given $t = 22s$

$g = 9.81 \frac{m}{s^2}$

a) Projectile motion — Ball Released From Rest 22 s of Free Fall

$Y_f = Y_i + V_{iy}\Delta t - \frac{1}{2}g\Delta t^2$

$Y_f = 0 \quad V_{iy} = 0$

$$Y_i = \frac{1}{2}(9.81 \frac{m}{s^2})(22s)^2 = 2274.02\ m$$

B) what speed would the vehicle be going after 22s?

Released from Freefall

$V_{iy} = 0$

$V_{fy} = \cancel{V_{iy}}^{0} - gt$

$$V_{fy} = -(9.81 \frac{m}{s^2})(22s) = -215.8 \frac{m}{s}$$

c) $M = 80{,}000\ kg \quad F_{Tpere} = 14{,}000\ lbf \quad 3$ engines

Total thrust $= F_{Tpere} \cdot 3$ engines $= 42$ kips $\Rightarrow 186.9\ kN$

Weight force $= 80{,}000\ kg \cdot 9.81 \frac{m}{s^2} = 784.8\ kN$

$$\Sigma F_y = F_T - W = 186.9 - 784.8 = -597.1\ kN$$

Without lift the plane doesn't generate enough thrust to overcome the force of gravity that's why a plane doesn't go up and down but a rocket can

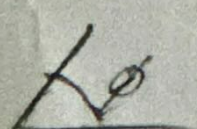
d) Assuming Lift = Thrust · 12 · $\cos\phi$

$\Sigma F_y = F_L - W$

$mg = 12F_T \cos\phi$

$\phi = \cos^{-1}\left(\frac{mg}{12F_T}\right)$

Max angle when forces are equal max lift when the plane ~~horizontal~~ parallel to the horizon earth



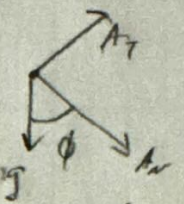
$$\phi = \cos^{-1}\left(\frac{80000 \cdot 9.81}{12 \cdot 186.9kN}\right) = 69.5^\circ$$

e) V_0 to achieve free fall for 22s

$\ddot{x} = 0 \quad \dot{x} = V_0\cos\phi \quad x = V_0\cos\phi \cdot t + x_0$

$\ddot{y} = -g \quad \dot{y} = V_0\sin\phi - gt \quad y = (V_0\sin\phi)t + y_0 - \frac{1}{2}gt^2$

$a_n = \frac{V^2}{\rho}$



Assuming $\Delta y = 0$
→ Starts and stops at same height

$V_0\sin\phi \cdot t = \frac{1}{2}gt^2 \rightarrow V_0 = \frac{gt}{2\sin\phi} = \frac{9.81\frac{m}{s^2} \cdot 22s}{2 \cdot \sin(64.5)}$

$\boxed{\rightarrow V_0 = 115.19\ \frac{m}{s}}$

plane peaks when $\dot{y} = 0 \quad \phi = 64.5°$

$gt_p = V_0\sin\phi \rightarrow t_p = \frac{V_0\sin\phi}{g} = \frac{(115.19)(\sin(64.5°))}{9.81\frac{m}{s^2}}$

$t_p = 11s$

$\Delta h = t((V_0\sin\phi) + -\frac{1}{2}gt) \rightarrow (11s)\left(115.19\frac{m}{s}\sin(64.5) - \frac{1}{2}(9.81)(11)\right)$

$\boxed{\Delta h = 593.5\ m}$

F) Yes, everything in the aircraft is moving at the same speed as the aircraft. Therefore relative to the plane all objects have a velocity of 0. This is what gives the "no gravity" effect. This is a valid frame for measurements because all objects exist in the same frame of reference undergoing the same external behavior.

Curtis 1.8 determines the required change in flight path angle of the plane to match the free fall motion of the people/items in the plane.