

1. The first part of the problem asks for the energy levels of a particle in a potential well. The potential is given by  $V(x) = 0$  for  $0 < x < a$  and  $V(x) = \infty$  for  $x < 0$  and  $x > a$ . The wave function must be zero at  $x = 0$  and  $x = a$ . The general solution for the wave function in the region  $0 < x < a$  is  $\psi(x) = A \sin(kx) + B \cos(kx)$ . Applying the boundary conditions  $\psi(0) = 0$  and  $\psi(a) = 0$  leads to  $B = 0$  and  $\sin(ka) = 0$ . This implies  $ka = n\pi$  for  $n = 1, 2, 3, \dots$ . The energy levels are given by  $E_n = \frac{\hbar^2 k^2}{2m} = \frac{\hbar^2 n^2 \pi^2}{2ma^2}$ .

2. The second part of the problem asks for the probability of finding the particle in a certain region. The wave function is  $\psi(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ . The probability of finding the particle between  $x_1$  and  $x_2$  is  $P = \int_{x_1}^{x_2} |\psi(x)|^2 dx = \frac{2}{a} \int_{x_1}^{x_2} \sin^2\left(\frac{n\pi x}{a}\right) dx$ . Using the identity  $\sin^2(\theta) = \frac{1 - \cos(2\theta)}{2}$ , the integral can be evaluated to give  $P = \frac{x_2 - x_1}{a} - \frac{\sin(2n\pi x_2/a)}{4n\pi} + \frac{\sin(2n\pi x_1/a)}{4n\pi}$ .