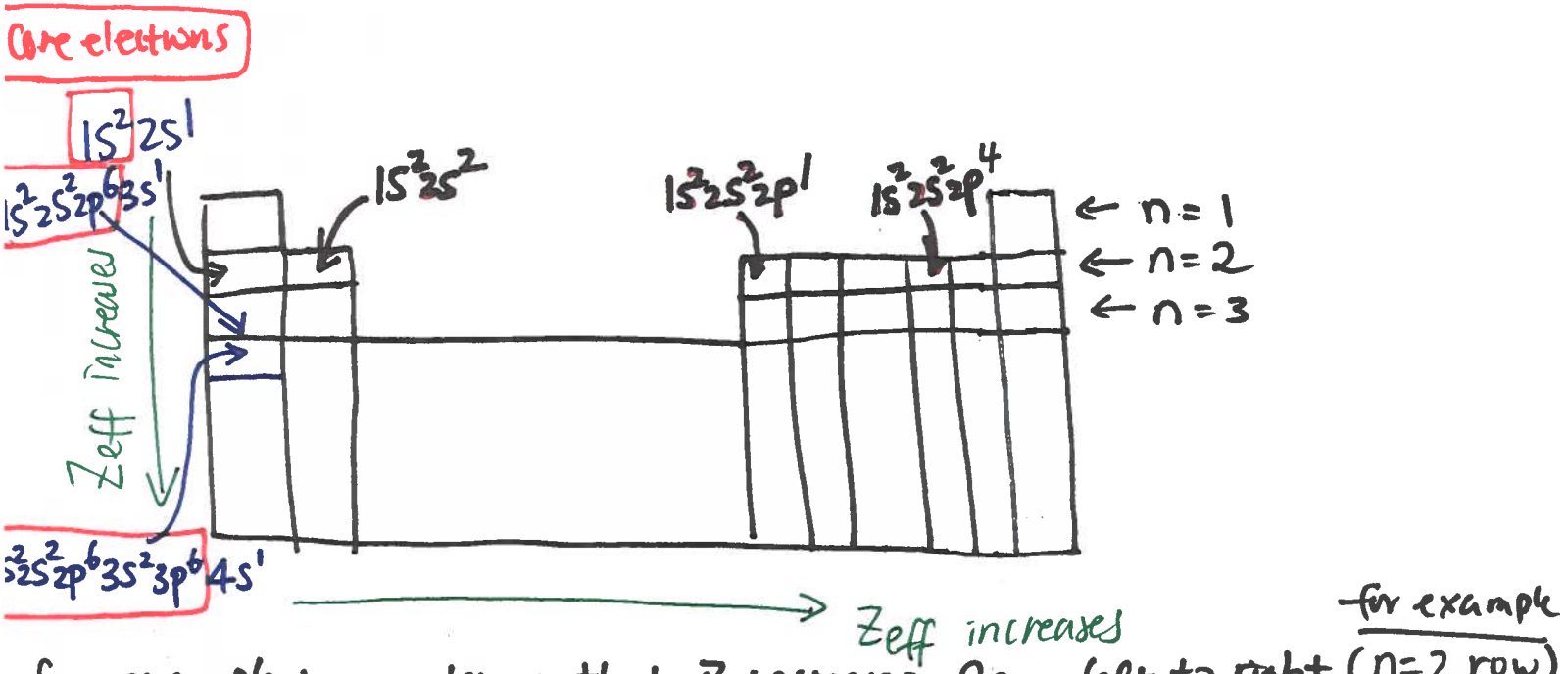
Effective nuclear charge (Z_{eff})

Shield the most

1. **Core electrons** screen nuclear charge
2. Valence electrons partially screen each other from nuclear charge



for example: we know that Z increases from left to right (n=2 row)

Consider elements in n=2. electronic configurations of some elements in period 2 are shown.

- They all have the same # of core electrons. (2) therefore, these 2 core electrons will screen the nuclear charge the most.
- these elements differ in their # of valence electrons. the valence electrons partially screen the nuclear charge as well. But not to the same extent as the core electrons. ∴ ΔZ_{eff} increase is big from left to right across the period.

Now consider the Z_{eff} increase down a group.
for example: group 1 elements. (electronic configurations of some elements are shown. the core electrons are boxed in red for convenience)

Z increases down a group
At the same time, # of core electrons also increases.
But valence electrons stay constant.

So,
as the # of core electrons increases down a particular group, we have more shielding. But, this shielding won't screen 100% of the nuclear charge. because Z also increases down a group.

∴ The ΔZ_{eff} down a group is not as large compared to the ΔZ_{eff} across a period. But Z_{eff} is still increasing down a certain group.

Ionization energy.

$$X(g) \longrightarrow X^+(g) + e^-$$

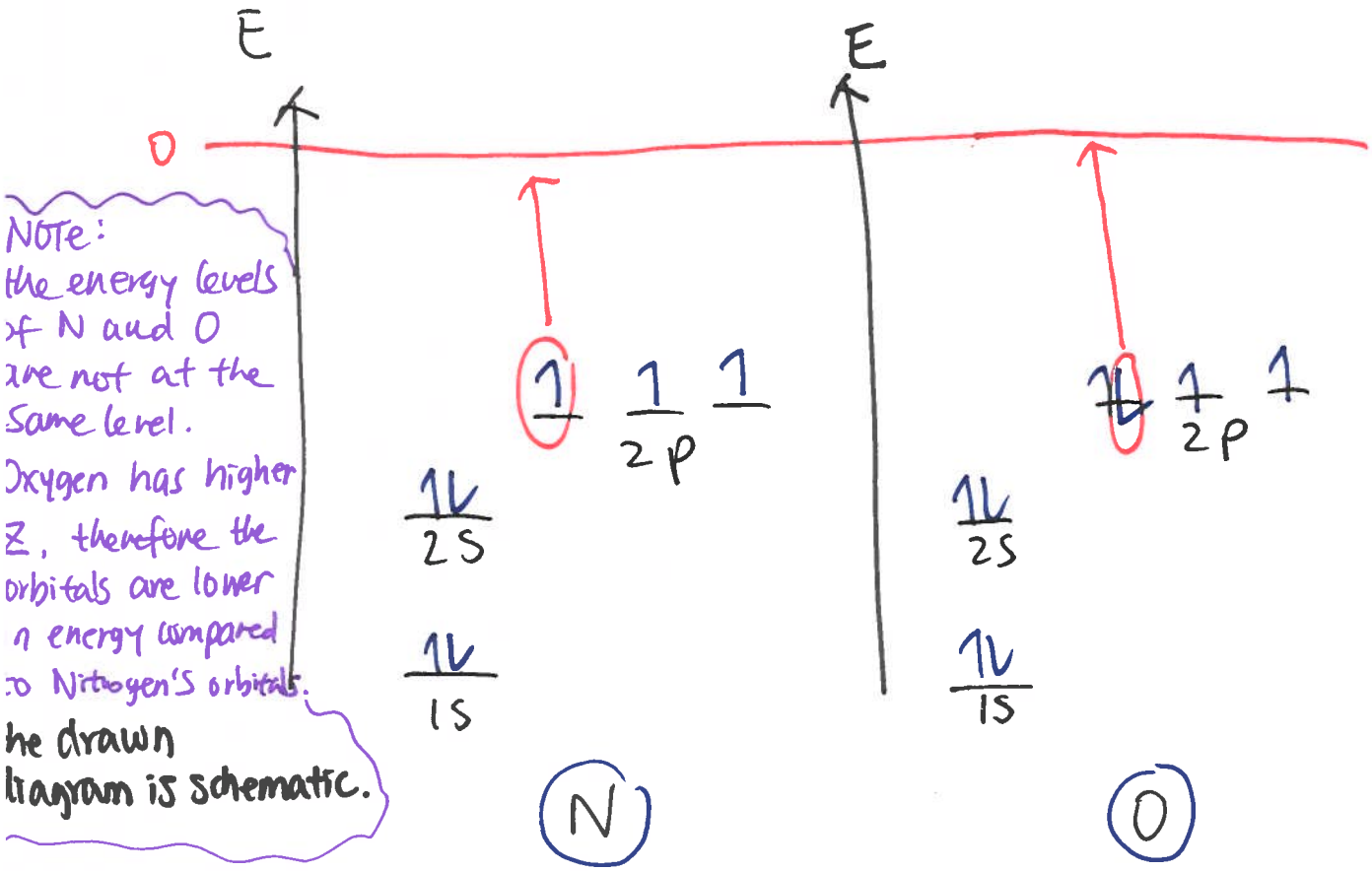
1st IE_1: $X(g) \longrightarrow X^+(g) + e^-$

2nd IE_2: $X^+(g) \longrightarrow X^{2+}(g) + e^-$

3rd IE_3: $X^{2+}(g) \longrightarrow X^{3+}(g) + e^-$

⋮

- the exceptions of Ionization energy trend (from plot)



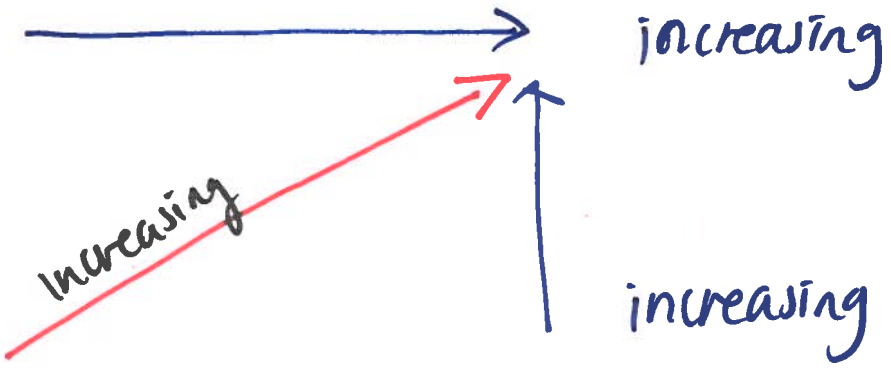
NOTE:
the energy levels of N and O are not at the same level.
Oxygen has higher Z, therefore the orbitals are lower in energy compared to Nitrogen's orbitals.
The drawn diagram is schematic.

more electronegative

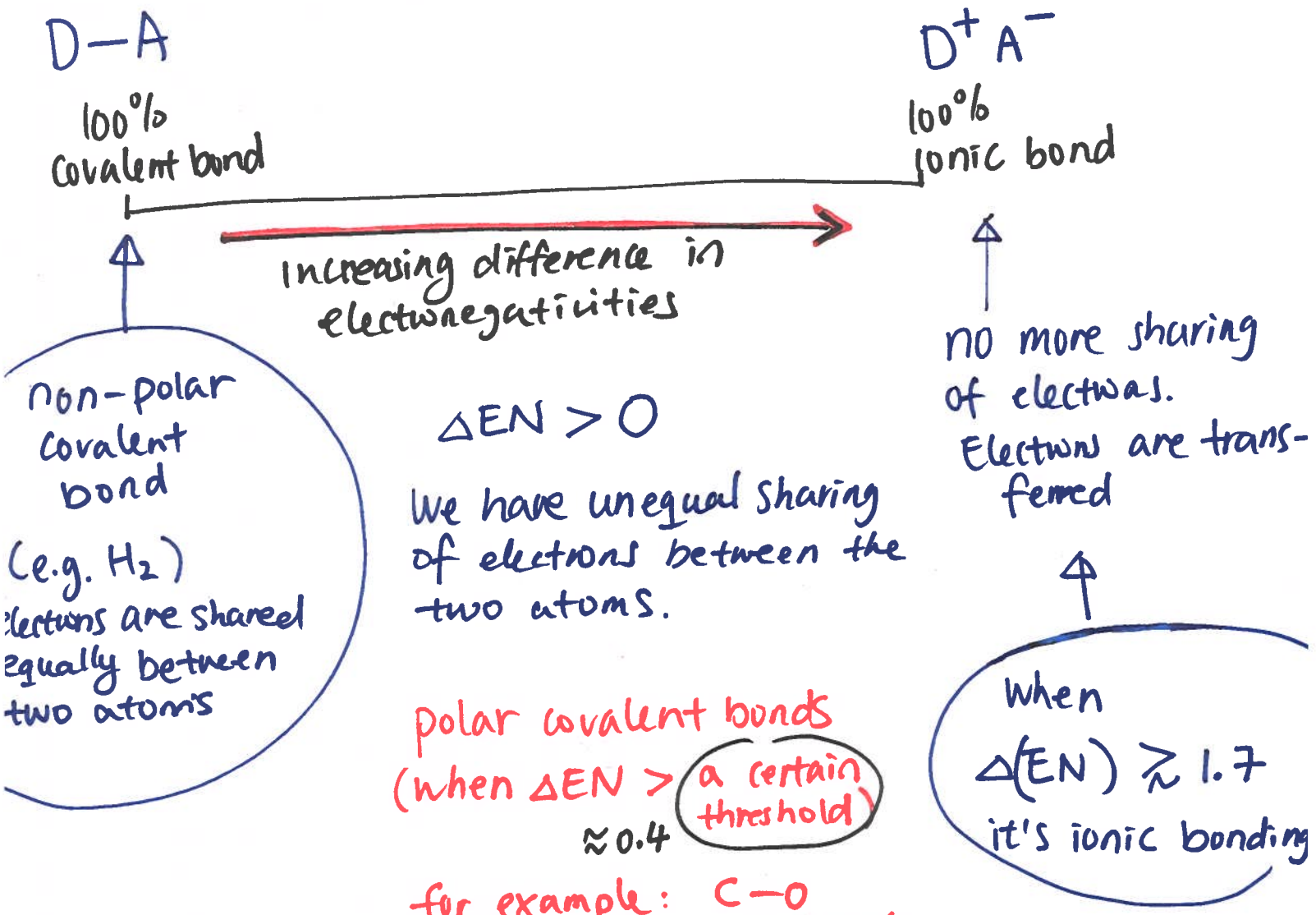
less electronegative

$$F > O > Cl > N$$

$$Br > I > S > C > H$$

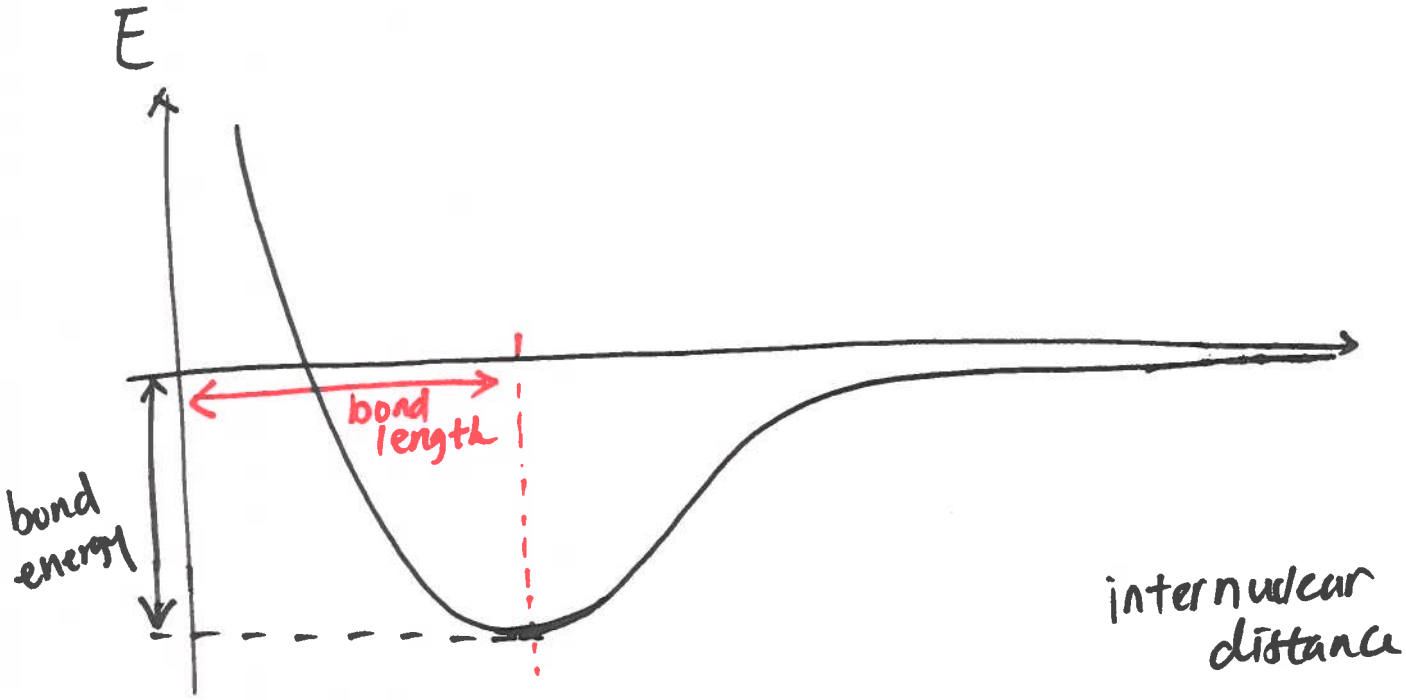


Electronegativity trend.



But. C–H is still considered non-polar because the ΔEN is small.

Δ(EN) is 0.35 for C–H bond
(check electronegativity value table)


E
bond length
bond energy
internuclear distance