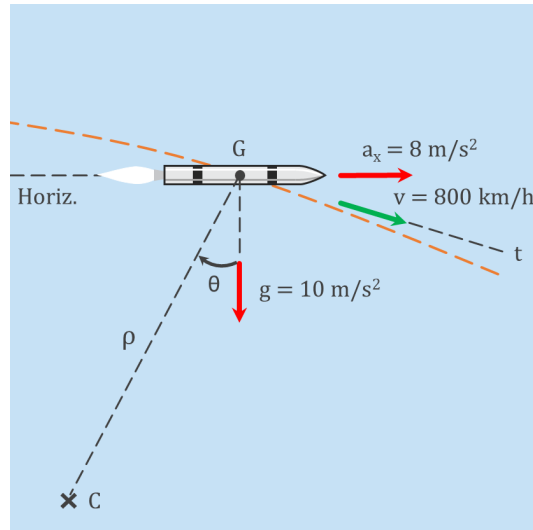


## Rocket Accelerates



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  $8 \text{ m/s}^2$ , 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  $800 \text{ km/h}$ . Determine the normal acceleration  $a_n$  with respect to the centre of curvature  $C$  in terms of  $g, a_x$  and  $\theta$ .

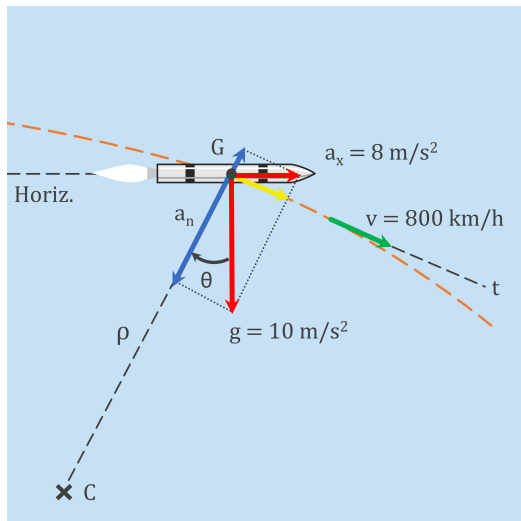


Figure 1: Rocket Accelerates

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 negative. Adding both terms results in the final answer:

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