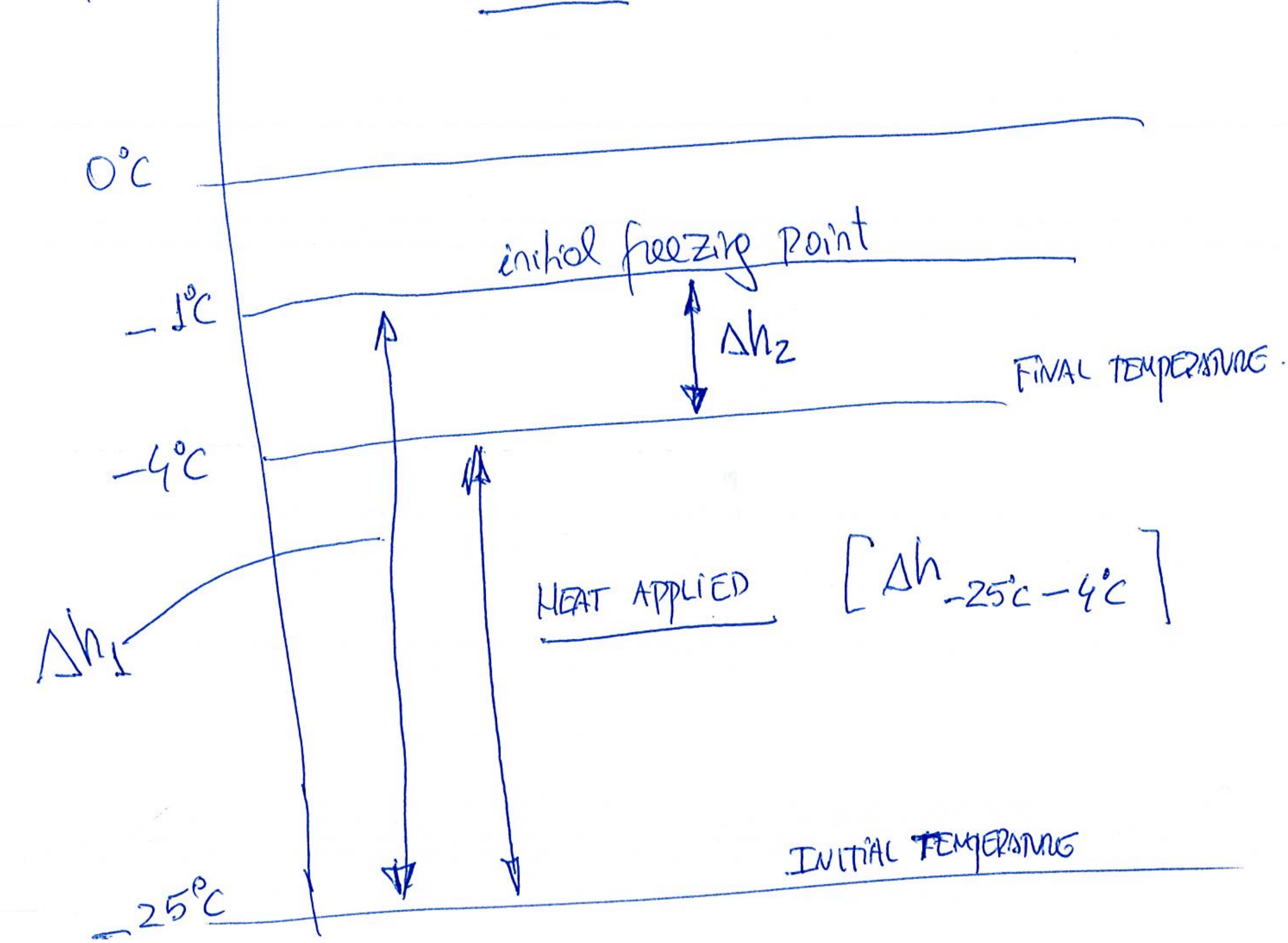
NOTES LECTURE 10-3-2017

Problem 2 _ PRACTICE PROBLEM



$$\Delta h_1 = \Delta h_{-25-\theta_{if}} = c_{SNF}(1-X_w)[\theta_{if} - \theta] + \cdots$$

θ_{if}: −1, θ: −25

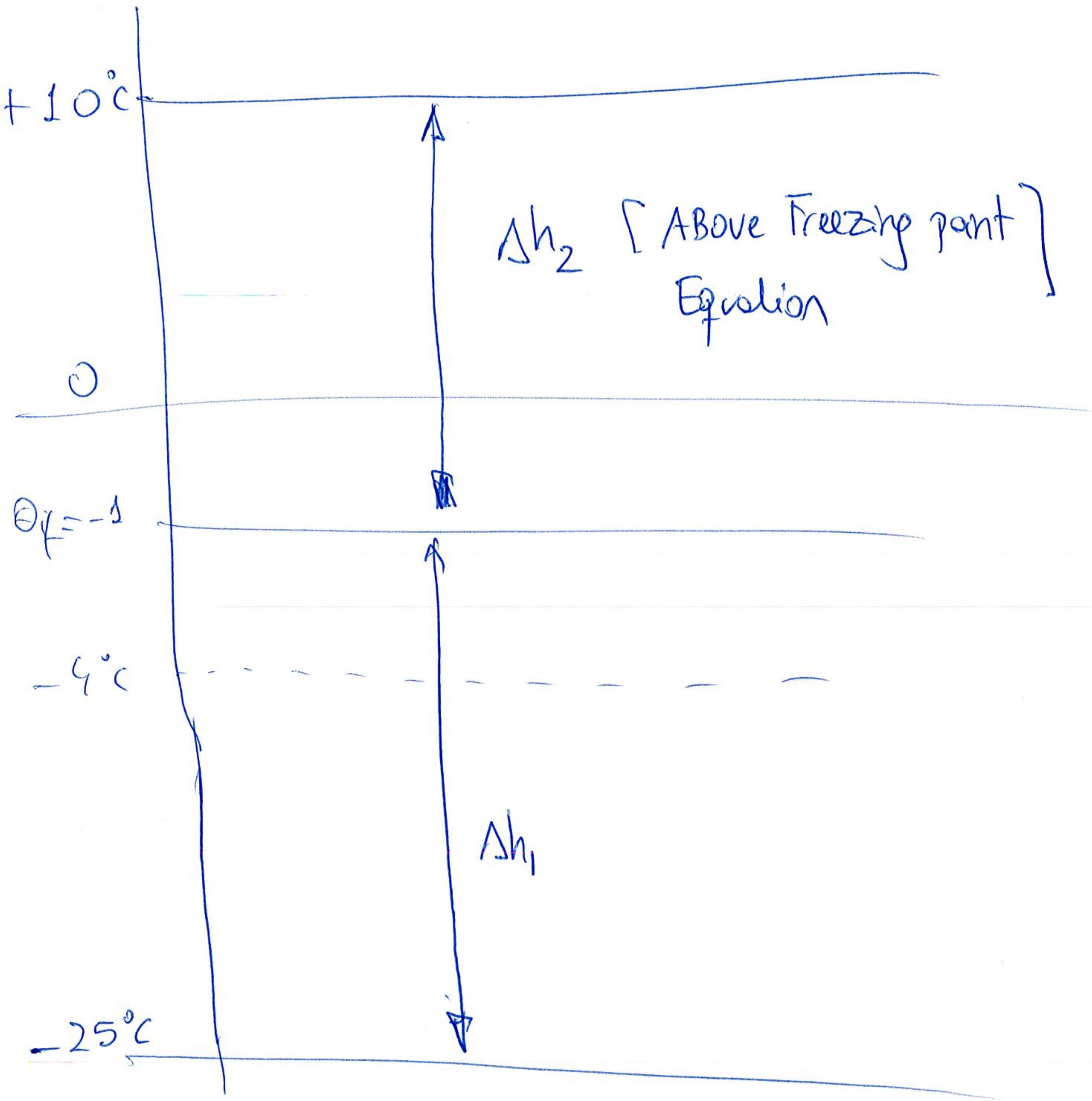
$$\Delta h_2 = \Delta h_{-4-\theta_{if}} = c_{SNF}(1-X_w)[\theta_{if} - \theta] + \cdots$$

$+ \cdots$

θ_{if}: −1, θ: −4

$$\Delta h_{-25°C \to 4°C} = \Delta h_1 - \Delta h_2$$

What happens if you have to heat up to +10°C ? [THIS IS NOT A QUESTION IN THE EXAM]



$$\boxed{\Delta h = \Delta h_1 + \Delta h_2}$$

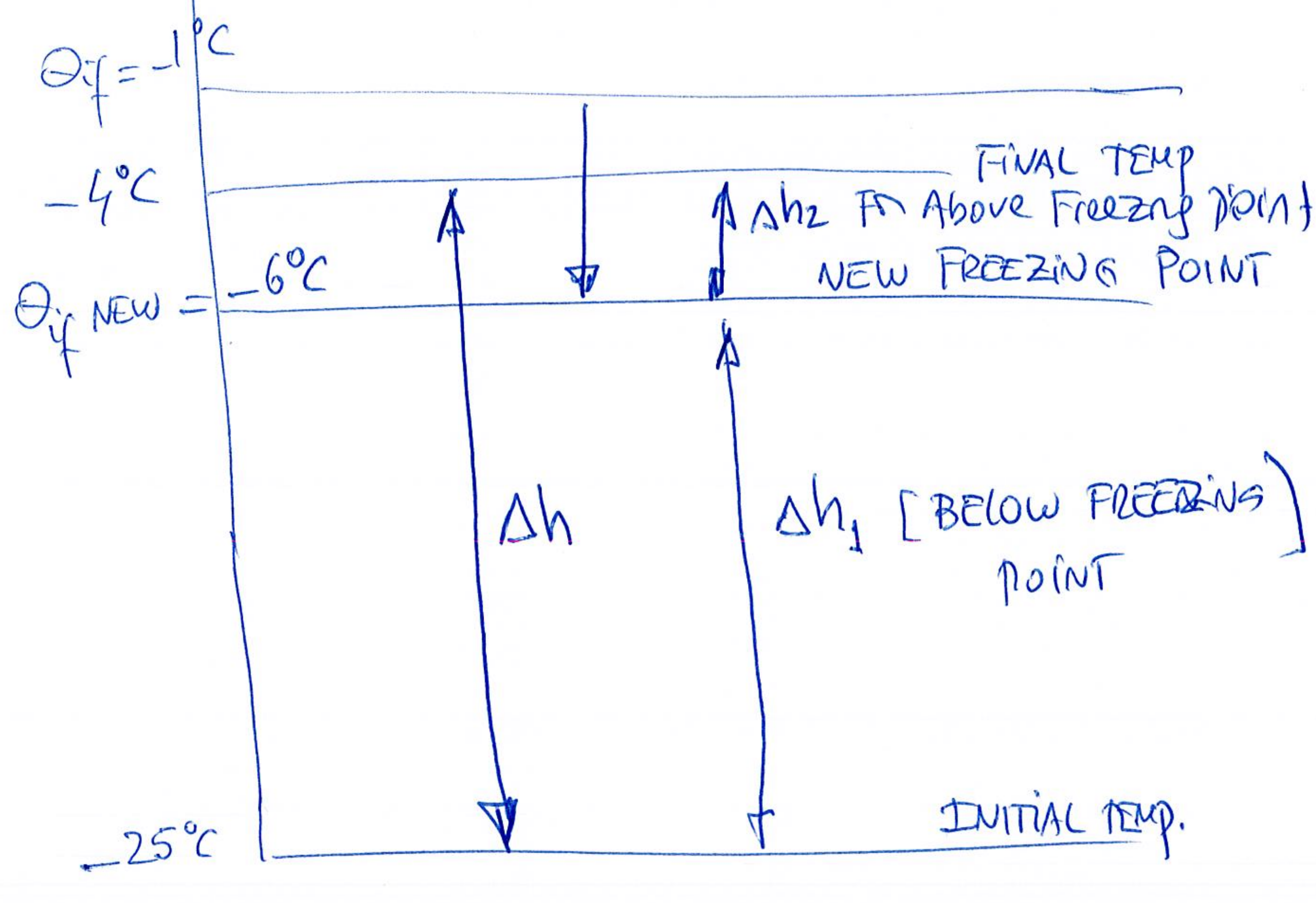
(b) THIS IS A QUESTION

$$\Delta h = \Delta h_1 + \Delta h_2$$

above Freezing point $-6^\circ C \rightarrow -4^\circ C$

below freezing point $-25^\circ C \rightarrow -6^\circ C$

0



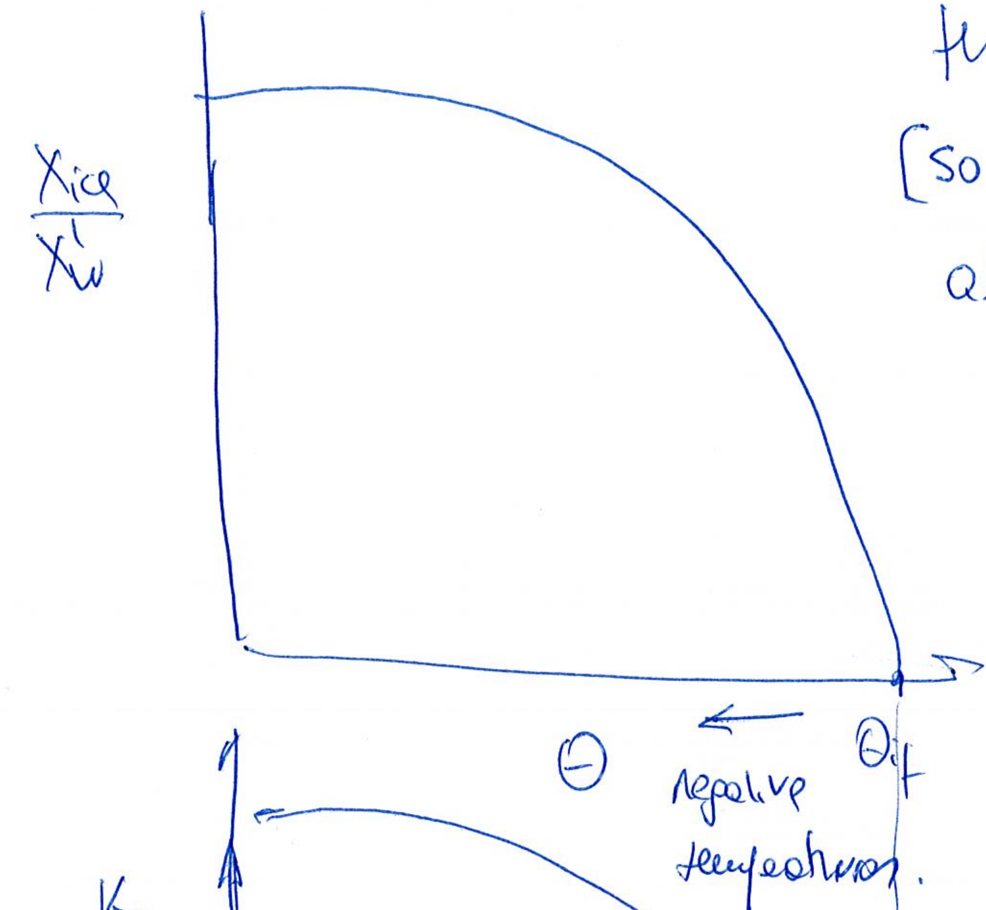
IMPORTANT EQUATION

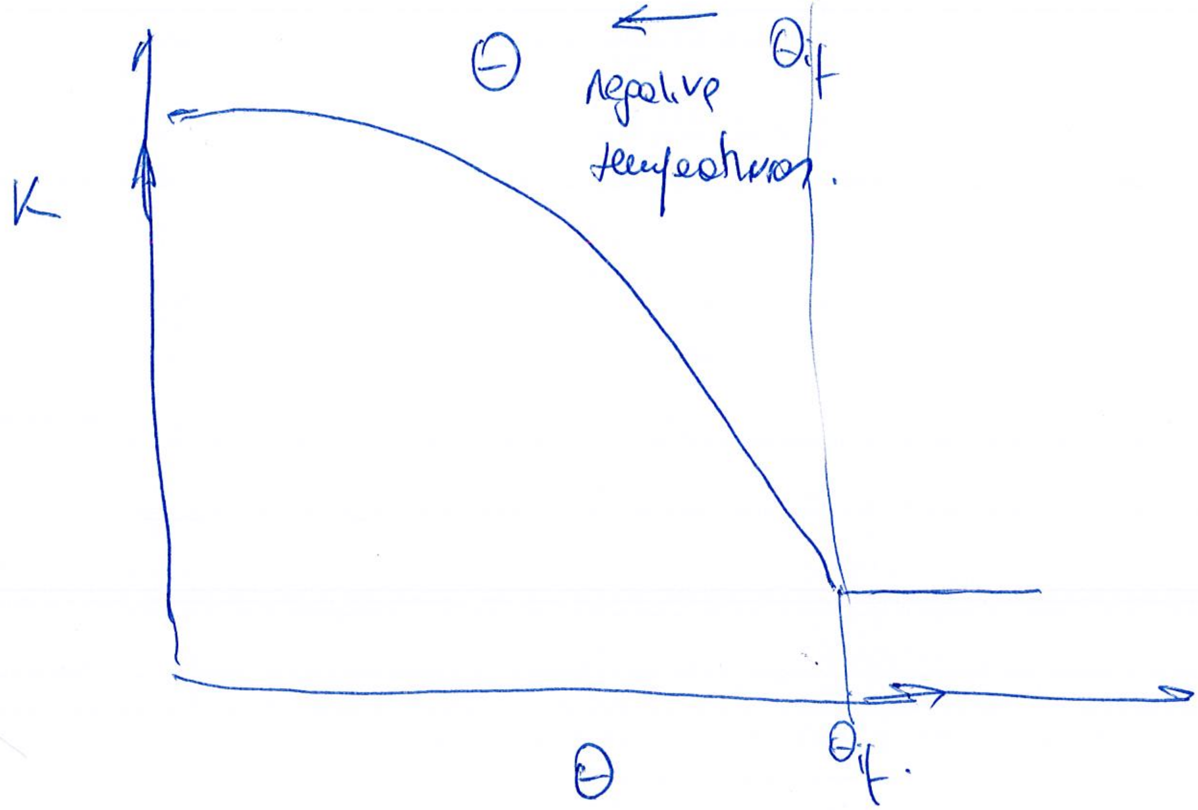
$$\frac{X_{ice}}{X'_w} = \left[1 - \frac{\Theta_{if}}{\Theta}\right]$$

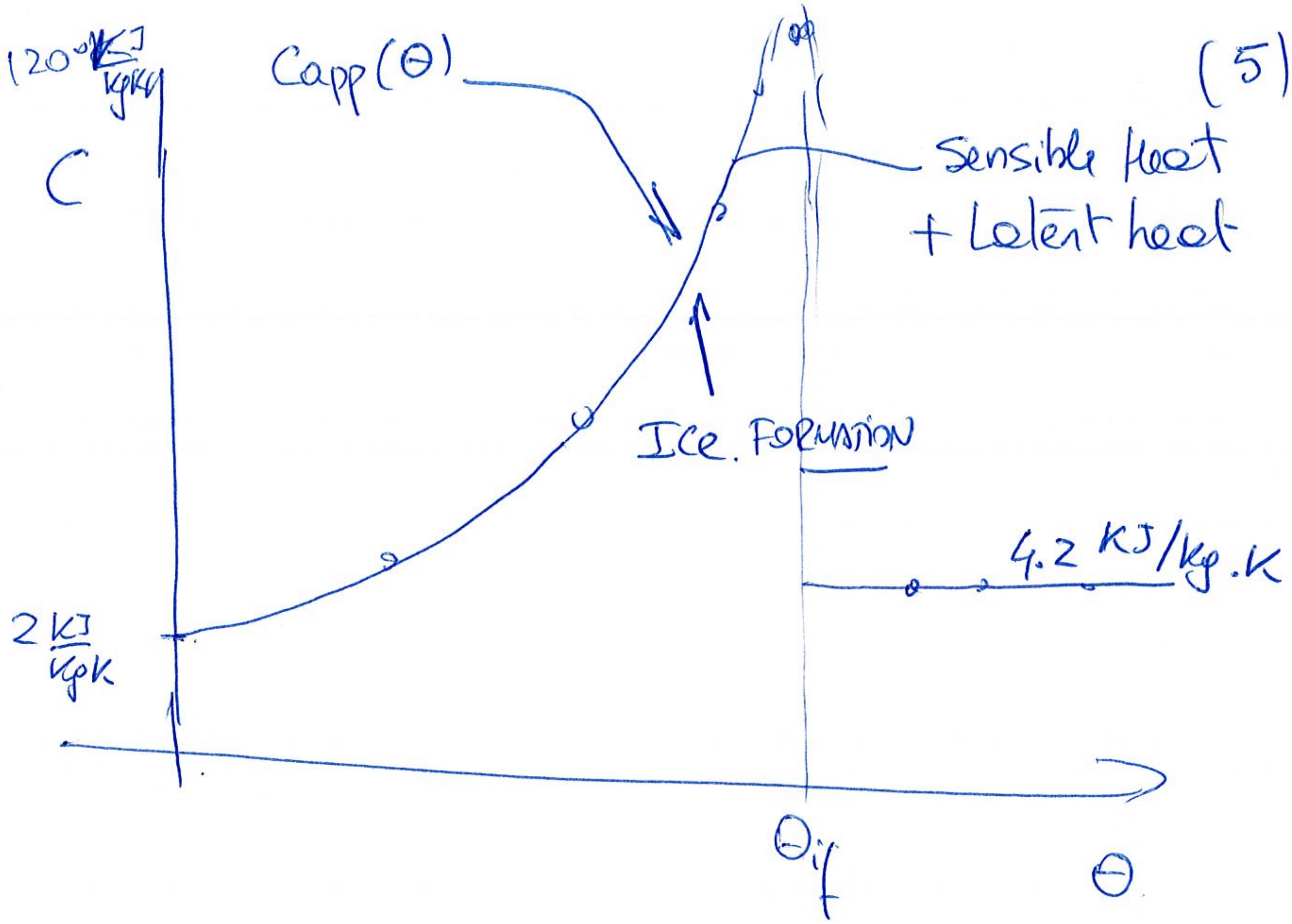
negative if water is solvent which has a freezing point of 0°C

temperature below the freezing point [so for biomaterials is always negative]

Question 1 EXAMPLE EXAM







Capp(Θ) VERY STRONG FUNCTION OF TEMPERATURE

$$\Delta h = \int_{\Theta_a}^{\Theta_{if}} C_{app}(\Theta)\, d\Theta \Longrightarrow \text{Equations in sheet}$$

below freezing point

Question 2 IN PRACTICE EXAM : $X_W = X'_W$? (6)

$X'_W = X_W - X_{BW}$

$$\Delta h_{\theta \to \theta_{if}} = C_{SNF}(1 - \overset{0.77}{X_W})(\theta_{if} - \theta) + C_{ice} X_{BW} \times (\theta_{if} - \theta) + \underset{4.2}{C_W} X'_W \theta_{if} \ln \frac{\theta_{if}}{\theta} + \underset{2.1}{C_{ice}} \underset{0.44}{X'_W} (\theta_{if} - \theta) - L X'_W \left[\frac{\theta_{if}}{\theta} - 1\right]$$

Water content 77% (w/w); $X_W = 0.77$

Initial Freezing point $= -1°C = \theta_{if}$

Specific heat of the fish solids $= 1.9 \frac{kJ}{kg K} = C_{SNF}$ $(1 - X_W)$

Bound water content $= 0.33 \frac{kg\ water}{kg\ dry\ solids}$ $\times$ ~~X_{SNF}~~

$X'_W = X_W - 0.33 = 0.77 - 0.33 = \underline{\underline{0.44}}$

SLIDE 45

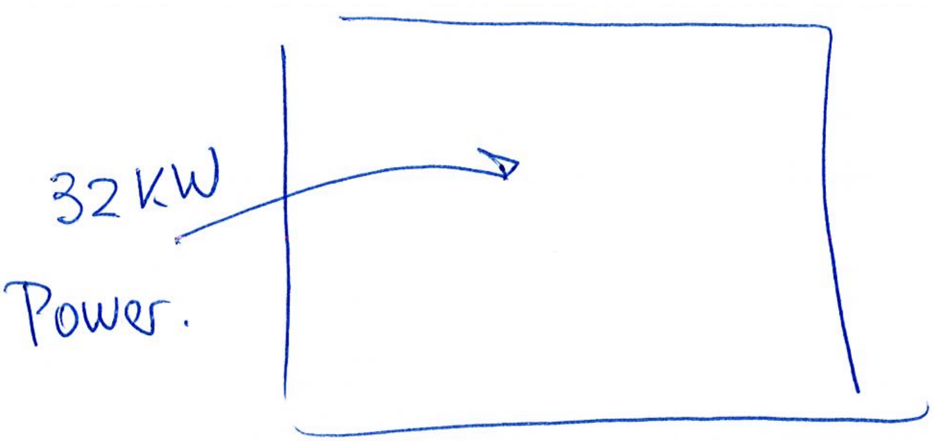
$$X_{BW} = BW \frac{kg\ of\ water}{kg\ \cancel{of\ SNF}} \times X_{SNF} \left[\frac{\cancel{kg\ of\ SNF}}{kg\ total\ solids}\right]$$

$$\Delta h_{-25°C \rightarrow -1°C} = 293 \frac{KJ}{Kg}.$$

$$\Delta h_{-4°C \rightarrow -1°C} = 179.4 \frac{KJ}{Kg}.$$

$$\Delta h_{-25 \rightarrow -4°C} = \Delta h_{-25 - -1°C} - \Delta h_{-4°C \rightarrow -1°C} =$$

$$= 293 \frac{KJ}{Kg} - 179.4 \frac{KJ}{Kg} = 113.6 \frac{KJ}{Kg}$$



$$\text{MASS OF MATERIAL PER HOUR} = \frac{32 KW \left[\frac{KJ}{s}\right]}{113.6 \frac{KJ}{Kg}} = \frac{32}{113.6} \frac{Kg}{\cancel{s}} \times \frac{3600 \cancel{s}}{1h}$$

MASS OF MATERIAL PER HOUR $\equiv$ THROUGPUT $= 1013.8 \frac{Kg}{h}$

$$C_w = 4.2 \frac{KJ}{Kg\,K} = 4.2 \frac{KJ}{Kg\,°C}$$

$$\Delta h = C_w \Delta\Theta = 4.2$$

$$\left.\begin{array}{l}\Theta_1 = -25°C \\ \Theta_2 = -4°C\end{array}\right\} \Delta\Theta = -4°C - (-25°C) = 21°C$$

$$\left.\begin{array}{l}\Theta_1 = -25°C + 273 \\ \Theta_2 = -4°C + 273\end{array}\right\} \Delta\Theta = (-4+\cancel{273}) - (-25+\cancel{273}) = 21K$$

$$K \equiv \frac{W}{m.K} \equiv \frac{W}{m.°C}.$$

THERMAL CONDUCTIVITY