

PHYSICS 551 - QUANTUM MECHANICS  
PROBLEM SET 10

1. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

2. Consider a particle in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The energy eigenvalues are  $E_n = \left(n + \frac{1}{2}\right)\hbar\omega$  and the eigenfunctions are  $\psi_n(x) = \frac{1}{\sqrt{2^n n!}} \left(\frac{m\omega}{\pi\hbar}\right)^{1/4} e^{-\frac{m\omega x^2}{2\hbar}} H_n\left(\sqrt{\frac{m\omega}{\hbar}}x\right)$ .

3. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

4. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

5. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

6. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

7. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

8. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .

9. A particle of mass  $m$  is confined to a one-dimensional infinite potential well of width  $a$ . The potential is zero for  $0 < x < a$  and infinite elsewhere. The wave function  $\psi(x)$  is real and satisfies the boundary conditions  $\psi(0) = \psi(a) = 0$ . The energy eigenvalues are  $E_n = \frac{n^2 \pi^2 \hbar^2}{2ma^2}$  and the corresponding eigenfunctions are  $\psi_n(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi x}{a}\right)$ .