

Worksheet #13 – PHY102 (Spring 2011)

Review Exercises — Part 2 of 2

These are further examples, continued from last week, of questions with the degree of difficulty that you can expect to encounter in your lab exam during the last week of class. You must use Mathematica to solve all parts of the problems.

IV. Plotting

Define $x(t) = 10t$ and $y(t) = 10t - 5t^2$.

1. Plot $x(t)$ vs. t on a graph.
2. Plot $x(t)$ vs. t and $y(t)$ vs. t , on the same graph.
3. Make a parametric plot of $(x(t), y(t))$.

V. Lists and Series

Compute

$$\sum_{j=1}^N \frac{1}{j} - \ln(N)$$

for $N = 10$ and $N = 1000$.

(Optional challenge: what is the limit for $N \rightarrow \infty$?)

VI. Ordinary differential equations

A mass $m = 1.1$ kg hangs vertically from a spring of spring constant $k = 2.2$ N/m. It is displaced from equilibrium by a small amount and then let free to oscillate. It experiences a damping force $-b\vec{v}$, where $b = 0.11$ in SI units. Assume the initial displacement is 0.01 m, with initial velocity zero.

Solve the linear differential equation for this problem:

$$x''(t) + 0.1x'(t) + 2x(t) = 0 .$$

Plot the resulting $x(t)$.

VII. Partial differential equations

Show that $\rho(x, t) = \frac{A}{t^{1/2}} \text{Exp}(-ax^2/t)$ solves the diffusion equation

$$\frac{\partial \rho(x, t)}{\partial t} = D \frac{\partial^2 \rho(x, t)}{\partial x^2},$$

provided that D is related to a . What is that relationship?