Use the ratio test to find out if the following series diverges or converges.

1) $\sum \frac{1}{n}$ 2) $\sum \frac{1}{n^2}$ 3) $\sum \frac{4^n}{n \cdot 3^n}$ 4) $\sum \frac{n^{10}}{10^n}$

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1) $\lim_{n\to\infty} \frac{\frac{1}{n+1}}{\frac{1}{n}}$

$= \lim_{n\to\infty} \frac{n}{n+1}$

$= 1$

∴ The ratio test is inconclusive at 1 because we know that $\sum \frac{1}{n}$ diverges.

2) $\lim_{n\to\infty} \frac{\frac{1}{(n+1)^2}}{\frac{1}{n^2}}$

$= \lim_{n\to\infty} \frac{n^2}{(n+1)^2}$

$= 1$

∴ The ratio test is inconclusive at 1 because we know that $\sum \frac{1}{n^2}$ converges.

3) $\lim_{n\to\infty} \frac{\frac{4^{n+1}}{(n+1)3^{n+1}}}{\frac{4^n}{n \cdot 3^n}}$

$= \lim_{n\to\infty} \frac{4 \cdot n}{(n+1)3}$

$= \lim_{n\to\infty} \frac{4}{3} \frac{n}{n+1}$

$= \frac{4}{3} > 1$

∴ $\sum \frac{4^n}{n \cdot 3^n}$ diverges.

4) $\lim_{n\to\infty} \frac{(n+1)^{10}}{10^{n+1}} \cdot \frac{10^n}{n^{10}}$

$= \lim_{n\to\infty} \frac{(n+1)^{10}}{10\, n^{10}}$

$= \frac{1}{10} < 1$

∴ $\sum \frac{n^{10}}{10^n}$ converges.