Phys 325 Quantum Mechanics I (Fall 2021) First Homework

Use the following functions for $f(x)$ and $g(x)$, where a is a positive constant:

$$f(x) = \begin{cases} -1 & \text{for } -a < x < 0 \\ +1 & \text{for } 0 < x < a \\ 0 & \text{otherwise} \end{cases} \qquad g(x) = \begin{cases} a^2 - x^2 & \text{for } |x| < a \\ 0 & \text{otherwise} \end{cases}$$

(a) $\int_{-\infty}^{\infty} x g(x) f(x) dx$

(b) $\int_{-\infty}^{\infty} g(x) \frac{df}{dx} dx$

(c) $\int_{-\infty}^{\infty} f(x) \frac{dg}{dx} dx$

(d) $\int_{-\infty}^{\infty} g(x) \exp(ikx) dx$

(e) $\int_{-\infty}^{\infty} f(q) \exp(-iqx) dq$

(f) $\int_{-\infty}^{\infty} f(x) \exp(-|x|/a) dx$

(g) $\int_{-\infty}^{\infty} x f(x) \exp(-|x|/a) dx$

(h) $\int_{-\infty}^{\infty} g(x) \exp(-|x|/a) dx$

(i) $\int_{-a/2}^{a/3} x f(x) \exp(-|x|/a) dx$

(j) $\int_{-a/3}^{\infty} \frac{d^2 g}{dx^2} \exp(+|x|/a) dx$