TL 9-96 (Vibrational spectrum of hydrogen molecule)

a) For an H_2 molecule,

$$\mu = \frac{m_1 m_2}{m_1 + m_2} = 0.5 \text{ amu}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}} = \frac{1}{2\pi}\sqrt{\frac{580 \text{ N/m}}{0.5 \text{ amu}}} = 133 \text{ THz}$$

$$\boxed{\lambda_{photon} = 2.25_{\mu m}}$$ for transition between any 2 energy level

b) for H-D molecule

$\mu = 0.67$ amu

$f = 115$ THz

$$\boxed{\lambda = 2.61_{\mu m}}$$

c) for D-D molecule

$\mu = 1.0007$ amu

$f = 94$ THz

$$\boxed{\lambda = 3.19_{\mu m}}$$