$$J = \pi^2 \int_0^{\frac{\pi}{2}} \frac{x^2}{\pi^2 + 4x^2}\,dx \longrightarrow \frac{k\,u^2}{1+u^2}$$

$$k\left[1 - \frac{1}{1+u^2}\right]$$

$u = x^2 \qquad u' = 2x$

$v' = \frac{1}{\pi^2 + 4x^2} \qquad v = \int \frac{1}{\pi^2 + 4x^2}\,dx$

$$v = \int \frac{1}{\pi^2 + 4x^2}\,dx$$

NO NEED FOR THAT

$\theta = \frac{2}{\pi}x \Rightarrow x = \frac{\pi}{2}\theta$

$d\theta = \frac{2}{\pi}dx \Rightarrow dx = \frac{\pi}{2}d\theta$

$$v = \int \frac{1}{\pi^2 + 4\left(\frac{\pi}{2}\theta\right)^2} \times \frac{\pi}{2}\,d\theta$$

$$= \frac{\pi}{2}\int \frac{1}{\pi^2 + \pi^2\theta^2}\,d\theta$$

$$= \frac{1}{2\pi}\int \frac{1}{1+\theta^2}\,d\theta$$

$$= \frac{1}{2\pi}\tan^{-1}(\theta) + c$$

$$= \frac{1}{2\pi}\tan^{-1}\left(\frac{2}{\pi}x\right) + C$$

$$J = \pi^2(uv - \int vu')$$

$$= \pi^2\left(\frac{1}{2\pi}\left[x^2\tan^{-1}\left(\frac{2}{\pi}x\right)\right]_0^{\frac{\pi}{2}} - \frac{1}{2\pi} \times 2\int_0^{\frac{\pi}{2}} x\tan^{-1}\left(\frac{2}{\pi}x\right)dx\right)$$

$$= \frac{\pi^2}{\pi}\left(\frac{1}{2}\left(\left(\left(\frac{\pi}{2}\right)^2\tan^{-1}(1)\right) - 0\right) - \int_0^{\frac{\pi}{2}} x\tan^{-1}\left(\frac{2}{\pi}x\right)dx\right)$$