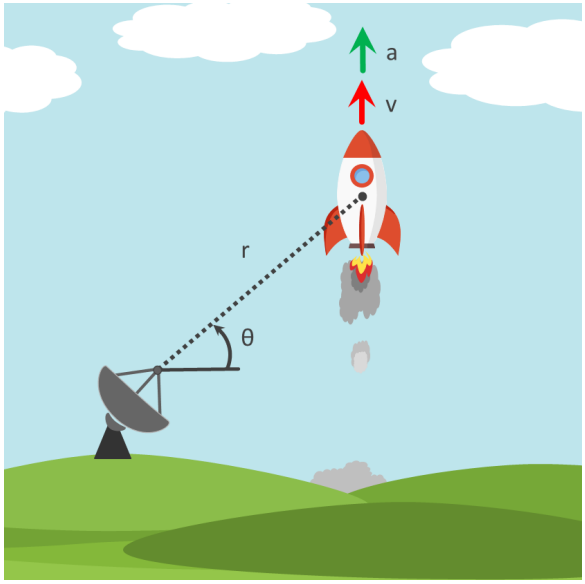
Rocket Tracking in Polar Coordinates



A rocket is fired vertically and tracked by a radar station. For the instant when $\theta = 60°$, the tracking data gives $r = 5000m$, $\ddot{r} = 15m/s^2$, and $\dot{\theta} = 0.02rad/s$. Calculate the magnitude of the velocity and acceleration of the rocket at this position.
Hint: Use the equations from the previous question. $v_\theta = r\dot{\theta}$ **and** $a_r = \ddot{r} - r\dot{\theta}^2$

Given:
Distance: $r = 5000m$
Acceleration: $\ddot{r} = 15m/s^2$
Angle: $\theta = 60°$
Rate of change of the angle: $\dot{\theta} = 0.02rad/s$

Using the given expressions for v_θ and a_r both can be calculated:

$$v_\theta = r\dot{\theta} \quad \Rightarrow \quad v_\theta = 5000 \cdot 0.02 = 100m/s \tag{1}$$

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

Both v_θ and a_r can be drawn into the figure, this results in Figure 1. Using basic geometry the velocity and acceleration can be expressed in terms of v_θ, a_r and θ.

$$v = \frac{v_\theta}{\cos\theta} \quad \Rightarrow \quad v = \frac{100}{\cos 60} = 200m/s \tag{3}$$

$$a = \frac{a_r}{\sin\theta} \quad \Rightarrow \quad a = \frac{13}{\sin 60} = 15.01m/s^2 \approx 15m/s^2 \tag{4}$$

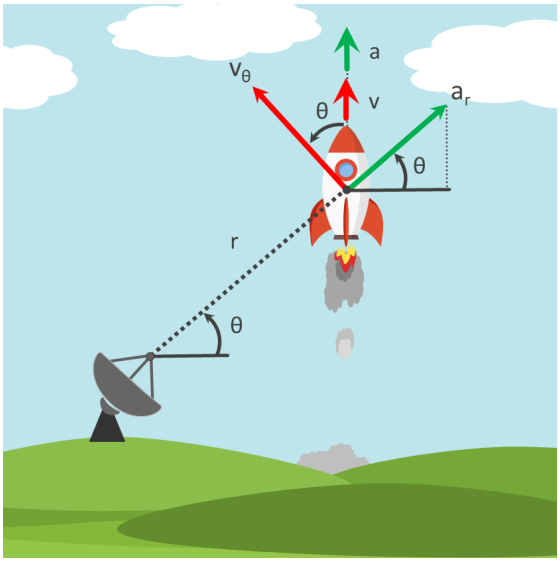


Figure 1: Rocket Tracking in Polar Coordinates, parallelograms.