22. (a) and (b) In the region $0 < x < L$, $U_0 = 0$, so Schrödinger's equation for the region is

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2} E\psi = 0$$

where $E > 0$. If $\psi^2(x) = B \sin^2 kx$, then $\psi(x) = B' \sin kx$, where B' is another constant satisfying $B'^2 = B$. Thus $d^2\psi/dx^2 = -k^2 B' \sin kx = -k^2\psi(x)$ and

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2} E\psi = -k^2\psi + \frac{8\pi^2 m}{h^2} E\psi \ .$$

This is zero provided that

$$k^2 = \frac{8\pi^2 mE}{h^2} \ .$$

The quantity on the right-hand side is positive, so k is real and the proposed function satisfies Schrödinger's equation. In this case, there exists no physical restriction as to the sign of k. It can assume either positive or negative values. Thus

$$k = \pm\frac{2\pi}{h}\sqrt{2mE} \ .$$