

Chapter 37 Problem 20 [†]

Given

$$f = 1.32 \times 10^{14} \text{ Hz}$$

Solution

Find the spacing between vibration energy levels.

In a harmonic oscillator the energy levels are given by

$$E_n = (n + \frac{1}{2})\hbar\omega$$

The difference between two levels is

$$\Delta E = E_n - E_{n-1} = (n + \frac{1}{2})\hbar\omega - ((n - 1) + \frac{1}{2})\hbar\omega$$

$$\Delta E = (n + \frac{1}{2} - n + 1 - \frac{1}{2})\hbar\omega = \hbar\omega$$

Since $\hbar = h/2\pi$ and $\omega = 2\pi f$, then

$$\Delta E = \frac{h}{2\pi} 2\pi f = hf$$

Substitute in the appropriate values gives

$$\Delta E = (6.63 \times 10^{-34} \text{ J} \cdot \text{s})(1.32 \times 10^{14} \text{ Hz}) = 8.75 \times 10^{-20} \text{ J}$$

Converting this to electron volts gives

$$\Delta E = 0.547 \text{ eV}$$

[†]Problem from Essential University Physics, Wolfson