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$$f_2 = \frac{z^2}{(z+1)^2}$$

$$g(z) = (z+1)^2 \cdot \frac{z^2}{(z+1)^2} = z^2$$

$$g'(z) = 2z$$

$$\text{Res}(f_2, -1) = \lim_{z \rightarrow -1} \frac{g'(z)}{1} = \lim_{z \rightarrow -1} 2z = -2$$