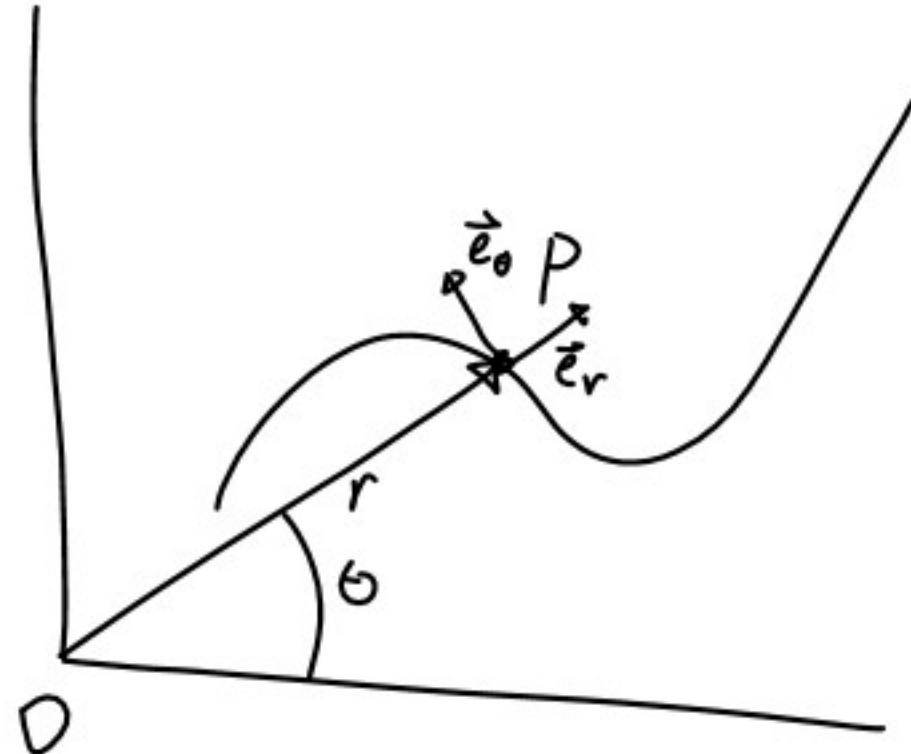


Radial and Transverse Components

\vec{e}_θ and \vec{e}_r unit vectors



$$\frac{d\vec{e}_r}{d\theta} = \vec{e}_\theta$$

$$\frac{d\vec{e}_\theta}{d\theta} = -\vec{e}_r$$

$$\frac{d\vec{e}_r}{dt} = \frac{d\vec{e}_r}{d\theta} \frac{d\theta}{dt} = \vec{e}_\theta \frac{d\theta}{dt}$$

$$\dot{\vec{e}}_r = \vec{e}_\theta \dot{\theta}$$

$$\frac{d\vec{e}_\theta}{dt} = -\vec{e}_r \frac{d\theta}{dt}$$

$$\dot{\vec{e}}_\theta = -\vec{e}_r \dot{\theta}$$

$$\vec{v} = \frac{d}{dt} r \vec{e}_r = \dot{r} \vec{e}_r + r \dot{\theta} \vec{e}_\theta = \dot{r} \vec{e}_r + r \dot{\theta} \vec{e}_\theta$$

$$\begin{aligned}\vec{a} &= \frac{d\vec{v}}{dt} = \frac{d}{dt} (\dot{r} \vec{e}_r + r \dot{\theta} \vec{e}_\theta) = \ddot{r} \vec{e}_r + \dot{r} \dot{\theta} \vec{e}_r + \dot{r} \vec{e}_\theta + r \ddot{\theta} \vec{e}_\theta + r \dot{\theta} \vec{e}_\theta \\ &= (\ddot{r} - r \dot{\theta}^2) \vec{e}_r + (r \ddot{\theta} + 2\dot{r} \dot{\theta}) \vec{e}_\theta\end{aligned}$$

As rod OA rotates, pin P moves along the parabola BCD . Knowing that the equation of this parabola is $r = 2b/(1 + \cos \theta)$ and that $\theta = kt$, determine the velocity and acceleration of P when (a) $\theta = 0$, (b) $\theta = 90^\circ$.

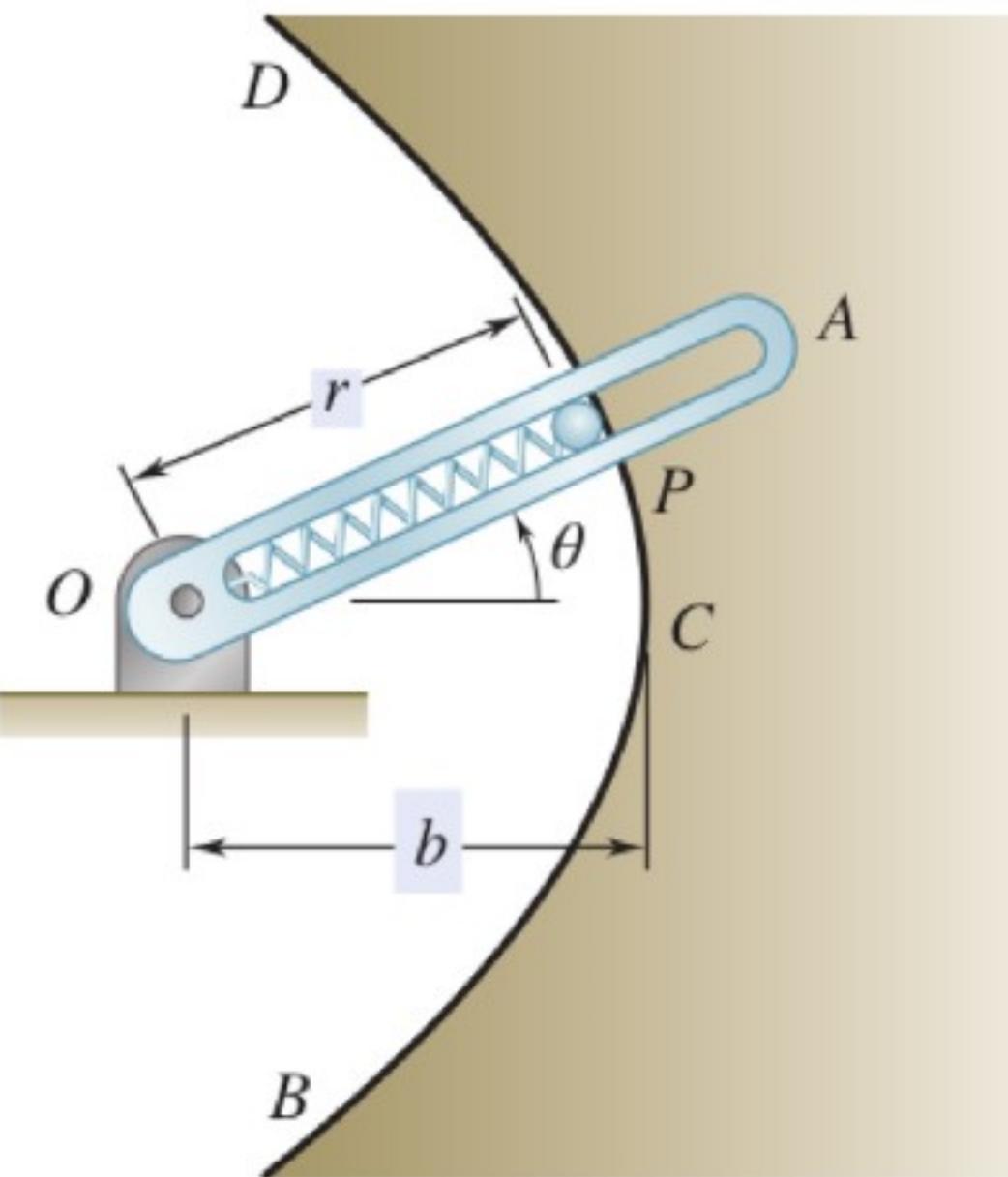
$$\vec{v} = \dot{r} \hat{e}_r + r \dot{\theta} \hat{e}_\theta$$

$$= \frac{2b k \sin kt}{(1 + \cos kt)^2} \hat{e}_r + \frac{2b}{1 + \cos kt} k \hat{e}_\theta$$

$$\vec{v}(0) = 0 \hat{e}_r + b k \hat{e}_\theta$$

$$90^\circ = kt$$

$$\vec{v}\left(\frac{90^\circ}{k}\right) = 2b k \hat{e}_r + 2b k \hat{e}_\theta$$



$$r = \frac{2b}{1 + \cos \theta} \quad \theta = kt$$

$$r = \frac{2b}{1 + \cos kt} \quad \dot{\theta} = k$$

$$\dot{r} = \frac{2b k \sin (kt)}{(1 + \cos kt)^2} \quad \ddot{\theta} = 0$$

$$\ddot{r} = 2b \left(\frac{k^2 \cos kt}{(1 + \cos kt)^2} + \frac{2k^2 \sin^2 kt}{(1 + \cos kt)^3} \right)$$

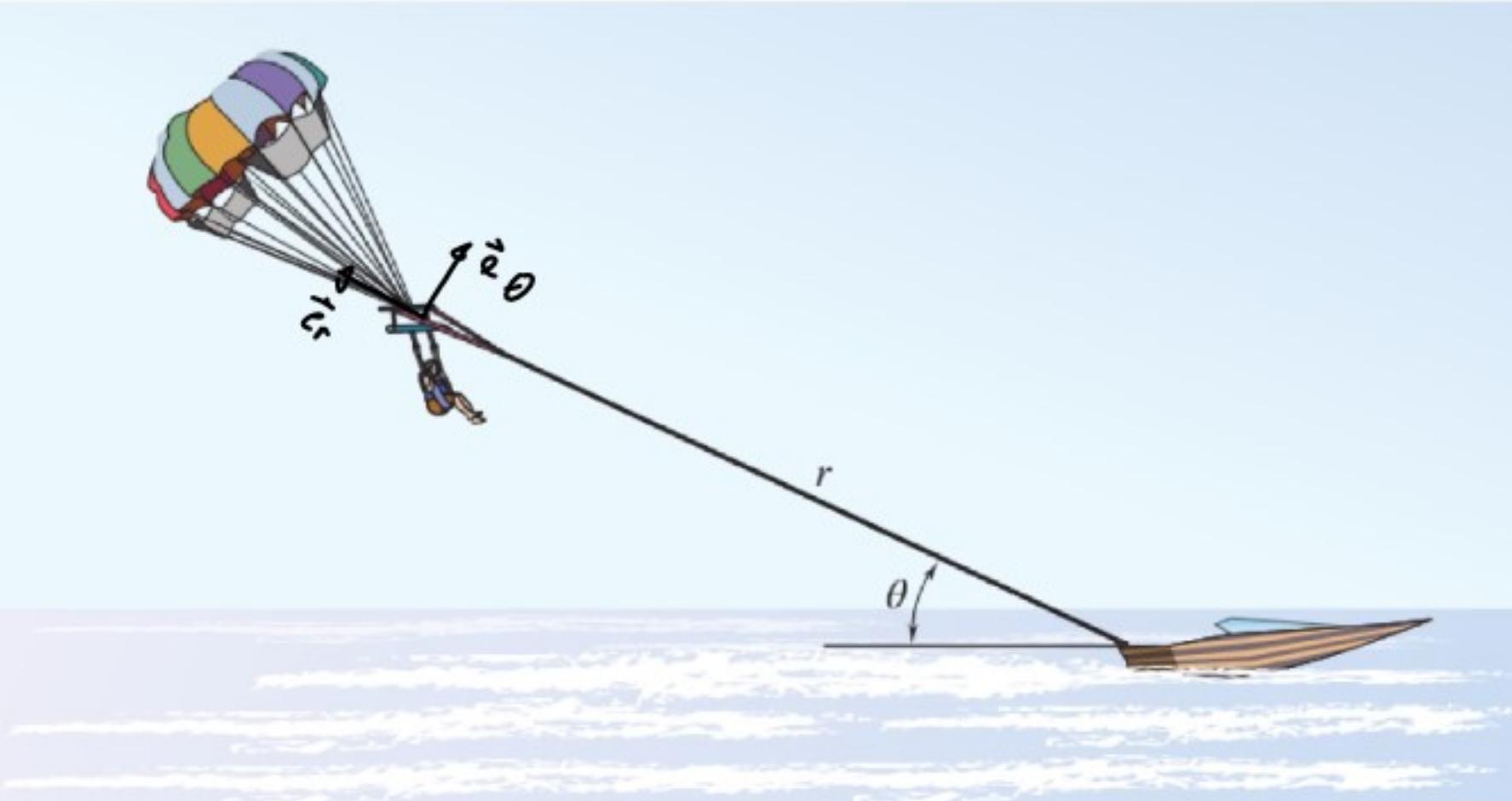
$$\vec{a} = (\ddot{r} + r \dot{\theta}^2) \hat{e}_r + (r \ddot{\theta} + 2\dot{r}\dot{\theta}) \hat{e}_\theta$$

$$= \left(2b \left(\frac{k^2 \cos kt}{(1+\cos kt)^2} + \frac{2k^2 \sin^2 kt}{(1+\cos kt)^3} \right) + \frac{2b}{1+\cos kt} k^2 \right) \hat{e}_r + \left(\frac{2b}{1+\cos kt} 0 + 2 \frac{2b k \sin kt}{(1+\cos kt)^2} k \right) \hat{e}_\theta$$

$$\vec{a}(0) = \left(2b \left(\frac{k^2}{1} \right) + b k^2 \right) \hat{e}_r + 0 \hat{e}_\theta$$

$$\vec{a}\left(\frac{10\pi}{k}\right) = \left(2b(2k) + 2b k^2 \right) \hat{e}_r + 2bk^2 \hat{e}_\theta$$

During a parasailing ride, the boat is traveling at a constant 30 km/hr with a 200-m long tow line. At the instant shown, the angle between the line and the water is 30° and is increasing at a constant rate of $2^\circ/\text{s}$. Determine the velocity and acceleration of the parasailer at this instant.



A diagram showing a parasailor suspended from a boat by a tow line. The boat is on the water, and the tow line extends upwards and to the left. A coordinate system is shown at the point where the tow line meets the boat, with the horizontal axis pointing right and the vertical axis pointing up. The tow line makes an angle θ with the horizontal. A velocity vector \vec{v} is shown originating from the boat, making an angle ϕ with the horizontal. The horizontal component of the velocity is labeled v_x and the vertical component is labeled v_y .

$$v_x = v_b \sin \theta$$
$$v_y = v_b \cos \theta$$

$$V_{x+\text{tot}} = V_x + 30 \text{ km/hr}$$