شركة تدريب هندسي

E.CAMP

الطريق الدائري بجوار المدرسة المعمارية

01064763583

PHYSICS 1

2021 - 2022 No.16

"CH. 8: Thermodynamics"

[A] Definitions: تعريفات هامة جداً

(1) Tempreture: الحرارة

is a measure of the average kinetic energy of the material measured in degree C°, F° or K.

← هى مقياس لمتوسط طاقة الحركة للمادة.

(2) Thermal energy: الطاقة الحرارية

→ called also amount of heat كمية الحرارة

→ units: Joule

السعر الحرارى calorie = 4.184 J

British thermal unit (1 BTU) = 1055 J

$$\boxed{Q = m c \Delta T}$$

Q — amount of heat m — mass

ΔT — change in tempreture.

c — specific heat الحرارة النوعية

(3) Specific heat: الحرارة النوعية

is the energy needed to change the tempreture of one gram of the material 1 °c. [J/g.°c] or J/kg.°c, cal/g.k

(4) Heat capacity: السعة الحرارية

$C = mc$ J/°c or cal/K

The energy needed to change the temp. of the material 1 °c

5 one calorie: السعر الحراري

is the energy necessary to change one gram of water 1 °c.

$1\ cal = 4.184\ J$ هام

$C_{water} = 1\ cal = 4.184\ J$

$1\ Cal = 1000\ cal$ → Kilocalorie

6 Latent heat : الحرارة الكامنة

is the energy required to change the water from a physical state to another

→ Latent heat of fusion

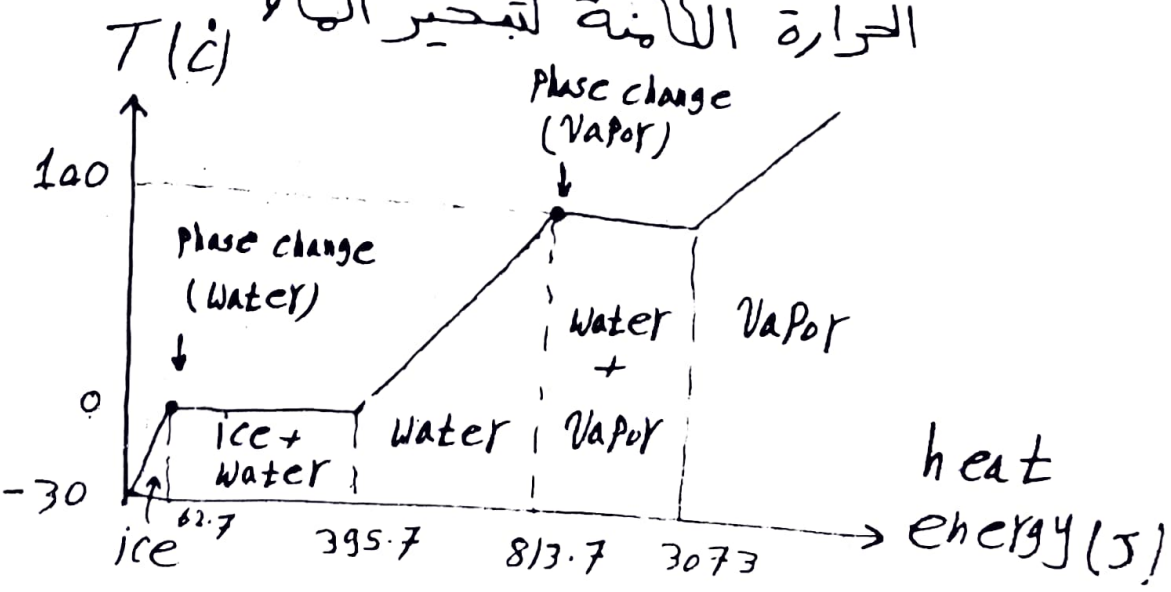
$$L_F = 80 \text{ cal/gram}$$

الحرارة اللازمة لإنصهار الجليد و تحويله الى ماء

→ Latent heat of Vaporization

$$L_V = 540 \text{ cal/gram}$$

الحرارة الكامنة لتبخير الماء



تعيين الحرارة النوعية

(1) عند خلط مادتين :

$T_1 , m_1 , c_1 + T_2 , m_2 , c_2 \longrightarrow T\,C^\circ$

$T_2 < T < T_1$

$Q_{lost} = -Q_{gained}$

$m_1 c_1 \Delta T_1 = -m_2 c_2 \Delta T_2$

$$\boxed{m_1 c_1 (T_1 - T) = m_2 c_2 (T - T_2)}$$

(2) عند خلط مادة مع الجليد :

$T_1 , m_1 , c_1 + m_{ice} L_F \longrightarrow 0\,C^\circ$

$Q_{lost} = -Q_{gained}$

$m_1 c_1 (T_1 - 0) = m_{ice} L_F$

$$\boxed{m_1 c_1 T_1 = m_{ice} L_F}$$

"Exercises"

1 800 g of Water are warmed (سخنت) from 10°C to 18°C, How much energy in 'J' were absorbed? (امتصت)

"answer"

$$Q = m\,c_w\,\Delta T = (800)(4.186)(18-10)$$

$$\boxed{Q = 26790.4\ J}$$

---

2 700 g of Water are allowed to cool from its boiLLing Point (الغليان) to 20°C, How much energy in 'KJ' are released (انطلقت) into the room.

"answer"

$$Q = mc_w\,\Delta T = (700)(4.186)(100-20)$$

$$= 234416 = \boxed{234.416\ KJ}$$

---

3 How much 'KJ' of energy must a heater supply in order for 200 kg of bathWater

to warm up from 10°c to our body tempreture 37°.

~ answer ~

$$Q = m\,c_w\,\Delta T = (200)(4186)(37-10)$$

$$= 22604400 = \boxed{22604.4\ KJ}$$

---

4 if 900 J of heat are absorbed by 800 g of water at 5°c, what will be its final tempreture?

~ answer ~

$$Q = 900 = m\,c_w\,\Delta T = (800)(4.186)(T_F - 5)$$

$$\therefore T_F = \frac{900}{(800)(4.186)} + 5 = \boxed{5.269\ ^\circ c}$$

---

5 800KJ were absorbed by a Pond (خزان) sending its tempreture rising from 20°c to 25°c, How much water was in the Pond?

~ answer ~

$$Q = 800 \times 10^3 = m\, C_W \Delta T = m\,(4186)(25-5)$$

$$\therefore m = \frac{800 \times 10^3}{4186 \times 5} = \boxed{38.222\ kg}$$

---

6 Find the specific heat of a matrial that lost 41900 J of energy when 200g of the material went down 50 $^\circ c$ in tempreture. What was the material?

"answer"

$\Delta T = 50\ ^\circ c$

$Q = m\, c\, \Delta T$

$41900 = (200)(c)(50)$

$$\therefore c = \frac{41900}{(200)(50)} = 4.19\ J/g.^\circ c$$

$\boxed{c = 4190\ J/kg.^\circ c}$ $\boxed{\text{Water}}$

$C_W = 4186 \simeq 4190$

1 What mass of copper originally at 50°C must be added to 1kg of 10°C water to raise its tempreture to 20°C ? [SP heat of Cu = 0.39 J/g.°C]

"answer"

$T_F = 20°C$ $T_1 = 50°C$ $m_1 = ??$

$T_2 = 10°C$ $m_2 = 1kg$

$$Q_{lost} = -Q_{gained}$$

$$m_1 C_1 \Delta T_1 = m_2 C_2 \Delta T_2$$

$$m_1 (0.39)(50-20) = (1000)(4.186)(20-10)$$

$$m_1 = 3577.78\ g = \boxed{3.578\ kg}$$

2 A 450 mL sample of water originally at 25°C, How cold will it get if we add 300 mL of 0.5°C water to the sample?

"answer"

$Q_{lost} = -Q_{gain}$ $(450)(4.18)(25-T_F) = (300)(4.18)(T_F - 0.5)$

$$\boxed{T_F = 15.2\ °C}$$

3 How much heat is required to vaporize 1 g of ice cube at 0°c.

⇒ the Latent heat of fusion of ice is 80 cal/g and the Latent of vaporizatio is 540 cal/g and specific heat of water is 1 cal/g.c

"Solution"

$M_{ice} = 1\ g$ $\quad L_F = 80\ cal/g$

$L_V = 540\ cal/g$ $\quad C_w = 1\ cal/g.c^\circ$

$T_i = 0\ c^\circ$ $\quad T_f = 100\ c^\circ$

$$Q = M_{ice} L_F + m_w C_w \Delta T + m_w L_V$$

$$Q = (1 \times 80) + (1)(1)(100 - 0) + (1)(540)$$

$$\boxed{Q = 720\ cal}$$

4 How much heat must be added to 60 g of ice to melt it completely?

~ answer ~

$$Q = mL_f = (60)(80\ cal) = 4800\ cal$$

$$= \boxed{4.8\ cal}$$

---

5 The cross-section of a steel rod is $10\ cm^2$, what is the least force that will prevent (يمنع) it from contraction (الانكماش) while cooling from $520^\circ C$ to $20^\circ C$, $\alpha_{steel} = 1.2 \times 10^{-5}\ C^\circ$

$E_{steel} = 200 \times 10^9\ N/m^2$

~ answer ~

Young ↘

$$\therefore E = \frac{F/A}{\Delta L/L} = \frac{F/A}{\alpha \Delta T} = \frac{F}{A \alpha \Delta T}$$

$$\therefore F = EA\alpha\Delta T$$

$$= (200 \times 10^9) \times (10 \times 10^{-4})(1.2 \times 10^{-5})(520 - 20)$$

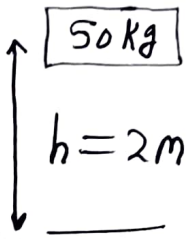
$$= \boxed{1.2 \times 10^6\ N} = \boxed{1.2 \times 10^6\ N} \rightarrow F$$

6 A student eats 2000 Calories (يوعب) dinner and wish to do the (مكافئ) equivalent work in the gym by lifting (يرفع) 50 kg barbell, How many times must he raise it to (يبذل) expend this energy?

- Assume he raises it 2m each time he lifts it and take 5s.

"answer"

$$N = \frac{Q}{W}$$



$Q = 2000 \times 4.18 \times 10^3 = 8.37 \times 10^6 \text{ J}$

$W = mgh = 50 \times 9.8 \times 2 = 980 \text{ J}$

$\therefore N = \frac{8.37 \times 10^6}{980} = \boxed{8534}$ times

time = (8534 × 5 sec) = 42670 S

= 11.86 hr !!

---

7 How many Calories required to raise the tempreture of 25 grams of water from 0 C° to 100 C°?

$C_w = 4.18 \text{ J/g.C}^\circ$

~answer~

$$\Rightarrow Q = mc\Delta T$$

$$= (25)(4.18)(100-0) = \boxed{10450\ J}$$

$$\Rightarrow Q = \frac{10450}{4.18} = \boxed{2500\ cal}$$

$$= \boxed{2.5\ Cal} \rightarrow \text{Capital} \equiv \text{Kilo}$$

---

8 How many Calories will you burn by drinking 1 L of water initially at $36.5^{\circ}F$, assume that the body must expend energy to heat the water to $98.6^{\circ}F$

~answer~

$$T_F = \frac{9}{5}T_C + 32 \Rightarrow T_C = \frac{5}{9}(T_F - 32)$$

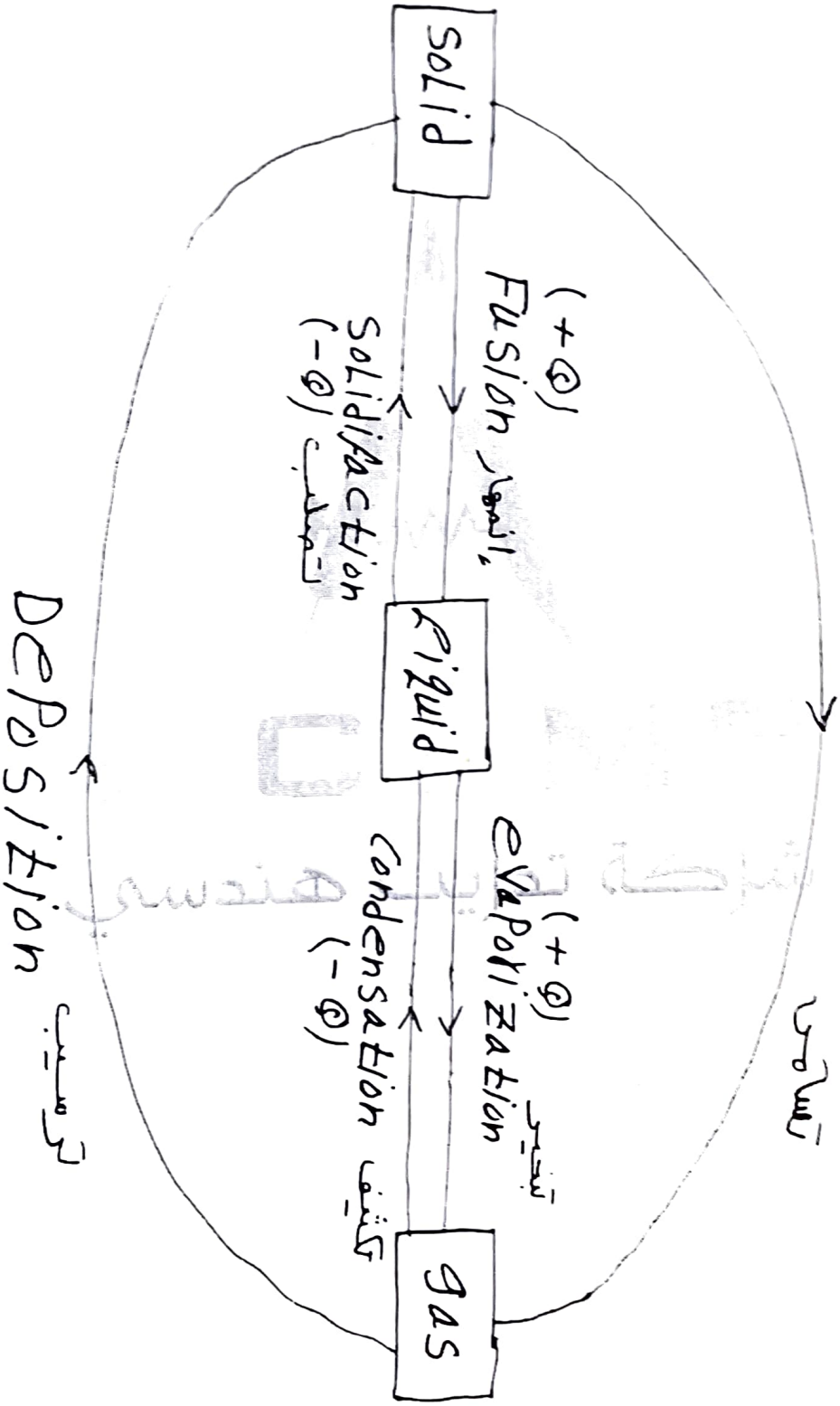
$$\therefore T_1 = \frac{5}{9}(36.5-32) = 2.5^{\circ}C$$

$$T_2 = \frac{5}{9}(98.6-32) = 37^{\circ}C$$

$$Q = mc\Delta T = (1kg)(4186)(37-2.5)$$

$$= 144417 = \boxed{34500\ cal} = \boxed{34.5\ Cal}$$

Notes


Solid
Liquid
Gas
(+Q) Fusion انصهار
Solidification تصلب (-Q)
(+Q) evaporization تبخير
condensation تكثيف (-Q)
sublimation تسامي
Deposition ترسيب