Determine, with proof, the region of convergence of the following series:

1. \( \sum_{n=1}^{\infty} (n!)^n z^{2^n} \)

2. \( \sum_{n=1}^{\infty} \left( \sin \left( \frac{\pi}{3} + iy \right) \right)^n \), where \( y \) is real.

3. \( \sum_{n=1}^{\infty} \frac{e^{inz}}{1 + 2^n} \)

4. \( \sum_{n=1}^{\infty} 2^{t_n} z^n \), where \( t_n \) is the largest power of 2 which divides \( n \), so \( t_1 = 0, t_2 = 1, t_3 = 0, t_4 = 2, \ldots \)