# ME 345 – HTx Fall 2023 Week 3 Homework

## Problem 1:

A solid aluminum sphere has a diameter of 15 [cm]. It is heated from 80 °C to 200 °C. The density of the aluminum is 2700 [kg/m3], and the isobaric heat capacity is 0.9 [kJ/kg-K].

1. Calculate the energy [kJ] required to accomplish this, assuming no heat is lost.

## Problem 2:

A college student built a study chamber made entirely of adabatic insulation on all sides. The dimensions are 4 [m] x 6 [m] x 6 [m]. The night before a big morning study session the room is initially at 15 °C. The student turns on a 150 [W] heater and places it inside and leaves it there for 10 hours.

1. Calculate the temperature of the air in the room after the heater has been on for 10 hours.

## Problem 3:

You have a brick wall that is 4 [m] tall, 7 [m] wide, and 30 [cm] thick. The surface temperature of the inside wall is 20 °C, and the surface temperature of the outside wall is 5 °C. Assume the thermal conductivity of the brick is 0.69 [W/m-K], and the density is 2000 [kg/m3]. Neglect heat transfer through the top/bottom/sides.

1. Calculate the heat rate [W] passing through the wall.
2. Calculate the heat flux [W/m2] passing through the wall.

## Problem 4:

A warm pipe loses heat to ambient air through natural convection. The pipe is 5 [cm] in diameter, 10 [m] in length, and has a surface temperature of 80 °C. The ambient air temperature is 5 °C, and the convection coefficient is found to be h = 25 [W/m2-K].

1. Calculate the heat rate [W] leaving the pipe to the ambient air.

## Problem 5:

You are trying to experimentally determine the thermal conductivity of a mystery material. The piece is 2 [cm] thick, and you apply a heat flux of 500 [W/m2] through the material, and wait for it to reach steady-state. All of the edges are insulated so no heat is lost through the ends. Once at steady-state you measure the temperatures of the inner and outer surface and find they are 0 °C and 80 °C.

1. Calculate the thermal conductivity [W/m-K] of this material.