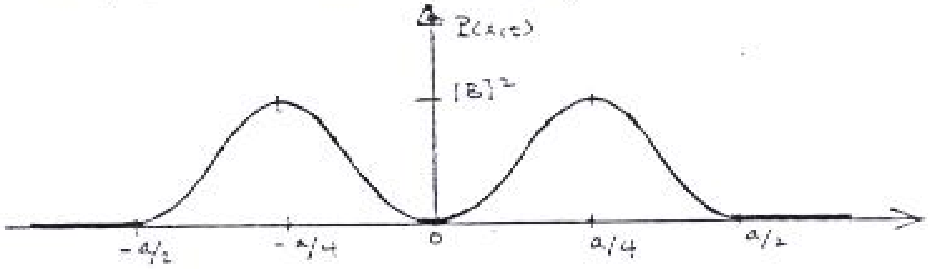
a) $E_2 = ?$

$$H\psi_2 = -\frac{\hbar^2}{2m}\frac{\partial^2\psi_2}{\partial x^2} = \left(\frac{2\pi}{a}\right)^2\frac{\hbar^2}{2m}\psi_2 \rightarrow \boxed{E_2 = \frac{2}{m}\left(\frac{\pi\hbar}{a}\right)^2}$$

b) $P(x,t) = |\psi_2(x,t)|^2 = |B|^2 \sin^2\left(\frac{2\pi x}{a}\right)$



c) $B = ?$

Normalization: $\int_{-\infty}^{+\infty}|\psi_2(x,t)|^2 dx = 1 \Rightarrow |B|^2\int_{-a/2}^{a/2}\sin^2\left(\frac{2\pi x}{a}\right)dx = \frac{|B|^2}{2}\int_{-a/2}^{a/2}dx$

$$\boxed{B = \sqrt{2/a} = A}$$

d) $\langle x\rangle = ?$

$$\langle x\rangle = \int_{-\infty}^{+\infty}\psi_2^* \, x \, \psi_2 \, dx = |B|^2\int_{-a/2}^{a/2} x \sin^2\left(\frac{2\pi x}{a}\right)dx = 0$$

e) $\langle p\rangle = ?$

$$\langle p\rangle = \frac{2\pi}{a}\frac{\hbar}{i}|B|^2\int_{-a/2}^{a/2}\sin\left(\frac{2\pi x}{a}\right)\cos\left(\frac{2\pi x}{a}\right)dx = 0$$

f) $\Delta x = ?$

$$\Delta x = \sqrt{\langle x^2\rangle} = \left\{\frac{2}{a}\int_{-a/2}^{a/2}x^2\sin^2\left(\frac{2\pi x}{a}\right)dx\right\}^{1/2} = \frac{a}{2}\sqrt{\frac{1}{3}-\frac{1}{2\pi^2}}$$

g) $\Delta p = ?$

$$\Delta p = \sqrt{\langle p^2\rangle} = \left\{\left(\frac{2\pi}{a}\right)^2\hbar^2\int_{-a/2}^{a/2}|\psi|^2dx\right\}^{1/2} = \frac{2\pi\hbar}{a}$$

h) $\Delta x \cdot \Delta p = ?$

$$\boxed{\Delta x\cdot\Delta p = \pi\hbar\sqrt{\frac{1}{3}-\frac{1}{2\pi^2}} \simeq 1.7\hbar} > (\Delta x\cdot\Delta p)_1$$

this is due to the fact that when the energy increases the uncertainty on the position Δx,