Demonstration for Concept Q 502.html   ring/ball/torch

Slide 503.html   Taipei skyscraper

$$\Delta T = \frac{\Delta L}{\alpha L_0} = \frac{0.471'}{(1.2\cdot 10^{-6}\,K^{-1})(1671')} = 23.5^\circ C$$

$$\Rightarrow T_2 = T_1 + \Delta T = \boxed{39.0\ ^\circ C}$$

Concept Q 503.html

$\Delta V = V_0 \beta \Delta T \Rightarrow$ C would have biggest ΔV

But question ask about $\Delta V / V_0 \Rightarrow$ E

For a cube: $\Delta V/V_0 = \frac{V_f - V_0}{V_0} = \frac{V_0 + V_0 \beta \Delta T - V_0}{V_0} = \beta \Delta T$

and $\frac{\Delta V}{V_0} = \frac{(L_0 + L_0 \alpha \Delta T)^3 - L_0^3}{L_0^3} = \frac{L_0^3[(1+\alpha\Delta T)^3 - 1]}{L_0^3}$

$$= 1 + 3\alpha\Delta T + 3\alpha\Delta T^2 + \alpha^3 \Delta T^3 - 1$$

$$= 3\alpha\Delta T + 3\alpha^2 \Delta T^2 + \alpha^3 \Delta T^3$$

$$\approx 3\alpha\Delta T \quad \text{for } \Delta T \ll 1$$

or $\beta \approx 3\alpha$ for $\Delta T \ll 1$

Application slide 504.html

$T_{winter} = -40^\circ C$

$T_{summer} = +40^\circ C$

$$\Delta L = L_0 \alpha \Delta T = (1\cdot 10^3 m)(1.2\cdot 10^{-5} K^{-1})(80K)$$

$$= \boxed{0.96\ m}$$

Concept Q 504.html

i) Twice as hot? No → needs to be on K scale

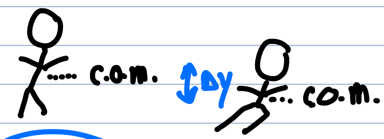
ii) H_2O pipes? Pipes shrink as they cool, but H_2O expands near 0°C

Hg thermometer?

$\beta_{Hg} > \beta_{glass} \Rightarrow$ Hg will shrink proportionally more than glass
[Table 1.2]

Concept Q s05.html

Energy to stand up : $mg\Delta y$



say $\Delta y \sim 0.5\,m$

$mg\Delta y \sim (80kg)(9.8\,m/s^2)(0.5m) = 392\,J$

vs

Energy in 1/100 of a candy bar (since a penny is $\frac{1}{100}$ of a dollar)

2 Calories = 2000 calories = 2000 calories $\frac{4.186J}{\text{calorie}}$ = 8372 J

1 cal = 4.186 J
1 kcal = 1 Calorie = 4186 J

1 calories raises 1g of H_2O by 1°C

Q	=	m	c		ΔT	
Heat [J]		mass [kg]	specific heat	$\left[\frac{J}{kg \cdot K}\right]$	Temp change	[K]

$dQ = mc\,dT$

dQ is not the heat contained in a body, but the heat required to raise T

specific heat examples

	J/kg·K
water	4190
air	716–1000
iron	470
ice	2100

Phase changes require heat as well

$Q = \pm mL_f$ = heat for changing solid ⟷ liquid

$Q = \pm m L_v$ = heat for changing liquid ⟷ gas

slide 505.html

$Q_{water} = Q_{steam\ water}$

$Q_{water} = m_{water} c_{water} \Delta T_{water}$

$Q_{steam\ water} = m_{steam} c_{water} \Delta T'_{water} + m_{steam} L_{v\,steam}$

and $m_{water} = 1.00\,kg$ $\quad c_{water} = 4190\ J/kg \cdot K$ $\quad \Delta T_{water} = 70.0 - 28.0 = 42.0°C$

$\Delta T'_{water} = 100.0 - 35.0 = 65.0°C$ $\quad L_{v\,steam} = 2256\ J/kg$

$$\frac{m_{steam}}{m_{water}} = \frac{c_{water} \Delta T_{water}}{c_{water} \Delta T'_{water} + L_{v\,steam}} = 0.0696$$