Heat Transfer Questions & Answers

Your question is incomplete: you have to outline in your post the first law that the professor used in his course. Make a correction by clicking on EDIT just right of your question and add the outline of the first law using LaTeX (write the precise mathematical terms he used). There are many ways the first law can be written.. I will answer your question once you do this.

Question by Student 201427115

hello professor, I think there is something wrong at our assignment. At problem 2, you wrote the answer is 9.6 $^\circ C$. But there is some problem to 9.6 $^\circ C$ become answer. Two coefficients of temperature of the plate have different units.

$\sigma = 5.67 \times 10 \wedge (-8) [W/m \wedge (2) K \wedge (4)]$

Its temperature unit is K.

$h = 12 [W/m \wedge (2)^\circ C]$

its temperature unit is $^\circ C$. so it can't be calculated directly. I attached my solution. So please answer me. Thank you for reading my question.

This is a very good question, and I am glad you are asking it. When using the relationship for radiation heat transfer (i.e. $q'' = \sigma T^4$), you must use units of absolute temperature like Kelvin or Rankine. But, when using the relationship for convective heat transfer (i.e. $q'' = h(T_{\rm s} - T_\infty)$) or conduction heat transfer (i.e. $q''_x = -k \partial T / \partial x$), you can use either units of Kelvin or of Celcius. This is because convective and conduction heat transfer depend on a simple difference of temperatures, and the difference in Kelvin is exactly equal to the difference in Celcius. Thus, you can change the unit Kelvin to Celcius as you wish. But, you can't do this for radiation thus because the radiative heat transfer can not be expressed as a simple difference of temperatures: it corresponds to a difference of T^4, and a difference of $\rm K^4$ is not equal to a difference of $^\circ \rm C^4$.

I'll give you 1.5 points bonus boost for your question. I would have given more if your LaTeX typesetting would have been better. You should write "$\rm W/m^2 {}^\circ C$" not "$\rm W/m \wedge (2)^\circ C$". To learn LaTeX quickly, just right click on any mathematical expression on my website. Then select "Show Math As" and then "TeX command".

Also, don't attach your solutions to your post (I deleted them). It's too time consuming for me to go through your solutions. Your question by itself was fine.

Question by Student 201027112

Hello professeur, I have a question about derivation of integral form of heat equation. Following the steps, it starts from differential form of heat equation.

$$\frac{\partial}{\partial t}(\rho c T) = -\frac{\partial}{\partial x}q''_x - \frac{\partial}{\partial y}q''_y - \frac{\partial}{\partial z}q''_z + S$$

And multiply by $dV = dxdydz$ and integrating both sides. I can understand up to this step.

$$\int_V \frac{\partial}{\partial t}(\rho c T) dV = -\int_z\int_y \partial q''_x\, dydz - \int_z\int_x \partial q''_y\, dxdz - \int_y\int_x \partial q''_z\, dxdy + \int_V S dV$$

But I've little confused from next step.

$$\frac{\partial}{\partial t}\int_V (\rho c T) dV = -\int_S \overrightarrow{q''} \cdot \hat{n} dS + \int_V S dV$$

I understand that this step is expressing each directions of heat fluxes (x, y, z direction) to single vecter form. But suddenly partial operator in front of each heat flux is gone. I've wondered this point.

$$\frac{\partial}{\partial t}\int_V (\rho c T) dV = q_{in} - q_{out} + \int_V S dV$$

Equation above is conclusion of integral form of heat equation. But for derivation of q_{in} and q_{out}, maybe partial operator should remain. Then partial operator and integral operator can be elimiated. I think the step that I wondered should be below.

$$\frac{\partial}{\partial t}\int_V (\rho c T) dV = -\int_S \partial\overrightarrow{q''} \cdot \hat{n} dS + \int_V S dV$$

Am I wrong or I miswrote in your lecture? If I'm wrong, where am I missed something in process of derivation? I'll wait your answer. Thank you. :)

This is a good point. The problem is in the second equation (maybe you made a mistake when writing down what I wrote, or maybe I made a mistake on the blackboard — this happens sometimes):

$$\int_V \frac{\partial}{\partial t}(\rho c T) dV = -\int_z\int_y \partial q''_x\, dydz - \int_z\int_x \partial q''_y\, dxdz - \int_y\int_x \partial q''_z\, dxdy + \int_V S dV$$

There is an integral missing. This equation should be:

$$\int_V \frac{\partial}{\partial t}(\rho c T) dV = -\int_z\int_y\int_{x=0}^{x=L} \partial q''_x\, dydz - \int_z\int_x\int_{y=0}^{y=H} \partial q''_y\, dxdz - \int_y\int_x \int_{z=0}^{z=D} \partial q''_z\, dxdy + \int_V S dV$$

Notice the missing integrals in front of the heat fluxes, and note that L, H, D are the length, height, and depth of the domain we are integrating. The integrals of the heat fluxes can be easily done and this will yield:

$$\int_{x=0}^{x=L} \partial q''_x = q''_{x=L} - q''_{x=0}$$

and similarly for the other dimensions. I'll give you a 2 point bonus boost for your question.

Question by Student 201427130

When I solve assignment #1, question #3. I find something strange. when I solve that, i define $q_{\rm rad.in}$ *and* $q_{\rm rad.out}$. *I only know energy moving occur that high temperture move to low temperture. But* $q_{\rm rad.out}$. *it is moved to high temperture to low temperture.* $q_{\rm rad.out}$ *is energy that* T_1 *to* T_2 *. But* T_1 *is colder than* T_2*. why we define that energy moving?*

Please typeset your question correctly using LaTeX, and I will answer it afterwards: T1 should be T_1, q[radiation in] should be $q_{\rm rad,in}$, etc. This will make your question easier to read for me and for the class, and I can then answer it using the same notation as you used. Besides, LaTeX skills can be an asset on a resume (LaTeX is not only used on my website: it's commonly used to typeset mathematics within google docs, wikipedia, scholarpedia, scholarly publications and books, etc).

Question by Student 201427130

I'm sorry for my mistake for not use latex. So I ask it again sir. When I solve assignment #1, question #3. I find something strange. when I solve that, i define $q_{\rm rad.in}$ *and* $q_{\rm rad.out}$. *I only know energy moving occur that high temperture move to low temperture. But* $q_{\rm rad.out}$. *it is moved to high temperture to low temperture.* $q_{\rm rad.out}$ *is energy that* T_1 *to* T_2 *. But* T_1 *is colder than* T_2*. why we define that energy moving?*

The *net* energy transfer must be from a hot body to a cold body. But this doesn't mean a cold body can not give energy to a hot body. If a cold body gives some energy to a hotter body, then the hotter body must give in return more energy to the cold body so that the net energy transfer is from hot to cold. I'll give you 1 point bonus boost for your question. Your question was good and I would have given more if you had typeset your mathematics correctly and if the spelling, grammar, and formulation of the sentences would be better.

Question by Student 201227123

Hello professor. In heat transfer tables, There is chart of efficiencies of retangular fins. I think this chart is relatvie with fins that isn't insulated at tip because $L_c = L + \frac{t}{2}$.
If tip of fin is insulated $L_c = L$
I wonder if the tip of fin is insulated and $L_c = L$*. Can I use chart of efficiencies of retangular fins? If I can't, how can I get a fin efficieny of retangular fins with respect to insulated tip.*

Yes, you are right, the chart is not for a fin with an insulated tip (because such fins are not commonly used). Thus, if the tip is insulated, you need to remember that $L_{\mathrm{c}} = L$ instead of $L_{\mathrm{c}} = L + \frac{1}{2}t$. I think I mentioned something about this in class... But I feel generous so I'll give you 1.5 point bonus boost for this question.

Question by Student 201327557

Hello sir. During doing assignment 3. #1. I just wonder about efficiencies of circumferential fins. What is the geometrical meaning of characteristic length L_c *and* r_{2c} *and why is* $L_c = L + \frac{t}{2}$ *and* $r_{2c} = r_1 + L_c$*. I heard in class that* $L_c = L + \frac{t}{2}$ *is because* $L_c = \frac{volume}{area}$ *but it didn't working.*