[TP] What is the oxidation number of the middle C in $CH_3CH_2C(O)OH$?

11% 1. −4
11% 2. −3
11% 3. −2
11% 4. −1
11% 5. 0
11% 6. +1
11% 7. +2
11% 8. +3
11% 9. +4

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Lecture 33 CH101 A2 (MWF 11:15 am)

Friday, December 1, 2017

For today ...

- Comment: H atom energy diagrams: Beyond Balmer's formula
- Ionization (photoelectric effect)
- Review: Lewis structures, formal charge and oxidation number

Next lecture: Review: Electron clouds; More than one electron: Orbital (yikes!) approximation; Electron shielding of one electron by others: http://goo.gl/hMNPLA; Building electron configurations

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Questions about the H atom

Question: Since the H atom has just one electron, isn't that electron always a 1s cloud?

Answer: No!

The atom with the 1s cloud electron can absorb energy (a photon) from light of frequency

$\nu = |E_{2p} - E_{1s}|/h$, or $\nu = |E_{3p} - E_{1s}|/h$, etc.,

and thereby the electron will be transformed into a 2p cloud, or a 3p cloud, etc.

Only if the atom emits any excess energy (a photon) will the electron be a 1s cloud.

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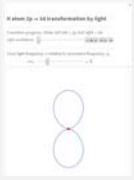
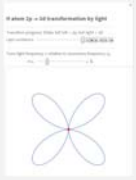
Questions about the H atom

Question: Since light transforms the 1s cloud into a p cloud, how can the electron be in a d cloud?

Answer: First, use light to form a p cloud, say as 1s → 2p.
http://quantum.bu.edu/CDF/101/1sTo2pTransition.cdf

Then, use light to transform the p cloud into a d cloud,
http://quantum.bu.edu/CDF/101/2pyTo3dxyTransition.cdf





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Questions about the H atom

Question: I see 1s → 2p and 2p → 3d, but how to get to 2s?

Answer: First, use light absorption to form a higher p cloud, say as 1s → 3p.

Then, light emission achieves 3p → 2s.

Ionization

What happens if an H atom absorbs a photon of energy greater than

$$E_{\text{photon}} = E_{\text{cloud},\infty} - E_{\text{cloud},1} = \text{Ry}\left(-\frac{1}{\infty^2} + \frac{1}{1^2}\right) = \text{Ry}(0 + 1) = \text{Ry}?$$

Ionization

The electron is ejected from the atom, leaving behind H^+.

This is called ionization, and …

$E_{\text{cloud},\infty} - E_{\text{cloud},1} = \text{Ry}$ is called the ionization energy, IE.

Ionization

Since $\Delta E_{\text{atom}} = -\Delta E_{\text{light}}$ and energy ΔE_{light} has been lost by the light, …

all energy in excess of the ionization energy is carried away as electron kinetic energy, KE,

$$\Delta E_{\text{atom}} = IE + KE$$

Ionization

Sketch the energy diagram for ionization of an electron from Li^{2+} in its $n = 6$ level by light of wavelength 310 nm.

Use your sketch to get the algebraic expression for the kinetic energy of the electron, using *h*, *c*, Ry, and 310 nm in your expression.

Ionization

Answer: The ionization energy of Li^{2+} ($n = 6$) is

$$IE = E_{\text{cloud},\infty} - E_{\text{cloud},6} = 0 + \text{Ry}\frac{3^2}{6^2} = \frac{\text{Ry}}{4}$$

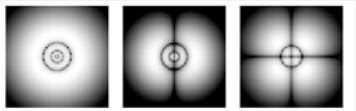
The photon energy is

$$E_{\text{photon}} = \frac{hc}{310\text{ nm}}$$

Therefore the kinetic energy of the electron is

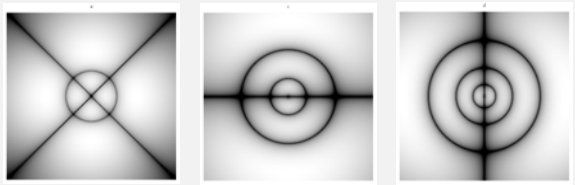
$$KE = E_{\text{photon}} - IE = \frac{hc}{310\text{ nm}} - \frac{\text{Ry}}{4} = 9.6 \text{ x } 10^{-20}\text{ J} = 0.60\text{ eV}$$

[TP] What is the *ionization energy* of H atom electrons with these electron clouds?



0% 1. 13.6 eV
0% 2. 13.6/4 eV
0% 3. 13.6/9 eV
0% 4. 13.6/16 eV
0% 5. They have different ionization energies

[Quiz] Which hydrogen atom electron cloud has the *smallest* ionization energy?



1. Left
2. Middle
3. Right
4. They all have the *same* ionization energy

Pictorial recipe for formal charge

Formal charge: Partition shared electrons equally.

$CH_3C(O)OH$

Pictorial recipe for oxidation number

Oxidation number: More electronegative atom gets all shared electrons.

$CH_3C(O)OH$

[TP] What is the oxidation number of the middle C in $CH_3CH_2C(O)OH$?

1. -4
2. -3
3. -2
4. -1
5. 0
6. $+1$
7. $+2$
8. $+3$
9. $+4$

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Pictorial recipe for oxidation number

Oxidation number: More electronegative atom gets all shared electrons.

$CH_3CH_2C(O)OH$