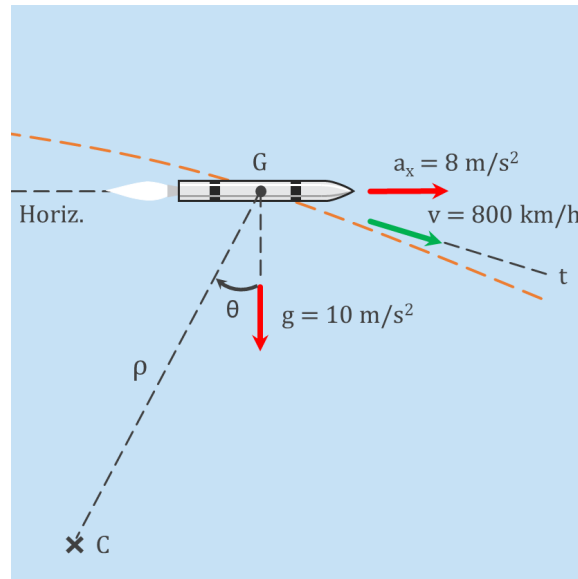


Rocket Acceleration



A rocket maintains at horizontal attitude of its axis during the powered phase of its flight (see the Figure). The acceleration due to horizontal thrust is 8 m/s^2 , and the downward acceleration due to gravity is $g = 10 \text{ m/s}^2$. At the instant represented, the velocity of the centre of mass G of the rocket along the $\theta = 15^\circ$ direction of its trajectory is 800 km/h . Determine the radius of curvature ρ in meters of the flight trajectory. Round to the nearest hundred (e.g. 8700 m).

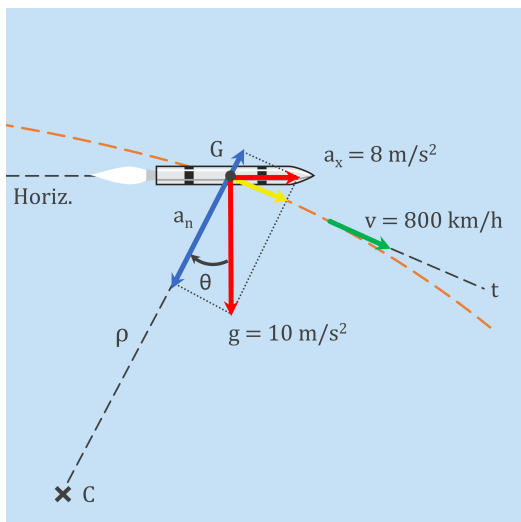


Figure 1: Rocket Accelerates

The normal acceleration a_n points towards the centre of curvature C . Figure 1 shows the acceleration vectors a_x and g deconstructed in the normal direction (blue) and the tangential direction (yellow). It can be easily seen that g and a_x deconstructed in the normal-direction are equal to $g \cos \theta$ and $a_x \sin \theta$, respectively. However, in this case $a_x \sin \theta$ points in the opposite way of a_n (points \nearrow instead of \swarrow). This means that to determine the final value of a_n , the term $a_x \sin \theta$ should be subtracted. Resulting in the final answer:

$$a_n = g \cos \theta - a_x \sin \theta \quad (1)$$

Given quantities:

Angle: $\theta = 15^\circ$

Gravitational acceleration: $g = 10 \text{ m/s}^2$

Horizontal acceleration: $a_x = 8 \text{ m/s}^2$

Velocity: $v = 800 \text{ km/h} \approx 222.22 \text{ m/s}$

Solution:

Inserting θ , g and a_x into Equation (1) results in:

$$a_n = g \cos \theta - a_x \sin \theta \quad \Rightarrow \quad a_n = 10 \cdot \cos(15^\circ) - 8 \cdot \sin(15^\circ) \approx 7.59 \text{ m/s}^2 \quad (2)$$

Rearranging results in the final answer:

$$\rho = \frac{v^2}{a_n} \quad \Rightarrow \quad \rho = \frac{222.22^2}{7.59} = 6507.40 \text{ m} \approx 6500 \text{ m} \quad (3)$$