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Practice problems set 3:
Geometric and telescoping series

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1. Determine whether the following geometric series converge or diverge. If they converge, find their values.

   a) $\displaystyle\sum_{k=1}^{+\infty} 6(0.9)^{k-1}$

   b) $\displaystyle\sum_{n=1}^{+\infty} (-3)^{n-1}$

   c) $\displaystyle\sum_{k=1}^{+\infty} \frac{12}{(-5)^{k+1}}$

   d) $\displaystyle\sum_{n=1}^{+\infty} \frac{(-3)^{n-1}}{4^n}$

   e) $\displaystyle\sum_{k=1}^{+\infty} \frac{1}{4^{k/2}}$

2. For which values of x does the geometric series $\displaystyle\sum_{n=1}^{+\infty} (\ln x)^{n-1}$ converge?

3. Find the value of b for which $1 + e^b + e^{2b} + e^{3b} + \cdots = 9$.

4. Determine whether the following telescoping series converge or diverge. If they converge, find their values.

   a) $\displaystyle\sum_{n=2}^{+\infty} \frac{2}{n^2 - 1}$

   b) $\displaystyle\sum_{n=1}^{+\infty} \frac{3}{n(n+3)}$

   c) $\displaystyle\sum_{n=2}^{+\infty} \left[\cos\left(\frac{1}{2n}\right) - \cos\left(\frac{1}{2n+2}\right) \right]$

   d) $\displaystyle\sum_{n=1}^{+\infty} \ln\left(\frac{n}{n+1}\right)$

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Answers

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1. a) Converges to 60.
    b) Diverges (DNE)

    c) Converges to $\frac{2}{5}$
    d) Converges to $\frac{1}{7}$

    e) Converges to 1

2. For x in the interval $\left(\frac{1}{e}, e\right)$

3. $b = \ln(8/9)$

4. a) Converges to $\frac{3}{2}$
    b) Converges to $\frac{11}{6}$

    c) Converges to $\cos(1/2) - 1$
    d) Diverges to $-\infty$