

Problem 1

$$\text{In}[*]:= \psi[x_] = \left(\frac{\alpha}{\sqrt{\pi}} \right)^{1/2} e^{-\frac{\alpha^2 x^2}{2}};$$

(b) Computing $|p_x|$

$$\text{In}[*]:= \text{Assuming}[\alpha > 0 \ \&\& \ \hbar > 0, \left(\int_{-\infty}^{\infty} \psi[x]^* (-\hbar^2 \partial_{x,x} \psi[x]) dx \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[*]= \sqrt{\frac{3}{2}} \alpha \hbar$$

(c) Computing Δx

$$\text{In}[*]:= \text{Assuming}[\alpha > 0, \left(\int_{-\infty}^{\infty} x^2 \psi[x]^* \times \psi[x] dx - \left(\int_{-\infty}^{\infty} x \psi[x]^* \times \psi[x] dx \right)^2 \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[*]= \frac{\sqrt{\frac{3}{2}}}{\alpha}$$

Computing Δp_x

$$\text{In}[*]:= \text{Assuming}[\alpha > 0 \ \&\& \ \hbar > 0, \left(\int_{-\infty}^{\infty} \psi[x]^* (-\hbar^2 \partial_{x,x} \psi[x]) dx - \left(\int_{-\infty}^{\infty} \psi[x]^* (-i \hbar \partial_x \psi[x]) dx \right)^2 \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[*]= \sqrt{\frac{3}{2}} \alpha \hbar$$

(d) Computing $\langle x^2 \rangle$

$$\text{In}[*]:= \text{Assuming}[\alpha > 0, \int_{-\infty}^{\infty} x^2 \psi[x]^* \times \psi[x] dx // \text{FullSimplify}]$$

$$\text{Out}[*]= \frac{3}{2 \alpha^2}$$

Problem 2

$$\text{In}[1]:= \psi[x_] = \left(\frac{\alpha}{\sqrt{\pi}} \right)^{1/2} e^{-\frac{\alpha^2 x^2}{2}};$$

(b) Computing $|p_x|$

$$\text{In}[2]:= \text{Assuming}[\alpha > 0 \ \&\& \ \hbar > 0, \left(\int_{-\infty}^{\infty} \psi[x]^* (-\hbar^2 \partial_{x,x} \psi[x]) dx \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[2]= \frac{\alpha \hbar}{\sqrt{2}}$$

(c) Computing Δx

$$\text{In}[3]:= \text{Assuming}[\alpha > 0, \left(\int_{-\infty}^{\infty} x^2 \psi[x]^* \times \psi[x] dx - \left(\int_{-\infty}^{\infty} x \psi[x]^* \times \psi[x] dx \right)^2 \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[3]= \frac{1}{\sqrt{2} \alpha}$$

Computing Δp_x

$$\text{In}[4]:= \text{Assuming}[\alpha > 0 \ \&\& \ \hbar > 0, \left(\int_{-\infty}^{\infty} \psi[x]^* (-\hbar^2 \partial_{x,x} \psi[x]) dx - \left(\int_{-\infty}^{\infty} \psi[x]^* (-i \hbar \partial_x \psi[x]) dx \right)^2 \right)^{1/2} // \text{FullSimplify}]$$

$$\text{Out}[4]= \frac{\alpha \hbar}{\sqrt{2}}$$