Problem 1

part a















so it takes 12.7 min to cool the candy to 71 F

part b

Re-arranging the energy balance, dT/dt = -(h\*A/Cp\*\* V)\*(T –Tair)



g(t) = dT/dt



Properties = h\*A/Cp\*\* V



Plotting the properties vs. time, we see that they are constant, so r = 2 cm,

h\*A/Cp\*\* V = 0.412



Since A = 4πr2 and V = 4/3 π r3

substituting this in with r = 2 cm,

3\*h/2\*Cp\* = 0.412

or h/Cp\* =0.412\*2/3 = 0.275



If the radius is increased to 4 cm, then the new properties (including size) must equal (h/Cp\*(4πr2/4/3 πr3), r = 4 cm





So, dT/dt = 0.206\*(Tair - T) for the new candy size

Carrying out this integration,



Using the initial condition that the candy temperature is 270 F, the solution becomes





Solving for the time to reach 71 F







so it takes 25.7 min to cool the larger size to 71 F

Alternatively, you can calculate the properties using the derivative and model directly

h/Cp\* = - dT/dt / (T-Tair) \* V/A

For a 2 cm radius, A = 4πr2 and V = 4/3 πr3

h/Cp\* = dT/dt / (T-Tair) \* 1/ (3\*2)









the subsequent analysis is the same as above

Problem 2

part a.











part b

The azetrope occurs when the liquid and vapor compositions are the same









So the azeotropic composition occurs at a water fraction of 0.693



Note if you look very carefully at this model, it actually predicts 2 azeotropic conditions, so either 69.3% or 68.6% are acceptable answers. This is a defect in the numerical models and would not actually occur.

Part c



T - total initial moles of mixture



Calculating the equilibrium V-L compositions at 180 mm Hg

the equilibrium vapor phase is 47.2% water and 53.8% acetic acid

the equilibrium liquid phase is 14.4% water and 85.6% acetic acid





setting up the component mass balances









So there are 9.48 moles of vapor of composition 47.5% water

and 10.4 moles of liquid of composition 14.4% water.

