5 (4.6) a) <u>No</u>, the particle will not remain localized at later times.

It is made up of <u>lots</u> of energy eigenfunctions, each w/ diff. time dependence. Each mode will bounce around w/ diff freq. ($= E/\hbar$) which will cause the packet to spread w/ time.

b) $A_1 \equiv$ amplitude that ψ is in state u_1

$$A_1 = \int dx\, u_1^*(x)\, \psi(x) = \int_{-a/2}^{0} dx \left[\sqrt{\frac{2}{a}} \cos\left(\frac{\pi x}{a}\right)\right]\left[\sqrt{\frac{2}{a}}\right]$$

$$= \frac{2}{a}\left[\frac{a}{\pi} \sin\left(\frac{\pi x}{a}\right)\right]_{-a/2}^{0} = \frac{2}{\pi}\left(0 - \sin\left(-\frac{\pi}{2}\right)\right) = \frac{2}{\pi}$$

$P_1 \equiv$ prob that ψ is in state $u_1 = |A_1|^2$

$$\boxed{P_1 = \frac{4}{\pi^2}}$$

$$A_2 = \int dx\, u_2^*(x)\, \psi(x) = \int_{-a/2}^{0} dx \left[\sqrt{\frac{2}{a}} \sin\left(\frac{2\pi x}{a}\right)\right]\left[\sqrt{\frac{2}{a}}\right]$$

$$= \frac{2}{a}\left[-\frac{a}{2\pi} \cos\left(\frac{2\pi x}{a}\right)\right]_{-a/2}^{0} = -\frac{1}{\pi}\left(1 - (-1)\right) = -\frac{2}{\pi}$$

$P_2 = |A_2|^2$

$$\Rightarrow \boxed{P_2 = \frac{4}{\pi^2}}$$