lecture 7 2023:24

Heat transfer continued

→ Consider 1-dimensional heat transfer along rod

→ Let it have a cross-sectional area, A

We will have a heat flow, or flux

$$\frac{dQ}{dt} = - K A \frac{dT}{dx}$$

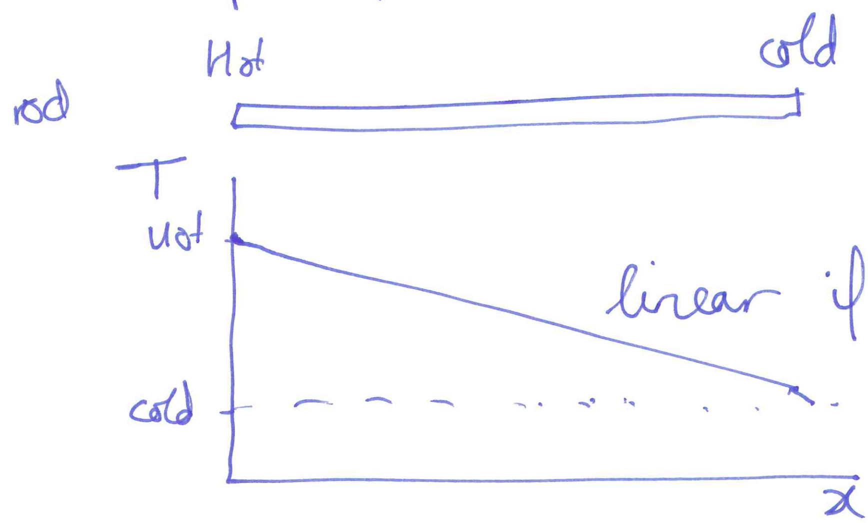
heat flow

time

kappa

→ temperature gradient

→ need the minus sign as heat flows from hot to ~~cod~~ cold



linear if in equilibrium

ie $\frac{dT}{dx}$ constant

eg copper/silver $K = 400\ Wm^{-1}K^{-1}$ metal

glass $K = 0.8\ Wm^{-1}K^{-1}$ insulator

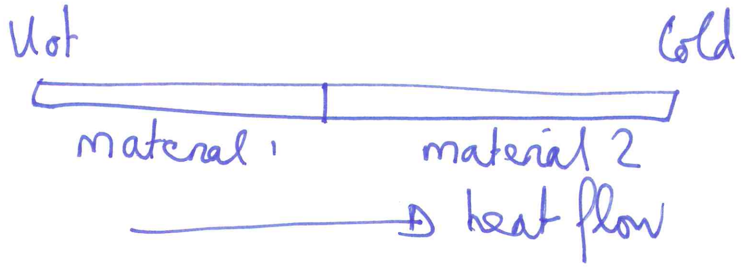
diamond $K = 1800\ Wm^{-1}K^{-1}$

Expanded polystyrene $K = 0.01\ Wm^{-1}K^{-1}$

⇒ heat conduction can be via electrons in an electrical conductor and via vibrations of the atoms.

Examples of heat flow:

①

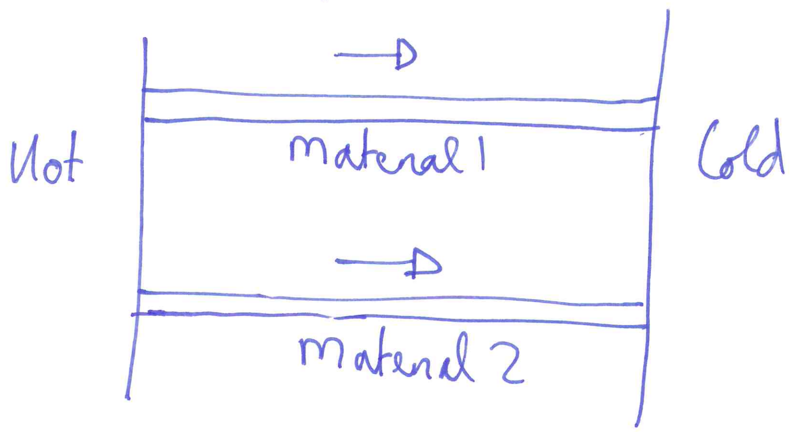


In equilibrium, heat flow $\frac{dQ}{dt}$ is the same in both materials

$$\frac{dQ_{material\,1}}{dt} = \frac{dQ_{material\,2}}{dt}$$

⇒ worked example, and Y/F example 17.12

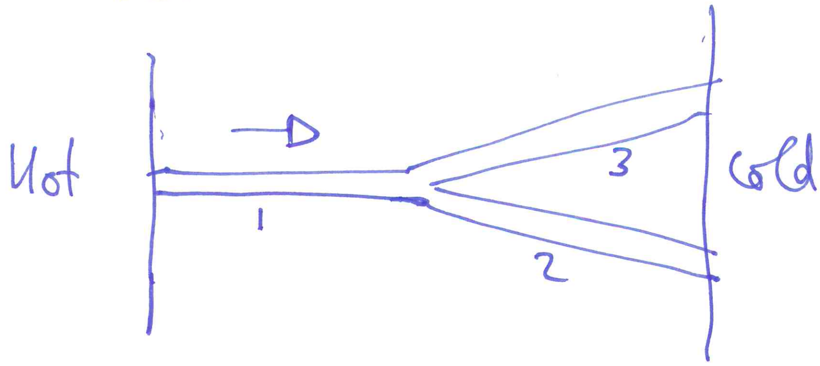
②



Here $\frac{dT}{dx}$ is the same for both rods.

and Total $\frac{dQ}{dt} = \frac{dQ_{material1}}{dt} + \frac{dQ_{material2}}{dt}$

Could have:



$$\frac{dQ_1}{dt} = \frac{dQ_2}{dt} + \frac{dQ_3}{dt}$$

(b) Convection

- Heat flow arising from motion of a fluid.

(c) Radiation

A ~~surfa~~ surface at temperature, T, will radiate at a power, P, proportional to the surface area and T^4:

$$P = \frac{dQ}{dt} = e\sigma A T^4$$

→ e: surface emissivity

→ σ: Stefan Boltzmann constant $5.67 \times 10^{-8}\ W m^{2} K^{-1}$

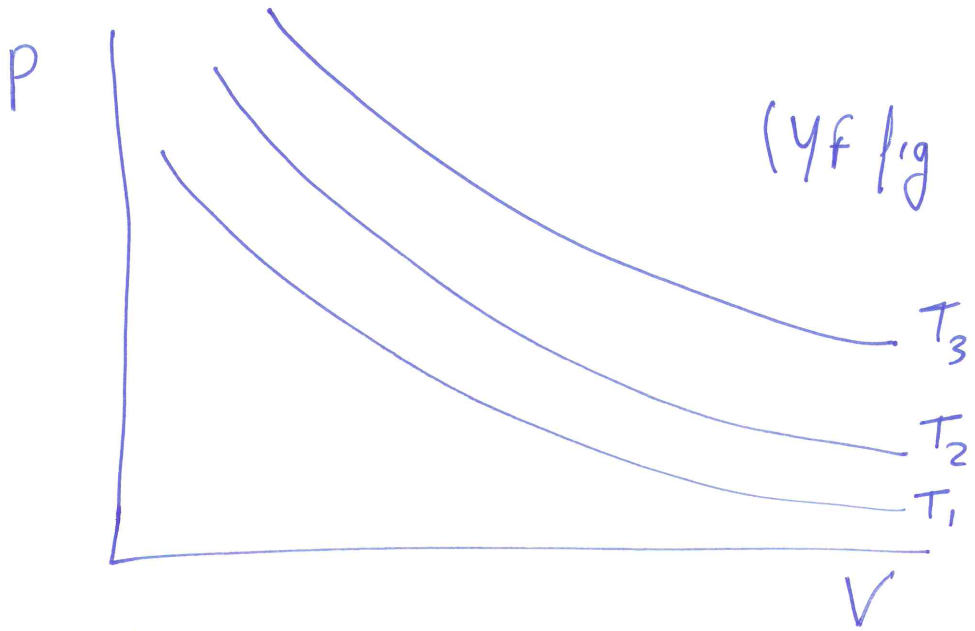
→ all bodies emit and absorb radiation.

→ will need a quantum theory to describe it properly.

2.2 pV diagrams

from $pV = nRT$, hold n and T constant, (isotherm)

then $p \propto 1/V$



(YF fig 18.6)

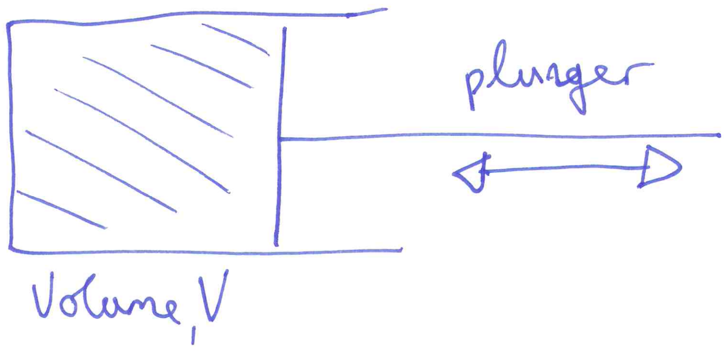
$T_3 > T_2 > T_1$

Often use these to study systems:

A piston:

n constant:

a "closed system"



For most of this module, we will consider ideal gases, however.....