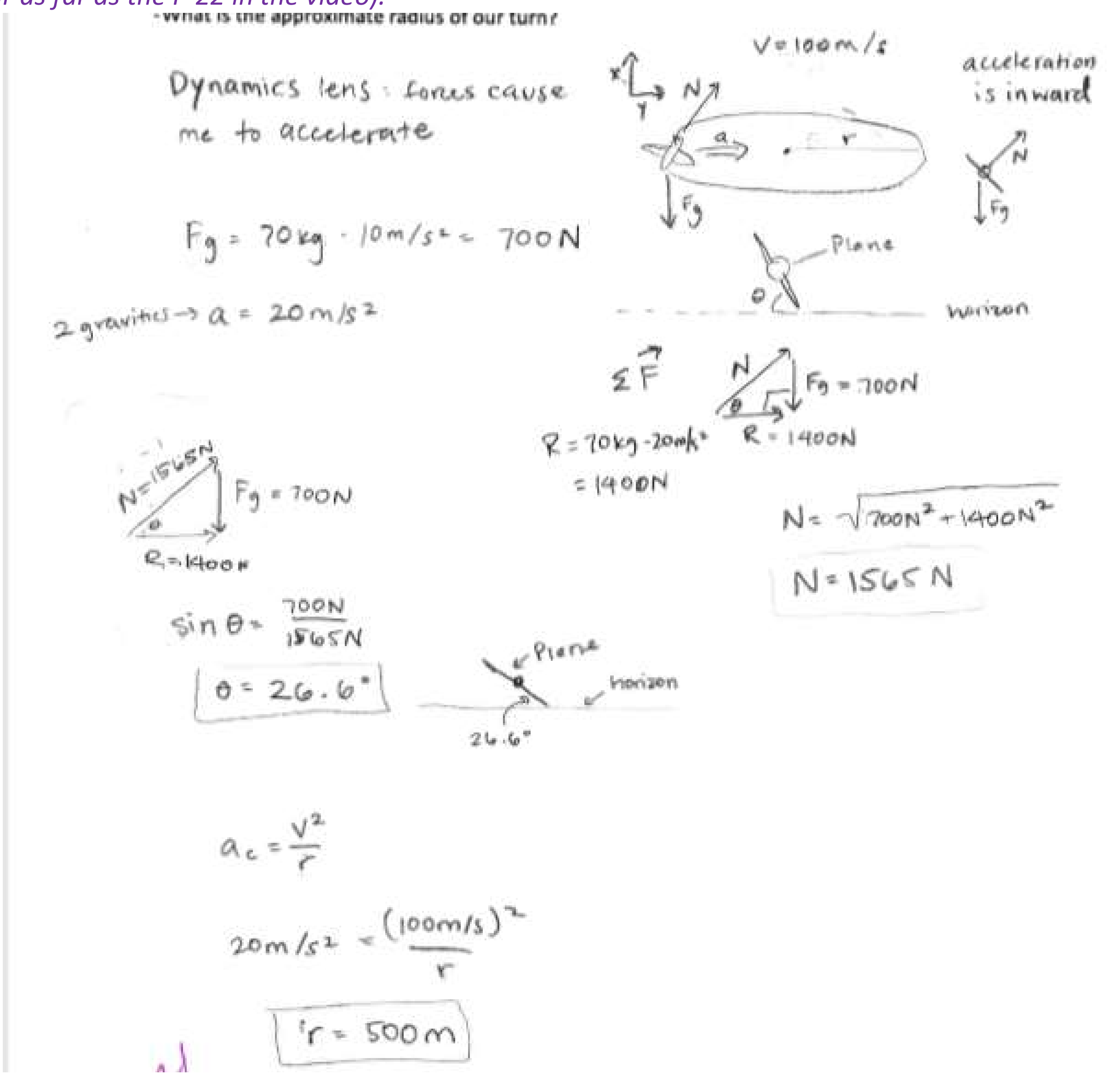
Assessment #10 121 Schwartz

1. My friend has her pilot's license and she decides to take me out in her racing plane and tells me she's going to pull a two gee turn… yikes, two gravities of acceleration! She pulls this circle at a speed of 100 m/s without changing elevation. My mass is 70 kg.
   - -What is the approximate weight indicated on the scale under me?
   - -What is the approximate angle made by the plane's wings and the horizon?
   - -What is the approximate radius of our turn?

   In my opinion, the most important part of this problem is drawing the airplane correctly, and from there doing a FBD. Almost no one did this. The student below did this well. However, they made one mistake: Theta, the angle is half the time used to refer to the angle the wings make with the horizon, and half the time it's the angle the VERTICAL (the normal force, or the perpendicular to the wings) makes with the horizon. These two angles are COMPLEMENTS of each other. Hence, the final drawing of the airplane at the end is incorrect. The angle identified should actually be 65 degrees… and the airplane is tipped very far (though not hear as far as the F-22 in the video).



Dynamics Lens : Forces causing acceleration

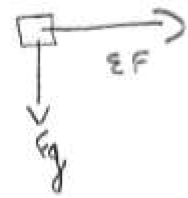
$\Sigma \vec{F} = m\vec{a}$ $\vec{a}_c = \frac{v^2}{R}$

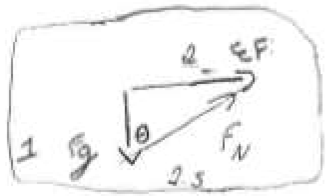
$\vec{a}_c = 20 m/s^2$

$v = 100 m/s$

$m = 70 kg$

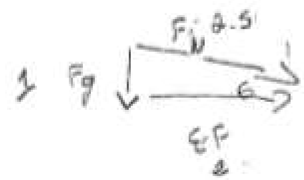
a_c =>





$\Sigma F = 2 F_g$

$F_N = 2.5 F_g$ =>



- $F_N = (2.5)(70 kg)(10 m/s)^2 = \boxed{1750 N}$

A+

- $\tan\theta = \frac{2}{1} = \boxed{63.4°}$

- $a_c = \frac{v^2}{R}$ $20 m/s^2 = \frac{100 m/s^2}{R}$ $\boxed{R = 500 m}$

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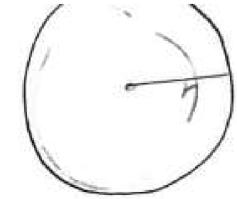
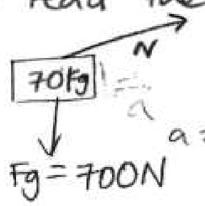
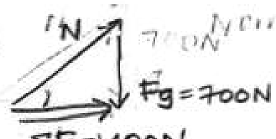
I am using a dynamics lens to solve this problem b/c forces cause acceleration and since the plane is moving in a circle, there is centripetal acceleration



○ scales read the normal force → scale reads 1565N under you



a ⇒



Normal force $= \sqrt{(1400^2 + 700^2)}$

Normal force ≈ 1565N

↓

$\Sigma F = ma$

$\Sigma F = 70\,kg \cdot 20\,m/s^2$

$\Sigma F = 1400N$

Centripetal acceleration

$a_c = \frac{V^2}{R} \rightarrow R = \frac{V^2}{a_c}$

$a_c = \frac{v^2}{R}$

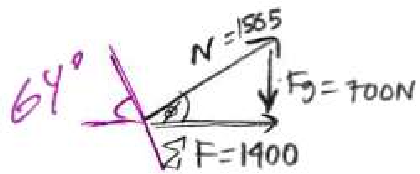
$Ra_c = v^2$

$R = \frac{v^2}{a_c}$

$R = \frac{10000\,m^2/s^2}{20\,m/s^2}$

$R = 500m$

approx. radius of turn: 500m



$\tan Ø = \frac{1}{2} \rightarrow Ø = \tan^{-1}(1/2)$

$Ø = 26.5°$

approx. angle made by plane's wings to horizon is 26.5°

lovely!

The Plane's vertical → *The complement*

2. I shoot a cannon ball into the air with a speed of 100 m/s at an angle of 30 degrees above the horizon in the middle of a level field.
   a) How far away does the ball land?
   b) How high does the ball get?
   c) What angle does the ball make with the horizon?

The most important part of this problem is recognizing it is 2D kinematics. Because acceleration is downward, we use horizontal and vertical axis, so we need to separate the problem: horizontally, the ball is moving along at a constant velocity. Vertically, the ball is under constant downward acceleration from gravity, positive velocity turning to negative velocity. I myself would have solved this differently… just recognizing that starting with vertical velocity of 50 m/s will spend 5 s moving upward and then 5 s moving downward. But this more math-heavy approach is also fine: