1. Develop an M-file to obtain first-derivative estimates for unequally spaced data. Test it with the following data:

x	0.6	1.5	1.6	2.5	3.5
$f(x)$	0.9036	0.3734	0.3261	0.08422	0.01596

where $f(x) = 5e^{-2x}\,x$. Compare your results with the true derivatives.

2. A jet fighter's position on an aircraft carrier's runway was timed during landing:

t, s	0	0.52	1.04	1.75	2.37	3.25	3.83
x, m	153	185	208	249	261	271	273

where x is the distance from the end of the carrier. Estimate **(a)** velocity (dx/dt) and **(b)** acceleration (dv/dt) using numerical differentiation.

3. The enthalpy of a real gas is a function of pressure as described below. The data were taken for a real fluid. Estimate the enthalpy of the fluid at 400 K and 50 atm (evaluate the integral from 0.1 to 50 atm).

$$H = \int_0^P \left(V - T\left(\frac{\partial V}{\partial T}\right)_P \right) dP$$

	V, L		
P, atm	$T = 350$ K	$T = 400$ K	$T = 450$ K
0.1	220	250	282.5
5	4.1	4.7	5.23
10	2.2	2.5	2.7
20	1.35	1.49	1.55
25	1.1	1.2	1.24
30	0.90	0.99	1.03
40	0.68	0.75	0.78
45	0.61	0.675	0.7
50	0.54	0.6	0.62

4. An nth-order rate law is often used to model chemical reactions that solely depend on the concentration of a single reactant:

$$\frac{dc}{dt} = -kc^n$$

where c = concentration (mole), t = time (min), n = reaction order (dimensionless), and k = reaction rate ($\text{min}^{-1}\ \text{mole}^{1-n}$). The *differential method* can be used to evaluate the parameters k and n. This involves applying a logarithmic transform to the rate law to yield,

$$\log\left(-\frac{dc}{dt}\right) = \log k + n \log c$$

Therefore, if the nth-order rate law holds, a plot of the $\log(-dc/dt)$ versus $\log c$ should yield a straight line with a slope of n and an intercept of $\log k$. Use the differential method and linear regression to determine k and n for the following data for the conversion of ammonium cyanate to urea: