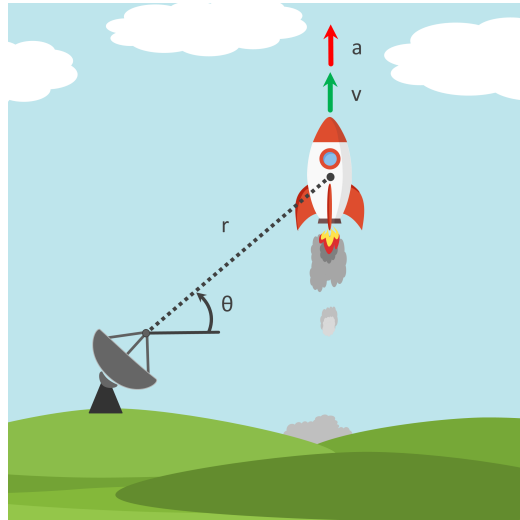


# Rocket Tracking in Polar Coordinates



A rocket is fired vertically and tracked by a radar station. For the instant when  $\theta = 60^\circ$ , the tracking data gives  $r = 5000$  m,  $\ddot{r} = 15$  m/s<sup>2</sup>, and  $\dot{\theta} = 0.02$  rad/s. Calculate the magnitude of the velocity and acceleration of the rocket at this position.

**Hint:** Use  $v_\theta = r\dot{\theta}$  and  $a_r = \ddot{r} - r\dot{\theta}^2$

*Given quantities:*

Distance:  $r = 5000$  m

Acceleration:  $\ddot{r} = 15$  m/s<sup>2</sup>

Angle:  $\theta = 60^\circ$

Rate of change of the angle:  $\dot{\theta} = 0.02$  rad/s

*Solution:*

Using the given expressions for  $v_\theta$  and  $a_r$ , both can be calculated:

$$v_\theta = r\dot{\theta} = 5000 \cdot 0.02 = 100 \text{ m/s} \quad (1)$$

$$a_r = \ddot{r} - r\dot{\theta}^2 = 15 - 5000 \cdot 0.02^2 = 13 \text{ m/s}^2 \quad (2)$$

Both  $v_\theta$  and  $a_r$  can be drawn into the figure, this results in Figure 1. Using basic trigonometry for a right triangle, the velocity and acceleration can be expressed in terms of  $v_\theta$ ,  $a_r$  and  $\theta$ .

$$v = \frac{v_\theta}{\cos \theta} = \frac{100}{\cos(60^\circ)} = 200 \text{ m/s} \quad (3)$$

$$a = \frac{a_r}{\sin \theta} = \frac{13}{\sin(60^\circ)} \approx 15.01 \text{ m/s}^2 \approx 15 \text{ m/s}^2 \quad (4)$$

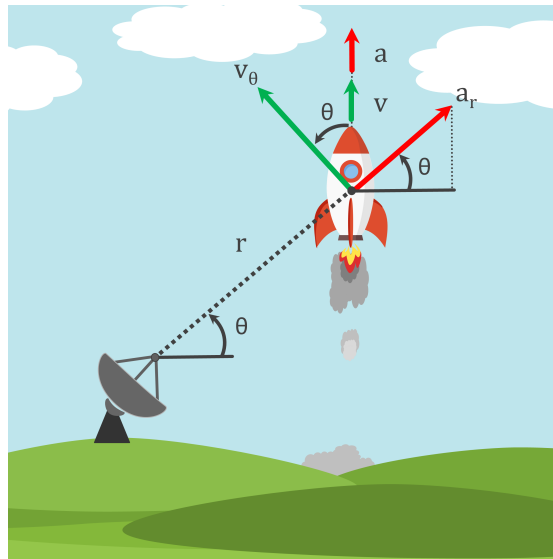


Figure 1: Rocket Tracking in Polar Coordinates, parallelograms.