2 (4.1) Linear operators satisfy (4-8) and (4-9). I'll check each:

a) (4-9): $O_1(c\psi) = x^3(c\psi) = c\,x^3\psi = c\,O_1\psi$ ✓

(4-8) $O_1(\psi_1+\psi_2) = x^3(\psi_1+\psi_2) = x^3\psi_1 + x^3\psi_2 = O_1\psi_1 + O_1\psi_2$ ✓

$\Rightarrow$ O_1 is linear

b) (4-9): $O_2(c\psi) = x\frac{d}{dx}(c\psi) = c\,x\frac{d}{dx}\psi = c\,O_2\psi$ ✓

(4-8): $O_2(\psi_1+\psi_2) = x\frac{d}{dx}(\psi_1+\psi_2) = x\frac{d}{dx}\psi_1 + x\frac{d}{dx}\psi_2 = O_2\psi_1 + O_2\psi_2$ ✓

$\Rightarrow$ O_2 is linear

c) (4-9): $O_3(c\psi) = \lambda(c\psi)^* = \lambda c^*\psi^* = c^*\lambda\psi^* = c^*O_3\psi \neq cO_3\psi$

$\Rightarrow$ O_3 is NOT linear

d) (4-9): $O_4(c\psi) = e^{(c\psi)} \neq ce^{\psi} = cO_4\psi$

$\Rightarrow$ O_4 is NOT linear

e) (4-9): $O_5(c\psi) = \frac{d}{dx}(c\psi) + a = c\left(\frac{d}{dx}\psi + \frac{a}{c}\right) \neq c\left(\frac{d}{dx}\psi + a\right) = c\,O_5\psi$

$\Rightarrow$ O_5 is NOT linear

f) (4-9): $O_6(c\psi) = \int_{-\infty}^{x} dx'\left((c\psi(x'))x'\right) = c\int_{-\infty}^{x} dx'\left((\psi(x'))x'\right) = c\,O_6\psi$ ✓

(4-8): $O_6(\psi_1+\psi_2) = \int_{-\infty}^{x} dx'\left((\psi_1(x') + \psi_2(x'))x'\right)$

$= \int_{-\infty}^{x} dx'\,(\psi_1(x')\,x') + \int_{-\infty}^{x} dx'\,(\psi_2(x')\,x') = O_6\psi_1 + O_6\psi_2$ ✓

$\Rightarrow$ O_6 is linear

3. (4.4) $\langle x^2\rangle = \int dx\, u_n^*(x)\,x^2\,u_n(x) = \frac{2}{a}\int_0^a dx\; x^2\sin^2\left(\frac{n\pi x}{a}\right)$

$= \frac{2}{a}\left\{\frac{a^3}{24\pi^3 n^3}\left(4n^2\pi^2 - 6n\pi\right)\right\}$ by Mathematica

$= a^2\left[\frac{1}{3} - \frac{1}{2n^2\pi^2}\right]$

$\Rightarrow$ $\boxed{\Delta x = \sqrt{\langle x^2\rangle} = a\sqrt{\frac{1}{3} - \frac{1}{2n^2\pi^2}}}$

(4-26) gives $\langle p^2\rangle = \frac{\hbar^2\pi^2n^2}{a^2}$; (4-25) shows $\langle p\rangle = 0$

$\Rightarrow \Delta p = \sqrt{\langle p^2\rangle} = \frac{\hbar\pi n}{a}$

$\Rightarrow$ $\boxed{\Delta p\,\Delta x = \hbar\sqrt{\frac{1}{3}\pi^2n^2 - \frac{1}{2}}}$