$$\sum_{k=1}^{\infty} \frac{1}{k!}$$

$$\lim_{k\to\infty} \frac{a_{k+1}}{a_k} = \lim_{k\to\infty} \frac{\frac{1}{(k+1)!}}{\frac{1}{k!}} = \lim_{k\to\infty} \frac{k!}{(k+1)!} = \lim_{k\to\infty} \frac{1}{k+1} = 0$$

$0 < 1 \to \boxed{\text{converges}}$

$$\sum_{k=1}^{\infty} \frac{k}{2^k}$$

$$\lim_{k\to\infty} \frac{a_{k+1}}{a_k} = \lim_{k\to\infty} \frac{\frac{k+1}{2^{(k+1)}}}{\frac{k}{2^k}} = \lim_{k\to\infty} \frac{k+1}{\cancel{2^k}\cdot 2} \cdot \frac{\cancel{2^k}}{k}$$

$$= \lim_{k\to\infty} \frac{k+1}{2k} = \frac{1}{2} < 1 \to \boxed{\text{converges}}$$

$$\sum_{k=1}^{\infty} \frac{k^k}{k!}$$

$$\lim_{k\to\infty} \frac{a_{k+1}}{a_k} = \lim_{k\to\infty} \frac{\frac{(k+1)^{k+1}}{(k+1)!}}{\frac{k^k}{k!}} = \lim_{k\to\infty} \frac{(k+1)^{k+1}}{(k+1)!} \cdot \frac{k!}{k^k}$$

$$= \lim_{k\to\infty} \left(\frac{k+1}{k}\right)^k$$

$$= \lim_{k\to\infty} \left(1 + \frac{1}{k}\right)^k$$

$$= e$$

$e > 1 \to$ series $\boxed{\text{diverges}}$

Why you should always use the divergence test first:

$$\lim_{k\to\infty} \frac{k^k}{k!} \neq 0 \Rightarrow \text{diverges}$$