

Heat Transfer Practice Problems Cheat Sheet

Equations and answers for the 20 worked examples

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Conduction (plane wall)	$q'' = k (T_1 - T_2) / L$	Series layers add $R'' = L/k$
Overall U	$U = 1 / R''_{\text{total}}$	Include $1/h_i$ and $1/h_o$ film resistances
Radial conduction (cylinder)	$q' = 2\pi k (T_1 - T_2) / \ln(r_2/r_1)$	W per metre of pipe
Critical radius (cylinder)	$r_{\text{cr}} = k / h$	Insulating below r_{cr} raises heat loss
Newton's law of cooling	$q'' = h (T_s - T_\infty)$	Convection
Flat-plate correlations	Laminar $Nu_x = 0.664 Re^{1/2} Pr^{1/3}$; turbulent $Nu_x = 0.0296 Re^{0.8} Pr^{1/3}$	Cross-flow cylinder: Hilpert $Nu = C Re^m Pr^{1/3}$
Radiation	$q = \epsilon \sigma A (T_s^4 - T_{\text{sur}}^4)$	Kelvin only; $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$
Parallel plates	$q'' = \sigma (T_1^4 - T_2^4) / (1/\epsilon_1 + 1/\epsilon_2 - 1)$	A radiation shield cuts the flux sharply
Lumped capacitance	$Bi = h L_c / k < 0.1$; $(T - T_\infty)/(T_i - T_\infty) = \exp(-t/\tau)$	$\tau = \rho V c / (h A)$
Generation in a plane wall	$T(x) = T_s + (\dot{q}/2k)(L^2 - x^2)$	Wire: $T(0) - T_s = \dot{q} r_0^2 / 4k$

Key takeaways

- The page works 20 problems, grouped as conduction, convection, radiation, combined modes and transient or generation cases.
- Always convert to kelvin for radiation, and check Bi before using the lumped model.
- Insulation helps only once its outer radius passes the critical radius.
- Source equations are mostly typeset images; the forms above are standard textbook equivalents, so check against the article.

Answers reported in the article (selected)

Problem	Result
1 Slab conductivity (80 mm, 25 W/m ²)	$k \approx 0.067 \text{ W/m} \cdot \text{K}$
4 Insulated steam pipe, 150→30 °C	$q' \approx 89 \text{ W/m}$
5 Critical radius, k 0.17, h 10	$r_{\text{cr}} = 17 \text{ mm}$
11 Space probe, 120 W, ϵ 0.85	$T_s \approx 265 \text{ K}$
14 Radiation shield, 500/300 K	$1,122 \rightarrow 142 \text{ W/m}^2$ ($\approx 87\%$ less)
18 Copper sphere, D 20 mm, h 60	$Bi \approx 5 \times 10^{-4}$; $t \approx 248 \text{ s}$
20 Wire, 250 A, 3 mm	$T(0) \approx 123 \text{ °C}$