Wasit Journal for Pure Science

Journal Homepage: https://wjps.uowasit.edu.iq/index.php/wjps/index
e-ISSN: 2790-5241 p-ISSN: 2790-5233

Evaluation of the noncarcinogenic health risks of copper in Wasit Governorate dust

Ali Abed Jaber

Department of Physics, College of Education for Pure Sciences, Wasit University, IRAQ

*Corresponding Author: Ali Abed Jaber

DOI: https://doi.org/10.31185/wjps.578
Received 21 October 2024; Accepted 12 December 2024; Available online 30 December 2024

ABSTRACT: An investigation was conducted in Wasit Governorate, where 32 indoor air samples were collected from popular locations and tested for the concentration of the metal copper (Cu). The samples were taken from air conditioning systems and then diluted with distilled water before being analyzed using Atomic Absorption Spectroscopy. The results indicated that the concentration of Cu exceeded the permissible limits set by international standards. The minimum, maximum, and average concentrations of Cu in the samples were found to be 1.45E-06, 9.2E-04, and 2.8E-05, respectively. Furthermore, a detailed assessment of non-carcinogenic toxic risks revealed significant findings that warrant serious attention.

Keywords: copper (Cu), non-carcinogenic, toxicity, Spectroscopy, concentration

1. INTRODUCTION

The Wasit Governorate holds significant importance in Iraq due to its renowned for its contributions to agriculture and industry. One of the primary areas of concern for researchers and specialists in this region revolves around the issue of copper toxicity, as excessive levels of copper in the environment can have detrimental effects on both public health and the ecosystem, despite its essential nature as a trace element for the body [1].

Copper accumulation in soil and water could lead to serious health and environmental problems in Wasit Governorate due to very active agricultural and industrial activities. Possible sources of copper pollution: intensive application of copper-containing fertilizers and pesticides, inappropriate discharge of industrial waste. These all types of pollution are showing their unspecified effects in future times in the form of detrimental effects to agricultural crops and the health of animals and humans, which require continuous studies and effective strategies to reduce these risks continuously [1].

The copper has been known to humanity for over 10,000 years and has been a valuable commodity in global trade among civilizations such as the Egyptians, Greeks, Romans, Aztecs, Balkans, and Chinese [3,4]. In recent years, copper has been utilized in industries such as construction, energy, transportation, electronics, and agriculture, as well as in animal nutrition [5]. The combination of copper sulfate, lime, and water was utilized in the 1880s to produce a fungicidal substance. This substance was then widely employed to address mildew issues in grapevines [4]. During the 1950s, the laboratory confirmed the empirical validation of copper's antifungal properties [6]. International interest in using copper in agriculture significantly increased after 1987 [5].

The impregnation of excess copper in any location should be varied, depending on many factors such as the local condition and human activities in that particular area. In Wasit Governorate, the following mentioned can be the reasons for higher Cu: content (industrial, mining, agriculture, environmental pollution, wastes, etc.) [7]. The following introductory discourse aims to establish the significance of undertaking a study in the Wasit Governorate, specifically on Cu toxicity, with the purpose of elucidating the potential health and environmental consequences of copper pollution and indicating measures that should be taken as preventive and remedial actions to safeguard life quality in the region (WHO).

The overall increase in the incidence probability of all types of cancers in Iraq is great in their importance for public health. Based on various statistical analyses, cancer diseases have been increasingly rising in Iraqi governorates and are specially focused on malignancies of the breast and lungs [8].This work, therefore, tried to quantify in the atmosphere just one important heavy metal concretely, copper in the urban atmospheres of the Wasit governorate by means of internal analyses run at public facilities such as infirmaries, health centers, police stations, and so on, to determine the levels of copper pollution and evaluate the probabilities of incidents of cancer associated with it.

2. RESEARCH METHODOLOGY

In order to evaluate the potential health risks associated with inhaling copper particles in the air at the locations under investigation, the average exposure to certain metals through inhalation is adjusted for the body weight of both children and adults over a specific period of time, using equation (1) [10].

$$D_{inh} = \frac{C*InhR*EFq*ED}{BW*AT} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

D_{inh} represents the contact via respiratory inhalation $(mg\ kg^{-1}day^{-1})$; $InhR$ denotes the inhalation rate (7.6 and 20 m^3day^{-1} for children $InhR_{child}$ and adults $InhR_{adult}$), respectively); EFq indicates the exposure incidence $(day\ year^{-1})$; which is a factor used in assessing environmental and health risks to determine the number of days or periods in which a person is exposed to a specific substance, whether pollution or chemical, during a specific period, usually one year. The EFq value was considered to be $(292\ day\ year^{-1})$, which is the number of days that children and adults can be exposed to during one year.

ED refers to the exposure duration (6 years for children (ED_{child}), and 24 years for adults (ED_{adult}), respectively); BW signifies the average body weight (15 kg for children (BW_{child}), and 70 kg for adults (BW_{adult}),; AT is the averaging time (for non-cancer toxic risks, $AT\ (days) = ED * 365$; for cancer risks, $AT\ (days) = 70 * 365$; C represents the exposure-point concentration $(mg\ m^{-3})$. This research evaluates health risk by the creation of the average daily dose $LADD$ of specified metals via inhalation, as outlined in equation (2) [11];

$$LADD = \frac{C*EFq}{AT} * \left(\frac{InhR_{child}*ED_{child}}{BW_{child}} + \frac{InhR_{adult}*ED_{adult}}{BW_{adult}}\right) \quad \ldots\ldots. (2)$$

The concept of a danger quotient should also be presented since it is very important. A hazard quotient, also known as an HQ, is a hypothetical concept that describes the relationship between the possible contact with a certain metal and the amount at which no negative effects may be predicted. Using the equation, one may get (HQ) after the value of (D_inh) has been determined. (3), [12];

$$HQ = \frac{D_{inh}}{RfD} \quad \ldots\ldots\ldots\ldots.. \quad (3)$$

The orientation dose, denoted by RfDI, is given as $(mg\ kg^{-1}\ day^{-1})$, and has a value of $4.02 * 10^{-2}$ for Cu [13]. When the intended HQ is less than 1, it is not possible to forecast any health belongings that are in opposition to one another due to interaction. In contrast, if HQ is more than one, then it is possible that unfavorable health impacts will occur.

3. RESULTS AND DISCUSSIONS

In this study, the content of copper was found to be low in tasters that were calm and collected from the air at several locations within the Wasit governorate. The information of the locations where the samples were gathered are shown in Table 1, which may be seen here as well. This includes venues such as government buildings, private residences, supermarkets, mobility centers, and so on. One factor served as the basis for the assignment of these seats, and that was the large number of persons who were occupying them.

One example of the graphical representations of the copper concentrations that were detected in the samples that were studied is shown in Figure 1. As of this representation, it is possible to notice the large difference in the measured copper concentrations, which may arise from a multitude of factors, such as industrial and agricultural activities, environmental pollution resulting from various sources such as vehicle exhausts or industrial facilities, a reason for increasing the concentration of copper in the environment, and other motives.

Additionally, the maximal, minimal, and total mean standards of copper concentrations (expressed in units) are delineated in Table (2), which indicate values of 9.24E-04, 1.446E-06, and 2.8E-05, respectively. The minimal value is attributed to the S5 sample, whereas the maximal value is associated with the S19 sample. Nevertheless, the findings pertaining to copper concentration measurements were juxtaposed with the values established by international organizations [11]. various authoritative entities, including the World Health Organization, have indicated that the majority of the measurements complied with internationally accepted standards; moreover, the overall mean of the measurements, when juxtaposed with findings from other nations such as China [13], revealed that the outcomes of this study were remarkably analogous, as illustrated in Table (1). Furthermore, the mean exposure levels to copper (Cu) via inhalation among both children and adults were assessed by (D_{inh}) $(in\ mg\ kg^{-1}day^{-1}\ \ unit)$, the hazard quotient (HQ) for both pediatric and adult populations regarding non-carcinogenic toxicological risks consumes remained computed and presented in Table (1). Notwithstanding the outcomes of *(HQ)* being below one, such results are deemed perilous concerning carcinogenic toxicological risks. This circumstance can be ascribed to the necessity of calculating the parameter for all quantified heavy metals, whereas this study exclusively evaluated Cu. Additionally, the lifetime average daily dose (LADD) of Cu via inhalation has been determined aimed at the tasters under investigation. As anticipated, the LADD values align with the concentrations measured, as the calculation of the LADD parameter is contingent upon concentration measurements. Table (3) delineates the smallest, supreme, and overall average values of LADD, which are recorded as 0.254, 162.377, and 21.141, respectively.

Table 1. - The specific coordinates of the analyzed specimens

Sampl. Code	Location	C mg/m3
S1	Directorate of Enlightenment in Wasit /Archive chamber	6.145E-06
S2	Wasit health directorate /Department of individuals	3.299E-04
S3	Wasit Governorate/ reception	1.194E-05
S4	Wasit Governorate / Cadre room	6.817E-05
S5	Medical Clinic	1.446E-06
S6	Noor Al-Mujtaba School /Class room	8.796E-06
S7	Appellate Court of Wasit /Contracts room	7.257E-05
S8	Appellate Court of Wasit /Store	3.904E-05
S9	Zahra Teaching hospital /Pharmacy	6.832E-05
S10	Zahra Teaching hospital /X-ray room	3.344E-05
S11	Riadh Cafeteria	1.012E-04
S12	Al-Isnad Company	6.597E-05
S13	Super Market	6.047E-05
S14	Elsoosn Cafeteria	6.157E-05
S15	Kitchens Workshop	1.510E-04
S16	Coffee shop	1.759E-04
S17	Al-Chef Restaurant	1.715E-04
S18	Coffee shop	1.034E-04
S19	Gym	9.236E-04
S20	Exchange port	4.338E-06
S21	Super market	1.319E-04
S22	Coffee shop	3.958E-05
S23	Super Market	2.375E-04
S24	Hai Al-Jihad health center/ Consulting room	4.398E-05
S25	Health Center	1.209E-04
S26	Real estate registration	5.061E-06
S27	Super Market	9.896E-05
S28	Grocery store	2.485E-04
S29	Al-Omal Restaurant	1.979E-04
S30	Super Market	6.047E-05
S31	Super Market	1.209E-04
S32	Super Market	8.356E-05
Max.		9.236E-04
Min.		1.446E-06
Average		2.8E-05

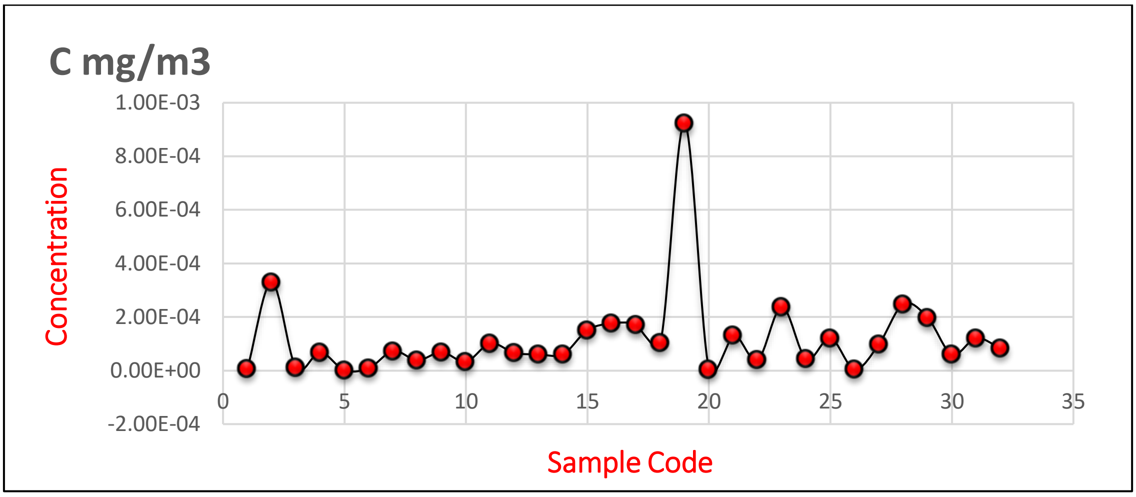

FIGURE 1. -The quantified levels of copper present in the analyzed samples.

Table 2. - Quantitative measurements of the concentration, reflecting the mean exposure levels of both pediatric and adult populations to Copper (Cu) via the inhalation pathway, particularly nonconcerning the carcinogenic toxicological risks associated with indoor Environments.

Samples Code	Dinh for chield	Dinh for adult
S1	2.491E-06	1.405E-06
S2	1.337E-04	7.540E-05
S3	4.839E-06	2.729E-06
S4	2.763E-05	1.558E-05
S5	5.861E-07	3.305E-07
S6	3.565E-06	2.011E-06
S7	2.941E-05	1.659E-05
S8	1.582E-05	8.924E-06
S9	2.769E-05	1.562E-05
S10	1.355E-05	7.643E-06
S11	4.100E-05	2.312E-05
S12	2.674E-05	1.508E-05
S13	2.451E-05	1.382E-05
S14	2.496E-05	1.407E-05
S15	6.121E-05	3.451E-05
S16	7.131E-05	4.021E-05
S17	6.953E-05	3.921E-05
S18	4.189E-05	2.362E-05
S19	3.744E-04	2.111E-04
S20	1.758E-06	9.915E-07
S21	5.348E-05	3.016E-05
S22	1.604E-05	9.048E-06
S23	9.627E-05	5.429E-05
S24	1.783E-05	1.005E-05
S25	4.902E-05	2.765E-05
S26	2.051E-06	1.157E-06
S27	4.011E-05	2.262E-05
S28	1.007E-04	5.680E-05
S29	8.022E-05	4.524E-05
S30	2.451E-05	1.382E-05
S31	4.902E-05	2.765E-05
S32	3.387E-05	1.910E-05
Maxi.		2.111E-04
Mini.		3.305E-07
Average		0.01

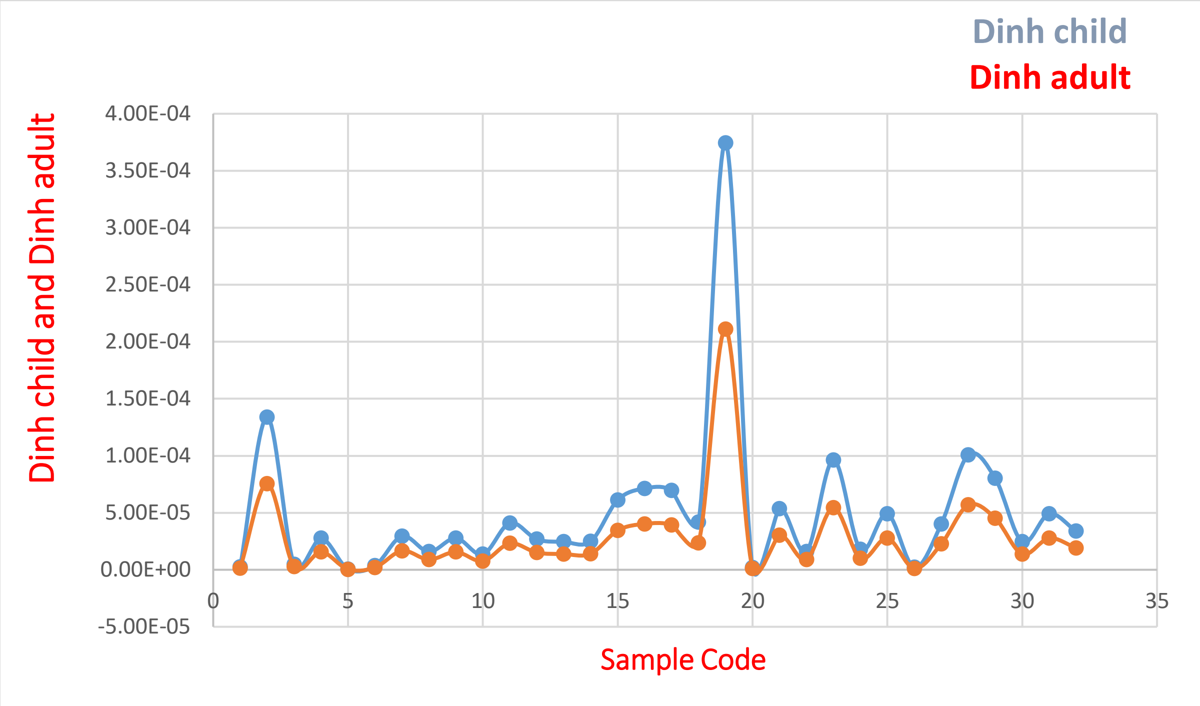

FIGURE 2. - Children and adults are subjected to inhalation exposure to noncarcinogenic toxicants present at indoor environments.

Table 1. Quantitative measures of concentration, encompassing the mean exposure levels of both children and adults to Copper (Cu) via inhalation, alongside the hazard quotient (*HQ*) for both demographics and the Lifetime Average Daily Dose (LADD) for children and adults pertaining to indoor noncancer-related toxicological risks.

Samples Code	HQ Child	HQ adult	LADD child	LADD adult
S1	0.00006	0.00003	1.080	0.270
S2	0.00333	0.00188	57.992	14.498
S3	0.00012	0.00007	2.099	0.525
S4	0.00069	0.00039	11.985	2.996
S5	0.00001	0.00001	0.254	0.064
S6	0.00009	0.00005	1.546	0.387
S7	0.00073	0.00041	12.758	3.190
S8	0.00039	0.00022	6.864	1.716
S9	0.00069	0.00039	12.011	3.003
S10	0.00034	0.00019	5.879	1.470
S11	0.00102	0.00058	17.784	4.446
S12	0.00067	0.00038	11.598	2.900
S13	0.00061	0.00034	10.632	2.658
S14	0.00062	0.00035	10.825	2.706
S15	0.00152	0.00086	26.547	6.637
S16	0.00177	0.00100	30.929	7.732
S17	0.00173	0.00098	30.156	7.539
S18	0.00104	0.00059	18.171	4.543
S19	0.00931	0.00525	162.377	40.594
S20	0.00004	0.00002	0.763	0.191
S21	0.00133	0.00075	23.197	5.799
S22	0.00040	0.00023	6.959	1.740
S23	0.00239	0.00135	41.754	10.438
S24	0.00044	0.00025	7.732	1.933
S25	0.00122	0.00069	21.264	5.316
S26	0.00005	0.00003	0.890	0.222
S27	0.00100	0.00056	17.397	4.349
S28	0.00251	0.00141	43.687	10.922

S29	0.00200	0.00113	34.795	8.699
S30	0.00061	0.00034	10.632	2.658
S31	0.00122	0.00069	21.264	5.316
S32	0.00084	0.00048	14.691	3.673
Max.	0.00931	0.00525	162.377	40.594
Mini.	0.00001	0.00001	0.254	0.064
Average	0.00121	0.00068	21.141	5.285

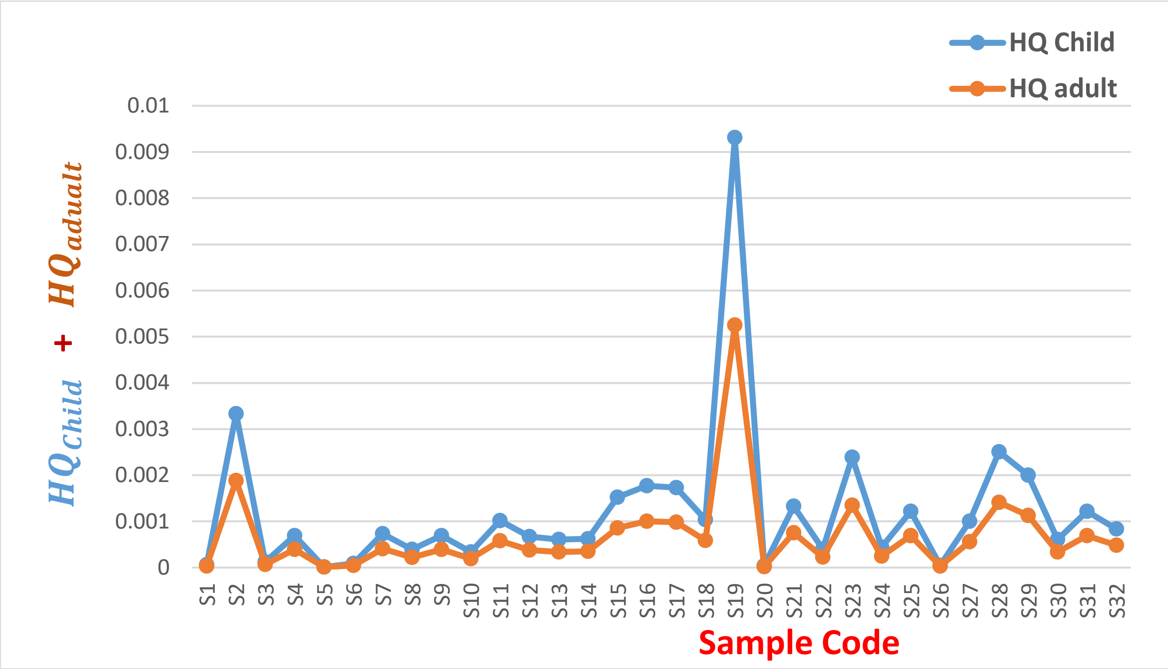

FIGURE 3. - The hazard quotient (HQ) associated with indoor non-carcinogenic toxicological risks for both Child and adult populations

4. CONCLUSIONS

The results derived from this study powerfully substantiate the proposition of substantial air pollution within the Wasit Governorate, a phenomenon that may be extrapolated to encompass all governorates in Iraq owing to the pronounced similarities in their respective environmental conditions. This form of pollution is deemed exceptionally perilous, as it emanates from raised levels of toxic copper, in adding to the related risks posed by its substantial mass upon inhalation. This inference can be corroborated by the outcomes of this examination, which propose that the levels of pollution may surpass those thresholds thought satisfactory on an international scale.

REFERENCES

[1] Ponge, Jean-François. "The soil as an ecosystem" (PDF). Biology and Fertility of Soils. 2015. 51 (6): 645–48

[2]Massimo Fagnano , Diana Agrelli , Alberto Pascale , Paola Adam , Nunzio Fiorentino , Claudia Rocco , Olimpia Pep e , Valeria Ventorino. Copper accumulation in agricultural soils: Risks for the food chain and soil microbial populations, Science of The Total Environment. September 2020. 734.

[3] Alloway, B.J. Sources of heavy metals and metalloids in soils. In Heavy Metals in Soils; Springer: Dordrecht, The Netherlands, 2013; pp. 11–50.

[4] Borkow, G.; Gabbay, J. Copper, an ancient remedy returning to fight microbial, fungal and viral infections. Curr. Chem. Biol. 2009, 3, 272–278.

[5] Richardson, H.W. Handbook of Copper Compounds and Applications; CRC Press: New York, NY, USA, 1997; ISBN 1-4822-7746-8. [Google Scholar]

[6] Benns, B.G.; Gingras, B.A.; Bayley, C.H. Antifungal activity of some thiosemicarbazones and their copper complexes. Appl. Microbiol. 1960, 8, 353–356. [Google Scholar] [PubMed]

[7] Panos Panagos, Cristiano Ball, Emanuele Lugato, Arwyn Jones, Pasquale Borrelli, Simone Scarpa, Alberto Orgiazzi, and Luca Montanarella, "Potential Sources of Anthropogenic Copper Inputs to European Agricultural Soils", Heavy Metals in Agricultural Soils: Sources, Releases and Environmental Impacts, 2018, 2380.

[8] Ministry of Health, Iraqi Cancer Registry Center (ICRC), "Report on the statics of cancers till 2009", Published in 2012.

[9] Iijima, A.; Sato, K.; Ikeda, T.; Sato, H.; Kozawa, K.; Furuta, N. Concentration distributions of dissolved Sb(III) and Sb(V) species in size-classified inhalable

[10] Jinglan Feng, Hao Yu, Xianfa Su, Shuhui Liu, Yi Li, Yuepeng Pan, and JianHui Sun; "Chemical composition and source apportionment of PM2.5 during Chinese Spring Festival at Xinxiang, a heavily polluted city in North China: Fireworks and health risks", Atmospheric Research 182, 176–188, (2016).

[11] Ali A. Jaber, Shafik S. Shafik, and Hadi D. Alattabi; " Cancer Risk Assailments Due to Inhale Lead Fly Ash by People in Wasit Governorate – Iraq"; Materials Science and Engineering, 2020.

[12] WHO/WMO. Air Monitoring Program Designed for Urban and Industrial Area Published for Global Environmental Monitoring System by UNEP. Geneva: WHO and WMO; 1971.

[13] Shafik S. Shafik, Basim Kh. Rejah, and Abdul Hussein Abdul Ameer, "Radon concentration measurements in sludge of oil fields in North Oil Company (N.O.C.) of Iraq"; Iraqi Journal of Physics, Vol.13, No.26, PP.139-145, 2015.