Use Euler's product formula and the value of $\Gamma(1/2)$ to prove Wallis's formula

$$\frac{\pi}{4} = \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdots \frac{2n}{2n+1} \frac{2n+2}{2n+1} \cdots$$

$$\Gamma(z) = \frac{1}{z} \prod_{n=1}^{\infty} \left(1 + \frac{1}{n}\right)^z \left(1 + \frac{z}{n}\right)^{-1} \tag{2.2.2}$$