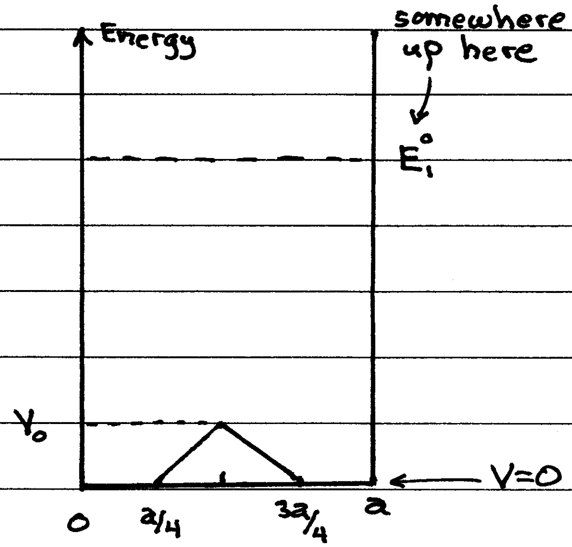
PREPARED BY
DATE

Time Independent Perturbation Theory (Example)



$$V(x) = \begin{cases} 0 & 0 \le x \le a/4 \\ V_0\left(\frac{4x}{a}-1\right) & a/4 \le x \le a/2 \\ V_0\left(-\frac{4x}{a}+3\right) & a/2 \le x \le 3a/4 \\ 0 & 3a/4 \le x \le a \end{cases}$$

$$H = H^\circ + H' \qquad H' = V(x)$$

1. Calculate the 1^{st} and 2^{nd} order corrections to the energy levels ($n=1$, and $n=2$)

2. Calculate the 1^{st} order correction to the $n=1$ and $n=2$ wavefunctions.

1.

$$E_n^1 = \langle \psi_n^\circ | H' | \psi_n^\circ \rangle = \langle \psi_n^\circ | V(x) | \psi_n^\circ \rangle$$

$$E_1^1 = 0.452642 \; V_0 = 0.452642 \left(\frac{V_0}{E_1^\circ}\right) E_1^\circ$$

$$E_2^1 = 0.148679 \; V_0 = \cdots\cdots \to 0.148679 \left(\frac{V_0}{E_1^\circ}\right) E_1^\circ$$

$$E_3^1 = 0.272516 \; V_0$$

$$E_n^2 = \sum_{m \ne n} \frac{\left|\langle \psi_m^\circ | H' | \psi_n^\circ \rangle\right|^2}{E_n^\circ - E_m^\circ} \qquad E_n = \frac{n^2\pi^2\hbar^2}{2ma^2} = n^2 E_1^\circ$$

$n=1$

$$E_1^2 = -0.0121996 \; V_0 \left(\frac{V_0}{E_1^\circ}\right) \qquad m = 2, 3, 4, \ldots, 9, 10$$

$n=2$

$$E_2^2 = -0.00302939 \; V_0 \left(\frac{V_0}{E_1^\circ}\right) \qquad m = 1, 3, 4, \ldots, 9, 10$$

$$E_1 = E_1^\circ + E_1^1 + E_1^2 + \cdots = E_1^\circ \left(1 + 0.452642\left(\frac{V_0}{E_1^\circ}\right) - 0.0121996\left(\frac{V_0}{E_1^\circ}\right)^2\right)$$

$$E_2 = E_2^\circ + E_2^1 + E_2^2 = E_2^\circ \left(1 + 0.0371697\left(\frac{V_0}{E_1^\circ}\right) - 0.00075\left(\frac{V_0}{E_1^\circ}\right)^2 + \cdots\right)$$