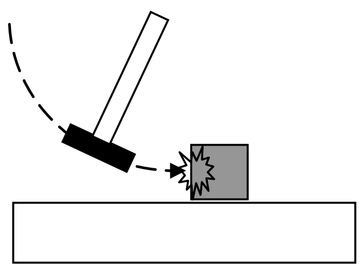
CT-1. A big steel mass, sitting on a frictionless table, is given a sharp blow to the side with a hammer. Initially, the position and velocity of the mass are $x = 0$, $dx/dt = 0$. During the collision, which lasts a few milliseconds, what happens to the velocity and the position of the mass?

A) the position increases suddenly, but the velocity stays near zero

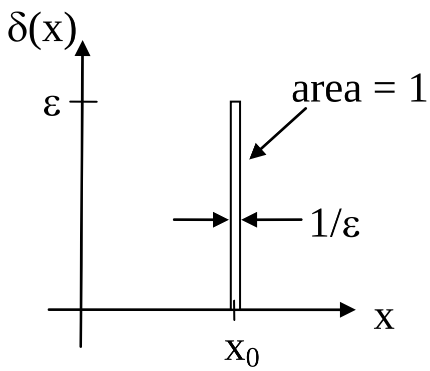
B) the velocity increases suddenly, but the position stays near zero

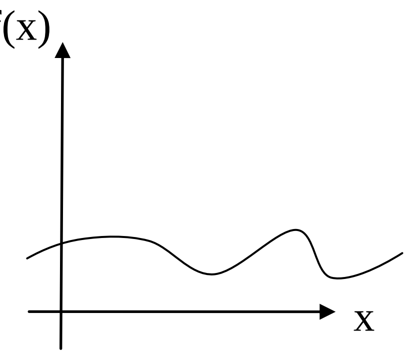
C) both the position and the velocity increase suddenly

D) neither the position nor the velocity increase suddenly



CT-2. Consider the functions $\delta(x)$ and $f(x)$ shown here. Notice that $\delta(x)$ is zero almost everywhere has integrated area = 1.





What is the approximate value of the integral $\int_{-\infty}^{+\infty} f(x)\,\delta(x)\,dx$?

A) 0 B) $f(x_0)$ C) $\varepsilon\, f(x_0)$ D) $f(0)$ E) $f(x_0)/\varepsilon$

CT-3. Consider the function $f(x) = \begin{cases} 0, & |x| > 1 \\ |x|, & |x| < 1 \end{cases}$.

Is the integral $\int_{-\infty}^{\infty} f(x)\, e^{iax}\, dx$

A) zero   B) non-zero and pure real   C) non-zero and pure imaginary

D) non-zero and complex

CT-4. Consider some linear operator **L** and consider the linear homogeneous equation **L**(x) = f(t). In general, f(t) is known, and I seek x = x(t).

Suppose I know a whole bunch of special case solutions $x_n(t)$ for a whole bunch of special functions $f_n(t)$, that is, $L(x_n) = f_n(t)$, n = 1, 2, 3,

If I am given a function $f(t) = \sum_n c_n f_n(t)$, (where c's are constants)

what is the particular solution x(t) to the equation **L**(x) = f(t)?

x(t) =

A) $\sum_n c_n \cdot x_n(t)$ B) $\sum_n \left(c_n + x_n(t)\right)$

C) $\sum_n \left(x_n(t)\right)^{c_n}$ D) $\sum_n x_n(t)$

E) Something else

CT-5.Recall that $f(t) = \int_{-\infty}^{+\infty} f(t')\,\delta(t'-t)\,dt'$

t is time and f has units of force/mass

In this equation, what are the units of $\delta(t'-t)$?

A) time   B) time^{-1} C) time^{-2} D) mass/time   E) mass/(force×time)

CT-6.Is the following operation legitimate?

$$\frac{d}{dt}\left(\int_{-\infty}^{\infty} f(t,t')dt'\right) \stackrel{?}{=} \int_{-\infty}^{\infty} \frac{d}{dt}\left[f(t,t')\right]dt'$$

A) Yes   B) No