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Theoretical study for some novelty Triazole derivatives by using Ab Intio calculations(RHF -Model) .

دراسة نظرية لبعض مشتقات الترايازول باستخدام الطريقة التامة (RHF) .

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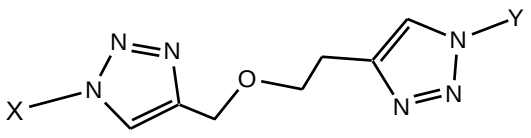
Abstract:-

RHF calculations, within Gaussian03 Program, have been carried out after complete optimization of geometry on X and Y disubstituted of (1H1,2,3,-triazole-4-Yl) ethoxy) methy)-1H-1,2,3-triazole) , where X is H , COOH , $COCH_3$, and 2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl. Y is C_7H_{15}. It was found that the compound R-sugar the more Stability than other compounds and all of them increasing dipole moment and hardness and decreasing in HOMO and LUMO energies. Geometrical parameters ,total energy ,electron charge ,Ionization energies , and the E^0,H^0,G^0,A^0,C_P,C_V and S^0 thermodynamics functions are reported.

Key words: RHF study , Triazole ,thermodynamics functions.

الخـــلاصـــــة:-

تضمنت هذه الدراسة اعتماد برنامج كاوس (Gaussian 03) لاستعمال طريقة الحساب التام على وفق طريقة نظرية دالة الكثافة (RHF) , وذلك لغرض حساب الأبعاد الهندسية (أطوال و زوايا التآصر)عند الشكل الهندسي المتوازن , لمركب ثنائي التعويض (1*H*-1,2,3,-triazole-4-Yl) ethoxy) methy)-1H-1,2,3-triazole) ,عندما تكون H , COOH , $COCH_3$, and 2,3,4,6-Tetra-*O*-acetyl-β-D-glucopyranosyl = X
Y = C_7H_{15}.X ,Y وكذلك تم حساب الدوال الثرموديناميكية (G^0,H^0,A^0,E^0) وكذلك الدوال الثرموديناميكية (S^0 , C_p ,C_V) , بعض الخصائص الفيزيائية وكذلك الشحنات . دلت الحسابات أن المركب R-sugar اكثر المشتقات استقرارية وله أعلى مقدار في كل من عزم ثنائي القطب , الصلابة , طاقة المدارين , فرق الطاقة بين المدارين, جهد التأين وكذلك زيادة في جميع قيم الدوال الثرموديناميكية .



Y= C_7H_{15}

X= H , COOH , $COCH_3$, and 2,3,4,6-Tetra-*O*- acetyl-β-D-glucopyranosyl

Introduction.

Triazoles are five-membered heterocyclic aromatic rings, which contain two carbon and three nitrogen atoms. They are in isomeric forms 1,2,3-triazole and 1,2,4-triazole, and each of them is found in two tautomeric forms [1].

Triazoles have received special attention in the medicinal fields because of low toxicity, high potency and broad range of biological activities such as antimicrobial [2] ,antifungal [3,4], antitumor[5] , and antitubercular activities [6]

Click chemistry has been successfully approached in many different scientific fields, and its potential has played an important role in materials chemistry [7], dendrimer build-up [8,9], polymers [10,11], nano particle synthesis [12], peptide-based[13] drug design and drug discovery [14,15].

Click Chemistry is a biocompatible reaction and can take place in living cells thus it became a facile and efficient tool for universal modification of nucleosides [16].

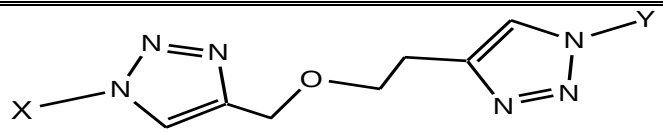
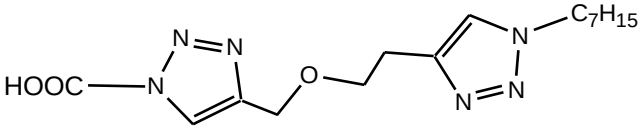
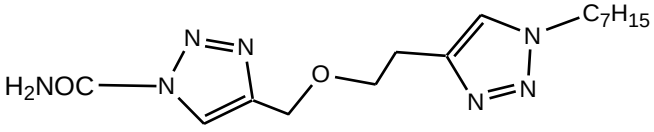
Glycoconjugates is the general classified for carbohydrates covalently linked with other chemical species such as proteins, peptides, lipids and saccharides [17], thus an important role in many biological processes; glycoconjugates have been detected, contain cellular recognition, particularly in cases of inflammation [18], tumor metastasis[19], and immune response in bacterial and viral infections[20].

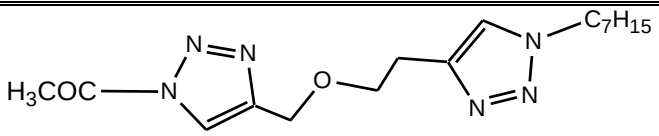
The click chemistry has been extensively used on glycoconjugation chemistry, like the Synthesis of 1-glycopyranosyl-4-substituted-1,2,3-triazoles.

Glucose or galactose have many free hydroxyl groups which differ in the reactivity due to their position and configuration [21].Therefore, it is important to protect many hydroxyl groups in each carbohydrate and left just one single hydroxyl group in order to expose to the selected reagent before glycosylation for the preparation of glycoconjugates [22,23].

COMPUTATIONAL

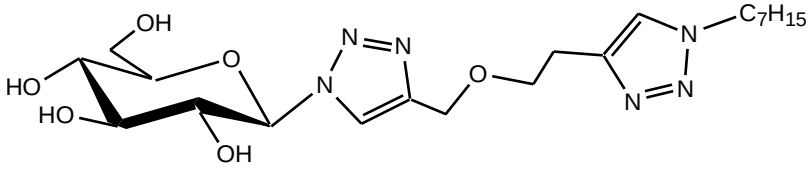
The compounds were investigated by conventional Ab Intio quantum theory and by HARTREE-FOCK (HF) using the Gaussian -03[24,25].


4-((2-(1*H*-1,2,3-triazol-4-yl)ethoxy)methyl)-1*H*-1,2,3-triazole
R-H

4-((2-(1-heptyl-1*H*-1,2,3-triazol-4-yl)ethoxy)methyl)-1*H*-1,2,3-triazole-1-carboxylic acid
R- COOH

4-((2-(1-heptyl-1*H*-1,2,3-triazol-4-yl)ethoxy)methyl)-1*H*-1,2,3-triazole-1-carboxamide
R-$CONH_2$



1-(4-((2-(1-heptyl-1*H*-1,2,3-triazol-4-yl)ethoxy)methyl)-1*H*-1,2,3-triazol-1-yl)ethanone

R-COCH3



(2*R*,3*S*,4*S*,5*S*)-2-(4-((2-(1-heptyl-1*H*-1,2,3-triazol-4-yl)ethoxy)methyl)-1*H*-1,2,3-triazol-1-yl)-6-(hydroxymethyl)tetrahydro-2*H*-pyran-3,4,5-triol

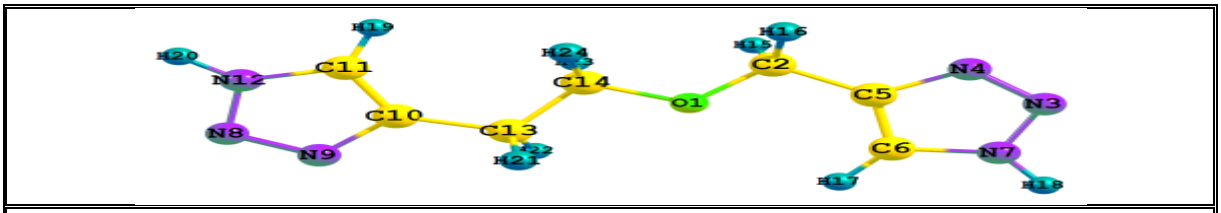
R-6-hydroxymethyl)tetrahydro-2H-pyran-3,4,5-triol.

Result and Discussion

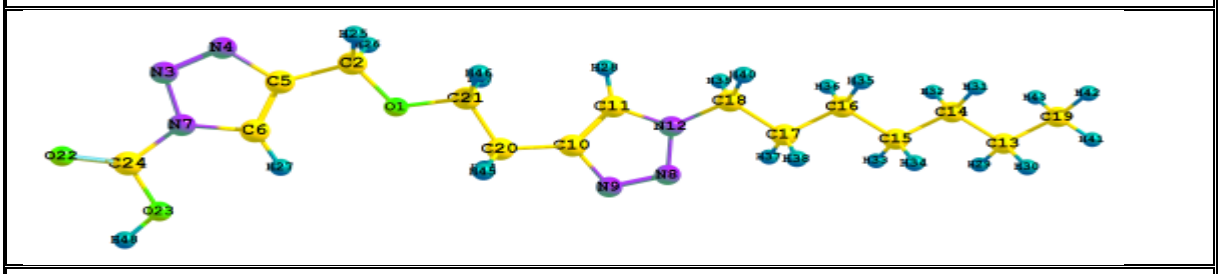
Geometrical parameter

In this research calculated the geometry (bond lengths and bond angels) of the four molecules of derivatives 4- (2-(1*H*1,2,3,triazole (e-4-y1) ethoxymethyl)(1*H*-1,2,3- triazole) (R-H),(R-COOH) (RO-CH_3), R-$CONH_2$, R-Suger using the Ab initio method of according to the Hartree – Fock method (RHF). According to the result calculated and recorded in the (table 1 and fig.1) Show that each the bonds (N_7-C_X) and (C_{10} –N_9) in compound R-sugar has high value compared to other compounds studies this value may be return to the Ion pair in nitrogen atom and electron with drawing of substituted groups of the other compound. Where the bond (N_3-N_7) compound of (R-COOH) has high value compare with the other this value this caused by electron pair on (N) atom in this bound length that caused conjugated effect with substituted groups.

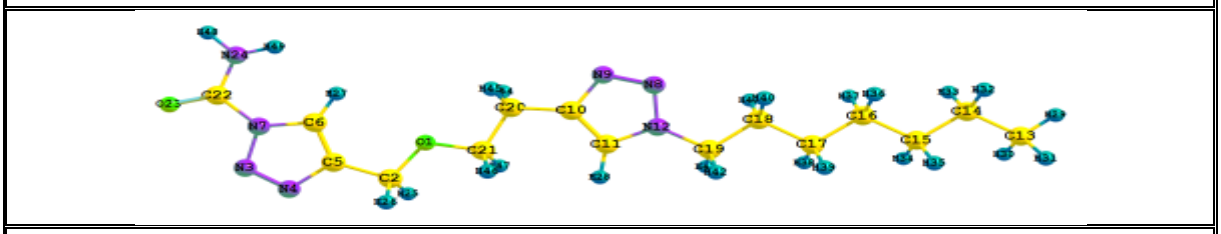
Also the change of the group substituted had effect on the value of the angles of the compounds studied in the research , have shown calculation in the (table 1 and fig.1). That the angle ($\angle C_6N_7N_3$) showed that in R-OCH_3 and R-H larger than the others because the size of substituted group in the compounds when the angle ($\angle$ N_4 N_3 N_7) the compound (R-OCH_3) has Larger value than the others because of the Ion pair on N with the electronagativity of the substituted groups.



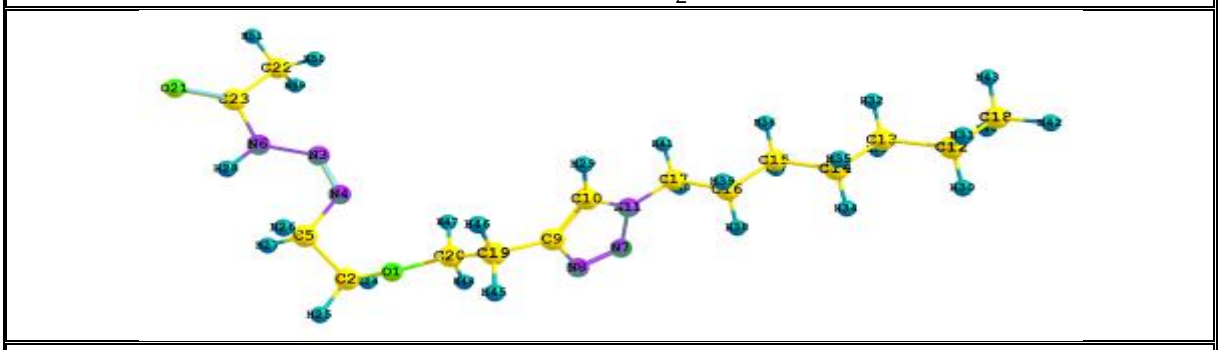
R-H



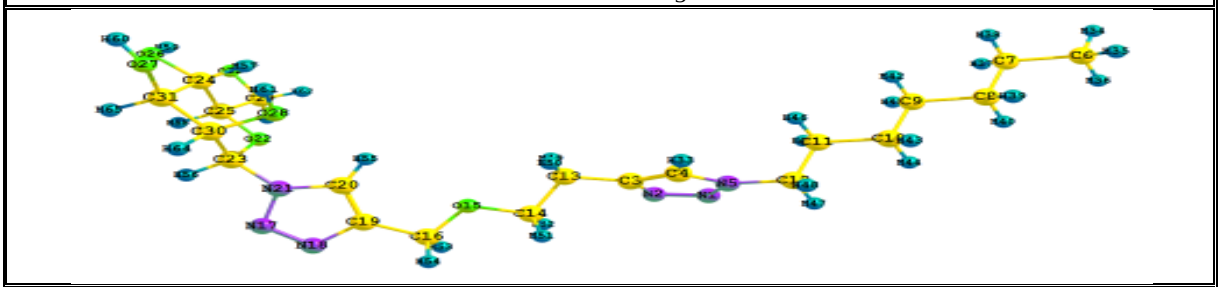
R-COOH



R-CONH$_2$



R-COCH$_3$



R-Sugar

Fig.(1): The geometric equilibrium for the 4- (2- (1*H*-1,2,3, - triazole (e-4-yl) ethoxymethyl (1H-1,2,3,triazole) derivatives.

Table (1) : Calculated geometric parameters (bond lengths in Angstrom length angles in degree) of the derivatives of(4-((2-(1H-1,2,3-triazol-4-ethoxy)methyl)-1-H-1,2,3,)Triazole calculated by (RHF)method.

R-H		R-COOH		R-CO NH2		R-CO CH3		R-Sugar	
Para Geo	Bond Lenght and Angle	Para Geo	Bond Lenght and Angle	ParaGeo	Bond Lenght and Angle	Para Geo	Bond Lenght and Angle	ParaGeo	Bond Lengh t and Angle
R(1-2)	1.426	R(1-2)	1.423	R(1-2)	1.423	R(1-2)	1.424	R(1-2)	1.288
R(3-4)	1.284	R(3-4)	1.266	R(3-4)	1.227	R(3-4)	1.270	R(4-5)	1.354
R(3-7)	1.343	R(3-7)	1.370	R(3-6)	1.368	R(3-7)	1.363	R(4-33)	1.064
R(4-5)	1.369	R(4-5)	1.384	R(4-5)	1.473	R(4-5)	1.379	R(5-12)	1.455
R(6-7)	1.354	R(6-7)	1.374	R(5-27)	1.088	R(6-7)	1.373	R(6-34)	1.084
R(6-17)	1.062	R(13-14)	1.533	R(6-23)	1.380	R(6-27)	1.061	R(6-35)	1.085
R(7-18)	0.989	R(13-19)	1.531	R(6-28)	0.996	R(7-22)	1.411	R(6-36)	1.085
R(8-9)	1.282	R(13-29)	1.087	R(7-8)	1.288	R(8-9)	1.288	R(7-8)	1.533
R(9-10)	1.375	R(14-15)	1.533	R(8-9)	1.370	R(9-10)	1.369	R(7-38)	1.087
A(4-3-7)	107.2	A(4-3-7)	107.0	A(4-3-6)	120.9	A(4-3-7)	107.6	A(2-3-4)	107.1
A(3-4-5)	109.6	A(3-4-5)	110.5	A(3-4-5)	122.6	A(3-4-5)	110.1	A(3-4-5)	105.3
A(3-7-6)	111.0	A(3-7-24)	121.0	A(7-6-27)	125.5	A(6-7-8)	112.9	A(6-7-8)	112.9
A(3-7-18)	119.7	A(6-7-24)	129.1	A(6-7-22)	130.7	A(6-7-37)	109.4	A(8-7-38)	109.3
A(7-6-17)	124.4	A(7-24-22)	126.0	A(7-22-23)	121.9	A(6-7-38)	109.4	A(7-8-9)	113.2
A(6-7-18)	129.4							A(7-8-39)	109.2
								A(7-8-40)	109.2

***Physical properties*.**

Depending on the Ab initio of method of calculation according to the Hartree - Fock method (RHF), is calculate some physical properties of the molecules studied in this research ; Dipole moments (μin Debye), energies (e V) of the high Occupied Molecular Orbital (E_{HOMO})and the Lower Unoccupied Molecular Orbital (E_{LUMO})and according Koopmans theorem (the negative E_{LUMO} is equal to the ionization potential) the calculation has been ionization energies (e V) , Also calculated the energy difference (ΔE, eV), And finally calculated (Molecular Hardness) Hardness (η) = $^1/_2$($E_{HOMO} - E_{LUMO}$), (Electron Affinity) E_A= - E_{LUMO} according Koopmans theorem[25-28]. Shown these results (table 2:) that compound R-$CONH_2$ has high value for each of (Dipole moments IP). And less value in E_{HOMO} (less the value of a negative energy), And the compound (R-COOH) has less value in ΔE (sense of activity of this compound is high) and (the compound R-Suger has high value hardness (η) Electron Affinity E_A).

Also, The MOPAC computational packages (semi-empirical method, AM1 model)employed to compute physical properties; heats of formation (ΔHf^{0}, kJ. mol^{-1}) [29,30] the results showed (Table 2:) for compound R-suger has lower heat of formation (more stability), Whereas the compound R-H has higher heat has of formation (less stability),Perhaps due this result to the effect of the group substitutes for the stability the compound .

Table 2: Calculated (ΔH^{o}_{f}, (KJ $mol^{-1)}$. (in Debye). Orbital energies (E_{HOMO},E_{LUMO}, Δ E in ev), 1P(in ev), E_A (in ev), and η-(in ev) for the derivatives of 4-(2-(1H1,2,3-triezo(e-4-y1) ethoxymethyl)-1H-1,2,3-triezole.

Comp.	R-H	R-COOH	$R-CONH_2$	$R-COCH_3$	R-Suger
ΔHf^{0}	513.0275	590.7735	250.7611	232.6355	-584.9466
μ	*2.6706*	*6.1405*	*8.0186*	*3.3893*	*3.8743*
HOMO	*-9.8073*	*9.7678*	*-9.8345*	*-9.51943*	*-9.2527*
LUMO	*3.8393*	*2.3124*	*2.6518*	*2.8852*	*0.0714*
ΔE	*0.5015*	*0.4439*	*0.4588*	*12.4047*	*0.4896*
IP	*9.8073*	*9.7678*	*9.8345*	*9.51943*	*9.2527*
E_A	*-3.839*	*-2.3124*	*-2.65177*	*-2.8852*	*-0.0714*
η	*-6.8233*	*-6.0401*	*-6.2431*	*-6.2044*	*-4.6621*

Thermodynamics functions

The fundamental vibration frequencies for the (R-H,R-COOH, $R-COCH_3$, $R-CONH_2$, R-Sugar) molecules along with the rotational constants, obtained in this study, were used to calculate the vibration and rotation contributions to the thermodynamic functions according to the statistical thermodynamic equations.

$$U_{vib}^{o} = \sum_{i=1}^{3N-6} \frac{RTX_i}{e^{X_i}-1}$$

$$X_i = \frac{1.44\bar{\nu}}{T}$$

$$S_{vib}^{0} = R\sum_{i=1}^{3N-6}\left[\frac{X_i}{e^{X_i}-1} - \ln\left(1-e^{-X_i}\right)\right] \qquad S_{rot}^{0} = R\left[\frac{3}{2} + \ln\frac{8\pi^2\left(8\pi^2 I_X I_Y I_Z\right)^{\frac{1}{2}}\left(KT\right)^{\frac{3}{2}}}{\sigma\hbar^3}\right]$$

These two contributions along with the others contribution, for the translation, electronic, and nuclear motions, were used to calculate E°, H°, S°, A°, and G° thermodynamic functions. Standard thermodynamic functions and heat capacity for the studied molecules listed Table: 3 looking at the calculation results show that each of the thermodynamic functions (G°, H°,A°, E°, S°,Cp, Cv) have the same gradient values (different the group substitutes)

$$\text{R-Sugar} > R-COCH3 > R-CONH2 > R-COOH > \text{R-H}$$

The deferent thermodynamic functions values due to deferent substituted groups (X), viz, the nitrogen atom that has Ion pair and a high electro-negative in addition to its high size which makes restricted movement. (-COOH,-suger,$-OCH_3$,$-ONH_2$,-H).

Table 3: The calculated standard thermodynamics functions at 298. K of the derivatives of4-(2-(1H1,2,3,-triazole(e-4-y1) ethoxy methyl)(1-H-1,2,3-traizole.

COMP	R-H	R-COOH	R-$COCH_3$	R-$CONH_2$	R-Suger
E° KJ/mol	150.465	1195.661	1313.085	1230.213	1672.369
S° KJ/mol..K	0.4554	0.7015	0.7854	0.6881	0.91985
C_V KJ/mol..K	0.1590	0.3269	0.3585	0.3243	0.4768
H° KJ/mol	2628.035	3973.321	3790.655	3707.783	4149.939
C_P KJ/mol..K	8.473	8.6409	8.6725	8.6383	8.7908
A° KJ/mol	2356.617	3255.137	322.557	3297.677	3601.709
G° KJ/mol	2492.326	3464.184	3556.606	3502.73	3875.824

The Charges

The Calculated for all charges atoms of the molecules studied according to the method (RHF),have shown calculation results of the charges **(Table 4:)** are each of the (N_7, O_1) has high negative value in compound (R-$CONH_2$) than the other's Perhaps the reason for this difference in electrical negative of substituted group . This scientific fact indicates that the compound (R-$CONH_2$) can be strong legend when it linked to metal complex formation , as a results founds that the amount of charge of these atoms

R-CONH2> R-Sugar > R-H > R-COOH > R-COCH3

Table:4Calculated charge for the derivatives of 4-(2-(1H1,2,3,-triazole(e-4-y1) ethoxy methyl)(1-H-1,2,3-traizole calculated by (RHF)method .

R-H		*R-COOH*		*R-CONH2*		*R-COCH3*		*R-Sugar*	
Atom	*Charge*	*Atom*	*Charge*	*Atom*	*Charge*	*Atom*	*Charge*	*Atom*	*Charge*
O1	-0.7558	O1	-0.7556	O1	-0.7602	O1	-0.7435	N1	0.0427
C2	0.0957	C2	0.1016	C2	0.0994	C2	0.0606	N2	-0.3571
N3	0.0428	N3	0.1231	N3	0.1311	N3	0.0745	C3	0.0485
N4	-0.3556	N4	-0.3172	N4	-0.3294	N4	-0.2651	C4	0.17668
C5	0.0176	C5	-0.0028	C5	0.0073	C5	-0.2177	N5	-0.7075
C6	0.2039	C6	0.3050	C6	0.2771	N6	-0.7638	C6	-0.4514
N7	-0.6985	N 7	-0.8599	N7	-0.8888	N7	0.0418	C7	-0.2997
N8	0.0517	N8	0.0533	N8	0.0539	N8	-0.3571	C8	-0.2903
N9	-0.3477	N9	-0.3566	N9	-0.3574	C9	0.0478	C9	-0.2951
C10	0.0374	C10	0.0389	C10	0.0386	C10	0.1782	C10	-0.3114
C11	0.1575	C11	0.1765	C11	0.1774	N11	-0.7077	C11	-0.2938
N12	-0.6999	N12	-0.7323	N12	-0.7321	C12	-0.2997	C12	-0.0341
C 13	-0.2784	C13	-0.2997	C13	-0.4515	C13	-0.2903	C13	-0.2987
C14	0.0589	C14	-0.2903	C14	-0.2997	C14	-0.2951	C14	0.0699
H15	0.1777	C15	-0.2946	C15	-0.2903	C15	-0.3113	O15	-0.7561
H16	0.1777	C16	-0.3133	C16	-0.2946	C16	-0.2938	C16	0.1016
H 17	0.2891	C17	-0.3082	C17	-0.3133	C17	-0.0339	N17	0.0413
H18	0.4203	C18	-0.0034	C18	-0.3083	C18	-0.4515	N18	-0.3504
H19	0.2678	C19	-0.4515	C19	-0.0037	C19	-0.2957	C19	-0.0022
H20	0.4209	C20	-0.2773	C20	-0.2776	C20	0.0532	C20	0.3046
H21	0.2081	C21	0.0563	C21	0.0569	O21	-0.5737	N21	-0.7805
H 22	0.2081	O22	-0.4850	C22	1.0856	C22	-0.5159	O22	-0.7228
H23	0.1503	O23	-0.7282	O23	-0.5323	C23	0.7638	C23	0.4923
H24	0.1503	C24	1.0697	N24	-0.9487	H24	0.1696	C24	0.1695
		H25	0.1819	H25	0.1835	H25	0.1787	C25	0.1258
		H26	0.1819	H26	0.1835	H26	0.2095	O26	-0.8082
		H27	0.3239	H27	0.2911	H27	0.1888	O27	-0.7867
		H28	0.2583	H28	0.2592	H28	0.4098	O28	-0.7679
		H29	0.1515	H29	0.1540	H29	0.2623	C29	0.0427
		H30	0.1515	H30	0.1491	H30	0.1519	C30	0.1445
		H31	0.1472	H31	0.1491	H31	0.1499	C31	0.1519
		H32	0.1472	H32	0.1515	H32	0.1471	O32	-0.8040
		H33	0.1554	H33	0.1515	H33	0.1498	H33	0.2629
		H34	0.1554	H34	0.1474	H34	0.1562	H34	0.1537
		H35	0.1503	H35	0.1474	H35	0.1508	H35	0.1491
		H36	0.1503	H36	0.1555	H36	0.1497	H36	0.1503
		H37	0.1916	H37	0.1555	H37	0.1582	H37	0.1518
		H38	0.1916	H38	0.1505	H38	0.1894	H38	0.1498
		H39	0.1886	H39	0.1505	H39	0.1606	H39	0.1472
		H40	0.1887	H40	0.1916	H40	0.2152	H40	0.1499
		H41	0.1539	H41	0.1916	H 41	0.1824	H41	0.1562

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