Ch1 - I

26/12/22

* Biochemical process could carry bo's of biochemical reactions, it could be done spontaniously (without any input energy)

A ⇌ B ⇒ Reaction

If could happen as a pathway

If it happen inside a biological cell we call it biochemical reaction

ex → unfolded protein → folded protein

- Thermodynamics will tell us if the reaction done spontaniously or not.

Thermodynamics → study of energy & it's effect on matter

1. classical : macroscopic large scale changes

2. statistical

system → sth we are trying to study

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* System surrounding → Everything else in the universe

System → A specific matter within a defined space

- When I defined a system we are studying if the matter exchange or take or release energy

There are different kinds of energy such as activation energy (need for the reaction to start)

→ we focus on chemical potential energy (inside the bonds)

* System → 1. open : exchange matter & energy

2. closed : only energy

3. Isolated : doesn't exchange matter energy or matter

- human body is example of open system
- not all energy could be extracted or used by us

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* Internal energy → stored in matter
  - every system
  → stored at different levels (ex atom, bonds)

- we can change the internal energy

X Some of the kinetic energy is →
1. Translational Energy → move from one place to another

2. Rotational → rotate

3. vibrational
   ↓
   vibrate

— we can only measure ΔU $(U_f - U_i)$

* work & heat they aren't energy, they are ways of transfering energy

Heat
=
↓
It could be transferred only if there is different in temp.

temperature
=
↓
Average of kinetic energy of a matter

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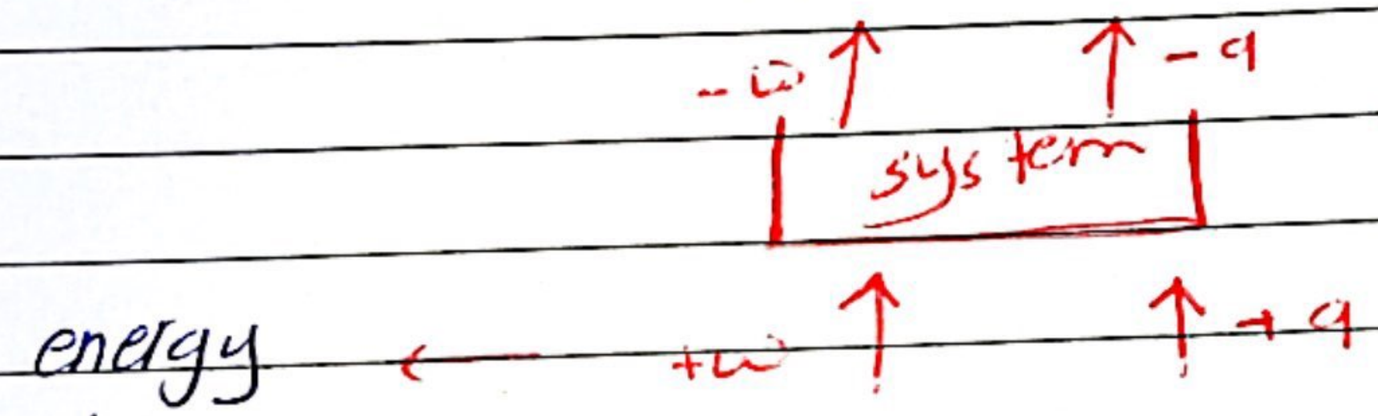
* $\Delta U = q + w = Uf - Ui$

q involve random movement of particles
- different directions -
- non-uniform -

w involve non-random movement of particles
- the same direction -
- uniform -

• system can do work on the surronding & the surronding can do work on the system •



1st law of thyrmo

↳ Energy is conserved, could be changed from one form to another but it can't be created or destryed

• Total energy of the universe is constant

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* Energy is conserved

↳ $\Delta E_{uni} = 0$

($\Delta E_{system} + \Delta E_{surr}$)

- $\Delta U = q + w$

Internal Energy

- work → Gas expansion
  → Electrical

* صلاايد رقم 1. ← — — —

عندي slender نعمل عليه ضغط عشان يأكيد volume تبع system ثابت

$A + B \rightleftharpoons C_{(g)} + D_{(g)}$ (change)

U_i → U_f

↓

الغاز الناتج عكسه يدفع piston لفوق ولو صار هيك عملية ما كانت ثابتة معناته system تبعي لعمل work على surronding

* work → Force to displace to a certain distance

وصلي شغل work as

$w = -P_{ex} \underline{V}$ → volume ΔV

✓ pressure

$\Delta V = q - (w)$ → Expansion work الشغل بكون

↳ $-p\Delta V$

* Most Biochemical reactions happen at constant pressure

* Most Biochemical they don't result in the increase of the volume

لو ظلت ثابتة بدي يعني

* P & temperature doesn't cause dramatic change in volume in our body

* Biochemical process → undergo a change, they might receive or emet heest, lose or gain energy as heat.

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ΔH [Exothermic — lose (-ΔH, -ql)
     Endothermic — Gain energy or heat

ΔG [Endergonic
     Exergonic

1 law → change in energy
سبب طاقة فكرة اذا تغير يكون
spon. in forward direction
تلقائي باتجاه

Note → some isothermal Constant
ΔH في تغير

Going to randomles
عشوائية

2 law
↓
change of Entropy.
ΔS of the universe is always increasing

$\Delta S_{uni} = \Delta S_{sys} + \Delta S_{surr}$

↓

$\Delta S^{f}_{sys} - \Delta S^{i}_{sys}$

* Most nature process is irreversible

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* لو رجع كالتوا الاولانية بس كنا ــــبب ا work مهم
يعتبر irreversible

$-\Delta S = zero$ for the system

$state_1 \xrightarrow{+\Delta S} state_2 \xrightarrow{-\Delta S} state_1$

$\Delta S_{sys} = k \ln W$

k → ثابت

W → عدد الطرق اللي اكسر فيها Molecules arrange و energy

arrange → عشوائيه

لما زادت قيمة W كان مبليء معناته More Random و spon. هتكون

* heat cause random motion of molecule

* work cause uniform motion of molecule

$\Delta S \propto q$

$\Delta S \propto \frac{1}{T}$

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* $T = 25^\circ$ ⟶ less kinatic molecule

* $T = 85^\circ$ ⟶ More kinatic molecule

$S_{85} > S_{25}$

لو بدي زيد S لمحيط system
provide them with
the same -q-
بدون تغيير
S25 More random S85

$$\Delta S > \frac{q}{T}$$

$$\Delta S > \frac{q_p}{T} \quad \Delta H = q_p \quad \times T$$

$$T\Delta S \geq \Delta H$$

$$0 \geq \boxed{\Delta H - T\Delta S} \rightarrow \Delta G$$

* ΔS ⟶ we will focus on breaking & making bonds

- Released energy from making bond must be higher than the energy of Broken
بدي ايها span.

Biochemical reaction
شغلتنا بالـ
Breaking
وعي بأعمل
Making
Bond

$A_{(s)} + B_{(s)} \rightleftharpoons C_{(g)} + D_{(g)}$

↓

$-\Delta H$

$+\Delta S$

$AB \rightarrow A + B$

↓

breaking بدو بس
يستلزم A مثلاً تفاعل
bond مع H_2O

* ΔG → stability

↓

بخبرنا إذا reaction
spon. أو لا

- if $G_f < G_i$
spon. بكون

* كيف stability الها دخل بـ Random ؟

مثال p.p Random للتحول لـ protein

ΔS of poly is less than the ...

Energy

Extra points +2

1- kenetic energy :-
the energy that come from motion

2. potential energy :-

Is the energy an object held it because of it's position relative to other objects

* work → + : work done on the system
→ - : work done by the system

* heat (q) → + : endothermic
زي تفاعلات endo تحتاج لطاقة فتبادها melting ice زي مثلا

→ - : exothermic
زي Freeze ice هاي لتفاعلات تعطي طاقة لل surr. فتبادي لطاقة عندما تنقص فتبادي سالبة
water becomes a solid
it releases heat warming up it's surro.

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* Exoorgnic → $-\Delta G$: spon.

* Endo orgnic → $+\Delta G$: non-spon.

* Spon. → $+\Delta S$
  → $-\Delta H$

* state function → ما تعتمد على المسار
بس على البداية والنهاية

* لو جبنا قنينة مي وحطيناها بالفريزر شو صار بالإشارات

q ← - لأنها فقدت حرارة
w ← - لأنها بذلت شغل للتمدد

لو كان سائل ثاني بدال المي شو بتكون الإشارة للـ w ؟ +

* Gibbs free energy → Amount of energy could be released

A → B

$\Delta G < 0$ span. in forward

$\Delta G > 0$ span. from B → A

$\Delta G = 0$ equilibrium

4 properties

↳

1.. $-\Delta H$ $+\Delta S$ ∴ span. in any degree of temperature

2.. $+\Delta H$ $-\Delta S$ ∴ non span. in all time

3.. $-\Delta H$ $-\Delta S$ ∴ span. at low temperature such as freeze water

4.. $+\Delta H$ $+\Delta S$ ∴ span. at high temperature such as melting ice

kinetics	thermo
• $\Delta G^{\ddagger}$ -activation energy-	• ΔG - Gibbs-
• we measure the speed of reaction - if the reaction happen quickly or slowly -	• we conclude if the reaction happen or not - stability -

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- Many of reactions happen inside our body at equilibrium, which mean $\Delta G = 0$

- Keq يقيسها لكل من conc. of products & reactants

$$A + B \rightleftharpoons C + D$$

بعد ميبلش Reaction بوقت بيصير
both reactions in both directions will happen at the same rate
وقتها Reaction بيوصل equilibrium $\Delta G = 0$

Most Reactions reach equilibrium

* بقدر أستعمل Keq لنعرف ΔH° و ΔS°
كيف أعمل هيك ؟

different temp. عند

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* Internal energy يزيد system الـ تبعا
بكمية شغل
Transfer q, w to the system

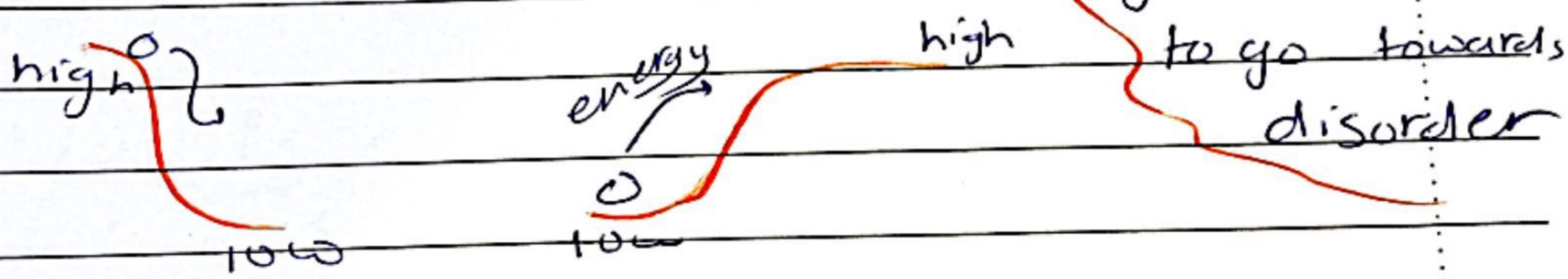
* Total energy in the isolated system can't be changed

- q = + (absorb) endothermic
- q = - (release) exo thermic

2- law

hot spon. → cold
X ←

ΔS > 0



Natural system tend to go towards disorder

* reason why natural spon. processes tend to go in an direction of ↑entropy, because nature tends to seek out the state that is more likely to occur (disorganized state has a higher probality of a current than an organized state)

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✗ The probability of disorganized state to occur increases with the number of molecules

only
↳ A → B spon. $\Delta S_{un} = +$
A ⇌ B equili. $\Delta S_{un} =$
A ← B nonspon $\Delta S_{un} = -$

ΔS_{un}	$=$ ΔS_{sys}	$+$ ΔS_{surr}	spon
+	+	+	Yes
		−	No
−	−		
+ $\lvert\Delta S_{sys}\rvert > \lvert\Delta S_{surr}\rvert$	+	−	Yes
+ $\lvert\Delta S_{surr}\rvert > \lvert\Delta S_{sys}\rvert$	−	+	No

* Identify each statment as T or F for a system undergoing an exothermic spon. process →

1 Entropy of the system increases F
2 " " " surr. " T
3 " " " uni " T
4 " " " system decreases T
5 " " " surr. " F

heat flow ↳ into the system DS_{sys} increases
↳ out the system DS_{sys} decreases

• عشان أصدر إذا DS يزيد أو يقل بدنا أحدد إتجاه

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* Gibbs free energy →

- 0 < k < 1 Reactant favor - k = + 10^(-)

ΔG = + ΔG > 0 non spon.

ΔG = 0 Equil. k = 1

ΔG = - ΔG < 0 spon.

- k > 1 product favor
- k = + 10^(+)

$W_{max} = \Delta G$
spon.

* a reaction proceeds spon. when it could lower it's energy. In fact a natural spon. process will occur in such a way to find the lowest possible energy state

& so we can see that when a change in free energy is negative it's usually associated with spon. process

- The change in enthalpy & entropy for a certain reaction are −46.5 kJ/mol & 212 J/mol·K. calculate the change in free energy at 25 c. Is the reaction spon. nonspon., or at equilibrium ?

J → kJ
÷1000

HcL ΔH = −92

HcL وبالعادة كانت

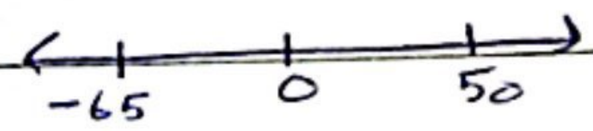
اضرب العدد

بمولات

* The standard free energy change for a reaction under certain conditions is -65 kJ/mol. At this instant which of the following events will occur?

$A \rightleftharpoons B$ $\quad \Delta G = -$ spon.

$\Delta G = -65 \longrightarrow P\uparrow R\downarrow$ $\quad \Delta G = 0$



A The free energy change will increase as reaction shifts to left

✓B " " " " " " " " to right

C " " " " decrease " " " to left

D " " " " " " " to right

E " " " " will remain the same since the reaction is equilibrium

	ΔH	ΔS	T	ΔG
	+	+	high	−
K ↓ ratio of products to Reactants	−	−	low	−
	−	+	all	−
	+	−	all	+

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