PHY 321 HW 2

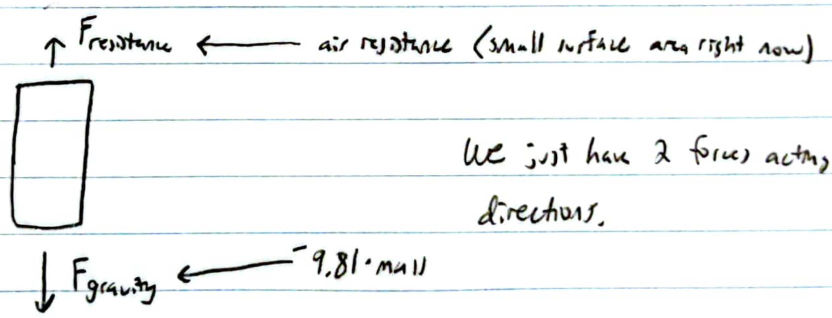
1a) No. Since $F = ma$, a cannot be 0 unless $F_{net} = 0$, and the net force cannot be zero if the object is only affected by a singular force (assuming the force is nonzero, otherwise the acceleration would trivially be zero).

1b) No. Zero acceleration would mean the ball would hover there forever. It still has $a = -9.81\ m/s^2$

1c) You'll still measure the typical acceleration of gravity ($g = -9.81\ m/s^2$) since the elevator is moving at a constant velocity.

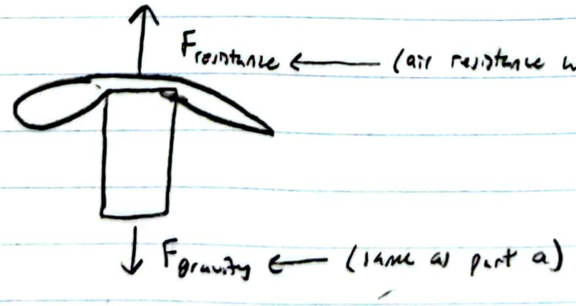
1d) Larger. The non-vacuum would have air resistance which slows the ball down (always decelerates the ball). In a vacuum the ball would go higher and come down at a faster velocity.

2a)



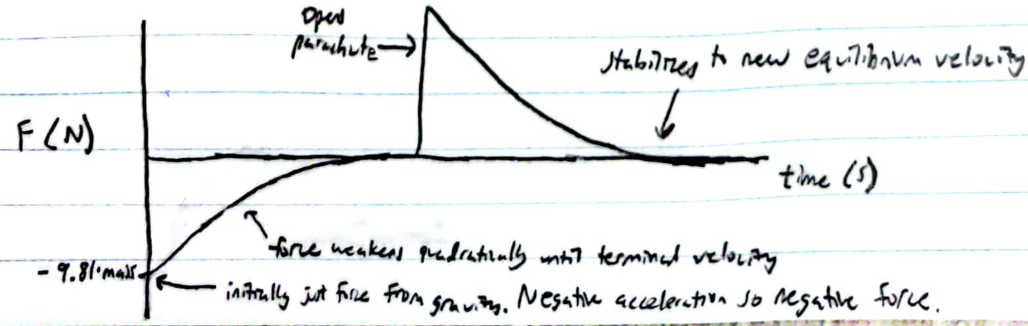
We just have 2 forces acting in opposite directions.

2b)



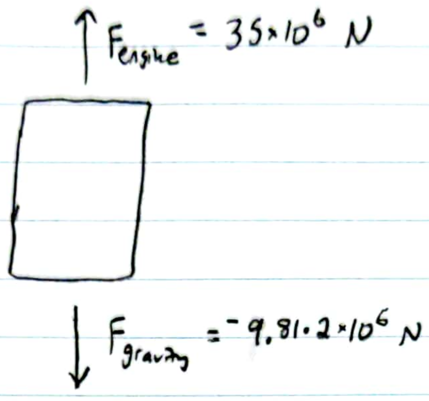
Alternatively, could consider human drag and parachute as separate forces. i.e. $F_{Parachute} + F_{drag} + F_{grav} = F_{net}$

2c)



3a) $F = 35\times10^6$ N. $m = 2\times10^6$ kg

immediately after lift-off $\Rightarrow v=0$ so air resistance $=0$. Also no force from ground since we've lifted off



3b) Use $F=ma$. $F_{net} = F_{engine} + F_{gravity} = 35\times10^6 - 9.81\cdot2\times10^6 = 15.38\times10^6$

$$F_{net} = ma$$
$$15.38\times10^6 = 2\times10^6\cdot a$$
$$\boxed{a = 7.69\ m/s^2}$$

in the upward direction, however you want to denote that (I'd say $\hat{k}$, $\hat{z}$, or e_3 direction)

3c) With assumption that F_{engine} is constant and mass is constant $\Rightarrow F_{gravity}$ is constant, F_{net} is constant without air resistance.

$\Rightarrow$ a is constant at $7.69\ m/s^2$

Thus after 20 s with $V_0 = 0$ m/s and $x_0 = 0$ m.

$$V_f = \int_0^{20} 7.69\,dt = [7.69t]_0^{20} = 7.69\cdot20 = \boxed{153.8\ m/s\ \text{upwards}}$$

integral unnecessary but done for completeness

To find x_f, we know $x = x_0 + v_0 t + \frac{1}{2}at^2$

$$\Rightarrow x = \frac{1}{2}at^2$$
$$x = \frac{1}{2}\cdot7.69\cdot20^2 = \boxed{1538\ m\ \text{up}}$$

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4) Exercise 1.35)

hit due east and only force in air is from gravity, so $y(t) = 0$.

x-dimension

initial velocity $= V_0 \cos\theta$

acceleration $= 0$

so constant velocity

$V_x(t) = V_0 \cos\theta$

$x(t) = V_0 t \cos\theta$

integrate, integration constant is zero.

z-dimension

initial velocity $: V_0 \sin\theta$

acceleration $= -9.8\ m/s^2$ $(F = 9.8m = ma)$

$V_z(t) = V_0 \sin\theta - 9.8t$

$z(t) = V_0 t \sin\theta - 4.9t^2$

integrate, integration constant is zero

position over time is thus $\boxed{V_0 t \cos\theta\, \hat{x} + [V_0 t \sin\theta - 4.9t^2]\hat{z} + 0\hat{y}}$

note: $\hat{y}$ and $\hat{z}$ are in abnormal order

to return to ground: $0 = V_0 t \sin\theta - 4.9t^2$

$0 = t(V_0 \sin\theta - 4.9t)$

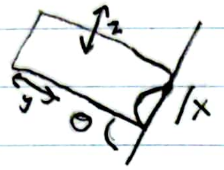
$V_0 \sin\theta - 4.9t = 0$

$4.9t = V_0 \sin\theta$

$\boxed{t = \frac{V_0 \sin\theta}{4.9}}$ ← units unknown, likely s and m

distance traveled: $x = V_0 \cdot \frac{V_0 \sin\theta}{4.9} \cos\theta = \boxed{\frac{V_0^2 \sin\theta \cos\theta}{4.9}}$ or $\boxed{\frac{V_0^2 \sin(2\theta)}{9.8}}$

5) Exercise 1.38)



In z-axis, there's no initial velocity and no force ⇒ no acceleration. So $z(t)=0$.

newton's 2nd Law stuff

x-dimension

initial velocity V_{ox}

no acceleration/force in this dimension. $F=ma=0$

$V_x(t) = V_{ox}$

$x(t) = V_{ox} t$ ($x_0 = 0$)

y-dimension

initial velocity V_{oy}

force is $mg\sin\theta = ma \Rightarrow a = g\sin\theta = -9.81\sin\theta$

$a = -9.81\sin\theta \Rightarrow V_y(t) = V_{oy} - 9.81t\sin\theta$ ($y_0 = 0$)

$y(t) = V_{oy}t - 4.9t^2\sin\theta$

position over time: $\vec{r}(t) = V_{ox}t\,\hat{x} + V_{oy}t - 4.9t^2\sin\theta\,\hat{y} + 0\,\hat{z}$

time to return to floor ($y=0$).

$0 = V_{oy}t - 4.9t^2\sin\theta$

$0 = t(V_{oy} - 4.9t\sin\theta)$

$0 = V_{oy} - 4.9t\sin\theta$

$\boxed{t = \frac{V_{oy}}{4.9\sin\theta}}$ ← likely s

distance from origin: $y=0$ and $z=0$, so only care about x.

$\boxed{X = V_{ox}\cdot\frac{V_{oy}}{4.9\sin\theta}}$ ← likely m