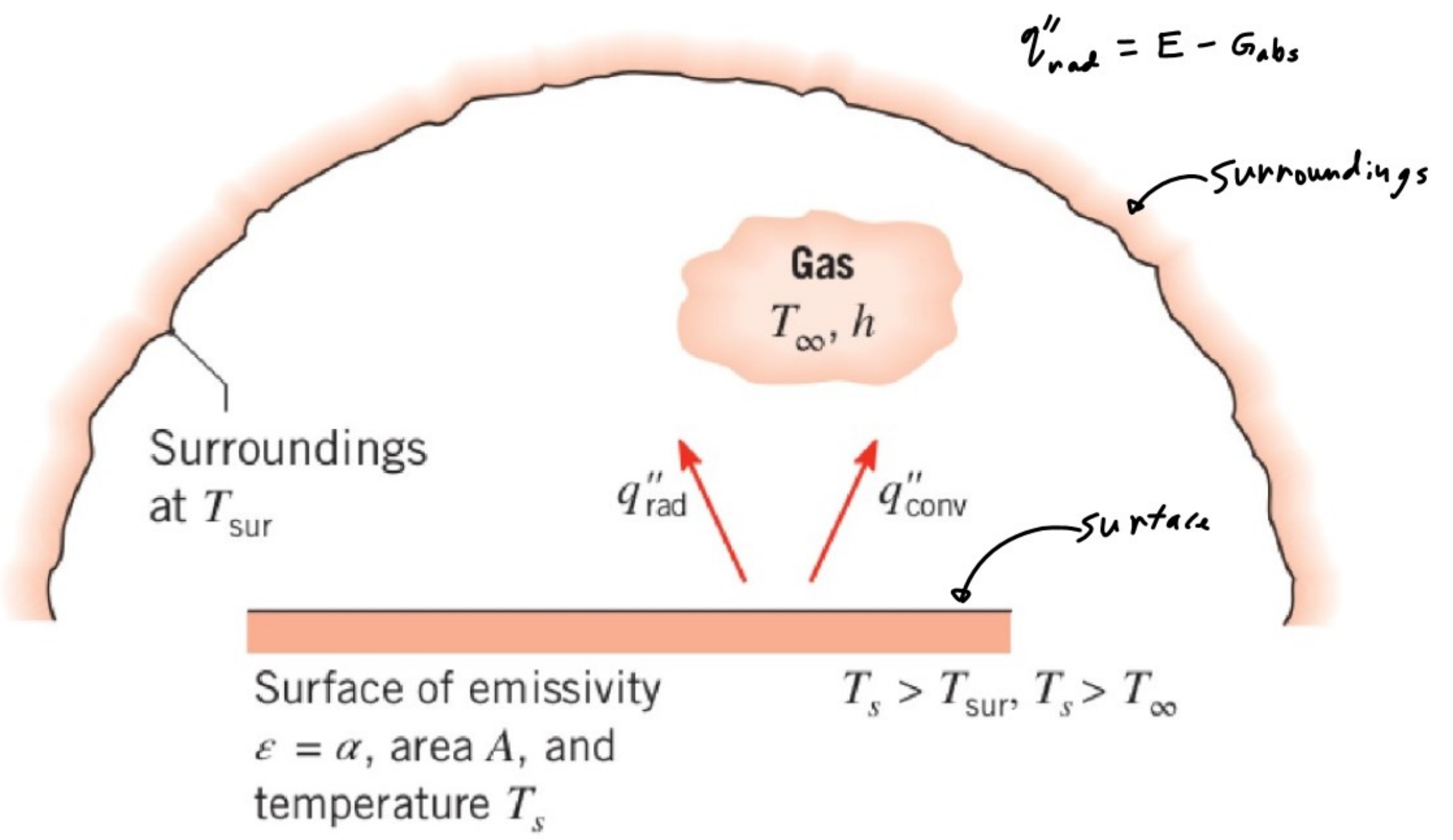


$q''_{rad} = E - G_{abs}$
surroundings
Gas
T_∞, h
Surroundings
at T_{sur}
q''_{rad}
q''_{conv}
surface
Surface of emissivity
$\varepsilon = \alpha$, area A, and
temperature T_s
$T_s > T_{sur}, T_s > T_\infty$

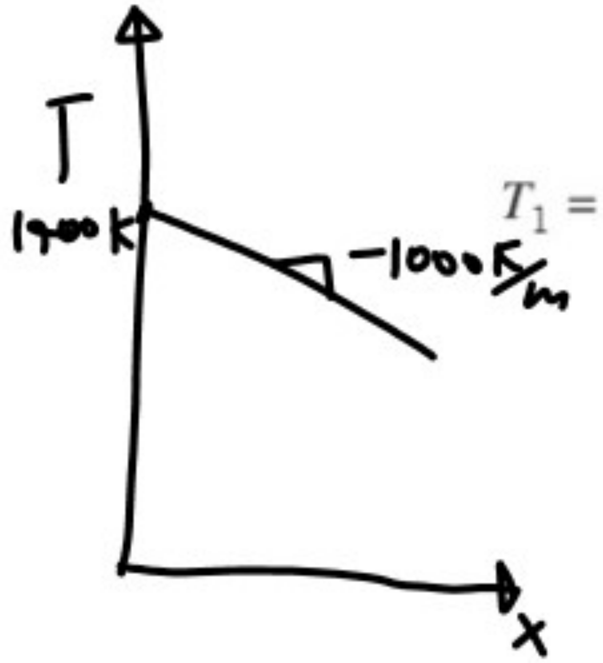
$$q''_{rad} = E - G_{abs}$$

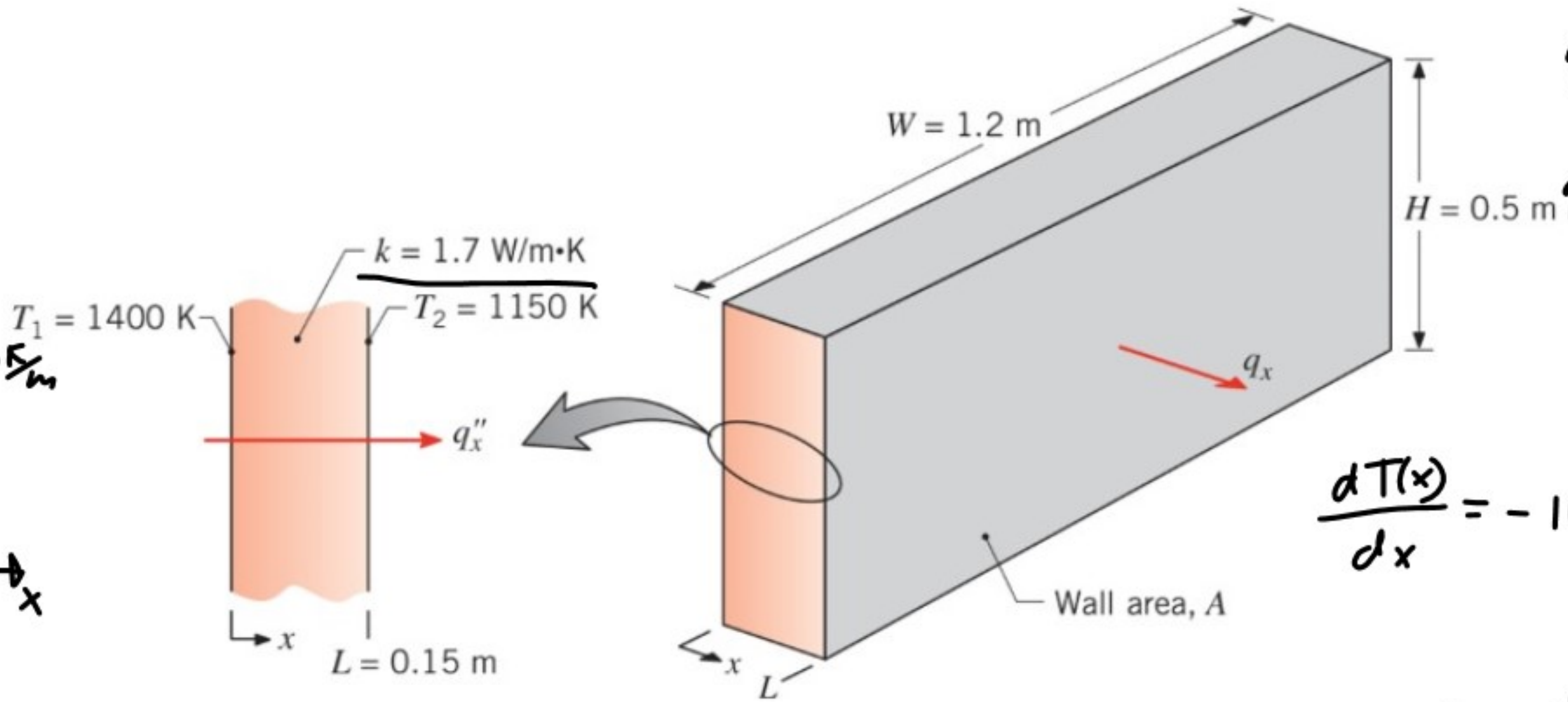
$$= \varepsilon \sigma T_s^4 - \alpha G$$

$$= \varepsilon \sigma T_s^4 - \alpha \sigma T_{sur}^4$$

if $\varepsilon = \alpha$ (gray surface)

$$= \varepsilon \sigma (T_s^4 - T_{sur}^4)$$





$$q_x'' = -k \frac{dT}{dx}$$

$$q_x'' = -1.7 \cdot -1000$$

$$= 1700 \frac{W}{m^2}$$

$$\frac{dT(x)}{dx} = -1000 \ K/m$$

Consider the fireclay brick wall of Example 1.1 that is operating under different thermal conditions. The temperature distribution, at an instant in time, is $T(x) = a + bx$ where $a = 1400$ K and $b = -1000$ K/m. Determine the heat fluxes, q_x'', and heat rates, q_x, at $x = 0$ and $x = L$. Do steady-state conditions exist?

$$q_x = q_x'' A = q_x'' W H$$

$$= 1700 \frac{W}{m^2} \, 1.2 m \; 0.5 m$$

$$= 1020 \ W$$

Thermodynamics

First Law

Total Energy is conserved

$\Delta E = Q - W$

Q heat transfered out

W work done by system

$\Delta E = E_{in} - E_{out} + E_g$

E_{in} energy flow in

E_{out} energy flow out

E_g energy generated

$\dot{E} = \dot{E}_{in} - \dot{E}_{out} + \dot{E}_g$

$\Delta E = \Delta(KE + PE + U_t)$

$U_t = U_{sens} + U_{lat}$

U_{sens} Molecule vibration energy

U_{lat} intermolecular forces

In heat transfer

ΔKE small

ΔPE small

ΔU_{lat} zero if no phase change

$\Delta E = \Delta U_{sens} = m c_v \Delta T$

$\frac{dU_{sens}}{dt} = m c_v \, dT/dt$

$q = \dot{m} c_p (T_{out} - T_{in})$