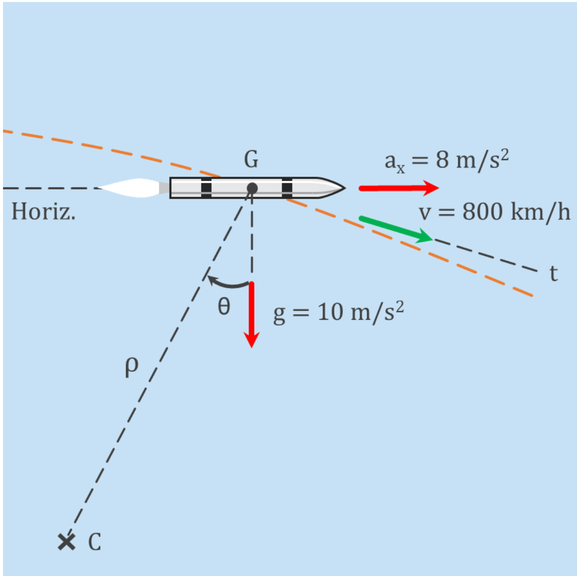
Rocket Accelerates



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/s^2, and the downward acceleration due to gravity is g = 10 m/s^2. At the instant represented, the velocity of the centre of mass G of the rocket along the θ = 15° direction of its trajectory is 800 km/h. Determine for this position the rate at which the velocity is increasing. Round to the nearest integer.

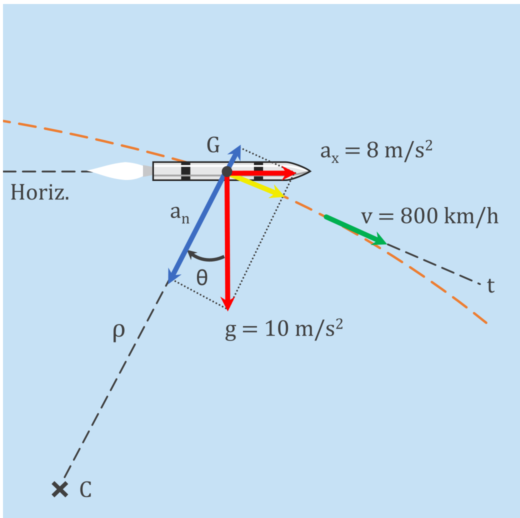


Figure 1: Rocket Accelerates

The rate at which the velocity increases is the tangential acceleration. The tangential acceleration a_t is parallel to v. 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 tangential-direction are equal to $g \sin\theta$ and $a_x \cos\theta$ respectively. Resulting in the final answer:

$$a_t = g \sin\theta + a_x \cos\theta \qquad (1)$$

Given quantities:

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

Solution:

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

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