

$$\sqrt{\pi} \frac{(4k)!}{2^{4k} (2k)! k!}, \quad k! \approx \sqrt{2\pi k} \left(\frac{k}{e}\right)^k$$

$$= \sqrt{\pi} \frac{1}{2^{4k}} \cancel{\sqrt{2\pi}} \sqrt{4k} \left(\frac{4k}{e}\right)^{4k} \frac{1}{\cancel{\sqrt{2\pi}} \sqrt{2k}} \left(\frac{e}{2k}\right)^{2k} \frac{1}{\sqrt{2\pi} \sqrt{k}} \left(\frac{e}{k}\right)^k$$

$$= \cancel{\sqrt{\pi}} \frac{1}{\cancel{\sqrt{2\pi}}} \frac{1}{2^{4k}} \frac{\sqrt{4k}}{\sqrt{2k}} \frac{1}{\sqrt{k}} e^{2k+k-4k} k^{4k-2k-k} \frac{4^{4k} 2^{-2k}}{2^{8k}}$$

$$= \frac{1}{2^{4k}} \frac{1}{\sqrt{k}} e^{-k} k^k \frac{2^{6k}}{2^{2k}}$$

$$= 4^k \frac{1}{\sqrt{k}} \left(\frac{k}{e}\right)^k = \frac{1}{\sqrt{2\pi}} 4^k \frac{1}{k} k! = \frac{1}{\sqrt{2\pi}} 4^k (k-1)!$$

not sure why  
I don't get  $k!$