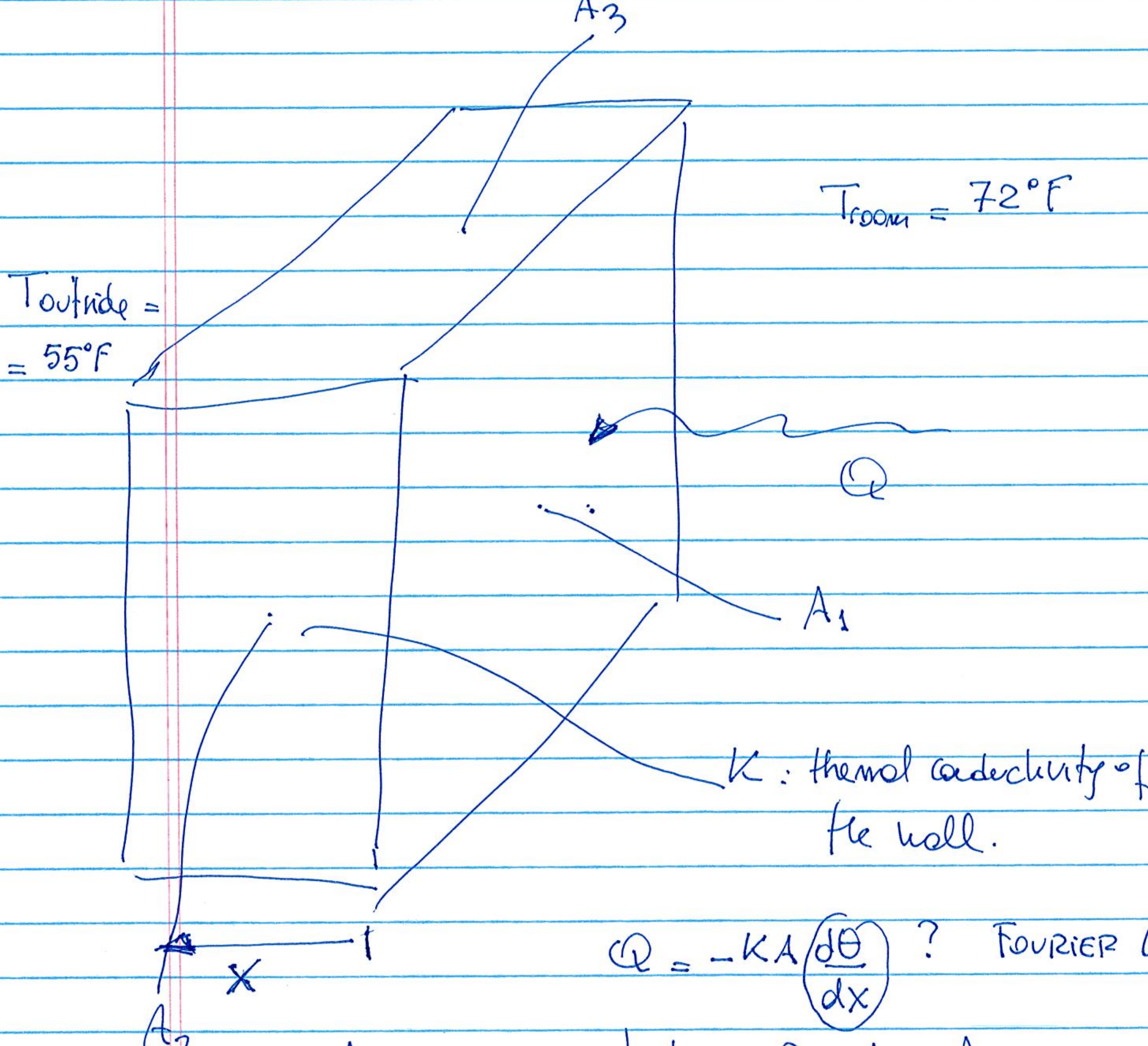
NOTES CLASS 9-7-2017 (1)

HEAT TRANSFER THROUGH A WALL



$$Q = -KA \frac{d\theta}{dx} \text{ ? FOURIER LAW}$$

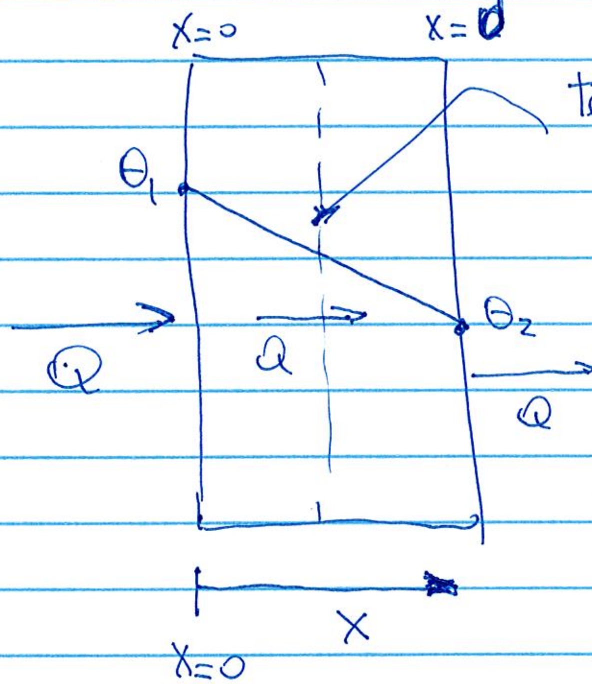
A is Area which one? Area A_1
Crossectional area.

What is X? Direction of heat flow

θ : temperature

$\frac{d\theta}{dx}$: temperature gradient.

For the particular case in the slide 2 of Lecture 3, temperature profile is linear. and how is gradient $\frac{d\theta}{dx}$?



$\frac{d\theta}{dx}$? = constant for $\theta(x)$ = linear.

what is the sign of $\frac{d\theta}{dx}$? NEGATIVE

could we get Q in terms of θ_1 & θ_2 rather than using $\frac{d\theta}{dx}$?

$$\int Q = -KA\frac{d\theta}{dx}$$

$$\int_{x=0}^{x=d} Q\,dx = -\int_{\theta_1}^{\theta_2} KA\,d\theta = -KA\int_{\theta_1}^{\theta_2} d\theta = -KA[\theta_2-\theta_1]$$

$$\int_{x=0}^{x=L} Q\,dx = Q\int_{x=0}^{x=d} dx = Qd = -KA[\theta_2-\theta_1]$$

$$Q = -KA\frac{d\theta}{dx}$$

By integration

and Assuming K = constant

A = constant because rectangular geometry.

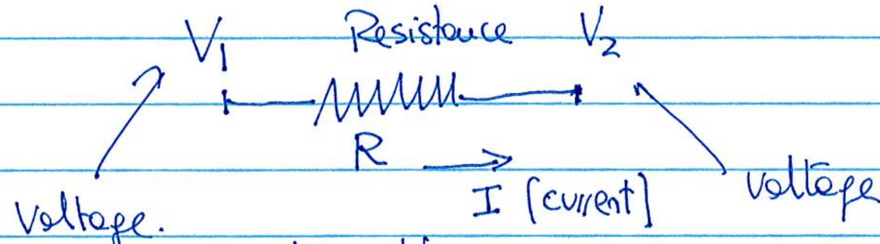
Q = constant

Because steady state

$$Qd = -KA[\theta_2-\theta_1] = KA[\theta_1-\theta_2]$$

$$\boxed{Q = KA\left(\frac{\theta_1-\theta_2}{d}\right) = \frac{\theta_1-\theta_2}{\frac{d}{KA}}}$$

Electrical problem



$$V_1 > V_2$$

$$V_1 - V_2 = RI \implies I = \frac{V_1-V_2}{R} \quad (1)$$

For same $V_1 - V_2$, the largest is R, the smallest is the current.

HEAT PROBLEM

$$Q = \frac{\theta_1-\theta_2}{\frac{d}{KA}} \quad (2)$$

(4)

By Comparing Eq 1 & Eq 2.

what is the driving force in heat transfer.?

$\Theta_1 - \Theta_2$ (compare with $V_1 - V_2$)

what is the "Current" [stuff is being transported] in the heat transfer problem?

Q

What is the resistance in the heat transfer Problem?

$$\boxed{\text{Resistance to heat transfer} = \frac{d}{KA}}$$

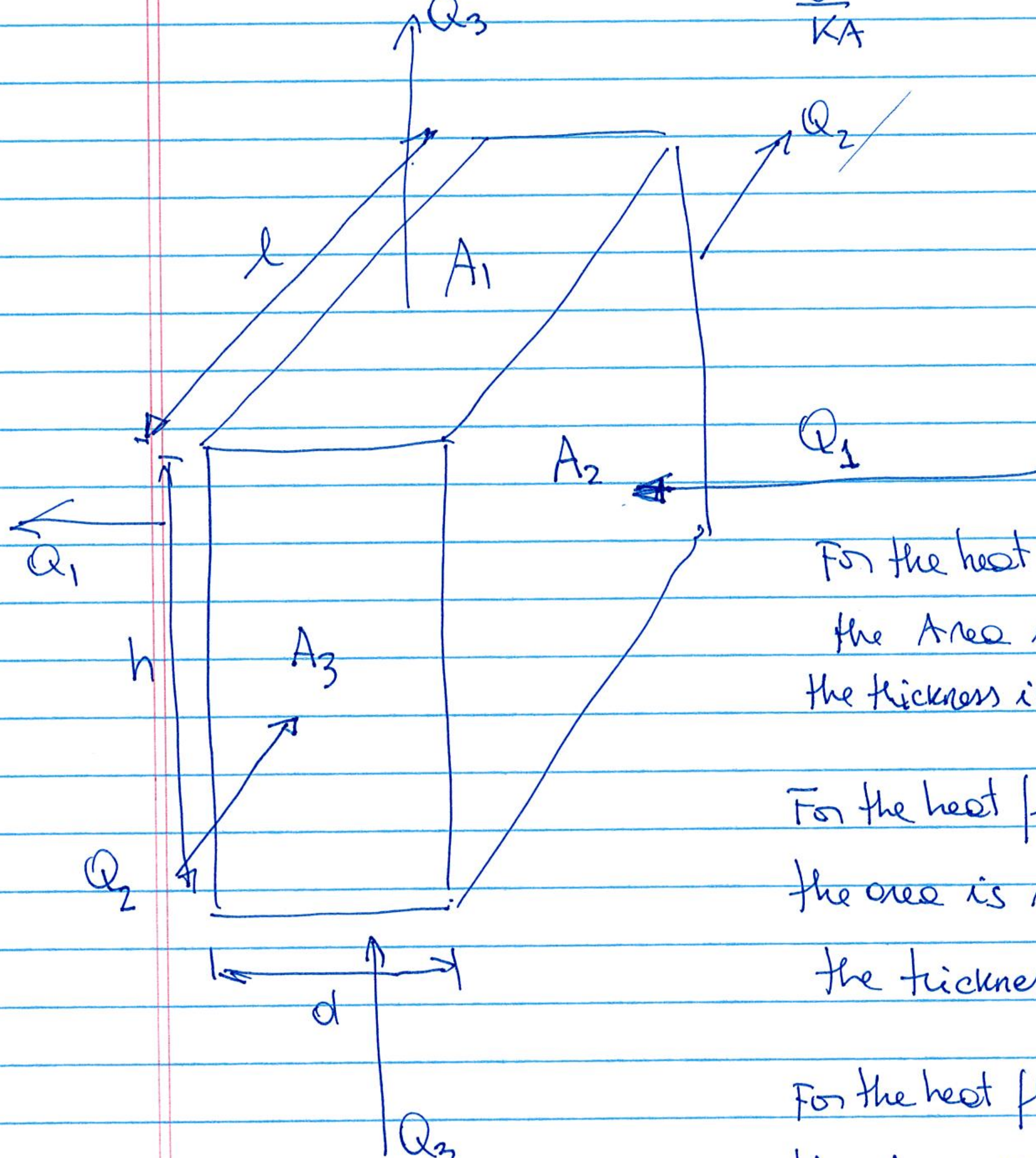
Metal $K = 50\,W/mK$

Brick $K = 3\,W/mK$

foam $K = 0.03\,W/mK$.

What one should consider when we have 1D heat Flow

$$Q = \frac{\Delta\theta}{\frac{d}{KA}}$$

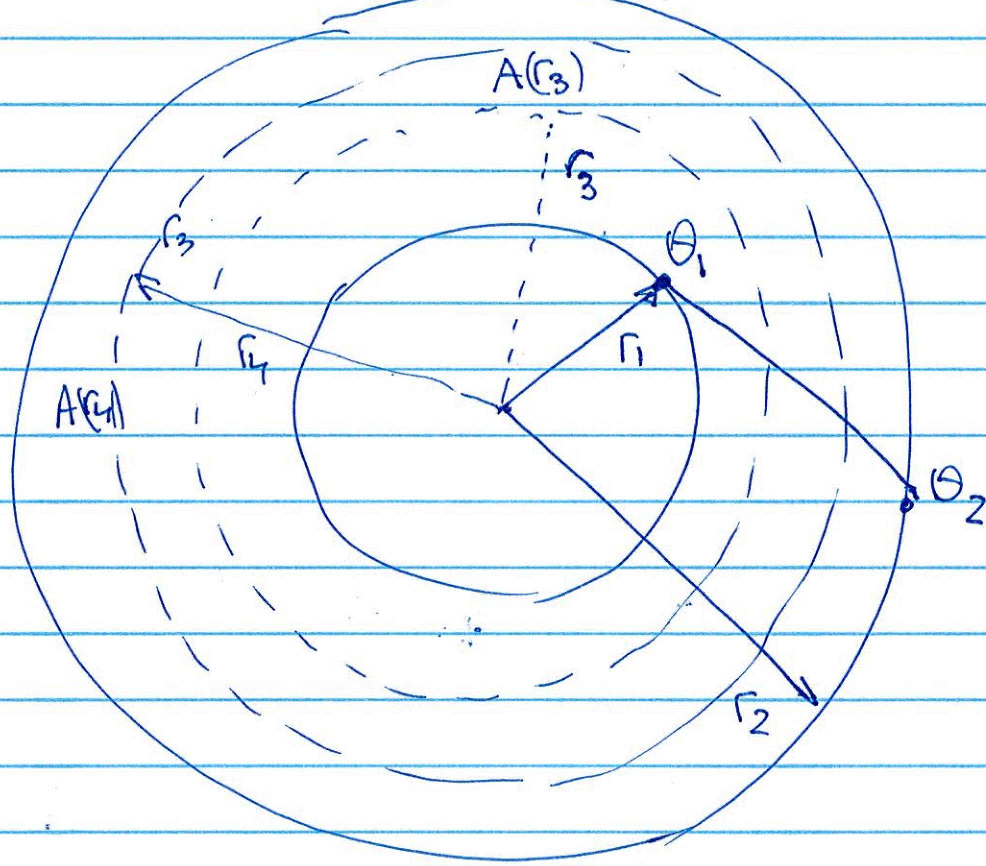


For the heat Flow Q_1 the Area is A_2, the thickness is d

For the heat flow Q_2 the area is A_3 and the thickness is l.

For the heat flow Q_3 the Area is A_1 and thickness is h

CYLINDER



Is the temperature Profile between θ_1 & θ_2 linear?

FOURIER EQUATION

$$Q = -KA \frac{d\theta}{dr}$$

$$A(r_1) = A_1 \neq A(r_2) = A_2$$

$$A(r) = 2\pi r L$$

BASED ON FOURIER LAW

$$\begin{cases} Q = -KA(r)\dfrac{d\theta}{dr} \\ A(r) = 2\pi r L \end{cases}$$

how is going to be $\dfrac{d\theta}{dr}$?

K = constant

$A \neq$ constant

Q = constant [because we are assuming steady state]

$r_1 \rightarrow r_2 \quad A(r) \uparrow$

$$\boxed{\text{when } r\uparrow \; A(r)\uparrow \text{ and because } Q = \text{constant} \quad \frac{d\theta}{dr}\downarrow}$$

$$Q = -K\,2\pi r L \frac{d\theta}{dr}$$

$$\int_{r_1}^{r_2} \frac{Q}{-K\,2\pi L}\frac{dr}{r} = \int_{\theta_1}^{\theta_2} d\theta$$