Flipping Physics Lecture Notes:

Number of g's or g-Forces

I have two different equations that I use to determine the number of g's, or what are also called g-Forces, which act on an object, they are:

- $vertical\ number\ of\ g's = \frac{F_N}{F_{g\ Earth}}$
- $horizontal\ number\ of\ g's = \frac{a_x}{g_{Earth}}$

Remember: $g_{Earth} = +9.81\frac{m}{s^2}$

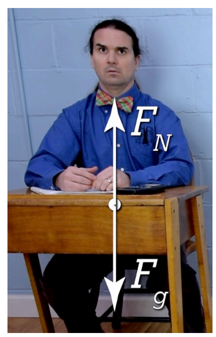
Number of g's is also sometimes called g-forces, however, I will not refer to number of g's as g-Forces because number of g's is not a force and calling it g-Forces will lead you to believe number of g's is a force, but number of g's is NOT a force.

Calculating the Number of g's for an object at rest:

$$horizontal\ number\ of\ g's = \frac{a_x}{g_{Earth}} = \frac{0}{g_{Earth}} = 0$$

$$\sum F_y = F_N - F_g = ma_y = m(0) = 0 \Rightarrow F_N = F_g$$

$$vertical\ number\ of\ g's = \frac{F_N}{F_{g\ Earth}} = \frac{F_g}{F_{g\ Earth}} = 1$$



Calculating the Number of g's for astronauts in the International Space Station:

$$horizontal\ number\ of\ g's = \frac{a_x}{g_{Earth}} = \frac{0}{g_{Earth}} = 0$$

$$vertical\ number\ of\ g's = \frac{F_N}{F_{g\ Earth}} = \frac{0}{F_{g\ Earth}} = 0 = apparent\ \ weightlessness$$

Apparent weightlessness is where the net Number of g's acting on the object equals zero.

In the lecture "What is the Maximum Speed of a Car at the Top of a Hill?", we determined the maximum linear velocity to drive a car over a hill and have the tires not leave the ground. When we did that problem, the critical point was where the force normal was equal to zero. In other words, the speed we determined is also the speed to drive the car such that the passengers would experience apparent weightlessness or where they would feel weightless while going over the hill.

Number of g's is a ratio of the acceleration experienced by the object with respect to the acceleration we typically experience here on planet Earth. If you are experiencing 2 vertical g's, you feel like you weigh twice what you normally do. If you are experiencing 1 and a half horizontal g's, you feel like you have a horizontal weight which is 1 and a half times your normal vertical weight and realize you don't normally experience weight horizontally. … Number of g's gives us a way of comparing the acceleration an object is experiencing to what the object would normally experience here on planet Earth.

Other Number of g's examples:

2011 Toyota Prius: $v_i = 0,\ \Delta t = 5.43\,\text{sec},\ v_f = 56\dfrac{km}{hr} \times \dfrac{1mi}{1.609km} = 34.804 \approx 35\dfrac{mi}{hr},$

$$v_f = 56\frac{km}{hr} \times \frac{1hr}{3600\,\text{sec}} \times \frac{1000m}{1km} = 15.\bar{5}\frac{m}{s};\ a_x = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t} = \frac{15.\bar{5} - 0}{5.43} = 2.86474\frac{m}{s^2}$$

$$\text{horizontal \# of g's} = \frac{a_x}{g_{Earth}} = \frac{2.86474}{9.81} = 0.29202 \approx 0.29$$

2020 Tesla Roadster:[♥] $v_i = 0,\ \Delta t = 1.9\,\text{sec},\ v_f = 60\dfrac{mi}{hr} \times \dfrac{1.609km}{1mi} = 96.54 \approx 97\dfrac{km}{hr},$

$$v_f = 60\frac{mi}{hr} \times \frac{1hr}{3600\,\text{sec}} \times \frac{1609m}{1mi} = 26.81\bar{6}\frac{m}{s};\ a_x = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t} = \frac{26.81\bar{6} - 0}{1.9} = 14.114\frac{m}{s^2}$$

$$\text{horizontal \# of g's} = \frac{a_x}{g_{Earth}} = \frac{14.144}{9.81} = 1.4387 \approx 1.4$$

NASA Space Shuttle:[♣] "Astronauts normally experience a maximum g-force of around 3gs during a rocket launch."

Russian Soyuz:[♠] "During a Soyuz launch, g-forces from 3.6 to 4.2g acceleration of gravity"

[♥] https://blog.caranddriver.com/new-tesla-roadster-first-look-zero-to-60-in-1-9-seconds-250-mph-top-speed-620-mile-range/
[♣] https://www.spaceanswers.com/space-exploration/what-g-force-do-astronauts-experience-during-a-rocket-launch/
[♠] http://www.space-affairs.com/index.php?wohin=3rdfloor_p