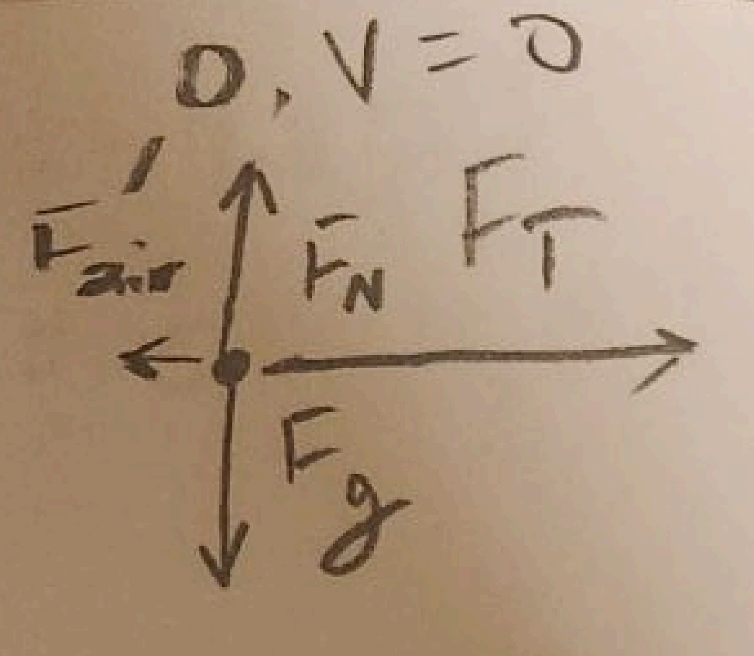
~~Space~~ Shuttle

[illegible]

Exercise #3

3a.

Given: $m = 2E6\ kg$, $F_T = 3.5E7\ N$, $g = 9.8\ m/s^2$



3b. At lift-off, $F_N = -F_g$, $F_{air} = 0$

$F_\Sigma = F_T = m \cdot a \Rightarrow \frac{F_T}{m} = a = \frac{3.5E7N}{2E6\ kg} = 1.75E1\ \frac{m}{s^2}$

3c. Let $\frac{da}{dt} = 0$ ∴

$\Delta y = v_i t + \frac{1}{2} a t^2$
$= 0 + \frac{1}{2} \cdot 1.75E1 \cdot 400\ m$
$= 3.5E3\ m.$

$V_f = V_i + at = 0 + 1.75E1 \cdot 20\ \frac{m}{s}$
$= 3.5E1\ \frac{m}{s}$

3d. From outside class materials,

$F_d(v^2) = \frac{1}{2} \rho C_d A (v^2)$

where ρ is the fluid density,
C_d is the dimensionless drag coefficient that depends on shape and (Re),
A is the cross-sectional area $\perp \vec{v}$.

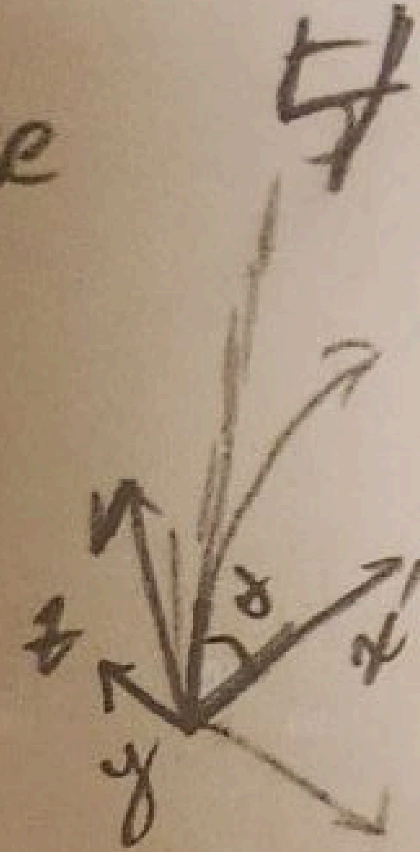
since $cV^2 = F_A$, units is $\frac{kg}{m}$.

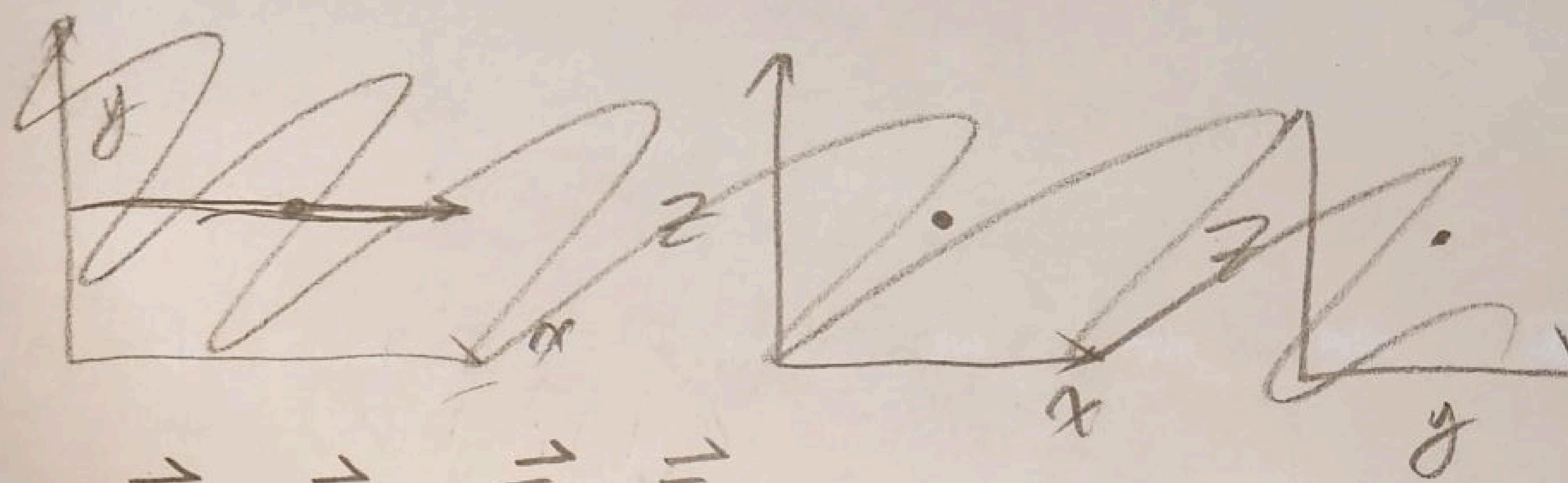
$\rho_{Air} = 1.225\ kg/m^3$, from NASA documents, A of the spaceshuttle orbiter is $\approx 20\ m^2$. From engineers at NASA, Space shuttle had a $C_D \approx 0.4$ during launch.

Thus $cV^2 \approx 4.9V^2$. ■

Exercise 5

$\boxed{4a.)}$





$\vec{F}_\Sigma = \vec{F}_z + \vec{F}_x + \vec{F}_y$

$\vec{F}_y = 0$

$\vec{F}_z = -9.8\frac{m}{s^2}\hat{z}$

$\vec{F}_x = 0$

$\therefore \quad \vec{F}_\Sigma = \vec{F}_z = -9.8\frac{m}{s^2}\hat{z} \cdot m$

$\Rightarrow \vec{a}_\Sigma = -9.8\frac{m}{s^2} =$

$0 = V_i \sin(\theta)\Delta t - \frac{1}{2}\cdot 9.8\frac{m}{s^2}\cdot \Delta t^2 \hat{z}$

$\boxed{4B.}$

$c=0$

$\frac{-V_i\sin\theta \pm \sqrt{V_i^2\sin^2\theta - 4\cdot 0}}{-2\cdot\frac{1}{2}9.8\frac{m}{s^2}} = \frac{V_i\sin\theta}{g} \pm \frac{V_i\sin\theta}{g}$

$\vec{r}(t) = \vec{V}_i t - \frac{1}{2}g t^2 \hat{z}$

$\Delta t = 0$ OR $\frac{2V_i\sin\theta}{g} = \Delta t$

this is the range formula.

$x(t) = |\vec{V}_i|\cos\theta\, t$

$y(t) = 0$

$z(t) = |\vec{V}_i|\sin\theta\, t - \frac{1}{2}g t^2$

4c. A check would be, input $\theta = 90°$ or $0°$, $x(t)$ ~~would~~ should be zero and $z(t) = \frac{-9.8\,m/s^2\,t^2}{2}$ respectively.

Also, one can check $|\vec{V}_i| = 0$, then $x(t)$ should be zero, and $z = -\frac{1}{2}gt^2$. For all values, $y = 0$.

~~For $\theta = 45°$, $|\vec{V}_i| \neq 0$,~~

$\forall$ values $\theta \in (0°, 90°)$, a numerical graph should qualitatively resemble a parabola. These values are correct.

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golf ball formulae: $\hat{z}$ is z-unit vector

Für Abishek;

$$\vec{q}(t) = \vec{V}_i t - \frac{1}{2} g t^2 \hat{z}$$

position as vector parametric of t

$$x(t) = V_i \cos\theta \, t$$
$$y(t) = 0$$
$$z(t) = V_i \sin\theta \, t - \frac{1}{2} g t^2$$

position as functions