

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 435

PROBLEM SET 1

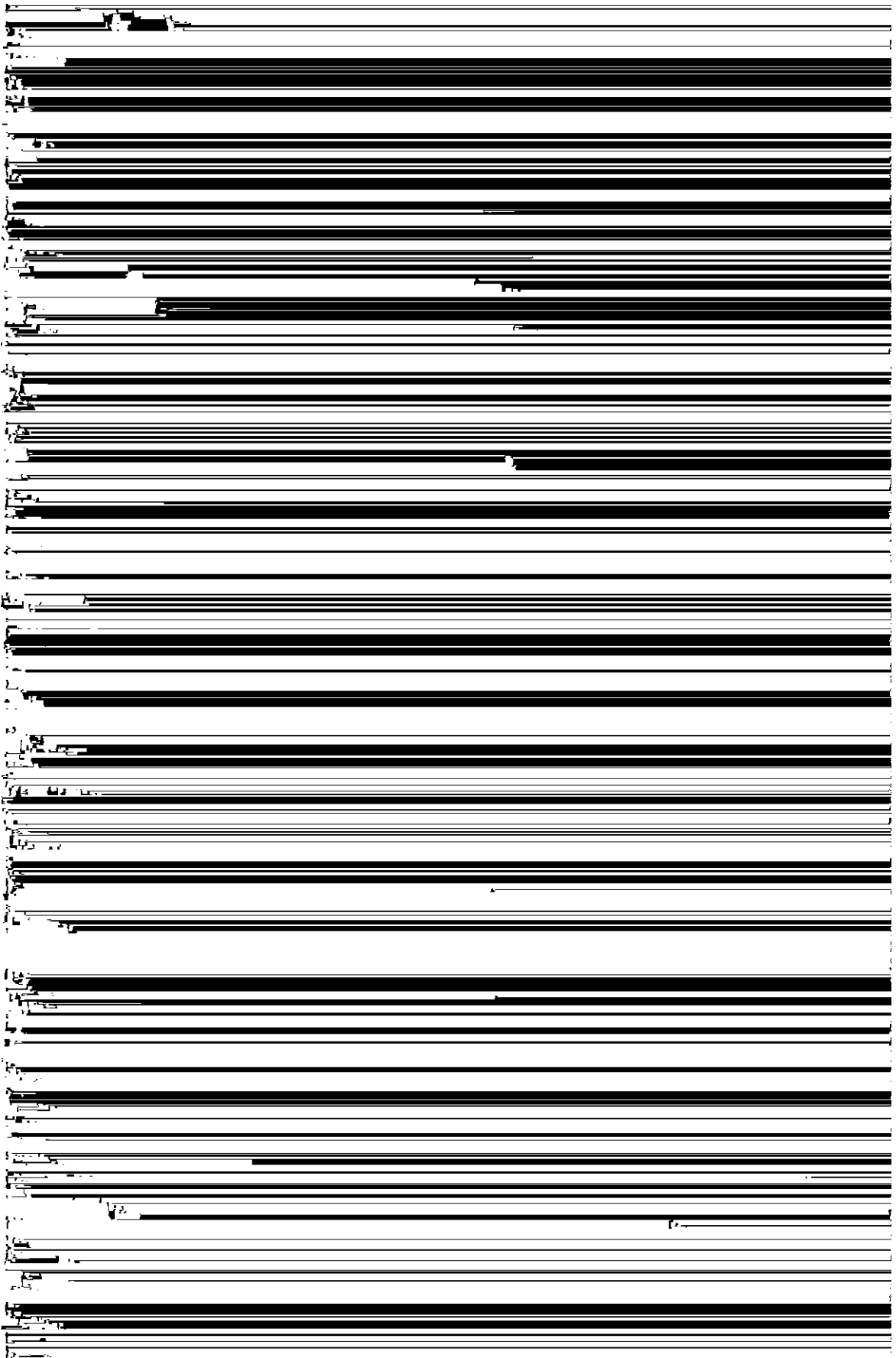
1. A particle of mass  $m$  moves in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The wave function  $\psi(x)$  satisfies the Schrödinger equation  $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \frac{1}{2}kx^2\psi = E\psi$ . For the ground state,  $\psi(x) = A e^{-\alpha x^2}$ . Find  $\alpha$  and  $E$ .

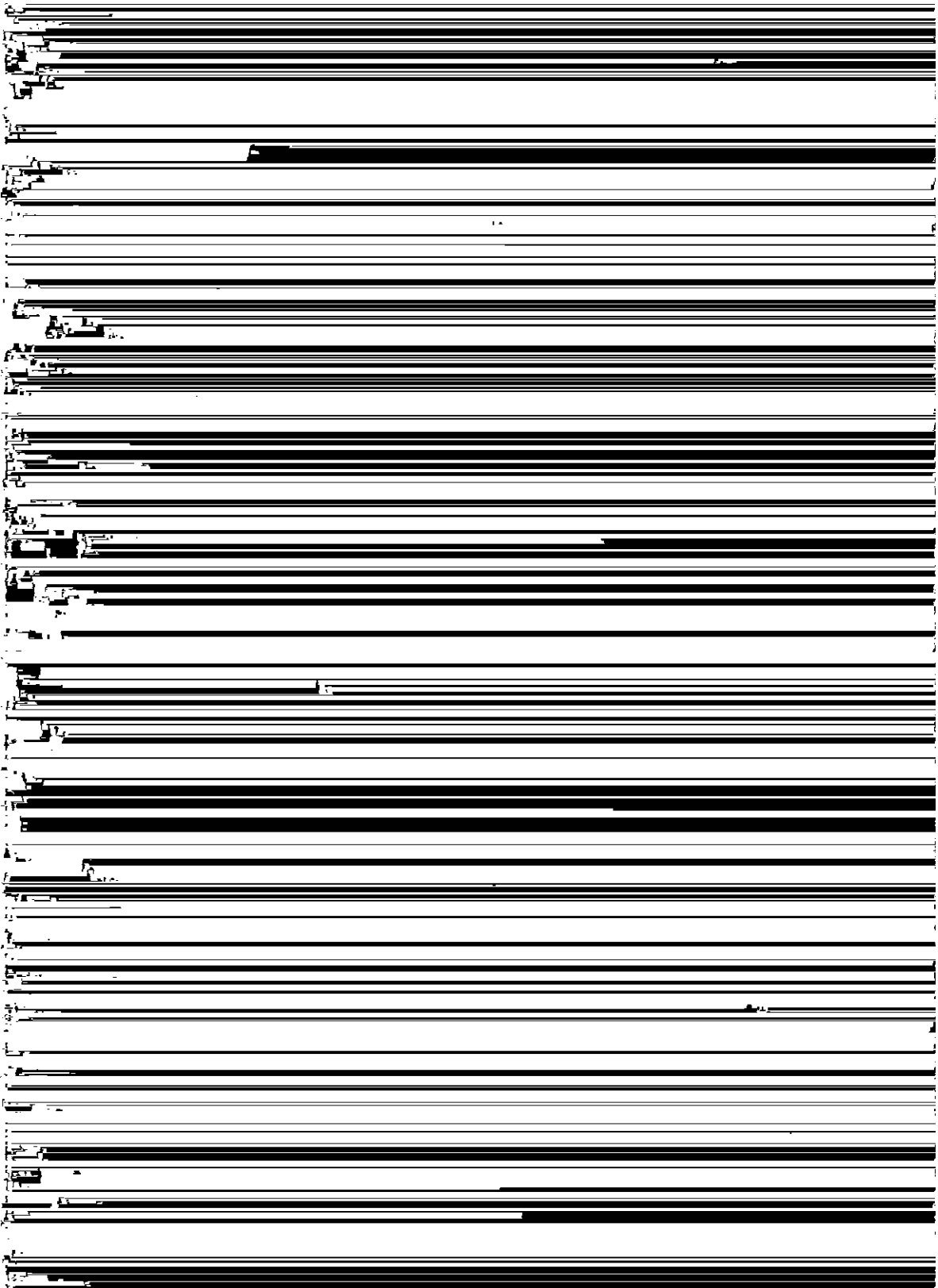
2. A particle of mass  $m$  moves in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The wave function  $\psi(x)$  satisfies the Schrödinger equation  $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \frac{1}{2}kx^2\psi = E\psi$ . For the first excited state,  $\psi(x) = B x e^{-\alpha x^2}$ . Find  $\alpha$  and  $E$ .

3. A particle of mass  $m$  moves in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The wave function  $\psi(x)$  satisfies the Schrödinger equation  $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \frac{1}{2}kx^2\psi = E\psi$ . For the second excited state,  $\psi(x) = C (x^2 - \beta) e^{-\alpha x^2}$ . Find  $\alpha$ ,  $\beta$ , and  $E$ .

4. A particle of mass  $m$  moves in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The wave function  $\psi(x)$  satisfies the Schrödinger equation  $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \frac{1}{2}kx^2\psi = E\psi$ . For the third excited state,  $\psi(x) = D (x^3 - \gamma x) e^{-\alpha x^2}$ . Find  $\alpha$ ,  $\gamma$ , and  $E$ .

5. A particle of mass  $m$  moves in a one-dimensional potential  $V(x) = \frac{1}{2}kx^2$ . The wave function  $\psi(x)$  satisfies the Schrödinger equation  $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \frac{1}{2}kx^2\psi = E\psi$ . For the fourth excited state,  $\psi(x) = E (x^4 - \delta x^2 + \epsilon) e^{-\alpha x^2}$ . Find  $\alpha$ ,  $\delta$ ,  $\epsilon$ , and  $E$ .







[REDACTED]

[REDACTED]

