Homework 19

N1. $m = \frac{1}{2}\,kg$, $\Delta t = 60°C$

$$\Delta E_{int} = m \cdot c \cdot \Delta t = 4.8\,kJ$$

N2. $t_{c,i} = 100°C$ $t_{m,i} = 10°C$

$t_f = 65°C$ $m_{coffee} = 150g$

$$\Delta E_{coffee} = m_c \cdot c_w \cdot \Delta t_c$$

$$\Delta E_{milk} = m_m \cdot c_w \cdot \Delta t_m$$

$$m_c \cdot \cancel{c_w} \cdot \Delta t_c + m_m \cdot \cancel{c_w} \cdot \Delta t_m = 0$$

$$\frac{m_m}{m_c} = -\frac{\Delta t_c}{\Delta t_m} = \frac{35°C}{55°C}$$

$$m_m = \frac{35}{55} \times 150g \simeq 95.(45)\,g$$

Homework 19

N 3

sun → ~5700 °C
~6000 K

dry ice → −78°C

liquid nitrogen → −196°C or 77K

Outer space → 2.7 K or
−270°C

Atom in a quantum
computer → −273.15°C
(particular case)

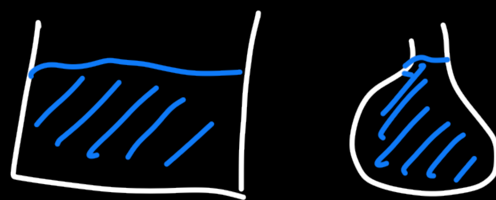
Classwork

Phases of matter

Solid

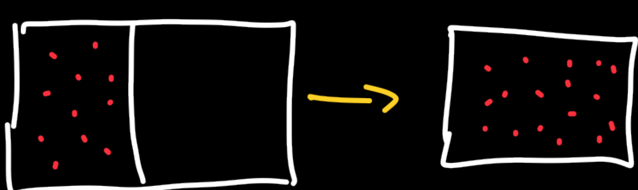
have a
- certain shape
- certain volume

Liquid



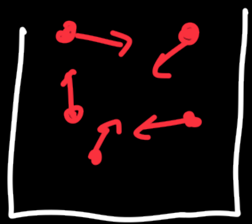
- no certain shape
- certain volume

Gas



- no certain shape
- no certain volume

Gas



On the molecular level almost free particles
→ almost no interaction
(ideal gas: no interaction at all!)

Liquid

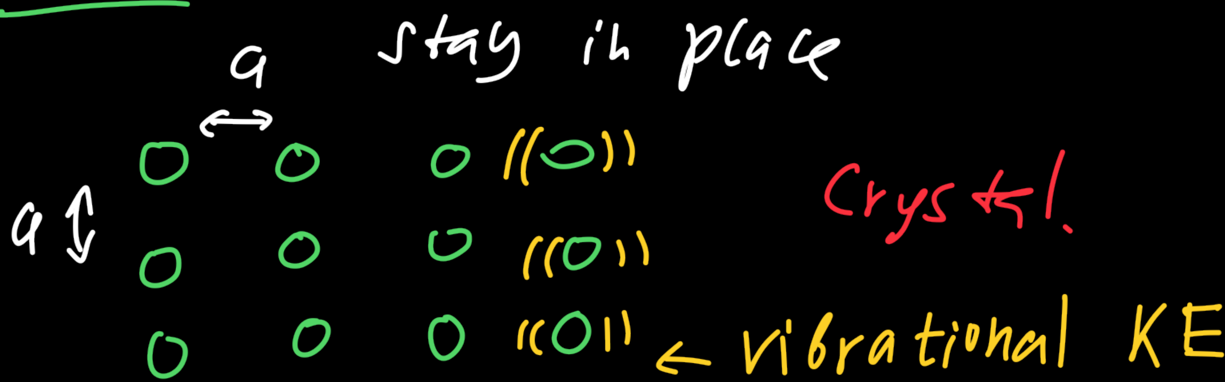
Interaction is stronger.

simple model: a chain.

molecules do not move too far from each other.

Solid

molecules are forced to stay in place



Crystal.

Phase transitions

Can we go from one phase to another?

idea: heat or cool down!

The type of an atom or a molecule doesn't matter.

Interaction between molecules and their kinetic energies matter!

Example: water

ice $\underset{}{\overset{0°C}{\rightleftarrows}}$ liquid $\overset{100°C}{\rightleftarrows}$ water vapor

Example: lead

lead $\xrightarrow[330°C]{}$ liquid lead $\xrightarrow[1700°C]{}$ gaseous lead solid nitrogen ← liquid n. ← nitrogen (gas)

−210°C (63K)   −196°C (77K)

Phase transition

solid → liquid: melting

liquid → solid: freezing

solid → gas: sublimation

gas → solid: desublimation

liquid → gas: boiling

gas → liquid: condensation

Latent heat

ice at 0°C → water at 0°C

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

↗ only for a fixed phase

$$\Delta E_{int} = \Delta KE + \Delta PE$$

During phase transition:

$$\Delta KE \simeq 0$$

$$\Delta PE \neq 0 \quad > 0 \text{ or } < 0$$

During melting

$$\Delta E_{melt} = \lambda \cdot m$$

λ – latent heat of melting

$$\Delta E_{evap} = r \cdot m$$

r – latent heat of evaporation

$$\Delta E_{freeze} = -\lambda \cdot m$$

$$\Delta E_{condens} = -r \cdot m$$