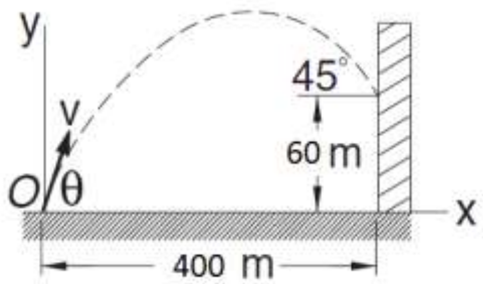
EP547 Computational QM with MATLAB (HW2)
Deadline 31/05/2013

Q1

A projectile is launched at point O with the velocity v at the angle θ to the horizontal. The parametric equation of the trajectory is given by

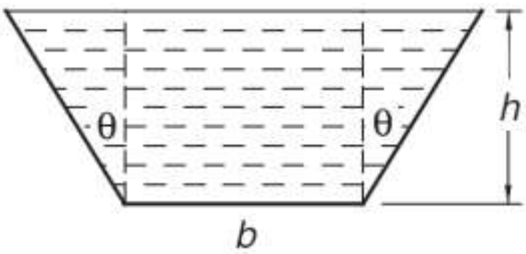
$$x = v\cos(\theta)t$$
$$y = v\sin(\theta)t - gt^2/2$$



where t is the time measured from the instant of launch and $g = 9.8\ m/s^2$. If the projectile is to hit the target at the 45^o angle shown in the figure, determine v, θ and the time of flight by using MATLAB solve() function.

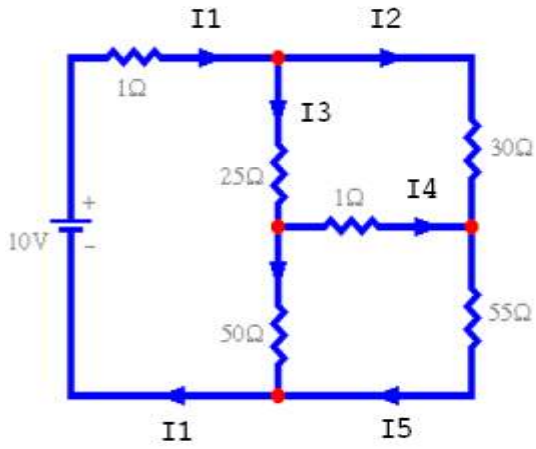
Q2

The figure shows the cross section of a channel carrying water. Determine *h*, *b* and *θ* that minimize the length of the wetted perimeter while maintaining a cross-sectional area of 6 m^2. (Minimizing the wetted perimeter results in least resistance to the flow.)
Use MATLAB fminsearch() function.



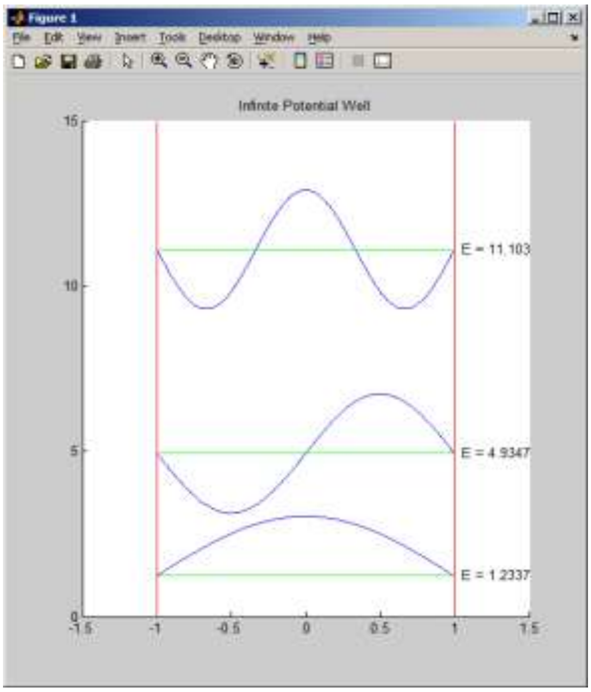
Q3

Using MATLAB, find the current flowing in each branch of the following circuit.



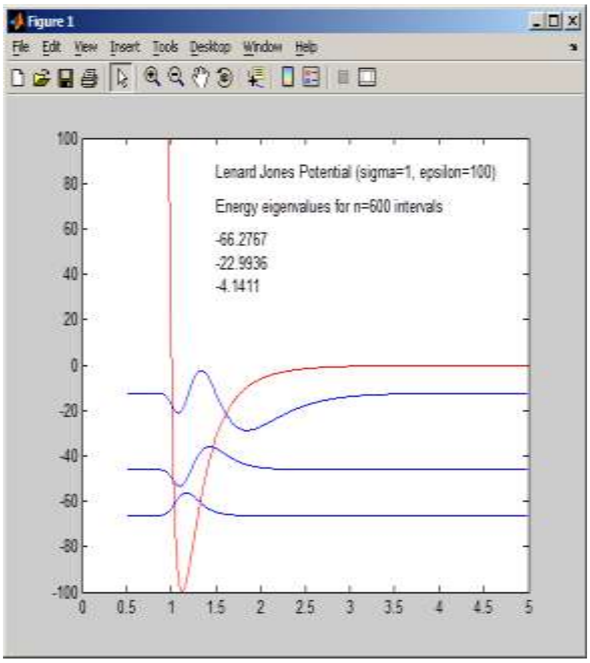
Q4

Modify `infwell.m` to obtain the lowest three energy levels and to draw the corresponding wavefunctions shown in figure. m = hbar = L = 1 and N = 1000 parts.



Q5

Modify `sqrwell.m` to obtain the lowest three energy levels of Lenard-Jones potential (sigma=1, epsilon=100) and to draw the corresponding wavefunctions shown in figure. m = hbar = L = 1 and N = 1000 parts.



Q6

Write a program to find ground state the expectation value in nm of the position of a proton in a finite square well (L=1 nm and V0=50 eV) Use true values of hbar and proton mass.
Hint: You should first normalize the wavefunction and then then use the formula: $< x >= \int \Psi^* x \Psi dx$

Q7

Use Shooting Method to obtain first 10 energy eigenvalues and wavefunctions of a particle in the harmonic potential, $V=x^2/2$. (hbar = m = L= 1)

Q8

Use Matching Method to obtain first 10 energy eigenvalues and wavefunctions of a particle in the harmonic potential, $V=x^2/2$. (hbar = m = L = 1)

Q9

Use the Variational Approach to obtain the ground state energy eigenvalue and wavefunction of a particle in the Lenard-Jones potential. (hbar = m = L = 1, sigma=1, epsilon=100)