```
%converting volume percentage of ethanol to mole fraction:
    liters_gin=10;
    percent_ethanol_gin=0.4;
    percent_water_gin=1-percent_ethanol_gin;

    %using density (in g/L) and molar mass (in g/mol) to calculate moles:
    mol_ethanol=liters_gin*percent_ethanol_gin*789/46.07;
    mol_water=liters_gin*percent_water_gin*1000/18.016;
    mol_total=mol_ethanol+mol_water;

    %dividing the calculated moles by the mol total to get mol fraction:
    ethanol_mol_fraction=mol_ethanol/mol_total;
    water_mol_fraction=mol_water/mol_total;
```

SAMPLE OUTPUT w/ 10L input feed:

```
mol_ethanol =
   68.5044
mol_water =
  333.0373
mol_total =
  401.5417
ethanol_mol_fraction =
    0.1706
water_mol_fraction =
    0.8294
```

```
%calculating mole fraction in liquid and vapor phase, looping for the 5
%runs
%setting initial z (mol composition of feed) values:
z1=ethanol_mol_fraction; z2=water_mol_fraction;

for i=1:5

    %using antoine equation and vapor pressure values from Poling,
    Prausnitz, and O'Connell (2001),
    %antoine eqn: ln Psat[kPa] = A - B/(C+T[degC])
    A1=16.8958; B1=3795.17; C1=230.918; %for ethanol (1)
    A2=16.3872; B2=3885.70; C2=230.170; %for water (2)
    pressure=101.325; %pressure at which the VLE apparatus operates

    %finding the bubble and dew temp to determine the appropriate temp
    %range for the runs:
    bubble_temp=fzero(@(bubble_temp) pressure-z1*exp(A1-
    B1/(bubble_temp+C1))-z2*exp(A2-B2/(bubble_temp+C2)), 75);
    dew_temp=fzero(@(dew_temp) 1/pressure-z1/exp(A1-B1/(dew_temp+C1))-
    z2/exp(A2-B2/(dew_temp+C2)), 75);

    %getting the temp input for each run
    temp=input(['Input temperature of run ' num2str(i) ' (in Celsius,
    between ' num2str(bubble_temp) ' and ' num2str(dew_temp) '): ']);

    %using Raoult's law, y_i P = x_i P_i^sat and Rachford-Rice eqn, sum z_i(K_i-1)/(1+V/F(K_i-1)) = 0
    sat_pressure_ethanol=exp(A1-(B1/(temp+C1)));
    sat_pressure_water=exp(A2-(B2/(temp+C2)));
    %solving Rachford-Rice equation numerically to find a=V/F:
    K_ethanol=sat_pressure_ethanol/pressure;
```

```
    K_water=sat_pressure_water/pressure;
    k_ethanol=1/(K_ethanol-1); k_water=1/(K_water-1);
    a=fzero(@(a) z1/(k_ethanol+a) + z2/(k_water+a), 1);
    %solving the molar composition of the liquid (x1 and x2) and vapor (y1
    and y2) phases from a
    x1=z1/(1+a*(K_ethanol-1)); x2=z2/(1+a*(K_water-1));
    y1=K_ethanol*x1; y2=K_water*x2;
```

SAMPLE OUTPUT w/ 10L input feed:

```
Input temperature of run 5 (in Celsius, between 94.6344 and 97.2262): 96.5
x1 =
    0.1072
x2 =
    0.8928
y1 =
    0.2129
y2 =
    0.7871
```

```
    %performing mass balance on the system
    %where eqn1 is the overall mass balance, L+V=total moles
    %and eqn2 is the ethanol mass balance, x1L+y1V=z1*total moles
    eqn1=[1, 1; x1, y1]; eqn2=[mol_total; z1*mol_total];
    sol=linsolve(eqn1,eqn2);
    mol_total=sol(2); %new total moles is the vapor output

    %converting moles and mol fraction to volume and volume percent using
    density (in g/L) and molar mass (in g/mol)
    volume_ethanol=mol_total*y1*46.07/789;
    volume_water=mol_total*y2*18.016/1000;
    volume_total=volume_ethanol+volume_water;
    fprintf('Total volume (liters): %.3f\n%%v/v ethanol: %.2f%%\n%%v/v
    water: %.2f%%\n', volume_total, volume_ethanol/volume_total*100,
    volume_water/volume_total*100);

    z1=y1; z2=y2; %new feed composition is the resulting liquid composition
end
```

FINAL OUTPUT W/ THE CHOSEN TEMPERATURES

```
Input temperature of run 1 (in Celsius, between 94.6344 and 97.2262): 96.7
Total volume (liters): 7.294
Volume of ethanol (liters): 3.280, %v/v ethanol: 44.97%
Volume of water (liters): 4.014, %v/v water: 55.03%
Input temperature of run 2 (in Celsius, between 93.7777 and 96.7): 95.7
Total volume (liters): 4.303
Volume of ethanol (liters): 2.282, %v/v ethanol: 53.03%
Volume of water (liters): 2.021, %v/v water: 46.97%
Input temperature of run 3 (in Celsius, between 92.2623 and 95.7): 94.7
Total volume (liters): 2.877
Volume of ethanol (liters): 1.717, %v/v ethanol: 59.68%
Volume of water (liters): 1.160, %v/v water: 40.32%
Input temperature of run 4 (in Celsius, between 90.8782 and 94.7): 93.7
Total volume (liters): 2.069
Volume of ethanol (liters): 1.350, %v/v ethanol: 65.26%
Volume of water (liters): 0.719, %v/v water: 34.74%
Input temperature of run 5 (in Celsius, between 89.6087 and 93.7): 92.7
Total volume (liters): 1.558
Volume of ethanol (liters): 1.091, %v/v ethanol: 70.01%
Volume of water (liters): 0.467, %v/v water: 29.99%
```