Calculus Challenge #9

Solutions Due February 25

Faster Than a Speeding Bullet?

1. A bullet passes through a piece of wood 10 cm thick. It enters the wood at 200 m/sec and exits at 80 m/sec. It is assumed that the velocity v of the bullet while in the wood obeys the differential equation $\frac{dv}{dt} = -kv^2$.

a) How long did it take the bullet to pass through the wood?

b) Do you think this model is realistic? Explain why or why not.

2. Richard Zimmer, while working on a Science Fair project as a student at Canyon del Oro High School in Tucson, Arizona, shot a 120 grain hollow point bullet from a 300 Winchester magnum rifle and measured the velocity of the bullet as a function of distance traveled.

Distance (ft)	0	300	600	900	1200	1500
Velocity (ft/sec)	3290	2951	2636	2342	2068	1813

It is claimed that a bullet, when fired horizontally, is subject only to air resistance which is proportional to some power of velocity. This means that $\frac{dv}{dt} = -k\,v^n$.

a) Find $\frac{dv}{dx}$.

b) Use the difference quotients from the data to estimate the values of k and n.

c) Find the velocity (v) as a function of distance (x).