

# VARMETRANSMISSION KAP. 1 INTRODUCTION



# FORLØB

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Se videoer op til  
hver lektion

Regne opgaver

Differential- og  
integralregning

2 case

Aflevering er en  
forudsætning for  
at deltage i  
eksamen

- radiator

- måling på  
varmeveksler

Eksamen  
mundtlig



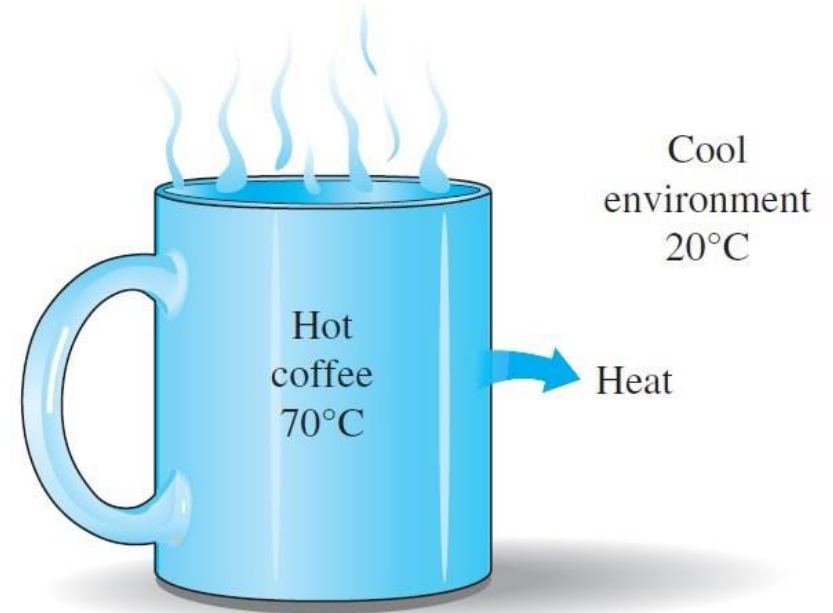
# Varmetransmission vs Termodynamik

## Termodynamik:

- Ligevægt vil blive nået ved 20°C.
- Mængden af varme overført.

## Varmetransmission:

- Hvor lang tid tager det?
- Hvad er varmeoverførselshastigheden  $\frac{\text{Mængden af varme}}{\text{Tid}}$



# HVOR HAR VI BRUG FOR VARMETRANSMISSION?

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Power generation

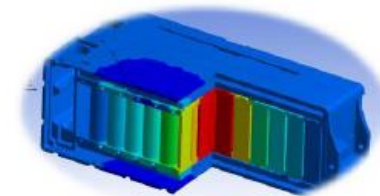
Cooling/refrigeration

Chemical industry

Indoor climate

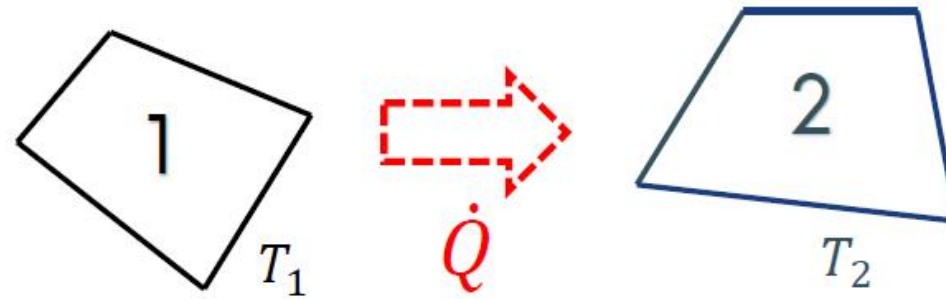
Thermal management

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# VARMETRANSMISSIONSMEKANISMER

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Three mechanisms of heat transfer

**Conduction:** →



**Radiation:** →



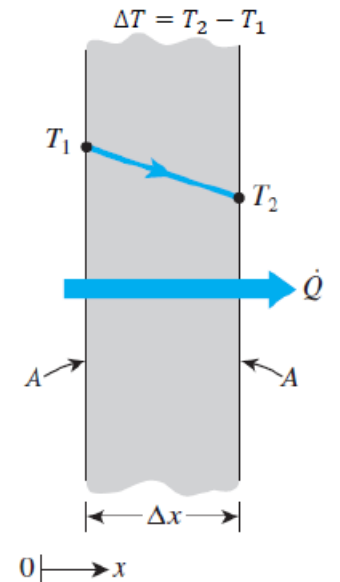
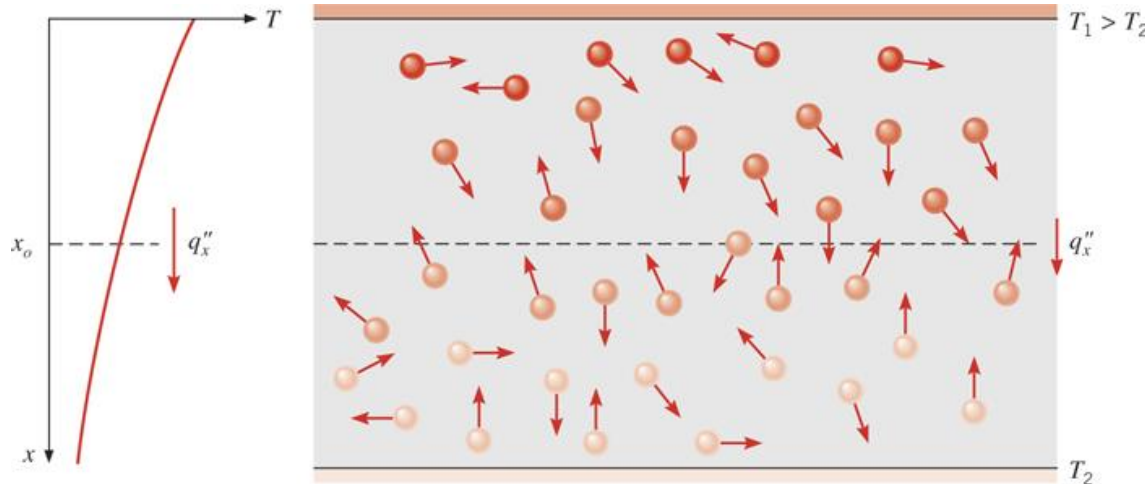
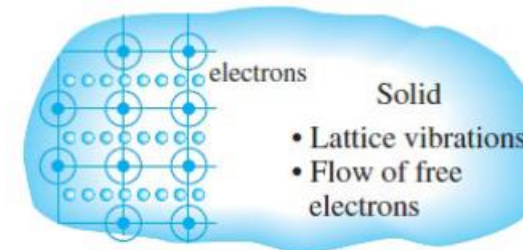
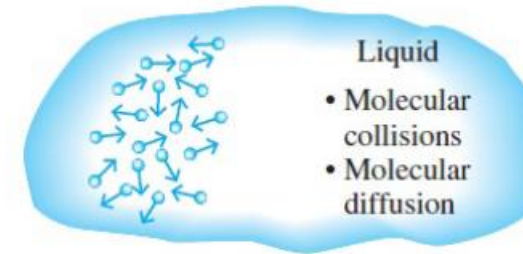
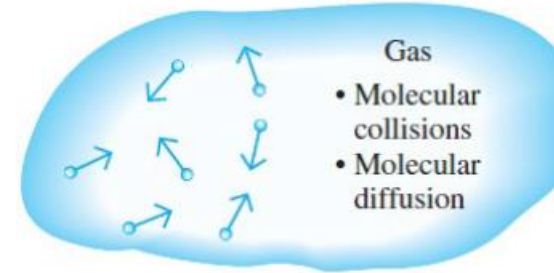
Illustrations from <https://www.drenergysaver.com/>



# KONDUKTION - VARMELEDNING

$$q_{cond} = -Ak \frac{dT}{dx}$$

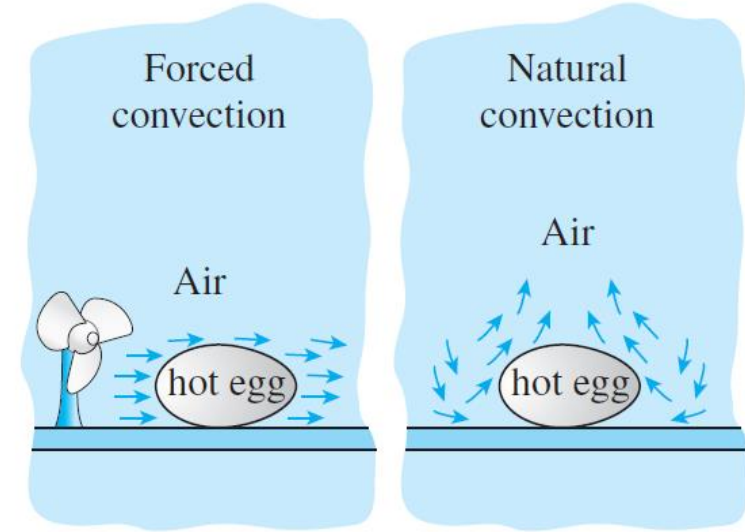
- Overførsel af energi fra mere energiske partikler i et stof til de tilstødende mindre energiske.
- Det sker både i faste stoffer og væsker.
- Altid gennem materielt medium.



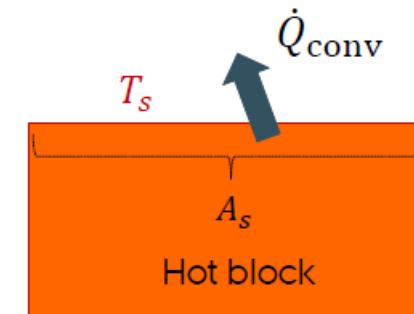
# KONVEKTION - VARMEOVERGANG

$$q_{conv} = hA(T_s - T_{\infty})$$

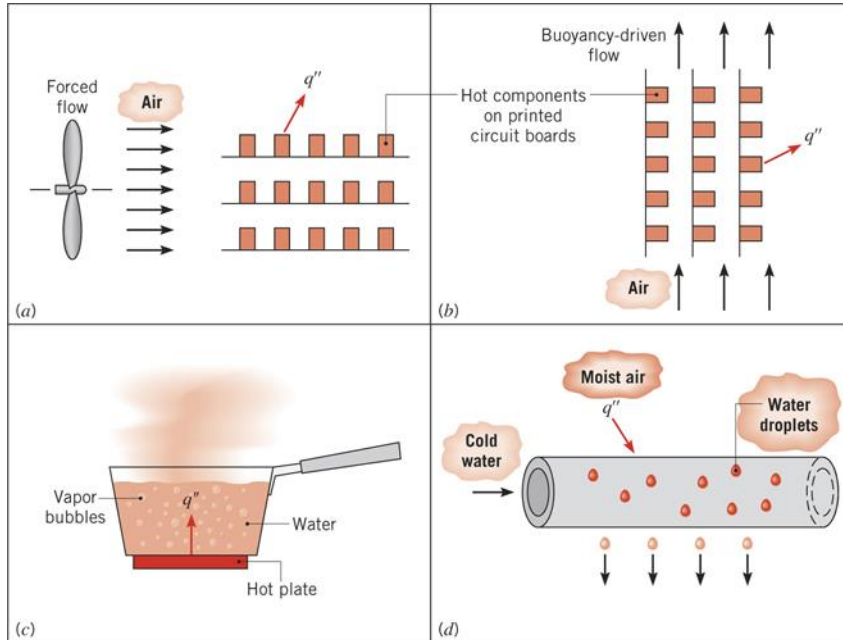
- Altid mellem en fast overflade og en strømmende væske.
- Naturlig (fri) konvektion: strøm skabt af opdriftskraft (strøm og varmeoverførsel koblet sammen)
- Tvungen konvektion: strøm skabt af en ekstern drivkraft (strøm og varmeoverførsel adskilt).



$T_{\infty}$  Ambient fluid



# KONVEKTION - VARMEOVERGANG



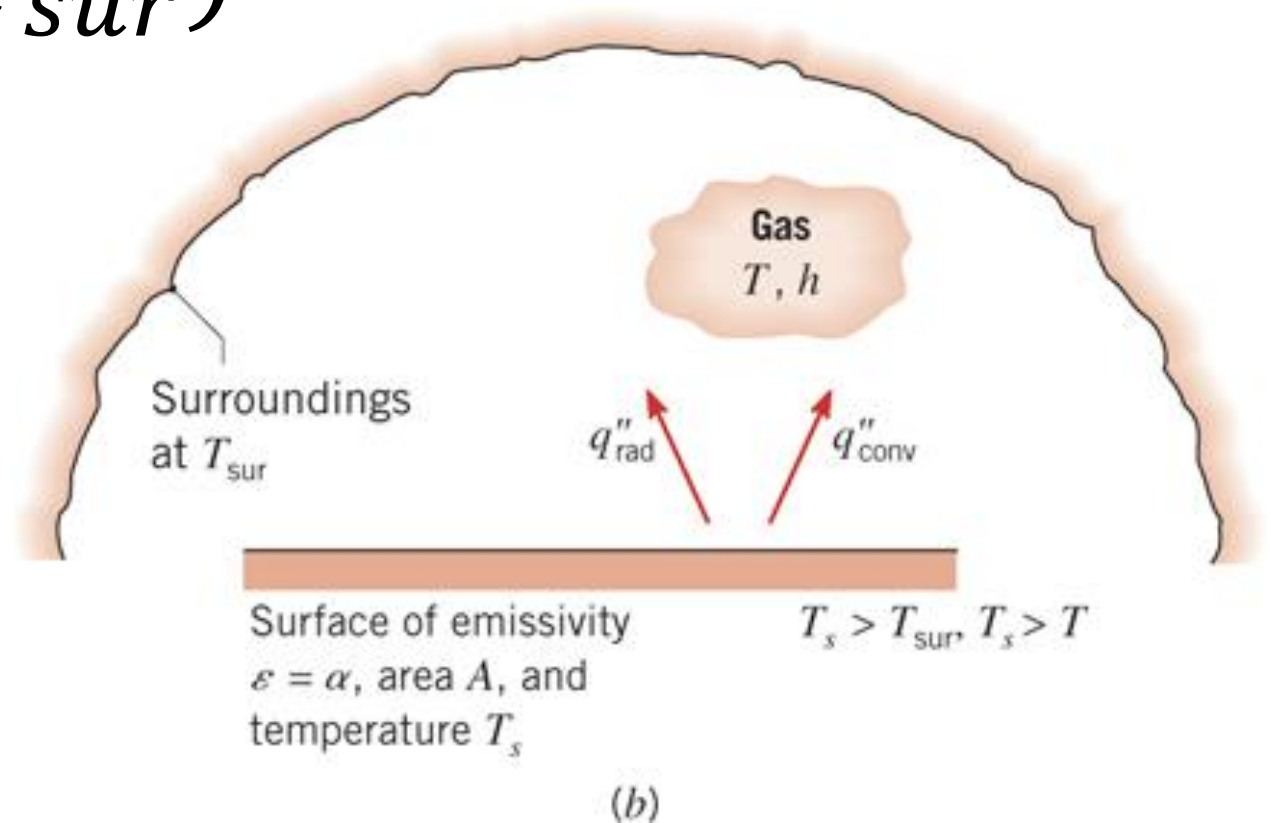
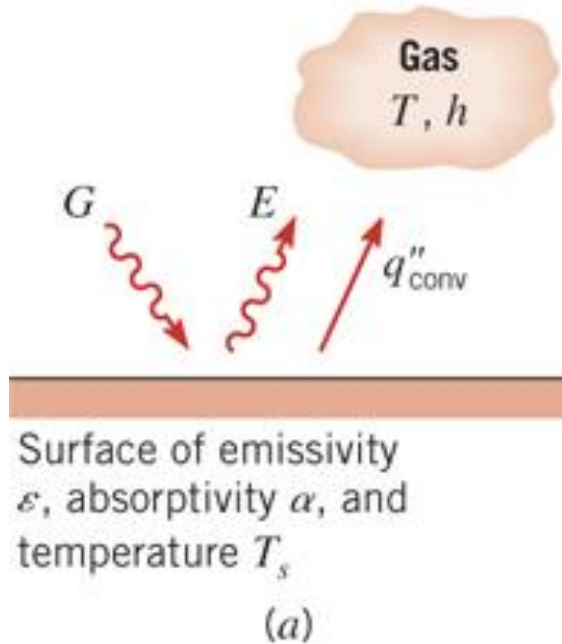
**TABLE 1.1** Typical values of the convection heat transfer coefficient

Process	$h$ (W/m <sup>2</sup> · K)
Free convection	
Gases	2–25
Liquids	50–1000
Forced convection	
Gases	25–250
Liquids	100–20,000
Convection with phase change	
Boiling or condensation	2500–100,000



# STRÅLING

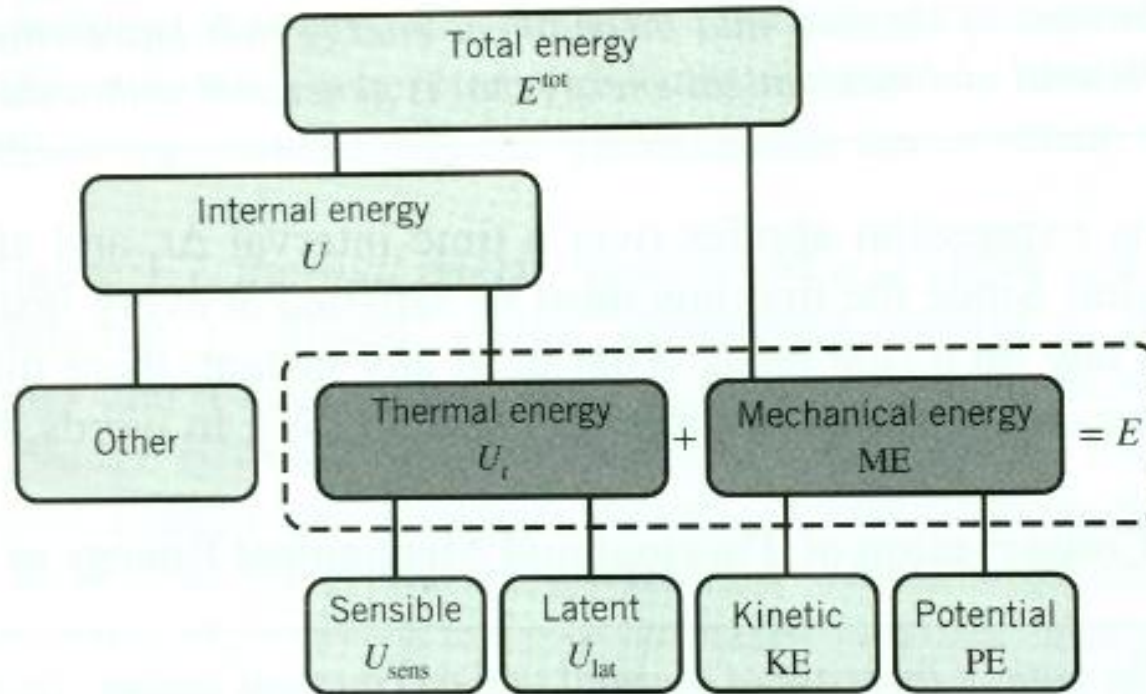
$$\overline{q_{rad}} = \varepsilon \sigma A (T_s^4 - T_{sur}^4)$$



# TERMODYNAMIK

Første hovedsætning

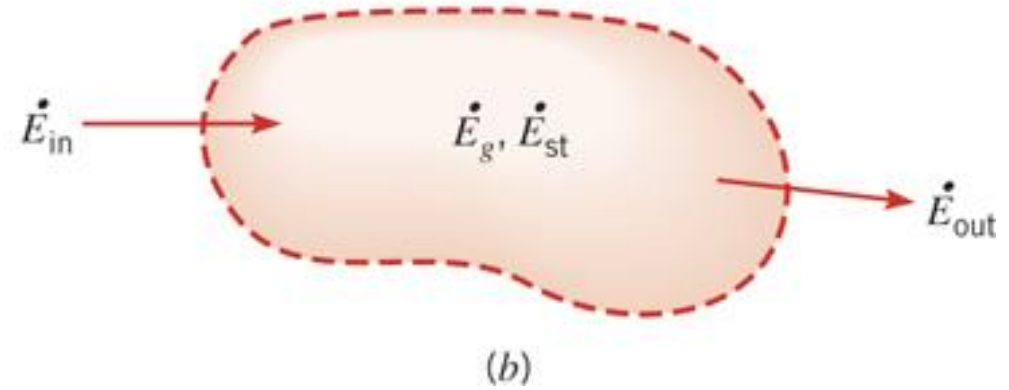
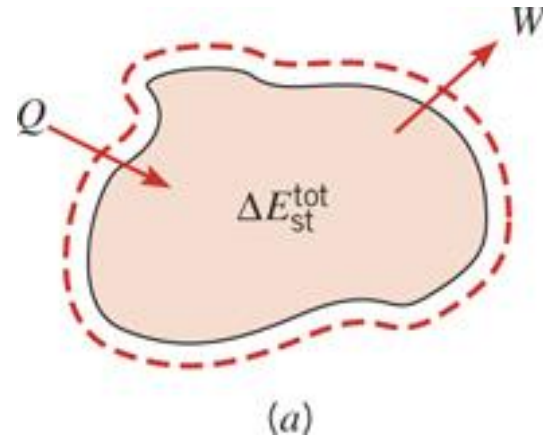
$$\Delta U = Q - W \quad \text{Bog}$$



**FIGURE 1.7** The components of total energy. The sum of thermal and mechanical energy,  $E$ , is of interest in the field of heat transfer.

# TERMODYNAMIK

Lukkede systemer

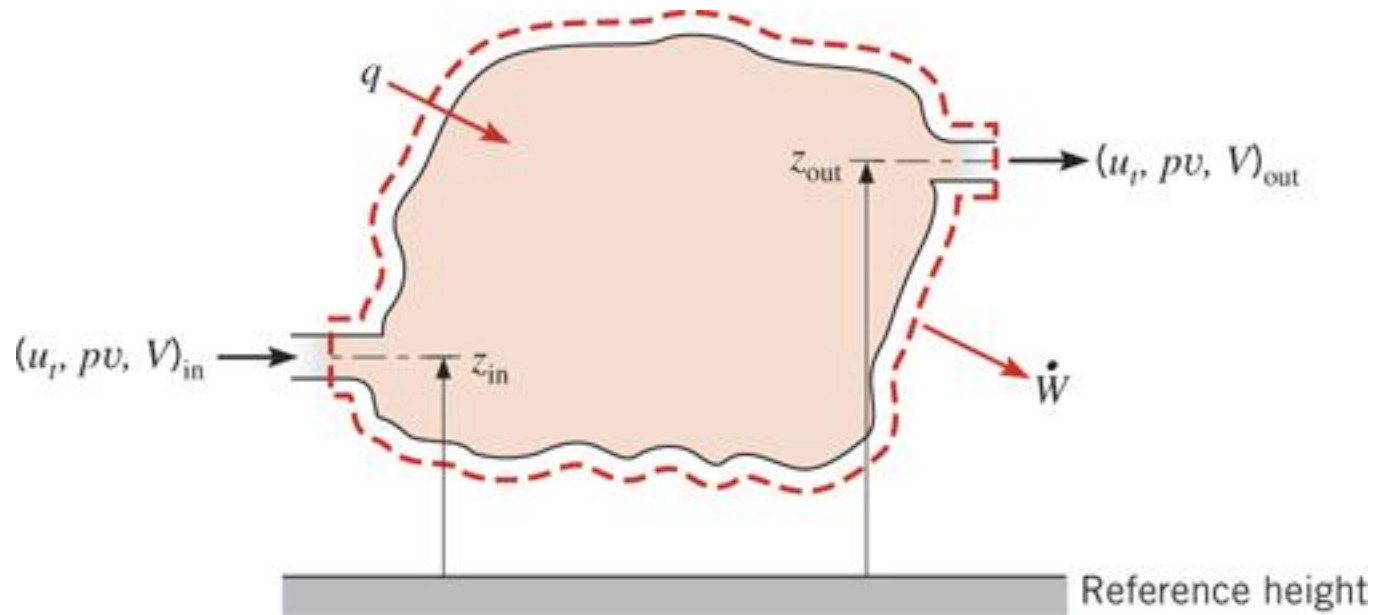


$$\Delta E_{st} = E_{in} - E_{out} + E_{gen} \quad [J]$$

$$\frac{dE_{st}}{dt} = \dot{E}_{in} - \dot{E}_{out} + \dot{E}_{gen} \quad [W]$$

# TERMODYNAMIK

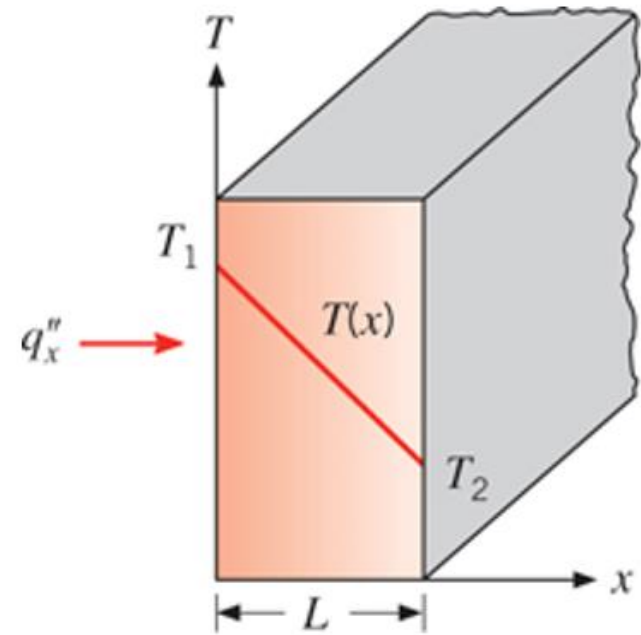
## Åbne systemer



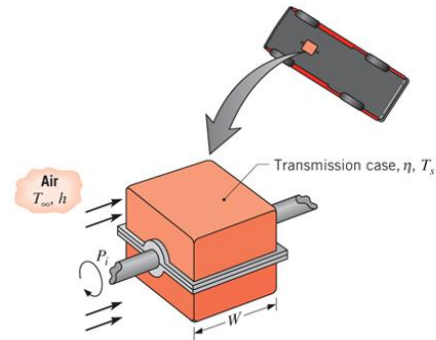
$$q = \dot{m}c_p(T_{out} - T_{in})$$

# OPGAVER

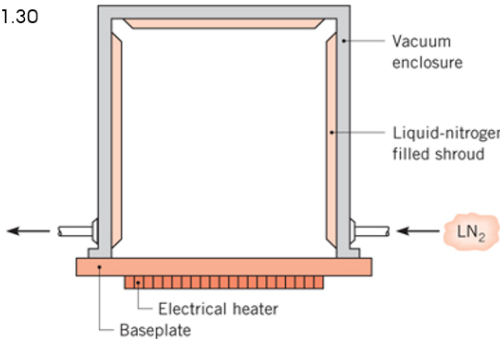
Opgave 1.6



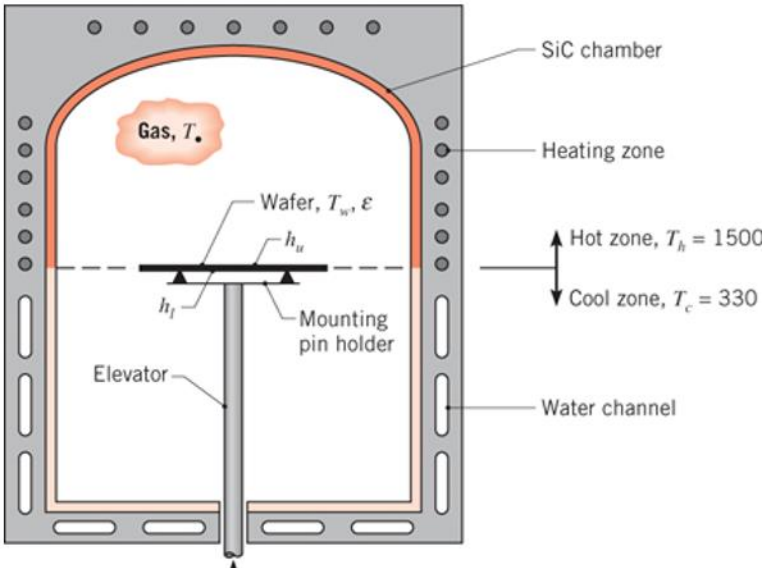
Opgave 1.19



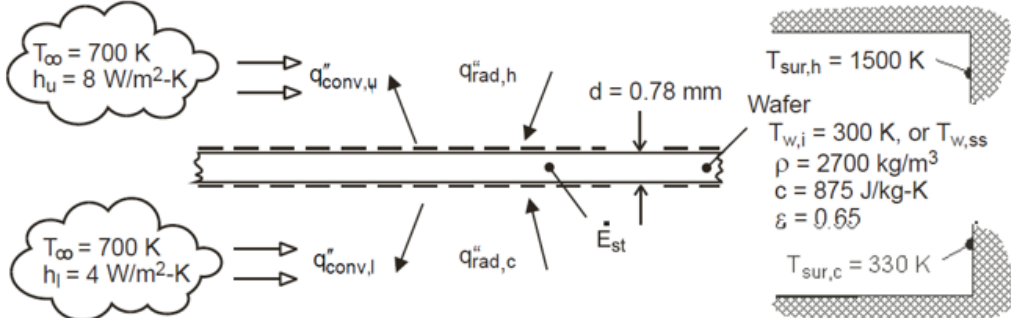
Opgave 1.30



Opgave 1.48



SCHEMATIC:





AARHUS  
UNIVERSITET