Homework 18

Recall: $\boxed{T_K = t_c + 273.15}$

1. $T_{body} = t_c + 273.15 \simeq (37 + 273)K$
$\simeq 310\ K$

2. $T_1 = 15 + 273 \simeq 288\ K$
$T_2 = 312\ K.$

$KE_{avg} = \frac{3}{2} k \cdot T, \quad k = 1.38 \cdot 10^{-23} \frac{J}{K}$

$$\frac{KE_2}{KE_1} = \frac{\cancel{3/2\, k} \cdot T_2}{\cancel{3/2\, k} \cdot T_1} = \frac{T_2}{T_1} \simeq 1.08$$

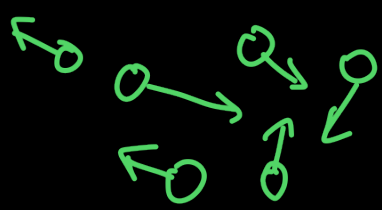
3. $T = 300\,K$

$$KE_{avg} = \underbrace{3/2\, kT = \frac{m \cdot v_{avg}^2}{2}}$$

Homework.

(3) $$m\vartheta^2 = 3\cdot kT$$

$$\vartheta^2 = \frac{3kT}{m} \Rightarrow \boxed{\vartheta = \sqrt{\frac{3k\cdot T}{m}}}$$

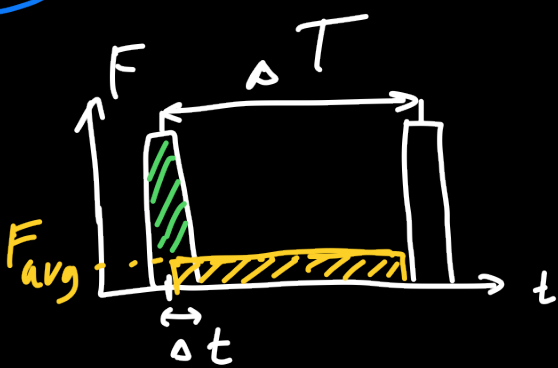


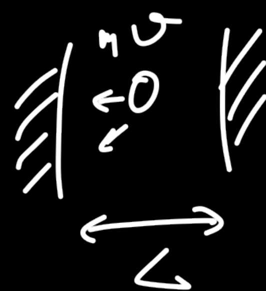
$$\vec{\vartheta}_{avg} = \frac{\vec{\vartheta}_1 + \ldots + \vec{\vartheta}_N}{N} = \vec{0}$$

$$\vartheta^2_{avg} = \frac{\vartheta_1^2 + \ldots + \vartheta_N^2}{N} \neq 0$$

$$\vartheta \simeq 680 \ m/s$$

(4*)





$$\Delta T = \frac{L}{\vartheta}$$

$$\boxed{J = F\cdot\Delta t = F_{avg}\cdot\Delta T}$$

Internal energy and specific heat

Last time: T is a measure of internal kinetic energy of microscopic atoms and molecules.

$$\boxed{T \sim KE_{avg.}}$$ ← only microscopic movements

There is also internal potential energy.

$$\boxed{E_{internal} = E_{int., kin} + E_{int., pot}}$$

$\Rightarrow$ $T \uparrow$ means that $E_{int} \uparrow$

$T \downarrow \Rightarrow E_{int} \downarrow$

$$\boxed{\Delta E_{int} \sim \Delta T}$$

$\Delta T > 0$

$\Downarrow$

$\Delta E_{int} > 0$

$$\boxed{\Delta E_{int} = c \cdot m \cdot \Delta T}$$

$$\Delta T_K = T_{K,2} - T_{K,1} =$$

$$= (t_{c,2} + 273) - (t_{c,1} + 273)$$

$$= t_{c,2} - t_{c,1} = \Delta t_c$$

m – mass od an object.

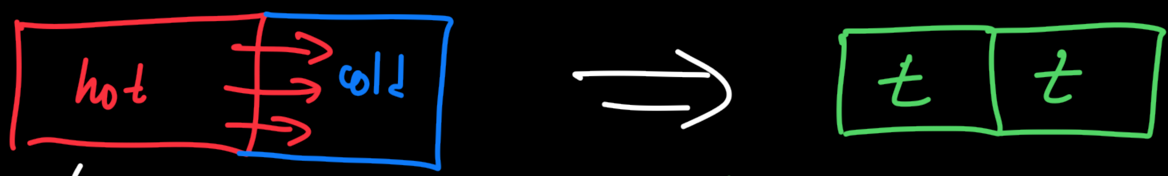
c – specific heat capacity or specific heat.

$$\boxed{[c] = \frac{J}{kg \cdot K} = \frac{J}{kg \cdot {}^\circ C}}$$

$$c_{water} = 4200 \frac{J}{kg \cdot K}$$

$$c_{iron} = 460 \frac{J}{kg \cdot K}$$

Heat transfer



$t_1 > t_2$

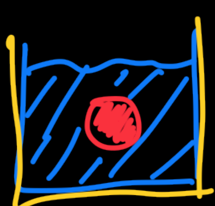
Thermal equilibrium.

We can use the above formula for ΔE_{int} to compute the equilibrium temperature

Problem.

$$\Delta E_{int} = c \cdot m \cdot \Delta t$$

Container is thermally insulated



$m_{iron} = 2\,kg$ | $m_w = 1\,kg$

$t_{iron} = 100°C$ | $t_w = 20°C$

What is the equilibrium temperature $t = ?$

Because the container is insulated and there is no change in mech. energy (+ no work)

$$\Rightarrow \quad \boxed{\Delta E_{int,\,tot.} = 0}$$

$$\boxed{\Delta E_{int.,\,tot} = \Delta E^{int}_{water} + \Delta E^{int}_{iron}}$$

$$\begin{cases} \Delta E_w = m_w \cdot c_w \cdot \Delta t_w = m_w c_w (t - t_w) \\ \Delta E_i = m_i \cdot c_i \, (t - t_i) \end{cases}$$

$$\boxed{m_w \cdot c_w \, (t - t_w) + m_i c_i \, (t - t_i) = 0}$$

$$t \, (m_w c_w + m_i \cdot c_i) = m_w c_w \cdot t_w + m_i c_i \cdot t_i$$

$$\boxed{t = \frac{m_w c_w \cdot t_w + m_i c_i t_i}{m_w c_w + m_i \cdot c_i}}$$

$$t = \frac{1kg \cdot 4200 \frac{J}{kg \cdot °C} \, 20°C + 2kg \cdot 460 \frac{J}{kg \cdot °C} \cdot 100°C}{1kg \cdot 4200 \frac{J}{kg \cdot °C} + 2kg \cdot 460 \frac{J}{kg \cdot °C}}$$

$$t = \frac{4600 + 4200}{256} \, °C$$

$$\boxed{t = 34°C}$$