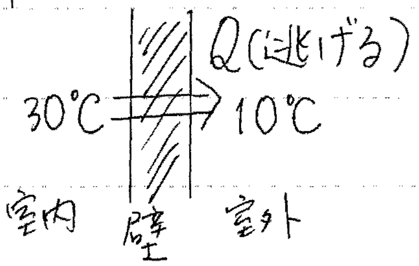
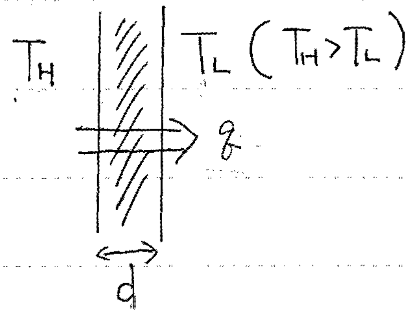
・熱伝導



1 平板の熱伝導



$q \propto T_H - T_L$

$q \propto \frac{1}{d}$

〈公式〉

$$q = \lambda \frac{T_H - T_L}{d}$$

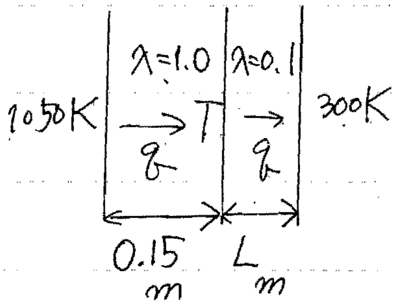
λ：熱伝導率

（単位面積あたり）

$$Q = \lambda S \frac{T_H - T_L}{d}$$

この式を壁1枚あたりにたてる。

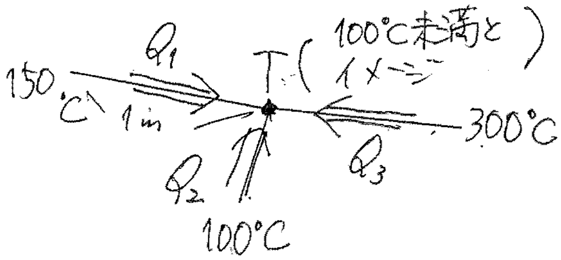
$$\begin{cases} q = 1000 = 1 \times \dfrac{1050 - T}{0.15} & (左) \\ 1000 = 0.1 \times \dfrac{T - 300}{L} \end{cases}$$



$T = 900K$. $L = 0.06$ ⇒ 肢2

3. 棒の熱伝導

〈公式〉 $Q = \lambda S \frac{T_H - T_L}{l}$ ⇒ 棒について代入.



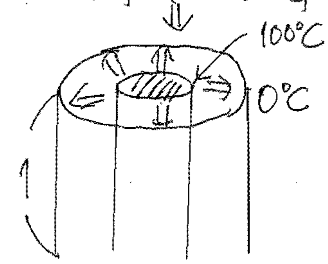
$Q_1 + Q_2 + Q_3 = 0$

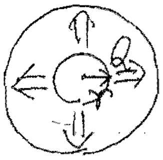
[No. 2] $(\lambda = 1, S = 1)$

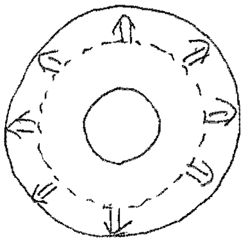
$\frac{150-T}{1} + \frac{100-T}{1} + \frac{300-T}{2} = 0$ ∴ $T = 160$℃

⇒ 肢1 //

4. 円筒の熱伝導

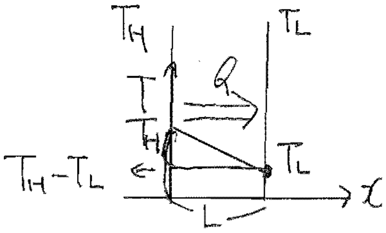






〈公式〉

$$Q = \lambda S \boxed{\frac{T_H - T_L}{L}} \fallingdotseq \lambda S \frac{-\Delta T}{\Delta x} \Rightarrow \boxed{Q = -\lambda S \frac{dT}{dx}}$$



⇓

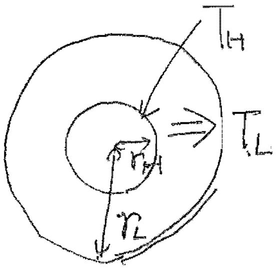
$$Q = -\lambda S(r) \frac{dT}{dr}$$

$S(r) = 2\pi r$

$$Q = -2\pi\lambda r \frac{dT}{dr}$$

$$\Downarrow$$

$$dT = -\frac{Q}{2\pi\lambda}\frac{dr}{r} \Rightarrow \int dT = -\frac{Q}{2\pi\lambda}\int\frac{dr}{r}$$



$$\int_{T_L}^{T_H} dT = -\frac{Q}{2\pi\lambda}\int_{r_L}^{r_H}\frac{dr}{r}$$

$$T_H - T_L = \frac{Q}{2\pi\lambda}\ln\frac{r_L}{r_H} \quad \cdots \text{①}$$

$$\rightarrow \quad Q = \frac{2\pi\lambda(T_H - T_L)}{\ln r_L/r_H} \quad /\!/$$

◎ $T(r)$ は?

$$T_H - T_L = \frac{Q}{2\pi\lambda}\ln\frac{r_L}{r_H} \quad \cdots \text{①}$$

$$\int_{T_H}^{T(r)} dT = \int_{r_H}^{r}\left(-\frac{Q}{2\pi\lambda}\right)\frac{dr}{r}$$

$$T_H - T(r) = \frac{Q}{2\pi\lambda}\ln\frac{r}{r_H} \quad \cdots \text{②}$$

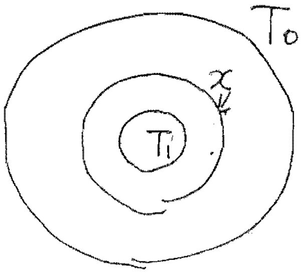
$$\rightarrow \quad \frac{T_H - T(r)}{T_H - T_L} = \frac{\ln(r) - \ln(r_H)}{\ln(r_L) - \ln(r_H)}$$

[No.3]
$$\frac{T_1 - T}{T_1 - T_2} = \frac{\ln(r) - \ln(r_1)}{\ln(r_2) - \ln(r_1)}$$

$T = \frac{T_1 + T_2}{2}$ を代入 ⇒ $r = \sqrt{r_1 r_2}$ … 肢2

[No.4]

管A: $q_A = \dfrac{2\pi k_1 (T_1 - T_0)}{\ln(r_2/r_1)}$



管B:

内側:
$$T_1 - x = \frac{q_B}{2\pi k_1} \ln\frac{r_1}{r_2}$$

外側
$$x - T_0 = \frac{q_B}{2\pi k_2} \ln\frac{r_2}{r_3}$$

$$T_1 - T_0 = \frac{q_B}{2\pi k_1} \ln\frac{r_1}{r_2} + \frac{q_B}{2\pi k_2} \ln\frac{r_2}{r_3}$$

⇒ 肢5

[No.5]

図1: $T_0 - T_1 = \dfrac{q_1}{4\pi\lambda_0} \ln 6$

図2: $T_0 - T_1 = \dfrac{q_2}{4\pi\lambda_0} \ln\dfrac{9}{2}$

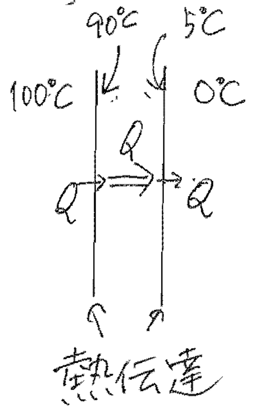
$\dfrac{\ln 6}{\ln\frac{9}{2}}$ ⇒ 肢3

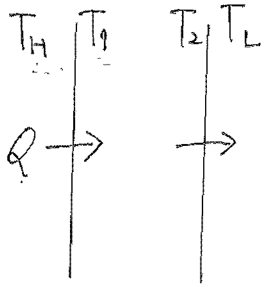
[No.6] t－r グラフ

$$\frac{dT}{dr} = -\frac{1}{\lambda S} Q$$ ← r, Q は一定

S { 外…大, 内…小 ⇒ 傾き { 外…小, 内…大 ⇒ 肢2

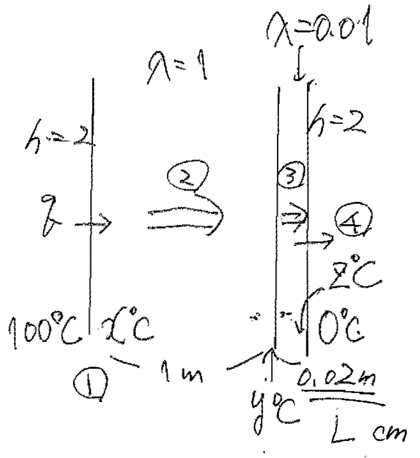
[No.7] 熱伝達





$Q = \alpha S(T_H - T_1)$

α：熱伝達率



① $q = 2(100 - x)$

② $q = x - y$

③ $q = \frac{1}{2}(y - z)$

④ $q = 2z$

⇓

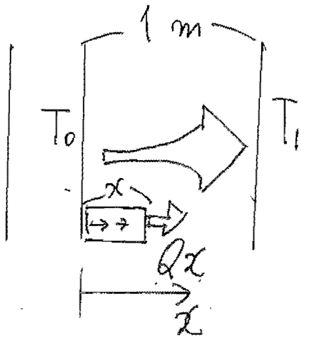
$$\begin{cases} q/2 = 100 - x \\ q = x - y \\ 2q = y - z \\ q/2 = z \end{cases} \Rightarrow q = 25$$

⇒ 肢4

①, ②, ④ 同じ

→ ③ $q = \frac{1}{L}(y - z) \Rightarrow L = 6\,\mathrm{cm}$

[No. 8]



$$Qx = -\lambda \frac{dT}{dx}$$

$$\therefore \frac{dT}{dx} = -\frac{Q}{\lambda}x$$

$$\rightarrow T_0 - T_1 = \frac{Q}{2\lambda}$$

$$\therefore Q = 2\lambda(T_0 - T_1)$$

$$\left(T(x) = -\frac{Q}{2\lambda}x^2 + T_0 \right)$$