HW1:

1. What does this script do?

```
clear;
vals=1:10;
for ii=vals;
    v(ii)=rand;
    x(ii)=ii;
    pause(1);
    plot(x,v);
end
```

How would you achieve the same output with a one-line command?

2. MATLAB can be used for calculations other than data acquisition and statistical analysis. For instance, it can be used for "Monte-Carlo" calculations, which are especially useful for evaluating multidimensional integrals:
Imagine that despite your ability to easily evaluate a function describing a closed surface, integrating it can not be done analytically. The Monte-Carlo technique would be to simply draw rectangular bounds along all dimensions, and uniformly sample the (known) interior volume, counting only the points which fall inside the boundary of integration. Then, the integral is simply the sum of the samples, normalized by the total number of sample points.
Write a MATLAB script to evaluate the volume of a sphere of known radius using this Monte-Carlo method. Compare this to the analytic solution, and extract a calculated value for π. What happens as the number of sample points increases?

3. MATLAB can be used for physics simulation. For instance, in electrostatics, the problem is often simply just to find the potential everywhere inside a region with known boundary conditions. If the dielectric constant is the same everywhere, Gauss' Law implies the potential solves "Laplace's equation" $\nabla^2\phi = 0$, which is just a statement that the solution has zero total curvature. In 2 dimensions, we can use the definition of the second derivative to arrive at a condition for the values of the solution on a regular grid:

$$\phi_{i,j} = \frac{\phi_{i+1,j} + \phi_{i-1,j} + \phi_{i,j+1} + \phi_{i,j-1}}{4}$$

where *i* and *j* are the indices along *x*- and *y*- directions. In other words, the value of the potential at every point is just the average of all the nearest neighboring points. With this in mind, run the code below in a script and use comments to add descriptions of the role of each of the blocks of commands:

```
clear

NUM=21;
THRESH=1e-6;
M=zeros(NUM);

AVG=(diag(ones(NUM+1,1),1)+diag(ones(NUM+1,1),-1))/4;

newM=rand(NUM);
```

```
while (sum(sum(abs(newM-M))) > THRESH)

  newM=M;

  M=[zeros(1,NUM); M; zeros(1,NUM)];
  M=[zeros(NUM+2,1) M zeros(NUM+2,1)];
  M(12,12)=1;

  M=AVG*M+(AVG*M')';

  M=M(2:(NUM+1),2:(NUM+1));

end

M=[zeros(1,NUM); M; zeros(1,NUM)];
M=[zeros(NUM+2,1) M zeros(NUM+2,1)];
M(12,12)=1;

surf(M)
```

What physical system is this code modeling?

4. You are trying to determine the acceleration due to gravity *g* by measuring the period of a pendulum, *T*, of length *L* using the relation $T = 2\pi\sqrt{\frac{L}{g}}$. The summary of measured data is T = 3.818 ± 0.009 *sec*, and L = 361.58 ± 0.40 *cm*. By propagating errors, determine the best value and uncertainty in *g*. If you could go back and revise the experiment, which quantity would you want to measure more precisely?