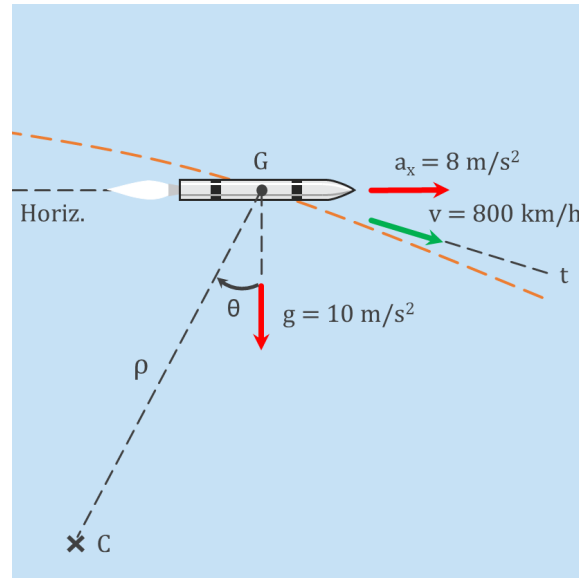# Rocket Accelerates

A rocket maintains at horizontal attitude of its axis during the powered phase of its flight. The acceleration due to horizontal thrust is 8 m/s², and the downward acceleration due to gravity is $g = 10$ m/s². At the instant represented, the velocity of the mass centre G of the rocket along the (θ) 15° 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).

To find the radius of curvature the following relation can be used:

$$a_n = \frac{v^2}{\rho} \quad \Rightarrow \quad \rho = \frac{v^2}{a_n} \qquad (1)$$

The normal acceleration a_n point towards the centre of curvature C. To find this acceleration, a parallelogram can be drawn using the other acceleration terms g and a_x (see Figure 1). It can be seen that g in the direction of a_n results in $g \cdot \cos(\theta)$ and a_x in the direction of a_n
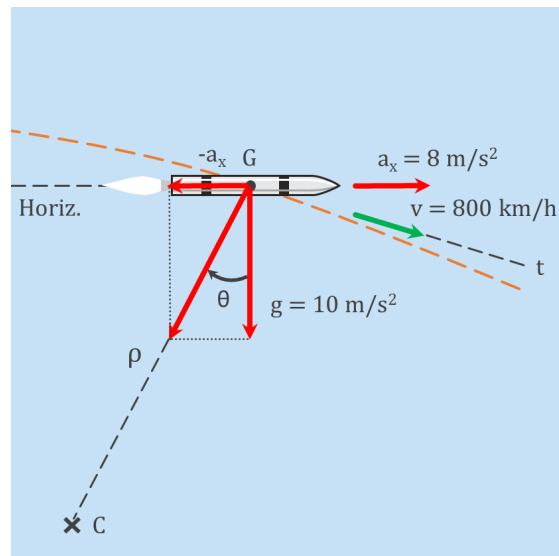

Figure 1: Rocket Accelerates, with parallelogram drawn that results in a_n.

results in $-a_x \cdot \sin(\theta)$. Adding both together results in the final answer:

$$a_n = g \cdot \cos(\theta) - a_x \cdot \sin(\theta) \qquad (2)$$

Given:
Angle: $\theta = 15°$
Gravitational acceleration: $g = 10 m/s^2$
Horizontal acceleration: $a_x = 8 m/s^2$
Velocity: $v = 800 km/h = 222.22 m/s$

Inserting θ, g and a_x into Equation 2 results in:

$$a_n = g \cdot \cos(\theta) - a_x \cdot \sin(\theta) \quad \Rightarrow \quad a_n = 10 \cdot \cos(15) - 8 \cdot \sin(15) = 7.59 m/s^2 \qquad (3)$$

This results in:

$$\rho = \frac{v^2}{a_n} \quad \Rightarrow \quad \rho = \frac{222.22^2}{7.59} = 6507.40 m \approx 6500 m \qquad (4)$$