FACAUT Nastasia

Scan6 1

I.E of Chemistry

15,75

ex. I

1) For Al: Z = 13, 13th group and 3rd period
For In: Z = 49, 13th group and 5th period
For Tl: Z = ~~81~~, 13th group and 6th period

2) They belong to the "p" block, and they are ~~all~~ metallic elements.
They are ordered by increasing radius like this:
$r_B < r_{Al} < r_{Ga} < r_{In} < r_{Tl}$

3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
It possesses 3 valence electrons.

4) a) $\sigma = 2 \times 0,35 + 8 \times 0,85 + 2 \times 1 = 9,5$
$Z^*_4 = 13 - 9,5 = 3,5$

b) Al^+ has one electron less on its valence shell than Al, hence:
$\sigma = 0,35 + 8 \times 0,85 + 2 = 9,15$
$Z^* = 13 - 9,15 = 3,85$

5) $E(Al)_{3p} = -13,6 \times \frac{Z^*_{3p}}{n^2} = -13,6 \times \frac{(3,5)^2}{3^2} = -18,5$ eV

$E(Al^+)_{3_1} = -13,6 \times \frac{Z^{*2}}{n^2} = -13,6 \times \frac{3,85^2}{3^2} = -22,4$ eV

1

$$E_{i_4} = 3 \times E(Al)_{3s} - 2E(Al^+)_{4} = 3 \times 18,5 - 3(-22,4) = 40,7 \text{ eV}$$

($3s$ → 3, 4 → 2)

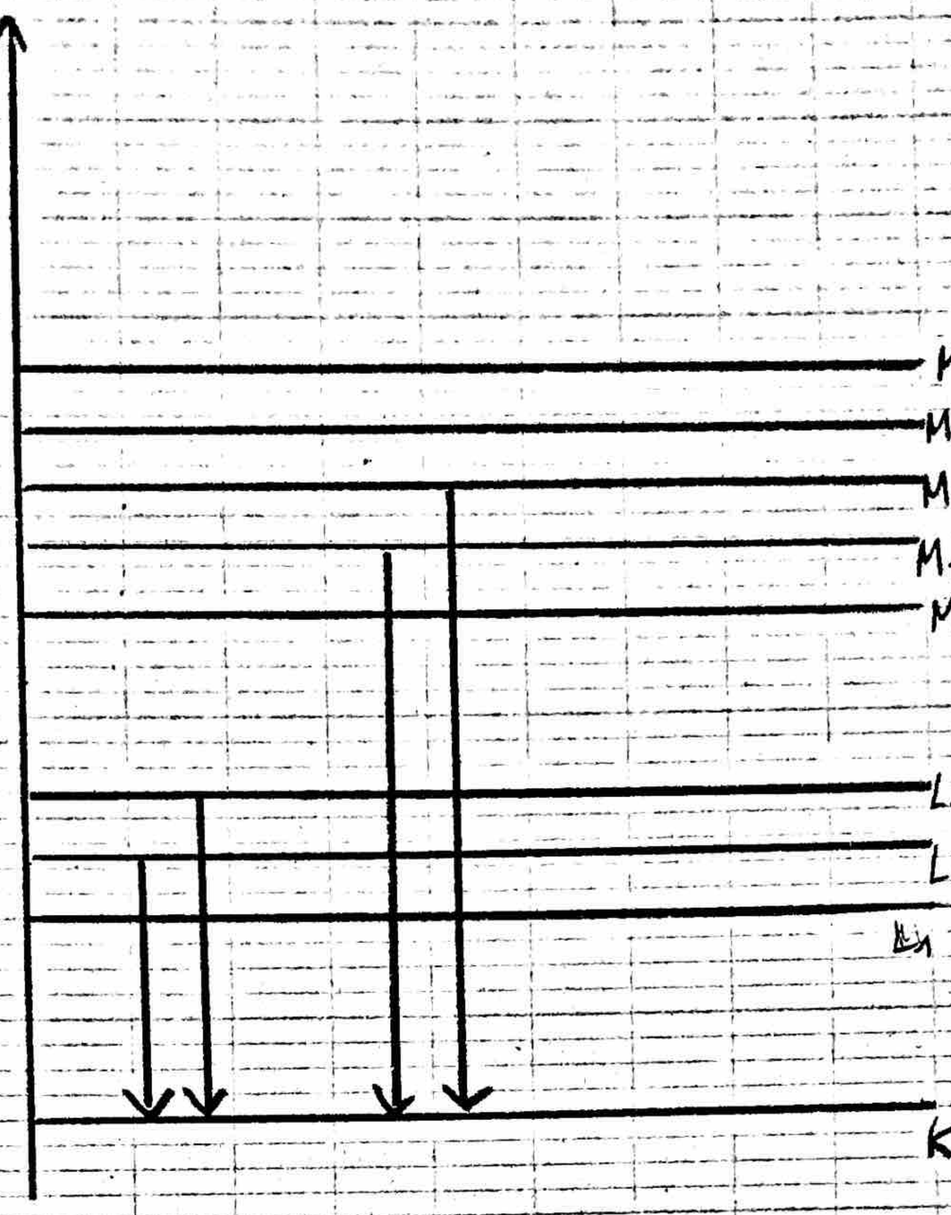
6) The value we obtained is ~~about~~ 56 % higher than the experimental one, hence there must be a problem either in the calculations or in the experiment ?

7) The fact that the 3rd and 4th ionization energies are very different is ~~cause~~ because for the 4th ionization energy, an electron from the $2p^6$ subshell is extracted, and this ~~shell~~ is saturated, hence more energy is required. While for the 3rd ionization energy, an electron from $3s^1$ is extracted, wich requires less energy.

ex. IV

ex III

A) 1)



n	l	j
3	2	5/2
3	2	3/2
3	1	3/2
3	1	1/2
3	0	1/2
2	1	3/2
2	1	1/2
2	0	1/2
1	0	1/2

↓ : possible transitions ($\Delta l = \pm 1$ $\Delta j = 0$ or $\pm 1/2$)

1

For Cr :

Data $E_K = 12400$ $E_{K-L_2} = E_K - E_{L_2} = 5989 - 583,8 = 5405,2$ eV

$$\lambda_{K-L_2} = \frac{12400}{5405,2} = 2,2941 \text{ Å}$$

$$E_{K-L_3} = 5989 - E_{L_3} = 5989 - 574,1 = 5414,9 \text{ eV}$$

$$\lambda_{K-L_3} = \frac{12400}{E_{K-L_3}} = \frac{12400}{5414,9} = 2,2899 \text{ Å}$$

$$\lambda_{K-L_{2,3}} = \frac{(\lambda_{K-L_2} + \lambda_{K-L_3})}{2} = \frac{2,2941 + 2,2899}{2}$$

$$= 2,292 \text{ Å}$$

0,75

For Co

$$E_{K-L_2} = E_K - E_{L_2} = 7709 - 793,2 = 6915,8 \text{ eV}$$

$$\lambda_{K-L_2} = \frac{12400}{6915,8} = 1,7930 \text{ Å}$$

0,75

$E_{K-L_3} = E_K - E_{L_3} = 7709 - 778,1 = 6930,9 \text{ eV}$

$\lambda_{K-L_3} = \frac{12400}{6930,9} = 1,7891 \text{ Å}$

$\lambda_{K-L_{2,3}} = \frac{\lambda_{K-L_2} + \lambda_{K-L_3}}{2} = \frac{1,7891 + 1,7930}{2} = \underline{1,7910 \text{ Å}}$

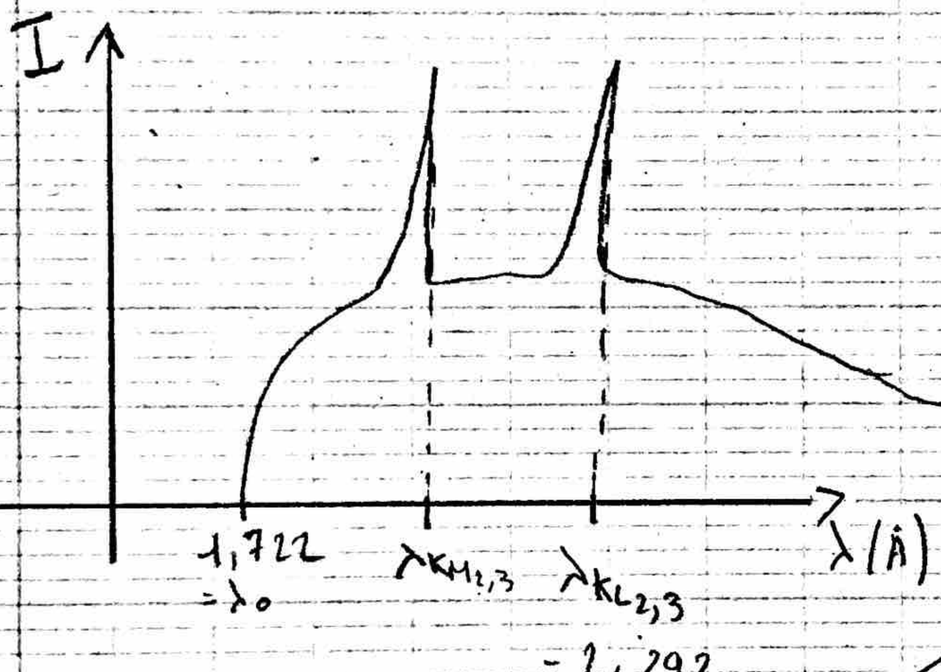
0,25

2) $\lambda_0 = \frac{12400}{7200} = 1,722 \text{ Å}$

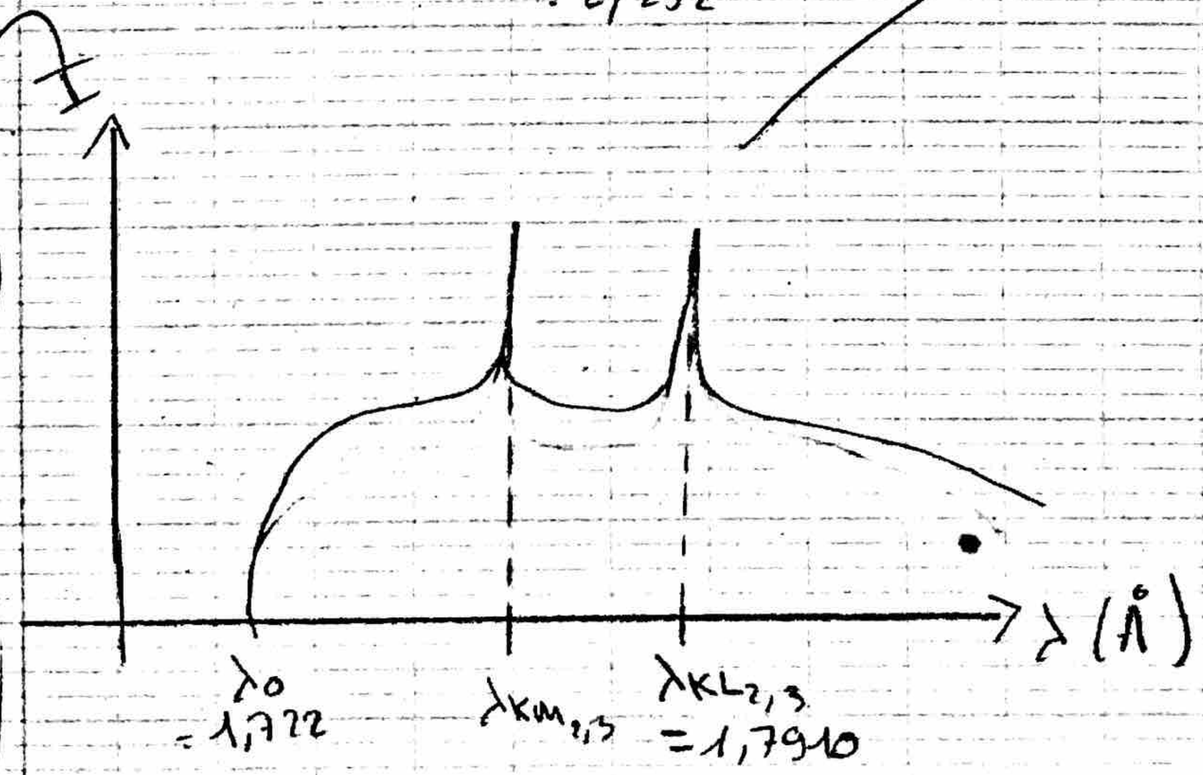
since $\lambda \gg \frac{hc}{eU}$

For Cu :

0,5

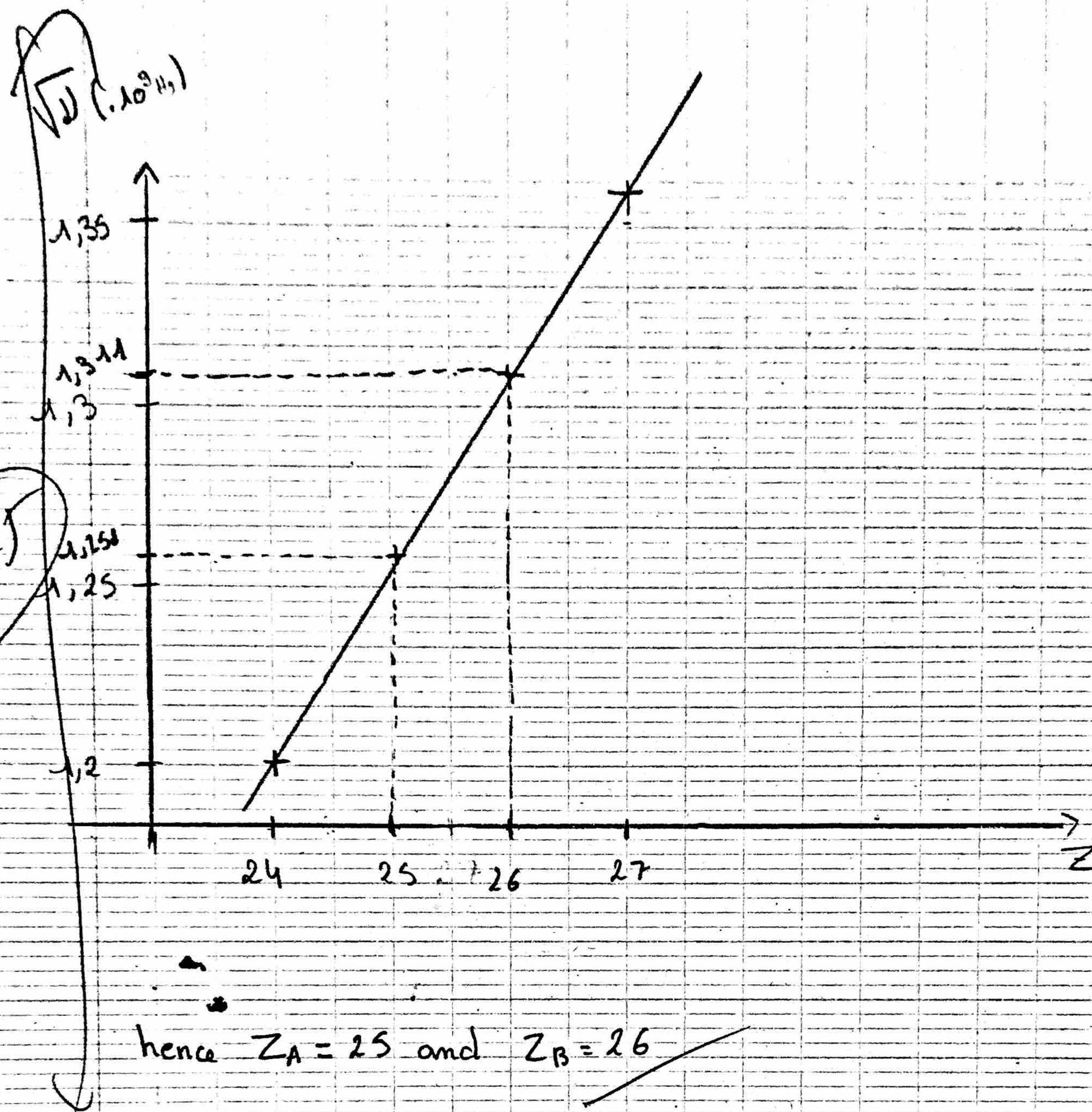


0,5



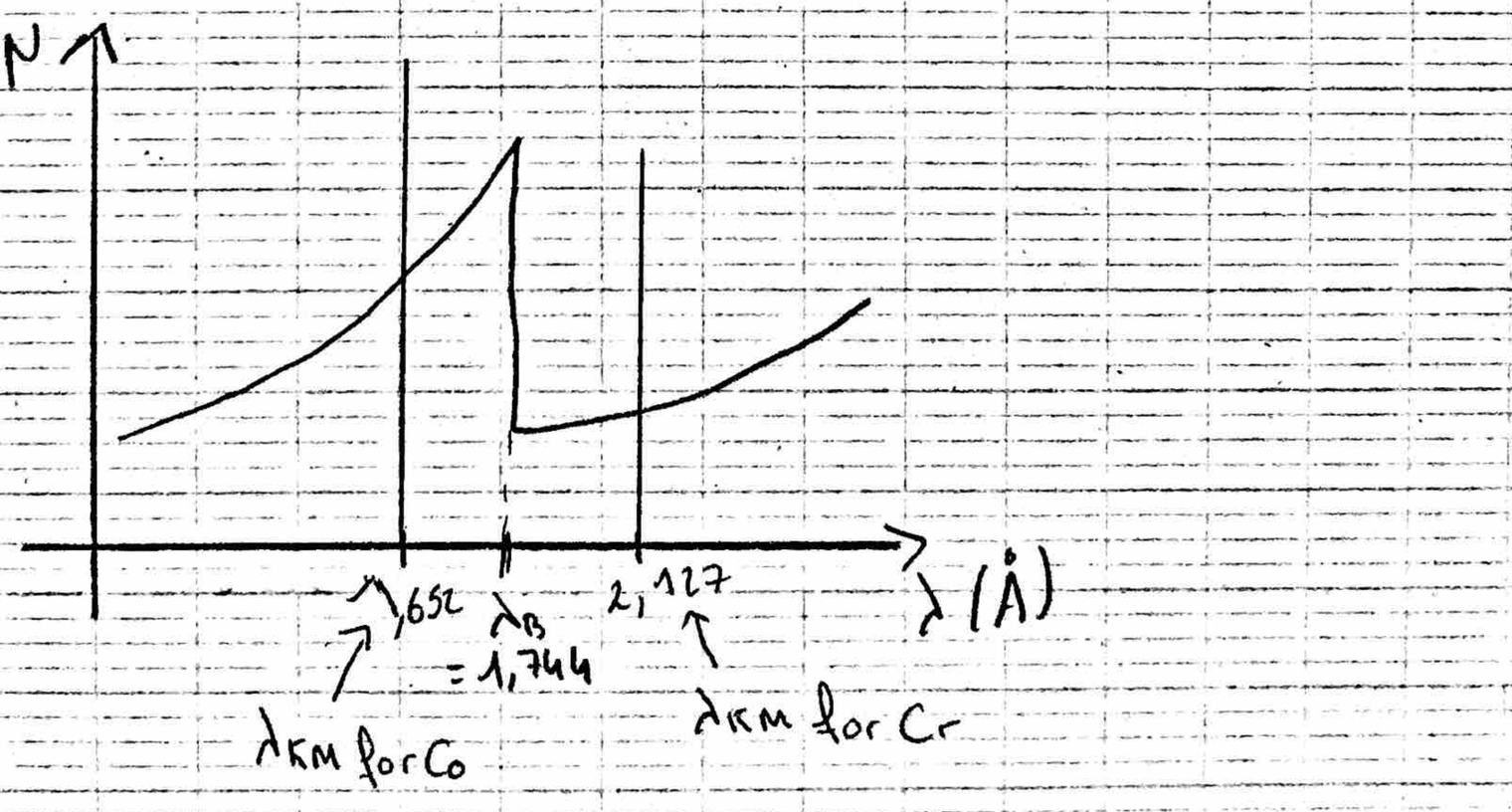
The continuous background that we can see on these spectras is the ~~enoco~~ Xrays emitted by the incoming electrons when they are slowed down ~~e~~ when approching the anticathode.

The two characteristic lines that we see correspond to



hence $Z_A = 25$ and $Z_B = 26$

d)



We can see that λ_{KM} for Co is in the Fe part of the graph with the highest absorption, hence of this ray will be removed by filter B.
However λ_{KM} for Cr is after the absorption drop, hence B cannot be used as a filter for the λ_{KM} ray of Cr.

ex. II

1) Each isotope's nucleus has the same composition, wich is 17 protons and ~~17~~ neutrons.

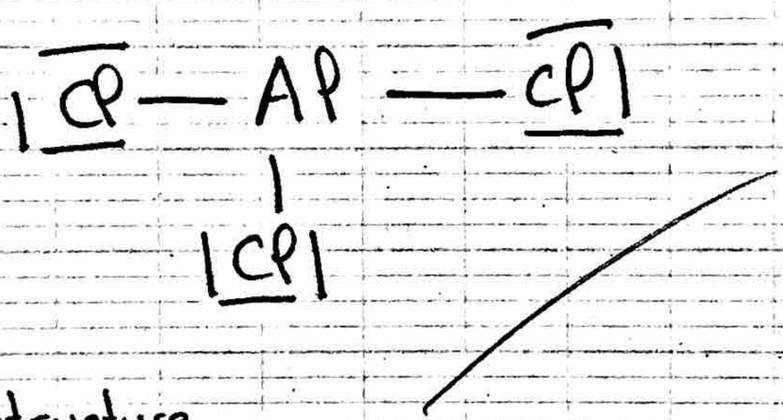
3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

It belong ~~to~~ to the 17th group (halogens).

4) a) Al: 3 valence electrons → $\cdot\dot{Al}\cdot$

Cl: 7 valence electrons → $|\dot{\underline{Cl}}|$

$AlCl_3$:



lewis structure

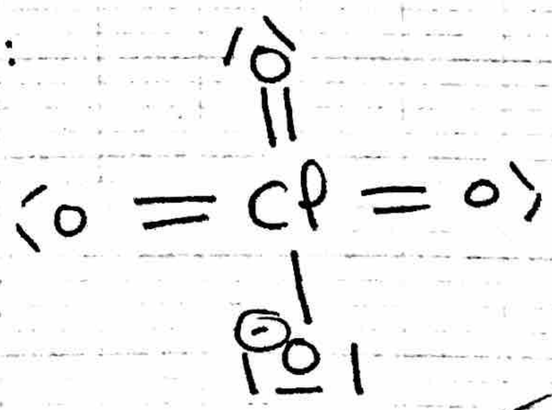
VSEPR theory: AX_3

hence $AlCl_3$ has a ~~pyramidal~~ structure and the angles betwee the Cl atoms are the same (120°).

b) In this molecule the Al will ~~complete~~ the octet rule with the electrons from the Cl atoms, (3 of them) otherwise the Al atom himself doesn't verify the octet rule.

5) a) O: $1s^2\ 2s^2\ 2p^4$ → $\cdot\ddot{\underline{O}}|$

lewis formula:



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0,5

the internal transitions (from level L to level K and from level M to level K).

3) a) For Cu

$E_{L_1-M} = E_{L_1} - E_M = \frac{12400}{23,10} = 536,8$ eV

hence $E_{L_1} - E_M = 536,8$ eV

$E_M = E_{L_1} - 536,8 = 459,2$ eV

$E_{K-M} = E_K - E_M = 5989 - 159,2 = \cancel{5828,8\text{eV}}$ 5830 eV

1,5

For Co

$E_{L_1-M} = E_{L_1} - E_M = \frac{12400}{17,13} = 723,9$ eV

hence $E_M = E_{L_1} - 723,9 = 929,1 - 723,9 = 201,2$ eV

$E_{K-M} = 7709 - 201,2 = 7508$ eV

b) For Cr $\lambda_{K-M} = \frac{12400}{E_{K-M}} = \frac{12400}{5830} = 2,127$ Å

For Co $\lambda_{KM} = \frac{12400}{7508} = 1,652$ Å

B 4) a) $\frac{I_{K-L}}{I_{K-M}} = \frac{I_{0\,KL} \times \exp(-\mu_{KL} \times 0,20)}{I_{0\,K-M} \times \exp(-\mu_{KM} \times 0,20)}$

$= \frac{7,4 I_{0\,K-M} \times \exp(-1,870 \times 0,20)}{I_{0\,K-M} \times \exp(-1,430 \times 0,20)}$

$= 7,4 \times \frac{\exp(-0,374)}{\exp(-0,286)}$

$= 6,78$

0,5

hence $\frac{I_{K-L}}{I_{K-M}} = 6,78$

b) $I = I_0 \exp(-\mu X)$

hence $X = \frac{\ln(I/I_0)}{-\mu}$

0,5

if $I = 0,98\ I_0$ then $\frac{I}{I_0} = 0,98$

hence $X = \frac{\ln 0,98}{-1,870}$ ~~= 0,0101 cm~~

$= 0,0108\ cm = 108,0\ \mu m$

the maximum thickness of the window is 108,0 µm.

0,5

C 5) a) The discontinuity corresponds to the drop in absorbtion of the metal, it corresponds to the λ_K of the metal.

0,5

b)

c) To compute the atomic number of A and B we use Moseley's law.

We first compute $\sqrt{\nu}$ for the K levels of these metals:

$\nu = \frac{c}{\lambda}$

Z	Cr: 24	Co: 27	A: ?	B: ?
λ_K (Å)	2,070	1,608	1,896	1,744
ν (Hz)	$1,449 \cdot 10^{18}$	$1,866 \cdot 10^{18}$	$1,582 \cdot 10^{18}$	$1,720 \cdot 10^{18}$
$\sqrt{\nu}$	$1,204 \cdot 10^{9}$	$1,366 \cdot 10^{9}$	$1,258 \cdot 10^{9}$	$1,311 \cdot 10^{9}$

$\lambda_K = \frac{12400}{E_K}$ $\nu = \frac{c}{\lambda_K \text{ in meters}}$

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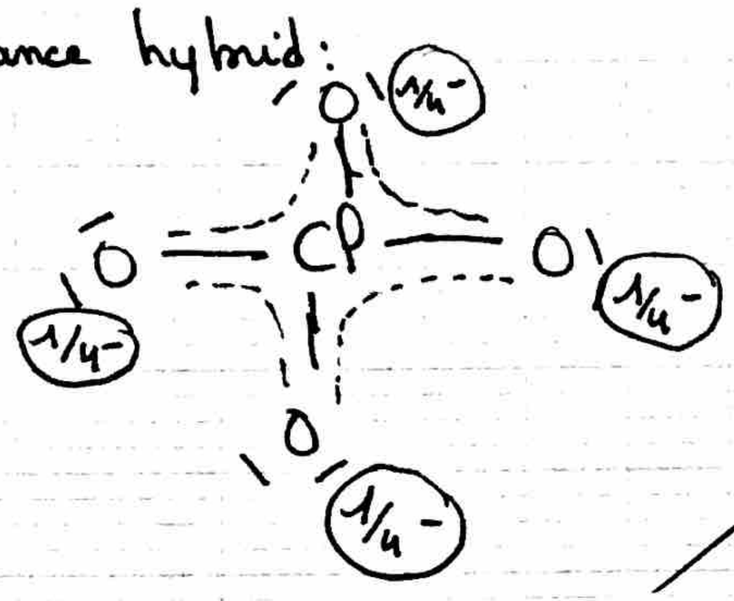
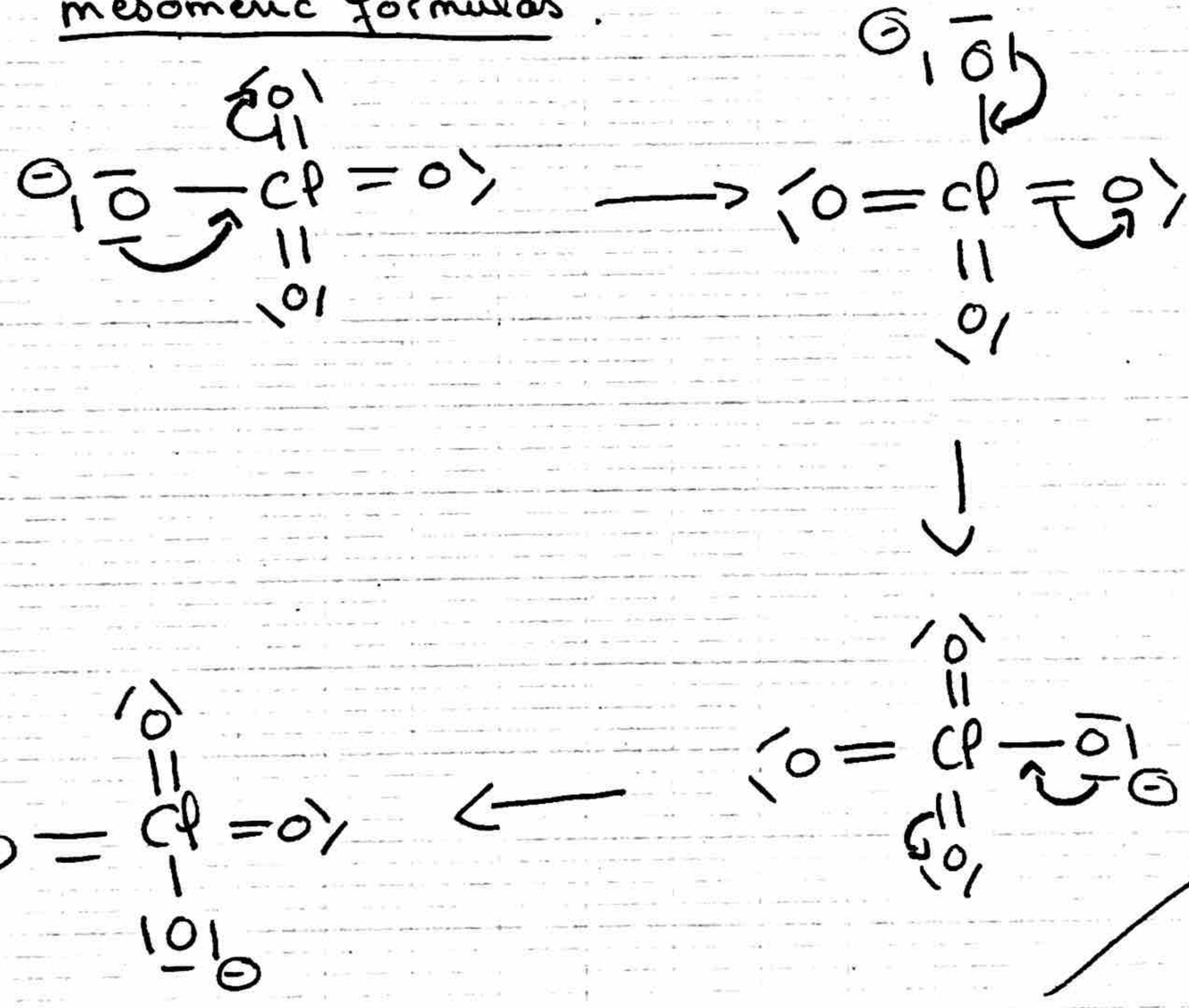
resonance hybrid:



mesomeric formulas:



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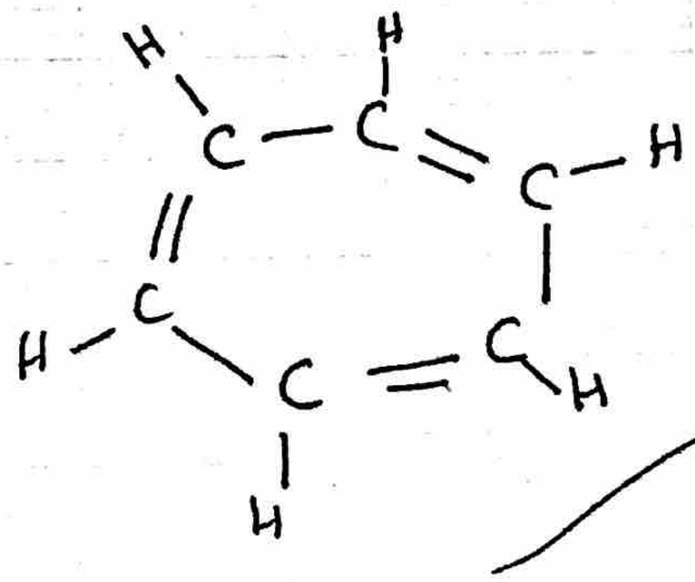
b) AX_4 → tetrahedral shape

1 bounding angle will be bigger than the other, around the single bond with one O atom.

6) a) The hybridization state of carbon atoms in benzene is sp^2



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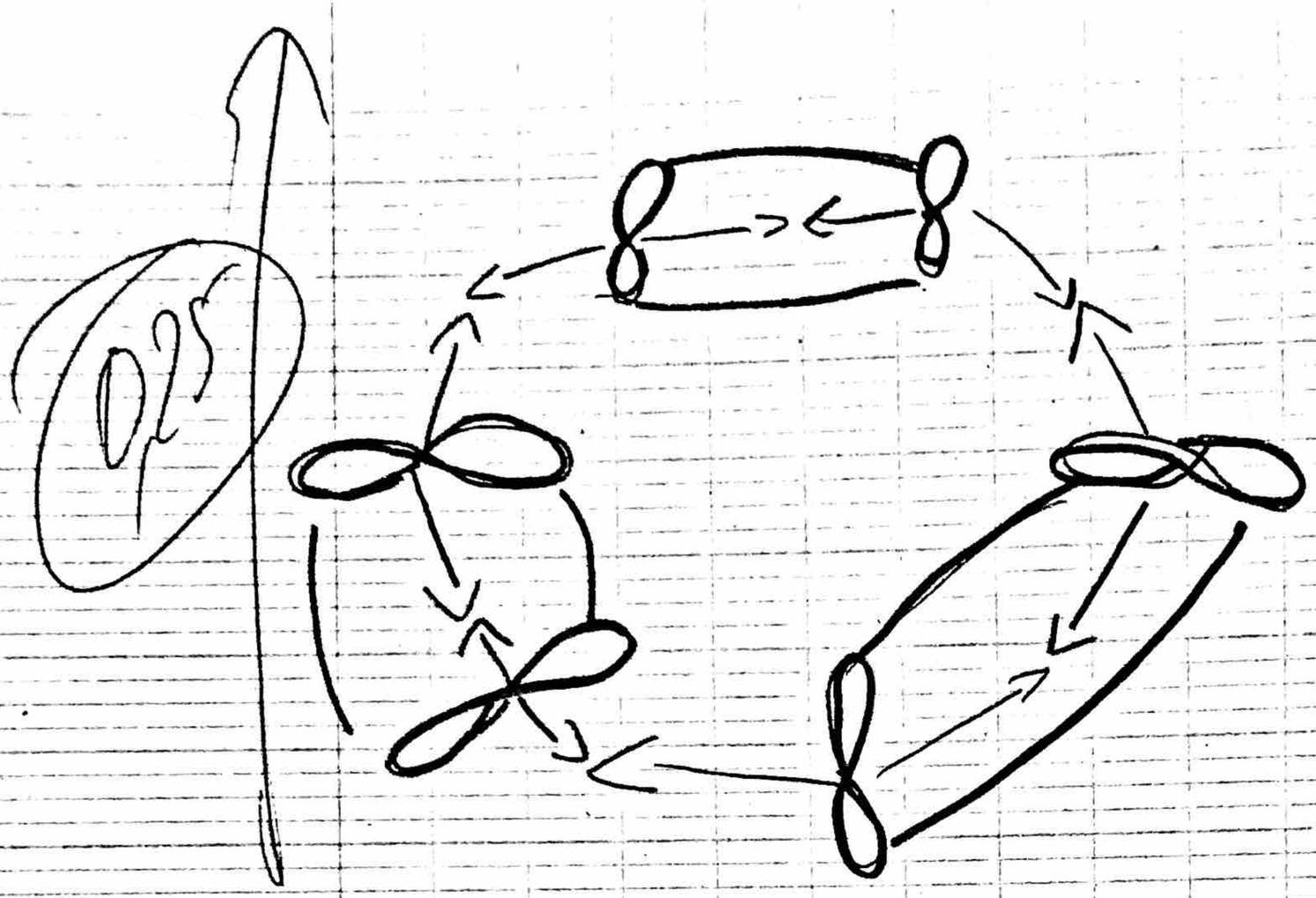
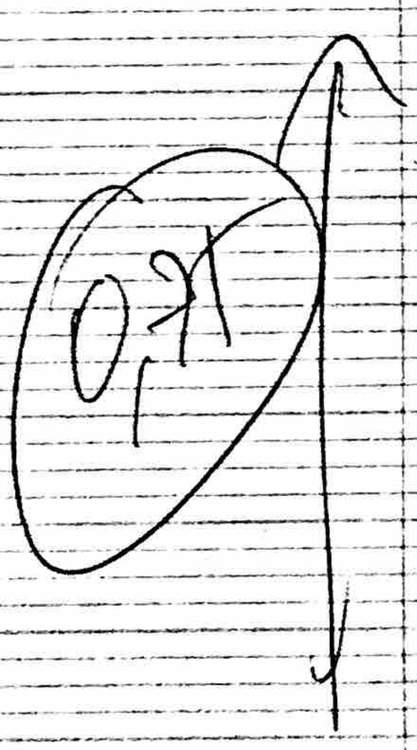


in red : π bonds

in grey (-><-) : σ bonds



b) b : π and σ bond (because double bond) but the σ bond has a π characteristic

a : σ bond (because the carbon has a sp^3 hybridization state).

orbitals used : ~~Carbon~~ 2s and 2p