The model correction for the exam (chemistry 1 - 2023/2024)

Exercise 1 3,00 pts

1 - The composition of the nucleus:

Isotope $^{63}_{29}Cu$: $A = 63$ (0,25) ; $Z = 29$ (0,25) , $N = 34$ (0,25)

Isotope $^{65}_{29}Cu$: $A = 65$ (0,25) ; $Z = 29$ (0,25) , $N = 36$ (0,25)

2 - Calculating percentages:

$$\begin{cases} \bar{M} = 63,54 = \dfrac{x \cdot 64,92 + y \cdot 62,92}{100} & 0,25 \\ x + y = 100 & 0,25 \end{cases}$$

$$\Rightarrow \begin{cases} x = 30,58\% & 0,25 \\ y = 69,42\% & 0,25 \end{cases} \Rightarrow \begin{matrix} ^{63}Cu : 69,42\% & 0,25 \\ ^{65}Cu : 30,58\% & 0,25 \end{matrix}$$

Exercise 2 3,25 pts

I) 1 - The atomic number:

$$\frac{1}{\lambda} = Z^2 R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad (0,25) \qquad n_2 > n_1$$

$$\frac{1}{\lambda} = Z^2 R_H \left(1 - \frac{1}{4}\right) \Rightarrow Z^2 = \frac{4}{3 \lambda R_H} \quad (0,25)$$

$$Z = \sqrt{\frac{4}{3 \cdot 75,75 \cdot 10^{-10} \cdot 1,1 \cdot 10^{7}}} = 4 \quad (0,25)$$

$\Rightarrow$ The ion expression is $_4X^{3+}$ (0,25)

2 - Calculating the energy:

$$\Delta E = \frac{hc}{\lambda} = \frac{6,62 \cdot 10^{-34} \cdot 3 \cdot 10^{8}}{75,75 \cdot 10^{-10}} = 0,2621 \cdot 10^{-16}\ J \;/\; 1,6 \cdot 10^{-19} \quad (0,25)$$

$$= 163,8\ eV \quad (0,25)$$

* Wave number

$$\bar{\nu} = \frac{1}{\lambda} = \frac{1}{75,75 \cdot 10^{-10}} = 13,2 \cdot 10^{7}\ m^{-1} \quad (0,25)\ (0,25)$$

$$E_{photon} = E_0 + E_c \quad 0,25$$

$$= E_0 + \frac{1}{2} m v^2$$

$$E_c = \left(h \cdot \frac{c}{\lambda} - E_0\right) \quad 0,25 \qquad / \; E_0 = 2\,eV = 3,2 \cdot 10^{-19}\,J \quad 0,25$$

$$E_c = \left(\frac{6,62 \cdot 10^{-34} \cdot 3 \cdot 10^{8}}{3,6 \cdot 10^{-7}} - 3,2 \cdot 10^{-19}\right)$$

$$E_c = 2,316 \cdot 10^{-19}\,J \quad 0,25 \quad = 1,44\,eV$$

Exercise 3 (7,25 pt)

1)

Element	Electronic configuration	period	Column	group	block
$_2He$	$1s^2$ 0,25	1 0,25	18 0,25	$VIII_A$ 0,25	s
$_{46}Pd$	$_{36}[Kr]\,5s^2\,4d^8$ 0,25	5 0,25	10 0,25	$VIII_B$ 0,25	d
$_{37}Rb$	$_{36}[Kr]\,5s^1$ 0,25	5 0,25	1 0,25	I_A 0,25	s
$_{53}I$	$_{36}[Kr]\,5s^2\,4d^{10}\,5p^5$ 0,25	5 0,25	17 0,25	VII_A 0,25	p

2) The element Pd is a transition element because its last electron belongs to the d subshell (or because it belongs to the d block) 0,25 0,25

3 -

a : $_{12}Mg$: $(1s^2)(2s^2\,2p^6)(3s^2)$ 0,25

b.

$$E_T(Mg) = 2E_{1s} + 8E_{2s2p} + 2E_{3s} \quad 0,25$$

$$0,25 \quad E_n = E_H \cdot \frac{Z^{*2}}{n^{*2}} \qquad / \; Z^* = Z - \sigma_{ij} \quad 0,25$$

$$E_{1s} = -\frac{13,6\,(12 - 0,31)^2}{1} \quad 0,25 \quad = -1858,52\,eV \quad 0,25$$

$E_{2s2p} = \frac{-13{,}6(12 - 7\times0{,}35 - 2\times0{,}85)^2}{4} = -209{,}51\ eV$ 0,25 0,25

$\cdot E_{3s} = \frac{-13{,}6(12 - 2\times1 - 8\times0{,}85 - 1\times0{,}35)^2}{9} = -12{,}27\ eV$ 0,25 0,25

$E_T(Mg) = 2\times(-1858{,}52) + 8(-209{,}51) + 2(-12{,}27)$

$= -5417{,}66\ eV$ 0,25

Exercise 4 (6,5 pts)

$_{33}As$: $_{18}[Ar]\ 4s^2\ 3d^{10}\ 4p^3$ 0,25

: $_{18}[Ar]\ 3d^{10}\ 4s^2\ 4p^3$ 0,25

[↑↓] [↑|↑|↑]

$\cdot\overline{As}\cdot$ 0,25

$_{33}As^*$: $_{18}[Ar]\ 3d^{10}\ 4s^1\ 4p^3\ 4d^1$

[↑] [↑|↑|↑] [↑| | | |] 0,25

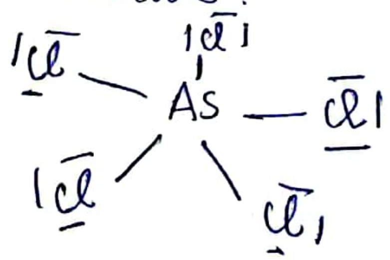
$\cdot\dot{As}\cdot$ 0,25

$_{17}Cl$: $_{10}[Ne]\ 3s^2\ 3p^5$ 0,25

[↑↓] [↑↓|↑↓|↑] 0,25

$\cdot\overline{Cl}|$ 0,25

Lewis representation of the molecule :



0,25

*Molecule : NCl_3

$_7N$: $_2[He]\ 2s^2 2p^3$ 0,25

[↑↓] [↑|↑|↑]
0,25

$\cdot\overline{N}\cdot$ 0,25

Lewis representation :

0,25

*Molecule : SO_2Br_2

$_8O$: $_2[He]\ 2s^2\ 2p^4$ 0,25

0,25 [↑↓] [↑↓|↑|↑]

$\cdot\overline{O}\cdot$ 0,25

$_{16}S$: $_{10}[Ne]\ 3s^2\ 3p^4$ 0,25

[↑↓] [↑↓|↑|↑]

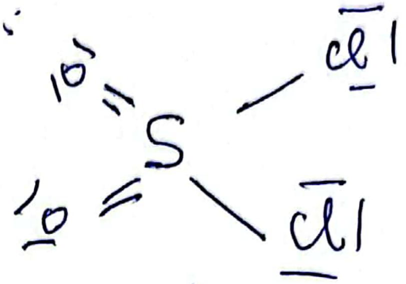
0,25

$|\overline{S}\cdot$ 0,25

$_{16}S^*$: $_{10}[Ne]\ 3s^1\ 3p^3\ 3d^2$ $:\dot{S}:$ 0,25

0,25 [↑] [↑|↑|↑] [↑|↑| | |]

Lewis representation :



0,25

2 - The four quantum numbers

$_{16}S$: $_{10}[Ne]\ 3s^2\ 3p^4$

[↑↓] [↑↓|↑|↑] (−1, 0, 1)

*

n	3	0,25
l	1	0,25
m_l	−1	0,25
m_s	−1/2	0,25