$\boxed{\#1}$

$$\lim_{n\to\infty} \frac{(2+3n)^2}{4-n^2} = \lim_{n\to\infty} \frac{4+12n+9n^2}{4-n^2}$$

$$= \lim_{n\to\infty} \frac{(4+12n+9n^2)\frac{1}{n^2}}{(4-n^2)\frac{1}{n^2}} =$$

$$= \lim_{n\to\infty} \frac{4/n^2 + \frac{12}{n} + 9}{\frac{4}{n^2} - 1}$$

$$= \frac{\lim_{n\to\infty}\left(4/n^2 + 12/n + 9\right)}{\lim_{n\to\infty}\left(4/n^2 - 1\right)} =$$

$$= \frac{\lim_{n\to\infty}(4/n^2) + \lim_{n\to\infty}(12/n) + \left(\lim_{n\to\infty} 9\right)}{\lim_{n\to\infty}(4/n^2) - \lim_{n\to\infty} 1}$$

$$= \frac{0+0+9}{0-1} = \boxed{-9}$$

$\boxed{\#2}$ We solve this problem in a similar manner

$$\lim_{n\to\infty} \frac{(8+n)^2}{5n^2+3} = \lim_{n\to\infty} \frac{64+16n+n^2}{5n^2+3}$$

$$= \lim_{n\to\infty} \frac{(64+16n+n^2)\frac{1}{n^2}}{(5n^2+3)\frac{1}{n^2}}$$

$$= \lim_{n\to\infty} \frac{\left(\frac{64}{n^2}+\frac{16}{n}+1\right)}{5+\frac{3}{n^2}}$$

$$= \frac{\lim_{n\to\infty} \frac{64}{n^2} + \lim_{n\to\infty} \frac{3}{n} + \lim_{n\to\infty} 1}{\lim_{n\to\infty} 5 + \lim_{n\to\infty} \frac{3}{n^2}} = \boxed{\frac{1}{5}}$$

$\to 0$ $\to 0$

$\to 0$

#3

$$\lim_{n\to\infty} \frac{3n^3+\frac{1}{3^n}}{4n^2+n} =$$

$$= \lim_{n\to\infty} \frac{\left(3n^3+\frac{1}{3^n}\right)\frac{1}{n^2}}{(4n^2+n)\frac{1}{n^2}} =$$

$$= \lim_{n\to\infty} \frac{\left(3n+\frac{1}{3^n\cdot n^2}\right)}{4+\frac{1}{n}} =$$

$\to 0$ diverges

$$= \frac{\lim_{n\to\infty}(3n) + \lim_{n\to\infty}\frac{1}{3^n\cdot n^2}}{\lim_{n\to\infty} 4 + \lim_{n\to\infty}\frac{1}{n}} = \frac{\infty}{4} = \infty$$

$\to 0$