MATE 201
Fall 2019

Homework # 4

Due date: November 21th, 2019
(lecture time)
No late submissions!

Group submission (up to 4 students per group) is allowed.

Your homework submission should have a cover page which contains the following information;
your name, student number, course name, homework number and date of submission.

Question 1:

A 0.6 m rod of a metal elongates 0.45 mm on heating from 20°C to 110°C. Determine the value of the linear coefficient of thermal expansion for this material.

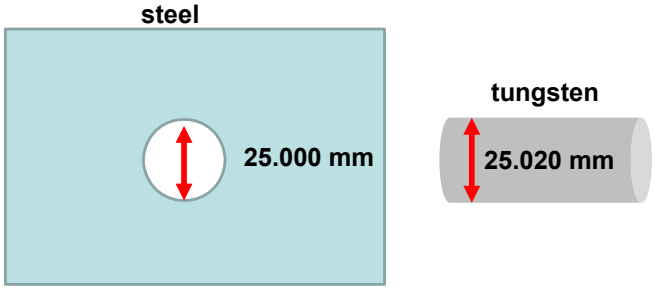
Question 2:

a) **To what temperature must a cylindrical rod of tungsten 25.020 mm in diameter and a plate of AISI 316 stainless steel having a circular hole 25.000 mm in diameter have to be heated for the rod to just fit into the hole? Assume that the initial temperature is 25°C.**

b) **What will be the hole diameter at that temperature?**

α_l (AISI 316 stainless steel) = 16.0 x 10^{-6} $(°C)^{-1}$

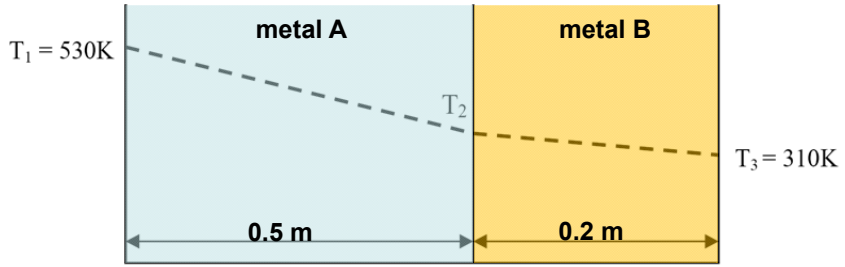
α_l (W) = 4.5 x 10^{-6} $(°C)^{-1}$



Question 3:

a) **Find the thermal conductivity of B if the steady-state heat flux is 18.6 x 10^3 W/m^2 and the conductivity of A is 52 W/mK.**

b) **What metal is B?**



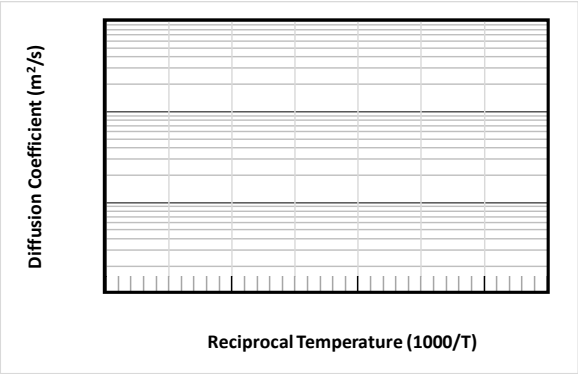
Question 4:

Hydrogen gas can be purified by diffusing it through a palladium sheet. Compute the total amount of hydrogen (in grams) that passes in 5 hours through a 6-mm-thick sheet of palladium having an area of 50x50 cm at 600°C. Assume that the steady state concentrations at the high-pressure and low-pressure sides of the plate are 2.0 and 0.4 kg of hydrogen per cubic meter of palladium.

Take the diffusion coefficient as 1.7×10^{-8} m^2/s.

Question 5:

The value of the diffusion coefficient for the diffusion of nickel in iron is 3.42×10^{-16} m^2/s at 1100°C and it is 4.87×10^{-14} m^2/s at 1400°C. What is the diffusion coefficient at 1300°C?



Question 6:

At 1600K, X is being diffused into an AX alloy with an initial X content of 0.15 wt.%. If the surface concentration of X is maintained at 0.85 wt.% what time is required in order to have 0.50 wt.% X at a depth of 2.3×10^{-3} mm below the surface?

Take D as 8×10^{-8} m^2/s

Question 7:

Nitrogen from a gaseous phase is to be diffused into pure iron at 675°C. If the surface concentration is maintained at 0.25 wt% N, what will be the nitrogen concentration 3 mm from the surface after 25 h?