1. Airline passengers frequently observe the wing-tips of their planes oscillating up and down with periods of the order of 1 sec and amplitudes of about 0.1 m.

(a) Prove that this is definitely not due to the zero-point motion of the wings by comparing the zero-point energy with the energy obtained from the quoted values plus an estimated mass for the wings. Take the mass of the wings to be 2000 kg.

(b) Calculate the order of magnitude of the quantum number n of the observed oscillation.

2. Reed, Chapter 5, 5-5

3. Reed, Chapter 5, 5-6

4. Reed, Chapter 5, 5-7

5. Reed, Chapter 5, 5-16

6. (a) Use the raising and lowering operators, $A^+$ and $A^-$, plus the following:

\begin{align*}
A^+ \Psi_n &= i\sqrt{n + 1}\Psi_{n+1} \\
A^- \Psi_n &= -i\sqrt{n}\Psi_{n-1}
\end{align*}

\begin{align*}
\hat{p}_{op} &= \frac{\alpha \hbar}{\sqrt{2}} (A^+ + A^-) \\
\hat{x}_{op} &= -\frac{i}{\sqrt{2\alpha}} (A^+ - A^-)
\end{align*}

and orthogonality to show that $\langle x \rangle = \langle p \rangle = 0$.

(b) Use the raising and lowering operators to evaluate an expression for $\langle x^2 \rangle$.

(c) Now do: Reed, Chapter 5, 5-17

7. Reed, Chapter 5, 5-18