

LATEX PRACTICE

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$$U(x) = \frac{mw^2x^2}{2}$$

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

$$\psi_0(x) = \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2}$$

$$-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \psi(x) + U(x)\psi(x) = E\psi(x)$$

$$\beta = \sqrt{\frac{m\omega}{\hbar}}$$

Build $-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \psi(x)$

$$\psi'_0(x) = \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2} (-\beta^2x)$$

$$\psi''_0(x) = \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} \left[\left(e^{-\frac{1}{2}\beta^2x^2} \times -\beta^2\right) + \left(e^{-\frac{1}{2}\beta^2x^2} (-\beta^2x) \times -\beta^2x\right) \right]$$

$$= \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2} [(-\beta^2) + \beta^4x^2]$$

$$= \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2} (\beta^2) [\beta^2x^2 - 1]$$

$$-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \psi(x) = \left(-\frac{\hbar^2}{2m}\right) \left(\left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2} (\beta^2) [\beta^2x^2 - 1] \right)$$

Build $U(x)\psi(x)$

$$U(x)\psi(x) = \left(\frac{mw^2x^2}{2}\right) \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2x^2}$$

Build $E\psi(x)$

$$E_0 = \frac{\hbar\omega}{2}$$

$$E_0\psi(x) = \frac{\hbar\omega}{2} \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2}$$

End result

$$\begin{aligned} & \left(-\frac{\hbar^2}{2m}\right) \left(\left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} (\beta^2) [\beta^2 x^2 - 1]\right) + \left(\frac{mw^2 x^2}{2}\right) \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} = \frac{\hbar\omega}{2} \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} \\ & \left(-\frac{\hbar^2}{2m}\right) \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} (\beta^2) [\beta^2 x^2 - 1] + \left(\frac{mw^2 x^2}{2}\right) \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} = \frac{\hbar\omega}{2} \left(\frac{\beta^2}{\pi}\right)^{\frac{1}{4}} e^{-\frac{1}{2}\beta^2 x^2} \\ & \left(-\frac{\hbar^2}{2m}\right) e^{-\frac{1}{2}\beta^2 x^2} (\beta^2) [\beta^2 x^2 - 1] + \left(\frac{mw^2 x^2}{2}\right) e^{-\frac{1}{2}\beta^2 x^2} = \frac{\hbar\omega}{2} e^{-\frac{1}{2}\beta^2 x^2} \\ & \left(-\frac{\hbar^2}{2m}\right) (\beta^2) [\beta^2 x^2 - 1] + \left(\frac{mw^2 x^2}{2}\right) = \frac{\hbar\omega}{2} \\ & \left(-\frac{\hbar^2}{2m}\right) \left(\frac{m\omega}{\hbar}\right) [\beta^2 x^2 - 1] + \left(\frac{mw^2 x^2}{2}\right) = \frac{\hbar\omega}{2} \\ & \left(-\frac{\hbar}{2}\right) (\omega) \left[\left(\frac{m\omega}{\hbar}\right) x^2 - 1\right] + \left(\frac{mw^2 x^2}{2}\right) = \frac{\hbar\omega}{2} \\ & \left(-\frac{\hbar\omega}{2}\right) \left[\left(\frac{m\omega}{\hbar}\right) x^2 - 1\right] + \left(\frac{mw^2 x^2}{2}\right) = \frac{\hbar\omega}{2} \\ & -\left(\frac{mw^2 x^2}{2}\right) + \frac{\hbar\omega}{2} + \left(\frac{mw^2 x^2}{2}\right) = \frac{\hbar\omega}{2} \\ & \frac{\hbar\omega}{2} = \frac{\hbar\omega}{2} \end{aligned}$$