Homework 8

Homework due Apr 30, 2021 23:14 CDT Past due

Due Date

Friday, 4/30 at 11:59 PM ET *(5/1 at 03:59 UTC)*

Directions:

1. Answer each of the homework problems listed below.
2. Click the **Click here to open Gradescope button** below to access Gradescope.
3. Follow the prompts to submit your PDF to the assignment **HW 8**.

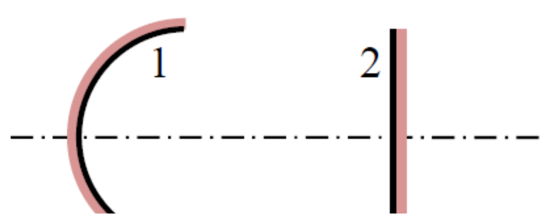
   Refer to the *Submitting Assignments With Gradescope* section of this course if you need a reminder of how to submit your assignment in Gradescope.

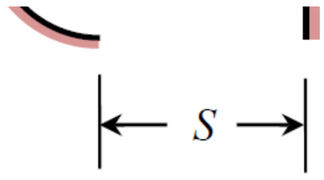
Homework Information and Guidelines:

1. Each student must turn in their own homework assignment and complete their own calculations, coding, etc. independently.
   - However, we encourage you to use most available resources including other textbooks, information from similar courses online, discussions with class and lab mates, office hours, etc. with the exception of using old solutions to the exact problems to complete the assignment.
   - Cite all your sources including discussions with colleagues and online websites. For example, if you and a friend compare answers or work together on a problem indicate this at the end of the problem. As an example, you might have a list like this at the end of each problem: "Resources used: [1] Fourier, J.B.J., *La Theorie Analytique de la Chaleur*, F. Didot, 1822. [2] Discussion with Joseph Fourier. [3] Wikipedia: Heat Flux, https://en.wikipedia.org/wiki/Heat_flux."
   - If we find papers with identical answers and approaches that do not indicate collaboration in the resource list, this is a violation of the academic honesty policy. Similarly, if your solutions match resources available online, this is a violation of the academic honesty policy.
2. Homework will be collected via Gradescope and is due at 11:59 PM ET. A grace period of 15 minutes is allowed in case of issues during the upload. Beyond that no late homework is accepted.
3. You may submit handwritten solutions or type up your solutions. We encourage you to use computer programs of your choice to solve problems, and some problems will require computational solutions. Recall "sketch" indicates you can draw something by hand, while "plot" indicates you should quantitatively calculate the curves and will likely use a computer program to create the graph. If "sketching" a curve, make sure trends, boundary conditions, etc. are clear.

Problem 1

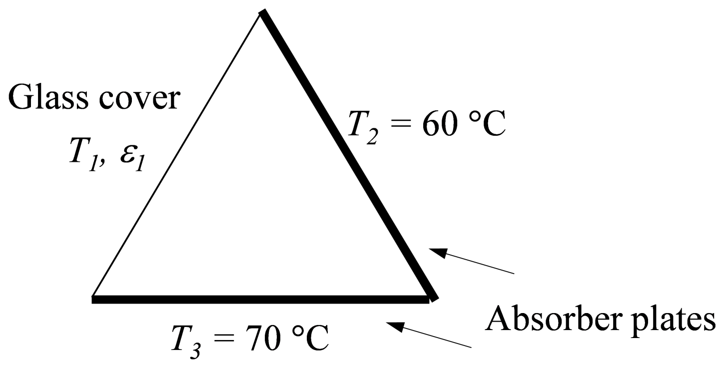
Given the concave surface of a hemisphere (surface 1), and a coaxial circular disk (surface 2) of the same diameter, recreate the axes shown below and plot the variation of the view factor F12 with separation distance S over the range 0 ≤ S < ∞. Label all important values.





Problem 2

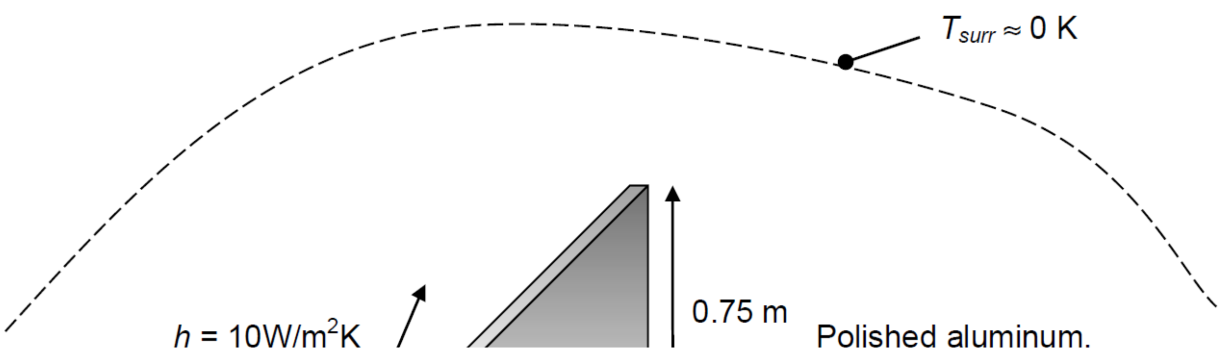
A solar collector consists of a long duct through which air is blown. Its cross section forms an equilateral triangle with 1 m side, as shown below. One side is made of glass with an emissivity of $\varepsilon 1$ = 0.9. The other two sides are absorber plates, which are painted in black.

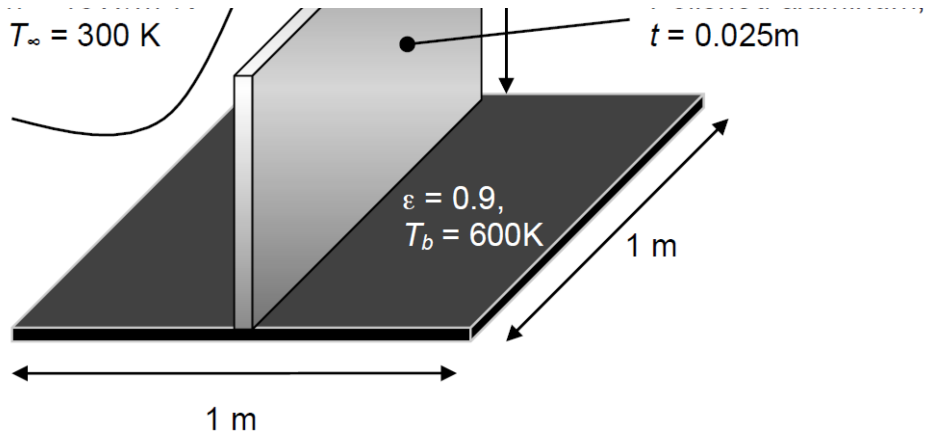


During the operation the surface temperatures are known to be T_1 = 25 °C, T_2 = 60 °C, and T_3 = 70 °C. What is the net rate at which radiation is transferred to the cover due to exchange with the absorber plates? State your assumptions clearly.

Problem 3

A single straight fin made of polished aluminum and with a thickness of t = 0.025 m is attached to a flat plate that acts as a gray body (ε = 0.9), as shown below. The fin can be considered a perfect mirror such that its reflectivity is 1.0 and is perfectly specular, and its tip can be considered insulated. Both the plate and the fin are subjected to convective cooling with a heat transfer coefficient of h = 10 W/m^{2}K. The plate's temperature is T_b = 600 K. The ambient air is at T_∞ = 300 K during the evening, when the structure is exposed to a clear sky such that the radiative temperature of the surroundings can be approximated as $T_{surr} \approx$ 0 K. Calculate the total rate of heat transfer leaving the combined fin/plate structure. State your assumptions clearly.





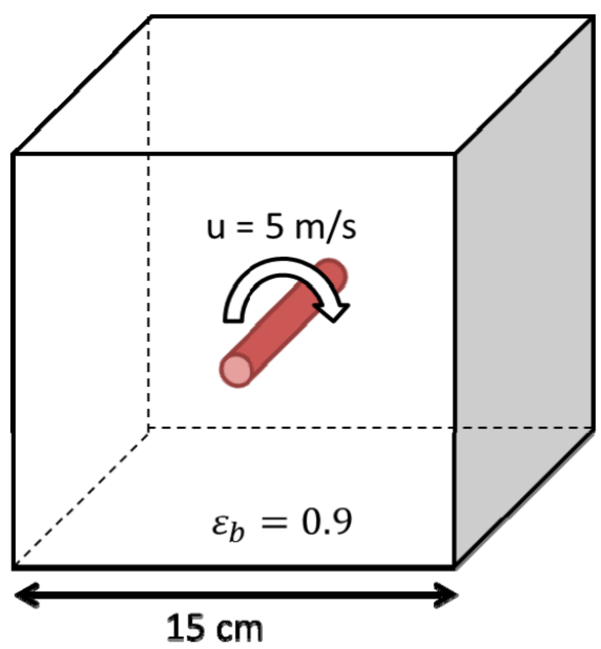
Problem 4

You are measuring the temperature of hot air flowing in a large pipe using a thermocouple. The thermocouple bead has a diameter of 3 mm, and its surface may be approximated to be diffuse, gray with an emissivity of 0.5. The air flow speed is 1 m/s. Your reading from the thermocouple is 1000 K. The pipe wall is maintained at 500 K. Determine the actual temperature of air. State your assumptions clearly. Hint: you may assume a temperature to evaluate thermophysical properties.

Problem 5

A single hotdog of mass m = 30 g is cooked inside an oven, as shown below. The hotdog is represented as a cylinder with a diameter of 2 cm and length of 10 cm with an emissivity of ε_h = 0.3 and a specific heat of 2500 J/kgK. The convection oven is a cube with a side length of 15 cm. The bottom wall of the oven has an emissivity of 0.9, while the other five walls are perfectly insulated. At a given time, the temperature of the hotdog is T_h = 350 K and increases at a rate of dT/dt = 0.25 K/s. Air flows around the hotdog at a temperature of T_∞ = 375 K and velocity u = 5 m/s. There is no convection heat transfer with the bottom wall or the end caps of the hotdog.

- (a) Find the heat transfer rate due to convection around the hotdog. State your assumptions clearly.
- (b) Determine the temperature of the bottom surface, T_b. You are given that the view factor from the bottom surface to the hotdog is F_{bh} = 0.07. State your assumptions clearly.



Gradescope (External resource) (100.0 points possible)

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Piazza

Post your questions/comments about Homework 8 to the *HW8* discussion forum in Piazza below (optional).

Piazza (External resource)

! This class has been made inactive. No posts will be allowed until an instructor reactivates the class.

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Updated Just now. Reload

no unread posts

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5 unresolved followups

181	total posts
765	total contributions
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28	students' responses

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