

Ex 1:

What temperature has the same value on both the Celsius and Fahrenheit Scale?

$$1X = \frac{9}{5}X + 32$$
$$\begin{array}{r} -\frac{9}{5}X \\ \hline .8X = 32 \\ \hline \end{array}$$
$$\begin{array}{r} -\frac{9}{5}X \\ \hline .8X = 32 \\ \hline \end{array}$$

$$X = -40$$

# Thermal Physics

When a hot object is brought in contact with a cold object, the two exchange energy (the net flow being from HOT to COLD) till they reach a state of thermal equilibrium.

## Zeroth Law of Thermodynamics

If system A is in thermal equilib. with system B and system B is in thermal equilib. with system C then systems A and C are in thermal equilib. with each other.

\* They are All the same TEMPERATURES!

# Linear Expansion



$$\Delta l = \alpha l_0 \Delta T$$

$\Delta l$  = change in length<sup>th</sup> ( / °C )

$\alpha$  = coefficient of linear expansion

$\Delta T$  = change in T ( °C )

$$l = l_0 (1 + \alpha \Delta T)$$

Ex 2:

The coefficient of linear expansion of

Al is  $24 \times 10^{-6} / ^\circ\text{C}$ . Find the

change in length of a 1.5 m long

Al rail if it is heated from  $20^\circ\text{F}$  to  $100^\circ\text{F}$

$$\Delta l = \alpha l_0 \Delta T$$

$$= (24 \times 10^{-6})(1.5)(37.8 - (-6.67))$$

$$\Delta l = 0.0016 \text{ m}$$

$$\begin{array}{cc} \downarrow & \downarrow \\ -6.67^\circ\text{C} & 37.8^\circ\text{C} \\ T_i & T_f \end{array}$$

Ex. 4

A 0.8 m rod at 4 C is heated to 150 C. The new length of the rod is observed to be 0.8015 m. Determine the coefficient of linear expansion of the rod.

$$\alpha = 1.28 \times 10^{-5} / ^\circ\text{C}$$

## Volumetric Expansion

$$\Delta V = 3\alpha V_0 \Delta T$$

$$\Delta V = \beta V_0 \Delta T$$

Ex 5

$\beta$

The coeff. of volumetric expansion of water is  $207 \times 10^{-6} / ^\circ\text{C}$ . Find the change in volume of 1 L of water when heated from  $5^\circ\text{C}$  to  $80^\circ\text{C}$ .

$$\begin{aligned} 1\text{L} &= 1 \times 10^{-3} \text{m}^3 & \Delta V &= \beta V_0 \Delta T \\ & & &= (207 \times 10^{-6})(1 \times 10^{-3})(75) \end{aligned}$$

A 1L aluminum cylinder is filled with water at  $5^\circ\text{C}$ . Determine the amount of water that spills out when the two are heated to  $85^\circ\text{C}$ .

1) Analyze  $\text{H}_2\text{O}$

2) Analyze Al

3) Put it all together

$$\alpha_{\text{Al}} = 24 \times 10^{-6} / ^\circ\text{C}$$

$$\beta_{\text{H}_2\text{O}} = 207 \times 10^{-6} / ^\circ\text{C}$$

Water

$$\begin{aligned} \Delta V &= \beta V_0 \Delta T \\ &= (207 \times 10^{-6})(1 \times 10^{-3})(80) \\ &= 1.6 \times 10^{-5} \end{aligned}$$

$$V_{\text{new}} = (1 \times 10^{-3}) + (1.6 \times 10^{-5})$$

$$V_{\text{H}_2\text{O}} = 1.01 \times 10^{-3}$$

$$(1.01 \times 10^{-3}) - (1.006 \times 10^{-3})$$

$$= 1.08 \times 10^{-5} \text{ m}^3$$

Aluminum

$$\begin{aligned} \Delta V &= \beta V_0 \Delta T \\ &= (3)(24 \times 10^{-6})(.001)(80) \end{aligned}$$

$$= 5.76 \times 10^{-6}$$

$$= (.001) + \downarrow$$

$$= 1.006 \times 10^{-3}$$