CHE312A: Homework 1

Instructions: Upload your original, legible and handwritten solution in pdf format, with the exact filename ⟨yourrollnumber⟩.pdf (e.g. 06302016.pdf). Include your name and roll number on the top of the first page. Include all necessary steps in detail, define all symbols and state all assumptions made in your solution.

1. Two surfaces, one highly polished and other heavily oxidized, are found to be emitting the same amount of energy per unit area. The highly polished surface has an emissivity of 0.15 at 1070°C, while the emissivity of the heavily oxidized surface is 0.78. Determine the absolute temperature of the heavily oxidized surface. (3 points)

2. The inner and outer surfaces of a 25 cm thick wall in summer are 27°C and 44°C, respectively. The outer surface of the wall exchanges heat by radiation with surrounding surfaces at 40°C and convection with ambient air also at 40°C with a convection heat transfer coefficient of 8 $W/m^2 \cdot K$. Solar radiation is incident on the outer surface at a rate of 150 W/m^2. If both the emissivity and the solar absorptivity of the outer surface are 0.8, determine the effective thermal conductivity of the wall. (4 points)

   Bonus: If the wall is a composite made of a layer of brick sandwiched between two concrete layers, what is the thickness of the brick layer?) (2 points)

3. A 1 cm^3 cube of ice at 0°C is added to 1 litre water at 30°C in an insulated container. After a long period of time, the ice melts into water. What would be the final temperature of the water after a long time? Ignore any changes to the pressure or volume of the system. Note that specific latent heat of fusion of water is 334 kJ/kg, the isobaric specific heat capacity of water is 4.1813 kJ/kg· K, and the density of ice is 0.91 g/cm^3. (3 points)

Information:

Material	Thermal conductivity k (W/m.K)
Glass	1
Brick	1.31
Concrete	0.8
Aluminium	237
Copper	401