Function $b(t) = \frac{t}{\tau}$ is very slow since $\tau \gg \frac{\hbar}{\epsilon}$. Therefore, the process is adiabatic up until $t = \tau$. In other words the system remains in the ground state until $t = \tau$. Then the Hamiltonian undergoes a sudden change. The wave function stays the same during this sudden change. However, the ground state of the Hamiltonian is now different. The probability of finding the system in this new ground state (which happens to be the same ground state as at $t = -\infty$) is given by

$$P = |\langle \psi_{ground}(t=\tau^+) | \psi_{ground}(t=\tau^-) \rangle|^2$$

At $t = \tau^+$ (or $t = -\infty$) $\quad H = \epsilon \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}$

and $\psi_{ground} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad E_{ground} = \epsilon$

At $t = \tau^-$ $\quad H = \epsilon \begin{pmatrix} 1 & \sqrt{\frac{3}{2}} & 0 \\ \sqrt{\frac{3}{2}} & 2 & \sqrt{\frac{3}{2}} \\ 0 & \sqrt{\frac{3}{2}} & 3 \end{pmatrix} \quad \underbrace{E_1 = 0}_{E_{ground}} \quad E_2 = 2\epsilon \quad E_3 = 4\epsilon$

and $\psi_{ground} = \begin{pmatrix} 3/4 \\ -\sqrt{6}/4 \\ 1/4 \end{pmatrix}$ [I skip elementary linear algebra]

Then

$$P = \left| (1\ 0\ 0) \begin{pmatrix} 3/4 \\ -\sqrt{6}/4 \\ 1/4 \end{pmatrix} \right|^2 = \frac{9}{16}$$