

Journal of Physics Special Topics

An undergraduate physics journal

A4 2 F9: The Orbital Fiero Fallacy

K. Pulgam, R. Sudhir and T. Kataria

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

November 2, 2025

Abstract

In the film F9: The Fast Saga, a 1984 Pontiac Fiero modified with a rocket engine is used to reach Low Earth Orbit. This paper analyses the physical plausibility of this scenario by calculating the required fuel mass. We find that to reach the necessary orbital velocity of approximately $9,140 \text{ m s}^{-1}$, in addition to ascent losses, the vehicle would require 88% of the total mass to be propellant. This yields a required mass fraction for the fuel that is unattainable for a vehicle of its design, rendering the stunt a physical impossibility.

Introduction

The *Fast & Furious* franchise is known for its escalating and often physics-defying stunts. In *F9: The Fast Saga*, characters Roman Pearce and Tej Parker pilot a rocket-powered Pontiac Fiero into space to destroy a satellite capable of global control. In the film, the Fiero is launched from a cargo aircraft, ignites its boosters at high altitude, and ultimately collides with the satellite after reaching orbit [1]. This paper investigates the feasibility of this stunt using basic principles of rocketry.

Theory

To achieve a stable Low Earth Orbit (LEO), an object must attain a specific horizontal velocity, not just altitude. This is the orbital speed, which is approximately $7,800 \text{ m s}^{-1}$ [2]. The change in velocity (Δv) a rocket can achieve is governed by the Tsiolkovsky Rocket Equation [3]:

$$\Delta v = v_{ex} \ln \left(\frac{m_0}{m_f} \right) \quad (1)$$

where Δv is the maximum change in velocity. v_{ex} is the effective exhaust velocity of the rocket engine. m_0 is the initial total mass (the vehicle, crew, and fuel). m_f is the final total mass (the vehicle and crew, after all fuel is expended), and the term, $\ln \left(\frac{m_0}{m_f} \right)$, is the natural logarithm of the mass ratio.

While the Tsiolkovsky equation assumes vacuum conditions, practical launch vehicles, like the Space Shuttle, require an additional $1,220 \text{ m s}^{-1}$ to overcome gravitational losses ($\Delta v_{gravity}$) and 120 m s^{-1} to overcome aerodynamic drag losses (Δv_{drag}) [4].

We model the vehicle as a two-stage rocket stack: a pair of strap-on solid boosters (Stage 1) that burn first and are then jettisoned, followed by a core stage consisting of a Merlin 1D engine mounted to the car (Stage 2).

Analysis and Results

The final mass (m_f) of the vehicle is composed of the car, crew, suits, and propulsion system. The Fiero has a mass of $m_{car} = 1,200 \text{ kg}$ [5]. The two occupants contribute $m_{crew} = 160 \text{ kg}$ (80

kg each) [6]. Assuming they use NASA ACES “pumpkin suits” ($m_{suits} = 14$ kg each) [7], the total suit mass is approximated as 30 kg. We assumed the propulsion system consists of a modified Merlin 1D engine ($m_{rocket} = 500$ kg) [8] and two auxiliary side thrusters ($m_{side} = 1,400$ kg each)[9], which include the motor casing, nozzle, and thrust structure.

The Merlin 1D produces a thrust of 981 kN with a vacuum specific impulse of 348 s [10], giving an exhaust velocity of $v_{ex} = 3,410$ m s⁻¹. The side thrusters, modelled as Castor 4B engines, have $I_{sp} = 281$ s [9], corresponding to $v_{ex} = 2,800$ m s⁻¹, and a thrust of 430 kN each[9].

The total velocity change required for orbital insertion is taken as the sum of the orbital velocity at low Earth orbit and estimated ascent losses, which would be $\Delta v_{req} = 9,140$ m s⁻¹.

Mass Model

The total mass remaining after all propellant is expended and following booster separation is

$$\begin{aligned} m_{f,2} &= m_{car} + m_{crew} + m_{suits} + m_{rocket} \\ &= 1,890 \text{ kg.} \end{aligned}$$

The combined dry mass of the two side boosters is $m_{booster, dry} = 2,800$ kg.

Staged Rocket Equation

Equation (1) is applied separately to each stage, with total $\Delta v_{req} = \Delta v_1 + \Delta v_2 = 9,140$ m/s. For the present analysis, we’ll assume the boosters supply $\Delta v_1 = 2,500$ m s⁻¹ and the main engine provides $\Delta v_2 = 6,640$ m s⁻¹.

The resulting mass ratios are

$$\begin{aligned} \left(\frac{m_o}{m_f}\right)_1 &= \exp\left(\frac{2,500}{2,800}\right) = 2.442, \\ \left(\frac{m_o}{m_f}\right)_2 &= \exp\left(\frac{6,640}{3,410}\right) = 7.009. \end{aligned}$$

Stage 2: Main Engine

After the jettison, the final mass after orbital insertion is $m_{f,2} = 1,890$ kg. The initial mass at

the start of this stage is

$$\begin{aligned} m_{0,2} &= \left(\frac{m_o}{m_f}\right)_2 \times m_{f,2} \\ &= 7.009 \times 1,890 \approx 13,247 \text{ kg.} \end{aligned}$$

The propellant consumed by the main engine is therefore

$$m_{prop,2} = m_{0,2} - m_{f,2} \approx 11,357 \text{ kg.}$$

Stage 1: Side Boosters

At the end of the booster burn, before jettison, the remaining mass is

$$\begin{aligned} m_{f,1} &= m_{0,2} + m_{booster,dry} \\ &= 13,247 + 2,800 = 16,047 \text{ kg.} \end{aligned}$$

The initial mass, when detached from the plane, is then

$$m_{0,1} = 2.442 \times 16,047 \approx 39,200 \text{ kg,}$$

and the booster propellant mass is

$$m_{prop,1} = m_{0,1} - m_{f,1} \approx 23,100 \text{ kg.}$$

Total Mass and Propellant Fraction

The complete vehicle at lift-off has a total mass of approximately

$$m_{0,total} \approx 39,200 \text{ kg,}$$

with a combined propellant mass of

$$m_{prop,total} = m_{prop,1} + m_{prop,2} \approx 34,500 \text{ kg.}$$

The overall propellant fraction is therefore

$$\frac{m_{prop,total}}{m_{0,total}} \approx 0.88,$$

meaning that about 88% of the total mass must be propellant.

Conclusion

While visually spectacular, the prospect of a Pontiac Fiero reaching orbit is not physically plausible. Our calculations show that the vehicle would need to be approximately 88% fuel by mass to achieve the required velocity for Low Earth Orbit. The structural and volumetric limitations of a passenger car make carrying this amount of propellant impossible.

References

- [1] <https://fastandfurious.fandom.com/wiki/F9#Plot> (accessed: 6 October 2025).
- [2] https://www.esa.int/ESA_Multimedia/Images/2020/03/Low_Earth_orbit (accessed: 6 October 2025).
- [3] <https://apmonitor.com/me575/index.php/Main/RocketLaunch> (accessed: 6 October 2025).
- [4] Sutton, GP 2016, Rocket Propulsion Elements, John Wiley & Sons, Incorporated, Newark. Available from: ProQuest Ebook Central. Page 125.
- [5] <https://fastestlaps.com/models/pontiac-fiero-gt> (accessed: 6 October 2025).
- [6] <https://tinyurl.com/43pemkb4> (accessed: 6 October 2025).
- [7] <https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/1860483> (accessed: 6 October 2025).
- [8] <http://www.astronautix.com/m/merlin1d.html> (accessed: 18 October 2025).
- [9] <http://www.astronautix.com/c/castor4bengine.html> (accessed: 02 November 2025).
- [10] <https://tinyurl.com/merlin-1d> (accessed: 18 October 2025).