

Find the length of r f Find r at $\theta = \pi/2$.

$$r = a(1 - \cos \theta) \text{ at } \theta = \pi/2$$
$$r = a(1 - \cos \theta)$$
$$= a(1 - \cos \pi/2)$$

$$= a(1 - 0) \quad \dots (1)$$

$$\boxed{r = a} \quad \dots (1)$$

$$\sin \phi = \sin \theta/2 = \sin(\pi/2/2) = \sin \pi/4$$
$$\boxed{\sin \phi = \frac{1}{\sqrt{2}}} \quad \dots (2)$$

$$P = r \sin \phi \quad \dots (3)$$

Substitute (1) and (2) values in (3).

$$P = a \times \frac{1}{\sqrt{2}} = \boxed{P = \frac{a}{\sqrt{2}}}$$

Find $P = r \sin \phi$

$$r = a(1 - \cos \theta)$$

Take log.

$$\log r = \log a + \log(1 - \cos \theta)$$

Diff w.r.t. θ .

$$\Rightarrow \frac{1}{r} \frac{dr}{d\theta} = 0 + \frac{+ \sin \theta}{(1 - \cos \theta)}$$

$$= \frac{1}{r} \frac{dr}{d\theta} = \frac{\sin \theta/2 \cos \theta/2}{2 \sin^2 \theta/2} = \frac{\cos \theta/2}{2 \sin \theta/2} = \cot \phi = \cot \theta/2$$
$$\Rightarrow \boxed{\phi = \theta/2}$$

$$r^2 = a^2 \sec 2\theta \text{ at } \theta = \pi/6$$

$$\sin \phi = \sin \left(\frac{\pi}{2} - 2\theta \right)$$

$$= \cos(2\theta)$$

$$= \cos(2 \times \pi/6)$$

$$= \cos \pi/3$$

$$\boxed{\sin \phi = \frac{1}{2}} \quad \dots \quad (1)$$

$$r^2 = a^2 \sec 2\theta$$

$$\Rightarrow r^2 = a^2 \cdot 2 \Rightarrow \boxed{r = a\sqrt{2}} \quad \dots (2)$$

$$P = r \sin \phi \quad \dots (3)$$

Substitute (1) and (2) in equation (3).

$$P = a\sqrt{2} \times \frac{1}{2} = \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}} \quad \boxed{P = \frac{a}{\sqrt{2}}}$$

$$r^2 = \frac{a^2}{\cos 2\theta}$$

log b/s.

$$2 \log r = 2 \log a - \log \cos 2\theta$$

\Rightarrow Diff w.r.t. θ .

$$2 \cdot \frac{1}{r} \frac{dr}{d\theta} = 0 - \frac{(2 \sin 2\theta)}{\cos 2\theta}$$

$$r \cdot \frac{1}{r} \frac{dr}{d\theta} = 2 \tan 2\theta$$

$$\omega \quad r \phi = \omega t \left(\frac{\pi}{2} - 2\theta \right) \Rightarrow (\phi = \pi/2 - 2\theta)$$

$$r = a \sec^2(\theta/2) \text{ at } \theta = \pi/3.$$

$$r = \frac{a}{\cos^2 \theta/2} \quad \left| \quad 2\cos^2 \theta/2 = \cos \theta + 1 \right.$$

$$r = \frac{2a}{\cos \theta + 1} \quad \left| \quad \begin{aligned} \cos \theta &= 2\cos^2 \theta/2 - 1 \\ \cos^2 \theta/2 &= \frac{\cos \theta + 1}{2} \end{aligned} \right.$$

$$\log r = \log 2a - \log(\cos \theta + 1)$$

$$\frac{1}{r} \frac{dr}{d\theta} = 0 - \frac{(-\sin \theta)}{(\cos \theta + 1)}$$

$$\frac{1}{r} \frac{dr}{d\theta} = \frac{\sin \theta}{1 + \cos \theta} \Rightarrow \frac{r \sin \theta/2 \cos \theta/2}{r \cos^2 \theta/2} = \tan \theta/2$$

$$= \tan(\pi/2 - \theta/2)$$

$$\Rightarrow \phi = (\pi/2 - \theta/2)$$

$$\sin \phi = \sin(\pi/2 - \theta/2).$$

$$= \cos \frac{\theta}{2}.$$

$$= \cos(\pi/6)$$

$$\boxed{\sin \phi = \frac{\sqrt{3}}{2}} \quad \dots (1)$$

$$\begin{aligned} r &= a \sec^2(\theta/2) \\ (\theta = \pi/3) &= a \sec^2(\pi/6) \end{aligned}$$

$$r = a \cdot \frac{4}{3} = \frac{4a}{3} \quad \dots (2)$$

$$p = r \sin \phi \quad \dots (3)$$

Substitute (1) & (2) in (3)

$$p = \frac{4a}{3} \times \frac{\sqrt{3}}{2} = \frac{2a}{\sqrt{3}} \Rightarrow p = \frac{2a}{\sqrt{3}}$$

$$\frac{2a}{r} = (1 - \cos \theta) \text{ at } \theta = \underline{\underline{\pi/2}}$$

$$\begin{aligned} \sin \phi &= \sin(-\theta/2) \\ &= -\sin(\pi/4) \end{aligned}$$

Find ϕ :

Take log.

$$\log 2a - \log r = \log(1 - \cos \theta)$$

Differentiate w.r.t. θ .

$$\Rightarrow 0 - \frac{1}{r} \frac{dr}{d\theta} = \frac{\sin \theta}{(1 - \cos \theta)}$$

$$\begin{aligned} -\omega r &= \omega + \theta/2 \\ \Rightarrow \omega(-\theta) &= \omega + \theta/2 \end{aligned} \quad \Rightarrow \frac{r \sin \theta/2 \cos \theta/2}{\cancel{r} \sin^2 \theta/2} = \boxed{\phi = -\theta/2}$$

$$\boxed{\sin \phi = -\frac{1}{\sqrt{2}}} \quad \dots (1)$$

$$\frac{2a}{r} = 1 - \cos \pi/2$$

$$\frac{2a}{r} = 1 - 0$$

$$\Rightarrow \frac{2a}{r} = 1 \Rightarrow \boxed{r = 2a} \quad \dots (2)$$

$$p = r \sin \phi \quad \dots (3)$$

Substitute (1) and (2) in (3).

$$p = -2a \times \frac{1}{\sqrt{2}} = -\frac{a}{\sqrt{2}} \quad p = -\frac{a\sqrt{2}}{2}$$

$$\text{Squaring} \Rightarrow \boxed{p^2 = 2a^2}$$

$$\rho = \frac{(1+y_1^2)^{3/2}}{y_2} \text{ or } \frac{(1+x_1^2)^{3/2}}{x_2}$$

$$y_1 = \frac{dy}{dx} \quad y_2 = \frac{d^2y}{dx^2} \quad x_1 = \frac{dx}{dy} \quad x_2 = \frac{d^2x}{dy^2}$$

$$\text{at } (0, 2a) \quad (2a, 0)$$

$$x = \sin \theta = y = 2x^2 + 3$$

$$\frac{dy}{dx} = \frac{d}{dx} (2x^2 + 3) \quad (2x^2 + 3)$$

$$y_1 = 4x \quad (2a, 0) \quad (0, 2a)$$

$$y_1 = 4 \times 2a = 8a$$

$$y_2 = \frac{d}{dx} (4x)$$

$$= 4 \quad 3/2$$

$$\rho = \frac{(1+y_1^2)^{3/2}}{y_2} = \frac{(1+8a^2)^{3/2}}{4}$$

$$y^2 = 4a^2 \left(\frac{2a-x}{a} \right)$$

$$0 = 4a^2 \left(\frac{2a-x}{a} \right)$$

$$\Rightarrow x = 2a$$

$$2y \cdot \frac{dy}{dx} = \frac{d}{dx} \left(\frac{4a^3}{a} - 4a^2 \right)$$

$$2y \cdot y_1 = 8a^3 \cdot -\frac{1}{x^2} - 0$$

$$= 2y \cdot y_1 = -\frac{8a^3}{x^2} \Rightarrow y_1 = -\frac{8a^3}{2x^2 \cdot y}$$

$$= y_1 = -\frac{4a^3}{y x^2} (2a, 0)$$

at x axis

$$\frac{dx}{dy} = \frac{y x^2}{4a^3}$$

$$x_1 = 0$$

$$x'' = \frac{d}{dy} (x')$$

$$\frac{1}{4a^3} \left[x' \cdot 1 + y \cdot 2x \cdot \frac{dy}{dx} \right]$$

$$= \frac{(1+x_1^2)^{3/2}}{x^2}$$