \text{ s}$

b) $\Delta x_f = V_{f0_x} \cdot t_f$
$= 34.04 \text{ m/s} \cdot 3.94 \text{ s}$
$= 134.12 \text{ m}$

So,
$t_f = 3.94 \text{ s}$
$\Delta x_f = 134.12 \text{ m}$

Parachute Phase (P)

$y_{max} = 136.76m$
$\Delta y_f = -76m$
$v_{P_y} = -11 m/s$
$v_{P_x} = -12 m/s$
$a_{P_y} = -9.8 m/s^2$

$t_p = ?$
$\Delta x_p = ?$
$\Delta y_p = ?$

a) $-\Delta y_p = y_{max} + \Delta y_f$
$= 136.76m - 76m$
$= 110.76m$
$\Delta y_p = -110.76m$

b) $\Delta y_p = v_{P_y} \cdot t_p$
$-110.76m = -11 m/s \cdot t_p$
$t_p = 10.07 s$

c) $\Delta x_p = v_{P_x} \cdot t_p = -12 m/s \cdot 10.07 s = -120.84m$

Final Calculation

$$\Delta X_{Final} = \Delta X_e + \Delta X_u + \Delta X_f + \Delta X_p = 119.14m + 122.54m + 134.12m - 120.84m$$
$$= 254.96m = \boxed{255.0m}$$

The rocket lands 255.0m east of the intial x-position