1 Fourier Transform of Cosine and Sine

(a) Find the Fourier transforms of $f(x) = \cos kx$ and $g(x) = \sin kx$.

(b) Find the Fourier transform of $g(x)$ using the formula for the Fourier transform of a derivative and your result for the Fourier transform of $f(x)$. Compare with your previous answer.

(c) In quantum mechanics, the Fourier transform is the set of coefficients in the expansion of a quantum state in terms of plane waves, i.e. the function $\tilde{f}(k)$ is a continuous histogram of how much each functions e^{ikx} contributes to the quantum state. What does the Fourier transform of the function $\cos kx$ tell you about which plane waves make up this quantum state? Write a sentence or two about how this makes sense.