A gas cell contains 50% H<sub>2</sub> and 50% N<sub>2</sub> by volume at a pressure of 200 kPa and a temperature of 500 K. A laser beam with a pulse energy of 1.0 J, a pulse length of 1 μsec, and a wavelength of 400 nm is focused to a diameter of 200 μm in the cell. Raman scattering is collected by a 100-mm-diameter, 100-mm-focal-length lens placed 200 mm from the 1-mm-long probe volume. The laser is linearly polarized in the z-direction and the collection lens is placed along the x-axis.

Calculate the number of photons collected by the lens in a single laser pulse due to Raman scattering from:

(a) the nitrogen Q-branch, v = 0 → v = 1, both polarizations detected
(b) the Q(1) line of the v = 0 → v = 1 transition of hydrogen, \( I_{zz}^\Omega \) detected
(c) the O(6) line of the v = 0 → v = 1 transition of nitrogen, both polarizations detected