1.	/20
2.	/20
3.	/20
4.	/20
5.	/20

First 3 letters of last name:
(Print capitals)

Section: 9am 11am
(circle one)

Name:

Exam 3

CM3120

Tuesday 19 March 2019

Instructions:

i. Closed book, closed notes. One 8.5" by 11" study sheet allowed, two sided; you may use a calculator; you may not use the internet or a cell phone. All work on the exam must be your own.
ii. Write your solution on one side of the page only. Do not write on the back of any pages.
iii. Please be neat. Only neat answers will be granted partial credit.
iv. Significant figures always count.
v. Please box your final answers.

1. (20 points)
   a. What is the Biot number? What does it mean in a heat-transfer problem if the Biot number is *small* versus *large* versus being *neither small nor large*?
   b. What is the role/importance of diffusion or mass transfer in the unit you are studying as part of your Friday Project?

2. (20 points) A solid aluminum sphere (radius $= 1.106cm$) initially at 20.0^oC is plunged into a well mixed bath ($T_{bath} = 30.0^oC$; heat transfer coefficient is $2.30 \times 10^3\ W/m^2K$). What is the temperature at the center of the sphere after 20.0 seconds?

3. (20 points) The geometry has a significant influence on the molar flux $\underline{N_A}$ in diffusion problems. For steady diffusion with no homogeneous reaction, answer the following questions (and justify your answers with brief calculations).
    a. For one-dimensional diffusion in a wide (x direction), deep (y direction) slab, how does the flux $N_{A,z}$ vary with z?
    b. In a cylindrical geometry, for one-dimensional diffusion (long tube, θ symmetry assumed) in the radial direction, how does the flux $N_{A,r}$ vary with r?
    c. In a spherical geometry, for one-dimensional diffusion (θ and ϕ symmetry assumed) in the radial direction, how does the flux $N_{A,r}$ vary with r?

4. (20 points) Water vapor (species A, $298K$, $1.000\ atm$, assume ideal gas and dilute mixture) is diffusing in air (species B) in steady, one-dimensional diffusion in the positive z-direction. If the mass flux of water $j_{A,z}$ is $5.00 \times 10^{-9} g/cm^2 s$, what is the weight-fraction composition gradient $d\omega_A/dz$? Please assign the correct sign and significant figures to your answer.

5. (20 points) The air in your apartment is dry, so to provide some humidity you plan to set out glasses of water that will evaporate over time, humidifying the room. For water ($24^o C$, $1.00\ atm$) steadily evaporating into air from the glass shown below, what is the rate of evaporation? You may assume that the mole fraction of water in the room is 0.011. You may assume ideal gas. Please give your answer in units of $moles/cm^2 s$.