Question

The energy equation for a vibrating diatomic molecule is:

$$\frac{1}{2}mv^2 + V(y) = E,$$

where y is the bond extension, $v = \frac{dy}{dx}$, m is the reduced mass, $V(y)$ is the potential energy, E is the total energy. An approximation to $V(y)$ is given by the Morse potential.

$$Y(y) = d(1 - e^{-by})^2$$

where d and b are positive constants. Sketch a rough graph of this function. By expanding $V(y)$ in powers of y show that in the harmonic approximation, when y is regarded as a small quantity, the molecule vibrates with a frequency:

$$f = \frac{1}{2\pi}\sqrt{\frac{2db^2}{m}}.$$

Answer