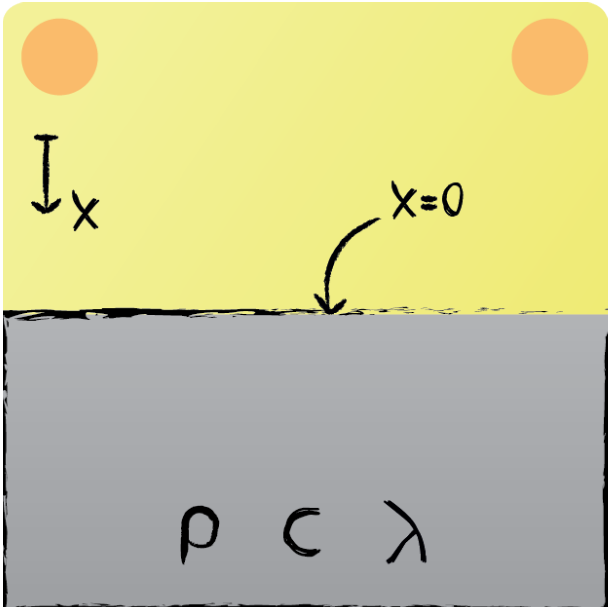
Exam Preparation - Conduction 1



A large body is suddenly imposed to a new temperature at its surface $T(x = 0, t > 0) = 500$ K. The body has an initial homogeneous temperature $T(x, t = 0) = 298$ K. Determine $T(x_1, t_1)$, for $t_1 = 18$ s at depth $x_1 = 3$ mm.

Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_\mathrm{a} - T_0} = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right)$$

Determining the Fourier number:

$$\mathrm{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.7178$$

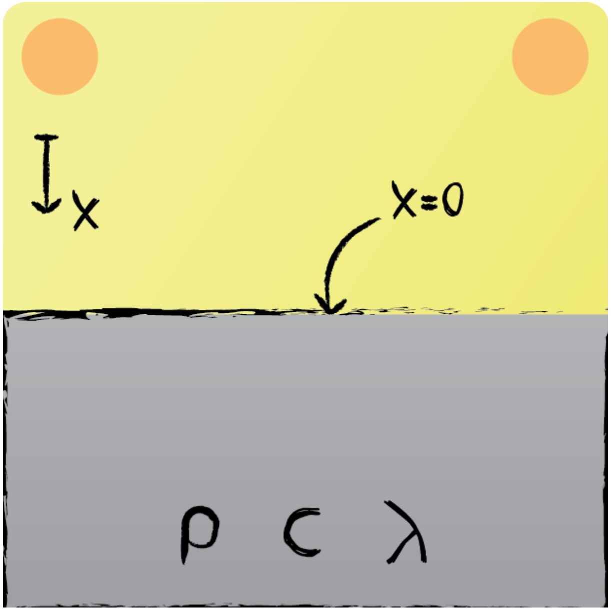
Determining Θ^*:

$$\Theta^* = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right) = 0.4039$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_\mathrm{a} - T_0) + T_0 = 380 \text{ K}$$

Exam Preparation - Conduction 2



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$$\Theta^* = \frac{T - T_0}{T_\mathrm{a} - T_0} = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right)$$

Determining the Fourier number:

$$\mathrm{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.2771$$

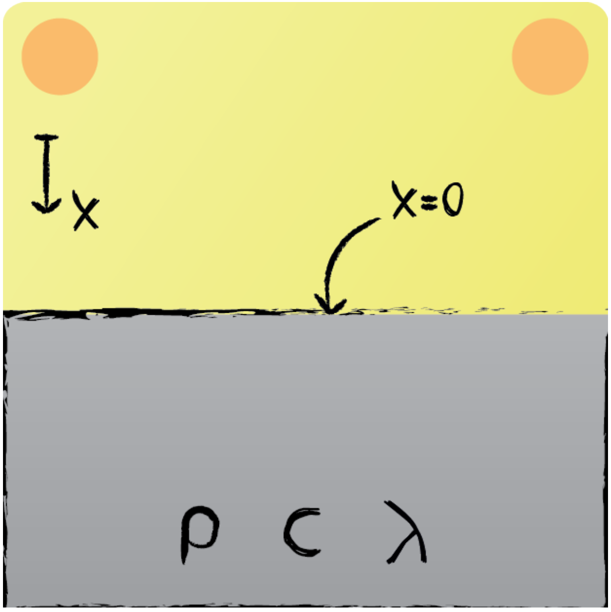
Determining Θ^*:

$$\Theta^* = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right) = 0.1792$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_\mathrm{a} - T_0) + T_0 = 334 \text{ K}$$

Exam Preparation - Conduction 3



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_a - T_0} = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right)$$

Determining the Fourier number:

$$\text{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.4450$$

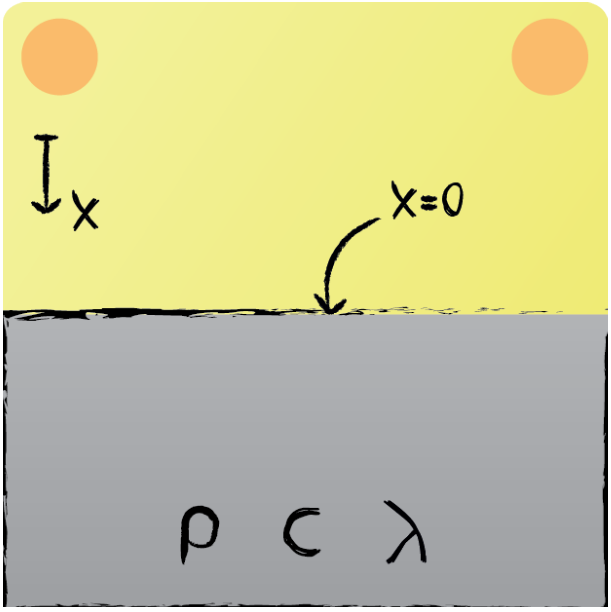
Determining Θ^*:

$$\Theta^* = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right) = 0.2891$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 356 \text{ K}$$

Exam Preparation - Conduction 4



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_\mathrm{a} - T_0} = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right)$$

Determining the Fourier number:

$$\mathrm{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.1162$$

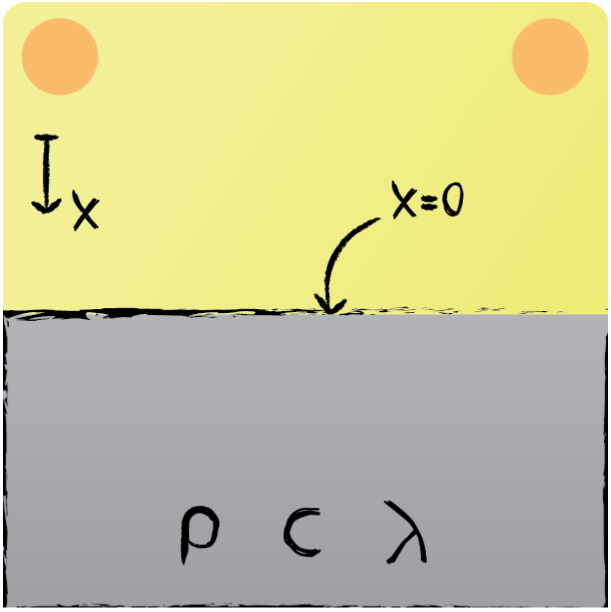
Determining Θ^*:

$$\Theta^* = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right) = 0.0380$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_\mathrm{a} - T_0) + T_0 = 306 \text{ K}$$

Exam Preparation - Conduction 5



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_a - T_0} = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right)$$

Determining the Fourier number:

$$\text{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 2.6923$$

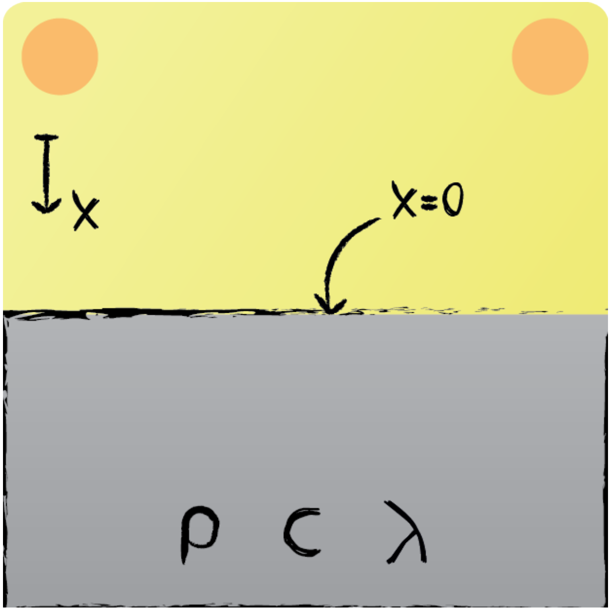
Determining Θ^*:

$$\Theta^* = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right) = 0.6666$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 433 \text{ K}$$

Exam Preparation - Conduction 6



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_a - T_0} = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right)$$

Determining the Fourier number:

$$\text{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 233.9312$$

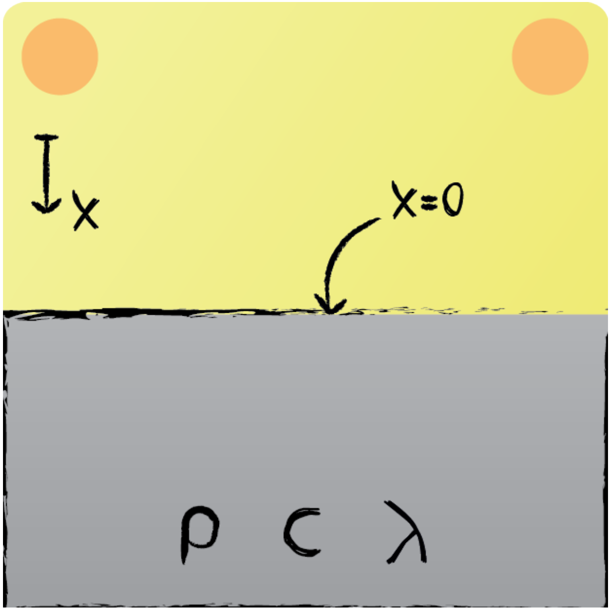
Determining Θ^*:

$$\Theta^* = 1 - \text{erf}\left(\frac{1}{\sqrt{4 \cdot \text{Fo}}}\right) = 0.9631$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 493 \text{ K}$$

Exam Preparation - Conduction 7



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_\mathrm{a} - T_0} = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right)$$

Determining the Fourier number:

$$\mathrm{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 0.2296$$

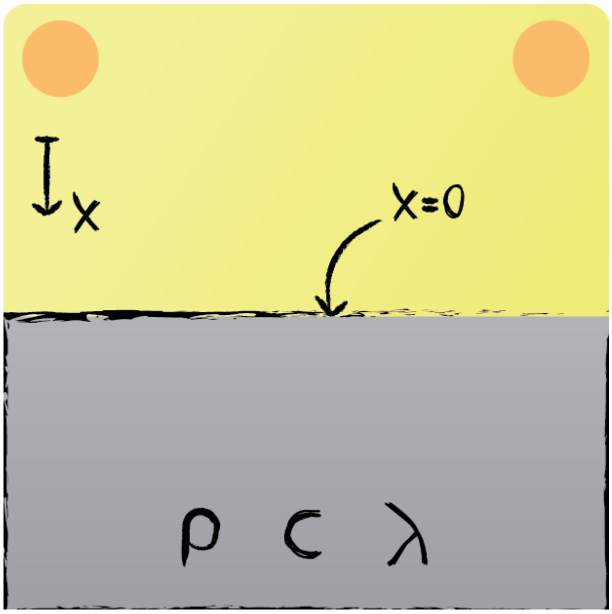
Determining Θ^*:

$$\Theta^* = 1 - \mathrm{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right) = 0.1400$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_\mathrm{a} - T_0) + T_0 = 326 \text{ K}$$

Exam Preparation - Conduction 8



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Problem type:
One-dimensional, unsteady-state heat conduction inside a semi-infinite plate with negligible heat transfer resistance.

Temperature profile inside a semi-infinite plate with negligible heat transfer resistance:

$$\Theta^* = \frac{T - T_0}{T_a - T_0} = 1 - \operatorname{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right)$$

Determining the Fourier number:

$$\mathrm{Fo} = \frac{\lambda \cdot t}{\rho \cdot c \cdot x^2} = 47.8515$$

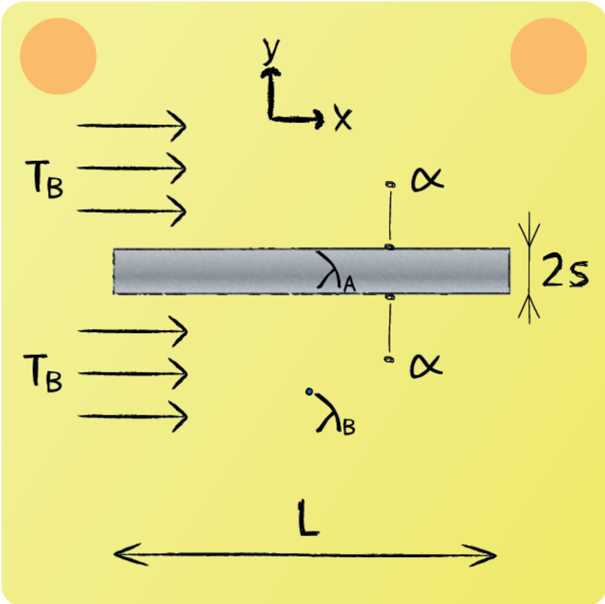
Determining Θ^*:

$$\Theta^* = 1 - \operatorname{erf}\left(\frac{1}{\sqrt{4 \cdot \mathrm{Fo}}}\right) = 0.9186$$

Rearranging Θ^* and filling in:

$$T = \Theta^* \cdot (T_a - T_0) + T_0 = 484 \text{ K}$$

Exam Preparation - Conduction 9



Choose the right equation to determine the heat transfer coefficient α for a plate of thicknes $2s$ and a thermal conductivity λ_A for a given problem specific Biot number Bi.

Heat transfer happens in the y-direction. Therefore the conductive inside and convective resistance outside the body in y-direction have to be brought into relation. Resulting in:

$$\mathrm{Bi_s} = \frac{\alpha \cdot L}{\lambda_\mathrm{A}}$$

Note that L is the characteristic length, which is the ratio $\frac{V}{A}$. Resulting in:

$$L = \frac{2s \cdot A_\mathrm{s}}{2 \cdot A_\mathrm{s}} = s$$

Where A_s is the surface area where the fluid is flowing over.

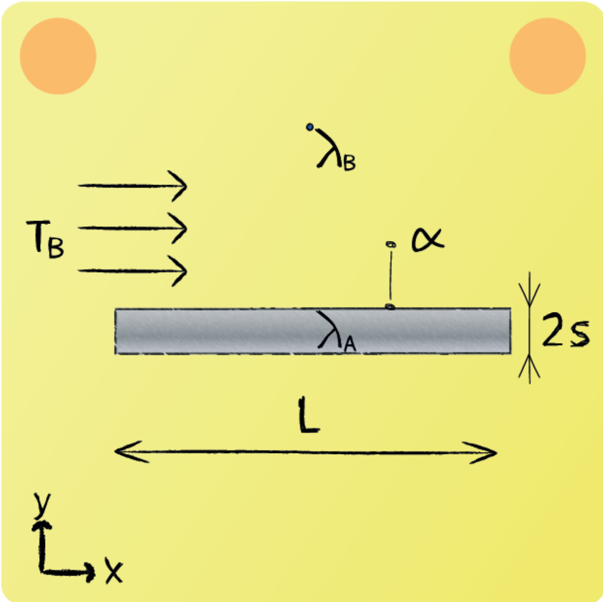
Therefore:

$$\mathrm{Bi_s} = \frac{\alpha \cdot s}{\lambda_\mathrm{A}}$$

And thus:

$$\longrightarrow \alpha = \frac{\mathrm{Bi} \cdot \lambda_\mathrm{A}}{s}$$

Exam Preparation - Conduction 10



Choose the right equation to determine the heat transfer coefficient α for a given problem-specific Nusselt number, Nu and given the fluid properties.

The Nusselt number Nu can be described as:

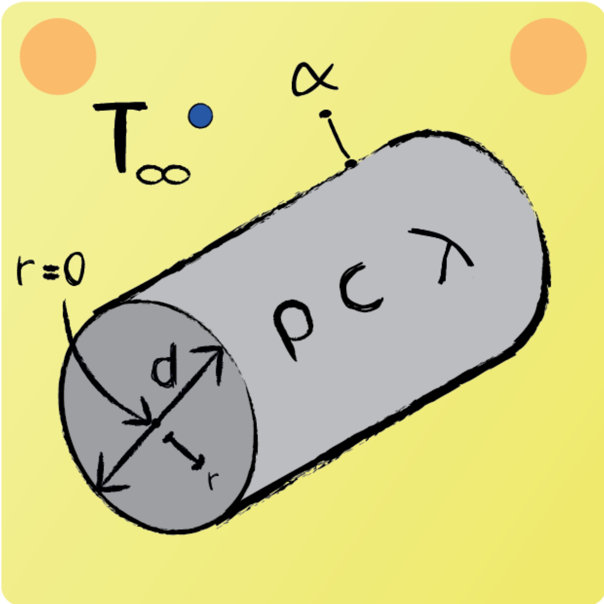
$$\mathrm{Nu_L} = \frac{\alpha \cdot L}{\lambda_\mathrm{B}}$$

Where L is the length of the flat plate where the fluid is flowing over and λ_B is the thermal conductivity of the fluid.

Therefore:

$$\longrightarrow \alpha = \frac{\mathrm{Nu_L} \cdot \lambda_\mathrm{B}}{L}$$

Exam Preparation - Conduction 11

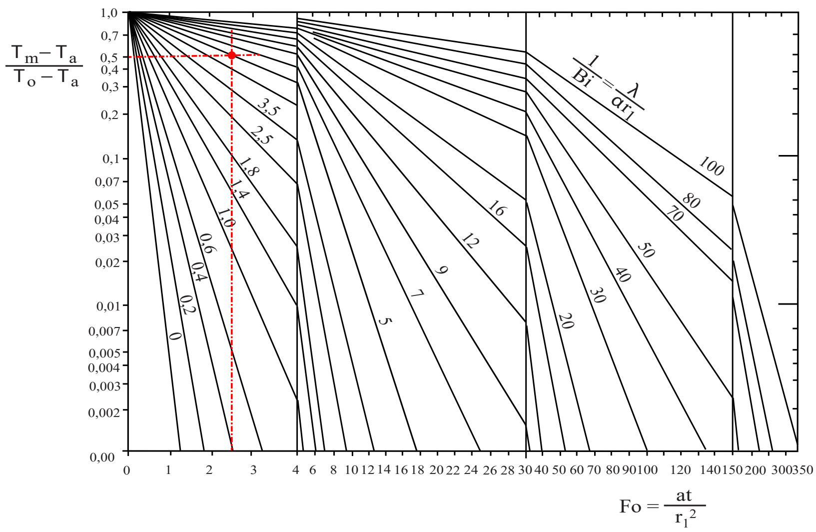


A cylinder of diameter $d = 0.5$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 323$ K is reached.

Problem type:
One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 5$$

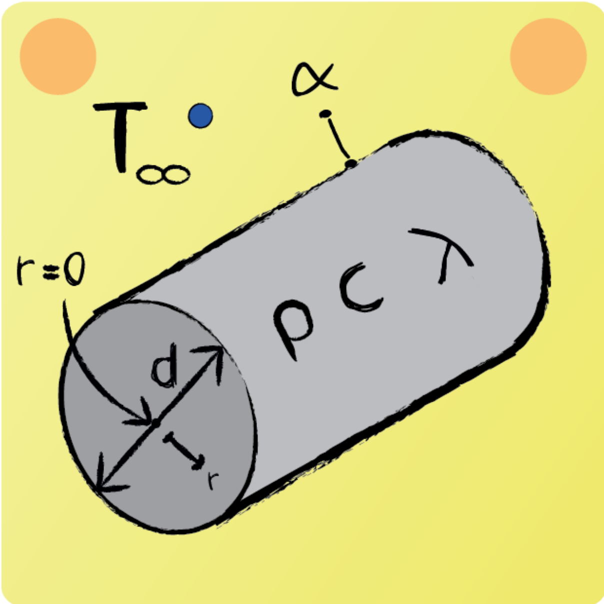
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.5$$



$$\rightarrow \mathrm{Fo} = 2.50$$

$$t = 7026.67 \text{ s}$$

Exam Preparation - Conduction 12



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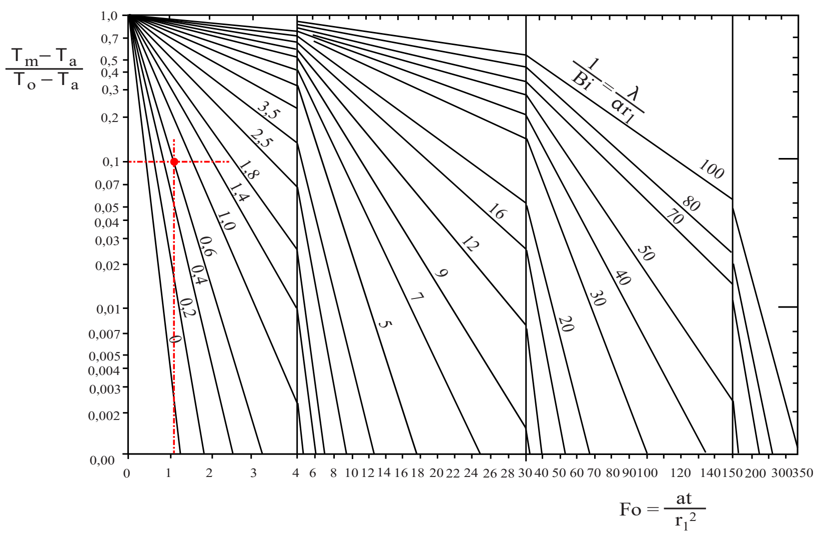
Problem type:
One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 0.6087$$

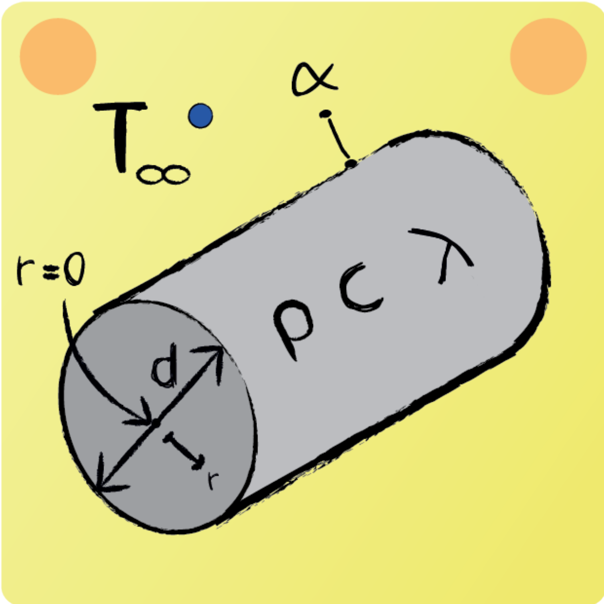
$$\frac{T_m - T_a}{T_o - T_a} = 0.1$$



$$\rightarrow \mathrm{Fo} = 1.08$$

$$t = 1876.66 \text{ s}$$

Exam Preparation - Conduction 13

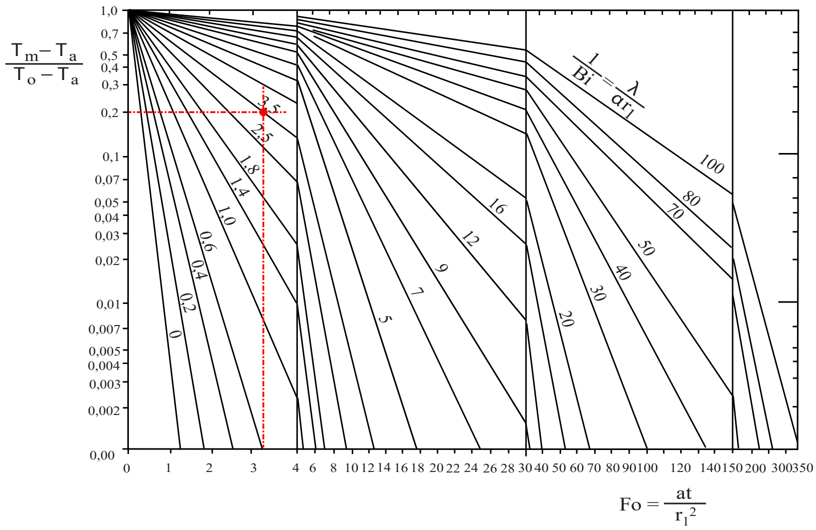


A cylinder of diameter $d = 0.5$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 341$ K is reached.

Problem type:
One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 3.50$$

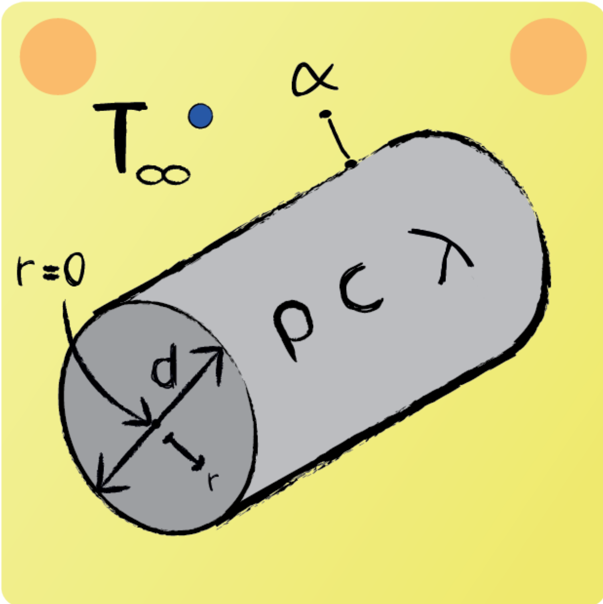
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.2$$



$$\rightarrow \mathrm{Fo} = 3.27$$

$$t = 14730.19 \text{ s}$$

Exam Preparation - Conduction 14

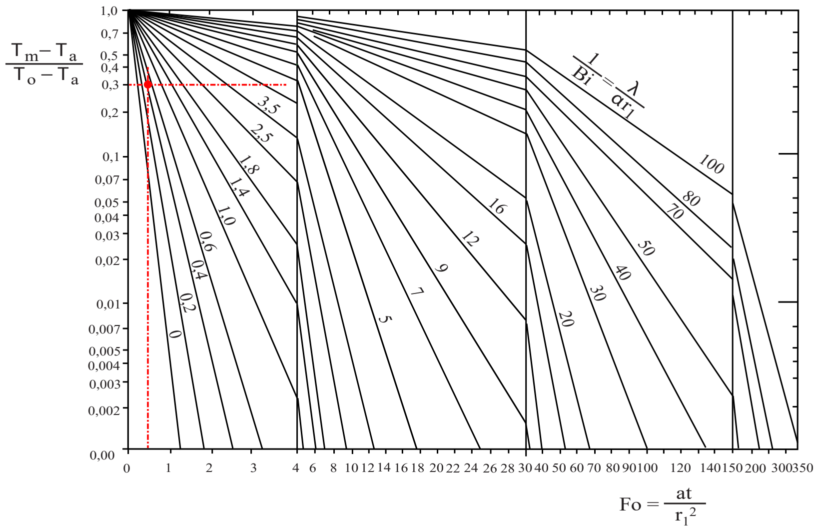


A cylinder of diameter $d = 0.5$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 335$ K is reached.

Problem type:
One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 0.41$$

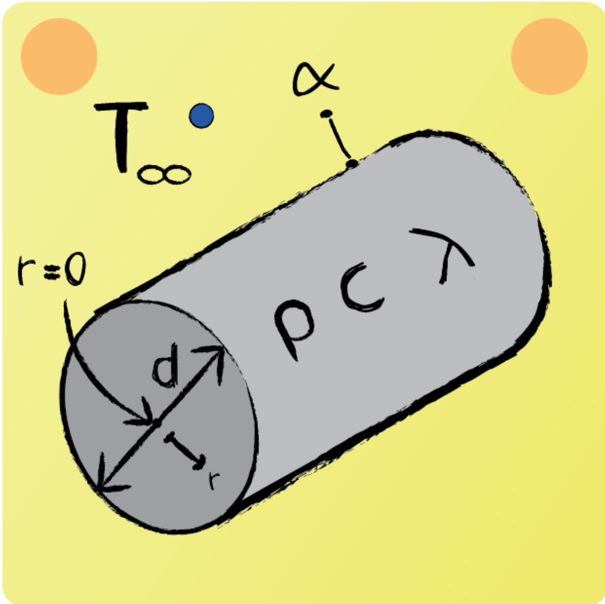
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.3$$



$$\rightarrow \mathrm{Fo} = 0.46$$

$$t = 4977.02 \text{ s}$$

Exam Preparation - Conduction 15

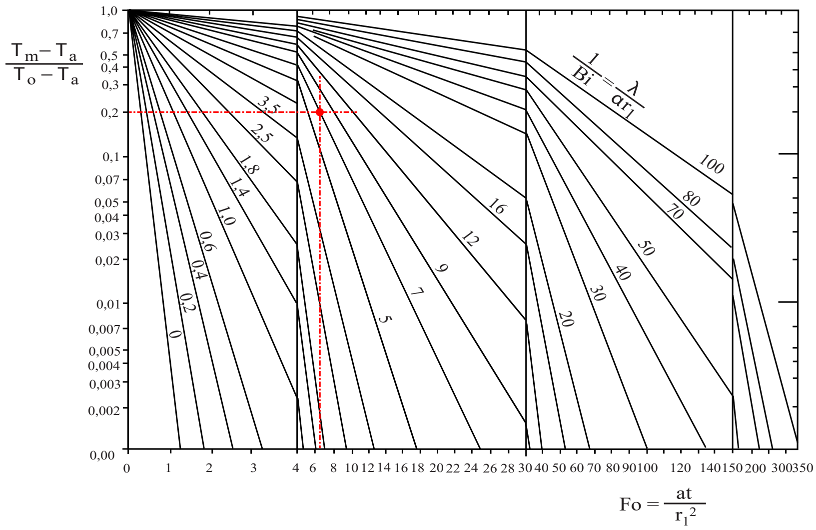


A cylinder of diameter $d = 0.5$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_{\mathrm{A}} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 341$ K is reached.

Problem type:
One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 7$$

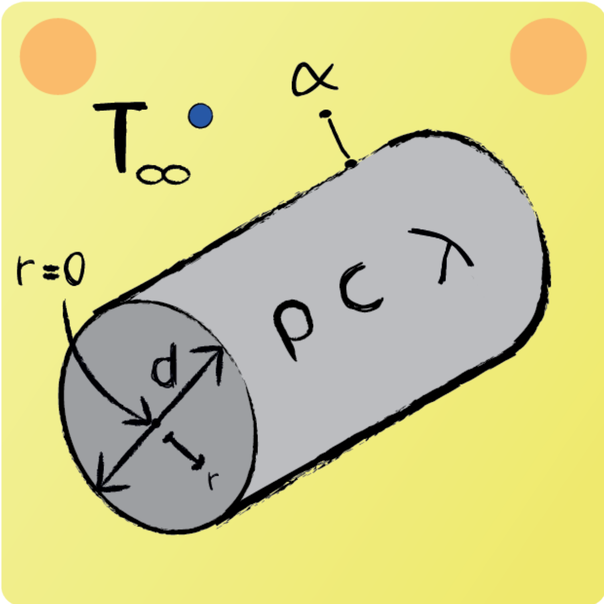
$$\frac{T_{\mathrm{m}} - T_{\mathrm{a}}}{T_{\mathrm{o}} - T_{\mathrm{a}}} = 0.2$$



$$\rightarrow \mathrm{Fo} = 6.51$$

$$t = 3021.11 \text{ s}$$

Exam Preparation - Conduction 16



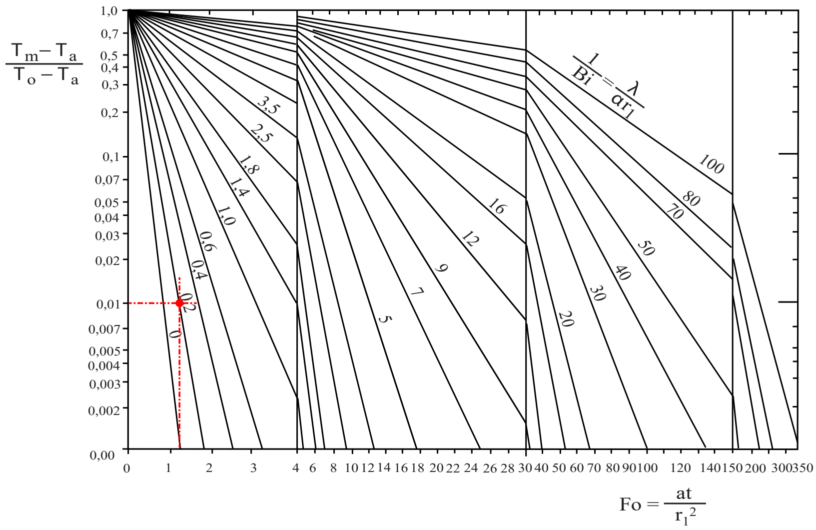
A cylinder of diameter $d = 0.5$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 352.4$ K is reached.

Problem type:

One-dimensional, unsteady heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 0.2$$

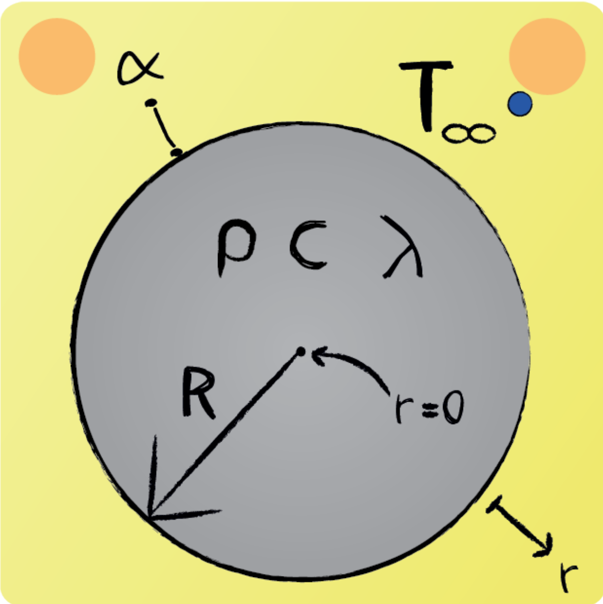
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.01$$



$$\rightarrow \mathrm{Fo} = 1.21$$

$$t = 6596.16 \text{ s}$$

Exam Preparation - Conduction 17

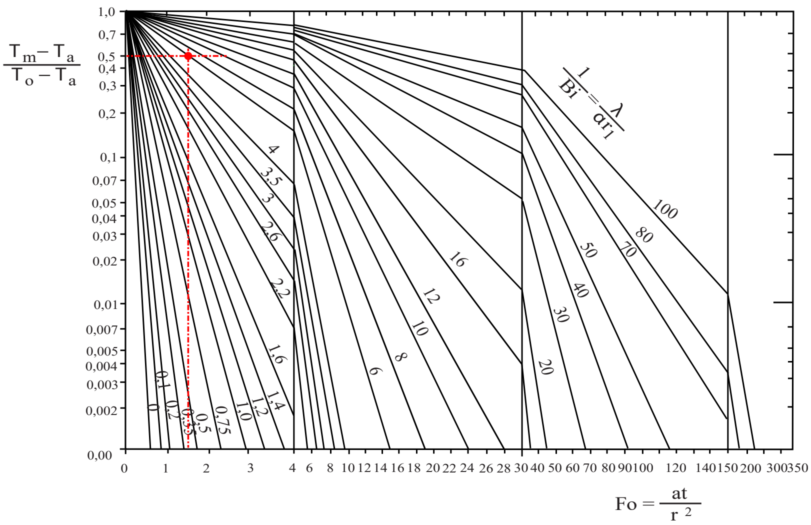


A sphere with radius $R = 1$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 323$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 6$$

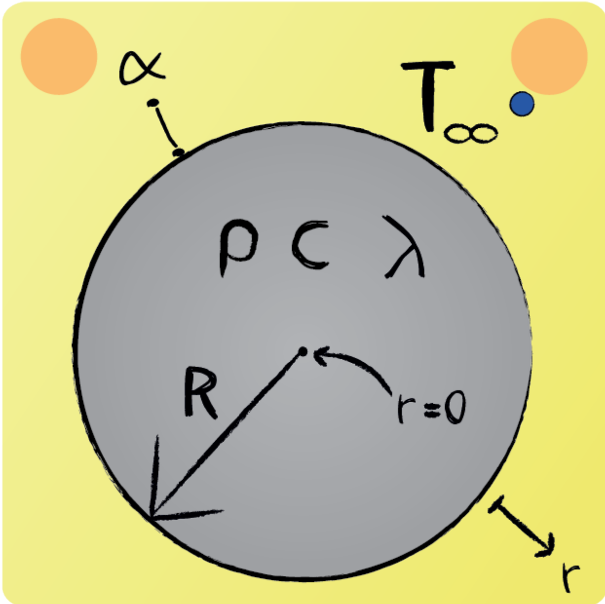
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.5$$



$\rightarrow \mathrm{Fo} = 1.49$

$t = 668.44$ s

Exam Preparation - Conduction 18



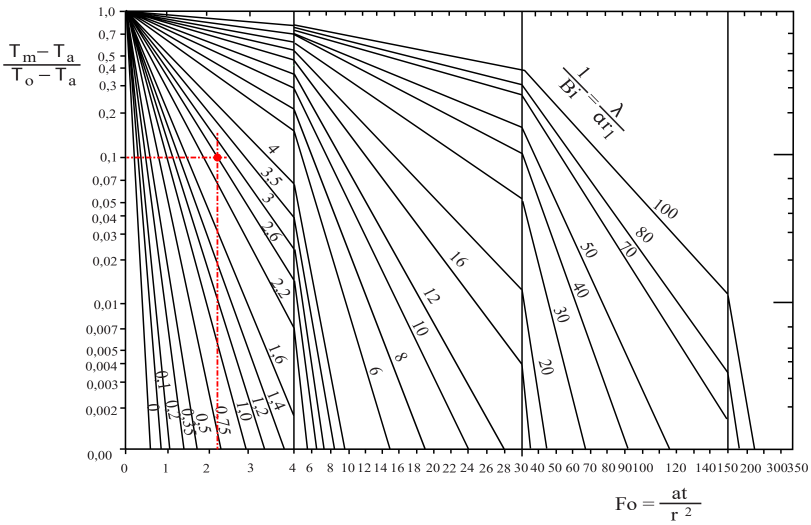
A sphere with radius $R = 1$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 347$ K is reached.

Problem type:

One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 2.60$$

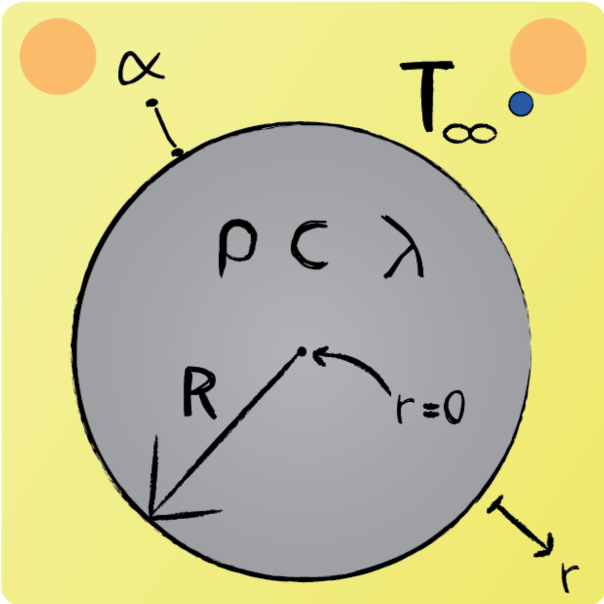
$$\frac{T_m - T_a}{T_o - T_a} = 0.1$$



$\rightarrow \mathrm{Fo} = 2.21$

$t = 615.32$ s

Exam Preparation - Conduction 19



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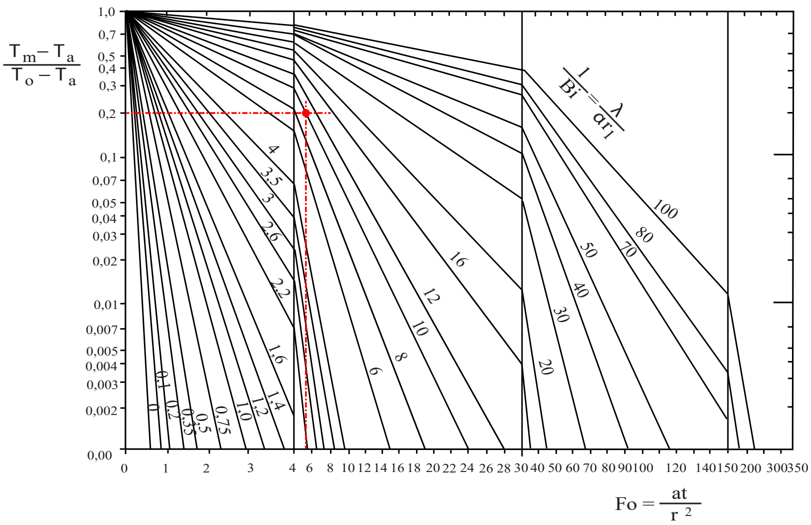
Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 10$$

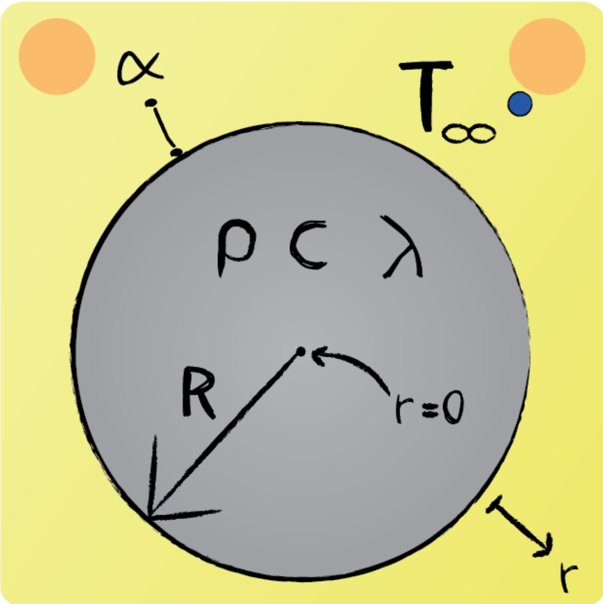
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.2$$



$$\rightarrow \mathrm{Fo} = 5.35$$

$$t = 3862.46 \text{ s}$$

Exam Preparation - Conduction 20



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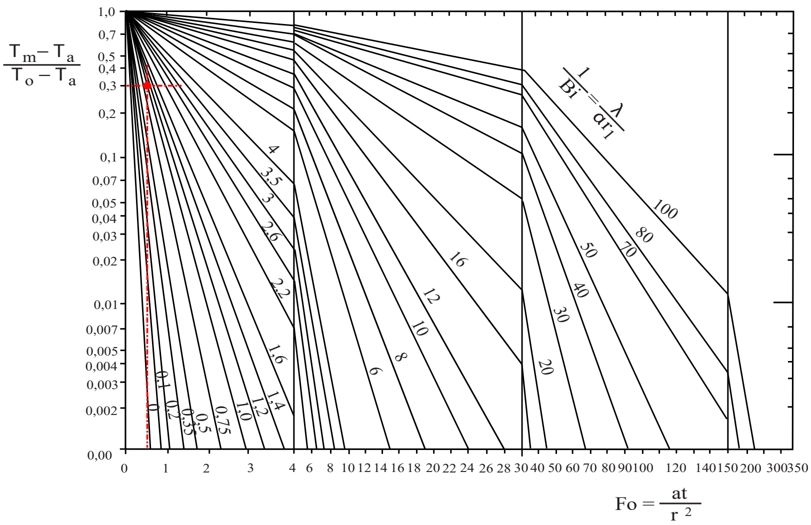
Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 1.02$$

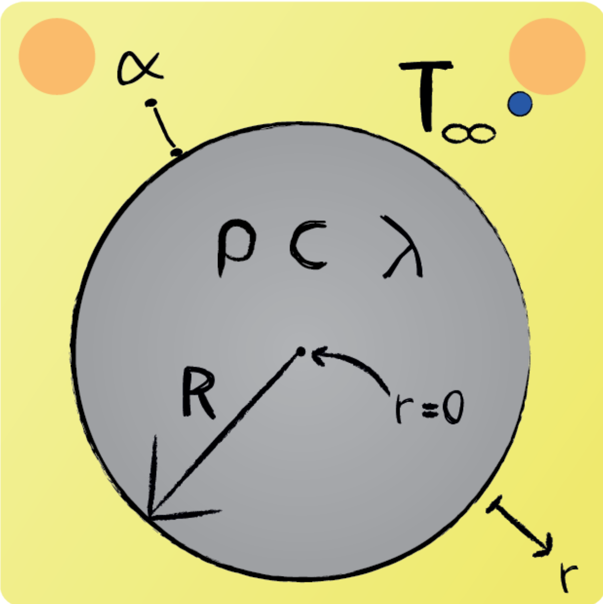
$$\frac{T_{\mathrm{m}} - T_{\mathrm{a}}}{T_{\mathrm{o}} - T_{\mathrm{a}}} = 0.3$$



$$\rightarrow \mathrm{Fo} = 0.51$$

$$t = 880.13 \text{ s}$$

Exam Preparation - Conduction 21

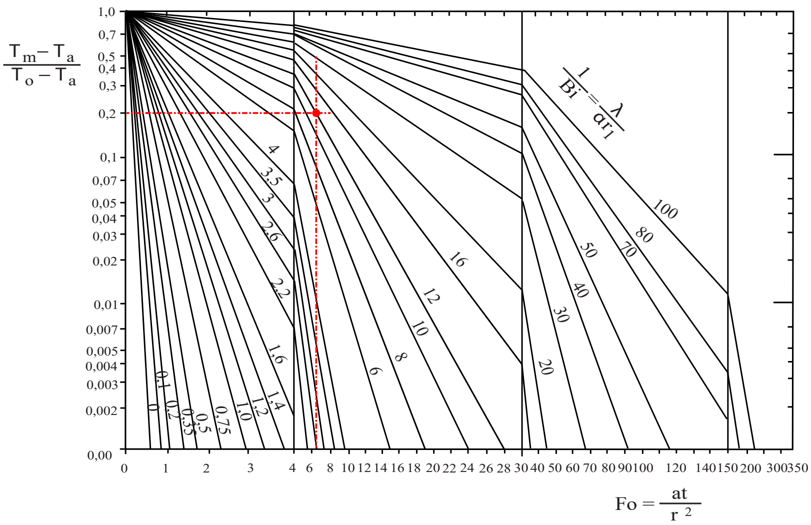


A sphere with radius $R = 1$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 341$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\text{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 12$$

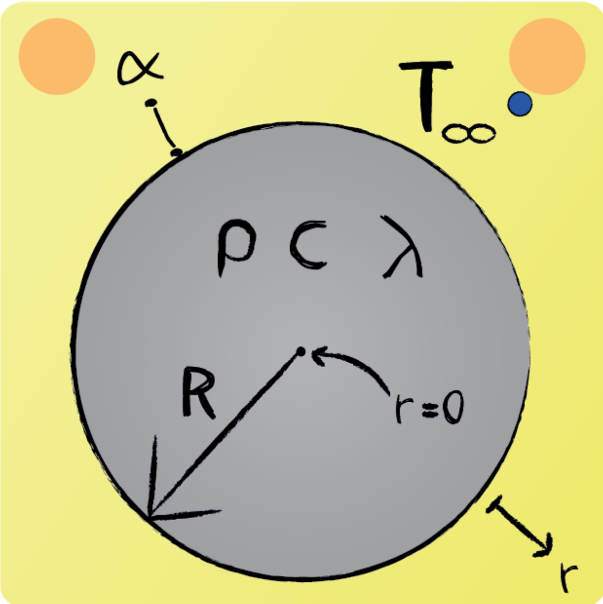
$$\frac{T_\text{m} - T_\text{a}}{T_\text{o} - T_\text{a}} = 0.2$$



$$\rightarrow \text{Fo} = 6.48$$

$$t = 481.08 \text{ s}$$

Exam Preparation - Conduction 22

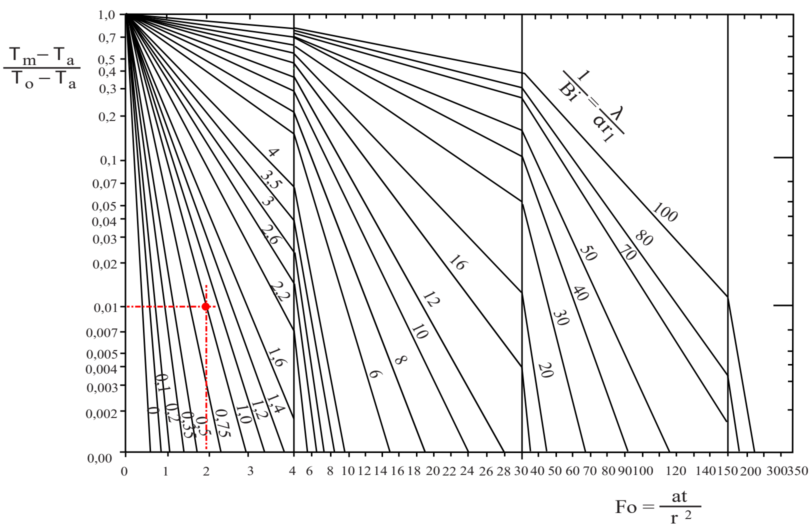


A sphere with radius $R = 1$ cm with initial homogeneous temperature $T(r, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_{\mathrm{A}} = 353$ K. Determine the time t_1 at which $T(r = 0, t_1) = 352.4$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot r_1} = 1$$

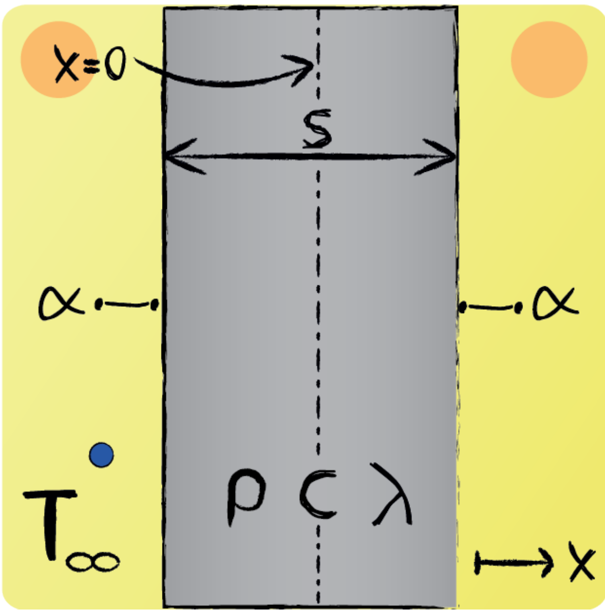
$$\frac{T_{\mathrm{m}} - T_{\mathrm{a}}}{T_{\mathrm{o}} - T_{\mathrm{a}}} = 0.01$$



$$\rightarrow \mathrm{Fo} = 1.92$$

$$t = 1675.65 \text{ s}$$

Exam Preparation - Conduction 23

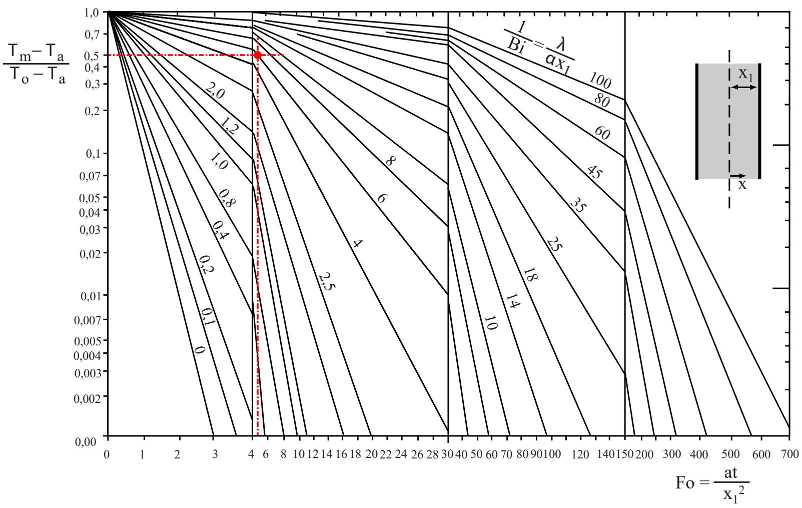


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 323$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 6$$

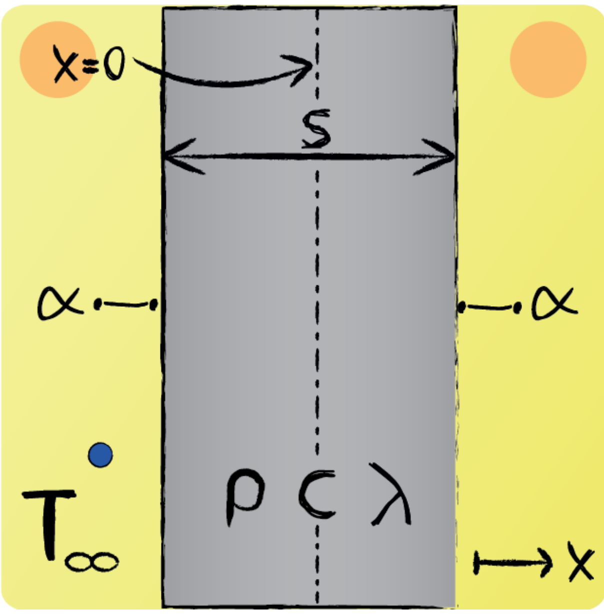
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.5$$



$$\rightarrow \mathrm{Fo} = 4.69$$

$$t = 2108.11 \text{ s}$$

Exam Preparation - Conduction 24

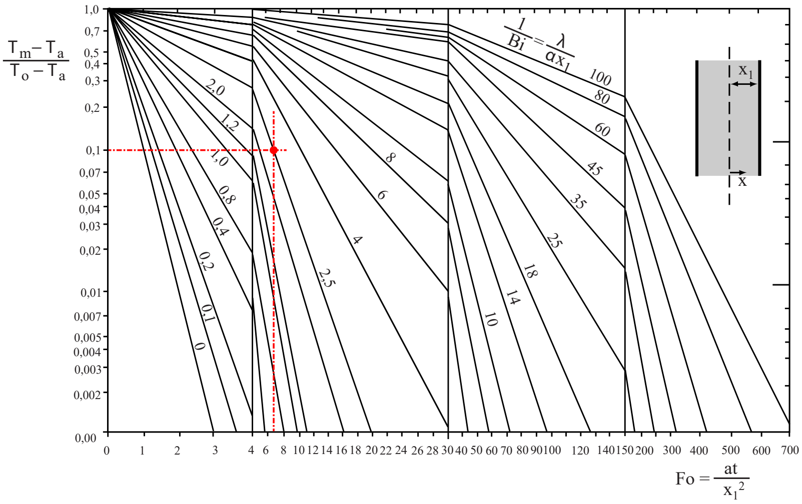


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 347$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 2.5$$

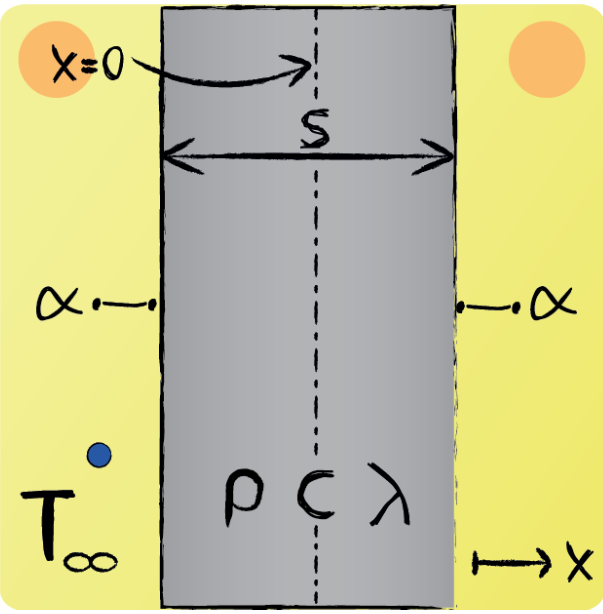
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.1$$



$$\rightarrow \mathrm{Fo} = 6.74$$

$$t = 1876.60 \text{ s}$$

Exam Preparation - Conduction 25

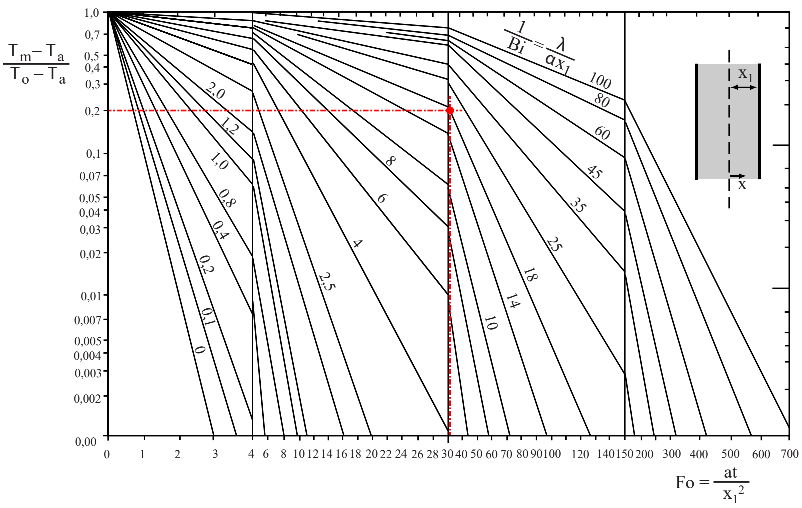


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 341$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 18.01$$

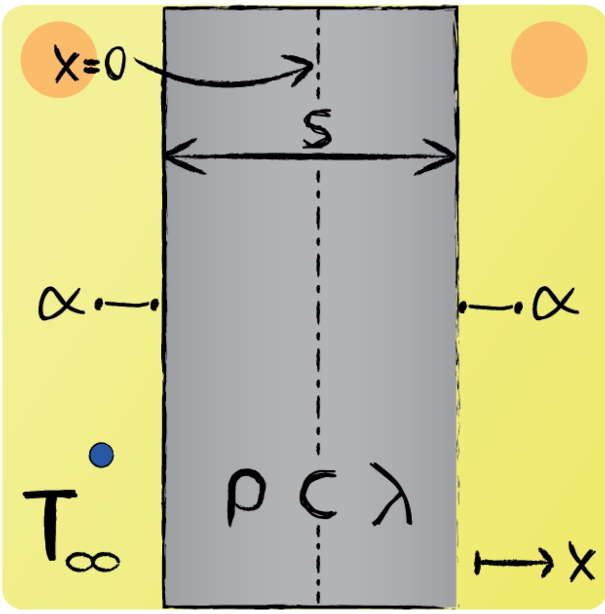
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.2$$



$$\rightarrow \mathrm{Fo} = 31.31$$

$$t = 2326.00 \text{ s}$$

Exam Preparation - Conduction 26

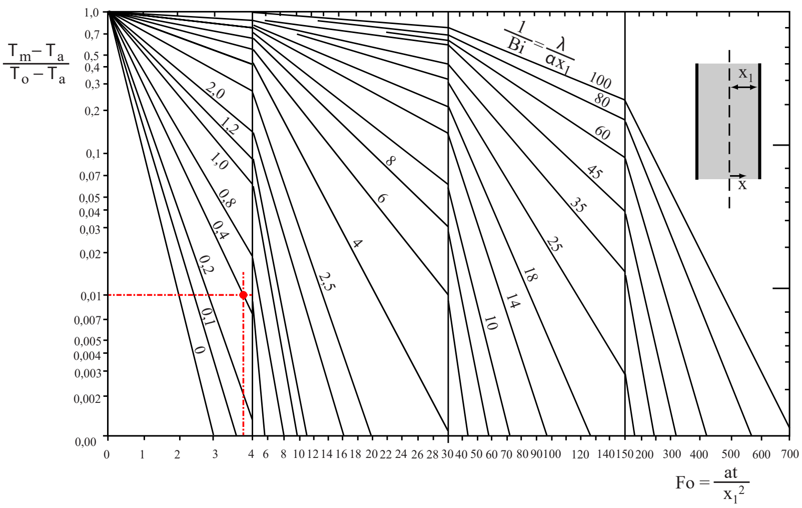


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 352.4$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\text{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 0.4$$

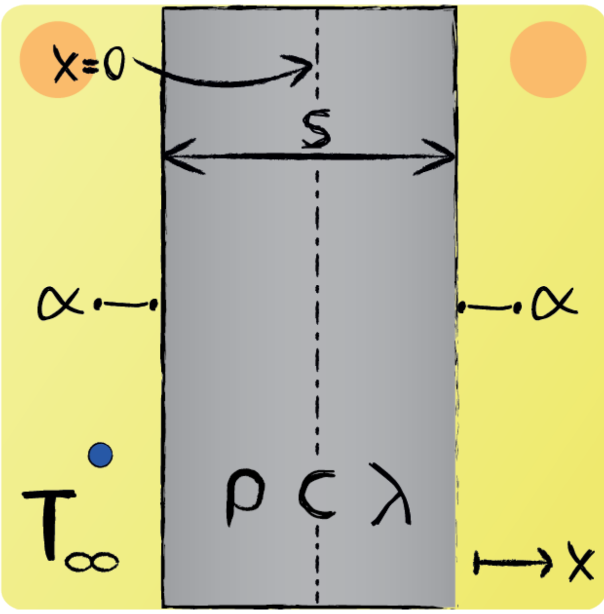
$$\frac{T_\text{m} - T_\text{a}}{T_\text{o} - T_\text{a}} = 0.01$$



$$\rightarrow \text{Fo} = 3.77$$

$$t = 3283.95 \text{ s}$$

Exam Preparation - Conduction 27

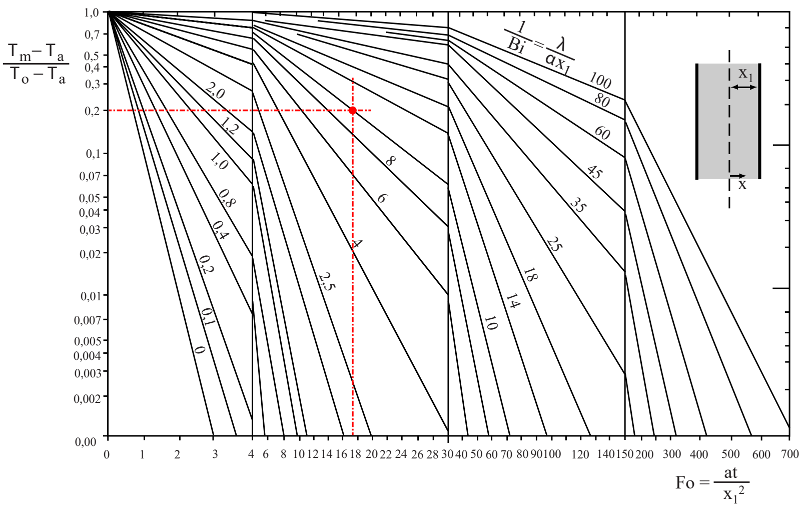


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_\mathrm{A} = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 341$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 10$$

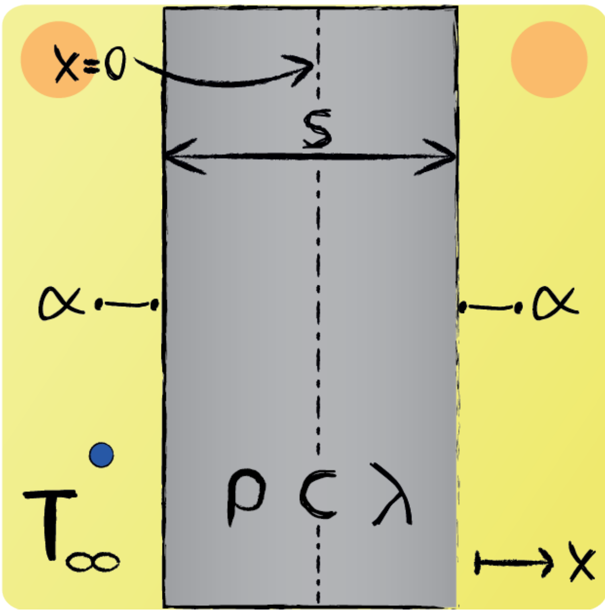
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.2$$



$$\rightarrow \mathrm{Fo} = 17.33$$

$$t = 12507.77 \text{ s}$$

Exam Preparation - Conduction 28

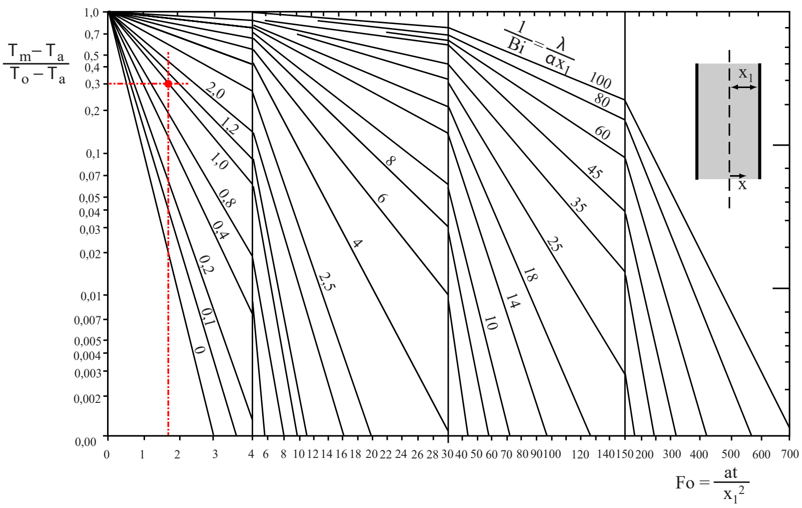


A plate with thickness $x = 2$ cm with initial homogeneous temperature $T(x, t = 0) = 293$ K, is suddenly exposed to a medium of temperature $T_A = 353$ K. Determine the time t_1 at which $T(x = 0, t_1) = 335$ K is reached.

Problem type:
One-dimensional, unsteady-state heat conduction that does penetrate.

$$\frac{1}{\mathrm{Bi}} = \frac{\lambda}{\alpha \cdot x_1} = 1.02$$

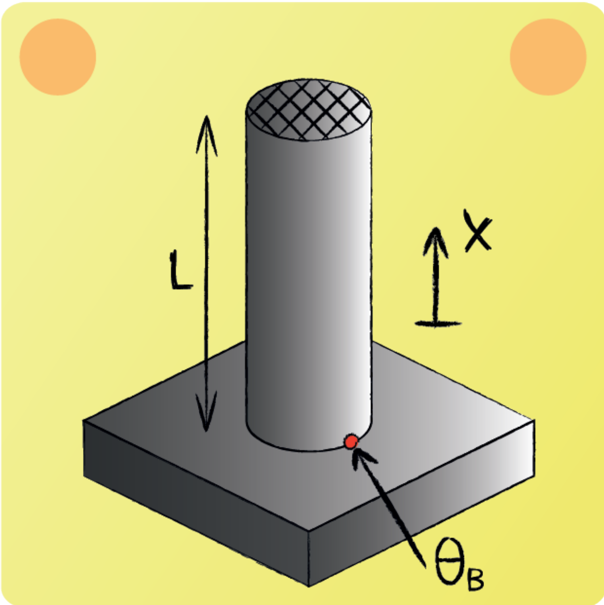
$$\frac{T_\mathrm{m} - T_\mathrm{a}}{T_\mathrm{o} - T_\mathrm{a}} = 0.3$$



$$\rightarrow \mathrm{Fo} = 1.68$$

$$t = 2884.73 \text{ s}$$

Conduction Fins 01



Choose the right boundary conditions for a fin with an adiabatic fin head!

Temperature difference:

$$\theta(x) = T(x) - T_\mathrm{A}$$

Boundary conditions:

$$T(x=0) = T_\mathrm{B}$$

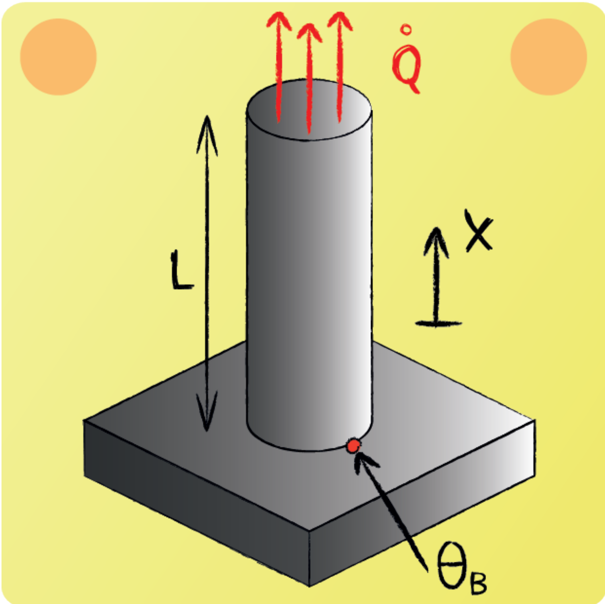
$$-\lambda \cdot A \cdot \left.\frac{dT}{dx}\right|_{x=L} = 0$$

Combining the temperature difference and the boundary conditions results in:

$$\theta(x=0) = T_\mathrm{B} - T_\mathrm{A} = \theta_\mathrm{B}$$

$$\lambda \cdot \left.\frac{d\theta}{dx}\right|_{x=L} = 0$$

Conduction Fins 02



Choose the right boundary conditions for a fin with transferring heat at the fin head!

Temperature difference:

$$\theta(x) = T(x) - T_{\mathrm{A}}$$

Boundary conditions:

$$T(x=0) = T_{\mathrm{B}}$$

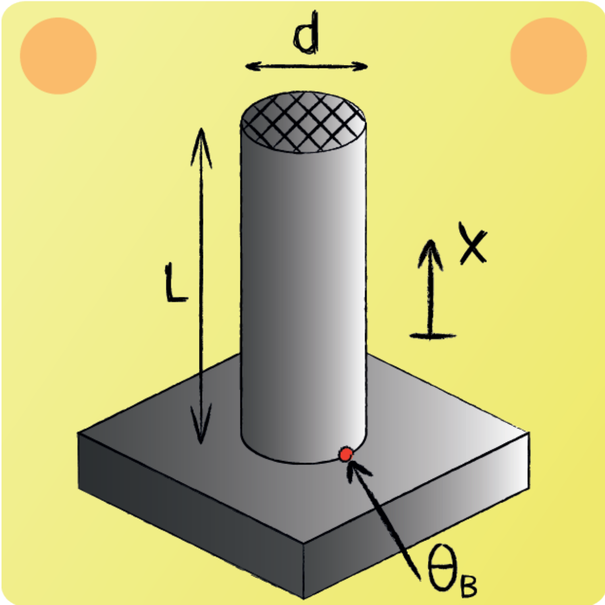
$$-\lambda \cdot A \cdot \left.\frac{dT}{dx}\right|_{x=L} = \alpha \cdot A \cdot (T(x=L) - T_{\mathrm{A}})$$

Combining the temperature difference and the boundary conditions results in:

$$\theta(x=0) = T_{\mathrm{B}} - T_{\mathrm{A}} = \theta_{\mathrm{B}}$$

$$-\lambda \cdot \left.\frac{d\theta}{dx}\right|_{x=L} = \alpha \cdot \theta(x=L)$$

Conduction Fins 03



Calculate the transferred heat for the given fin with an adiabatic head!

Boundary conditions:

$$\theta(x=0) = \theta_B$$

$$-\lambda \cdot \left.\frac{d\theta}{dx}\right|_{x=L} = 0$$

Heat flow through the fin:

$$\dot{Q} = \lambda \cdot A_\mathrm{c} \cdot m \cdot \theta_\mathrm{B} \cdot \tanh\left(m \cdot L\right)$$

Where:

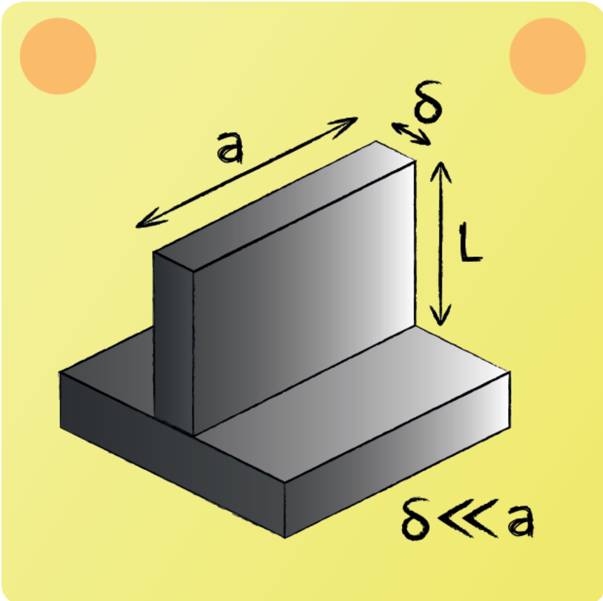
$$m = \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot d}}$$

$$A_\mathrm{c} = \frac{1}{4}\pi d^2$$

And thus:

$$\dot{Q} = \lambda \cdot A_\mathrm{c} = \frac{1}{4}\pi d^2 \cdot \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot d}} \cdot \theta_\mathrm{B} \cdot \tanh\left(\sqrt{\frac{4 \cdot \alpha}{\lambda \cdot d}} \cdot L\right)$$

Conduction Fins 04



Determine the fin parameter m for the shown fin geometry.

$$m^2 = \frac{\alpha \cdot U}{\lambda \cdot A_c} = \frac{\alpha \cdot 2 \cdot (\delta + a)}{\lambda \cdot \delta \cdot a} = \frac{2 \cdot \alpha}{\lambda} \cdot \left(\frac{1}{\delta} + \frac{1}{a}\right)$$

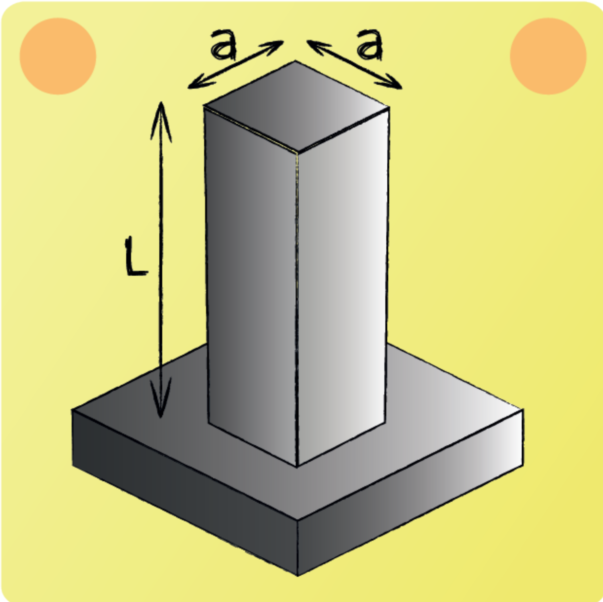
Where:

$$\frac{1}{\delta} >> \frac{1}{a}$$

And thus:

$$m \approx \sqrt{\frac{2 \cdot \alpha}{\lambda \cdot \delta}}$$

Conduction Fins 05



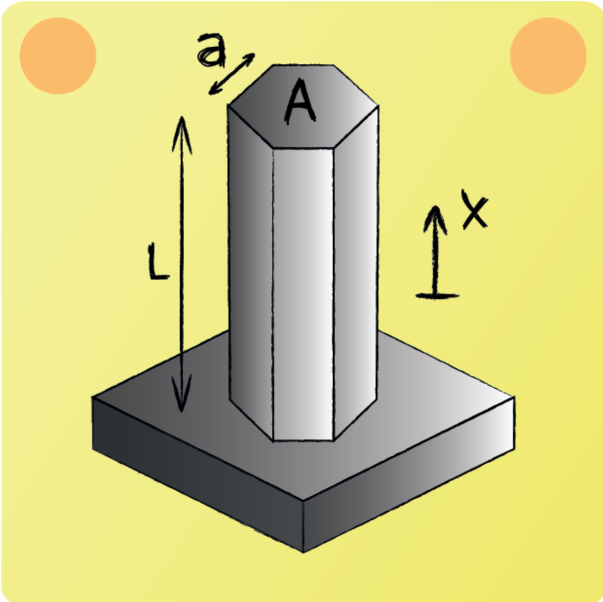
Determine the fin parameter m for the shown fin geometry.

$$m^2 = \frac{\alpha \cdot U}{\lambda \cdot A_c} = \frac{\alpha \cdot 4 \cdot a}{\lambda \cdot a^2} = \frac{4 \cdot \alpha}{\lambda \cdot a}$$

And thus:

$$m = \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot a}}$$

Conduction Fins 06



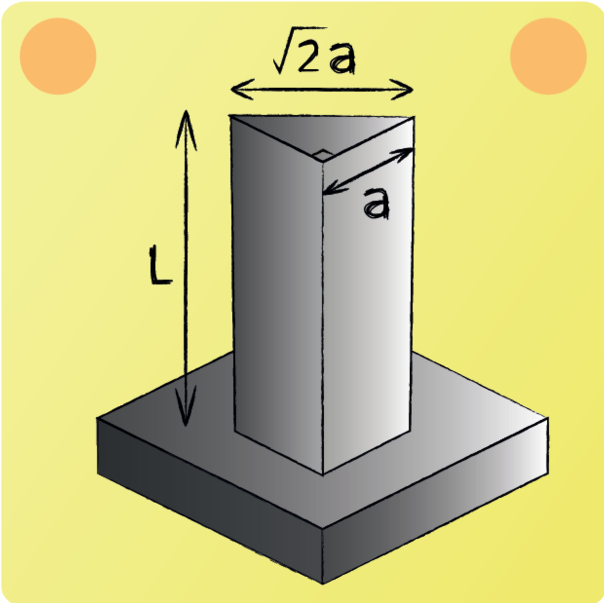
Determine the fin parameter m for the shown fin geometry.

And thus:

$$m^2 = \frac{\alpha \cdot U}{\lambda \cdot A_c} = \frac{\alpha \cdot 6 \cdot a}{\lambda \cdot A_c}$$

$$m = \sqrt{\frac{6 \cdot \alpha \cdot a}{\lambda \cdot A_c}}$$

Conduction Fins 07



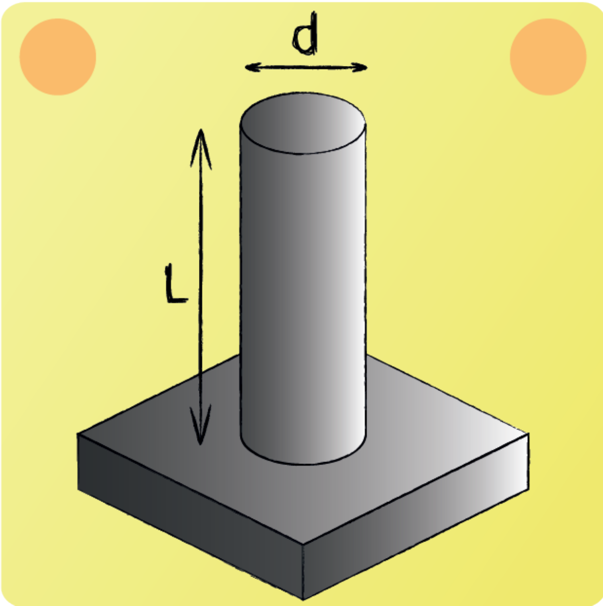
Determine the fin parameter m for the shown fin geometry.

$$m^2 = \frac{\alpha \cdot U}{\lambda \cdot A_c} = \frac{\alpha \cdot a \cdot (2+\sqrt{2})}{\lambda \cdot \frac{1}{2} \cdot a^2}$$

And thus:

$$m = \sqrt{\frac{\alpha \cdot (4+2\sqrt{2})}{\lambda \cdot \cdot a}}$$

Conduction Fins 08



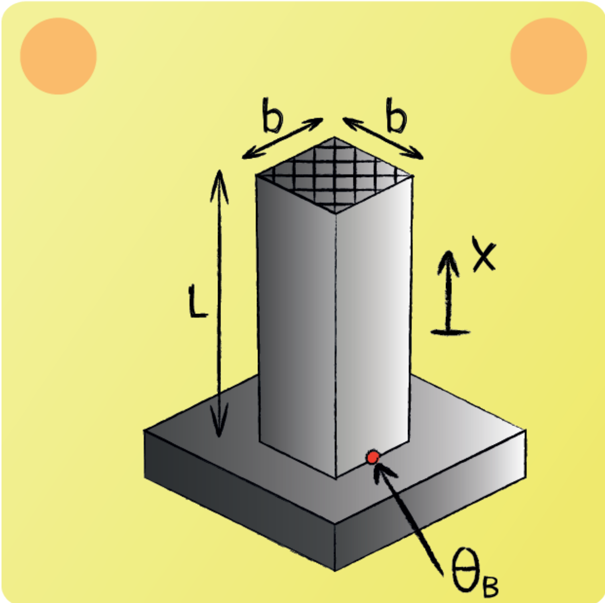
Determine the fin parameter m for the shown fin geometry.

$$m^2 = \frac{\alpha \cdot U}{\lambda \cdot A_{\mathrm{c}}} = \frac{\alpha \cdot d \cdot \pi}{\lambda \cdot \frac{1}{4}\pi d^2}$$

And thus:

$$m = \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot d}}$$

Conduction Fins 09



Calculate the transferred heat for the given fin with an adiabatic head!

Boundary conditions:

$$\theta(x=0) = \theta_B$$

$$-\lambda \cdot \left.\frac{d\theta}{dx}\right|_{x=L} = 0$$

Heat flow through the fin:

$$\dot{Q} = \lambda \cdot A_\mathrm{c} \cdot m \cdot \theta_\mathrm{B} \cdot \tanh\left(m \cdot L\right)$$

Where:

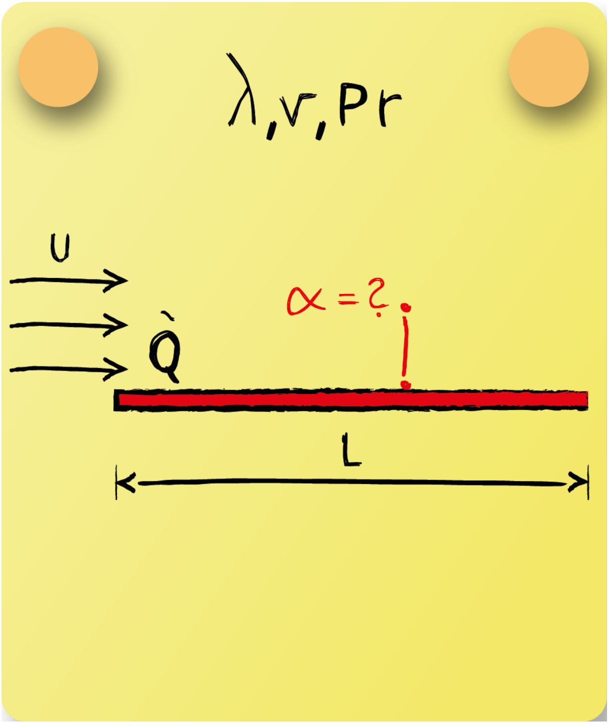
$$m = \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot b}}$$

$$A_\mathrm{c} = b^2$$

And thus:

$$\dot{Q} = \lambda \cdot b^2 \cdot \sqrt{\frac{4 \cdot \alpha}{\lambda \cdot b}} \cdot \theta_\mathrm{B} \cdot \tanh\left(\sqrt{\frac{4 \cdot \alpha}{\lambda \cdot b}} \cdot L\right)$$

Heat Transfer Correlation 2.1



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 6.51 \cdot 10^4$$

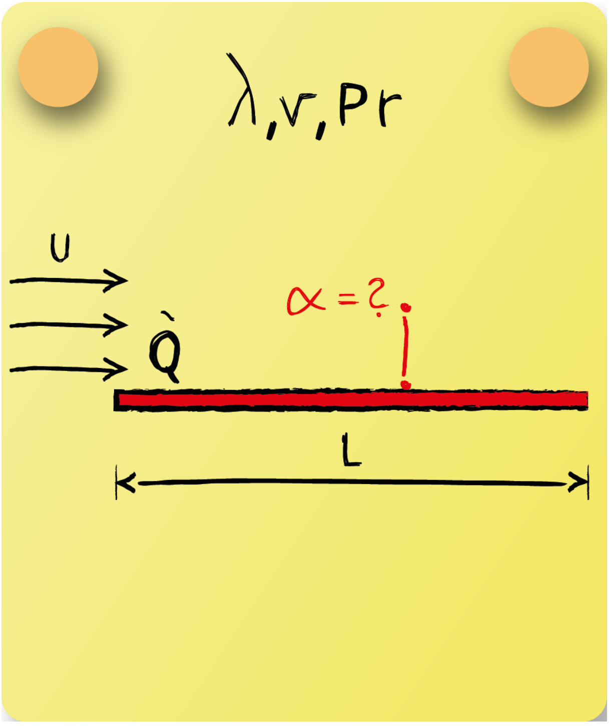
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} = 151.53$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.78\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 2.2



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 2.40 \cdot 10^3$$

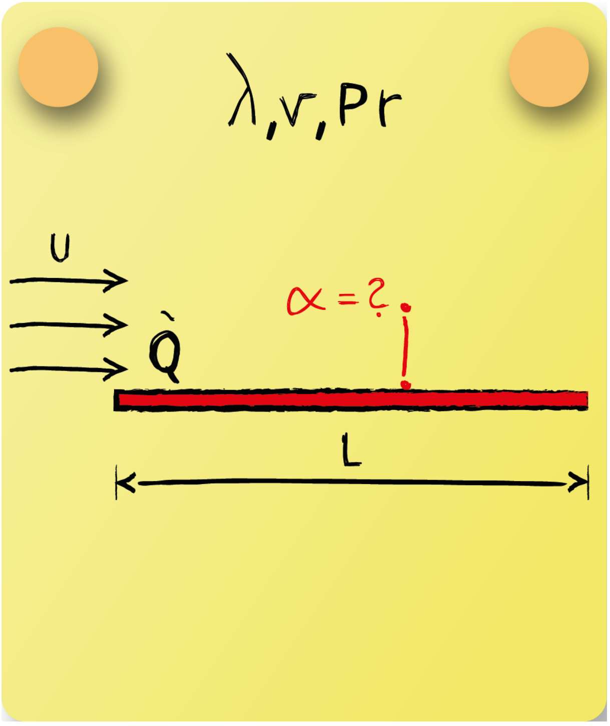
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} = 32.54$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.163 \ \mathrm{W/m^2K}$$

Heat Transfer Correlation 2.3



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 1.52 \cdot 10^4$$

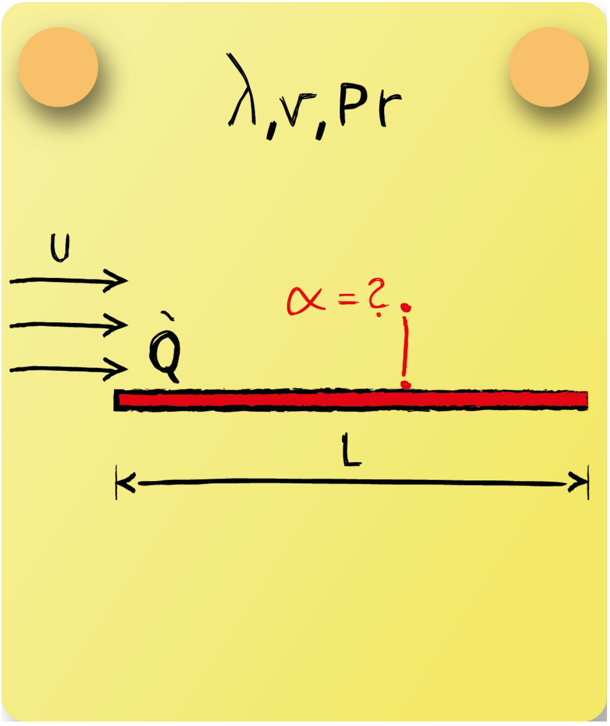
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} = 133.40$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 84.17\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 2.4



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 3.38 \cdot 10^4$$

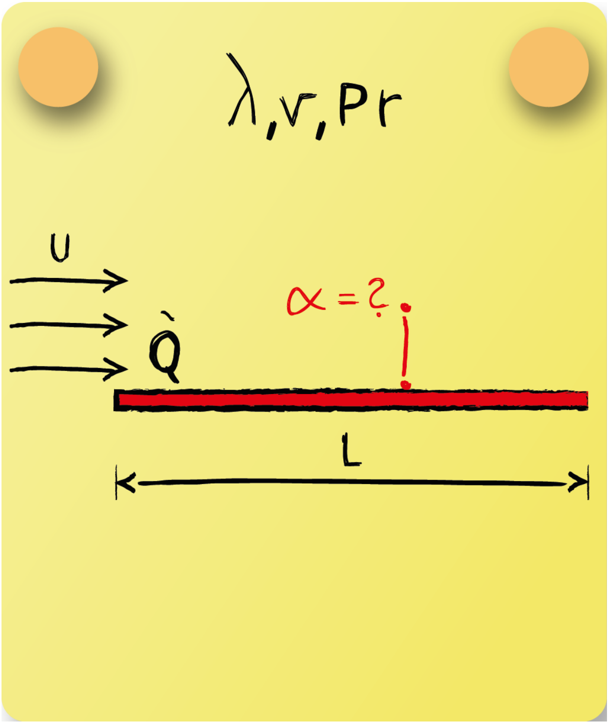
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} = 237.08$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 14.60\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 2.5



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 1.85 \cdot 10^3$$

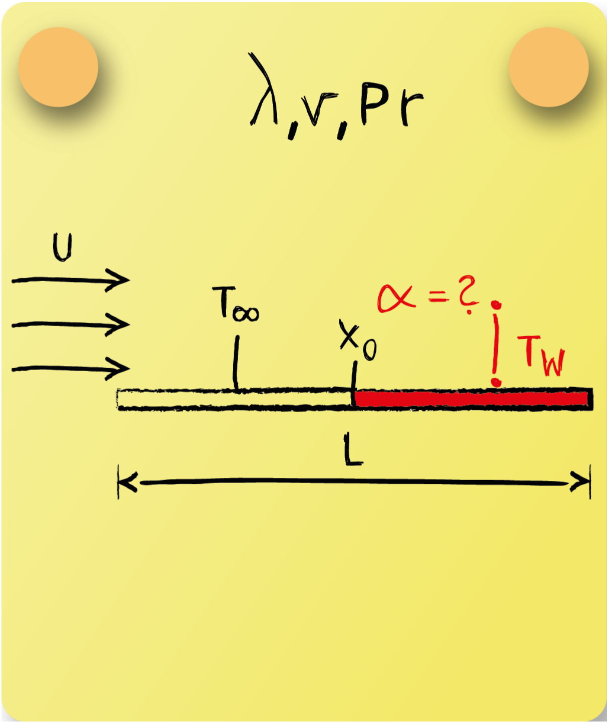
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} = 25.57$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.247\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 3.1



A fluid streams over a flat plate. The plate is heated from x_0. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 2.40 \cdot 10^3$$

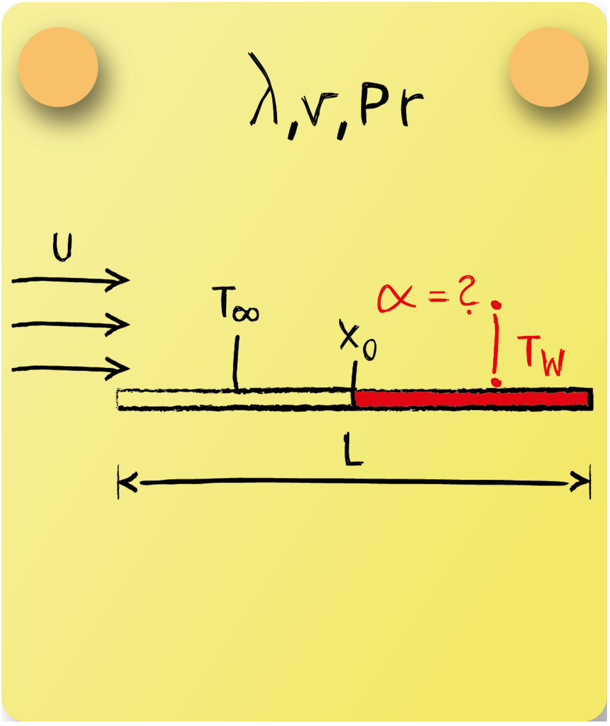
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} \frac{\left[1 - \left(\frac{x_0}{L}\right)^{\frac{3}{4}}\right]^{\frac{2}{3}}}{\left[1 - \frac{x_0}{L}\right]} = 35.64$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.18\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 3.2



A fluid streams over a flat plate. The plate is heated from x_0. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 1.52 \cdot 10^4$$

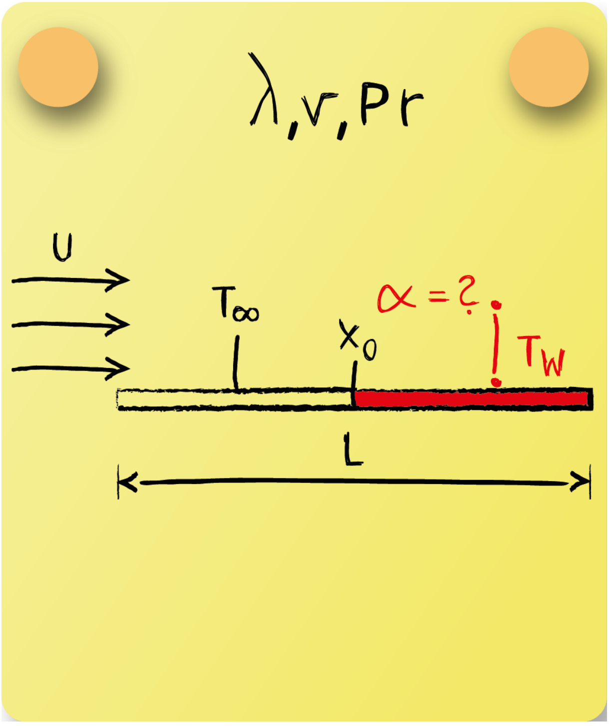
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} \frac{\left[1 - \left(\frac{x_0}{L}\right)^{\frac{3}{4}}\right]^{\frac{2}{3}}}{\left[1 - \frac{x_0}{L}\right]} = 146.14$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 92.21\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 3.3



A fluid streams over a flat plate. The plate is heated from x_0. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 3.38 \cdot 10^4$$

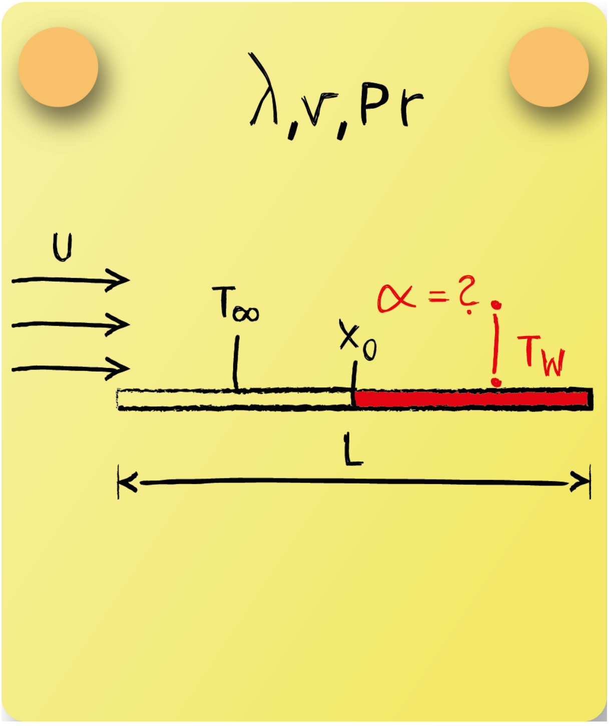
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} \frac{\left[1 - \left(\frac{x_0}{L}\right)^{\frac{3}{4}}\right]^{\frac{2}{3}}}{\left[1 - \frac{x_0}{L}\right]} = 259.72$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 16\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 3.4



A fluid streams over a flat plate. The plate is heated from x_0. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 1.85 \cdot 10^3$$

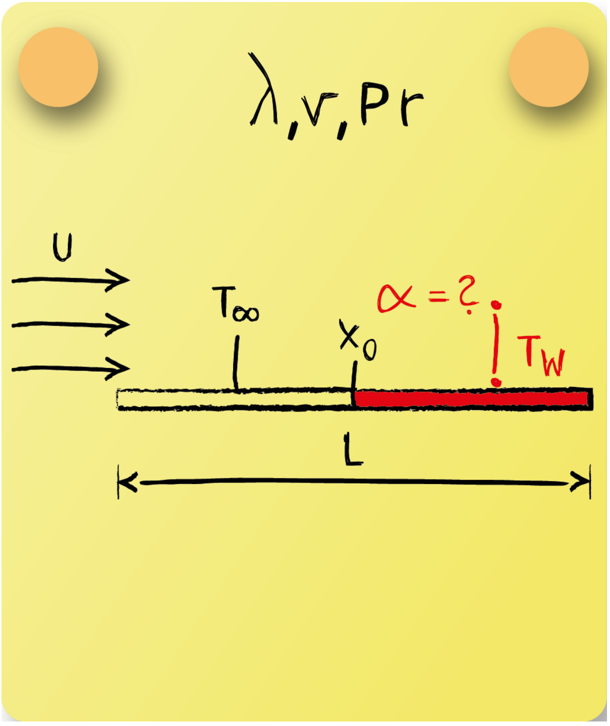
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} \frac{\left[1 - \left(\frac{x_0}{L}\right)^{\frac{3}{4}}\right]^{\frac{2}{3}}}{\left[1 - \frac{x_0}{L}\right]} = 28.01$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.27\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 3.5



A fluid streams over a flat plate. The plate is heated from x_0. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 6.52 \cdot 10^4$$

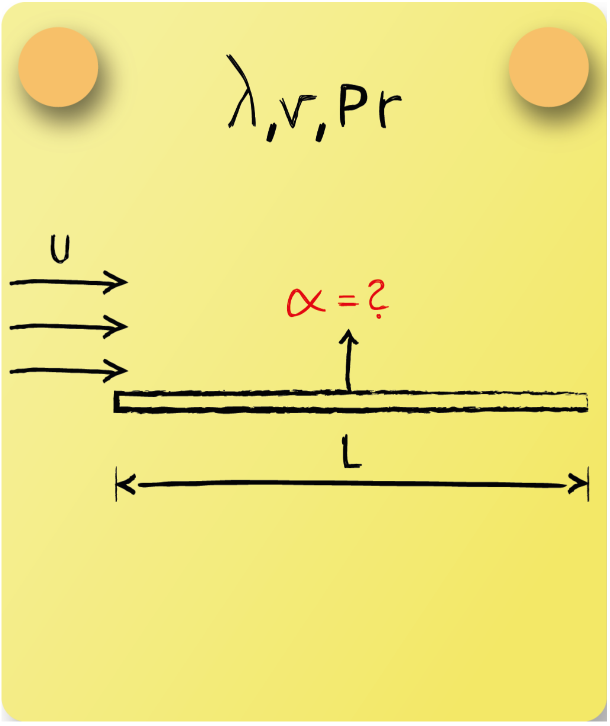
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.664 \cdot \mathrm{Re_L}^{\frac{1}{2}} \cdot \mathrm{Pr}^{\frac{1}{3}} \frac{\left[1 - \left(\frac{x_0}{L}\right)^{\frac{3}{4}}\right]^{\frac{2}{3}}}{\left[1 - \frac{x_0}{L}\right]} = 166.01$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 0.85\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 4.1



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 6.52 \cdot 10^5$$

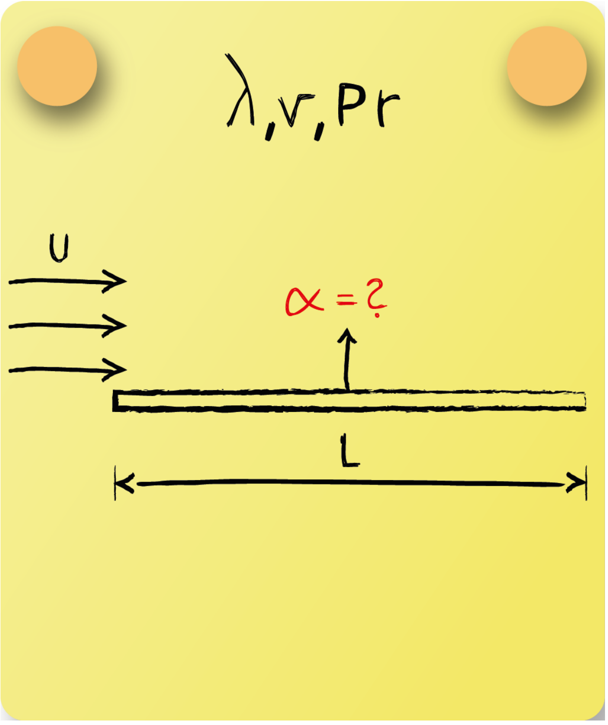
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.036 \cdot \mathrm{Pr}^{0.43} \cdot \left(\mathrm{Re_L}^{0.8} - 9400\right) = 1.10 \cdot 10^3$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 2.82\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 4.2



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 9.61 \cdot 10^5$$

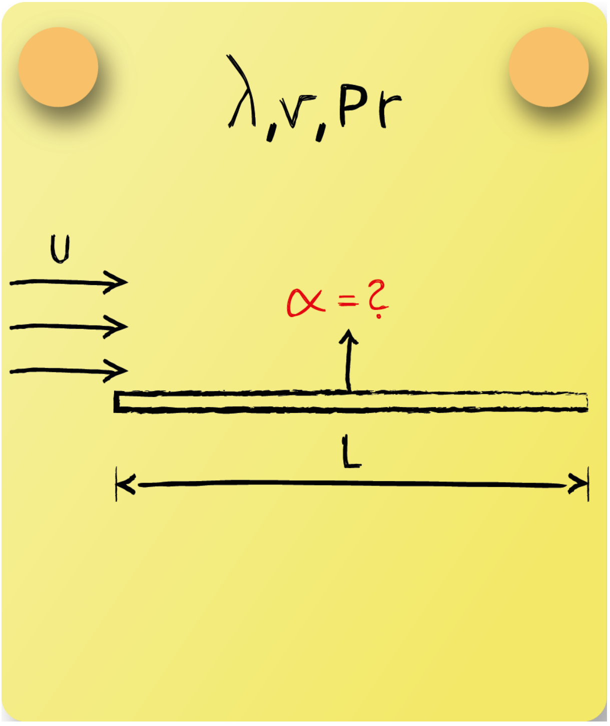
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.036 \cdot \mathrm{Pr}^{0.43} \cdot \left(\mathrm{Re_L}^{0.8} - 9400\right) = 1.86 \cdot 10^3$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 4.67\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 4.3



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 7.60 \cdot 10^5$$

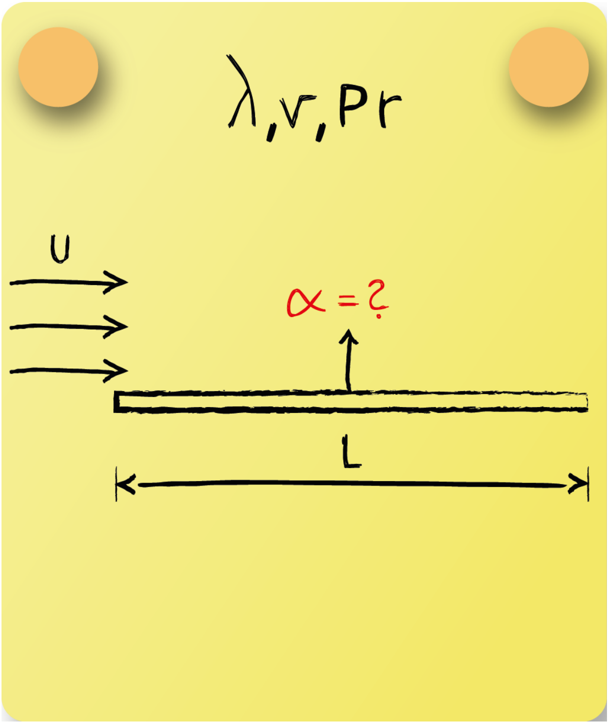
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.036 \cdot \mathrm{Pr}^{0.43} \cdot \left(\mathrm{Re_L}^{0.8} - 9400\right) = 2.79 \cdot 10^3$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 1759\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 4.4



A fluid streams over a flat plate. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_L} = \frac{u \cdot L}{\nu} = 7.40 \cdot 10^5$$

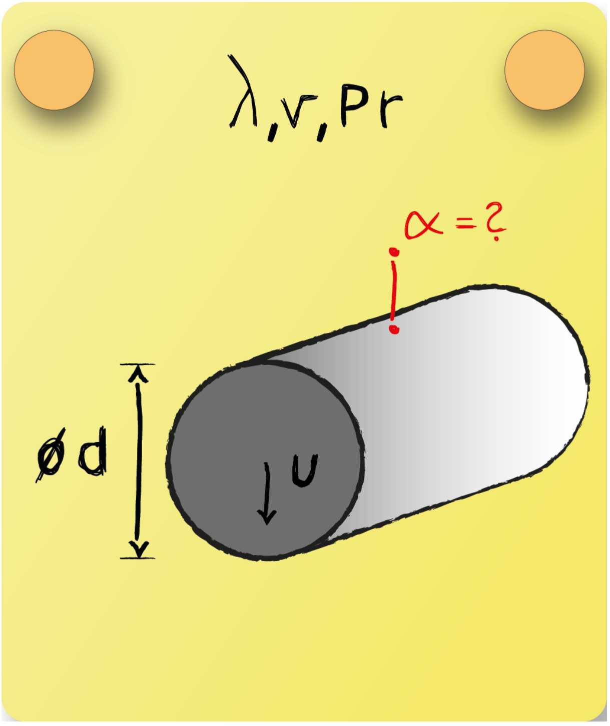
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.036 \cdot \mathrm{Pr}^{0.43} \cdot \left(\mathrm{Re_L}^{0.8} - 9400\right) = 1.25 \cdot 10^3$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 3.03\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 5.1



A cylinder falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 6.67 \cdot 10^4$$

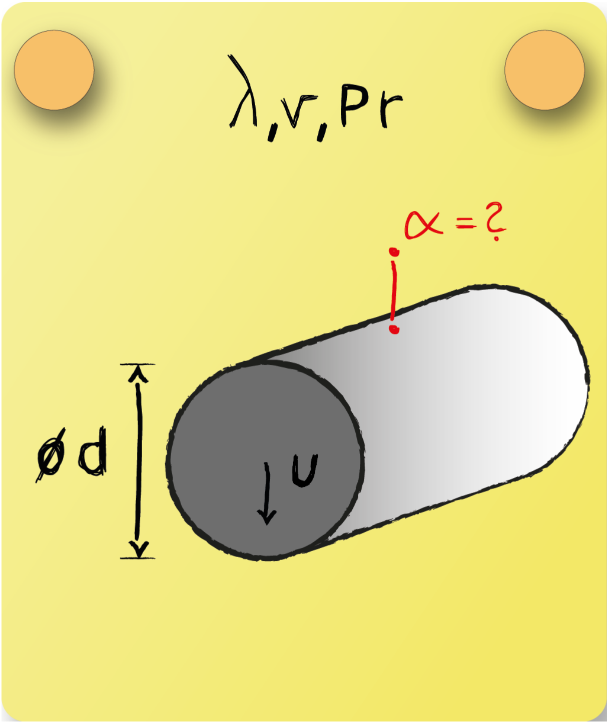
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 0.0266 \cdot \mathrm{Re_d}^{0.805} \cdot \mathrm{Pr}^{0.4} = 177.27$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 23.05\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 5.2



A cylinder falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 3.33 \cdot 10^3$$

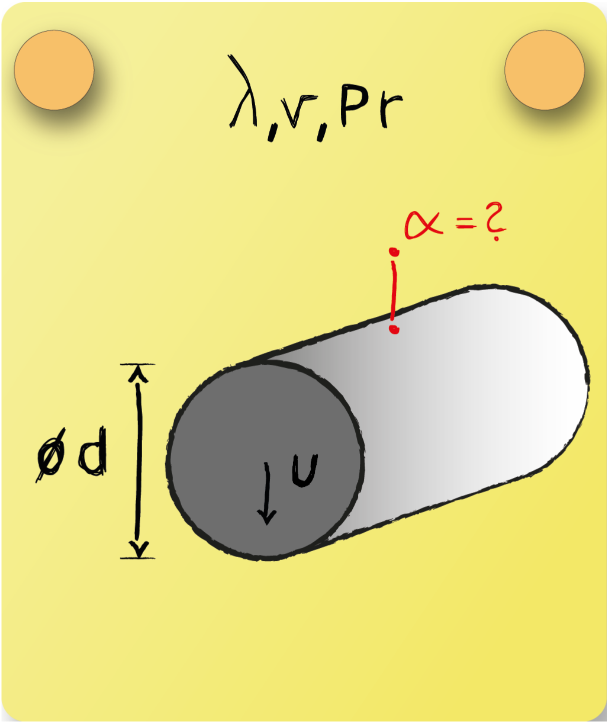
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 0.683 \cdot \mathrm{Re_d}^{0.466} \cdot \mathrm{Pr}^{0.4} = 28.95$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 156.31\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 5.3



A cylinder falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 2.94 \cdot 10^4$$

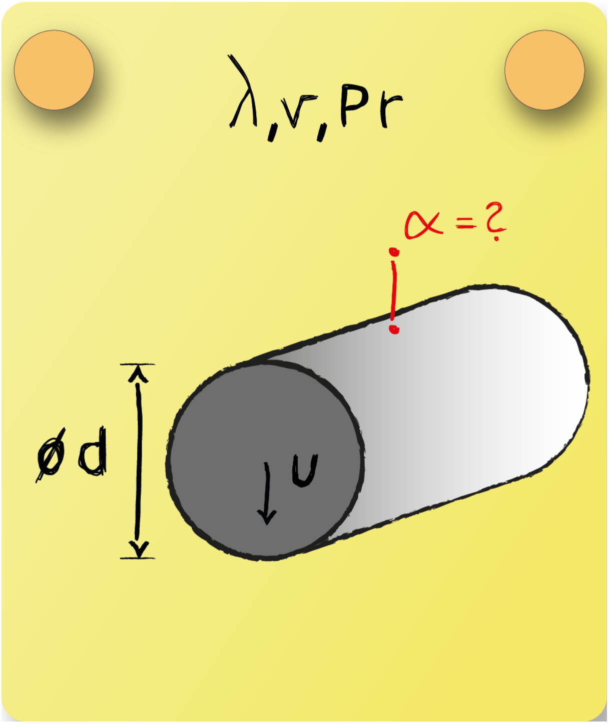
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 0.193 \cdot \mathrm{Re_d}^{0.618} \cdot \mathrm{Pr}^{0.4} = 242.74$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 1238.0\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 5.4



A cylinder falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 5.56$$

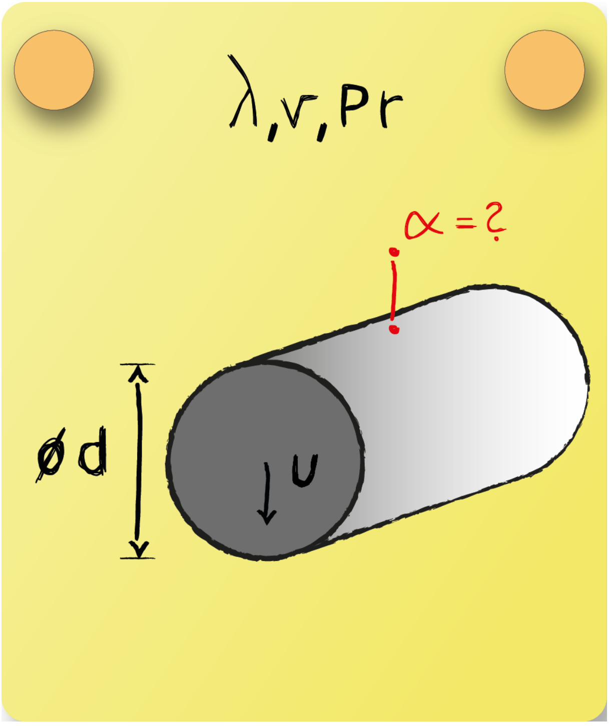
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 0.911 \cdot \mathrm{Re_d}^{0.385} \cdot \mathrm{Pr}^{0.4} = 6.39$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 70.27\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 5.5



A cylinder falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0.794$$

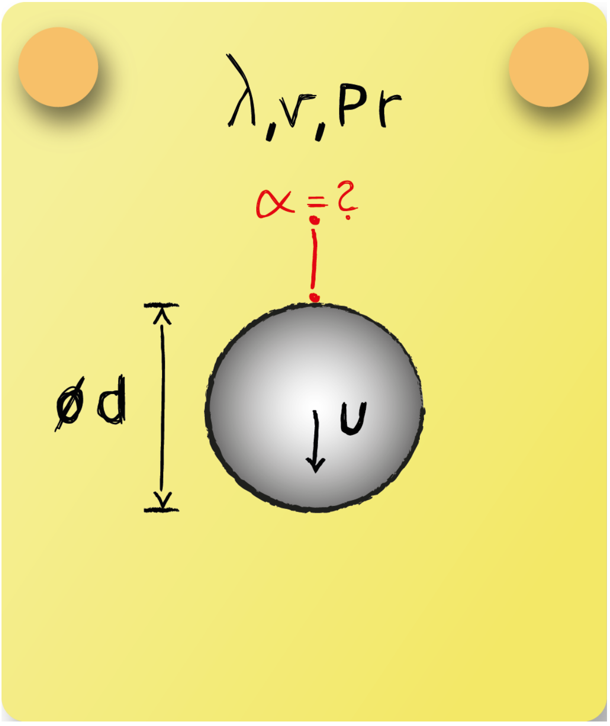
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 0.989 \cdot \mathrm{Re_d}^{0.330} \cdot \mathrm{Pr}^{0.4} = 0.781$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 15.77\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 11.1



A sphere falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 6.51 \cdot 10^4$$

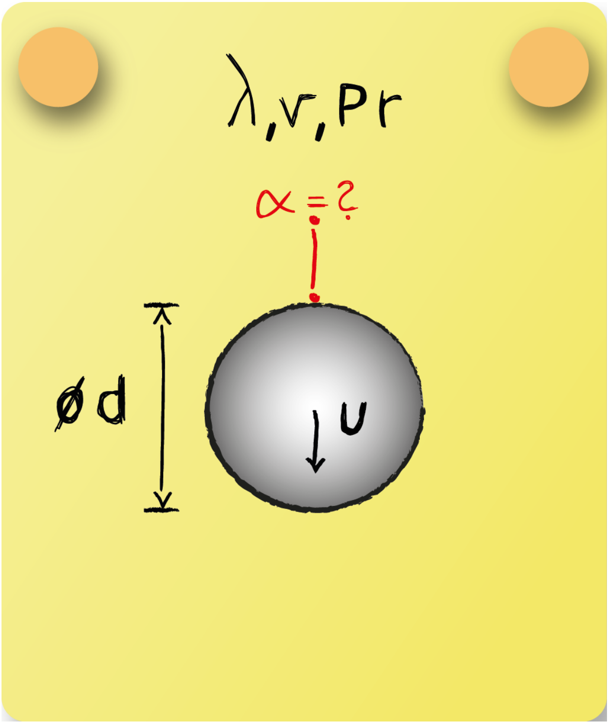
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2+\left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 176.20$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 22.55\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 11.2



A sphere falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 1.20 \cdot 10^4$$

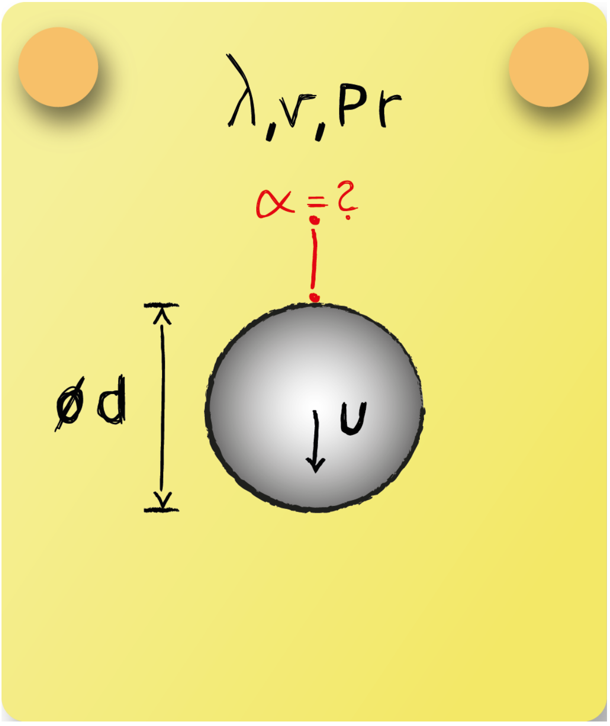
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 77.28$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 193.83\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 11.3



A sphere falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 2.79 \cdot 10^4$$

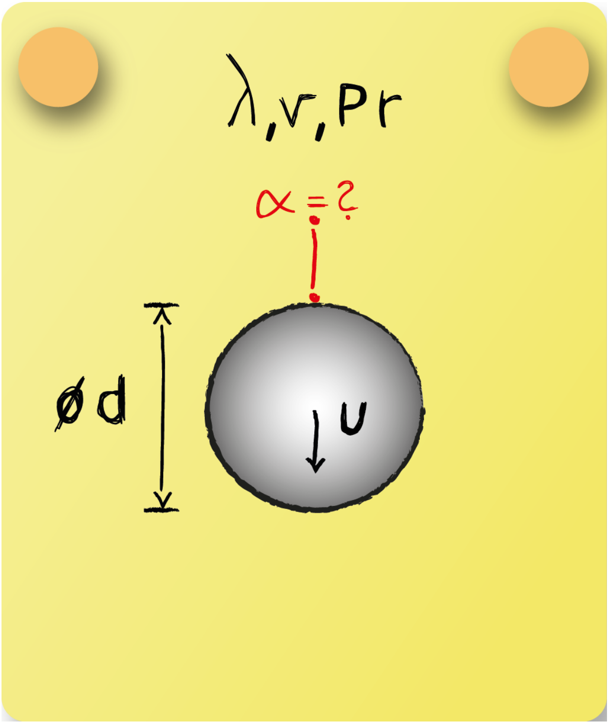
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 347.25$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 1948.08\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 11.4



A sphere falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 15.20$$

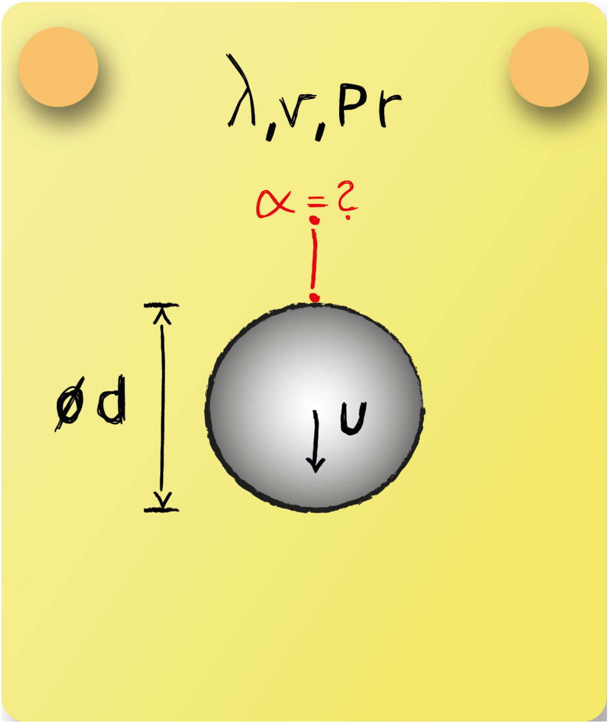
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 5.46$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 344.74\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 11.5



A sphere falls through a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 54.95$$

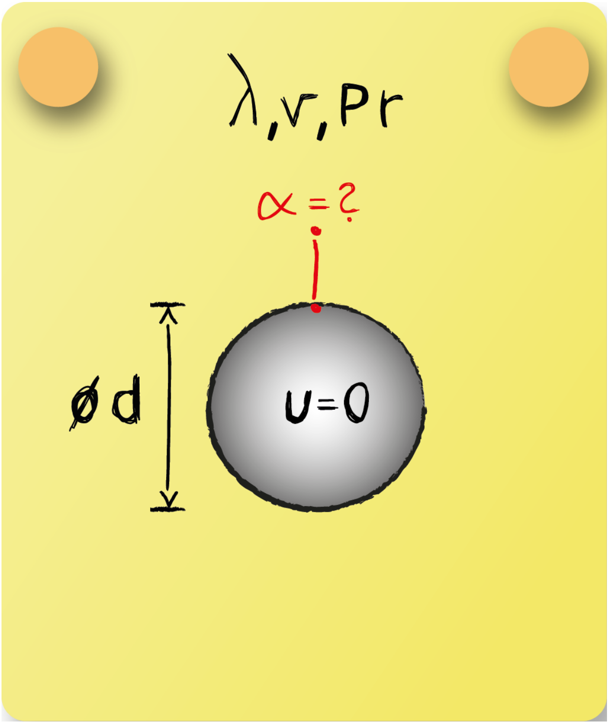
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 16.04$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 186.08\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 12.1



A sphere is in a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0$$

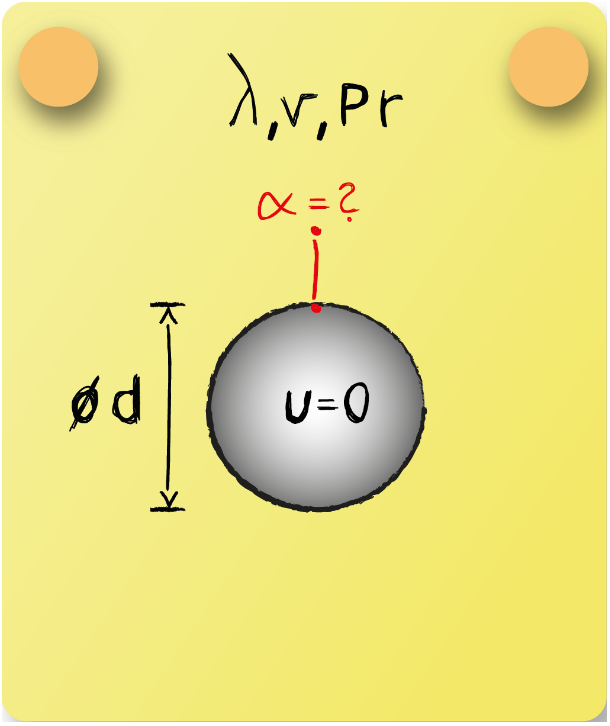
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 2$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 0.256\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 12.2



A sphere is in a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0$$

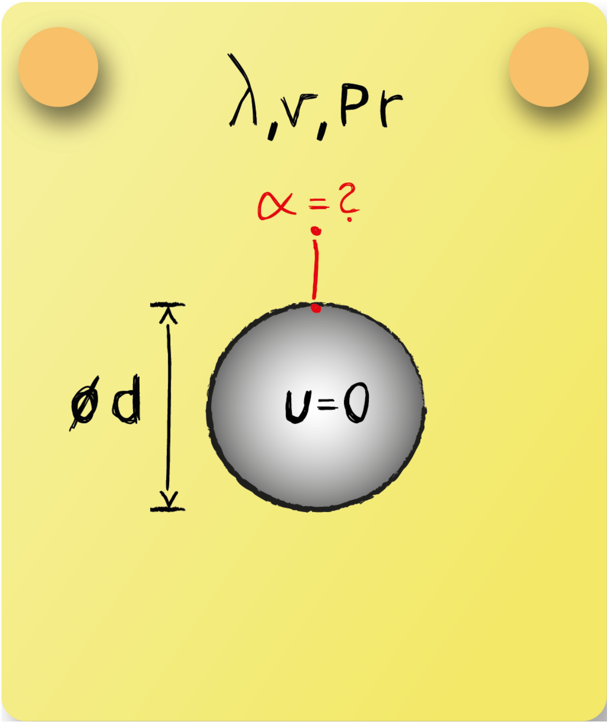
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 2$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 5.02\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 12.3



A sphere is in a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0$$

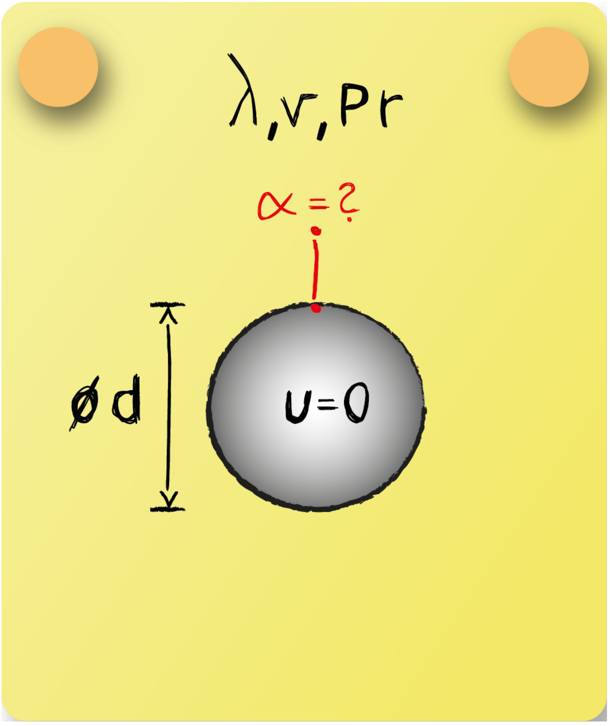
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 2$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 11.22\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 12.4



A sphere is in a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0$$

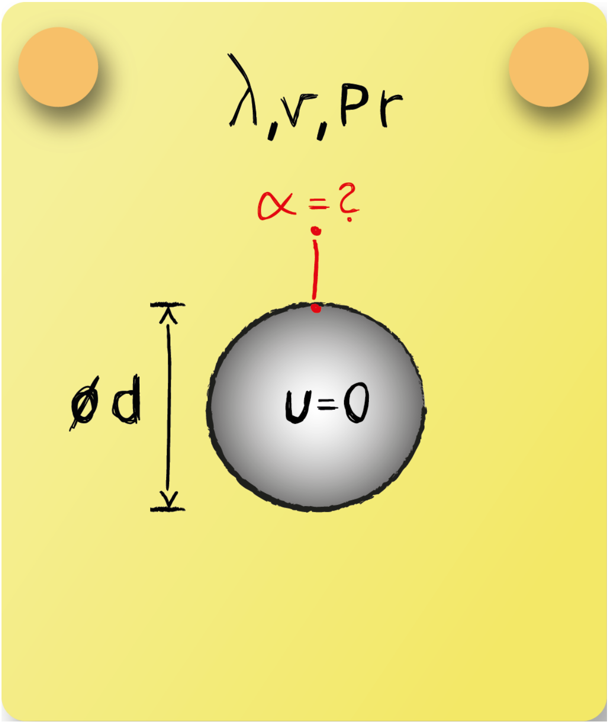
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 2$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 126.2\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 12.5



A sphere is in a non-moving fluid. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 0$$

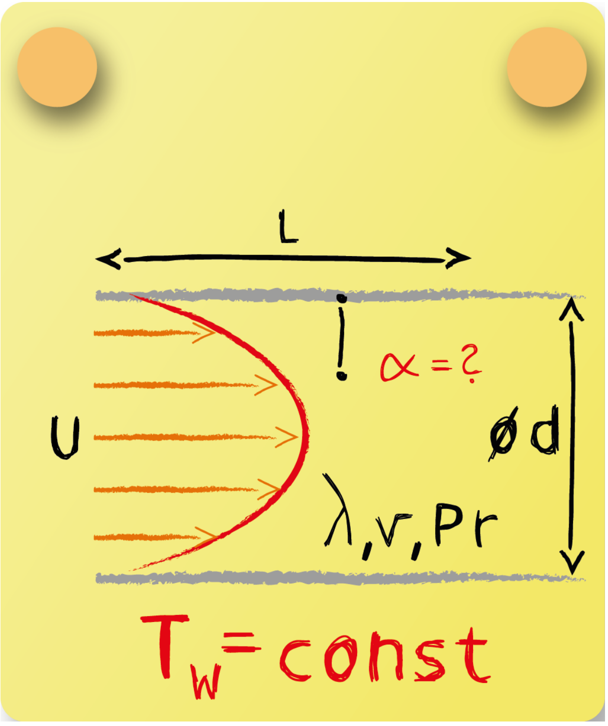
Nusselt number:

$$\overline{\mathrm{Nu_d}} = 2 + \left(0.4 \cdot \mathrm{Re_d}^{\frac{1}{2}} + 0.06 \cdot \mathrm{Re_d}^{\frac{2}{3}}\right) \cdot \mathrm{Pr}^{0.4} \cdot \left(\frac{\eta_\infty}{\eta_\mathrm{w}}\right)^{\frac{1}{4}} = 2$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_\mathrm{f}}{d} = 23.2\ \mathrm{W/m^2K}$$

Heat Transfer Correlation 13.1



A fluid flows through a pipe with isothermal surface. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 1400$$

Thermal entry length:

$$L_{\mathrm{th}} = 0.05 \cdot \mathrm{Re_d} \cdot \mathrm{Pr} \cdot d = 4.97 \text{ m} > L$$

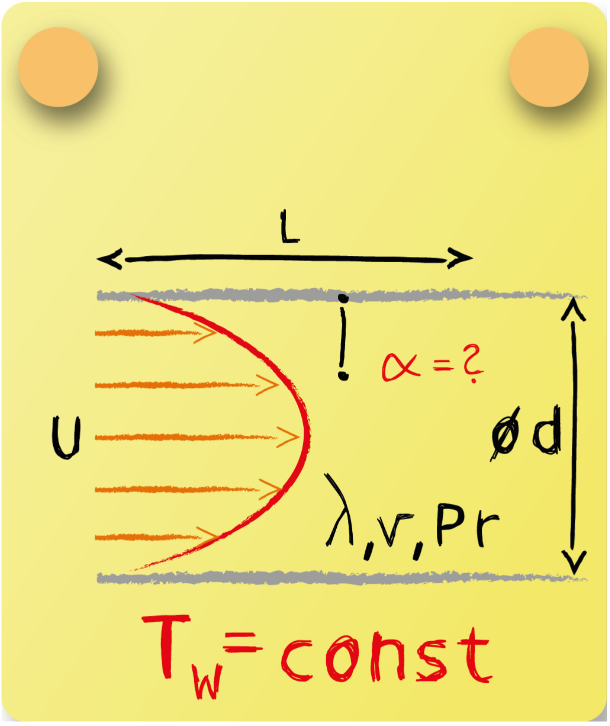
Nusselt number:

$$\overline{\mathrm{Nu_d}} = \left(3.66 + \frac{0.0677 \cdot \left(\mathrm{Re_d} \cdot \mathrm{Pr} \cdot \frac{d}{L}\right)^{1.33}}{1 + 0.1 \cdot \mathrm{Pr} \cdot \left(\mathrm{Re_d} \cdot \frac{d}{L}\right)^{0.83}}\right) \cdot \left(\frac{\eta}{\eta_{\mathrm{w}}}\right)^{0.14} = 5.72$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_{\mathrm{f}}}{d} = 1.49 \text{ W/m}^2\text{K}$$

Heat Transfer Correlation 13.2



A fluid flows through a pipe with isothermal surface. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 1266.67$$

Thermal entry length:

$$L_{\mathrm{th}} = 0.05 \cdot \mathrm{Re_d} \cdot \mathrm{Pr} \cdot d = 0.58 \text{ m} > L$$

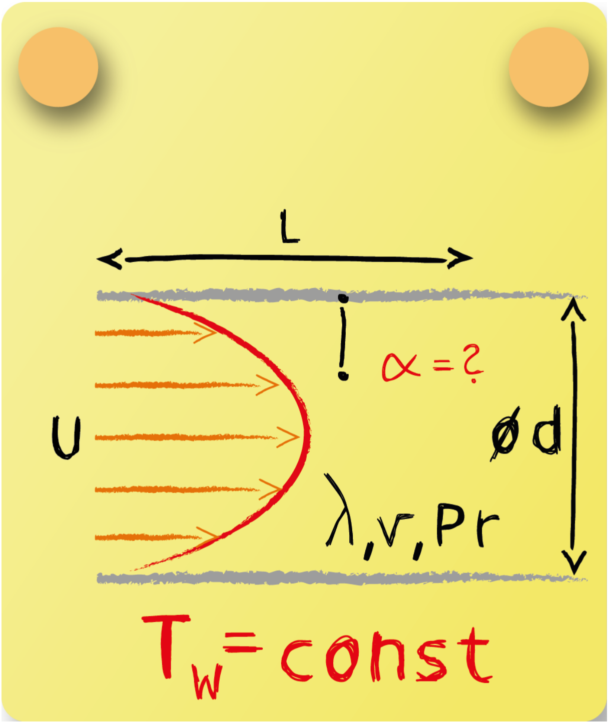
Nusselt number:

$$\overline{\mathrm{Nu_d}} = \left(3.66 + \frac{0.0677 \cdot \left(\mathrm{Re_d} \cdot \mathrm{Pr} \cdot \frac{d}{L}\right)^{1.33}}{1 + 0.1 \cdot \mathrm{Pr} \cdot \left(\mathrm{Re_d} \cdot \frac{d}{L}\right)^{0.83}}\right) \cdot \left(\frac{\eta}{\eta_{\mathrm{w}}}\right)^{0.14} = 5.56$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_{\mathrm{f}}}{d} = 30.03 \text{ W/m}^2\text{K}$$

Heat Transfer Correlation 13.3



A fluid flows through a pipe with isothermal surface. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 1823.53$$

Thermal entry length:

$$L_{\mathrm{th}} = 0.05 \cdot \mathrm{Re_d} \cdot \mathrm{Pr} \cdot d = 197.85 \text{ m} > L$$

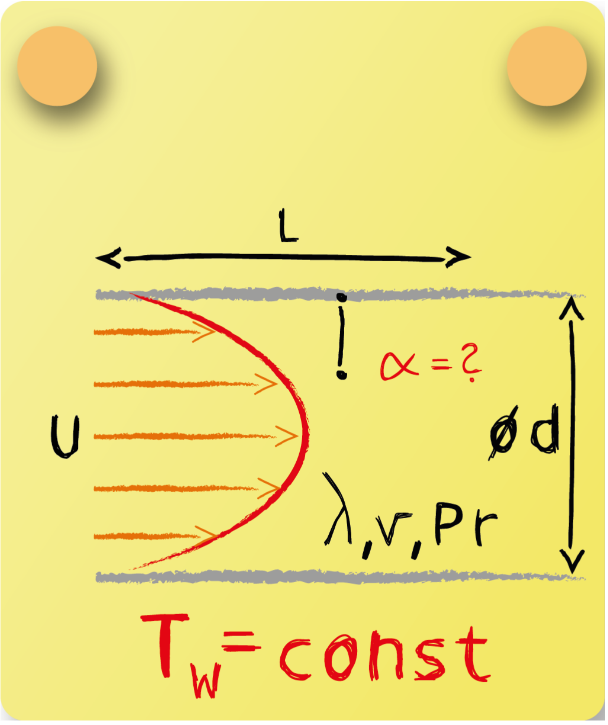
Nusselt number:

$$\overline{\mathrm{Nu_d}} = \left(3.66 + \frac{0.0677 \cdot \left(\mathrm{Re_d} \cdot \mathrm{Pr} \cdot \frac{d}{L}\right)^{1.33}}{1 + 0.1 \cdot \mathrm{Pr} \cdot \left(\mathrm{Re_d} \cdot \frac{d}{L}\right)^{0.83}}\right) \cdot \left(\frac{\eta}{\eta_{\mathrm{w}}}\right)^{0.14} = 7.29$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_{\mathrm{f}}}{d} = 12.00 \text{ W/m}^2\text{K}$$

Heat Transfer Correlation 13.4



A fluid flows through a pipe with isothermal surface. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 1861.11$$

Thermal entry length:

$$L_{\mathrm{th}} = 0.05 \cdot \mathrm{Re_d} \cdot \mathrm{Pr} \cdot d = 155.87 \text{ m} > L$$

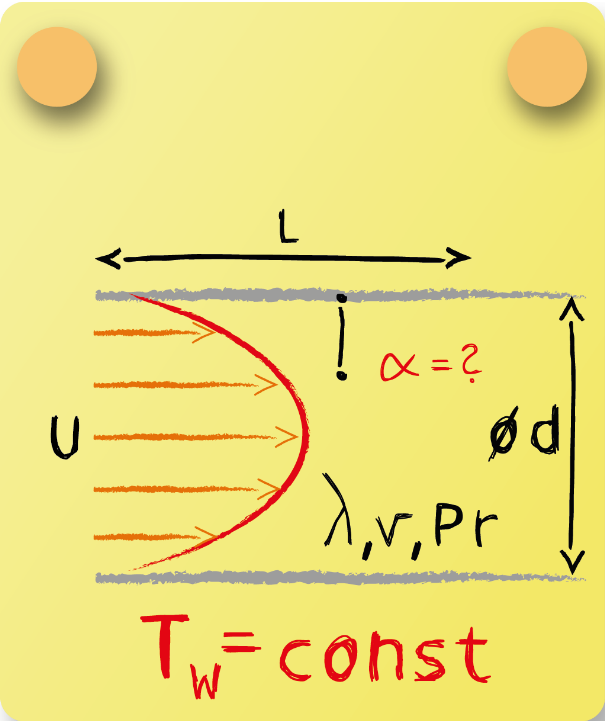
Nusselt number:

$$\overline{\mathrm{Nu_d}} = \left(3.66 + \frac{0.0677 \cdot \left(\mathrm{Re_d} \cdot \mathrm{Pr} \cdot \frac{d}{L}\right)^{1.33}}{1 + 0.1 \cdot \mathrm{Pr} \cdot \left(\mathrm{Re_d} \cdot \frac{d}{L}\right)^{0.83}}\right) \cdot \left(\frac{\eta}{\eta_{\mathrm{w}}}\right)^{0.14} = 4.88$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_{\mathrm{f}}}{d} = 8.01 \text{ W/m}^2\text{K}$$

Heat Transfer Correlation 13.5



A fluid flows through a pipe with isothermal surface. Calculate the mean heat transfer coefficient $\bar{\alpha}$.

Reynolds number:

$$\mathrm{Re_d} = \frac{u \cdot d}{\nu} = 214.29$$

Thermal entry length:

$$L_{\mathrm{th}} = 0.05 \cdot \mathrm{Re_d} \cdot \mathrm{Pr} \cdot d = 0.065 \text{ m} > L$$

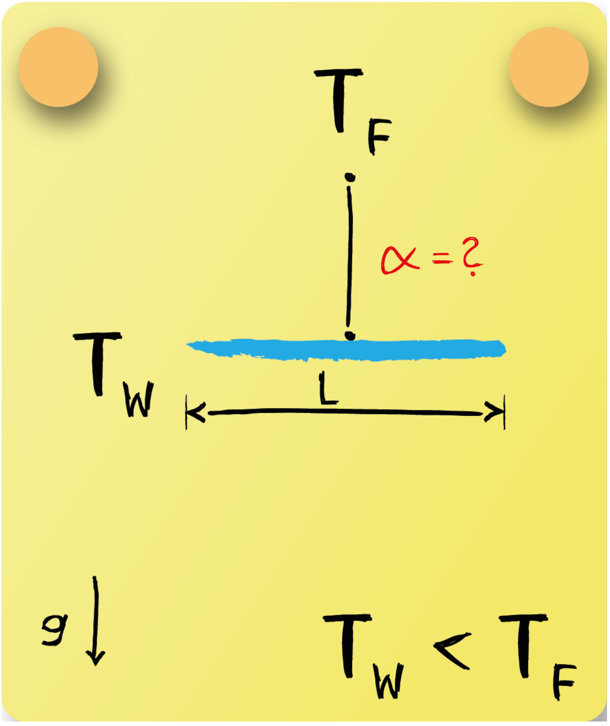
Nusselt number:

$$\overline{\mathrm{Nu_d}} = \left(3.66 + \frac{0.0677 \cdot \left(\mathrm{Re_d} \cdot \mathrm{Pr} \cdot \frac{d}{L}\right)^{1.33}}{1 + 0.1 \cdot \mathrm{Pr} \cdot \left(\mathrm{Re_d} \cdot \frac{d}{L}\right)^{0.83}}\right) \cdot \left(\frac{\eta}{\eta_{\mathrm{w}}}\right)^{0.14} = 5.80$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_d}} \cdot \lambda_{\mathrm{f}}}{d} = 128.93 \text{ W/m}^2\text{K}$$

Heat Transfer Correlation 20



A horizontal plate stands in a non-moving ideal gas. Calculate the mean heat transfer coefficient $\bar{\alpha}$ on the upper surface.

Coefficient of volume expansion for an ideal gas:

$$\beta = \frac{1}{T_\mathrm{F}} = 0.0033\ \mathrm{K}^{-1}$$

Grashof number:

$$\mathrm{Gr_L} = \frac{g \cdot \beta \cdot (T_\mathrm{F} - T_\mathrm{w}) \cdot L^3}{\nu^2} = 4.662 \cdot 10^5$$

And thus $\mathrm{Gr_L} \cdot \mathrm{Pr} = 3.053 \cdot 10^5$.
Nusselt number:

$$\overline{\mathrm{Nu_L}} = 0.27 \cdot (\mathrm{Gr_L} \cdot \mathrm{Pr})^{\frac{1}{4}} = 6.35$$

Heat transfer coefficient:

$$\bar{\alpha} = \frac{\overline{\mathrm{Nu_L}} \cdot \lambda_\mathrm{f}}{L} = 4.95\ \mathrm{W/m^2K}$$