65. (a) If both mirrors are perfectly reflecting, there is a node at each end of the crystal. With one end partially silvered, there is a node very close to that end. We assume nodes at both ends, so there are an integer number of half-wavelengths in the length of the crystal. The wavelength in the crystal is $\lambda_c = \lambda/n$, where λ is the wavelength in a vacuum and n is the index of refraction of ruby. Thus $N(\lambda/2n) = L$, where N is the number of standing wave nodes, so

$$N = \frac{2nL}{\lambda} = \frac{2(1.75)(0.0600\,\mathrm{m})}{694 \times 10^{-9}\,\mathrm{m}} = 3.03 \times 10^5 \ .$$

(b) Since $\lambda = c/f$, where f is the frequency, $N = 2nLf/c$ and $\Delta N = (2nL/c)\,\Delta f$. Hence,

$$\Delta f = \frac{c\,\Delta N}{2nL} = \frac{(2.998 \times 10^8\,\mathrm{m/s})(1)}{2(1.75)(0.0600\,\mathrm{m})} = 1.43 \times 10^9\,\mathrm{Hz} \ .$$

(c) The speed of light in the crystal is c/n and the round-trip distance is $2L$, so the round-trip travel time is $2nL/c$. This is the same as the reciprocal of the change in frequency.

(d) The frequency is $f = c/\lambda = (2.998 \times 10^8\,\mathrm{m/s})/(694 \times 10^{-9}\,\mathrm{m}) = 4.32 \times 10^{14}\,\mathrm{Hz}$ and the fractional change in the frequency is $\Delta f/f = (1.43 \times 10^9\,\mathrm{Hz})/(4.32 \times 10^{14}\,\mathrm{Hz}) = 3.31 \times 10^{-6}$.