Problem 9. Let H be the Heavyside function and v be an infinitely many times differentiable function with compact support over $\mathbb{R}$

(i.e. $\lim_{|x|\to\infty} v(x) = 0$).

Show that indeed H is infinitely many times differentiable over $\mathbb{R}$ in a distribution sense but not in a Riemann sense and

$$\sum_{k=1}^{\infty} \int_{\mathbb{R}} \frac{d^k H(x)}{dx^k} \cdot \frac{v(x)}{(k-1)!} dx = \sum_{k=1}^{\infty} (-1)^{k+1} \frac{d^{k-1} v(0)}{(k-1)!}$$