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# Interactions of Photons and electrons in high energy state and change of elementary properties.

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Subject- Quantum physics

## 1. TITLE

1.1. Effect of bombarding Electrons with High wavelength Photons.

Keywords- quantum physics, electrons, photons, theoretical physics.

## 2. Abstract

2.1. The abstract explores the intricate interplay between photons and electronics within high-energy environments, unravelling the dynamic transformations of elementary properties. In the realm of high-energy physics, the interactions between photons and electronic systems have far-reaching implications, influencing the fundamental nature of matter and energy.

The research employs advanced experimental and theoretical frameworks to scrutinize the quantum mechanical intricacies of photon-electronics interplay. Through meticulous analysis, the study discerns the quantum states, energy transfers, and transformative processes that transpire when photons engage with electronic systems operating at heightened energy levels.

## 3. Introduction

The experiment could result in 2 outcomes, either the color of the salt could change due to it being bombarded with high wavelength photons or the salt does not change color showing how bombarding of high wavelength photons does not affect salts / micro metals proving that photons behave in a very interesting way with electrons, protons and neutrons in a salt.

Hypothesis-

1. The color of salt changes showing how the wavelength of Photons that are exposed to the electrons, determines the color of the salt produced.

2. The salt remains the same color from which we can conclude that the photons that salt is exposed to don't affect the salts color and the color can be attributed to other properties of the electron, protons and neutrons.

2.3.1. in case of no change in color {2} more experiments must be conducted to find the property of salt that determines its color.

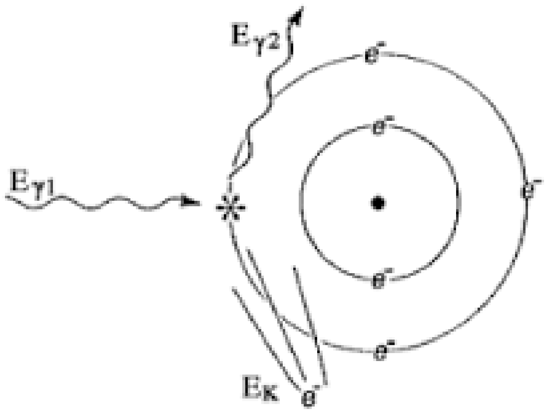



Figure.1.1
Shows the interaction of photons and electrons
Electron or photons interaction with an electron in atom (Compton effect)

# 4.methods

4.2. to achieve a proper observation 3 experiments, must conducted.

4.2.1. 30 ml of HCL, 9 g of Na2co3 and green lights of 250 to 350 nm.

4.2.2.(EXP. main). 60 ml of HCl, 18.2 grams of Na2co3 and red lights of wavelength 620 to 750 nm.

4.2.3. 60 ml of HCL, 18.2 grams of Na2co3 and green lights of 250 to 350 nm.

We use 3 methods and 3 experiments to achieve proper results and to make sure that there is no room for error or external issues.

# Labeled-

- {1.1}
- {1.2}
- {1.3}

The basic components-
4.3.1. Circuit for green lights of 250 to 350 nm

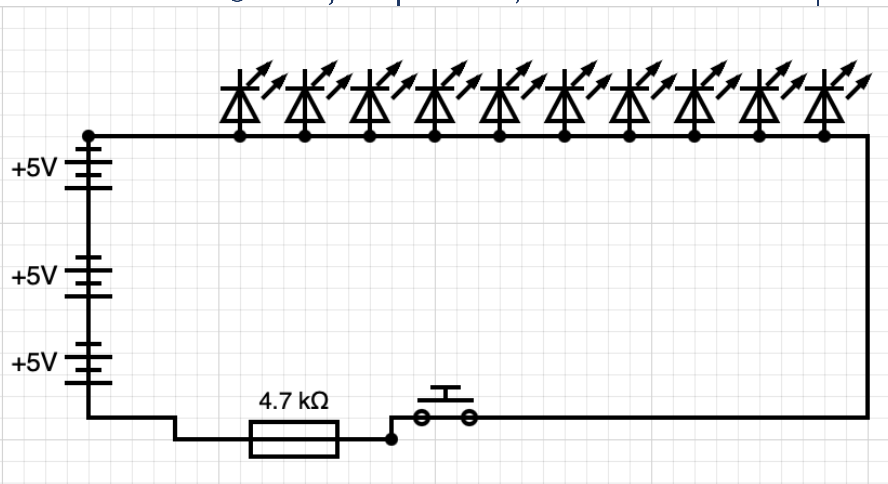



Figure 1.2

4.3.2. circuit for red lights of wavelength 620 to 750 nm.

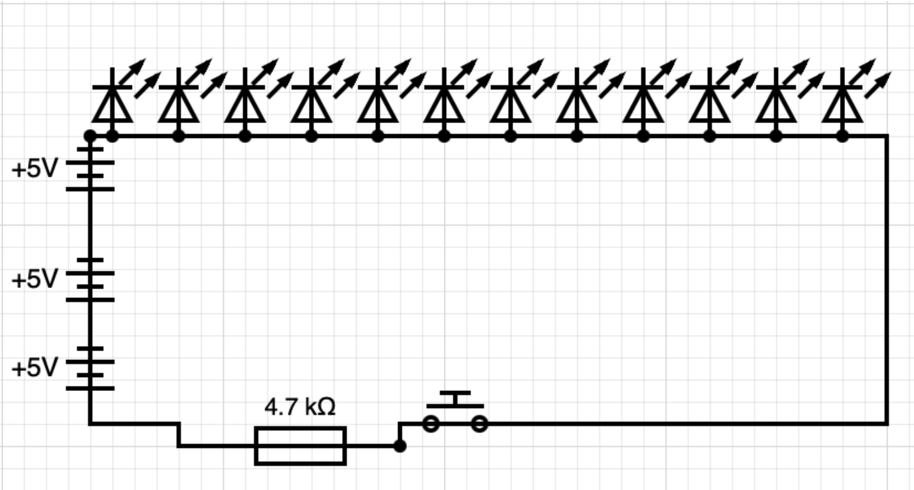



Figure 1.3

4.3.3 circuit for green lights of 250 to 350 nm

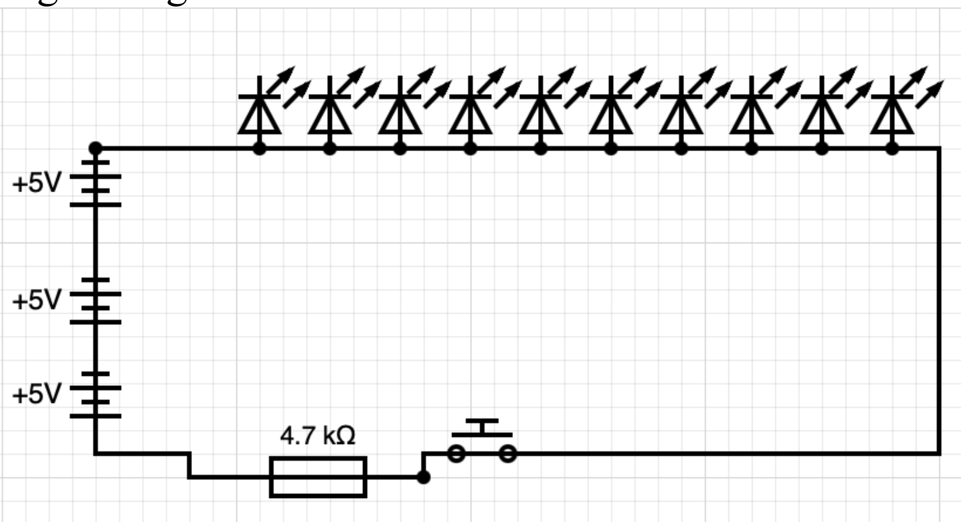



Figure 1.4

4.4.1. these experiments help us to come to a proper conclusion on the hypothesis.

HCL + Na2Co3 -----(green light) ----- Nacl + co2 + H20

HCL + Na2Co3 -----(red light) ----- Nacl + co2 + H20

## Discussion

5.1.1. in the first case {1} the photons cause disturbances in the exited electrons participating in the chemical bond/transformation.

These photons with specific wavelengths might affect the wavelengths the final molecule or atom would absorb changing the final color of the salt.

This change in the color of salt could mean the alteration of something elementary of an atom.

5.1.2. in the second case {2} the photons don't have any effect on the salts color which determines that the color of salt or color in general is based on another property.

This would require a completely new experiment to determine the result.

5.2.1-(interactions)

$$p_f c = \frac{p_i c m_e c^2}{m_e c^2 + 2p_i c}$$

$$p_f c \approx \frac{p_i c m_e c^2}{2p_i c} = \frac{m_e c^2}{2} = 0.256 MeV$$

$$\begin{bmatrix} 10GeV \\ 10GeV \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 0.511MeV \\ 0 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 10GeV + 0.511MeV \\ 10GeV \\ 0 \\ 0 \end{bmatrix} \quad \text{Lab frame}$$

$$\begin{bmatrix} E^*_{photon} \\ p^* c \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} E^*_{electron} \\ -p^* c \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} E^*_{photon} + E^*_{electron} \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \text{Zero-momentum frame}$$

The interactions of wave(photons) and electrons

$$\mathbf{H}_A = \frac{1}{2}\hbar\omega_{eg}\boldsymbol{\sigma}_z;$$

$$\omega_{eg} = \frac{1}{\hbar}(E_e - E_g).$$

$$\begin{aligned}\langle \mathbf{A} \rangle &= Tr\{\boldsymbol{\rho}\mathbf{A}\} = \sum_n \langle n|\,\boldsymbol{\rho}\mathbf{A}\,|n\rangle \\ &= \sum_n \langle n|\psi\rangle \langle\psi|\,\mathbf{A}\,|n\rangle = \langle\psi|\,\mathbf{A}\sum_n |n\rangle\langle n|\psi\rangle \\ &= \langle\psi|\,\mathbf{A}\,|\psi\rangle\,.\end{aligned}$$

$$\boldsymbol{\rho} = \frac{1}{2}\mathbf{1} + \frac{1}{2}(\rho_{ee} - \rho_{gg})\boldsymbol{\sigma}_z + d_x\boldsymbol{\sigma}_x + d_y\boldsymbol{\sigma}_y,$$

$$\begin{aligned}d_x &= \frac{1}{2}(\rho_{eg} + \rho_{ge}) = \Re\{\langle\boldsymbol{\sigma}^{(+)}\rangle\}, \\ d_y &= \frac{\mathrm{j}}{2}(\rho_{eg} - \rho_{ge}) = \Im\{\langle\boldsymbol{\sigma}^{(+)}\rangle\}.\end{aligned}$$

$$\begin{aligned}\boldsymbol{\rho} &= \rho_{ee}\frac{1}{2}(\mathbf{1} + \boldsymbol{\sigma}_z) + \rho_{gg}\frac{1}{2}(\mathbf{1} - \boldsymbol{\sigma}_z) + \rho_{eg}\boldsymbol{\sigma}^+ + \rho_{ge}\boldsymbol{\sigma}^- \\ &= \frac{1}{2}\mathbf{1} + \frac{1}{2}(\rho_{ee} - \rho_{gg})\boldsymbol{\sigma}_z + \rho_{eg}\boldsymbol{\sigma}^+ + \rho_{ge}\boldsymbol{\sigma}^-,\end{aligned}$$

$$\langle \mathbf{A} \rangle = Tr\{\boldsymbol{\rho}\mathbf{A}\} = p_e\,\langle e|\,\mathbf{A}\,|e\rangle + p_g\,\langle g|\,\mathbf{A}\,|g\rangle\,.$$

$$\left\langle \vec{d} \right\rangle = Tr\{\rho\vec{d}\} = -\vec{M}^* Tr\{\rho\sigma^+\} + c.c. = -\vec{M}^*\rho_{ge} + c.c.$$

$$\begin{aligned}\dot{\boldsymbol{\rho}} &= \frac{d}{dt}|\psi\rangle\langle\psi| + h.c. = \frac{1}{\mathrm{j}\hbar}\mathbf{H}\,|\psi\rangle\langle\psi| - \frac{1}{\mathrm{j}\hbar}|\psi\rangle\langle\psi|\,\mathbf{H} \\ &= \frac{1}{\mathrm{j}\hbar}[\mathbf{H}, \boldsymbol{\rho}]\,.\end{aligned}$$

$$\frac{d}{dt}\rho_{gg} = -\frac{d}{dt}\rho_{ee} = \Gamma_e\rho_{ee} - \Gamma_a\rho_{gg}.$$

$$\frac{d}{dt}\rho_{ge} = \mathrm{j}\omega_{eg}\rho_{eg} - \frac{\Gamma_e + \Gamma_a}{2}\rho_{ge}.$$

$$w_0 = \frac{\Gamma_a - \Gamma_e}{\Gamma_a + \Gamma_e} = \frac{-1}{1 + 2n_{th}} = -\tanh\left(\frac{\hbar\omega_{eg}}{2kT}\right).$$

## 5.results

Exp {4.2.1} showed a very miniscule change in color
From white to pale pink.

## Additional Diagrams-

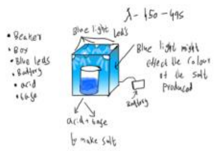
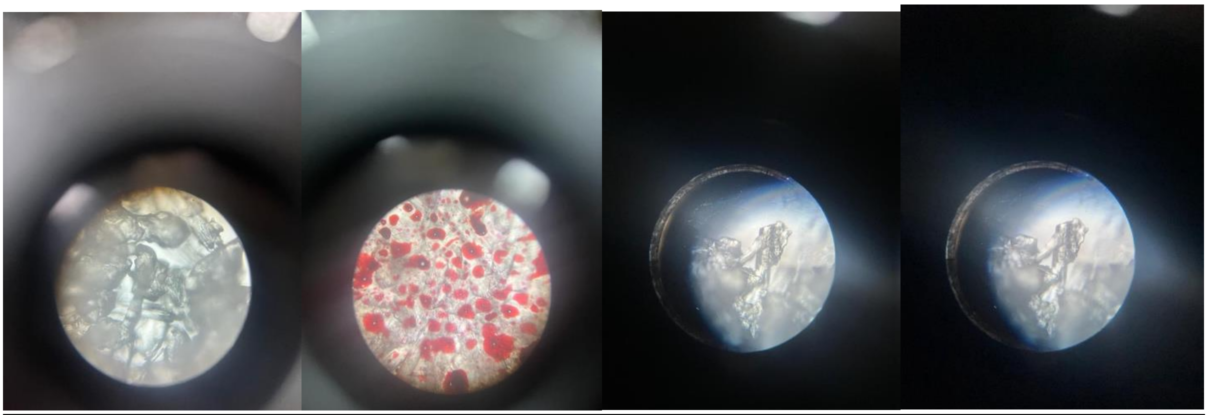


Diagram or blueprint of the experimental setup
Figure1.5

## Additional pictures



Pictures of salt produced by exp 1
Figures 2.0 2.1 2.2 2.3

## Exp pictures

Pictures of the experimental setup
3.1. 3.2

## Conclusion

The color of the salt showed varied results and has shown both results hyp{1}& hyp{2}.

This shows that there are interactions between the electron and proton during the reaction of Na2co3 and HCL in EXP {1}.

This begs for a secondary experiment to determine the exact reason for this.

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# References

**Principles of physical chemistry-**
Rutherford's scattering exp – (23)
Photoelectric effect – (24)
Dule characteristics of an electron – (33)
Compton effect – (36)
Wave nature of electron – (21)

**Principles of quantum physics-**
Motion of wave packets – 121, C5
Spin of electron – 149, C6
Displacement operators – 99, C4

**Quantum theory of scattering of X-ray by light elements**
**-Author H Compton**

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