











KINETIC STUDIES OF THE EFFECT OF ORGANIC SULPHIDES  
ON THE OXIDATION OF OTHER SULPHIDES.

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Abstract.

The rates of oxidation of three Organic sulphides viz. methyl phenyl sulphide, (P), p-methoxyphenyl methyl sulphide (M) and methyl p-nitrophenyl sulphide (N). have been obtained in ethanol using  $\text{MoO}_2(\text{acac})_2$  as catalyst and  $\text{Bu}^t\text{OOH}$  as the oxidizing agent.

A Hammett plot gave a rho value of -2.1 and the activation energies for the oxidation of P, M and N were estimated to be 63.60, 40.12 and 197.46  $\text{Kj mol}^{-1}$  respectively.

The effect of organic sulphide on the oxidation of another sulphide was also ascertained. Positive and negative deviations were observed from the expected slope.



Acknowledgements.

The author would like to express his deepest appreciation to Prof. R. R. Hiatt for his helpful supervision, encouragement, love and patience during the course of this work.

I will also like to thank Prof. E. A. Cherniak, a father and friend for deriving the kinetic equation used to fit data accumulated from the competitive kinetics.

My thanks also go to Brother Ricardo Persad formally of the Computer Science Dept. Brock Univ. for writing programs to fit equations used in analysing the kinetic data.

I also appreciate the kindness of Prof. M. F. Richardson for permitting me to use her computer to type this thesis.



Oh, What a prize! Oh What a gain.  
Christ is the goal toward which I press.  
Nothing I treasure, nor aught desire,  
But Christ of all-inclusiveness.  
My Hope, my Glory and my Crown  
Is Christ. the One of Peerlessness.

L.S.M.



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## • Conclusions

A new method has been developed for the determination of the  $\text{Mg}^{2+}$  concentration in aqueous solutions by atomic absorption spectrometry. The method is based on the formation of a complex between  $\text{Mg}^{2+}$  and  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ . The absorbance of the solution is measured at 253.7 nm. The method is simple, rapid, and accurate. The detection limit is approximately 10  $\mu\text{g}/\text{L}$ . The precision is better than 5% for samples containing 100  $\mu\text{g}/\text{L}$  of  $\text{Mg}^{2+}$ . The method can be used for the determination of  $\text{Mg}^{2+}$  in aqueous solutions, such as natural waters, industrial effluents, and pharmaceutical products.

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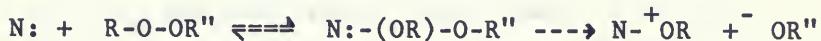
## INTRODUCTION.

### HETEROLYTIC REACTIONS OF PEROXIDES.

Hydroperoxides are chemicals which contain the group O-OH attached to C, Si, Ge, Sn, or S. Commonly encountered compounds of this group are those in which the O-OH group is joined to a carbon e.g. R-O-OH or R-(CO)-O-OH where R is an alkyl group. Presently there are various reviews (1-10) and books dealing exclusively or partially with peroxides(11-17).

Free radical reactions are common in peroxide reactions but nevertheless, some of its reactions proceed through polar mechanisms. Swern (18) spearheaded work on non-radical reactions of peroxides. Reviews on this had been done by Swern (19) Edwards (1) and Bunton (20). The study of the electrophilic behaviour of peroxides in reactions with electron pair donors has been done by Boeseken and Swern (21).

Peroxides react with a variety of substrates such as sulphides, sulfoxides, amines, hydroxylamines, olefins, phosphines, and phosphites. Edwards (1) put forward a model and general characteristics of these substrates with peroxides.



The following postulates can be put forward on the basis of the model.

- a). Reactions should follow a second order rate law (first order in peroxide and in nucleophile).
- b). Reaction rate should be related to the basicity of the leaving group,  $R''O^-$ .



c). Definite orientation of reactants in Transition State should result in a negative value of change in entropy.

d). Because of lone pair of electrons on the oxygen atom, the rate should be sensitive to acid catalysis.

It will suffice to mention here that all the substrates previously mentioned are rapidly oxidized by peroxides. Smooth oxidations by hydroperoxides require the use of catalyst.

#### CATALYSIS IN HYDROPEROXIDES REACTIONS.

The catalytic activity of the transition metal acetylacetonates  $\text{Cr}^{+3}$ ,  $\text{V}^{+3}$ ,  $\text{VO}^{2+}$ ,  $\text{MoO}_2^{+2}$ ,  $\text{Co}^{3+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Mn}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Ni}^{2+}$ ,  $\text{TiO}_2^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Zr}^{4+}$ . had been investigated in the epoxidation of 2,4,4-trimethyl-1-pentene with tert-butylhydroperoxide(22). Results showed that  $\text{Cr}^{3+}$ ,  $\text{MoO}_2^{+2}$ ,  $\text{VO}^{2+}$ ,  $\text{V}^{3+}$  compounds gave good yields of the epoxide, other metals gave either little or no epoxide at all due to decomposition of the tert-butylhydroperoxide. The effectiveness of 30 transition metal complexes in the epoxidation of 2-methyl-2pentene was studied by Sheng and Zajacek(23).  $\text{Mo}(\text{CO})_6$  and  $\text{MoO}_2(\text{acac})_2$  were found to be most effective catalysts. Sheldon (24) has shown that  $\text{Mo}(\text{CO})_6$ ,  $\text{W}(\text{CO})_6$  and  $\text{MoO}_2(\text{acac})_2$  are the best homogenous catalysts and  $\text{TiO}_2$  on  $\text{SiO}_2$  the best heterogenous catalyst in epoxidation of cyclohexene with tert-butylhydroperoxide.

The role of the catalyst in the epoxidation reaction was explained by two factors.



The first is the Lewis acidity of the catalysts which withdraws electrons from the peroxidic oxygen of the hydroperoxide, making it more susceptible to attack by nucleophile. Lewis acidity of metal complexes increases with increasing oxidation state of the metal. In agreement with this theory, catalytically active species were found to be  $\text{Mo}^{6+}$ ,  $\text{W}^{6+}$ ,  $\text{V}^{5+}$  and  $\text{Ti}^{4+}$ .

The second factor is the oxidation potential of the catalyst, i.e. its tendency to gain or lose electrons. The metals which are strong oxidants will cause decomposition of the hydroperoxide, and weaker ones will behave as catalysts. The higher activity of  $\text{Mo}^{6+}$  compared with  $\text{Cr}^{6+}$  is easily explained on the basis of these two factors. Both are good Lewis acids, but  $\text{Cr}^{6+}$  is also a strong oxidant making it a poor catalyst.

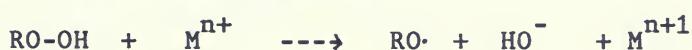
#### METAL-CATALYZED REACTIONS OF HYDROPEROXIDES.

Generally speaking metals which catalyzed reactions of hydroperoxides can be divided in two main groups. The first group, which facilitate homolysis of the O-O bond by having close lying oxidation states comprise of Co, Mn, Fe, and Cu. The second group facilitating heterolysis of the O-O bond includes Mo, V and W.

#### HOMOLYTIC MECHANISM IN METAL CATALYSIS.

Homolytic decomposition of hydroperoxides by metal ions can be divided into 3 groups.

1. REDUCTIVE CLEAVAGE.



and the resulting model can be used to predict the probability of a particular outcome occurring, given the observed variables. This type of classification model is often used in fields such as medicine, finance, and marketing to determine the likelihood of a particular event occurring based on observed variables. These models are typically built using statistical methods such as logistic regression or decision trees.

Classification models are also used in fields such as law enforcement and national security to predict the likelihood of a particular individual being involved in a criminal activity. These models are often built using machine learning techniques such as support vector machines or random forests. Classification models are also used in fields such as finance and marketing to predict consumer behavior based on observed variables such as age, gender, and income.

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2. OXIDATIVE CLEAVAGE.



3. CATALYTIC REDOX CLEAVAGE.



The most effective auto-oxidation catalysts are Co and Mn.

HETEROLYTIC MECHANISM IN METAL CATALYSIS.

Heterolytic cleavage of hydroperoxides catalyzed by metal ions such as  $Mo^{6+}$ ,  $V^{5+}$ ,  $Cr^{6+}$  and  $W^{6+}$  were studied for a wide range of organic substrates. The active oxidizing agent is the complex of the hydroperoxide with the catalyst in its highest oxidation state. This means that complexes such as  $Mo(CO)_6$ ,  $Mo^0$ ,  $W(CO)_6$ ,  $W^0$ ,  $VO(acac)_2$ ,  $V^{+4}$  are oxidized by hydroperoxide to their highest oxidation states +6 for Mo and W and +5 for vanadium and these species form complexes with hydroperoxide (23).

ACTIVATION OF CATALYSTS.

The oxidation of  $Mo^{+5}$  to  $Mo^{+6}$  by ethyl benzene hydroperoxide was observed by electron spin resonance (ESR) studies (25). ESR signals of molybdenum resinate,  $Mo^{+5}$  in ethyl benzene decreased with the addition of ethyl benzene hydroperoxide. This observed change was due to a redox process.

## CHARGE TRANSFER



Water molecule can be reduced to  $\text{H}_2\text{O}^\cdot$  by  $\text{O}(\text{H}_2\text{O})^\cdot$  and  $\text{H}_2\text{O}$ .

## CHARGE TRANSFER COMPLEXES

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QUESTION

Similar studies were done with  $\text{VO}(\text{acac})_2$  (26). The UV-Visible spectrum of  $\text{VO}(\text{acac})_2$  in ethanol gave maxima at 775 and 580nm. These were attributed to d-d transition of this complex.

Addition of excess tert-butylhydroperoxide to  $\text{VO}(\text{acac})_2$  solution caused these maxima to disappear. This pointed to the fact that the single electron responsible for the d-d transition had been removed in the oxidation process by the tert-butylhydroperoxide. Similarly, the ESR spectrum of  $\text{VO}(\text{acac})_2$  in ethanol showed 8 resonance lines which disappeared after addition of excess tert-butylhydroperoxide. The half life of the  $\text{V}^{+5}$  species was estimated to be 20s.

#### COMPLEXATION OF CATALYSTS.

Hydroperoxide-Metal complex formation was extensively studied for  $\text{MoO}_2^{+2}$ ,  $\text{VO}^{+2}$  acetylacetone and molybdenum(dioxo-bis 1,2-cyclohexanediolate) by Svitych (27,28) and Skibida (29) in their NMR work. The complexation caused the NMR signals of the proton in the O-OH group of the tert-butylhydroperoxide to be shifted and broadened.

#### METAL ION-CATALYZED EPOXIDATION OF OLEFINS.

The synthetic usefulness of hydroperoxide-Mo or V combinations, with particular reference to oxidation of alkenes and alkynes has been reviewed by Sharpless and Verhoeven (30). The kinetic and mechanistic aspects have been adequately discussed by Hiatt (31) and by Sheng and Zajacek (32).



The kinetic of epoxidation of 1- and 2-octene and 2-methyl-1-pentene in the presence of  $\text{Mo}(\text{CO})_6$  (32,33) and for cyclohexene with  $\text{VO}(\text{acac})_2$  (34) were studied. Similarly the substitution effects in aromatic systems were investigated by Howe and Hiatt (35).

The effects of catalysts, solvent, temperature, olefin structure, hydroperoxide structure, oxygen, 2-octene with p-nitrocumene, cumene, and tert-butylhydroperoxide in the presence of  $\text{Mo}(\text{CO})_6$  were investigated by Sheng and Zajacek (32,33). They showed that Mo compounds including oxides, sulphides, halides, heteropolytungstic acids, salts of heteropolytungstic acids, esters of heteropolytungstic acids and molybdenum compounds are superior catalysts in those reactions.

Non-polar solvents such as benzene and methylcyclohexane are more effective solvents than polar solvents such as ethyl alcohol and tert-butyl alcohol. Low effectiveness of the polar solvent comes from competitive reaction between the solvent and hydroperoxide for the molybdenum catalyst. Also the reaction rate increases with increase in the number of alkyl substituents on the double bond in question. The substitution of an electron withdrawing group in the para position of cumene hydroperoxide increased the rate of reaction. Presence of oxygen showed no noticeable effect on the rate, but the life span of the catalyst was reduced. Under CO atmosphere, the reaction rate is retarded due to the need to change at least one ligand with hydroperoxide. Stereospecificity of the reaction was also uncovered.



Pure cis and trans-2-butene oxidation gave exclusively the corresponding cis and trans epoxide respectively. The data obtained by Sheng and Zajacek indicate that epoxidation reaction proceeds according to the rate law

$$\text{RATE} = k_3 [t\text{-BuO-OH}][\text{Olefin}][\text{Mo}(\text{CO})_6].$$

Howe and Hiatt (35) also found this rate law to apply to the epoxidation of styrene with tert-butylhydroperoxide and molybdenum naphthanate. Epoxidation of cyclohexene by tert-butyl hydroperoxide in the presence of vanadium acetylacetone gave first order dependence on cyclohexane and catalyst in the concentration range [0.00875M - 1.795M] and [0.00006M - 0.0012M] respectively, but dependence on hydroperoxide concentration was found to be analogous to Michaelis - Menton equation for enzyme catalysis by Gould et al (34). The rate of epoxidation was reduced by tert-butyl alcohol which was a reaction product. In contrast to molybdenum catalyzed oxidation, vanadium catalyzed oxidation showed a rapid catalyst deactivation. Sheng et al (37) have reported that the epoxidation of 1,4-hexadiene with tert-butylhydroperoxide in the presence of  $\text{Mo}(\text{CO})_6$  gave predominantly the internal epoxide. When the pure cis and trans-1,4-hexadiene were reacted separately, the ratio of internal epoxide was 11:1 for the cis isomer and 6:1 for the trans.

#### KINETIC AND MECHANISTIC STUDIES OF THE EPOXIDATION.

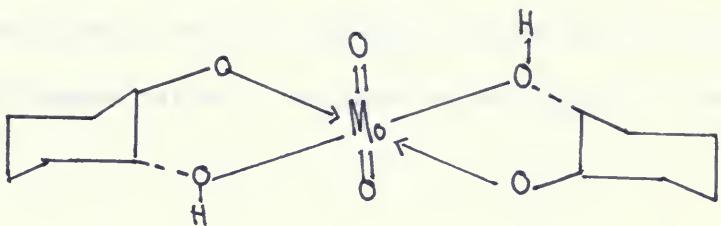
Kinetic and mechanistic studies of the epoxidation of cyclohexene and cyclooctene with tert-butylhydroperoxide were reported in a work by E.S.Gould et al (36).



Their kinetic observations were consistent with the formation of  $V^{+5}$ -Hydroperoxide complex in the vanadium catalyzed systems. In molybdenum catalyzed systems the formation of molybdenum-hydroperoxide-olefin complexes are also consistent with the kinetic data. Association constants for the molybdenum complexes were also found to be  $k_{Mo-O1} = 6.22 M^{-1}$   $k_{Mo-HP} = 21.3$ ,  $k_{Mo-HP-O1} = 0.29 M^2$ . Although  $MoO_2(acac)_2$  had a reaction rate of 100 times faster than the previously mentioned vanadium complexes, the kinetics of the molybdenum-catalyzed systems was found to be complicated.

The effect of the nature of the ligand on the catalytic activity of  $Mo^{+6}$  complexes was elucidated by Sheldon(38). The final epoxidation rates of cyclohexene with tert-butylhydroperoxide in the presence of  $Mo(CO)_6$ ,  $MoO_2(acac)_2$ ,  $MoO_2$  (propane-1,2-diol),  $MoO_2$  (trans-cyclohexane-1,2-diol)<sub>2</sub>,  $MoO_2$  (cis-cyclohexane-1,2-diol)<sub>2</sub> are similar after different initial rates. The data pointed to the fact that the same catalytic species was formed after an initial period.  $MoO_2$  (trans-cyclohexane-1,2-diol)<sub>2</sub> complex (36) was isolated from the  $Mo(CO)_6$  and  $MoO_2(acac)_2$  catalyzed epoxidation of cyclohexene with tert-butylhydroperoxide(39). This complex was also obtained from the reaction of  $MoO_2(acac)_2$  with epoxycyclohexane and tert-butylhydroperoxide in benzene in methylcyclohexane.





The hydroperoxide decomposition and epoxidation reaction became competitive when equimolar quantities of olefin and hydroperoxide were employed.

Substitution effects were studied in Mo(naph) catalyzed epoxidation of styrene with tert-butylhydroperoxide by Hiatt(35). The kinetics of the reaction showed that the reaction is first order in hydroperoxide in the range of 0.1-0.4 M, 1.5 in catalyst at lower concentrations 0-0.00002 g atom of Mo per kilogram and 0.5 at higher concentrations 0.2- 0.55 g atom of Mo per kilogram), but first order in catalyst when benzene was employed as the solvent. m-Cl, p-Cl, m-Br, p-Br, m-NO<sub>2</sub> and p-methyl substituted styrene were used in the epoxidation and second order rate constants were determined. The bi-product alcohol did not inhibit the reaction rate , but catalyst deactivation was observed.

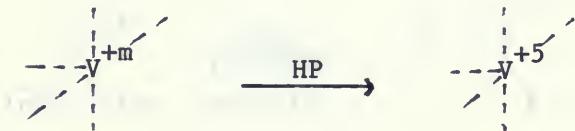


Sapunov et al (40) in agreement with Gould et al (36), had shown the formation of Mo-Olefin, Mo-hydroperoxide, and Mo-Olefin-hydroperoxide complexes when molybdenum caproate was used as catalyst for their kinetic studies.

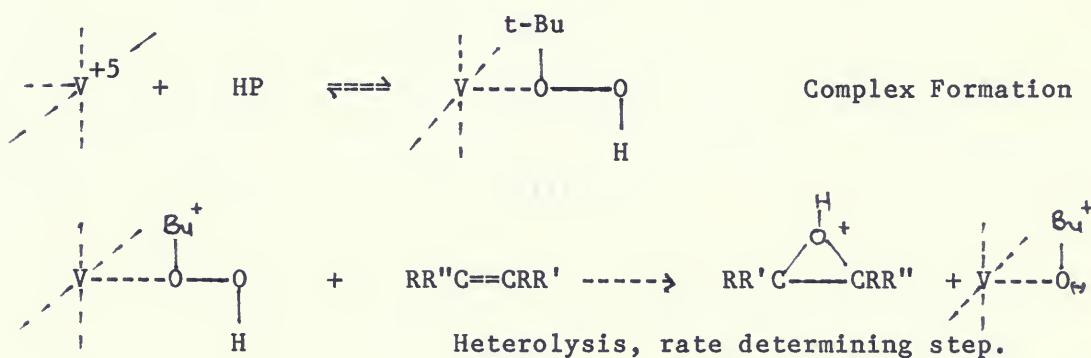
Sapunov et al (41) also studied solvent effects. He realized that solvents which have good capabilities for complex formation inhibited the reaction quite markedly. In THF and tert-butyl acetate, the reaction does not proceed. High dielectric constant solvents such as nitrobenzene, dichloroethane lower the reaction rate.

#### MECHANISM OF THE EPOXIDATION OF OLEFINS IN THE PRESENCE OF

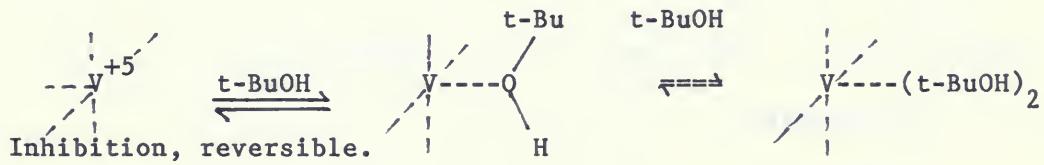
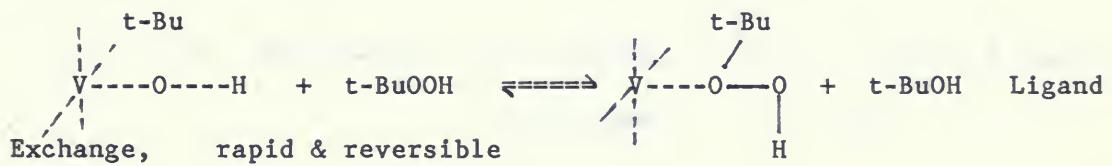
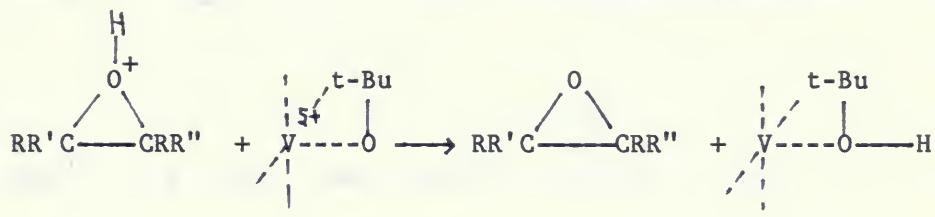
##### VANADIUM CATALYST (34)



Catalyst activation , Rapid, irreversible(34).

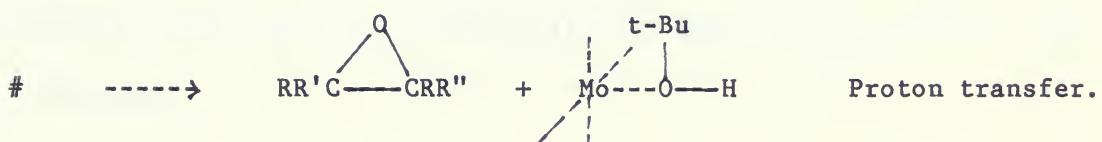
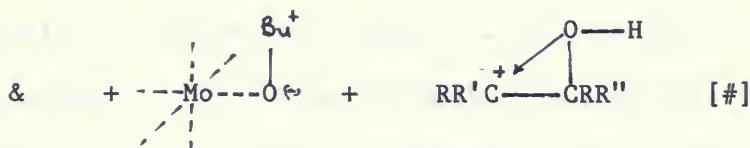
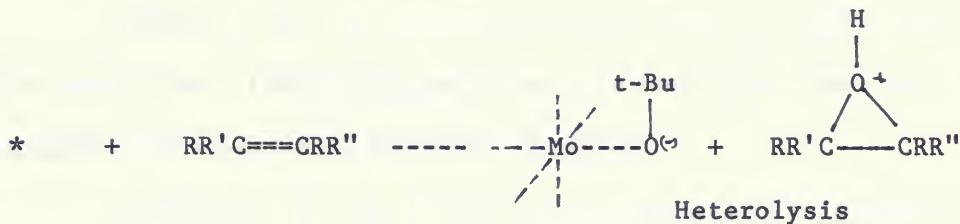
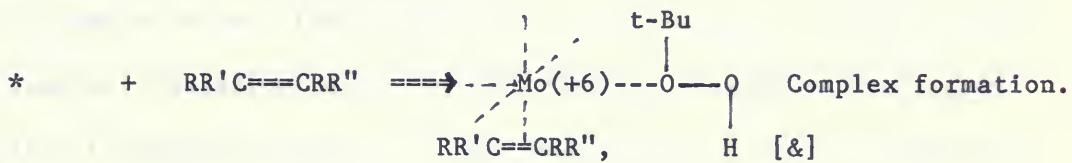
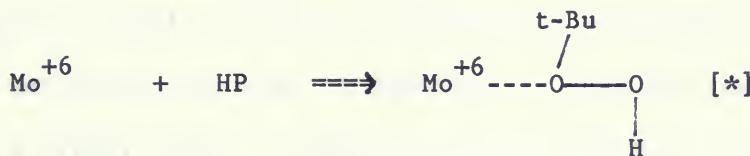
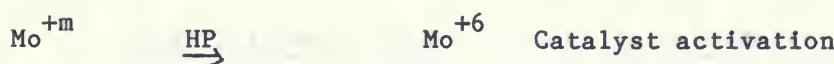








MECHANISM OF MOLYBDENUM CATALYZED EPOXIDATION OF OLEFINS.





EPOXIDATION OF ALLYL ALCOHOLS IN THE PRESENCE OF METAL ION.

Sheng and Zajacek (37) used  $\text{Mo}(\text{CO})_6$  and  $\text{VO}(\text{acac})_2$  as catalyst in their studies of epoxidation of various allyl alcohols with tert-butylhydroperoxide. In contrast to olefinic compounds,  $\text{VO}(\text{acac})_2$  gave a higher yield of epoxide than did  $\text{Mo}(\text{CO})_6$  in their reactions with allyl alcohols. As mentioned earlier on, the co-product alcohol forms complexes with vanadium better than molybdenum; therefore the higher activity of vanadium catalyst in the epoxidation of allyl alcohol was explained by the formation of vanadium-allyl alcohol complex.

Farberov et al (42) had shown that the allyl alcohol-vanadium complex caused self inhibition, and the rate decreased when the concentration of co-product alcohol increased.

Sharpless et al (43) studied the stereoselectivity of the metal catalyzed epoxidation of olefinic alcohols. The results of the epoxidation of geraniol, linalool, 4B-hydroxy-cholesterol and 3-cyclohexene-1-ol with tert-butylhydroperoxide in the presence of either  $\text{Mo}(\text{CO})_6$  or  $\text{VO}(\text{acac})_2$  catalyst showed that the epoxidations are selective and yield only one of the possible isomeric epoxy alcohols (see fig. next page).

2000-10000 years ago, the last glacial maximum.

Glaciers covered most of Northern Europe

and much of Northern America. The ice sheets were very thick, up to 4 km thick in some places. They covered most of Canada and all of Greenland. They also covered parts of the United States, including the Great Lakes and the Northeast. The ice sheets were formed by snow falling onto land and being compressed by the weight of the snow above it. This process took thousands of years. The ice sheets eventually melted, leaving behind large areas of land that are now lakes and rivers. The melting of the ice sheets caused sea levels to rise, which led to the formation of the North Sea and the English Channel.

The last ice age ended about 10,000 years ago.

Since then, the climate has been getting warmer.

This is called global warming, and it is happening now.

The last ice age ended about 10,000 years ago.

Since then, the climate has been getting warmer.

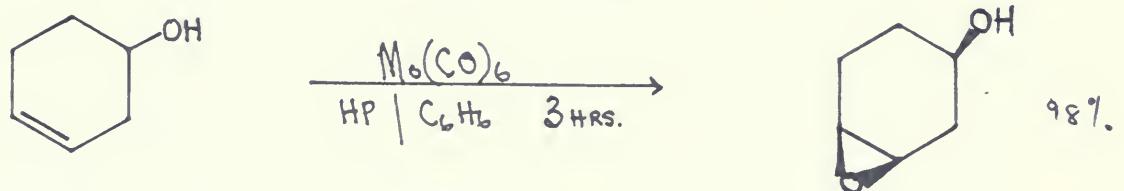
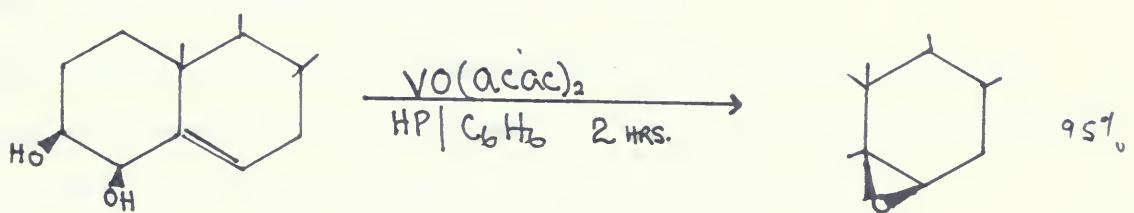
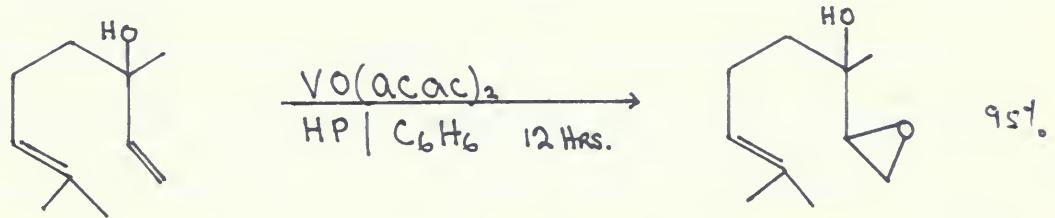
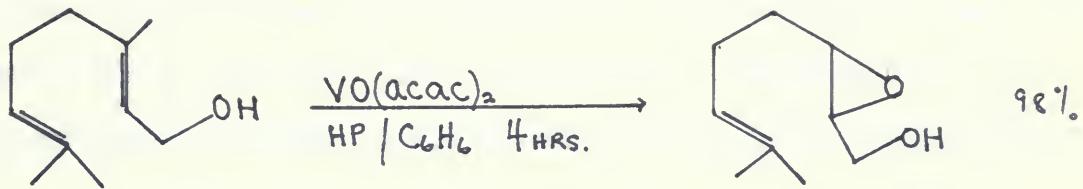
This is called global warming, and it is happening now.

The last ice age ended about 10,000 years ago.

This is called global warming, and it is happening now.

The last ice age ended about 10,000 years ago.

(continued)





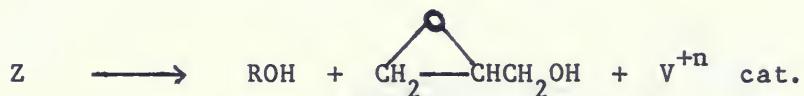
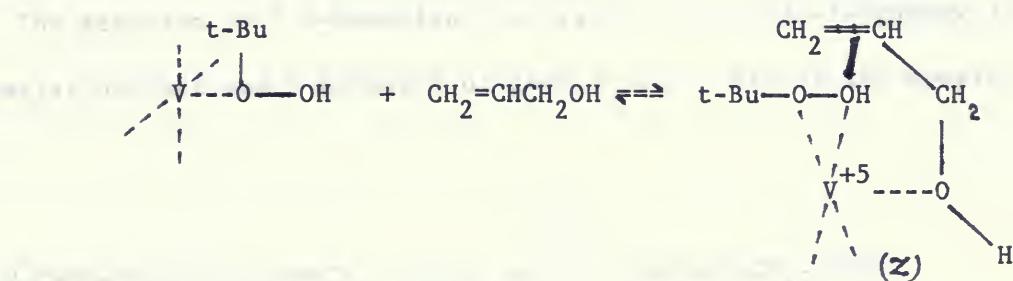
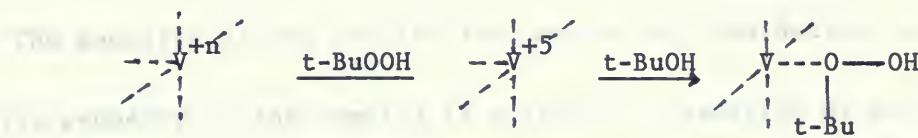
The epoxidations of 3-cyclohexene-1-ol and 2-cyclohexene-1-ol showed that homoallyl alcohols reacted faster than allyl alcohols in the  $\text{Mo}(\text{CO})_6$  catalyzed system, whereas the epoxidation of allyl alcohols is much faster in the  $\text{VO}(\text{acac})_2$  catalyzed system. The different stereoselectivity of the epoxidation of allyl alcohols in the  $\text{Mo}(\text{CO})_6$  catalyzed systems, whereas the epoxidation of allyl alcohols is much faster in the  $\text{VO}(\text{acac})_2$  catalyzed system. The different stereoselectivity of the epoxidations of acyclic allyl alcohols with tert-butylhydroperoxide in the presence of  $\text{VO}(\text{acac})_2$  and  $\text{Mo}(\text{CO})_6$  complexes, and with m-chloroperbenzoic acid were also observed (44,46). It was found that the selectivity of the epoxidation is dependent on the structure of the allyl alcohol and the oxidizing reagent. Much work has been done on the epoxidation of allyl alcohols, homoallyl alcohols and bis-homoallyl alcohols; the results are in a reviewed article by Sharpless et al (45).

#### MECHANISM OF THE EPOXIDATION OF ALLYL ALCOHOLS.

Sheng et al (37) put forward a mechanism (see next page) which says that after conversion of  $\text{V}^{+4}$  to  $\text{V}^{+5}$ , the tert-butylhydroperoxide- $\text{V}^{+5}$  complex forms first; then this complex complexes further with allyl alcohol (or vice versa) before the bond is epoxidized. This ternary complex is more stable than the hydroperoxide-vanadium complex.



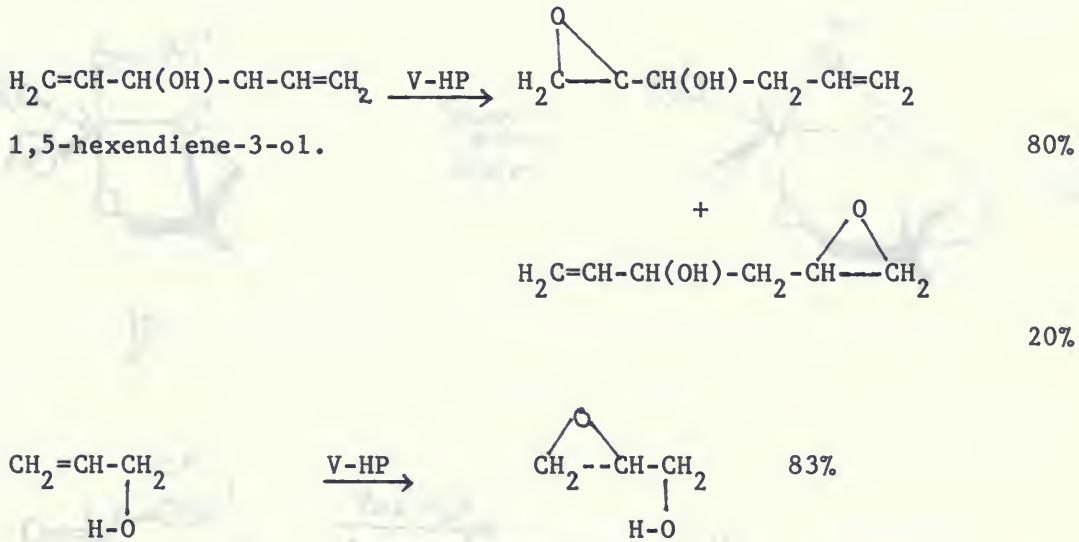
MECHANISM OF THE EPOXIDATION OF ALLYL ALCOHOLS.





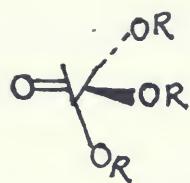
The geometry of the complex also makes the epoxidation favourable, hence if the geometry of the complex is altered by insertion of additional carbon atom(s) between the double bond and the hydroxyl group, a poor yield of epoxide was obtained.

The reaction of 1,5-hexadien-3-ol gave 1,2-epoxide-3-hydroxy-5-hexene as a major product and 5-hexene-2-ol gave a poor yield of the epoxide (37).

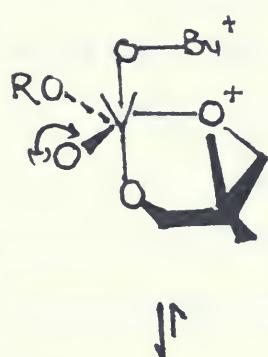
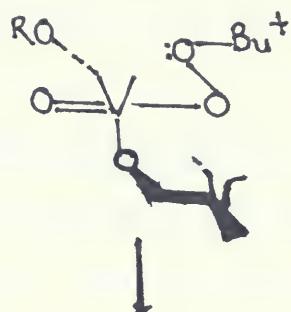


A detailed mechanism (see next page) was suggested by Sharpless (45). After the formation of  $\text{V}^{+5}$  alkoxide complex, the vanadium-tert-butylhydroperoxide and allyl alcohol complex forms. The slow step was thought to be the oxygen transfer step.

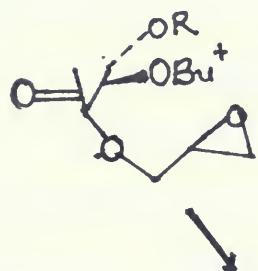
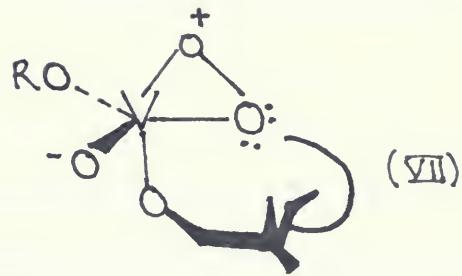




$\xrightarrow[\text{ALLYL ALCOHOL}]{\text{HP}}$

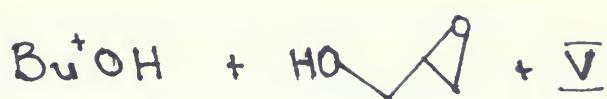


SLOW  
STEP.



$\xrightarrow[\text{ALLYL ALCOHOL}]{\text{Bu}^+\text{O}_2\text{H}}$

VI.





The epoxidation process involving the attack of olefins on peroxide reagents will be subjected to fairly rigid stereochemical requirements. The displacement on the peroxide bond occurs from the back side and along the axis of the O---O bond being broken.

#### METAL CATALYZED OXIDATION OF PHOSPHINES, ARSINES, & STIBENES.

Metal catalyzed oxidation of triphenylphosphines with tert-butylhydroperoxide gave reaction rates  $10^4$  -  $10^5$  times faster than the acid catalyzed reaction (47).

The kinetic data indicate that the oxidation reaction proceeds according to the rate law below,

$$\text{Rate} = [\text{Ph}_3\text{M}][\text{HP}][k_2+k_3\text{cat}] \quad (49.)$$

The oxidation of triphenylarsine and stilbene also follow the same rate law (48). Uncatalyzed reaction proceed together. The catalytic effect of Mo(naph) and  $\text{MoO}_2(\text{acac})_2$  were found to be the same. Molybdenum catalysts gave reaction rates 10 times faster than the vanadium catalysts. The mechanism of the reaction is similar to that suggested for olefins.

#### METAL CATALYZED OXIDATION OF AMINES & ANILINES.

Oxidation of aniline was carried out with tert-butylhydroperoxide in the presence of various catalysts such as  $\text{Mo}(\text{CO})_6$ ,  $\text{Mo}(\text{naph.})$ ,  $\text{VO}(\text{acac})_2$ ,  $\text{V}(\text{naph.})$ ,  $\text{W}(\text{CO})_6$ ,  $\text{Co}(\text{acac})_2$  and  $\text{Co}(\text{naph.})$ .  $\text{VO}(\text{acac})_2$  was found to be the most active catalyst.  $\text{VO}(\text{acac})_2$  catalyzed oxidation of aniline with tert-butylhydroperoxide gave nitrobenzene.

the same problem is considered in [10] for the case of a single agent and a single target object, and the authors show that the solution can be obtained by solving a constrained optimization problem with a quadratic cost function.

## 2. PROBLEM FORMULATION AND PRELIMINARIES

We consider a system of multiple agents moving in a 2D plane.

Let  $\mathcal{A} = \{1, 2, \dots, N\}$  denote the set of agents, and let  $\mathcal{O} = \{1, 2, \dots, M\}$  denote the set of objects.

Agents are represented by circles and objects by squares.

Position of each agent and object is denoted by

$$\mathbf{x}_i^t = (\cos(\theta_i^t), \sin(\theta_i^t))^\top \quad \forall i \in \mathcal{A}, t \in \mathbb{N}$$

respectively, where  $t$  denotes the time step, and  $\theta_i^t$  is the orientation of agent  $i$ .

Each agent has a maximum velocity  $v_{\max}$ , and each object has a maximum speed  $s_{\max}$ .

Let  $\mathbf{v}_i^t = (v_i^t \cos(\theta_i^t), v_i^t \sin(\theta_i^t))^\top$  denote the velocity of agent  $i$  at time  $t$ .

Let  $\mathbf{s}_j^t = (s_j^t \cos(\phi_j^t), s_j^t \sin(\phi_j^t))^\top$  denote the speed of object  $j$  at time  $t$ .

Let  $\mathbf{a}_i^t = (a_i^t \cos(\theta_i^t), a_i^t \sin(\theta_i^t))^\top$  denote the acceleration of agent  $i$  at time  $t$ .

## 3. PROBLEM STATEMENT AND MAIN RESULTS

We now state the problem and the main results. The problem is to find

the control inputs  $\mathbf{u}_i^t = (\dot{\theta}_i^t, \ddot{\theta}_i^t)^\top$  for each agent  $i$  at time  $t$  such that

the agent reaches its target object  $j$  at time  $t+1$  ( $\mathbf{x}_i^{t+1} = \mathbf{x}_{j+1}^t$ ) and the distance between the agent and the object is minimum.

The target object  $j$  is defined as the object with the minimum value of  $\text{AO}(s_i^t)$  among all objects, where  $\text{AO}(s_i^t)$  is the angle of approach of agent  $i$  to object  $j$ .

Let  $\text{AO}(s_i^t)$  be the angle of approach of agent  $i$  to object  $j$  at time  $t$ , and let  $\text{AO}(s_i^{t+1})$  be the angle of approach of agent  $i$  to object  $j$  at time  $t+1$ .

Then, we have

No reaction occurred in the absence of catalyst. Product analysis showed no traces of intermediates such as phenylhydroxylamine. Nitrobenzene was obtained even though the formation of 1 mole of nitrobenzene requires 3 moles of hydroperoxide.  $\text{Mo}(\text{CO})_6$  showed an induction period of about 10 minutes, during which the catalyst became the active species.

Competitive kinetic studies were done on substituted anilines and their order of activity was found to be as follows in decreasing order  $p\text{-CH}_3$ ,  $m\text{-CH}_3$  aniline,  $p\text{-Cl}$ ,  $p\text{-Br}$ ,  $m\text{-Cl}$ ,  $m\text{-Br}$ . By using appropriate  $\sigma$  and  $\sigma^+$  values versus  $\log.[k/k'']$ , good correlations were obtained in both cases with  $\rho = -1.42$  and  $-1.97$ . These results indicate an electron deficient transition state. Within the range 0.4-2.1M, aniline was found to be first order in the rate determining step but due to auto-inhibition of tert-butylhydroperoxide and catalyst degradation, the order of reaction with respect to catalyst and hydroperoxide could not be assessed. The mechanism of aniline oxidation is the same as the epoxidation mechanism.

A series of tertiary amines were oxidized with different hydroperoxides in the presence of  $\text{Mo}(\text{CO})_6$  and  $\text{VO}(\text{acac})_2$  (50). In the  $\text{Mo}(\text{CO})_6$  system containing pyridine and tert-butylhydroperoxide, the reaction rate was retarded by pyridine-N-oxide after an initial period, due to complexation of pyridine-N-oxide with molybdenum.

and the other 80% are composed of other proteins. Some of the proteins include cytoskeletal proteins, which are involved with maintaining the structural integrity of the cell. Other proteins include enzymes, which catalyze various reactions. The proteins are composed of amino acids, which are the building blocks of proteins. The amino acids are linked together by peptide bonds to form the protein structure. The proteins are also involved in various cellular processes, such as signal transduction, gene expression, and metabolism.

The proteins are composed of amino acids, which are the building blocks of proteins. The amino acids are linked together by peptide bonds to form the protein structure. The proteins are also involved in various cellular processes, such as signal transduction, gene expression, and metabolism.

A white solid consisting of molybdenum:pyridine-N-oxide:carbon monoxide in the ratio 1:2:4 precipitated from the reaction medium.  $\text{VO}(\text{acac})_2$  does not catalyze the pyridine oxidation due to strong complexation of vanadium with pyridine-N-oxide.

The difference in reactivity between amines and olefins is due to availability of unshared electron pair on the nitrogen atom.

OXIDATION OF ORGANIC SULPHIDES BY PEROXY ACIDS, HYDROGEN PEROXIDE,  
& HYDROPEROXIDE.

Reactions of organic sulphides with either hydrogen peroxide or hydroperoxide normally give the sulphoxides whereas peracids readily produce sulphones. The rate of the oxidation of sulphide to sulphoxide and sulphoxide to sulphone differ greatly. For example peracetic acid in acetic acid oxidizes diphenyl sulphide to the sulphoxide thousand times faster than the sulphoxide to sulphone (51). In contrast to the first stage of oxidation, there is little quantitative information about the second stage of oxidation. Presumably the same mechanism is operative.

OXIDATION BY PEROXY ACIDS.

Overberger and Cummins(52) examined the oxidation of p,p'-dichlorobenzyl sulphide by peroxybenzoic acid and para substituted peroxybenzoic acid in toluene and 2-propanol at -20 to -65°C.

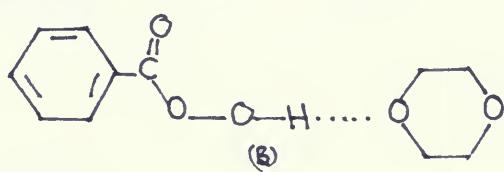
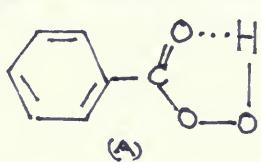
The reaction was found to be first order in peroxy acid and first order in sulphide, with no apparent catalysis from the resulting benzoic acid.



The reactions were characterized by low enthalpies of activation (5-11 kcal/mol) and large negative entropies of activation (-19 to -34 eu.). Electron withdrawing substituents on the peroxy acid increased the rate, a Hammett plot gave  $\rho = +0.91$ . The authors suggested that the reaction occurred by a nucleophilic attack of a cyclic hydrogen bonded form of the peroxy acid by sulphide.



The oxidation proceeded faster in toluene than in 2-propanol with lower energies and entropies of activation. Rate studies by Modena et al (53-55) with peroxybenzoic acid in a variety of solvents (chloroform, dichloromethane, carbon tetrachloride, benzene, nitrobenzene, dimethylformamide, dioxane, tert-butyl alcohol, 2-propanol, ethanol, methanol, 2,2,2-trifluoro ethanol) demonstrated a rate increase with a change of solvent character from basic to non-basic solvents. There appears to be a general correlation of the rates with the capacity of peroxy acids to exist in either a chelate form (A) or an open chain, solvated configuration (B).





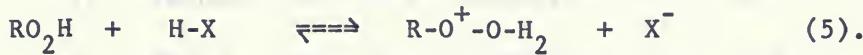
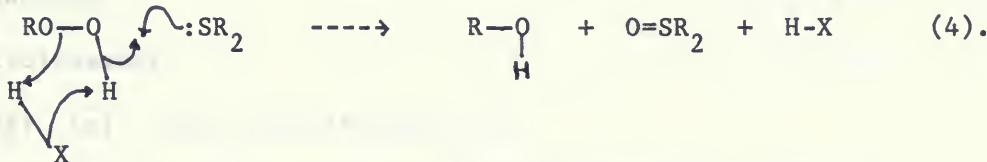
The possibility of catalysis by strong acids seems to have been little explored. However, Modena and Todesco (53) did mentioned that the presence of trifluoroacetic acid as a catalyst accelerated the reaction of diaryl sulphides with peroxybenzoic acid.

#### OXIDATION BY HYDROGEN PEROXIDE & HYDROPEROXIDE.

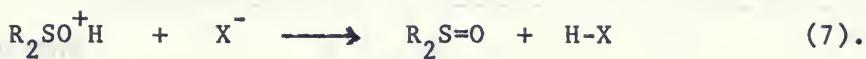
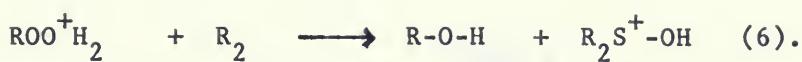
The first mechanistic studies were done by Bateman et al(56-60) using both saturated and unsaturated sulphides with tert-butylhydroperoxides. Curci and Edwards recently studied the reaction of hydrogen peroxide with thioxane. In hydroxylic solvents, the reaction is first order in hydrogen peroxide or hydroperoxide and sulphide. Free radical inhibitors had no effect on the kinetics but it was sensitive to acid catalysis. The stoichiometry is 1:1 as in equation below.



Two mechanisms are put forward to explain the above observations. The first (eq.4) consists of a one step interaction of sulphide with hydroperoxide solvent complex. The second (eq.5-7), involves an acid - base reaction between the peroxide and solvent producing  $[R-O-O-H_2]^+$  as the active oxidant.







Both mechanisms require catalytic effect of a solvent, which varies according to the acidity or added acid which assumes the role of solvent HX.

TABLE 1<sup>a</sup>.

OXIDATION OF CYCLOHEXYL METHYL SULPHIDE BY HYDROPEROXIDE.

SOLVENT	t-BuO-OH.			CYCLOHEXYNOL-OOH.		
	$k^b$	$\Delta H^\ddagger$	$\Delta S^\ddagger$	$k^{b,c}$	$\Delta H^\ddagger$	$\Delta S^\ddagger$
t-BuOH	$1.43 \times 10$	16.9	-29	$11.0 \times 10$	14.5	-32
n-BuOH	$17.10 \times 10$	14.4	-31			
MeOH	$22.00 \times 10$	13.5	-33	$165.0 \times 10$	12.0	-34
Ethylene	$230.00 \times 10$	12.1	-34	$127.0 \times 10$	10.4	-35
Benzene				$560.0 \times 10$	10.9	
Cyclohexene				$670.0 \times 10$	8.5	

NB: (a). Data from reference 58.

(b). Second Order Rate constants at  $50^\circ\text{C}$  in  $\text{M}^{-1}\text{s}^{-1}$ .

(c). Third Order Rate constants at  $50^\circ\text{C}$  in  $\text{M}^{-2}\text{s}^{-1}$ .

•  $\lambda_{\text{max}} = \frac{\pi^2}{L} \approx 0.628$  rad/m

•  $\lambda = \frac{2\pi}{k} = \frac{2\pi}{\omega/\omega_0} = \frac{2\pi\omega_0}{\omega}$  m

•  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$  m  
•  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$  m  
•  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$  m

$\lambda = \frac{2\pi}{k}$

Parameter	Value	Description
$\omega_0$	5.0 rad/s	Angular frequency at resonance
$\omega$	4.9 rad/s	Angular frequency at $\delta = -1\%$
$\delta$	-1%	Deviation from resonance
$\lambda$	6.28 m	Wavelength at $\delta = -1\%$
$\lambda_{\text{max}}$	0.628 m	Wavelength at resonance

MB: (8)  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$

•  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$  m

•  $\lambda = \frac{2\pi}{k} = \frac{2\pi\omega_0}{\omega}$  m

TABLE 2<sup>a</sup>.

## HYDROGEN PEROXIDE OXIDATION OF THIOXANE AND RELATED CASES.

SOLVENT	$k_{\text{water}}/k_{\text{sol}}$	H <sup>#</sup>	S <sup>#</sup>
ACETIC ACID	0.106	-	-
WATER	1.000	13.0	- 27
DEUTERIATED WATER	1.680	12.9	- 28
ETHYLENE GLYCOL	5.200	13.6	- 28
METHANOL	41.800	14.5	- 2
2-PROPANOL	226.000	15.3	- 30
TERT- BUTYL ALCOHOL	473.0	17.4	- 24
N-METHYL ACETAMIDE	1170.0	18.7	- 22

(a). Data from reference (61).

Evidence to support the first mechanism comes from comparison of cyclohexenyl hydroperoxide and tert-butylhydroperoxide in their reactions with cyclohexylmethyl sulphide under identical conditions. Cyclohexenyl hydroperoxide reacts faster than the tert-butylhydroperoxide (table 1<sup>a</sup>).

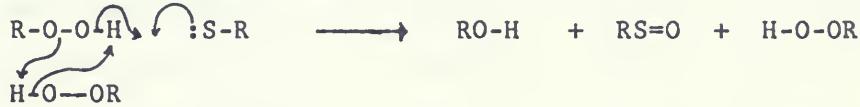
# THE 1992 WORLD BANK

Country	Population	GDP (1991)	Per Capita GDP (1991)
China	1,170,000,000	\$150 billion	\$130
India	880,000,000	\$100 billion	\$115
U.S.	250,000,000	\$1,000 billion	\$4,000
Japan	125,000,000	\$300 billion	\$2,400
United Kingdom	55,000,000	\$100 billion	\$1,800
Germany	80,000,000	\$150 billion	\$1,875
France	58,000,000	\$100 billion	\$1,750
Australia	18,000,000	\$50 billion	\$2,778
Canada	28,000,000	\$100 billion	\$3,571
South Korea	45,000,000	\$20 billion	\$444
Brazil	140,000,000	\$20 billion	\$143
Mexico	80,000,000	\$10 billion	\$125
Argentina	35,000,000	\$10 billion	\$286
Italy	55,000,000	\$100 billion	\$1,818
Spain	38,000,000	\$50 billion	\$1,316
Austria	7,000,000	\$10 billion	\$1,429
Netherlands	15,000,000	\$20 billion	\$1,333
Ireland	3,000,000	\$5 billion	\$1,733
Portugal	9,000,000	\$5 billion	\$556
Switzerland	6,000,000	\$20 billion	\$3,333
Belgium	9,000,000	\$15 billion	\$1,667
Denmark	4,000,000	\$10 billion	\$2,500
Norway	4,000,000	\$10 billion	\$2,500
Sweden	8,000,000	\$20 billion	\$2,500
Finland	4,000,000	\$10 billion	\$2,500
Malta	300,000	\$1 billion	\$3,333
Other countries	1,000,000,000	\$100 billion	\$100
Total	4,500,000,000	\$4,500 billion	\$1,000

The following table shows the population and gross domestic product (GDP) of the world's 100 largest countries.

Each country's population is given in millions. The total population of the world is 5.5 billion. The total GDP of the world is \$4,500 billion. The per capita GDP is the average GDP per person in each country.

It is also more acidic, and hence less basic towards protonation by solvent. Stronger acidity should facilitate the reaction if the first mechanism is correct, whereas weaker basicity should disfavour the equilibrium of reaction 5. The large negative entropy changes (tables 1&2) have been cited as favouring the cyclic first mechanism. However, the second mechanism, involving unstable ions and requiring solvation could very well have negative entropies of activation. Oxidation of sulphides is enhanced by electron donating groups and lowered by electron withdrawing substituents (62). The reaction is quite complicated in non-hydroxylic solvents (59). In the general case, the role of the solvent HX is played by a second molecule of hydroperoxide, and kinetically the reaction becomes second order with respect to hydroperoxide.



It is viewed as a bimolecular interaction of the sulphide with dimeric hydroperoxide. The dimer is the dominant component in the neat hydroperoxide solution as has been mentioned by Hughes and Bateman (59) in their I.R. studies. In the absence of alternative hydrogen bonding substances such as alcohols, the weakly basic product sulfoxide bonds to the hydroperoxide which retards the reaction rate. Similarly other organic bases retard the reaction.

Fractional orders (0.4-0.7) in sulphide concentration have been observed in some solvents and also oxygen catalyses the reaction as well. Addition of an acid stronger than the hydroperoxide changes the order from 2



to 1. Generally it is best to stay away from non-hydroxylic solvents.

#### METAL CATALYZED OXIDATION OF ORGANIC SULPHIDES.

Kinetic and mechanistic studies of metal-catalyzed oxidation of organic sulphides with hydroperoxide were reported by Modena et al (26, 63-70) and Koseoglu,S.S (71).

$\text{MoO}_2(\text{acac})_2$  and  $\text{VO}(\text{acac})_2$  were employed as catalysts in the oxidation of di-n-butyl sulphide (26, 63). Kinetic data accumulated point to a reaction order of one for hydroperoxide, sulphide and catalyst within the range of 0.0001-0.002 M for  $\text{VO}(\text{acac})_2$  and 0-0.00001 M for  $\text{MoO}_2(\text{acac})_2$ . A general equation describing the kinetics of sulphide oxidation is,

$$\text{Rate} = k_2[\text{HP}]^m[\text{S}]^n + k_3[\text{Cat.}]^p[\text{HP}]^q[\text{S}]^r + k_{\text{dec}}[\text{Cat.}]^s[\text{HP}]^t.$$

In systems which employs large excess of sulphide, and the ratio of hydroperoxide concentration to catalyst is greater than 8, the uncatalyzed oxidation is much lower and insignificant. Also the decomposition of hydroperoxide cannot compete with the oxidation reaction hence the rate equation becomes;

$$\text{Rate} = k_3[\text{Cat.}][\text{S}][\text{HP}]. \quad \text{or} \quad \text{Rate} = k_{\text{obs}}[\text{S}][\text{HP}].$$

$$\text{where } k_{\text{obs}} = k_3[\text{Cat.}].$$

Freshly prepared catalyst solution is required in the oxidation reaction, because the rate constants were found to be 2-20% lower when excess sulphide was added to solutions containing small amount of decomposed hydroperoxide. The  $\text{MoO}_2(\text{acac})_2$  is about 80 times better catalyst than  $\text{VO}(\text{acac})_2$ .

Multiplication Rule for Powers with the Same Base

If  $a$  is a real number,  $m$  and  $n$  are integers, then  $a^m \cdot a^n = a^{m+n}$ .

$\text{Example: } 3^4 \cdot 3^5 = 3^{4+5} = 3^9$

$$\cdot (x)^7 \cdot x^3 = x^{7+3} = x^{10}$$

$\text{Example: } 5^2 \cdot 5^3 = 5^{2+3} = 5^5$

$\text{Example: } (-2)^6 \cdot (-2)^{-3} = (-2)^{6+(-3)} = (-2)^3$

$\text{Example: } (-3)^{-2} \cdot (-3)^{-5} = (-3)^{-2+(-5)} = (-3)^{-7}$

$\text{Example: } (-4)^{-3} \cdot (-4)^{-2} = (-4)^{-3+(-2)} = (-4)^{-5}$

$\text{Example: } (-5)^{-4} \cdot (-5)^{-3} = (-5)^{-4+(-3)} = (-5)^{-7}$

$\text{Example: } (-6)^{-5} \cdot (-6)^{-2} = (-6)^{-5+(-2)} = (-6)^{-7}$

$\text{Example: } (-7)^{-6} \cdot (-7)^{-3} = (-7)^{-6+(-3)} = (-7)^{-9}$

$\text{Example: } (-8)^{-7} \cdot (-8)^{-4} = (-8)^{-7+(-4)} = (-8)^{-11}$

$\text{Example: } (-9)^{-8} \cdot (-9)^{-5} = (-9)^{-8+(-5)} = (-9)^{-13}$

$\text{Example: } (-10)^{-9} \cdot (-10)^{-6} = (-10)^{-9+(-6)} = (-10)^{-15}$

$\text{Example: } (-11)^{-10} \cdot (-11)^{-7} = (-11)^{-10+(-7)} = (-11)^{-17}$

$\text{Example: } (-12)^{-11} \cdot (-12)^{-8} = (-12)^{-11+(-8)} = (-12)^{-19}$

$\text{Example: } (-13)^{-12} \cdot (-13)^{-9} = (-13)^{-12+(-9)} = (-13)^{-21}$

$\text{Example: } (-14)^{-13} \cdot (-14)^{-10} = (-14)^{-13+(-10)} = (-14)^{-23}$

$\text{Example: } (-15)^{-14} \cdot (-15)^{-11} = (-15)^{-14+(-11)} = (-15)^{-25}$

$\text{Example: } (-16)^{-15} \cdot (-16)^{-12} = (-16)^{-15+(-12)} = (-16)^{-27}$

$\text{Example: } (-17)^{-16} \cdot (-17)^{-13} = (-17)^{-16+(-13)} = (-17)^{-29}$

$\text{Example: } (-18)^{-17} \cdot (-18)^{-14} = (-18)^{-17+(-14)} = (-18)^{-31}$

$\text{Example: } (-19)^{-18} \cdot (-19)^{-15} = (-19)^{-18+(-15)} = (-19)^{-33}$

$\text{Example: } (-20)^{-19} \cdot (-20)^{-16} = (-20)^{-19+(-16)} = (-20)^{-35}$

$\text{Example: } (-21)^{-20} \cdot (-21)^{-17} = (-21)^{-20+(-17)} = (-21)^{-37}$

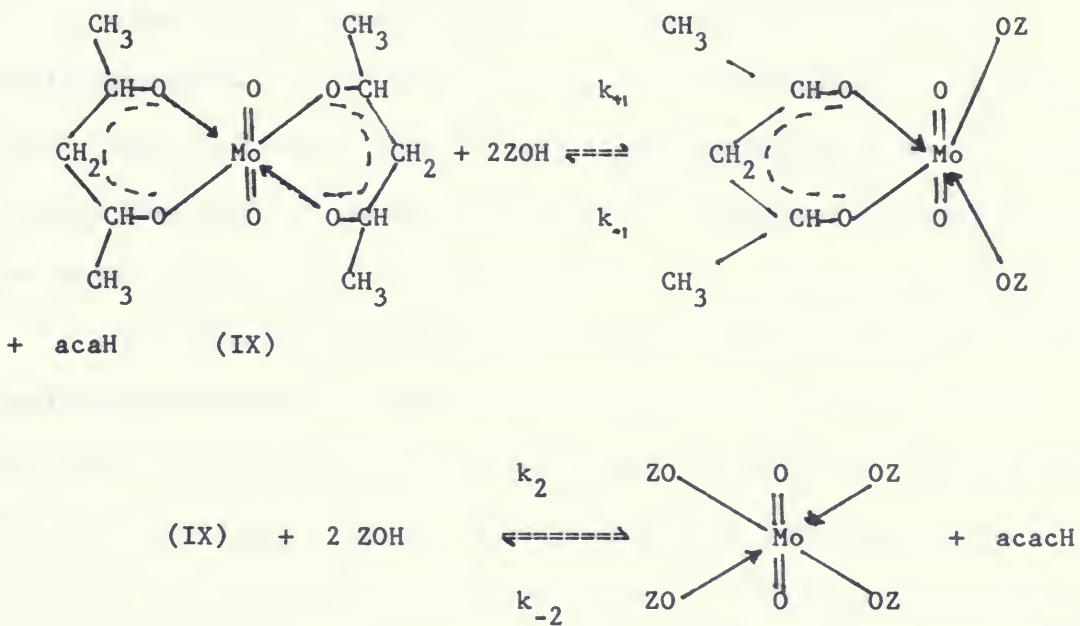
$\text{Example: } (-22)^{-21} \cdot (-22)^{-18} = (-22)^{-21+(-18)} = (-22)^{-39}$

$\text{Example: } (-23)^{-22} \cdot (-23)^{-19} = (-23)^{-22+(-19)} = (-23)^{-41}$

A Hammett plot was obtained from the  $\text{VO}(\text{acac})_2$  catalyzed oxidation of p-methyl, H, Cl,  $\text{NO}_2$  substituted methyl phenyl sulphide with hydrogen peroxide. A rather low rho value (- 0.5) was obtained compared to the acid catalyzed reaction of arylmethyl sulphides with the oxidizing agent; rho = -1.13 (72). However, the sign of the rho value was as expected.

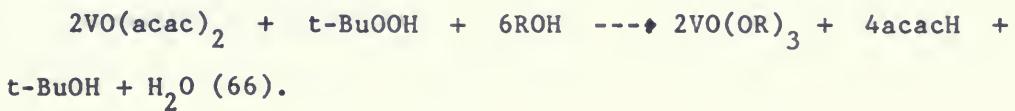
The effect of different alcohols (methanol, ethanol, and 2-propanol was studied in the  $\text{MoO}_2(\text{acac})_2$  catalyzed oxidation of di-n-butyl sulphide with tert-butylhydroperoxide (68). The third order rate constants for 2-propanol, ethanol and methanol were found to be 320, 160, and 6  $\text{mol}^{-2} \text{s}^{-1}$  respectively. The reactivity of these systems gave opposite results to those expected on the basis of alcohol acidity. In the uncatalyzed oxidation, the rate constants which are opposite to the rate constants of catalytic oxidation are 1, 1.4, and 4 for 2-propanol, ethanol and methanol respectively. Acetylacetone showed retardation of reaction similar to that of CO in the  $\text{Mo}(\text{CO})_6$  catalyzed reaction when  $\text{MoO}_2(\text{acac})_2$  was employed as catalyst. The reaction in ethanol is 100 times faster than the uncatalyzed, and the addition of 0.002M of acetylacetone suppressed the reaction to four times as fast as the uncatalyzed system. Modena (68) showed that  $\text{MoO}_2(\text{acac})_2$  was in equilibrium with the solvent alcohol before peroxide containing catalytically active species formed. NMR studies were consistent with the equilibration.

and the *influence* of the *surrounding environment*.  
Introducing a new variable, we can also distinguish between two types of  
learning: *habituative* and *associative*. In the first type, the animal is not  
able to learn to associate different situations. In the second, however,  
the animal can learn to associate different situations (SV) with different  
reinforcement rates. Moreover, the latter is more difficult to measure.  
Individual differences in learning capacity: On the one hand, there is  
individual variation in the rate at which different animals learn new skills.  
This is often interpreted as individual differences in cognitive competence.  
On the other hand, individual differences in learning capacity are often  
interpreted as individual differences in motivation or interest in learning.  
Thus, it is often assumed that the rate at which an animal learns something  
depends on its intrinsic motivation to learn and its ability to learn.  
However, this is not always the case. There are also individual differences  
in the rate at which an animal learns something, even if it has the same  
motivation and the same cognitive abilities as other animals.  
It is also known that some animals learn faster than others, even if they  
have the same motivation and cognitive abilities.  
For example, *laboratory rats* learn faster than *domestic cats*, even though  
they have the same motivation and cognitive abilities.  
This suggests that there are other factors that influence the rate at which  
an animal learns something.  
One such factor is the *environmental complexity*. If the environment is  
complex, it is more difficult for the animal to learn new skills. This is because  
the animal has to learn how to navigate through the complex environment  
and find the reward. This requires more time and energy, which may  
result in slower learning.



The importance of ligand displacement was shown for catalytic activity of the complex. Metal ions with tightly held ligands such as  $\text{MoO}_3$  (dien) and  $\text{Na}[\text{Mo}_2\text{O}_6 \text{EDTA}]$  are poor catalysts whereas those with loosely held ligands such as  $\text{MoO}_2(\text{acac})_2$  and  $\text{MoO}_2$  quinolin-8-ol are good catalysts in the epoxidation of cyclohexene by tert-butylhydroperoxide (73).

Modena et al had shown that  $\text{VO}(\text{OR})_3$  or preferably  $\text{VO}(\text{OR})_2\text{OOR}$  are the catalytically active species which form as shown by the equation below by exchange of ligand in the  $\text{VO}(\text{acac})_2$  catalyzed systems.

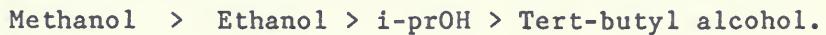






Spectroscopic and potentiometric experiments showed that acetylacetone was completely removed from the co-ordination sphere of the metal, and in alcoholic mediums fast ligand exchange of the  $\text{V}^{+5}$  species occurs. NMR study of ligand exchange of  $\text{V}^{+5}$  alkoxides is consistent with the above results (74).

The rates of oxidation of di-n-butyl sulphide with tert-butylhydroperoxide, catalyzed by  $\text{MoO}_2(\text{acac})_2$  in pure benzene and benzene-ROH mixtures (R = methyl, ethyl, isopropyl, or tert-butyl.) were determined by Modena et al (69). Addition of small amounts up to a moderate concentration increased the rate to a maximum; and then decreased with increasing alcohol concentration. The degree of reaction rate depression was found to be dependent on the type of alcohol. The effect of the alcohols tested was in the following order,



This was due to :

- 1). The capability of alcohols to displace original ligands (acac).
- 2). Involvement in the transition state.
- 3). Competitive complexation of alcohols with hydroperoxides.

In contrast to Modena et al, Koseoglu (71) has shown that sulphide plays an important role in the oxidation of sulphide to sulphonide. The oxidation of diphenyl sulphide with tert-butylhydroperoxide in the presence of  $\text{Mo}(\text{CO})_6$  gave diphenyl sulphonide and diphenyl sulphone. The rate equation was given as,



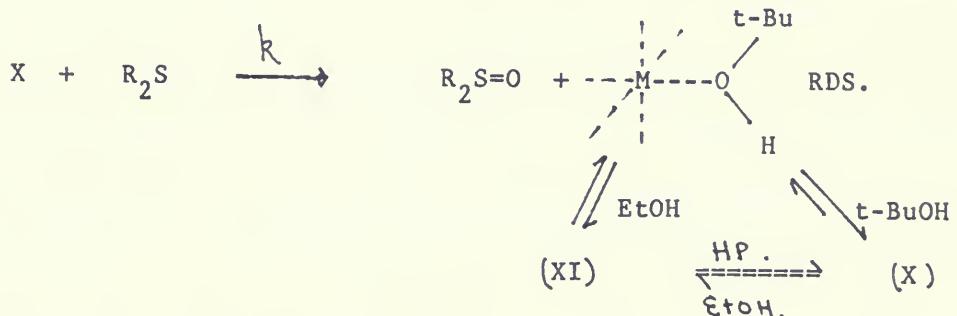
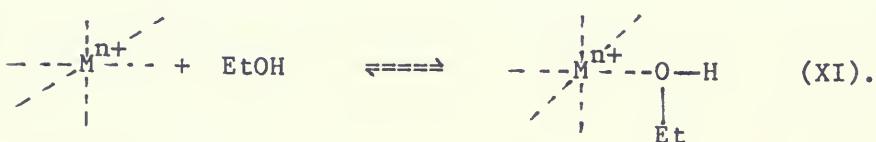
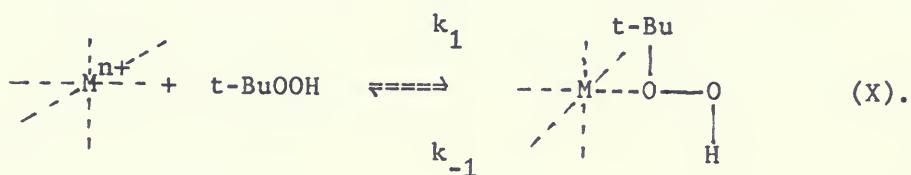
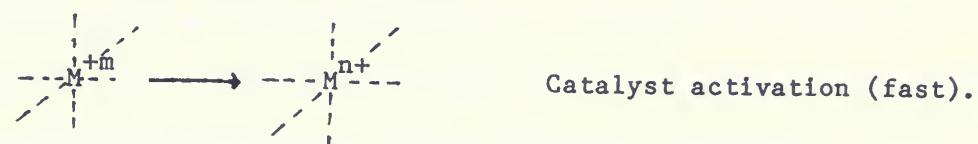
$$\text{Rate} = k_3 [S][\text{Cat}][\text{HP}] + k_3' [\text{HP}][\text{SO}][\text{Cat}].$$

The third order rate constants were found to be  $17.2 \text{ M}^{-2} \text{ s}^{-1}$  and  $1.55 \text{ M}^{-2}$  per sec. in ethanol at  $35^\circ\text{C}$  for the oxidation of diphenyl sulphide and diphenyl sulphoxide respectively. Diphenyl sulphoxide under the same conditions did not react. Seemingly large amounts of the diphenyl sulphide is required for the oxidation of diphenyl sulphoxide. Use of  $\text{VO}(\text{acac})_2$  as catalyst gave a rate constant of  $2.35 \text{ M}^{-2} \text{ s}^{-1}$ .



MECHANISM OF THE METAL CATALYZED SULPHIDE OXIDATION.

Sulphide oxidation occurs generally by the nucleophilic attack of the sulphide at the O-O bond of the hydroperoxide-metal [V<sup>+5</sup> or M<sup>+6</sup>] ion complex (26).





The aim of this project is mainly concerned with the kinetic studies of the effect of organic sulphide on the oxidation of other sulphides. The compounds of interest are methyl phenyl sulphide (P), p-methoxyphenyl methyl sulphide (M) and methyl p-nitrophenyl sulphide (N). The reaction is carried out in absolute ethanol using  $\text{MoO}_2(\text{acac})_2$  as catalyst and t-butyl hydroperoxide as the oxidizing agent. The effect was studied by performing competitive kinetics on a mixture of two different sulphides.



## EXPERIMENTAL.

### APPARATUS:

Infra-red spectra were recorded on a Perkin Elmer 710B grating infra-red spectrometer.  $^1\text{H}$  Nuclear Magnetic Resonance were obtained on a Bruker WP-80 CW N.M.R. spectrometer with TMS as internal standard and  $\text{CDCl}_3$  as solvent. GC MS were obtained on an AEI MS-30 double beam mass spectrometer which is interfaced to a Pye Gas Chromatograph. For UV analysis, Varian DMS 100 UV-Visible spectrophotometer with a micro processor and an Epson plotter were used. GC. analyses were performed on an F&M 700 Laboratory Gas Chromatograph with a thermal conductivity detector.

### REAGENTS:

The commercially available reagents which were used in this work are listed in the table below. They were used without any purification except  $\text{MoO}_2(\text{acac})_2$  and ethanol.

### PURIFICATION OF $\text{MoO}_2(\text{acac})_2$ .

$\text{MoO}_2(\text{acac})_2$  was recrystallized by dissolving the commercial product in warm acetylacetone. Ligroin was then added, the protecting material was then filtered off and pure yellow  $\text{MoO}_2(\text{acac})_2$  precipitated on standing in nitrogen atmosphere. The crystals were filtered off, washed with ligroin, dried and kept under nitrogen atmosphere.



PURIFICATION OF ABSOLUTE ETHANOL:

Absolute ethanol was refluxed with MgO and distilled. The ethanol was again refluxed with EDTA, distilled and kept over 4A° molecular sieves.

REAGENTS PURCHASED AND USED.

CHEMICAL	SOURCE	PURITY
THIOANISOLE	ALFA PRODUCTS	99%
p-CHLORONITROBENZENE	ALDRICH CHEMICAL COMPANY	99%
4-(METHYLMERCAPTO)PHENOL	" " "	-
t-BUTYLHYDROPEROXIDE	LUCIDOL	90%
MoO <sub>2</sub> (acac) <sub>2</sub>	K & K	-
ABSOLUTE ETHANOL	COMMERCIAL	-
METHYL IODIDE	ALDRICH CHEMICAL COMPANY	99%
POTASSIUM IODIDE	B. D. H. CHEMICALS	99.5%
SODIUM SULPHIDE NANOHYDRATE	ANALAR	-
GLACIAL ACETIC ACID	B.D.H. CHEMICALS	99.5%
SODIUM METAPERIODATE	BAKER ANALYZED REAGENT	100.0%
ISOPROPANOL	COMMERCIAL	

SYNTHESIS OF COMMERCIALLY UNAVAILABLE REAGENTS

1). PREPARATION OF METHYL p-NITROPHENYL SULPHIDE:

The method of C.C.Price et al (76) was employed to prepare the corresponding thiol. An alcoholic solution of sodium disulphide nanohydrate which was prepared from 175.3g (1 mole) of the substance and 23.4g (0.73 moles) of sulphur in 95% ethanol was poured into a boiling



solution of p-nitrochlorobenzene (157.5g) in 250ml of 95% ethanol over a period of 20 mins. A solution of NaOH containing 40g of the solid in 50ml of distilled water was prepared. About 100ml of 95% ethanol was added to the NaOH solution and the whole mixture was poured into the boiling solution over a period of 30 mins. The entire mixture was boiled under reflux for an hour, then cooled and poured into 1Kg. of crushed ice and 1,500ml of distilled water. The precipitate was filtered off and the filtrate was acidified with conc. HCl until all the p-nitrothiophenol precipitated out. The yellow precipitate was filtered off and washed with 500ml of distilled water. This was then dissolved in 150ml of 95% ethanol to which 40g (1 mole) of NaOH in 1,500ml of water was added. The solution was filtered again and the p-nitrothiophenol was re-precipitated with conc. HCl. The p-nitrothiophenol was dried in a dessicator containing  $P_2O_5$ . The yield was about 43%. Melting point was 76-78.5°C.

The process of methylation of the thiophenol was done following the method of C.M.Suter et al (75). 47g (0.30moles) of p-nitrothiophenol and 50g (excess) of methyl iodide were added to the solution of sodium ethylate prepared by dissolving 12g (0.52 moles) of Na in 225ml of absolute ethanol, and the mixture refluxed for 2.5 hours. The ethanol was removed by distillation, and the reaction mixture poured into water. The crude product was extracted with ether and dried using anhydrous sodium sulphate. The ether was evaporated on a steam bath. 33g (70%) yield of the pure methyl p-nitrophenyl sulphide was obtained after three recrystallizations from methanol.

Следует отметить, что в последние годы в Канаде наблюдается тенденция к уменьшению количества иммиграции из Европы и Азии, а также из Южной Америки. Вместо этого, большая часть иммиграции приходит из Китая, Индии, Пакистана, Бангладеш, Нигерии, Ганы, Сомали и других стран Африки. Это связано с тем, что Канада стала более привлекательной для иммигрантов из развивающихся стран, где растут экономика и социальные стандарты. В то же время, Канада остается популярным направлением для иммиграции из развитых стран Европы и Америки.

The methyl p-nitrophenyl sulphide was further identified by  $^1\text{H}$  NMR. The  $^1\text{H}$  NMR spectrum of the compound showed signals at delta = 2.5 (3H, singlet), 7.1-8.2 (4H, multiplet). Melting point was 78-80°C

#### PREPARATION OF p-METHOXYPHENYL METHYL SULPHIDE

This compound was prepared by methylation of 4-(methylmercapto)phenol by methyl iodide in sodium ethylate solution. The same procedure as before(75) was used.

75.13g (0.54 moles) of 4-(methylmercapto)phenol, 77g (excess) of methyl iodide and a solution of sodium ethylate 13g (0.595 moles) of the sodium in 300ml of absolute ethanol were used. 35g (42.5%) of p-methoxyphenyl methyl sulphide were obtained. The identity and purity of the compound were established by  $^1\text{H}$  NMR and GC, MS analyses. The  $^1\text{H}$  NMR spectrum showed peaks at delta = 2.3 (3H, singlet), 3.6 (3H, singlet), and 6.6-7.4 (4H, multiplet).

#### PREPARATION OF METHYL PHENYL SULPHOXIDE.

Methyl phenyl sulphoxide preparation was done following C.R.Johnson's (78) method. 3g. (0.024 moles) of methyl phenyl sulphide was added to the solution of sodium metaperiodate in water. Approximately 100ml of methanol was added to dissolve the sulphide. The system was stirred and kept in an ice bath for a day. The precipitated sodium iodate was removed by filtration and the filtrate extracted with chloroform. The extract was dried over anhydrous sodium sulphate, and the solvent was removed using a rotary evaporator. The pure sulphoxide was distilled under reduced pressure. 2g. of methyl phenyl sulphoxide was obtained. The  $^1\text{H}$  NMR spectrum showed signals at delta = 2.7 (3H, singlet) and 7.4-7.8 (5H, multiplet).

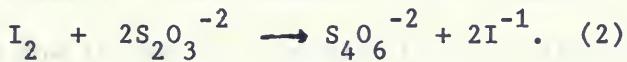


KINETIC STUDIES: OXIDATION OF ORGANIC SULPHIDES BY HYDROPEROXIDE.

Koseoglu, S.S. (71) found that pre-mixing and pre-equilibration of solutions gave reproducible results, therefore the same procedure was followed.

The catalyst,  $\text{MoO}_2(\text{acac})_2$ , was dissolved in absolute ethanol in a 25ml volumetric flask and 4-5ml of the catalyst solution was added to the appropriate sulphide in 250ml round bottomed flask. The solution of tert-butylhydroperoxide was prepared in a liter volumetric flask using absolute ethanol. Both solutions were then equilibrated for at least two hours at reaction temperature. Reactions were carried out under nitrogen atmosphere. 2ml aliquots were taken at different time periods and the disappearance of t-BuOOH was estimated by iodometric method. It will suffice to mention here that in the case of methyl p-nitrophenyl sulphide the hydroperoxide was not pre-equilibrated because of extensive expansion of the solution at the temperature of studies.

TITRATION: Standard sodium thiosulphate was titrated against iodine which was produced from the oxidation of iodide ion by tert-butylhydroperoxide Eq.(1) to give iodide ion Eq.(2).



and the corresponding  $\lambda$  values. In this case, we find that  $\lambda = 0.001$  is a good choice and the corresponding  $\mu$  value is  $\mu = 0.001$ . The corresponding  $\lambda$  and  $\mu$  values are used in the numerical simulations.

Figure 3 shows the results of the numerical simulations. The figure consists of four subplots, each showing the evolution of the system over time. The top-left subplot shows the evolution of the variable  $x_1$ , which starts at 1.0 and decreases rapidly towards zero. The top-right subplot shows the evolution of the variable  $x_2$ , which starts at 0.0 and increases rapidly towards one. The bottom-left subplot shows the evolution of the variable  $x_3$ , which starts at 0.0 and increases slowly towards one. The bottom-right subplot shows the evolution of the variable  $x_4$ , which starts at 0.0 and remains near zero throughout the simulation. The figure also includes a legend indicating the four variables and their corresponding colors.

Figure 4 shows the results of the numerical simulations for different initial conditions. The figure consists of four subplots, each showing the evolution of the system over time for a different initial condition. The top-left subplot shows the evolution of the variable  $x_1$  for an initial condition where  $x_1 = 0.5$ ,  $x_2 = 0.5$ ,  $x_3 = 0.5$ , and  $x_4 = 0.5$ . The top-right subplot shows the evolution of the variable  $x_2$  for the same initial condition. The bottom-left subplot shows the evolution of the variable  $x_3$  for the same initial condition. The bottom-right subplot shows the evolution of the variable  $x_4$  for the same initial condition. The figure also includes a legend indicating the four variables and their corresponding colors.

The titration flask contained 20:80 glacial acetic acid: 2-propanol mixture with excess potassium iodide. 2ml of the reaction mixture was pipetted into this and refluxed for about 3 mins. and then titrated. It is appropriate to mention here that in the case of methyl p-nitrophenyl sulphide, water and starch indicator were added half-way during the titration.

#### GAS CHROMATOGRAPHIC ANALYSIS.

##### PREPARATION OF COLUMNS:

100g of Chromosorb P 80/100 mesh were weighed and a solution prepared by dissolving 20g of Carbowax 20M in 200ml chloroform was poured onto evaporating dish to dry. The dried mixture was packed into firstly 0.25 inch x 6 feet copper column and secondly into a teflon column.

An F & M gas chromatograph with a thermocouple detector was used. Helium was the carrier gas. A 5-10 micro liter sample was injected. The GC conditions were,

a). Oven temperature =  $180^{\circ}\text{C}$  , Detector temp. =  $350^{\circ}\text{C}$ .

Injection port temp. =  $250^{\circ}\text{C}$  Helium flow =  $75\text{ml min}^{-1}$

Although good separations were obtained for absolute ethanol, methyl phenyl sulphide and its sulphoxide analogue, no peaks were observed for methyl p-nitrophenyl sulphide and its sulphoxide derivative. This might be due to the low concentrations of the substrates used, the nitro-derivatives being very insoluble in absolute ethanol.

functionality and the ability to make a significant contribution to the field of  
information systems research. The contributions of this paper are summarized below.  
The first contribution is the development of a conceptual model of the relationship between  
the information system and its environment. This model is based on the idea that the  
information system is a complex system that interacts with its environment in a dynamic  
and non-linear way. The second contribution is the development of a methodology for  
the design and implementation of information systems that is based on the principles of  
complexity theory.

REFERENCES

### Complexity Theory and Information Systems

Complexity theory has been applied to information systems in several ways:

1. As a way of understanding the behavior of information systems. This approach has been used to study the dynamics of information systems, such as the way they change over time and how they interact with their environment. This approach has been used to study the dynamics of information systems, such as the way they change over time and how they interact with their environment.

2. As a way of designing information systems. This approach has been used to design information systems that are more robust and able to handle uncertainty and change.

3. As a way of implementing information systems. This approach has been used to implement information systems that are more efficient and effective.

4. As a way of evaluating the performance of information systems. This approach has been used to evaluate the performance of information systems in terms of their ability to handle uncertainty and change.

5. As a way of improving the quality of information systems. This approach has been used to improve the quality of information systems by identifying and addressing the causes of errors and inefficiencies.

Complexity theory has been applied to information systems in several ways:

- 1. As a way of understanding the behavior of information systems. This approach has been used to study the dynamics of information systems, such as the way they change over time and how they interact with their environment. This approach has been used to study the dynamics of information systems, such as the way they change over time and how they interact with their environment.
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- 3. As a way of implementing information systems. This approach has been used to implement information systems that are more efficient and effective.
- 4. As a way of evaluating the performance of information systems. This approach has been used to evaluate the performance of information systems in terms of their ability to handle uncertainty and change.
- 5. As a way of improving the quality of information systems. This approach has been used to improve the quality of information systems by identifying and addressing the causes of errors and inefficiencies.

### COMPETITIVE KINETICS.

In this kind of kinetics two different organic sulphides were oxidized simultaneously in the same medium, to determine (if any) the effect of one on the other. The two sulphides of interest were dissolved in absolute ethanol and a known concentration of the catalyst was added and the whole system was equilibrated at the reaction temperature for about two hours. At the end of this time a known volume of a standard t-butyl hydroperoxide solution was added and the timer was started simultaneously. At known time intervals 2ml aliquots were pipetted and the amount of hydroperoxide consumed was estimated. A plot of  $\ln F$  versus time was carried out and the observed slope was compared with the expected.

The equation used for the evaluation of competitive kinetic data is given as

$$\ln F = R t$$

$$\text{where } F = \frac{[C]_0 (k_1 [A]_0 + k_2 [B]_0 + [f(k_2 - k_1) - k_2] ([C]_0 - [C]))}{(k_1 [A]_0 + k_2 [B]_0) [C]}$$

$$R = k_1 [A]_0 + k_2 [B]_0 + [C]_0 [f (k_2 - k_1) - k_2]$$

$$f = \frac{k_1 [A]_0}{k_2 [B]_0 + k_1 [A]_0}$$

See appendix for definition of terms.



ULTRA VIOLET SPECTRAL ANALYSIS.

The results from the kinetic studies seem to point to the fact that the presence of the nitro-derivative suppresses the over-all rate of oxidation. It was therefore decided to see whether the nitro group has any effect on the catalyst. The UV spectra of the sulphides alone and the sulphides in the presence of the catalyst (pre-equilibrated) were noted.



## RESULTS

Oxidations were carried out on three organic sulphides, methyl phenyl sulphide, p-methoxyphenyl methyl sulphide and methyl p-nitrophenyl sulphide, each singly at three temperatures, and then in pairwise mixtures, also at three different temperatures. For each circumstance, no fewer than six and seldom less than nine or ten runs were performed. The results are summarized in the following two tables, with more detailed information given in the subsequent tables and graphs.

For individual sulphides, the summary reports mean third order rate constants, ( Rate =  $k_3$  [Mo] [RSR'] [ROOH] ) together with standard deviations expressed as a percentage of the mean value, where

$$\text{Variance} = (k_1 - k')^2 / (N-1)$$

$$\text{Standard deviation} = (\text{variance}/N)^{.5}$$

Since 95% confidence limits may be expressed as + 2 standard deviations, it will be noted that in most cases 95% confidence is within + 2% of the mean  $k_3$  value or less, and in no case is it greater than + 4%.

The summary table for mixtures compares observed and "expected" slopes for the data treated as if the two sulphides reacted independently, (appendix, page 108). Standard deviations and confidence limits for the observed slopes may be calculated in the usual way. Error in the "expected" slope, R, for sulphides

$$R = k_a A_o + k_b B_o + C_o [f(k_b - k_a) - k_b]$$

$$f = k_a A_o / (k_a A_o - k_b B_o).$$



A and B with individual rate constants  $k_a$  and  $k_b$  is not a simple function of the errors inherent in  $k_a$  and  $k_b$ , but rather depends on relative magnitudes of the several constants. Calculations with sample numbers show two types of behaviour. In the M + P mixtures , where  $A_o$  is approximately equal to  $B_o$ ,  $k_a$  is approximately equal to  $k_b$  and  $C_o$  is small, a 2% increase in both  $k_a$  and  $k_b$  results in a 2% increase in the calculated value of R. If  $k_a$  is increased by 2% and  $k_b$  is decreased by 2%. there is no change in R. In this case, then, the effect is linear and confidence limits in  $k_a$  and  $k_b$  can be directly applied to R.

In mixtures of M + N or P + N, however, where the concentration of N, ( $B_o$ ), is limited by solubility and  $k_b$  is small relative to  $k_a$ , only errors in  $k_a$  are reflected in R. Increase or decrease in  $k_b$  by a factor of 10 change the value of R by less than 1%. This is as it should be, of course, since the nitro compound, by itself, does not react appreciably at the temperatures where the mixtures were carried out. Given complete independence of reaction, it should be only an inert diluent.

It is then clear that while the differences between observed and "expected" slopes may appear numerically small, they are statistically significant. If one were to assume a "worst case", with standard deviation of 2% in both rate constants and observed slopes, there is only one of the nine comparisons that would fail a 97.5% level of confidence test.



SUMMARY OF THIRD ORDER RATE CONSTANTS FOR INDIVIDUAL SULPHIDES.

$k_3 \text{ M}^{-2}$ , (Number of Runs), (Standard Deviation in %).

T°C	P	M	N <sup>1</sup>
21	588. (10) (1.1%)	1290 (10) (0.7%)	27.3
29	1200. (10) (0.8%)	2280 (10) (0.6%)	72.8
38	2770. (10) (0.8%)	2970 (10) (1.6%)	206.

1 extrapolated from measurements at 60°C [ $(2050 \text{ M}^{-2} \text{ min}^{-1})$  (6)  
(1.9%)], 65°C [ $3470 \text{ M}^{-2} \text{ min}^{-1}$  (6) (0.1%)] and 70°C [ 5310  
 $\text{M}^{-2} \text{ min}^{-1}$  (6) (-)]

$$D = \langle \langle G \rangle \rangle = \lim_{n \rightarrow \infty} \frac{1}{n}$$

SUMMARY OF COMPETITIVE KINETICS.

E = expected slope

O = observed slope (number of runs) (Standard deviation in %).

T<sup>o</sup>C

M + P

E                           O

22	0.0210	0.0268 (10) (0.7%)
28	0.0368	0.0400 (6) (0.6%)
38	0.0622	0.0835 (9) (1.1%)

M + N

21	0.0117	0.0048 (6) (1.9%)
29	0.0212	0.0151 (10) (0.9%)
38	0.0299	0.0260 (10) (0.8%)

P + N

21	- 0.0002	-0.00104 (10) (1.5%)
29	0.0131	0.0090 (9) (1.0%)
39	0.0298	0.0197 (10) (1.8%).



DATA ON METHYL PHENYL SULPHIDE.

TEMP. 21°C

$$[S] = 0.5113, \quad [HP] = 0.0645, \quad [S_2O_3^{\text{--}}] = 0.0500$$

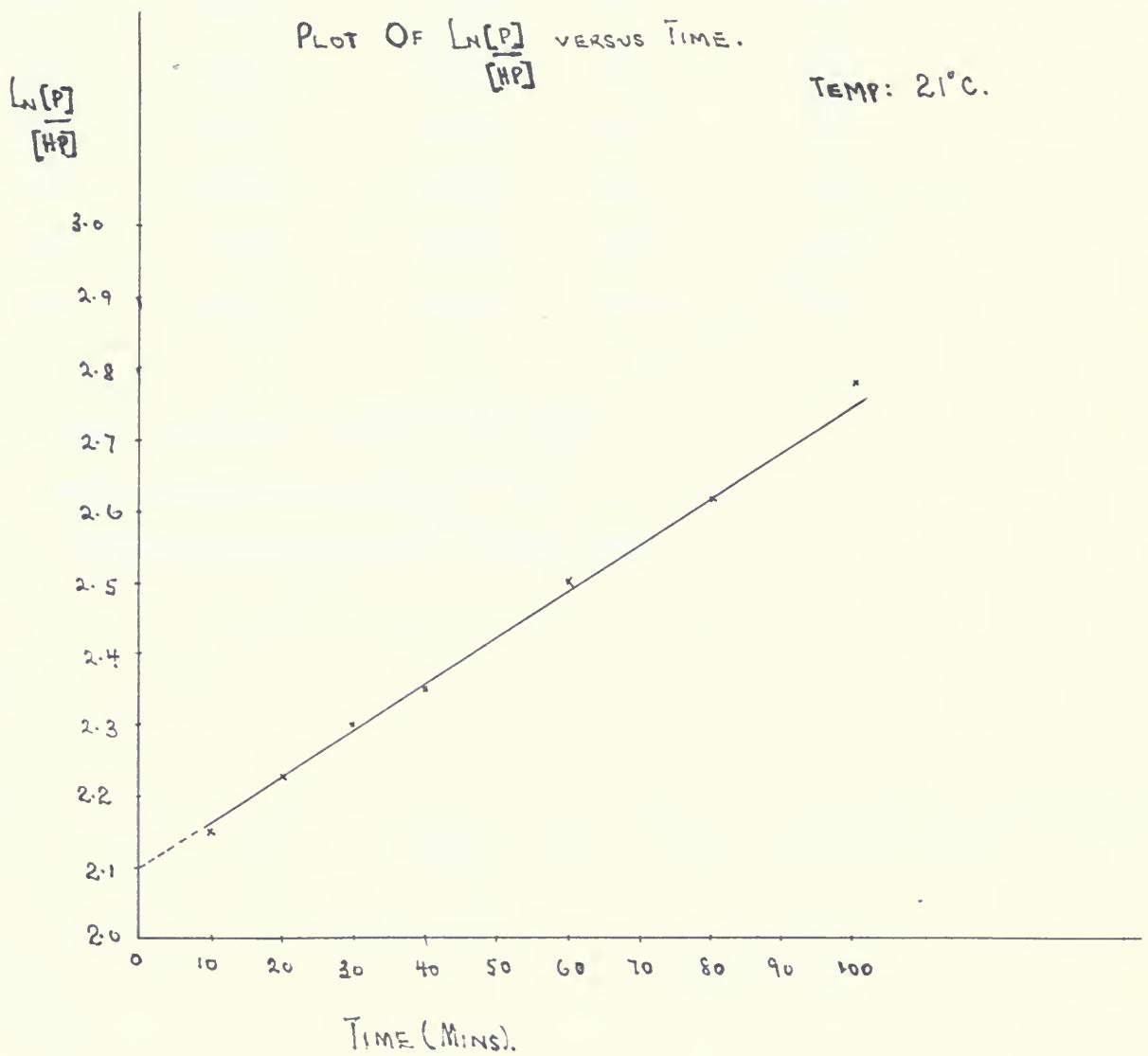
Run No.	$[\text{MoO}_2(\text{acac})_2] \times 10^5$	$k(\text{obs})$	$k_3 \text{ M}^{-2}/\text{min}$	$k_2 \times 100 \text{ M}/\text{min}$
1	2.44	0.0064	578.16	1.43
2	2.44	0.0064	578.16	1.44
3	2.44	0.0064	614.70	1.50
4	2.52	0.0068	604.55	1.52
5	2.52	0.0063	560.10	1.41
7	2.52	0.0063	560.10	1.41
8	2.54	0.0068	598.63	1.52
9	2.54	0.0068	598.63	1.52
10	2.54	0.0068	598.63	1.52

$$\text{MEAN } k_2 \text{ value} = 1.48 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}.$$

$$\text{MEAN } k_3 \text{ value} = 587.96 \text{ M}^{-2} \text{ min}^{-1}.$$

$$\text{STANDARD DEVIATION OF } k_3 = 6.6$$







METHYL PHENYL SULPHIDE, TEMP. 29°C

Run No.	$[MoO_2(acac)_2] \times 10^5$	$k_{(obs)}$	$k_3 \times 10^{-3} M/min$	$k_2 \times 10 M/min$
11	2.44	0.0130	1.19	2.91
12	2.44	0.0128	1.17	2.87
13	2.44	0.0130	1.19	2.91
14	2.44	0.0130	1.19	2.91
15	2.44	0.0132	1.21	2.95
16	2.44	0.0127	1.17	2.84
17	2.41	0.0129	1.20	2.89
18	2.41	0.0130	1.21	2.91
19	2.41	0.0139	1.29	3.11
20	2.41	0.0130	1.21	2.91

MEAN  $k_2$  value =  $2.92 \times 10^{-2} M^{-1} min^{-1}$

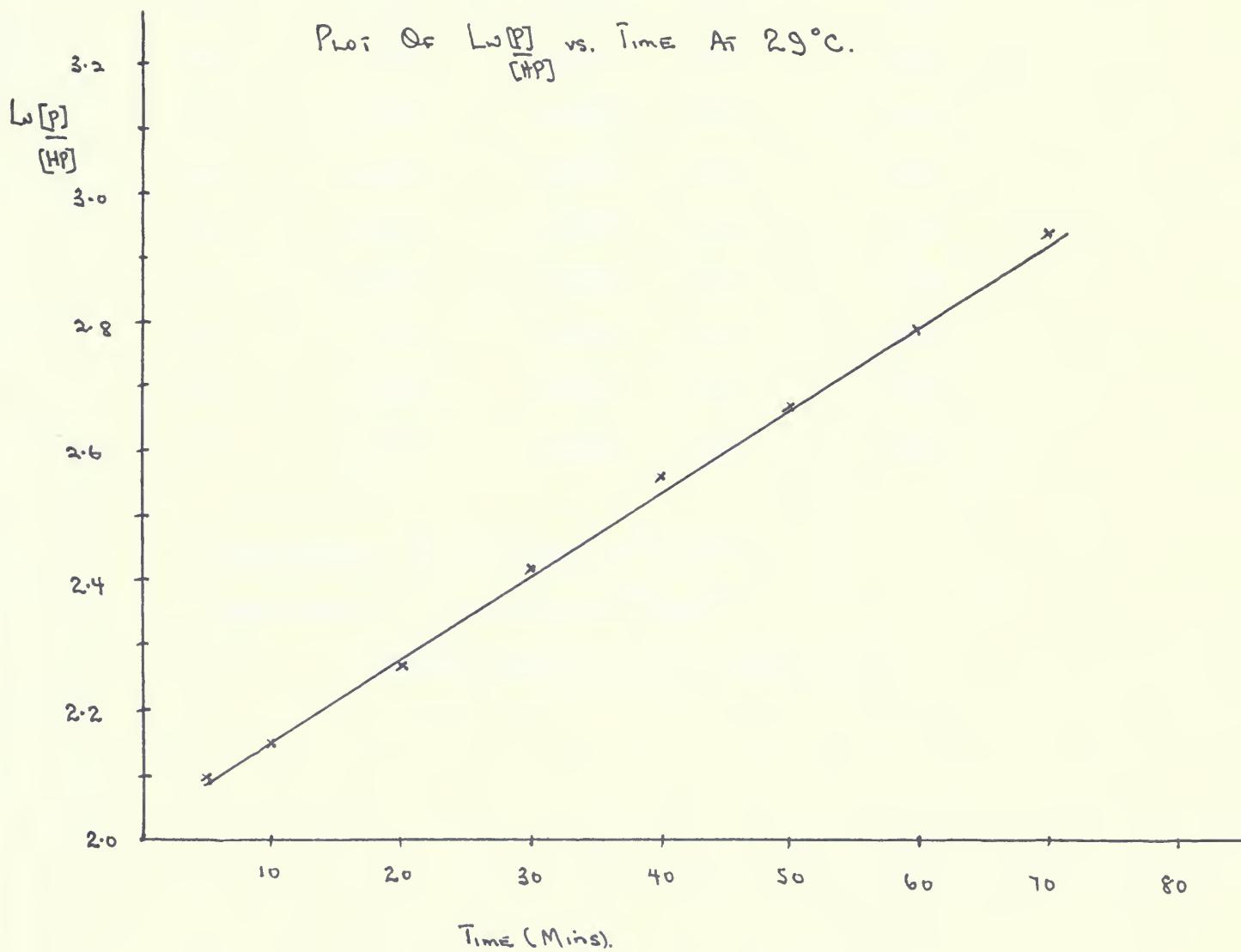
MEAN  $k_3$  value =  $1.20 \times 10^3 M^{-2} min^{-1}$ .

Standard deviation of  $k_3$  =  $0.0107 \times 10^3$

$\delta \omega_0$	$\delta \omega_{\text{min}}$	$\delta \omega_{\text{max}}$	$\delta \omega_{\text{mean}}$	$\delta \omega_{\text{std}}$
0.001	-0.002	0.001	0.000	0.001
0.01	-0.010	0.000	-0.005	0.005
0.03	-0.030	0.010	-0.010	0.010
0.1	-0.100	0.000	-0.050	0.050
0.3	-0.300	0.050	-0.150	0.150
1.0	-1.000	0.000	-0.500	0.500
3.0	-3.000	0.000	-1.500	1.500
10.0	-10.000	0.000	-5.000	5.000
30.0	-30.000	0.000	-15.000	15.000

where  $\epsilon = 10^{-12}$  is the numerical error of the direct solution of the system of linear equations. The value of  $\delta \omega_0$  is set to zero. The values of  $\delta \omega_{\text{min}}, \delta \omega_{\text{max}}, \delta \omega_{\text{mean}}$  and  $\delta \omega_{\text{std}}$  are given in Table 2. It can be seen that the mean value of  $\delta \omega$  is very close to zero, while the standard deviation of the values of  $\delta \omega$  is rather large.

Plot of  $\frac{L_w(p)}{L_w(p)_0}$  vs. Time At 29°C.





METHYL PHENYL SULPHIDE, TEMP. 38°C

Run No.	$[MoO_2(acac)_2] \times 10$	$k_{obs}$	$k_3 \times 10^{-3} M^{-2}/min.$	$k_2 \times 10^2 M^{-1}/min.$
21	2.44	0.0301	2.76	6.74
22	2.44	0.0311	2.85	6.96
23	2.32	0.0291	2.80	6.51
24	2.32	0.0290	2.80	6.49
25	2.32	0.0300	2.89	6.71
26	2.44	0.0295	2.71	6.60
27	2.44	0.0306	2.81	6.85
28	2.44	0.0298	2.74	6.67
29	2.44	0.0291	2.68	6.51
30	2.44	0.0292	2.68	6.54

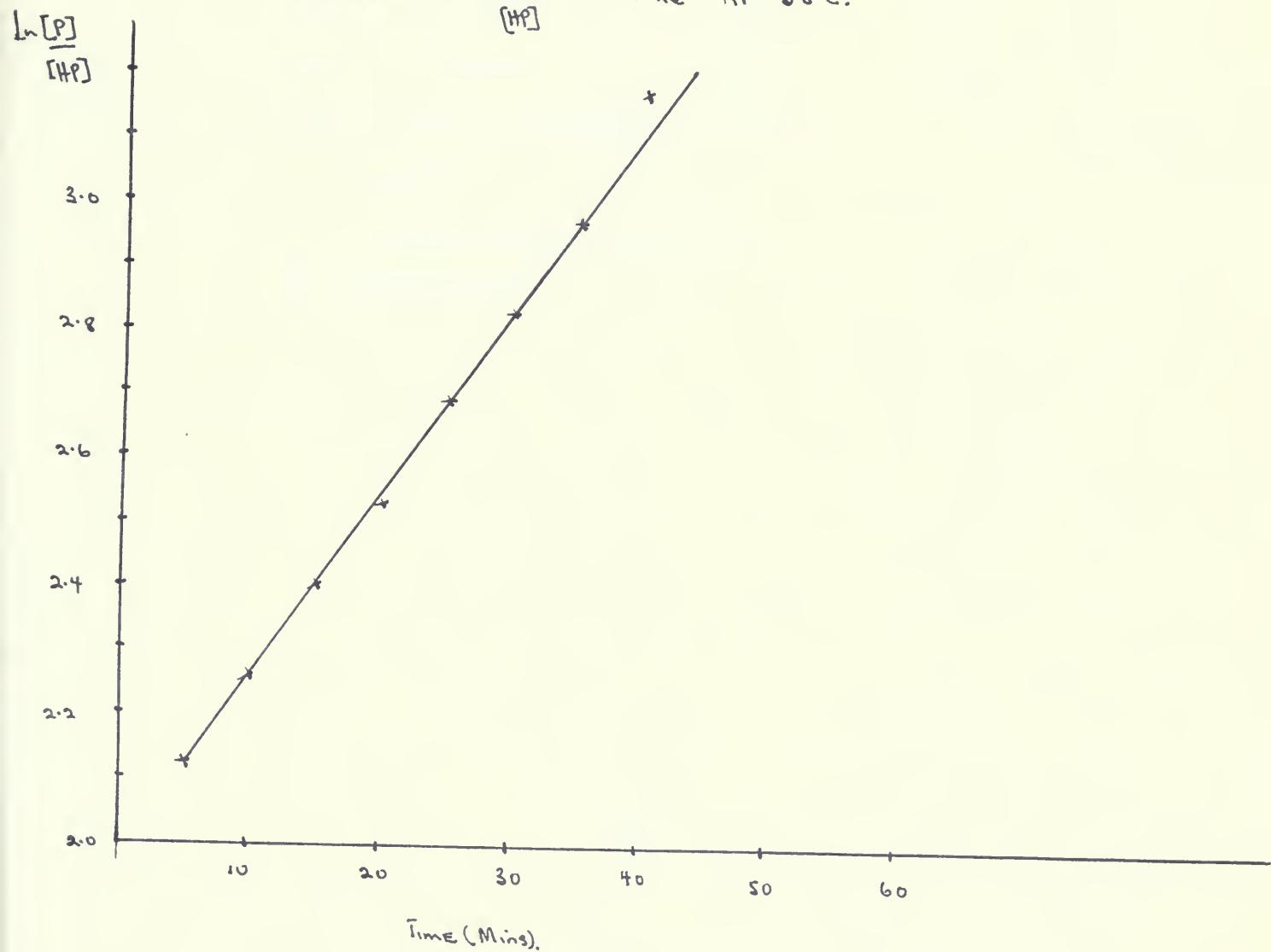
MEAN VALUE OF  $k_2 = 6.66 \times 10^{-2} M^{-1} min^{-1}$ .

MEAN VALUE OF  $k_3 = 2.77 \times 10^3 M^{-2} min^{-1}$

standard deviation of  $k_3 = 0.022 \times 10^3$



Plot of  $\ln \frac{P}{[HP]}$  vs. Time at 38°C.





ARRHENIUS PLOT FOR METHYL PHENYL SULPHIDE.

T(K).	1/T (K <sup>-1</sup> )	k <sub>3</sub> M <sup>-2</sup> /min.	Lnk <sub>3</sub>
294	0.0034	587.16	6.38
302	0.0033	1200	7.09
311	0.0032	2710	7.91

$$\text{Slope} = (7.91 - 6.38) \times 10^3 (3.4 - 3.20)^{-1}$$

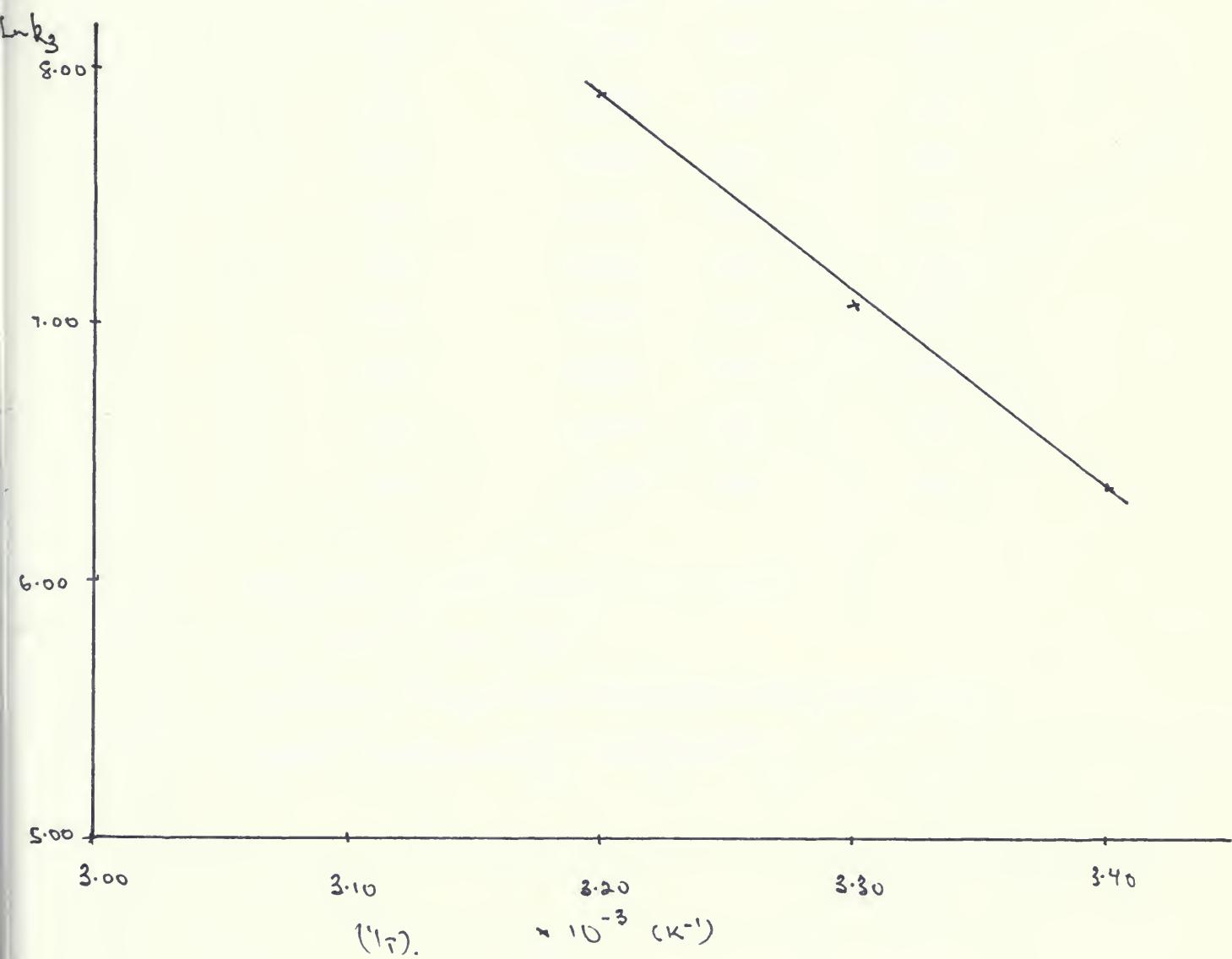
$$= E_a R^{-1}$$

$$= 8.314 \times 1.53 \times 5 \times 10^3 = E_a$$

$$E_a = 63.60 \text{ KJ mol}^{-1}$$



ARRHENIUS PLOT FOR METHYL PHENYL SULPHIDE.





p-METHOXYPHENYL METHYL SULPHIDE, TEMP. 21°C.

$$[S] = 0.4442, \quad [HP] = 0.0645, \quad [S_2O_3^{\text{--}}] = 0.0500$$

Run No.	[CATALYST] $\times 10^5$	$k(\text{obs})$	$k_3 \times 10^3 \text{ M}^{-1}/\text{min.}$	$k_2 \times 10^2 \text{ M}^{-1}/\text{min.}$
31	2.44	0.0124	1.34	3.27
32	2.44	0.0125	1.29	3.14
33	2.44	0.0125	1.29	3.14
34	2.43	0.0125	1.29	3.14
35	2.43	0.0125	1.29	3.14
36	2.20	0.0109	1.25	2.74
37	2.20	0.0111	1.27	2.79
38	2.44	0.0124	1.34	3.27
39	2.44	0.0125	1.29	3.14
40	2.44	0.0125	1.29	3.14

MEAN VALUES  $k_2 (\text{M}^{-1} \text{ min}^{-1}) = 3.17 \times 10^{-2}$

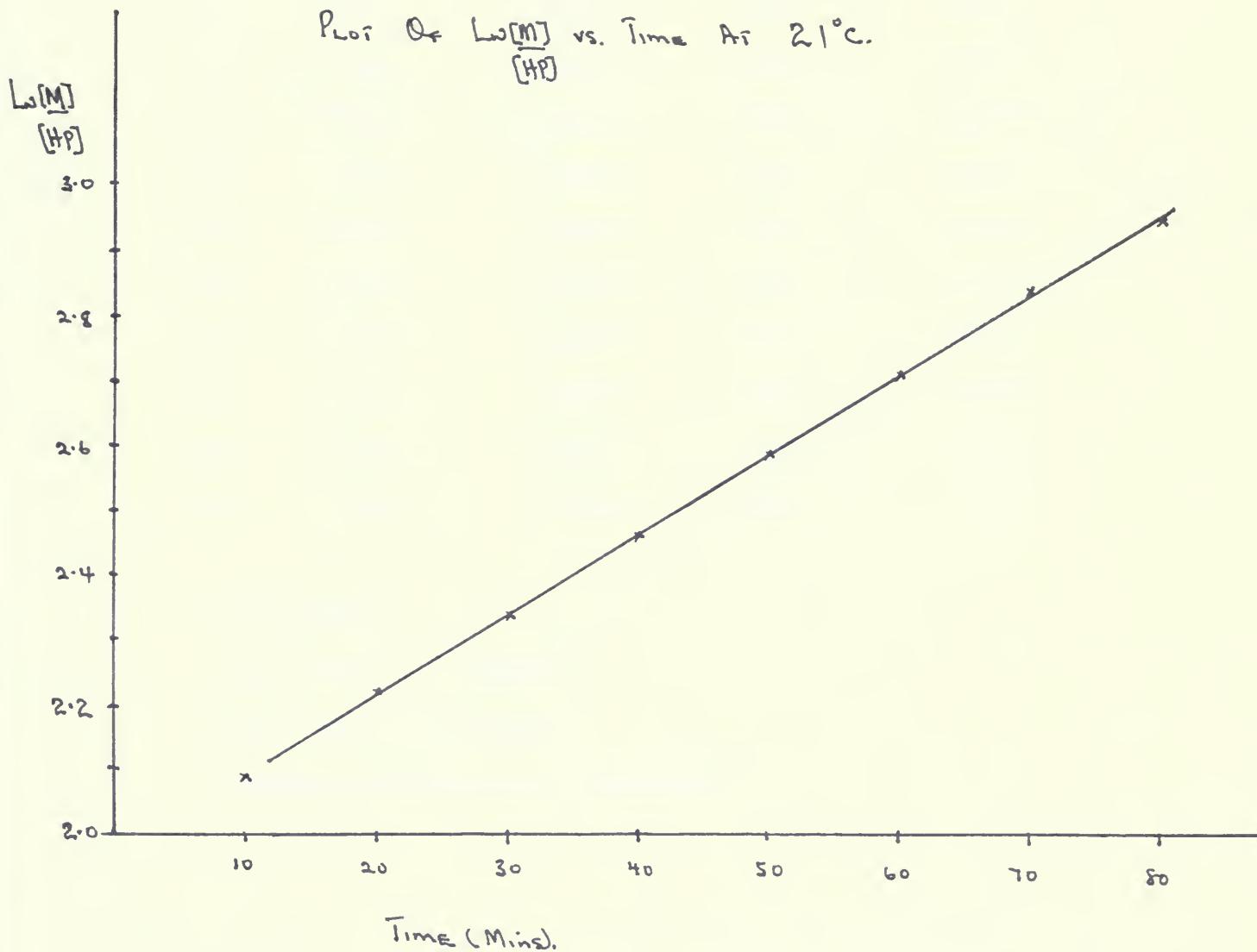
$k_3 (\text{M}^{-2} \text{ min}^{-1}) = 1.29 \times 10^3$

\* Run Nos. 36 and 37 were excluded in Mean value of  $k_2$ .

Standard deviation of  $k_3 = 0.0087 \times 10^3$



Plot of  $\frac{L_w[M]}{[HP]}$  vs. Time At  $21^\circ C.$





p-METHOXYPHENYL METHYL SULPHIDE, TEMP. 29°C

	[S] = 0.5922	[HP] = 0.0645,	$[S_2O_3^{\equiv}] = 0.0500$	
Run No.	[CATALYST.] $\times 10^5$	k(obs)	$k_3 \times 10^{-3} M/min.$	$k_2 \times 10^{-1} M/min.$
41	2.44	0.0291	2.26	5.51
42	2.44	0.0293	2.28	5.55
43	2.44	0.0294	2.28	5.57
44	2.44	0.0286	2.22	5.42
45	2.44	0.0287	2.23	5.44
46	2.44	0.0287	2.23	5.44
47	2.44	0.0298	2.32	5.65
48	2.44	0.0302	2.35	5.72
49	2.48	0.0304	2.32	5.76
50	2.48	0.0302	2.31	5.73

MEAN VALUES :

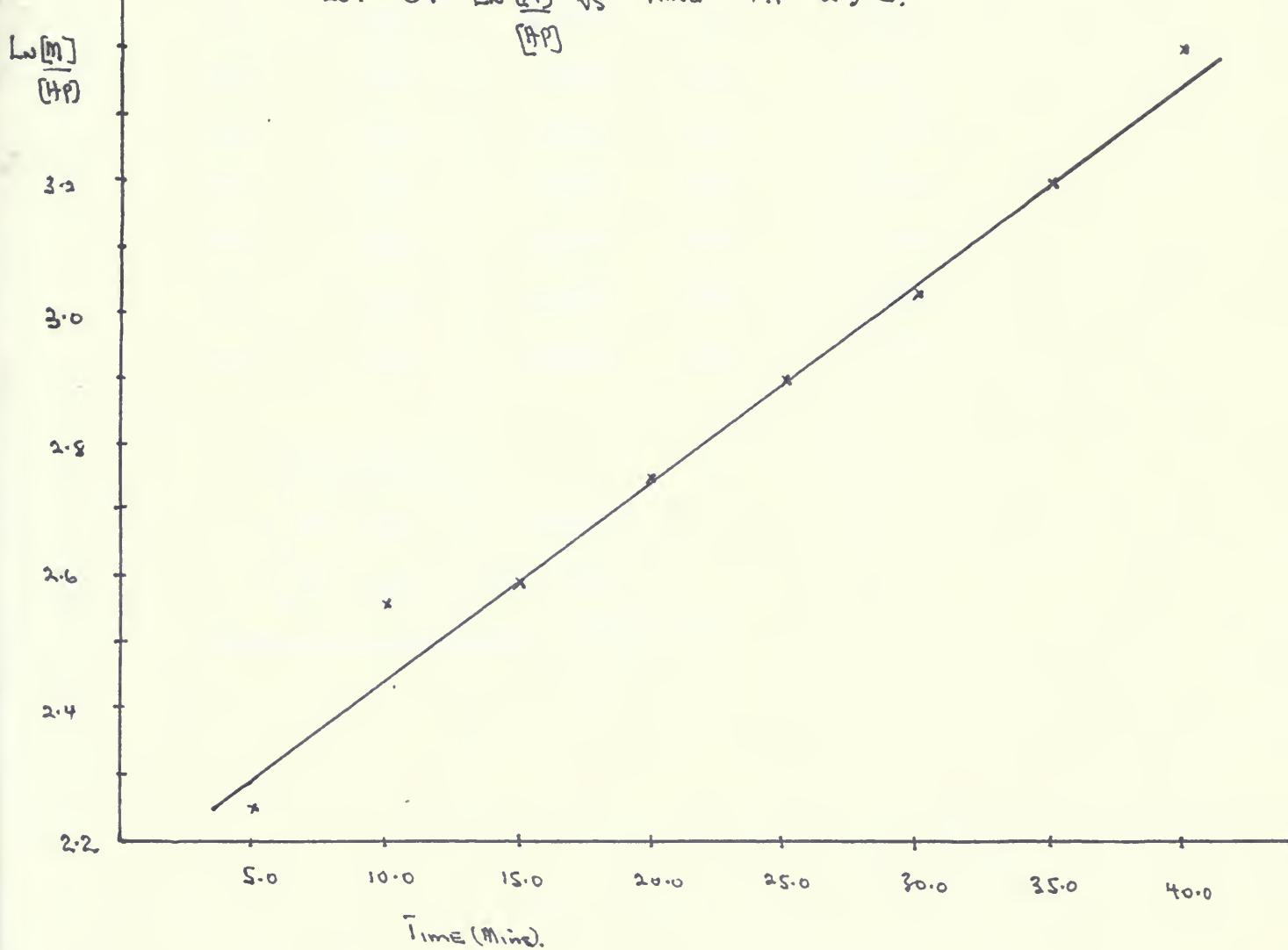
$$k_2(M^{-1} min^{-1}) = 5.58 \times 10^{-2}$$

$$k_3(M^{-2} min^{-1}) = 2.28 \times 10^3$$

Standard deviation of  $k_3 = 0.014 \times 10^3$



Plot Of  $\ln \frac{[M]}{[M]_0}$  vs Time At 29°C.





p-METHOXYPHENYL METHYL SULPHIDE, TEMP. 38°C.

$$[S] = 0.5922, [HP] = 0.0645, [S_2O_3^{\text{--}}] = 0.0500$$

Run No.	[CATALYST] $\times 10^5$	$k_{\text{obs}}$	$k_3 \times 10^{-3} \text{ M/min}$	$k_2 \times 10^{-1} \text{ M/min}$
51	2.44	0.0379	2.94	7.18
52	2.44	0.0404	3.14	7.66
53	2.44	0.0368	2.86	6.97
54	2.44	0.0335	2.60	6.35
55	2.44	0.0391	3.04	7.41
56	2.44	0.0392	3.04	7.43
57	2.44	0.0390	3.03	7.39
58	2.44	0.0392	3.04	7.43
59	2.44	0.0393	3.05	7.45
60	2.44	0.0383	2.93	7.26

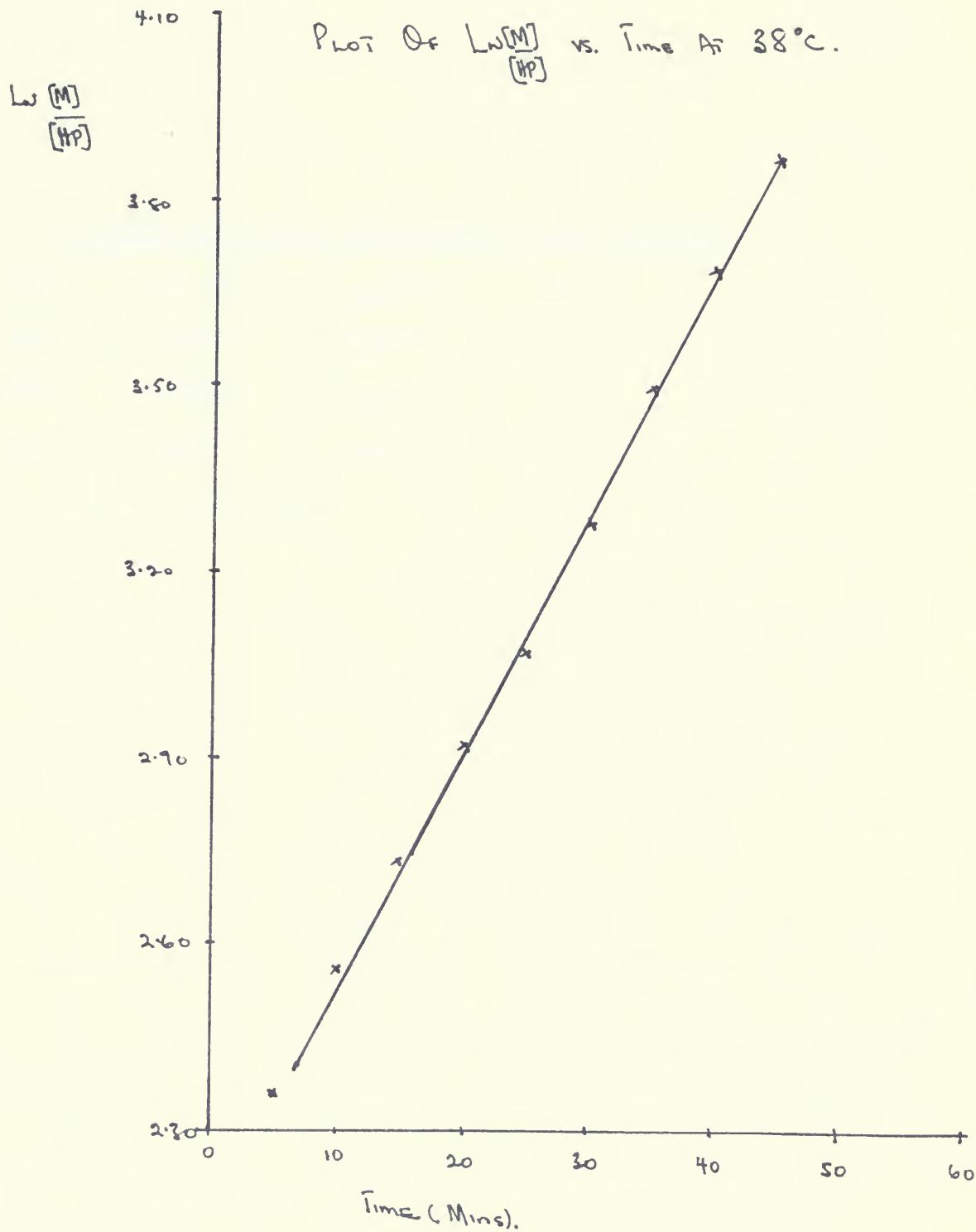
MEAN VALUES :

$$k_2 (\text{M}^{-1} \text{ min}^{-1}) = 7.25 \times 10^{-2}$$

$$k_3 (\text{M}^{-2} \text{ min}^{-1}) = 2.97 \times 10^3$$

$$\text{Standard deviation of } k_3 = 0.047 \times 10^3$$







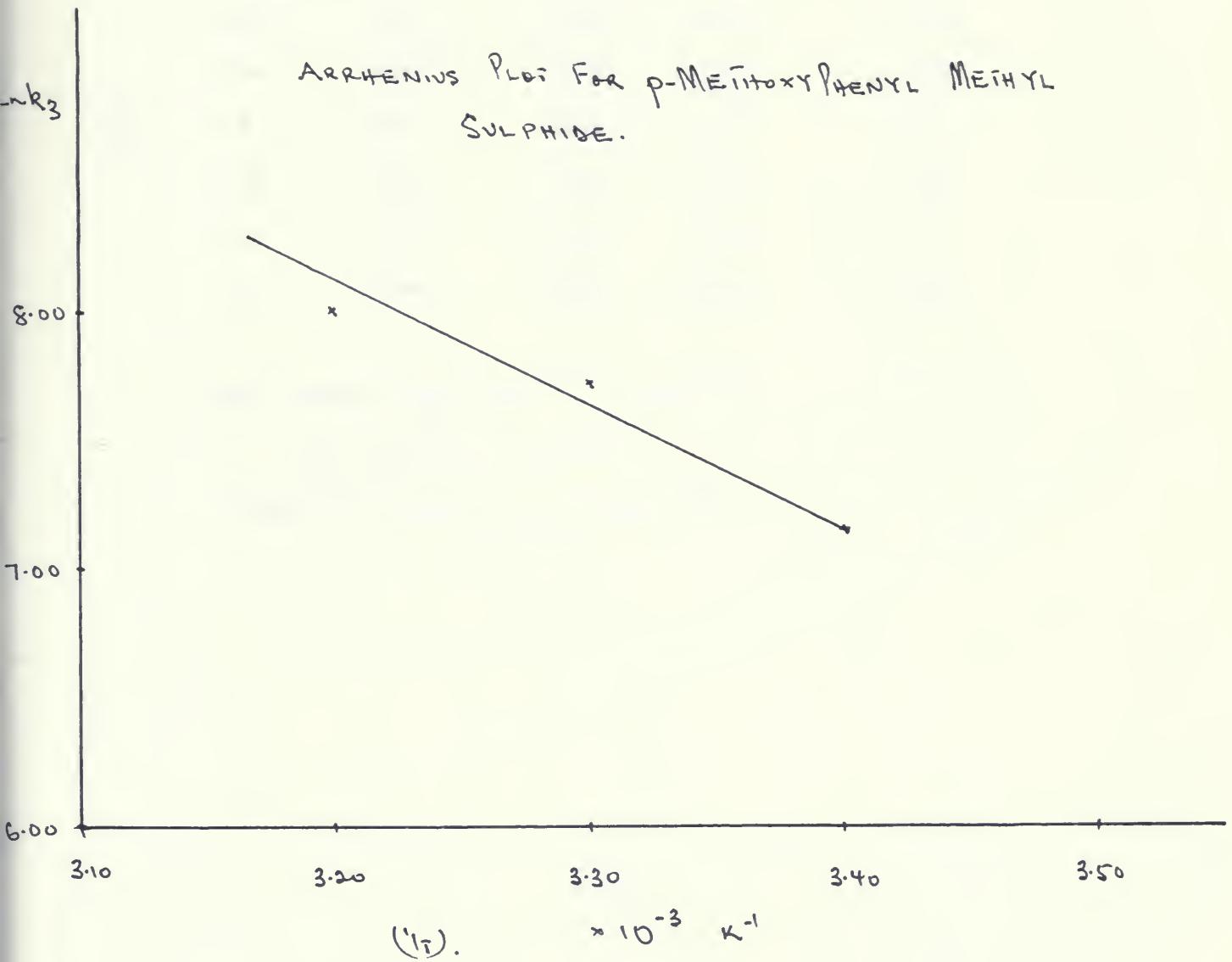
ARRHENIUS PLOT FOR p-METHOXYPHENYL METHYL SULPHIDE.

T (K).	1 T (K <sup>-1</sup> ).	k <sub>3</sub> × 10 <sup>-3</sup>	Ln k <sub>3</sub>
294	0.0034	1.29	7.16
302	0.0033	2.28	7.73
311	0.0032	3.01	8.01

$$E_a = 40.12 \text{ KJ mol}^{-1}$$



ARRHENIUS PLOT FOR p-METHOXYPHENYL METHYL  
SULPHIDE.





METHYL p-NITROPHENYL SULPHIDE, TEMP. 60°C

$$[S] = 0.0343 \quad [HP] = 0.0122 \quad [S_2O_3^{\text{--}}] = 0.018$$

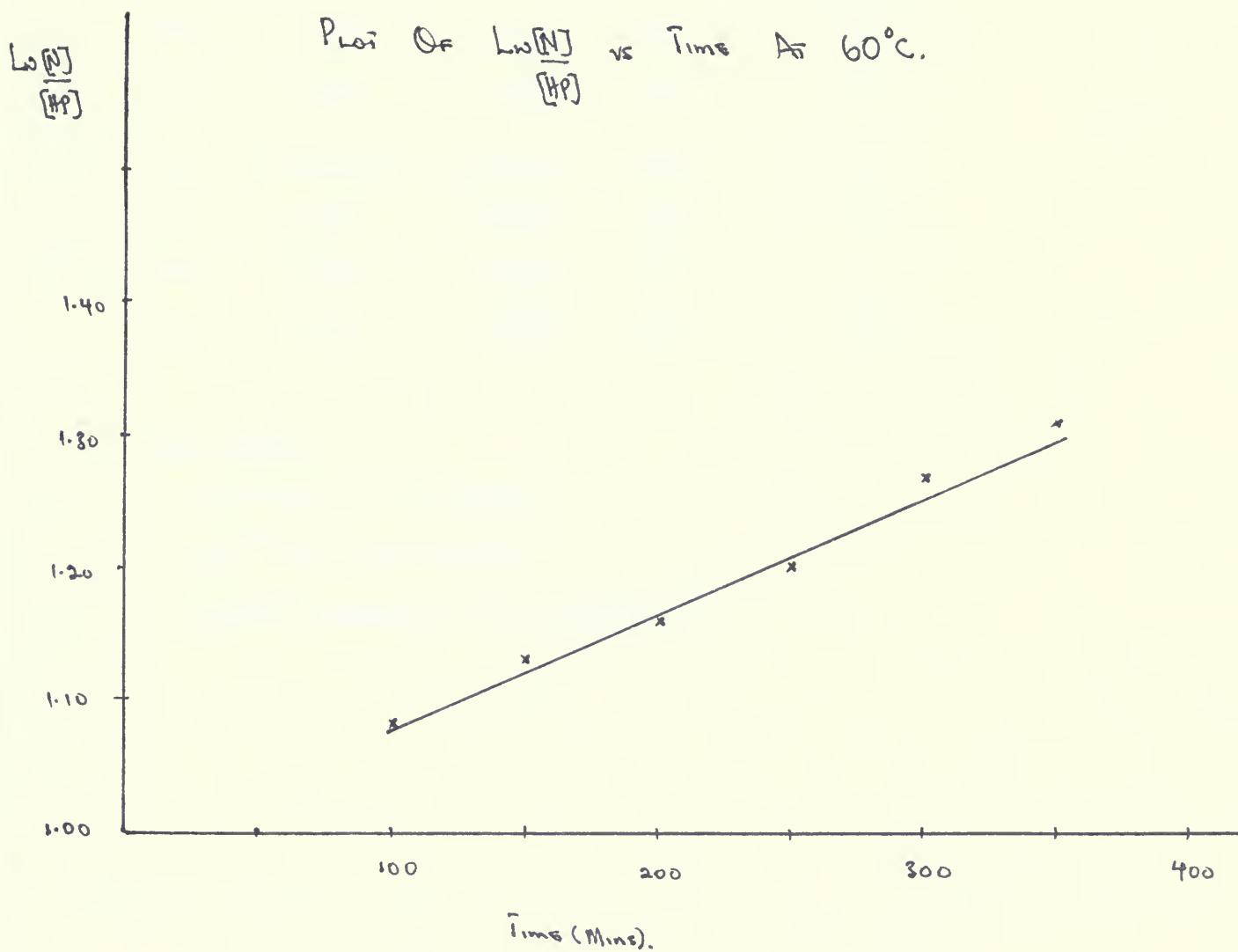
Run No	[CATALYST] $\times 10^5$	$k(\text{obs.})$	$k_3 \times 10^{-3} \text{ M}^{-2}/\text{min}$	$k_2 \times 10^2 \text{ M}/\text{min}$
61	1.95	0.0009	2.085	4.07
62	1.95	0.0009	2.085	4.07
63	1.95	0.0009	2.085	4.07
64	1.95	0.0008	1.855	3.62
65	1.95	0.0009	2.085	4.07
66	1.95	0.0009	2.085	4.07

$$\text{MEAN VALUES : } k_2 (\text{M}^{-1} \text{ min}^{-1}) = 3.99 \times 10^{-2}$$

$$k_3 (\text{M}^{-2} \text{ min}^{-1}) = 2.05 \times 10^3$$

$$\text{Standard deviation of } k_3 = 0.038 \times 10^3$$







METHYL p-NITROPHENYL SULPHIDE, TEMP. 65°C.

	[S] = 0.0343	[HP] = 0.0122	$[S_2O_3^{\text{--}}] = 0.0180$	
Run No	$[\text{CATALYST}] \times 10^5$	$k_{\text{obs.}}$	$k_3 \times 10^{-3} \text{ M}^{-2} \text{ min}^{-2}$	$k_2 \times 10^3 \text{ M}^{-1} \text{ min}^{-1}$
73	1.95	0.0015	3.47	6.78
74	1.95	0.0015	3.48	6.79
75	1.95	0.0015	3.48	6.79
76	1.95	0.0015	3.48	6.79
77	1.95	0.0014	3.46	6.76
78	1.95	0.0014	3.46	6.76

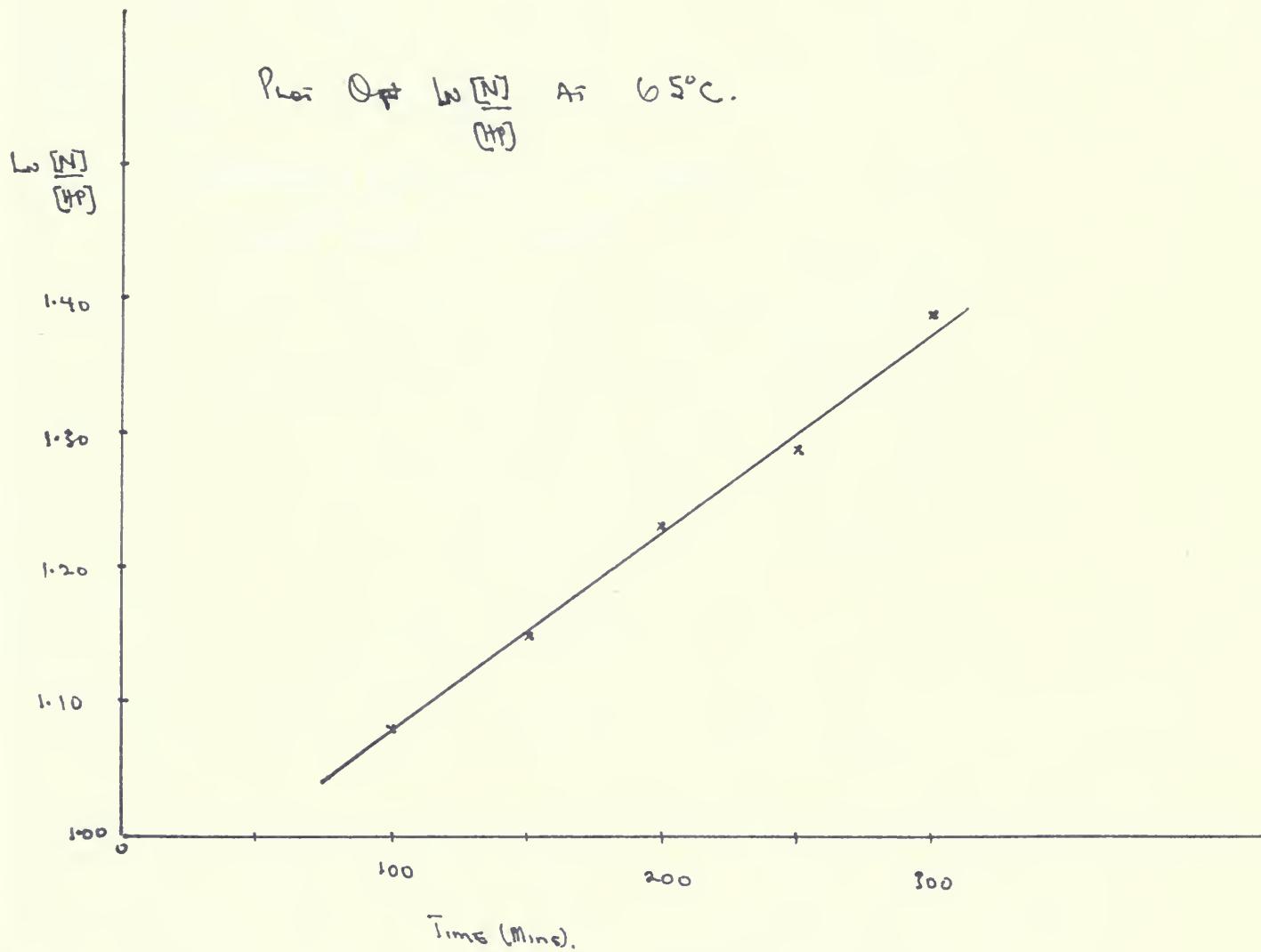
MEAN VALUE :

$$k_2 (\text{M}^{-1} \text{ min}^{-1}) = 6.71 \times 10^{-2}$$

$$k_3 (\text{M}^{-2} \text{ min}^{-1}) = 3.47 \times 10^3$$

$$\text{Standard deviation of } k_3 = 0.0040 \times 10^3$$







METHYL p-NTROPHENYL SULPHIDE, TEMP. 70°C .

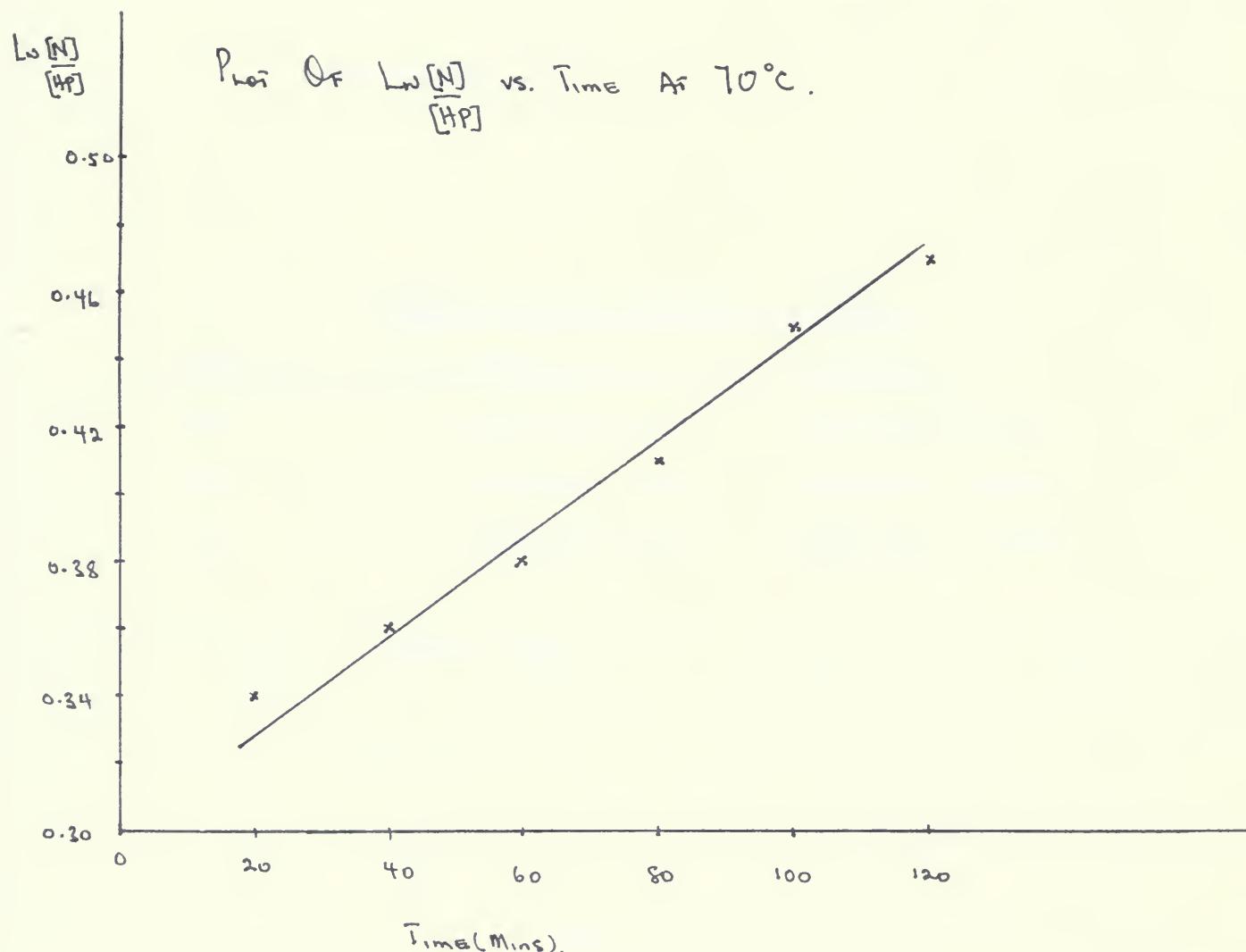
$$[S] = 0.0285 \quad [HP] = 0.0204 \quad [S_2O_3^{\text{--}}] = 0.0180$$

Run No.	[catalyst] $\times 10^5$	$k(\text{obs.})$	$k_3 \times 10^{-3} \text{ M}^{-2}/\text{min}$	$k_2 \times 10^{-1} \text{ M}^{-1}/\text{min}$
67	3.25	0.0014	5.31	1.73
68	"	"	"	"
69	"	"	"	"
70	3.25	"	"	"
71	"	"	"	"
72	"	"	"	"

$$\text{MEAN VALUE : } k_2 (\text{M}^{-1} \text{ min}^{-1}) = 1.73 \times 10^{-1}$$

$$k_3 (\text{M}^{-2} \text{ min}^{-1}) = 5.31 \times 10^{-3}$$







ARRHENIUS PLOT FOR p-NITRO DERIVATIVE.

T (K)	1 T (K <sup>-1</sup> )	k <sub>3</sub> × 10 <sup>-3</sup>	Lnk
333	0.00300	2.05	7.63
338	0.00296	3.44	8.14
343	0.00292	8.87	9.10

$$E_a = 197.46 \text{ KJ mol}^{-1}.$$

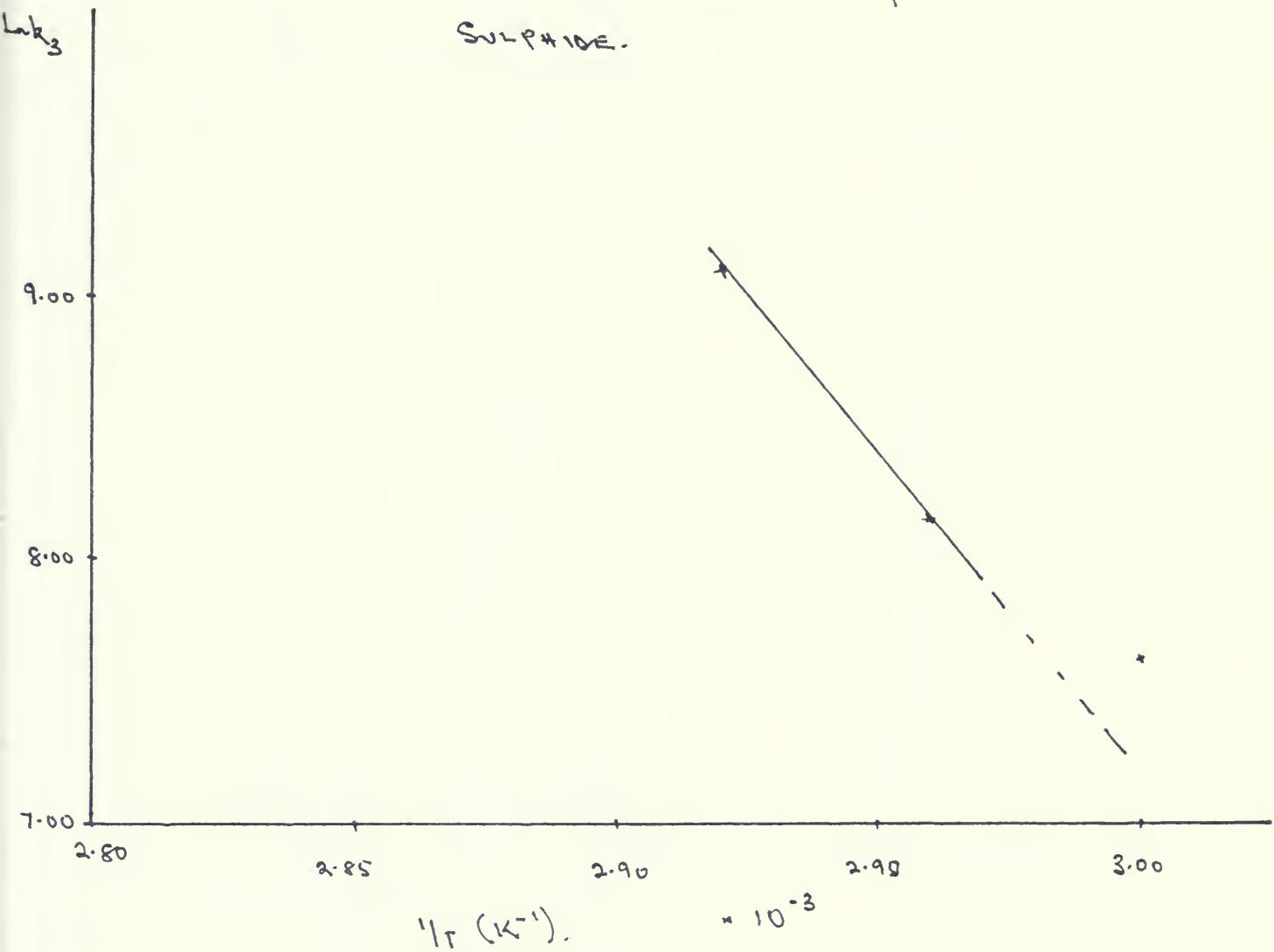
HAMMETT PLOT FOR COMPOUNDS P, M AND N.

TEMP. (K)	COMPD. M	COMPD. N
294	Log. [k' / k] = 0.32	Log. [k'' / k] = -2.60
302	Log. [k' / k] = 0.28	Log. [k'' / k] = -2.29
311	Log. [k' / k] = 0.04	Log. [k'' / k] = -1.86

$$\text{SLOPE} = -2.11$$

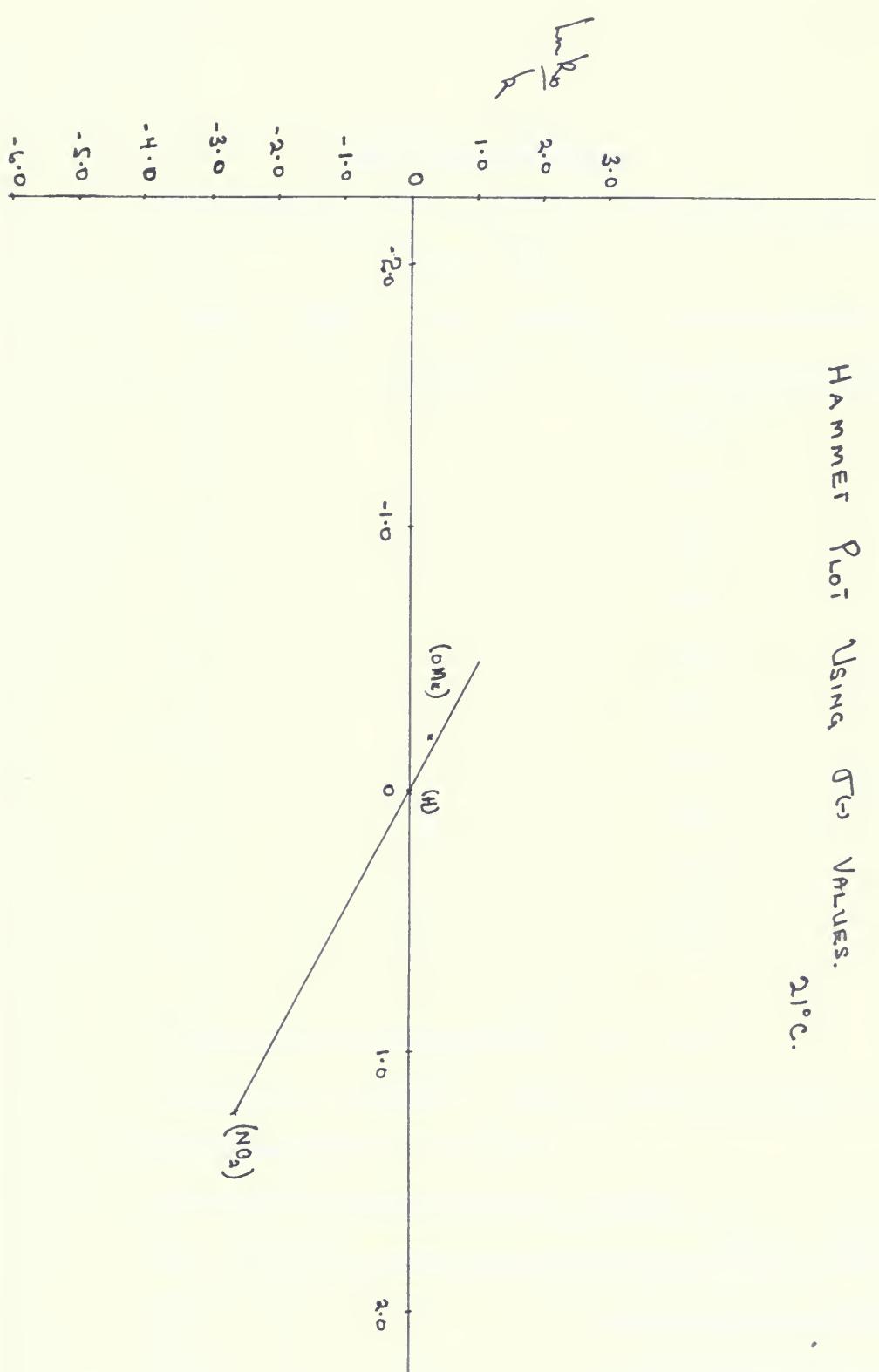


ARRHENIUS PLOT FOR METHYL p-NITROPHENYL  
SULFIDE.





HAMMER PLOT USING  $\sigma_{(-)}$  VALUES.  
21°C.





COMPETITIVE KINETICS.

p-Methoxyphenyl methyl sulphide + Methylphenyl sulphide.

Temp. 22°C

$$[C]_o = 0.0645 \quad [A]_o = 0.4442 \quad [B]_o = 0.5113$$

Run No	Observed Slope $\times 10^2$
1	2.75
2	2.66
3	2.66
4	2.66
5	2.65
6	2.64
7	2.65
8	2.60
9	2.70
10	2.81

Calculated or expected slope =  $2.1 \times 10^{-2}$

[Catalyst] =  $2.44 \times 10^{-5}$ , Mean of observed values = 0.02678

Standard deviation =  $6.07 \times 10^{-4}$ ,

95% confidence limit = 0.0268  $\pm$  0.0006

$[A]_o$  = Initial concentration of p-methoxyphenyl methyl sulphide.

$[B]_o$  = " " " methyl phenyl sulphide.

$[C]_o$  = " " " t-butyl hydroperoxide

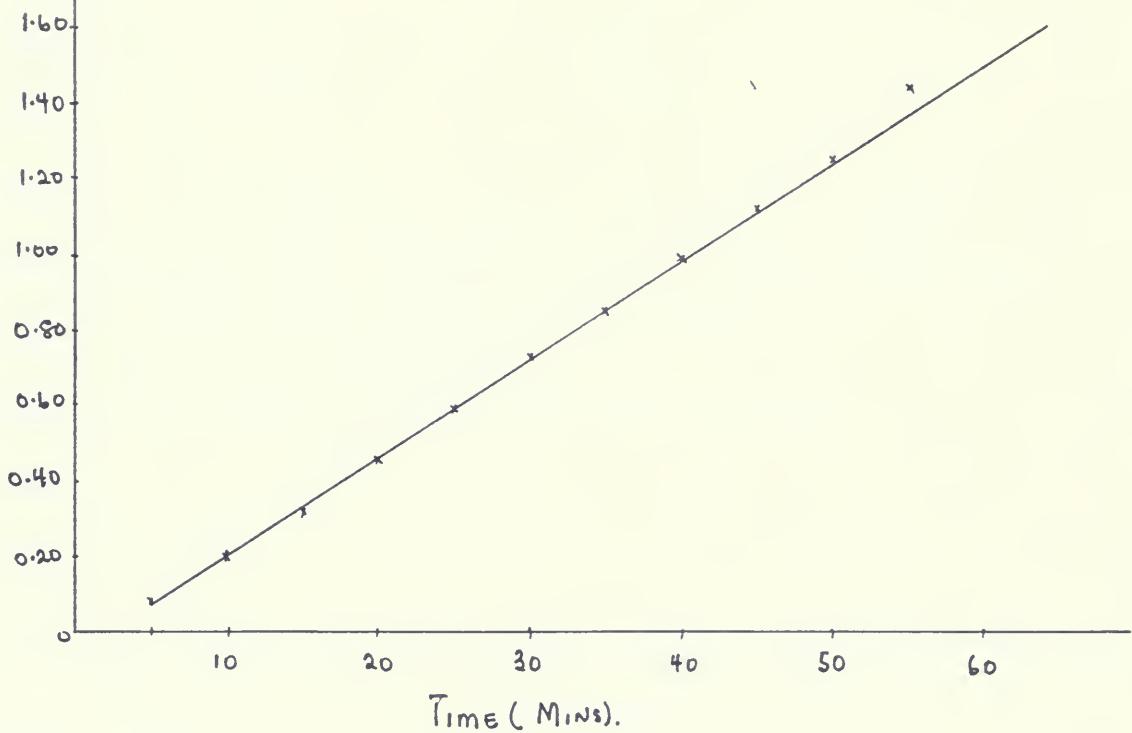


$\ln F$

Plot Of  $\ln F$  vs. Time.

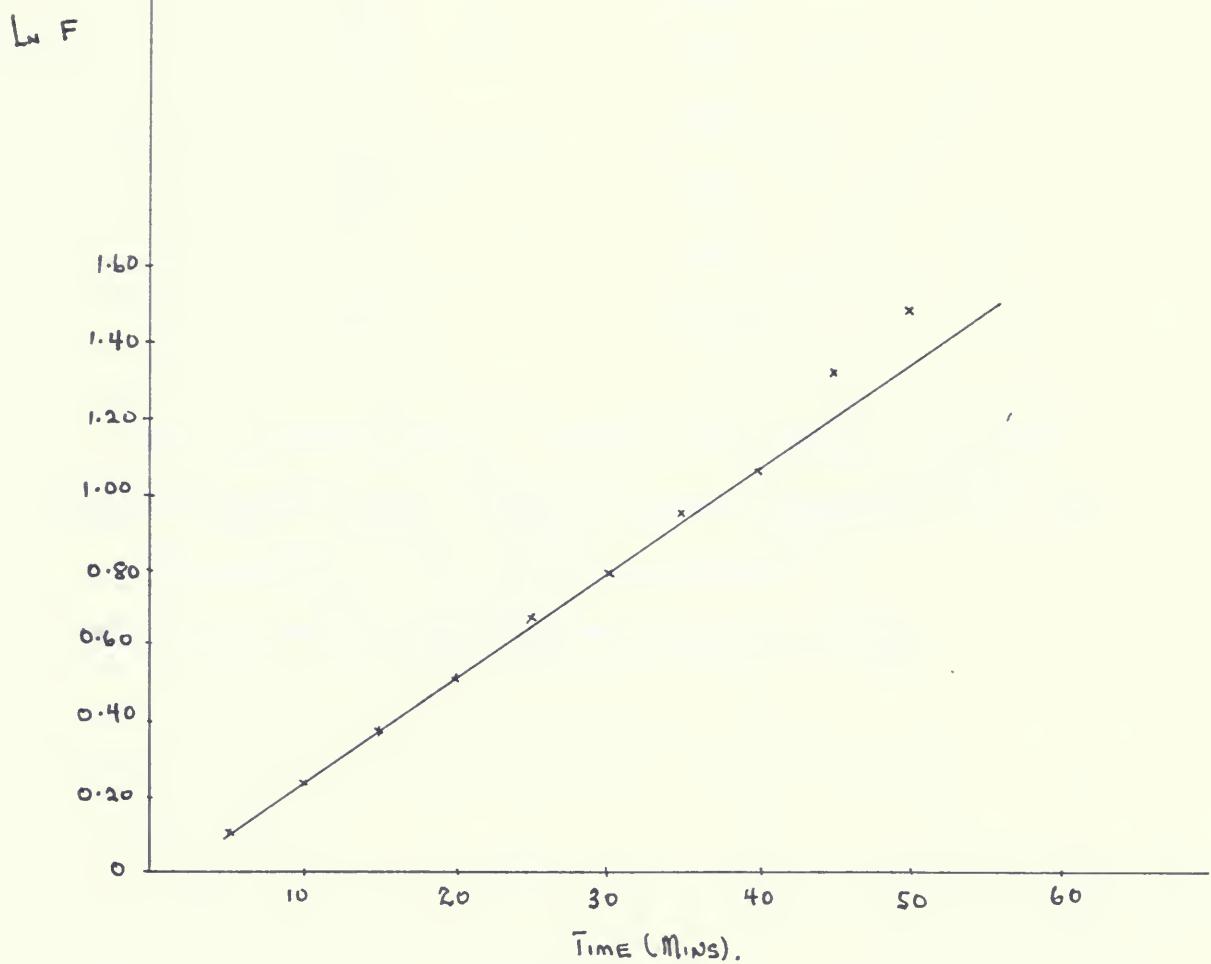
M+P

Temp:  $22^{\circ}\text{C}$ .





Plot of  $\ln F$  vs Time.  
 $M + P$  Temp:  $22^\circ C.$





p-Methoxyphenyl methyl sulphide + methyl phenyl sulphide

$$[C]_o = 0.0645 \quad [A]_o = 0.4442 \quad [B]_o = 0.5113$$

$$\text{Temp.} = 28 + 0.5^\circ\text{C}$$

Run No.	Observed Slope $\times 10^2$
11	4.05
12	4.07
13	3.99
14	3.91
15	3.99
16	4.00

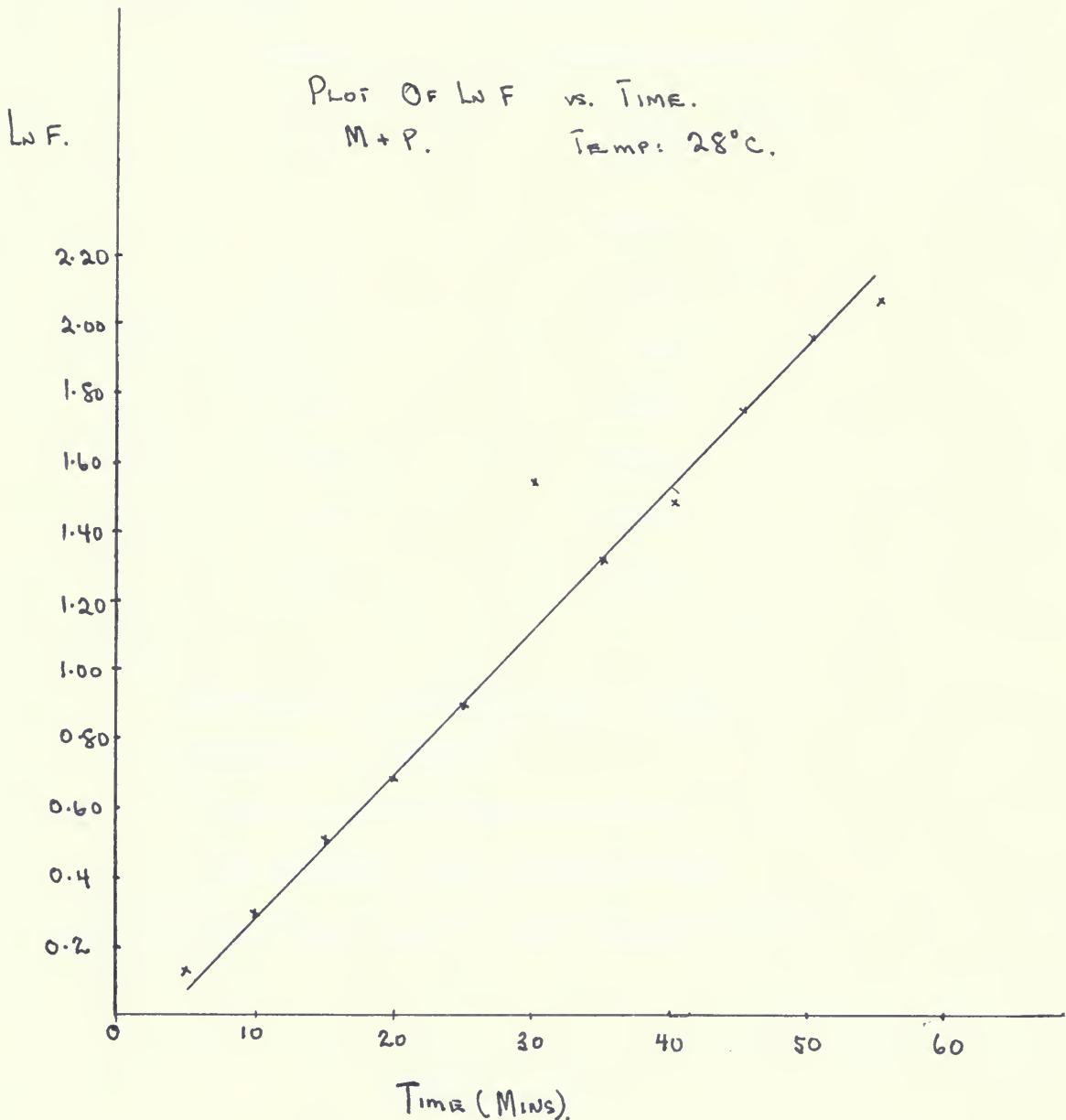
$$\text{Calc. or expected slope} = 0.0368, \quad [\text{Catalyst}] = 3.44 \times 10^{-5}$$

$$\text{Mean of observed values} = 0.0400, \quad \text{Standard deviation} = 6.0 \times 10^{-4}$$

$$95\% \text{ confidence limit} = (4.00 \pm 0.06) \times 10^{-2}$$

$[A]_o$ ,  $[B]_o$  and  $[C]_o$  have the same meaning as before.







p-Methoxyphenyl methyl sulphide + methyl phenyl sulphide

TEMP. 38°C

[C]<sub>o</sub> = 0.0645      [A]<sub>o</sub> = 0.4442      [B]<sub>o</sub> = 0.5113

Run No.                          Observed Slope  $\times 10^2$

17	8.64
18	8.64
19	8.64
20	7.94
21	7.99
22	8.23
23	8.37
24	8.31
25	8.35

Expected or calculated slope = 0.0622

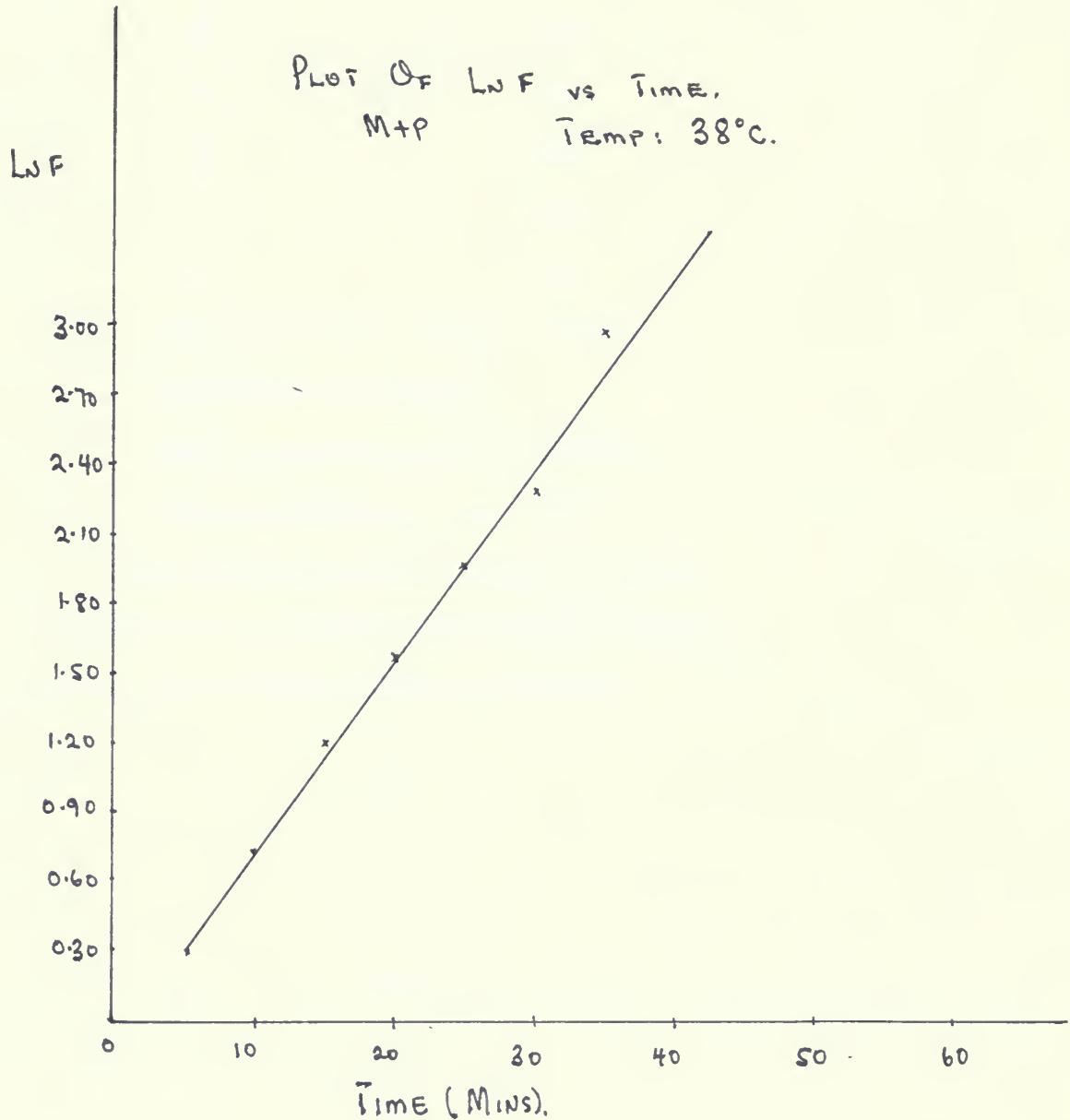
[Catalyst] =  $2.44 \times 10^{-5}$

Mean of observed slope = 0.0835,

95% confidence limit = 0.0835  $\pm$  0.002

[A]<sub>o</sub>, [B]<sub>o</sub> and [C]<sub>o</sub> have the same meaning as before.







p-Methoxyphenyl methyl sulphide + methyl p-Nitrophenyl sulphide

TEMP. 21 +0.5°C

$$[C]_o = 0.0645 \quad [A]_o = 0.4442 \quad [B]_o = 0.0171$$

Run No.	Observed Slope $\times 10^3$
---------	------------------------------

27	4.90
28	4.40
29	4.90
33	4.90
34	4.90
35	4.90

Expected or calc. value = 0.0117,

[Catalyst] =  $2.44 \times 10^{-5}$

Mean of observed slope = 0.0049,

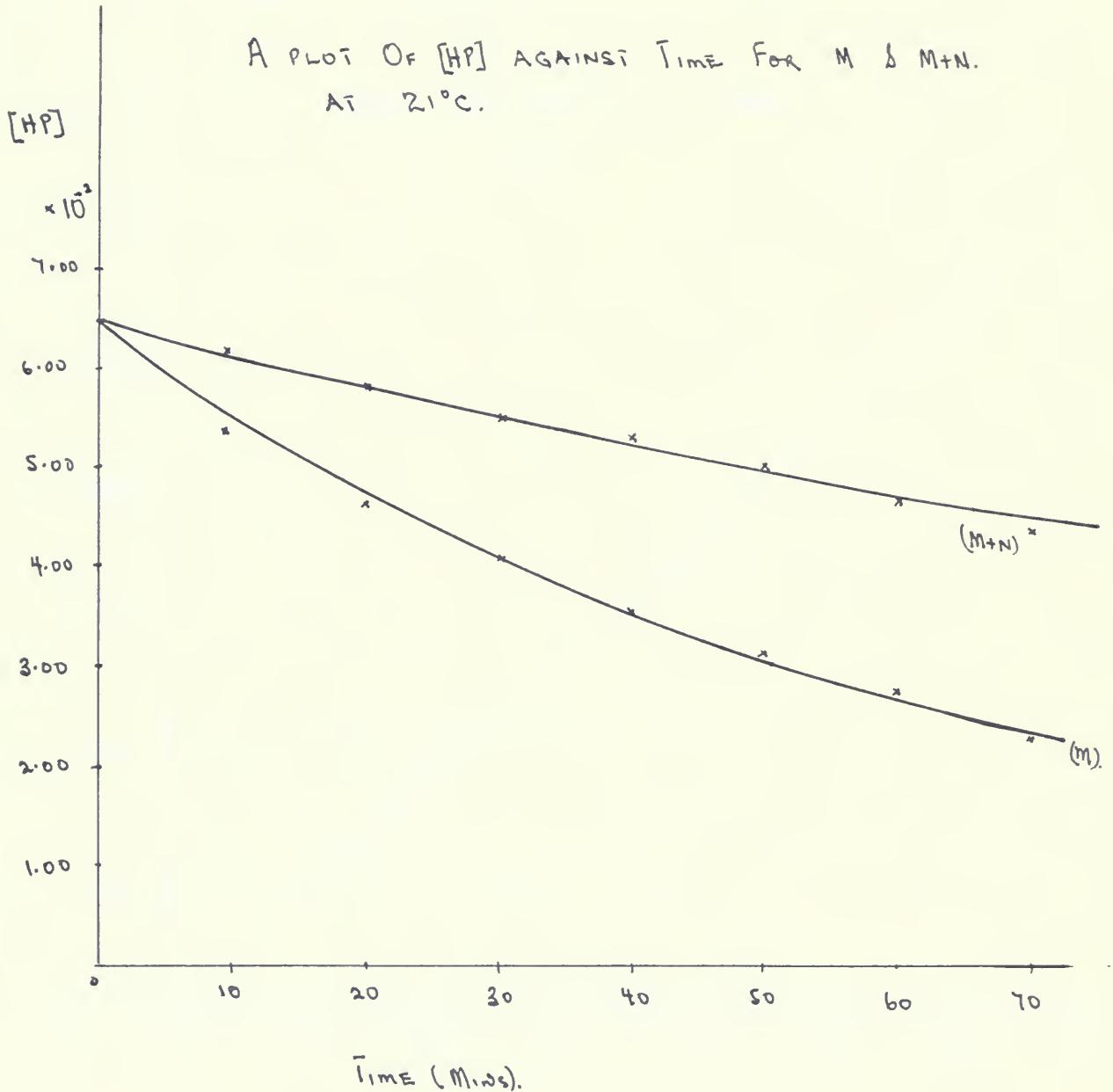
Standard deviation =  $3.2 \times 10^{-4}$

95% confidence limit =  $4.9 \times 10^{-3} + 0.0004$

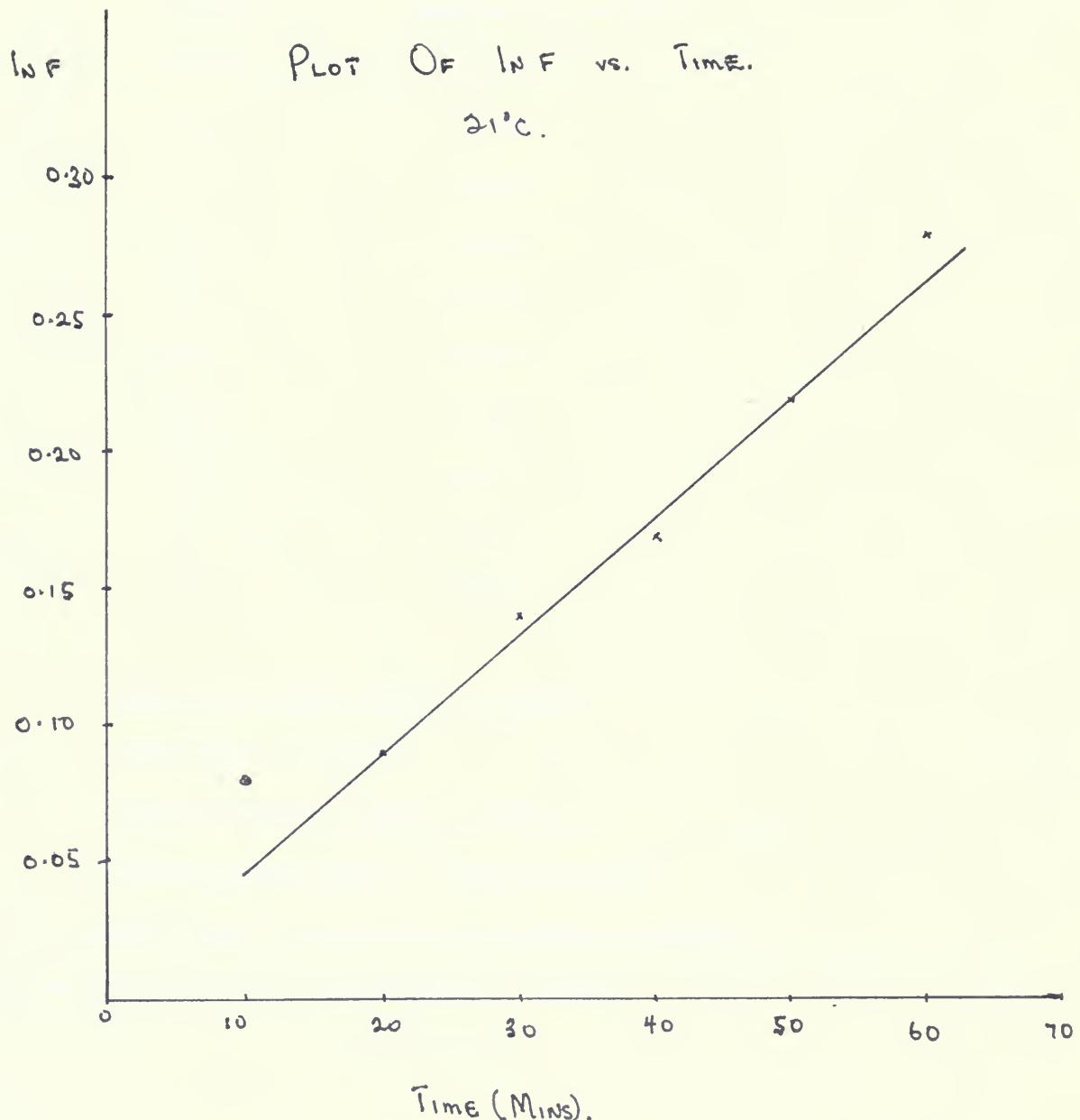
$[B]_o$  = Initial conc. of methyl p-nitrophenyl sulphide.

$[A]_o$  and  $[C]_o$  have the same meaning as before.











TEMP. 29° C.

p-Methoxyphenyl methyl sulphide + methyl p-Nitrophenyl sulphide,

$$[C]_o = 0.0645 \quad [A]_o = 0.4442 \quad [B]_o = 0.0171$$

Run No.	Observed Slope $\times 10^2$
---------	------------------------------

37	1.46
38	1.49
39	1.48
40	1.46
41	1.49
42	1.52
43	1.54
44	1.49
45	1.57
46	1.59

Expected or calc. value = 0.0212,

$$[\text{Catalyst}] = 2.44 \times 10^{-5}$$

Mean of observed slopes = 0.0151,

95% confidence limit = 0.0151  $\pm$  0.0003

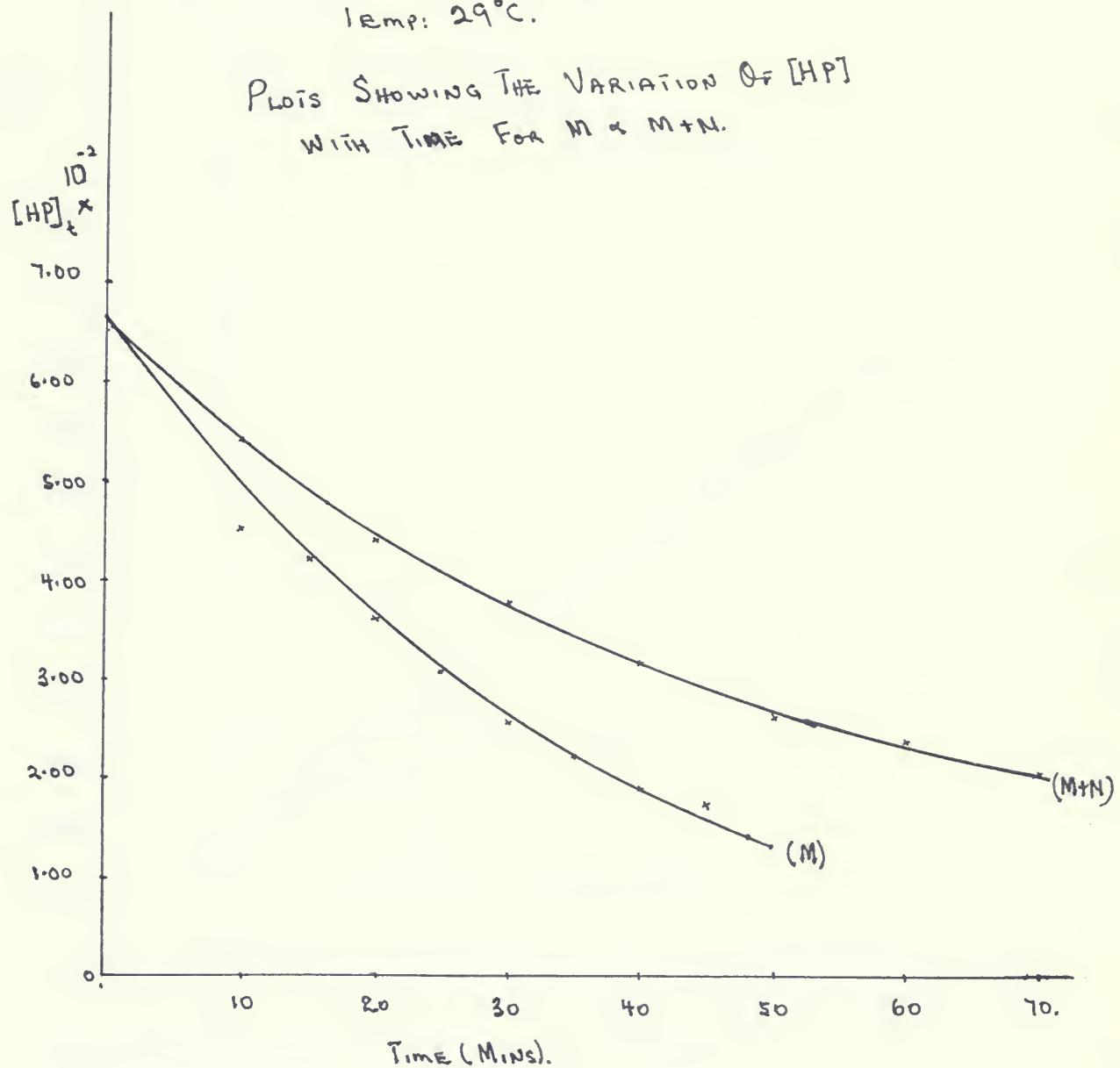
$[B]_o$  = Initial conc. of methyl p-nitrophenyl sulphide.

$[A]_o$  and  $[C]_o$  have the same meaning as before.



Temp: 29°C.

PLots SHOWING THE VARIATION OF [HP]  
WITH TIME FOR M & M+N.



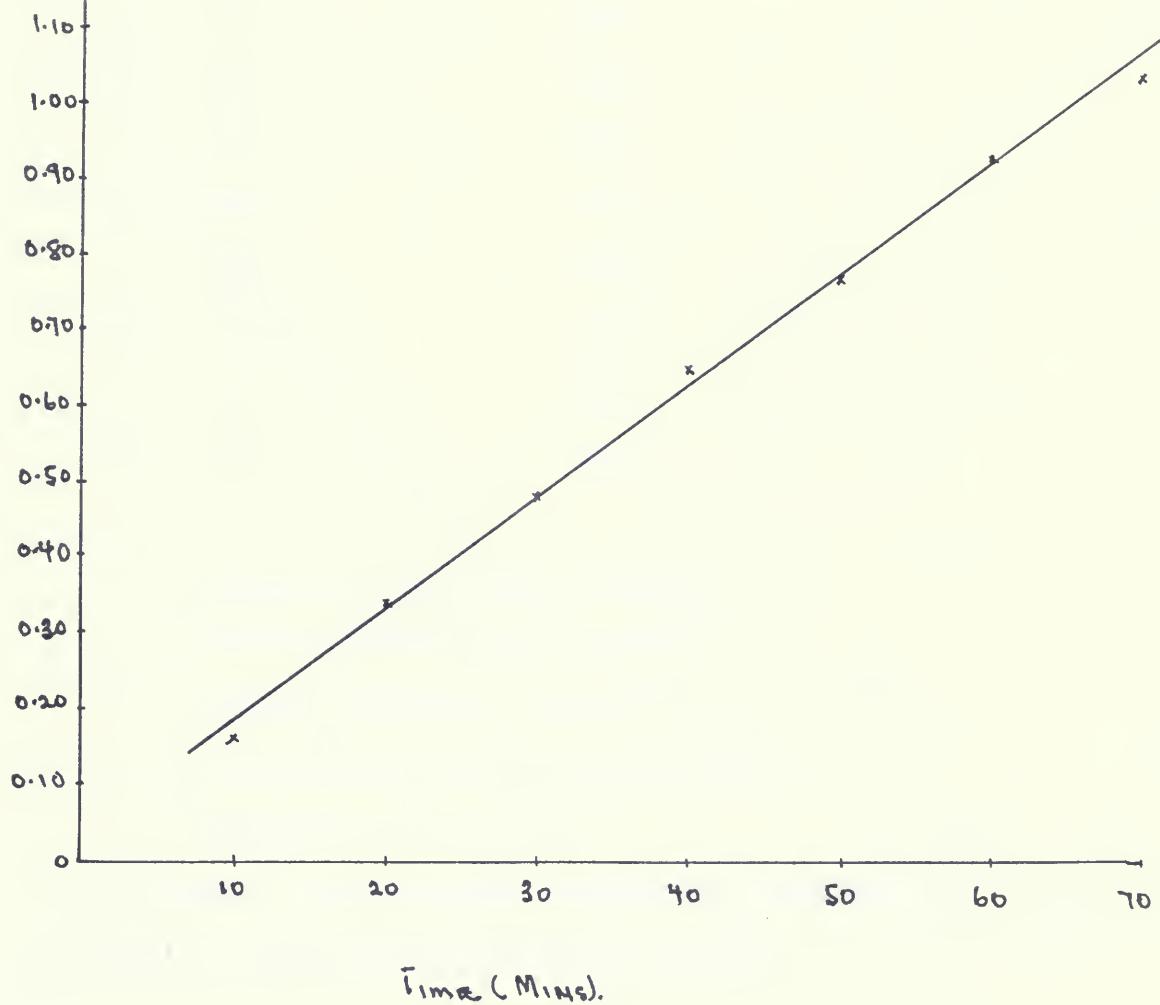


Ln F.

Plot Of Ln F vs. Time.

M + N

Temp: 29°C.





TEMP. 38<sup>o</sup>C

p-Methoxymethylphenyl sulphide + p-Nitromethylphenyl sulphide

$$[C]_o = 0.0645 \quad [A]_o = 0.4442 \quad [B]_o = 0.0171$$

Run No.	Observed Slope $\times 10^2$
---------	------------------------------

47	2.59
48	2.59
49	2.55
50	2.54
51	2.56
52	2.52
53	2.61
54	2.70
55	2.67
56	2.68

Expected or calc. value = 0.0279,

Mean of observed value = 0.0260

Standard deviation =  $6.3 \times 10^{-4}$

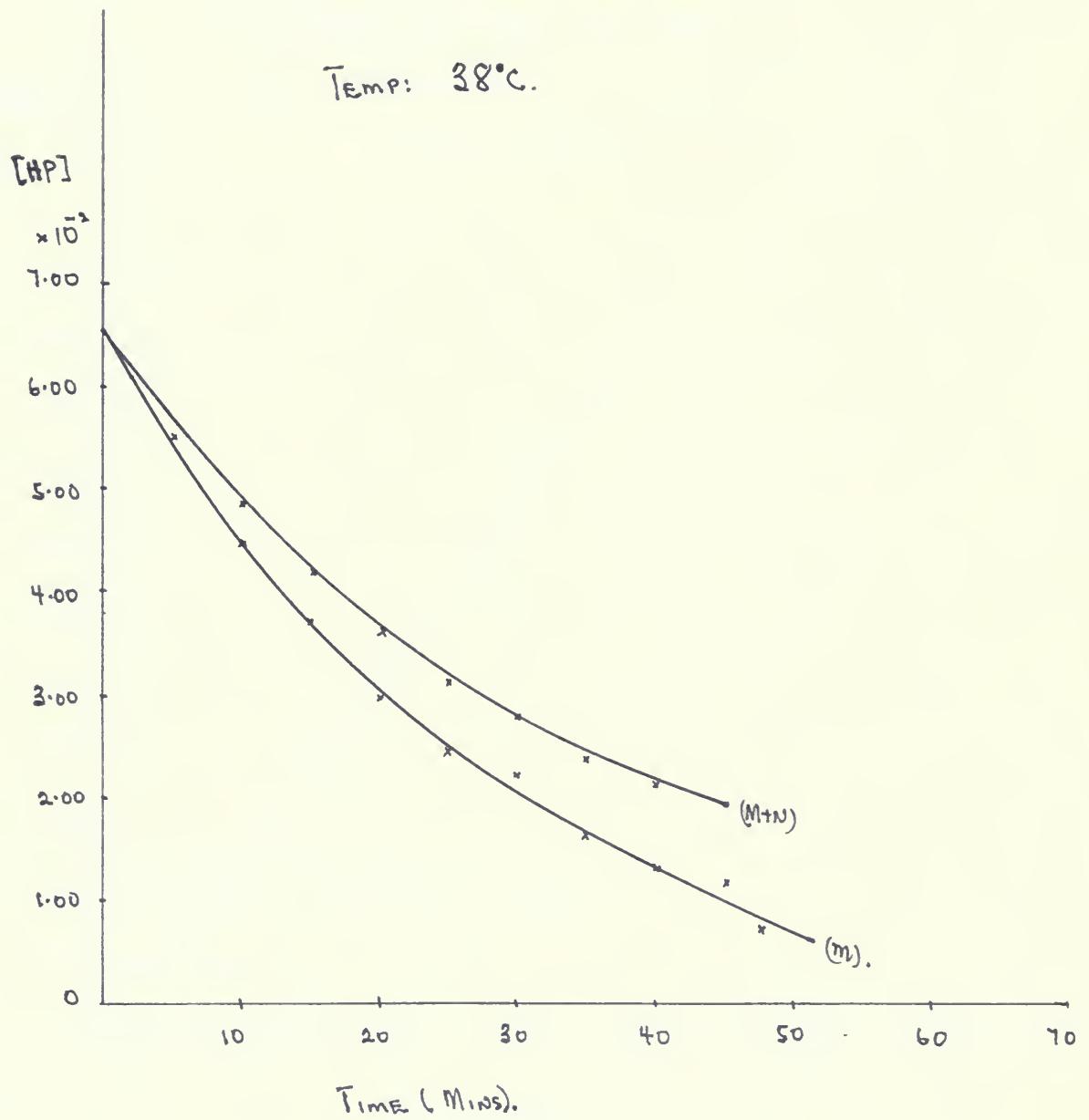
95% confidence limit =  $0.0260 \pm 0.0004$

[Catalyst] =  $2.44 \times 10^{-5}$

$[A]_o$  = Initial conc. of methyl p-nitrophenyl sulphide.

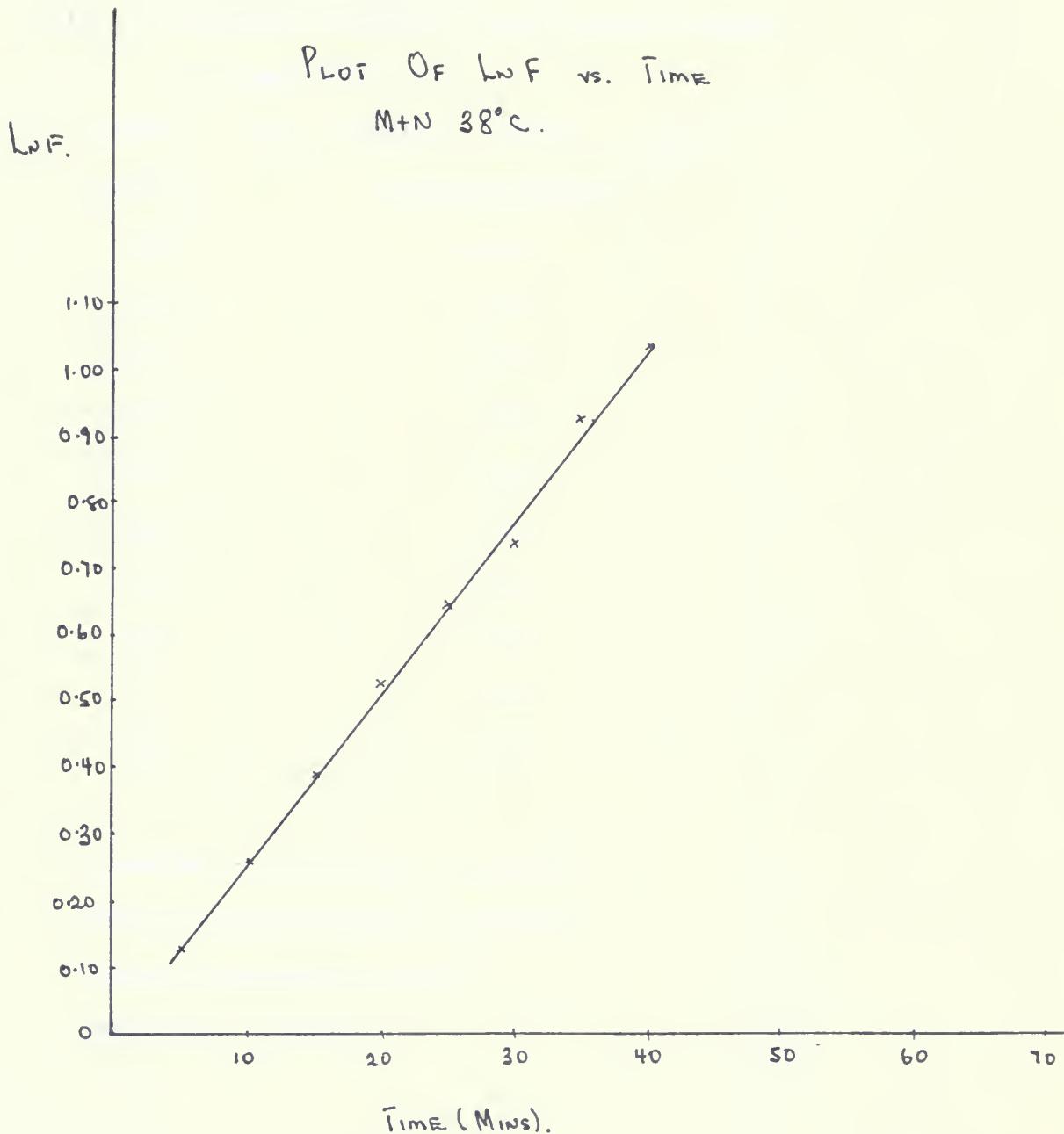
$[B]_o$  and  $[C]_o$  have the same meaning as before.





Time (Mins).







In the following data

$[A]_o$  = Initial conc. of methyl phenyl sulphide.

$[B]_o$  = " " methyl p-nitrophenyl sulphide.

$[C]_o$  = " " t-butyl hydroperoxide.

Methyl p-nitrophenyl sulphide + Methyl phenyl sulphide

Temp. 21°C

$[C]o = 0.0645$        $[A]o = 0.5113$        $[B]o = 0.0171$

Run No.                          Observed Slope  $\times 10^3$

57	-1.1
58	-1.1
59	-1.1
60	-1.0
61	-1.0
62	-1.0
63	-1.1
64	-1.0
65	-1.0
66	-1.0

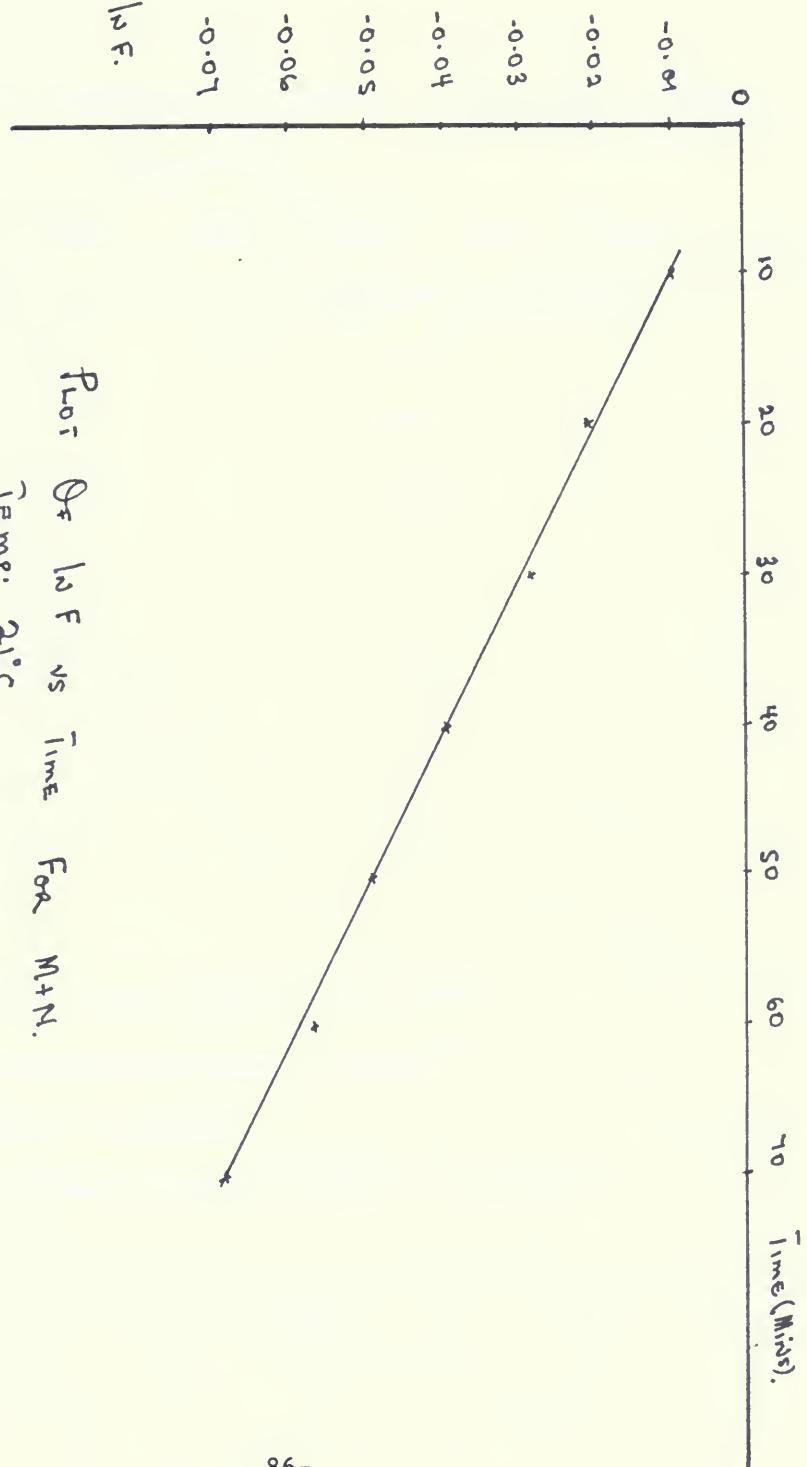
Expected or calc. value =  $-2.00 \times 10^{-4}$

Mean of observed values =  $-1.1 \times 10^{-3}$

Standard deviation =  $5 \times 10^{-5}$

$[Catalyst] = 2.44 \times 10^{-5}$





Plot of  $\ln F$  vs Time for M+N.  
Temp:  $21^{\circ}\text{C}$ .



methyl p-Nitrophenyl sulphide + Methyl phenyl sulphide.

Temp. 29°C

[C]o = 0.0645      [A]o = 0.5113      [B]o = 0.0171

Run No.	Observed Slope $\times 10^3$
---------	------------------------------

69	9.4
----	-----

70	9.4
----	-----

71	8.9
----	-----

72	9.0
----	-----

74	9.1
----	-----

75	8.6
----	-----

76	8.7
----	-----

77	9.0
----	-----

78	9.0
----	-----

Expected or calc. value =  $1.31 \times 10^{-2}$

Mean of observed values =  $9.0 \times 10^{-3}$

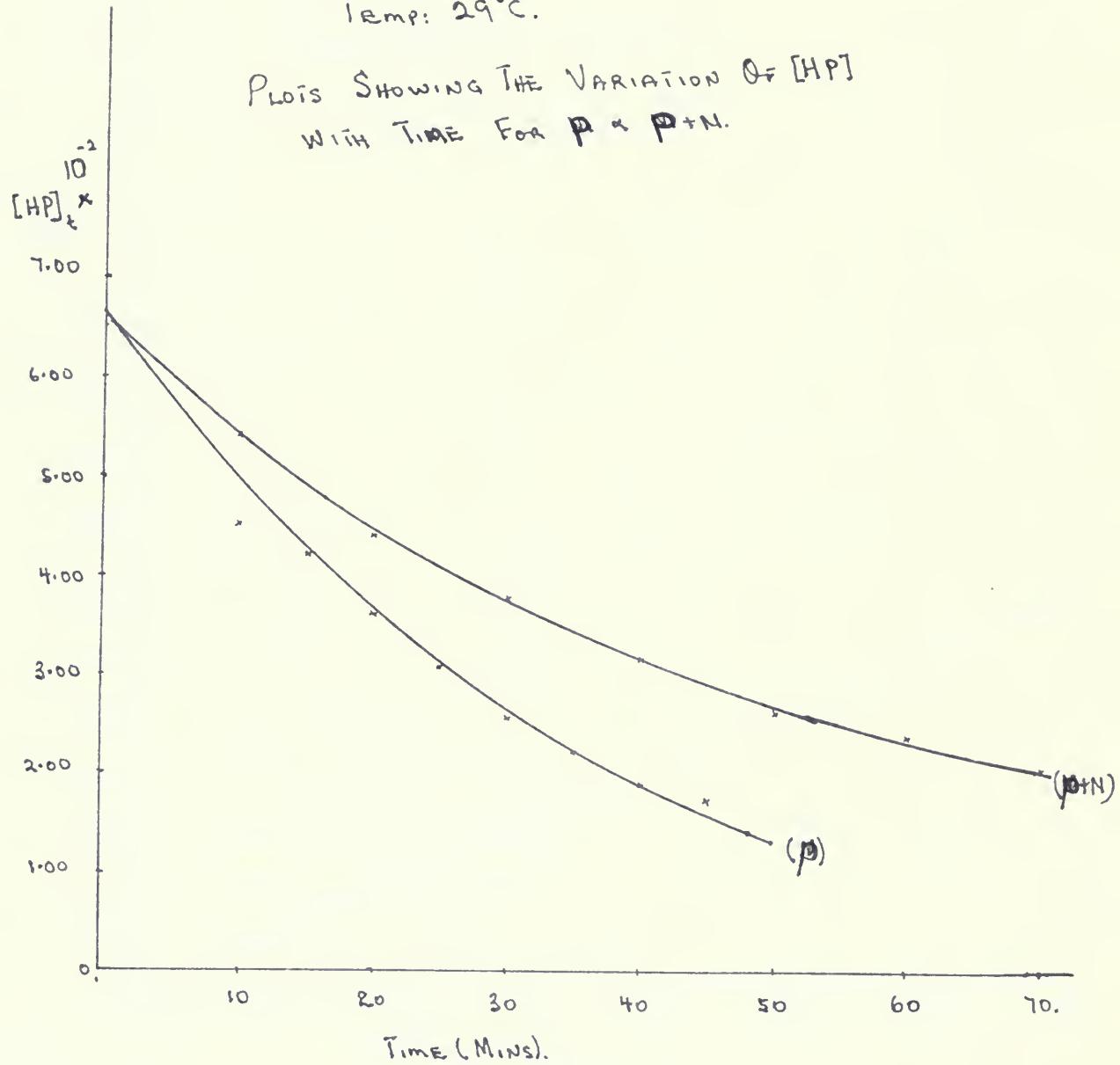
[Catalyst] =  $2.44 \times 10^{-5}$

95% confidence limit =  $9.0 \times 10^{-3} \pm 2.0 \times 10^{-4}$

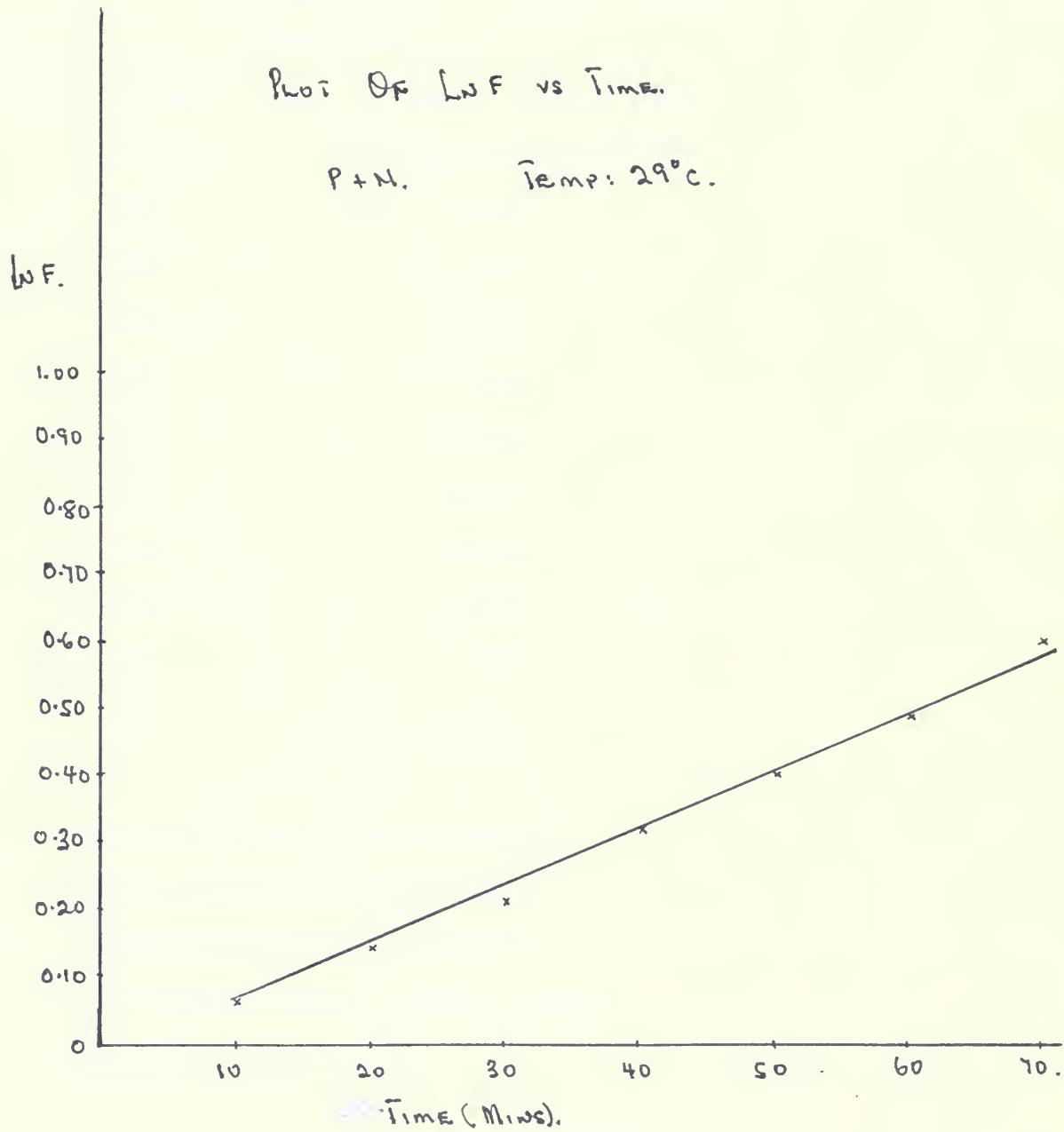


Temp: 29°C.

Plots Showing The Variation Of [HP]  
With Time For P & P+N.









methyl p-Nitrophenyl sulphide + Methyl phenyl sulphide

Temp. 39° C

[C]<sub>o</sub> = 0.0645      [A]<sub>o</sub> = 0.5113      [B]<sub>o</sub> = 0.0171

Run No.	Observed Slope $\times 10^2$
79	1.95
80	2.04
81	1.91
82	2.01
83	2.05
84	2.03
85	2.03
86	1.79
87	1.77
88	2.10

Expected or calc. value = 0.0298.

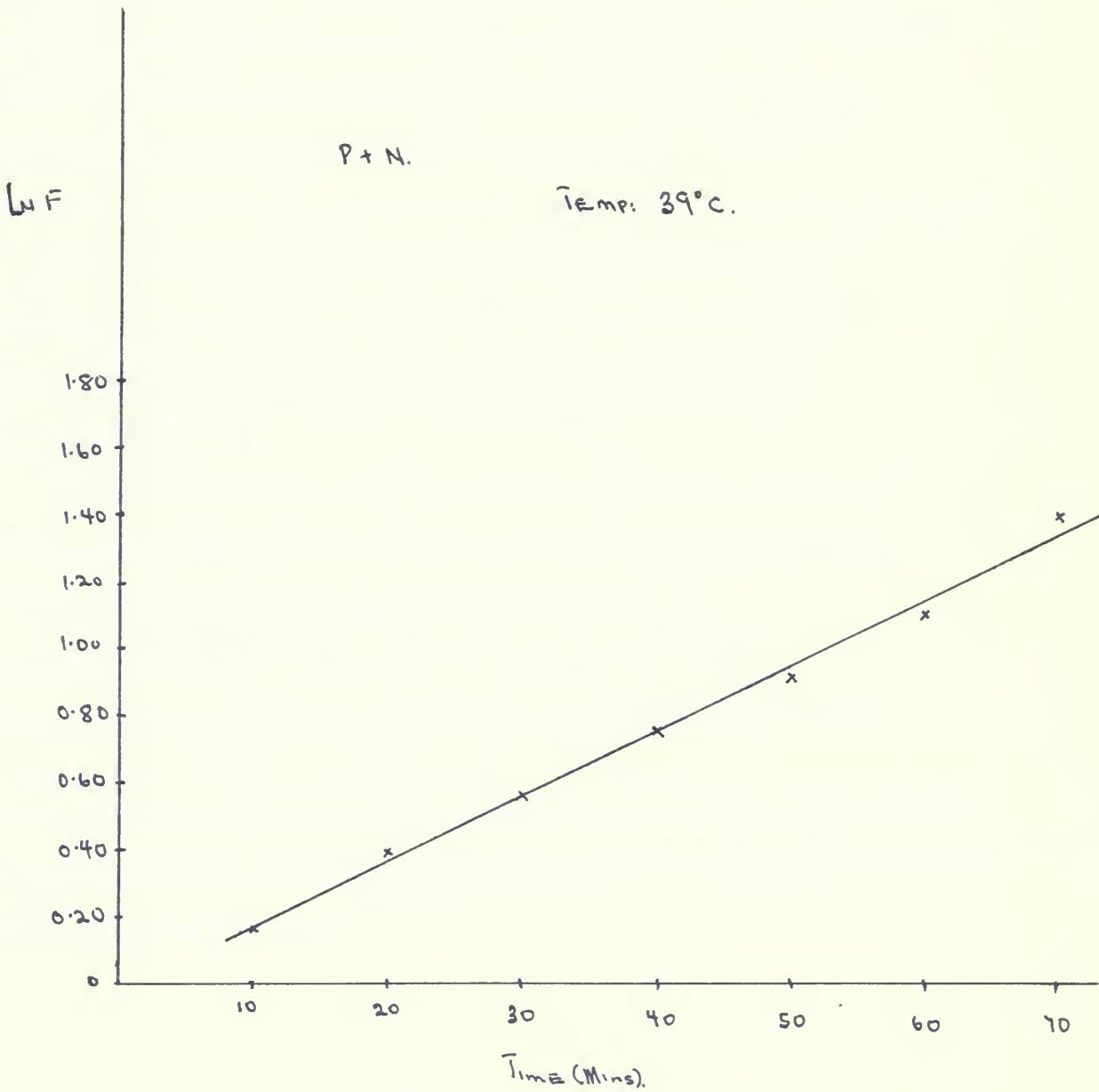
Mean of observed slope = 0.0197.

Standard deviation =  $1.1 \times 10^{-3}$ .

95% confidence limit =  $0.0197 \pm 0.0008$

[catalyst] =  $2.44 \times 10^{-5}$ .







## DISCUSSION.

The rate constants for the oxidation of three different organic sulphides namely methyl phenyl sulphide -(P), p-methoxyphenyl methyl sulphide -(M) and methyl p-nitrophenyl sulphide (N) with tert-butyl hydroperoxide in the presence of  $\text{MoO}_2(\text{acac})_2$  as catalyst have been obtained in absolute ethanol at 21, 29 and  $38^\circ\text{C}$  for P and M. The kinetics of N were accomplished at 60, 65 and  $70^\circ\text{C}$ . The third order rate constants for methyl phenyl sulphide are  $587.96 \text{ M}^{-2} \text{ min}^{-1}$ ,  $1.20 \times 10^3 \text{ M}^{-2} \text{ min}^{-1}$  and  $2.71 \times 10^3 \text{ M}^{-2} \text{ min}^{-1}$  respectively for the three temperatures. The catalyst concentration range was  $2.32-2.54 \times 10^{-5} \text{ M}$  giving means for the second order rate constants in the neighbourhood of  $1.48 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$ . The standard deviations for the  $k_2$  values for the three temperatures are  $5 \times 10^{-4}$ ,  $7.3 \times 10^{-4}$  and  $1.59 \times 10^{-3}$ .

The observed third order rate constants for the oxidation of p-methoxyphenyl methyl sulphide to sulfoxide were  $1.29 \times 10^3$ ,  $2.28 \times 10^3$  and  $3.01 \times 10^3 \text{ M}^{-2} \text{ min}^{-1}$  while the second order rate constants were  $3.17 \times 10^{-2}$ ,  $5.58 \times 10^{-2}$  and  $7.25 \times 10^{-2} \text{ M}^{-1} \text{ min}^{-1}$  with increasing temperatures. The standard deviation for the  $k_2$ 's were  $2.14 \times 10^{-2}$ ,  $1.3 \times 10^{-3}$  and  $3.7 \times 10^{-3}$  in the order of increasing temperatures. The results show that electron donating groups increase the reaction rate while electron withdrawing groups retard or suppress the reaction rate.

## ANSWER

ANSWER: The following is a list of questions which will

(1) How many electrons are in the outermost shell of an atom?  
Ans: 8  
(2) What is the symbol for the element Boron?  
Ans: B  
(3) What is the atomic number of Carbon?  
Ans: 6  
(4) What is the symbol for the element Oxygen?  
Ans: O  
(5) What is the atomic number of Nitrogen?  
Ans: 7  
(6) What is the symbol for the element Hydrogen?  
Ans: H  
(7) What is the atomic number of Helium?  
Ans: 2  
(8) What is the symbol for the element Chlorine?  
Ans: Cl  
(9) What is the atomic number of Sodium?  
Ans: 11  
(10) What is the symbol for the element Phosphorus?  
Ans: P  
(11) What is the atomic number of Magnesium?  
Ans: 12  
(12) What is the symbol for the element Potassium?  
Ans: K  
(13) What is the atomic number of Calcium?  
Ans: 20  
(14) What is the symbol for the element Iron?  
Ans: Fe  
(15) What is the atomic number of Zinc?  
Ans: 30  
(16) What is the symbol for the element Lead?  
Ans: Pb  
(17) What is the atomic number of Gold?  
Ans: 79  
(18) What is the symbol for the element Uranium?  
Ans: U  
(19) What is the atomic number of Thorium?  
Ans: 90  
(20) What is the symbol for the element Uranium-235?  
Ans:  $^{235}\text{U}$

ANSWER: The following is a list of questions which will

(1) What is the symbol for the element Hydrogen?  
Ans: H  
(2) What is the atomic number of Hydrogen?  
Ans: 1  
(3) What is the symbol for the element Helium?  
Ans: He  
(4) What is the atomic number of Helium?  
Ans: 2  
(5) What is the symbol for the element Lithium?  
Ans: Li  
(6) What is the atomic number of Lithium?  
Ans: 3  
(7) What is the symbol for the element Beryllium?  
Ans: Be  
(8) What is the atomic number of Beryllium?  
Ans: 4  
(9) What is the symbol for the element Boron?  
Ans: B  
(10) What is the atomic number of Boron?  
Ans: 5  
(11) What is the symbol for the element Carbon?  
Ans: C  
(12) What is the atomic number of Carbon?  
Ans: 6  
(13) What is the symbol for the element Nitrogen?  
Ans: N  
(14) What is the atomic number of Nitrogen?  
Ans: 7  
(15) What is the symbol for the element Oxygen?  
Ans: O  
(16) What is the atomic number of Oxygen?  
Ans: 8  
(17) What is the symbol for the element Fluorine?  
Ans: F  
(18) What is the atomic number of Fluorine?  
Ans: 9  
(19) What is the symbol for the element Neon?  
Ans: Ne  
(20) What is the atomic number of Neon?  
Ans: 10

The effect of temperature increase on the rate seems to be more pronounced for methyl phenyl sulphide than p-methoxy derivative. A Hammett plot was carried out for the three compounds and a rho value of -2.11 was obtained. The sign of the rho value is in agreement with the effect of the substituents on the kinetics. However, the small rho value (-2.11) compared to -1.13 quoted by Modena et al (72) for the acid catalyzed oxidation of aryl methyl sulphides might be due to difference in catalyst used. The activation energies for the oxidation of the various compounds are 63.60, 40.12 and 197.46 KJ mol<sup>-1</sup>.

The oxidation of methyl p-nitrophenyl sulphide in ethanol presented some difficulties. The first was the colour it imparted to the reaction medium. The colour of the compound is golden yellow if crystallized from methanol. The original titration mixture consisted of iodine in a mixture of glacial acetic acid : 2-propanol which is also yellow. It was therefore not easy to get sharp end points, however, this problem was overcome by use of starch indicator half way during the titration.

The second difficulty was with the solubility of the compound in absolute ethanol. It is so insoluble that only dilute solutions were used in the kinetics.

Reasonably good rate constants, however, were obtained as shown by the standard deviations of  $k_3$  and  $k_2$  both were of the order of  $10^{-3}$ .

and the same number of neurons required to build an  
array of 1000 neurons, which would require 1000 neurons of  
approximately 1000 connections each, or 1000<sup>2</sup> connections per neuron.  
This is a very large number of connections, and it is difficult to see how  
such a system could be implemented in hardware. However, it is  
possible to implement such a system using a different approach.  
One way to do this is to use a hierarchical architecture where  
the connections between neurons are organized into layers.  
The first layer consists of 1000 neurons, each with 1000  
connections to the second layer. The second layer consists of  
1000 neurons, each with 1000 connections to the third layer.  
This continues until the final layer, which consists of 1000 neurons,  
each with 1000 connections to the previous layer. This  
approach is called a feed-forward neural network, and it is  
much easier to implement than a fully connected network.  
In addition, it is possible to use a different type of connection  
between neurons, called a recurrent connection, which allows  
information to flow back from one layer to the previous layer.  
This can be used to implement more complex functions, such as  
recognition and classification.

The effect of organic sulphide on the oxidation of another sulphide was also studied. An equation was established for the competitive kinetics based on the assumption that there is no interaction between the sulphides. The data from the competitive reactions were compared with the expected values calculated on the assumption of no interaction.

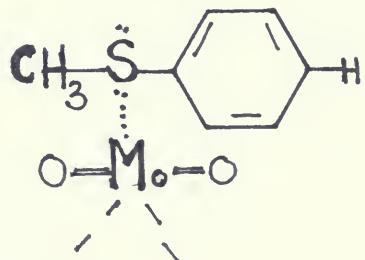
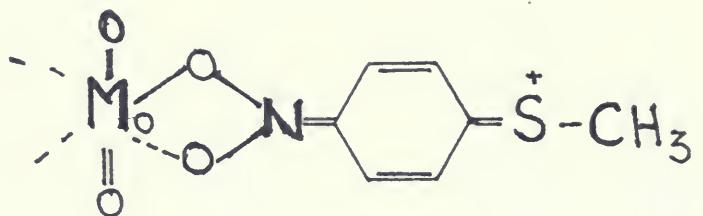
It came out that a combination of p-methoxy derivative (M) and the unsubstituted methyl phenyl sulphide (P) gave a higher rate and thus predicted a positive interaction. All the mixtures of M + P showed rate increase but there is a considerable spread in the percentage increase viz. from 9% through 28 to 34% than expected. A combination of the nitro derivative with either (P) or (M) showed suppressed rate. The p-nitro derivative suppressed the rate by as much as 58%. The extent of rate suppression, however, decreased with increase in temperature, e.g. the observed rate suppression at 29 and 38°C were 29 and 7% of the expected. This could be attributed to the fact that the nitro group interacts with the catalyst through its oxygen ends whereas the others interact through the sulphur atom. This was shown by the different shifts in the UV spectra. The UV spectra of nitro-derivative and catalyst showed band shifts to the lower energy range, whereas the others interacting through the sulphur end showed band shifts to higher energy region.

and the 1990s, the Chinese government has been making significant efforts to control its population growth. In 1979, the Chinese government introduced the "one child per family" policy, which has been widely adopted across the country. This policy has led to a significant decrease in the birth rate, and has helped to stabilize the population. However, the implementation of this policy has also led to a number of social and economic problems, such as gender bias and rural-urban migration. The Chinese government has since relaxed some of the restrictions, allowing couples to have two children if they are from different ethnic groups or if they are from the same ethnic group but are separated by a large age gap. The government has also implemented a range of social programs to support families, such as maternity leave and child care subsidies. These programs have helped to ease the burden of raising children, and have contributed to the overall stability of the population.

Presumably the oxygen ends are acting as bi-dentate ligand. If interaction is strong enough to displace the original ligand, acetylacetone then there is the possibility of the activation process of Mo from +5 to +6 to be inhibited. This could explain in part the suppressing effect of the nitro -derivative.



INTERACTION OF THE CATALYST WITH P AND N.





ce: 1  
ple identity: Phosme.

orbance mode

inate Maximum 3.500

inate Minimum 0.000

er Wavelength 400.0 nm.

er Wavelength 190.0 nm.

n Speed 100.0 nm/min.

dwidth 0.2 nm.

e Constant 0.3 sec

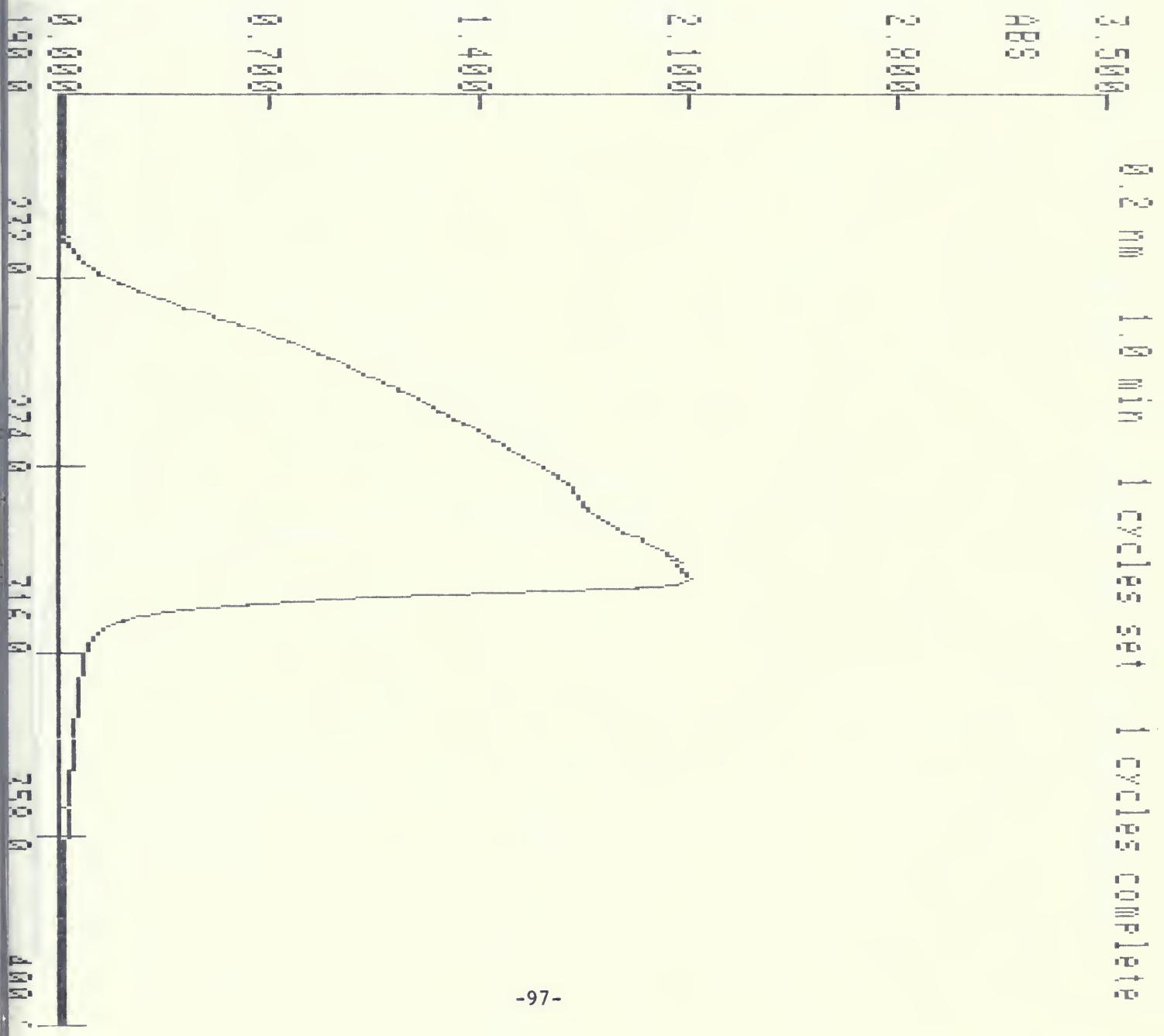
eline Corrected

Peak(s) detected

k at wavelength 298.9 nm. of value 2.103

k at wavelength 209.0 nm. of value 0.003

k at wavelength 193.7 nm. of value -0.001



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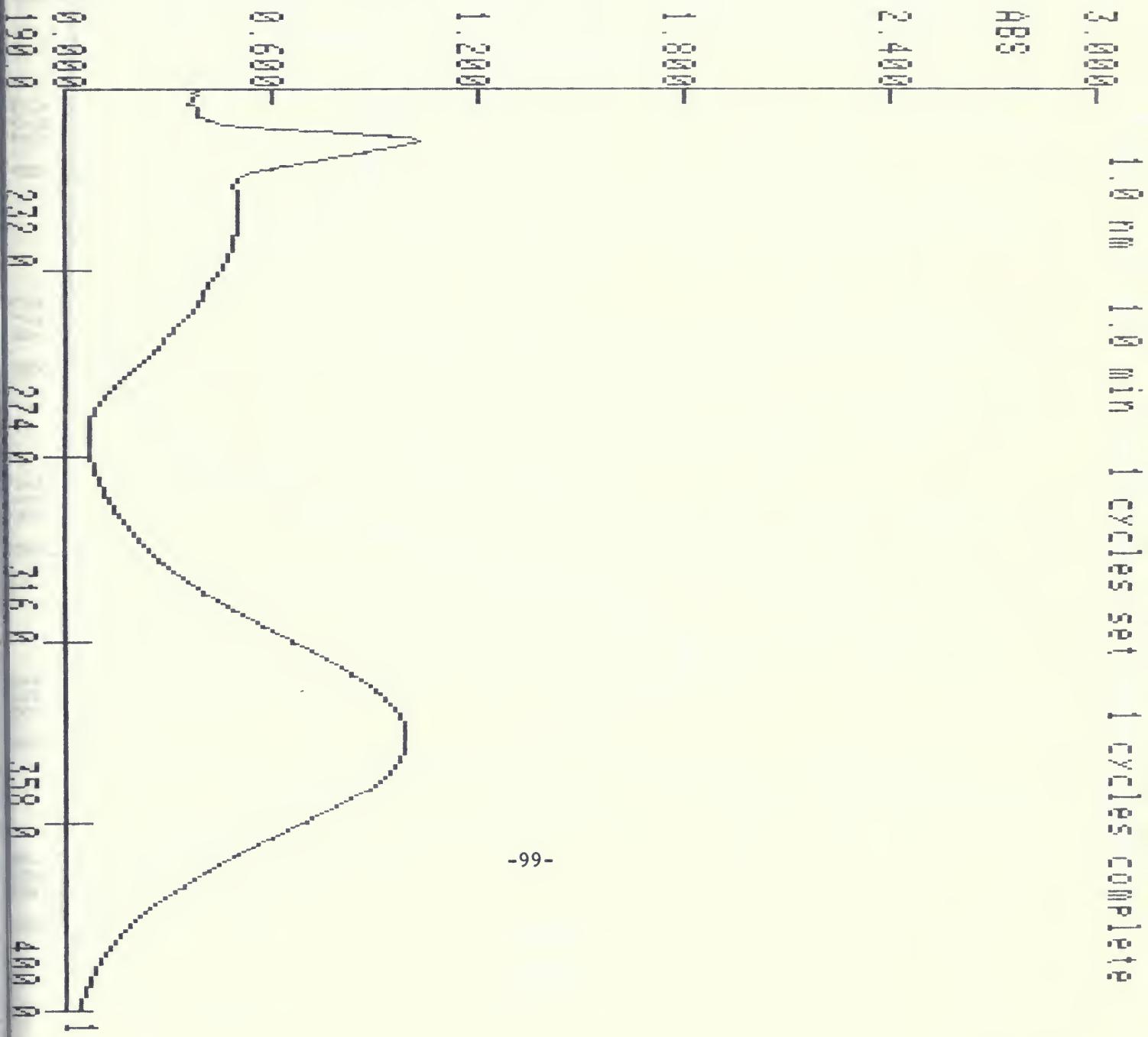
re: 1  
ole identity:  $\text{MoO}_3(\text{acac})_3 + \text{PhSMe}$ .  
orbance mode  
nate Maximum 3.500  
nate Minimum 0.000  
er Wavelength 400.0 nm.  
er Wavelength 190.0 nm.  
Speed 100.0 nm/min.  
Width 0.2 nm.  
e Constant 0.3 sec  
eline Corrected

Peak(s) detected  
at wavelength 297.5 nm. of value 2.088  
at wavelength 208.6 nm. of value -0.021





e:  
ce: 1  
ple identity: NO2-c1ccc(cc1)S(C)(C)C.  
orbance mode  
nate Maximum 3.000  
nate Minimum 0.000  
er Wavelength 400.0 nm.  
er Wavelength 190.0 nm.  
n Speed 100.0 nm/min.  
dwidth 1.0 nm.  
e Constant 0.3 sec  
6 Peak(s) detected  
ak at wavelength 338.0 nm. of value 0.985  
ak at wavelength 217.0 nm. of value 0.498  
ak at wavelength 201.6 nm. of value 1.018



—  $\omega = 0$   
—  $\omega = 2\pi$   
—  $\omega = 4\pi$   
—  $\omega = 6\pi$

—  $\omega = 8\pi$   
—  $\omega = 10\pi$

—  $\omega = 12\pi$   
—  $\omega = 14\pi$

—  $\omega = 16\pi$   
—  $\omega = 18\pi$

—  $\omega = 20\pi$   
—  $\omega = 22\pi$

—  $\omega = 24\pi$   
—  $\omega = 26\pi$

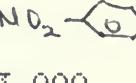
—  $\omega = 28\pi$   
—  $\omega = 30\pi$

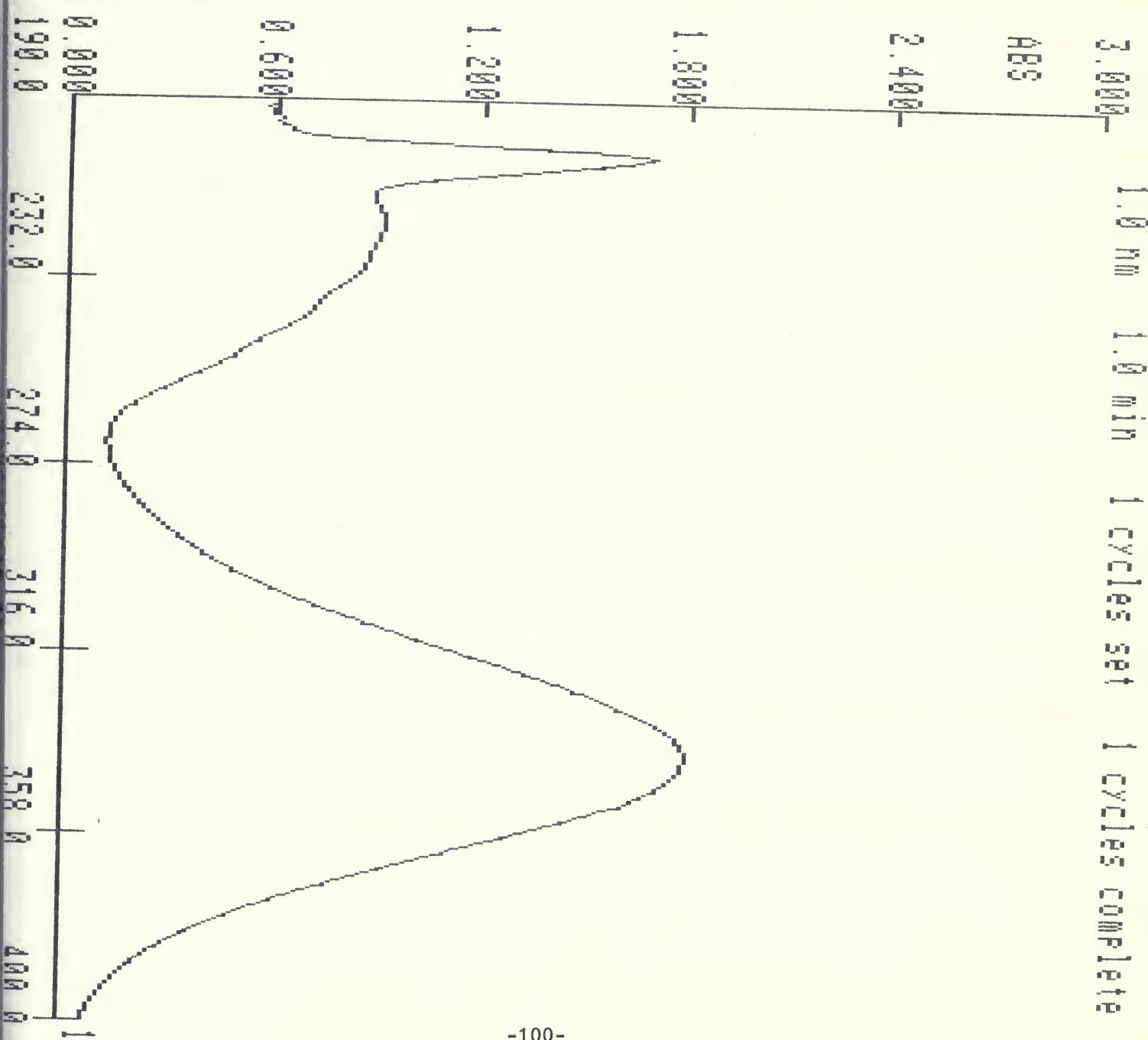
—  $\omega = 32\pi$   
—  $\omega = 34\pi$

—  $\omega = 36\pi$   
—  $\omega = 38\pi$

—  $\omega = 40\pi$   
—  $\omega = 42\pi$

—  $\omega = 44\pi$   
—  $\omega = 46\pi$

ace: 1  
ample identity:  $\text{NO}_2$ --S-CH<sub>3</sub> + MnO<sub>2</sub>(acac)<sub>2</sub>.  
orbance mode  
inate Maximum 3.000  
inate Minimum 0.000  
er Wavelength 400.0 nm.  
er Wavelength 190.0 nm.  
n Speed 100.0 nm/min.  
dwidth 1.0 nm.  
e Constant 0.3 sec  
Peak(s) detected  
k at wavelength 338.5 nm. of value 1.807  
k at wavelength 217.0 nm. of value 0.906  
k at wavelength 202.1 nm. of value 1.690



2.000 1.800 1.600 1.400 1.200 1.000 0.800 0.600 0.400 0.200 0.000 -0.200 -0.400 -0.600 -0.800 -1.000 -1.200 -1.400 -1.600 -1.800 -2.000 -2.200 -2.400 -2.600 -2.800 -3.000 -3.200 -3.400 -3.600 -3.800 -4.000

1.0 min 1.0 min 1 cycles set 1 cycles complete



### CONCLUSION.

It is apparent from the results obtained that the oxidation of organic sulphides are affected by the presence of a second organic sulphide. The results show that p-nitromethylphenyl sulphide suppress the rate, presumably because of its strong interaction with the catalyst. The extent of interaction may be estimated by taking the E.S.R. of the catalyst in the presence of the compound. The increase in oxidation rate when methylphenyl sulphide was added to p-methoxymethylphenyl sulphide could not be easily explained on the basis of interaction. Even though the interaction of the catalyst with methylphenyl sulphide is opposite to that observed for the nitro derivative.

The various activation energies of the oxidation of the compounds used, and the sign of the slope in the Hammet plot confirm the fact that electron donating groups increase the rate of oxidation whereas electron withdrawing groups retard the rate.

For unambiguous conclusion on the effect of organic sulphides in the metal catalyzed oxidation of other organic sulphides, the extent of interaction of the compounds with various metal catalysts needs to be further investigated.



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• *W*hat is the probability that a randomly selected person from the population has a disease?

• *P*ersons with the disease are called **cases**.

• *P*ersons without the disease are called **non-cases**.

• *P*ersons with the disease are called **cases**.

• *P*ersons without the disease are called **non-cases**.

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• *P*ersons without the disease are called **non-cases**.

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• *P*ersons without the disease are called **non-cases**.

• *P*ersons with the disease are called **cases**.

• *P*ersons without the disease are called **non-cases**.

• *P*ersons with the disease are called **cases**.

• *P*ersons without the disease are called **non-cases**.

• *P*ersons with the disease are called **cases**.

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APPENDIX.



## COMPETITIVE KINETICS.



$$-\frac{d[C]}{dt} = k_1[A][C] + k_2[B][C].$$

$$k_1 = k'_1 [\text{cat}].$$

$$k_2 = k'_2 [\text{cat}].$$

$$\text{Let } [C] = [C]_0 - x = c - x$$

$$[A] = [A]_0 - fx = a - fx$$

$$[B] = [B]_0 - (1-f)x = b - (1-f)x.$$

$$\frac{dx}{dt} = k_1(a - fx)(c - fx) + k_2(b - (1-f)x)(c - x).$$

$$= (c - x)[k_1(a - fx) + k_2(b - x + fx)].$$

$$= (c - x)[k_1a - k_1fx + k_2b - k_2x + k_2fx].$$

$$= (c - x)[k_1a + k_2b + x(k_2f - k_1f - k_2)].$$

$$\text{Let } k_1a + k_2b = \alpha.$$

$$k_2f - k_1f - k_2 = \beta.$$

$$\frac{dx}{dt} = (c - x)[\alpha + \beta x].$$

$$\frac{\frac{dx}{dt}}{(c - x)[\alpha + \beta x]} = dt.$$

This is of the form

$$\frac{\theta dx}{c - x} + \frac{\phi dx}{\alpha + \beta x} = dt.$$



$$-\frac{1}{\alpha + \beta c} \ln(c-x) + \frac{1}{\alpha + \beta c} \ln c + \frac{1}{\alpha + \beta c} \ln(\alpha + \beta x) - \frac{1}{\alpha + \beta c} \ln \alpha = t.$$

$$\frac{1}{\alpha + \beta c} \ln \frac{c(\alpha + \beta x)}{(c-x)\alpha} = t.$$

$$\frac{1}{(k_1[A]_0 + k_2[B]_0 + \{k_2f - k_1f - k_2\}[C]_0)} \ln \frac{c(\alpha + \beta x)}{(c-x)\alpha} = t.$$

$$-\frac{1}{k_1[A]_0 + k_2[B]_0 + [C]_0 \{f(k_2 - k_1) - k_2\}} \cdot \ln \frac{[C]_0}{k_1[A]_0 + k_2[B]_0} \cdot \frac{\{k_1[A]_0 + k_2[B]_0 + [f(k_2 - k_1) - k_2]x\}}{[C]_0 - x} = t.$$

$$x = [C]_0 - [C]$$

$$\ln [C]_0 (k_1[A]_0 + k_2[B]_0 + \{f(k_2 - k_1) - k_2\} ([C]_0 - [C])) = k_1[A]_0 + k_2[B]_0 + [C]_0 \{f(k_2 - k_1) - k_2\}$$

$$(k_1[A]_0 + k_2[B]_0) [C]$$

$$\Rightarrow \ln F = Rz.$$

$$\text{Where } F = [C]_0 (k_1[A]_0 + k_2[B]_0 + \{f(k_2 - k_1) - k_2\} ([C]_0 - [C]))$$

$$(k_1[A]_0 + k_2[B]_0) [C]$$

$$R = k_1[A]_0 + k_2[B]_0 + [C]_0 \{f(k_2 - k_1) - k_2\},$$

$$f = \frac{k_1[A]_0}{k_2[B]_0 + k_1[A]_0} \quad \text{NB } 0 \leq f \leq 1$$



$$\frac{[\alpha\theta + \beta x\theta + (\phi c - \phi x)]dx}{(c-x)(\alpha + \beta x)} = dt.$$

$$\therefore \alpha\theta + \phi c = 1.$$

$$\beta x\theta + -\phi x = 0.$$

$$\therefore \begin{aligned} \beta\theta &= \phi \\ \Rightarrow \theta &= \phi/\beta \end{aligned}$$

$$\alpha\theta = 1 - \phi c$$

$$\frac{\alpha\phi}{\beta} = 1 - \phi c$$

$$\left(\frac{\alpha}{\beta} + c\right)\phi = 1.$$

$$\phi = \frac{1}{\left(\frac{\alpha}{\beta} + c\right)} \quad \theta = \frac{1}{\alpha + \beta c}.$$

$$= \frac{\beta}{\alpha + \beta c}.$$

$$\int_{\alpha+\beta c}^x \frac{1}{\alpha+\beta x} \cdot \frac{dx}{c-x} + \int_{\alpha+\beta c}^x \frac{\beta dx}{(\alpha+\beta c)(\alpha+\beta x)} = \int_0^t dt.$$

$$\left[ -\frac{1}{\alpha+\beta c} \ln(c-x) \right]_0^x + \left[ \frac{1}{\alpha+\beta c} \ln \alpha + \beta x \right]_0^x = t.$$



### KINETICS OF METHYL PHENYL SULPHIDE.

Reaction mixture consists of ;

- 1). 5ml of catalyst solution  $[\text{MoO}_2(\text{acac})_2]$  in absolute ethanol with concentrations ranging from  $1-3 \times 10^{-5}$  M.
- 2). 5ml of hydroperoxide solution of approximately 0.3147M
- 3). 1ml of methyl phenyl sulphide with density  $1.585 \text{ g ml}^{-1}$ .
- 4). 14ml of absolute ethanol.

Total volume of solution was 25ml.

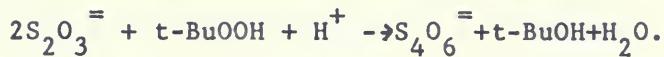
2ml aliquots were pipetted and titrated with standard sodium thiosulphate solution of strength 0.0500M.

1ml of PhSMe is equivalent to 0.012742 moles. Hence its concentration is 0.5113M.

#### Estimation of [HP].

2.5ml of the approx. 0.3147M solution was made up to 25ml with absolute ethanol. 2ml of the resulting solution was estimated using the standard thiosulphate solution.

Average titre value = 2.58ml.



2.58ml is equivalent to  $2.58 \times 0.00005$  moles of sodium thiosulphate.

Equivalent moles of HP =  $2.58 \times 0.000025$  moles.

Therefore  $[\text{HP}] = 0.3225 \text{ M}$ . Initial conc. of  $[\text{HP}]' = 0.0645 \text{ M}$



KINETIC EQUATION FOR THE REACTION.

$$\begin{aligned}-d/dt[HP] &= k_3[\text{Cat}][S][HP]. \\ &= K_2[S][HP]. \quad \text{where } k_2 = k_3[\text{Cat}].\end{aligned}$$

Let  $[S] = b$   $[HP] = a$  and  $x = \text{amount of HP used at time } t.$

Then  $dx/dt = k_2[a-x][b-x].$  or  $dx [a-x][b-x] = k_2 dt.$

Integrating this within the limits  $0-x$  after separation into partial fractions gave  $\ln[b-x]/[a-x] - \ln[b/a] = [b-a] k_2 t.$

A plot of  $\ln [S]/[HP]$  against  $t$  should yield a straight line with slope  $[b-a] k_2 = k_{\text{obs}}$

SAMPLE DATA & CALCULATION.

COMPD.: PhSMe      TEMP.  $21^{\circ}\text{C}$       Run. 1.

FINAL	INITIAL	VOLUME USED (ml)	TIME (min).
5.25	0.50	4.75	10.15
9.50	5.25	4.25	20.00
4.50	0.50	4.00	30.00
8.31	4.55	3.76	40.00
3.71	0.50	3.21	60.00
6.60	3.73	2.87	79.85
9.10	6.62	2.48	100.00

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$$\{ \text{sum}(\{2^1, 4^2\}) \} = \{2^3\} + \{4^2\}$$

Figure 10.20 *Effect of age*

Let  $vv$  represent the volume of thiosulphate used, then the equivalent moles of HP in 2ml is given by  $vv \times 0.025 \times 10^{-3}$

$$[HP]'' \text{ at time } t = vv \times 0.0125 = [a-x] \text{ and } x = [HP]' - [HP]''$$

TIME(min)	$[a-x] \times 10^2$	$[HP]' - [HP]'' \times 10^2$	$[b-x] \times 10^2 \ln[b-x]/[a-x]$	
10.15	5.938	0.512	50.458	2.1398
20.00	5.313	1.137	49.833	2.2385
30.00	5.000	1.450	49.520	2.2929
40.00	4.700	1.750	49.220	2.3487
60.20	4.013	2.437	48.533	2.4927
79.85	3.588	2.862	48.108	2.5959
100.00	3.100	3.350	47.620	2.731



compound : F temperature : 21  
sample no. : 1 no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.75	0.06	0.01	2.14
4.25	0.05	0.01	2.24
4.00	0.05	0.01	2.30
3.76	0.05	0.02	2.35
3.21	0.04	0.02	2.50
2.87	0.04	0.03	2.60
2.48	0.03	0.03	2.74

report of (x,y) values and slope

time	10.15	20.00	30.00	40.00	50.00	79.85	100.00								
lnval	1	2.14	1	2.24	1	2.30	1	2.35	1	2.50	1	2.60	1	2.74	1

slope = 0.0064



compound : P tempreature : 21  
sample no. : 2 no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	inv1
==	==	=	=====
4.75	0.06	0.01	2.14
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.75	0.05	0.02	2.35
3.20	0.04	0.02	2.50
2.85	0.04	0.03	2.61
2.50	0.03	0.03	2.73

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00
Inv1	2.14	2.23	2.30	2.35	2.50	2.61	2.73

slope = 0.0064



compound : P temperature : 21  
sample no. : 3 no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.70	0.06	0.01	2.15
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.75	0.05	0.02	2.35
3.20	0.04	0.02	2.50
2.80	0.04	0.03	2.62
2.40	0.03	0.03	2.77

report of (x,y) values and slope

time	10.00	20.00	30.02	40.01	60.00	80.00	100.01	1							
lnval	1	2.15	1	2.23	1	2.30	1	2.35	1	2.50	1	2.62	1	2.77	1

slope = 0.0067



compound : P      temperature : 21  
sample no. : 4      no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.70	0.06	0.01	2.15
4.32	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.75	0.05	0.02	2.35
3.23	0.04	0.02	2.49
2.78	0.03	0.03	2.63
2.39	0.03	0.03	2.77

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.01	
Inval	1	2.15	2.23	2.30	2.35	2.49	2.63	2.77

slope = 0.0068



compound : P temperature : 21  
sample no. : 5 no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645  
  
vv == ht = x = Inval  
=====

4.70	0.06	0.01	2.15
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.75	0.05	0.02	2.35
3.20	0.04	0.02	2.50
2.90	0.04	0.03	2.59
2.50	0.03	0.03	2.73

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00
Inval	2.15	2.23	2.30	2.35	2.50	2.59	2.73

slope = 0.0063



compound : P tempreture : 21  
sample no. : 6 no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.75	0.06	0.01	2.14
4.25	0.05	0.01	2.24
4.02	0.05	0.01	2.29
3.73	0.01	0.06	3.91
3.20	0.04	0.02	2.50
2.90	0.04	0.03	2.59
2.49	0.03	0.03	2.73

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
Invail	2.14	2.24	2.29	3.91	2.50	2.59	2.73			
slope =	0.0043									



compound : p      tempreture :    21  
sample no. :    7      no. of cases :    7  
alpha : 0.0500,    beta : 0.5113,    delta : 0.0645

vv	ht	x	lerval
==	==	=	=====
4.70	0.06	0.01	2.15
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.80	0.05	0.02	2.34
3.20	0.04	0.02	2.50
2.89	0.04	0.03	2.59
2.51	0.03	0.03	2.72

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00	1
lerval	2.15	2.23	2.30	2.34	2.50	2.59	2.72	1
slope	=	0.0063						



compound : P      tempreture :      21  
sample no. :    8      no. of cases :    7  
alpha :    0.0500,    beta :    0.5113,    delta :    0.0645

vv	ht	x	lnval
==	==	=	=====
4.75	0.06	0.01	2.14
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.75	0.05	0.02	2.35
3.50	0.04	0.02	2.50
3.20	0.03	0.02	2.63
2.78	0.03	0.03	2.77
2.40	0.03	0.03	

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00
lnval	2.14	2.23	2.30	2.35	2.50	2.63	2.77
slope	0.0068						



compound : P      tempreture : 21  
sample no. : 9      no. of cases : 7  
alpha : 0.0500,    beta : 0.5113,    delta : 0.0645

vv	ht	x	inval
==	==	=	=====
4.73	0.06	0.01	2.15
4.28	0.05	0.01	2.24
4.00	0.05	0.01	2.30
3.74	0.05	0.02	2.36
3.20	0.04	0.02	2.50
2.81	0.04	0.03	2.62
2.39	0.03	0.03	2.77

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00
inval	2.15	2.24	2.30	2.36	2.50	2.62	2.77
slope	=	0.0068					



compound : P      temppreture : 21  
sample no. : 10    no. of cases : 7  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.70	0.06	0.01	2.15
4.30	0.05	0.01	2.23
4.00	0.05	0.01	2.30
3.80	0.05	0.02	2.34
3.20	0.04	0.02	2.50
2.85	0.04	0.03	2.61
2.35	0.03	0.04	2.79

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	60.00	80.00	100.00
Invall	2.15	2.23	2.30	2.34	2.50	2.61	2.79

slope = 0.0068

report of std for P      at 21 degrees

std = 0.00000059

summary of slopes and the inverse of the temppreture

slopes : 0.006389, 0.006399, 0.006726, 0.006792, 0.006265, 0.004260, 0.006267, 0.006814, 0.006753, 0.006819, inverse of temppreture : 0.003401



compound : P temperature : 29  
sample no. : 1 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	inval
==	==	=	=====
5.05	0.06	0.00	2.09
4.70	0.06	0.01	2.15
4.10	0.05	0.01	2.27
3.50	0.04	0.02	2.42
3.00	0.04	0.03	2.56
2.65	0.03	0.03	2.67
2.35	0.03	0.04	2.79
2.00	0.03	0.04	2.94

report of (x,y) values and slope

time	5.09	10.00	20.00	30.00	40.00	50.00	60.00	70.00								
inval	2.09	1	2.15	1	2.27	1	2.42	1	2.56	1	2.67	1	2.79	1	2.94	1
slope =	0.0130															



compound : P temperature : 29  
sample no. : 2 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.05	0.06	0.00	2.09
4.75	0.06	0.01	2.14
4.05	0.05	0.01	2.28
3.55	0.04	0.02	2.40
3.05	0.04	0.03	2.54
2.75	0.03	0.03	2.64
2.30	0.03	0.04	2.81
2.05	0.03	0.04	2.91

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	2.09	2.14	2.28	2.40	2.54	2.64	2.81	2.91
slope	=	0.0128						



compound : P temperature : 29  
sample no. : 3 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
5.05	0.06	0.00	2.09
4.70	0.06	0.01	2.15
4.05	0.05	0.01	2.28
3.55	0.04	0.02	2.40
3.00	0.04	0.03	2.56
2.75	0.03	0.03	2.64
2.30	0.03	0.04	2.81
2.00	0.03	0.04	2.94

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inv1	2.09	2.15	2.28	2.40	2.56	2.64	2.81	2.94
slope =	0.0130							



compound : P temperature : 29  
sample no. : 4 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

yy	ht	x	Inval
==	==	=	=====
5.05	0.06	0.00	2.09
4.70	0.06	0.01	2.15
4.12	0.05	0.01	2.27
3.48	0.04	0.02	2.42
3.00	0.04	0.03	2.56
2.65	0.03	0.03	2.67
2.30	0.03	0.04	2.81
2.02	0.03	0.04	2.93

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	2.09	2.15	2.27	2.42	2.56	2.67	2.81	2.93
slope =	0.0130							



compound : P tempreature : 29  
sample no. : 5 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.08	0.06	0.00	2.08
4.72	0.06	0.01	2.15
4.08	0.05	0.01	2.28
3.60	0.04	0.02	2.39
3.90	0.04	0.03	2.59
2.75	0.03	0.03	2.64
2.35	0.03	0.04	2.79
1.95	0.02	0.04	2.96

report of (x,y) values and slope

time	5.09	10.00	20.00	30.00	40.00	50.00	60.00	70.00									
lnval	1	2.08	1	2.15	1	2.28	1	2.39	1	2.59	1	2.64	1	2.79	1	2.96	1

slope = 0.0132



compound : P tempreture : 29  
sample no. : 6 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.10	0.06	0.00	2.08
4.75	0.06	0.01	2.14
4.07	0.05	0.01	2.28
3.55	0.04	0.02	2.40
3.10	0.04	0.03	2.53
2.70	0.03	0.03	2.66
2.35	0.03	0.04	2.79
2.08	0.03	0.04	2.90

report of (x,y) values and slope

time	5.10	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	2.08	2.14	2.28	2.40	2.53	2.66	2.79	2.90
slope								



compound : P temperature : 29  
sample no. : 7 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
5.10	0.06	0.00	2.08
4.75	0.06	0.01	2.14
4.05	0.05	0.01	2.28
3.55	0.04	0.02	2.40
3.07	0.04	0.03	2.54
2.70	0.03	0.03	2.66
2.40	0.03	0.03	2.77
2.00	0.03	0.04	2.94

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
inval	2.08	2.14	2.28	2.40	2.54	2.66	2.77	2.94

slope = 0.0129



compound : P temperature : 29  
sample no. : 8 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.15	0.06	0.00	2.07
4.80	0.06	0.00	2.13
4.00	0.05	0.01	2.30
3.60	0.04	0.02	2.39
3.05	0.04	0.03	2.54
2.75	0.03	0.03	2.64
2.35	0.03	0.04	2.79
2.00	0.03	0.04	2.94

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	2.07	2.13	2.30	2.39	2.54	2.64	2.79	2.94

slope = 0.0130



compound : P      temperature : 29  
sample no. : 9      no. of cases : 8  
alpha : 0.0500,    beta : 0.5113,    delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.05	0.06	0.00	2.09
4.68	0.06	0.01	2.16
4.12	0.05	0.01	2.27
3.55	0.04	0.02	2.40
3.05	0.04	0.03	2.54
2.75	0.03	0.03	2.64
2.30	0.03	0.04	2.81
1.80	0.02	0.04	3.04

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	2.09	2.16	2.27	2.40	2.54	2.64	2.81	3.04

slope = 0.0139



compound : F temperature : 29  
sample no. : 10 no. of cases : 8  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
5.05	0.06	0.00	2.09
4.80	0.06	0.00	2.13
4.05	0.05	0.01	2.28
3.60	0.04	0.02	2.39
3.10	0.04	0.03	2.53
2.75	0.03	0.03	2.64
2.37	0.03	0.03	2.78
1.98	0.02	0.04	2.95

report of (x,y) values and slope

time	5.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	
inval	1	2.09	2.13	2.28	2.39	2.53	2.64	2.78	2.95
slope	=	0.0130							

report of std for F at 29 degrees

std = 0.00000010

summary of slopes and the inverse of the temperature

slopes : 0.012986, 0.012787, 0.012950, 0.013030, 0.013192, 0.012681, 0.012868, 0.013038, 0.013858, 0.012965,  
inverse of tempreature : 0.003311



compound : P temperature : 38  
sample no. : 1 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.80	0.06	0.00	2.13
4.15	0.05	0.01	2.26
3.55	0.04	0.02	2.40
3.10	0.04	0.03	2.53
2.60	0.03	0.03	2.69
2.25	0.03	0.04	2.83
1.93	0.02	0.04	2.97
1.57	0.02	0.04	3.17
1.37	0.02	0.05	3.30
1.18	0.01	0.05	3.44
0.95	0.01	0.05	3.65

report of (x,y) values and slope

time	5.00	10.02	15.06	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.01
Inv1	2.13	2.26	2.40	2.53	2.69	2.83	2.97	3.17	3.30	3.44	3.65
slope =	0.0301										



compound : P temperature : 38  
sample no. : 2 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.85	0.06	0.00	2.12
4.10	0.05	0.01	2.27
3.55	0.04	0.02	2.40
3.01	0.04	0.03	2.56
2.60	0.03	0.03	2.69
2.10	0.03	0.04	2.89
1.80	0.02	0.04	3.04
1.58	0.02	0.04	3.16
1.30	0.02	0.05	3.35
1.15	0.01	0.05	3.47
0.90	0.01	0.05	3.71

report of (x,y) values and slope

time	5.00	10.03	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.12	2.27	2.40	2.56	2.69	2.89	3.04	3.16	3.35	3.47	3.71
slope =	0.0311										



compound : P tempreature : 38  
sample no. : 3 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.85	0.06	0.00	2.12
4.12	0.05	0.01	2.27
3.58	0.04	0.02	2.40
3.10	0.04	0.03	2.53
2.62	0.03	0.03	2.68
2.32	0.03	0.04	2.80
1.98	0.02	0.04	2.95
1.65	0.02	0.04	3.12
1.45	0.02	0.05	3.24
1.20	0.02	0.05	3.43
1.00	0.01	0.05	3.60

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
Inv1	2.12	2.27	2.40	2.53	2.68	2.80	2.95	3.12	3.24	3.43	3.60
slope =	0.0291										



Compound : P      tempreture : 38  
sample no. : 4      no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

VV	ht	x	Inval
==	==	=	=====
4.85	0.06	0.00	2.12
4.10	0.05	0.01	2.27
3.58	0.04	0.02	2.40
3.12	0.04	0.03	2.52
2.60	0.03	0.03	2.69
2.35	0.03	0.04	2.79
1.96	0.02	0.04	2.96
1.64	0.02	0.04	3.13
1.45	0.02	0.05	3.24
1.22	0.02	0.05	3.41
1.00	0.01	0.05	3.60

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
Inv1	2.12	2.27	2.40	2.52	2.69	2.79	2.96	3.13	3.24	3.41	3.60
slope =	0.0290										



compound : P tempreture : 38  
sample no. : 5 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv ==	ht ==	x =	lnval =====
4.80	0.06	0.00	2.13
4.15	0.05	0.01	2.26
3.55	0.04	0.02	2.40
3.15	0.04	0.03	2.51
2.55	0.03	0.03	2.71
2.25	0.03	0.04	2.83
1.95	0.02	0.04	2.96
1.50	0.02	0.05	3.21
1.40	0.02	0.05	3.28
1.20	0.02	0.05	3.43
0.95	0.01	0.05	3.65

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.01
lnval	2.13	2.26	2.40	2.51	2.71	2.83	2.96	3.21	3.28	3.43	3.65
slope =	0.0300										



compound :	P	temperature :	38		
sample no. :	6	no. of cases :	11		
alpha :	0.0500,	beta :	0.5113,	delta :	0.0645

	$\text{ht}$	$\text{vv}$	$\text{X}$	$\text{Inval}$
4.80	0.06	0.00	2.13	====
4.15	0.05	0.01	2.26	
3.55	0.04	0.02	2.40	
3.10	0.04	0.03	2.53	
2.60	0.03	0.03	2.69	
2.30	0.03	0.04	2.81	
1.80	0.02	0.04	3.04	
1.60	0.02	0.04	3.15	
1.40	0.02	0.05	3.28	
1.20	0.02	0.05	3.43	
1.00	0.01	0.05	3.60	

report of  $(x,y)$  values and slope



compound : P tempreature : 38  
sample no. : 7 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.85	0.06	0.00	2.12
4.10	0.05	0.01	2.27
3.55	0.04	0.02	2.40
3.01	0.04	0.03	2.56
2.60	0.03	0.03	2.69
2.10	0.03	0.04	2.89
1.88	0.02	0.04	3.00
1.55	0.02	0.05	3.18
1.30	0.02	0.05	3.35
1.15	0.01	0.05	3.47
0.95	0.01	0.05	3.65

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.12	2.27	2.40	2.56	2.69	2.89	3.00	3.18	3.35	3.47	3.65
slope	=	0.0306									



compound : P temprature : 38

sample no. : 8 no. of cases : 11

alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====

4.80	0.06	0.00	2.13
4.15	0.05	0.01	2.26
3.55	0.04	0.02	2.40
3.10	0.04	0.03	2.53
2.60	0.03	0.03	2.69
2.25	0.03	0.04	2.83
1.95	0.02	0.04	2.96
1.55	0.02	0.05	3.18
1.40	0.02	0.05	3.28
1.15	0.01	0.05	3.47
1.00	0.01	0.05	3.60

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.13	2.26	2.40	2.53	2.69	2.83	2.96	3.18	3.28	3.47	3.60
slope	=	0.0298									



compound : P tempreature : 38  
sample no. : 9 no. of cases : 11  
alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	lnval
4.85	0.06	0.00	2.12
4.12	0.05	0.01	2.27
3.58	0.04	0.02	2.40
3.10	0.04	0.03	2.53
2.60	0.03	0.03	2.69
2.32	0.03	0.04	2.80
1.98	0.02	0.04	2.95
1.65	0.02	0.04	3.12
1.45	0.02	0.05	3.24
1.20	0.02	0.05	3.43
1.00	0.01	0.05	3.60

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.12	2.27	2.40	2.53	2.69	2.80	2.95	3.12	3.24	3.43	3.60
slope =	0.0291										



compound : P tempreature : 38

sample no. : 10 no. of cases : 11

alpha : 0.0500, beta : 0.5113, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.85	0.06	0.00	2.12
4.15	0.05	0.01	2.26
3.60	0.04	0.02	2.39
3.10	0.04	0.03	2.53
2.60	0.03	0.03	2.69
2.35	0.03	0.04	2.79
1.95	0.02	0.04	2.96
1.65	0.02	0.04	3.12
1.46	0.02	0.05	3.24
1.19	0.01	0.05	3.44
1.00	0.01	0.05	3.60

report of (x,y) values and slope

time | 5.00 | 10.00 | 15.00 | 20.00 | 25.00 | 30.00 | 35.00 | 40.00 | 45.00 | 50.00 | 55.00 |

Invval | 2.12 | 2.26 | 2.39 | 2.53 | 2.69 | 2.79 | 2.96 | 3.12 | 3.24 | 3.44 | 3.60 |

slope = 0.0292

report of std for P at 38 degrees

std = 0.00000048

summary of slopes and the inverse of the tempreature

slopes : 0.030134, 0.031069, 0.029126, 0.029025, 0.030050, 0.029491, 0.030575, 0.029763, 0.029113, 0.029237, inverse of tempreature : 0.003215

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compound : M tempreature : 21

sample no. : 1 no. of cases : 8

alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv ==	ht ==	x =	lnval =====
4.30	0.05	0.01	2.09
3.70	0.05	0.02	2.22
3.23	0.04	0.02	2.34
2.85	0.04	0.03	2.46
2.47	0.03	0.03	2.59
2.17	0.03	0.04	2.71
1.88	0.02	0.04	2.84
1.67	0.02	0.04	2.95

report of (x,y) values and slope

time | 10.05 | 20.00 | 30.00 | 40.00 | 50.00 | 59.98 | 70.00 | 80.00 |

lnval | 2.09 | 2.22 | 2.34 | 2.46 | 2.59 | 2.71 | 2.84 | 2.95 |

slope = 0.0124



compound : H tempreature : 21  
sample no. : 2 no. of cases : 7  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.30	0.05	0.01	2.09
3.65	0.05	0.02	2.23
3.20	0.04	0.02	2.35
2.80	0.04	0.03	2.47
2.40	0.03	0.03	2.61
2.10	0.03	0.04	2.74
1.90	0.02	0.04	2.83

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	2.09	2.23	2.35	2.47	2.61	2.74	2.83
slope =	0.0125						



compound : H tempreature : 21  
sample no. : 3 nu. of cases : 7  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	inval
==	==	=	=====
4.30	0.05	0.01	2.09
3.65	0.05	0.02	2.23
3.22	0.04	0.02	2.34
2.78	0.03	0.03	2.48
2.43	0.03	0.03	2.60
2.10	0.03	0.04	2.74
1.90	0.02	0.04	2.83

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inv1	2.09	2.23	2.34	2.48	2.60	2.74	2.83

slope = 0.0125



compound : M tempreature : 21  
sample no. : 4 no. of cases : 7  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.30	0.05	0.01	2.09
3.65	0.05	0.02	2.23
3.20	0.04	0.02	2.35
2.80	0.04	0.03	2.47
2.45	0.03	0.03	2.60
2.10	0.03	0.04	2.74
1.90	0.02	0.04	2.83

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	2.09	2.23	2.35	2.47	2.60	2.74	2.83

slope = 0.0125



compound : H temperature : 21  
sample no. : 5 no. of cases : 8  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.30	0.05	0.01	2.09
3.70	0.05	0.02	2.22
3.25	0.04	0.02	2.34
2.85	0.04	0.03	2.46
2.48	0.03	0.03	2.58
2.20	0.03	0.04	2.70
1.85	0.02	0.04	2.86
1.67	0.02	0.04	2.95

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
lnval	2.09	2.22	2.34	2.46	2.58	2.70	2.86	2.95
slope	=	0.0125						



compound : H tempreture : 21  
sample no. : 6 no. of cases : 7  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lval
==	==	=	=====
4.60	0.06	0.01	2.03
4.25	0.05	0.01	2.10
3.80	0.05	0.02	2.20
3.20	0.04	0.02	2.35
2.90	0.04	0.03	2.44
2.62	0.03	0.03	2.53
2.38	0.03	0.03	2.62

report of (x,y) values and slope

time	5.12	10.03	20.00	30.00	40.00	50.00	60.00							
inval	2.03	1	2.10	1	2.20	1	2.35	1	2.44	1	2.53	1	2.62	1
slope =	0.0109													



compound : H temperature : 21  
sample no. : 7 no. of cases : 8  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.25	0.05	0.01	2.10
3.75	0.05	0.02	2.21
3.20	0.04	0.02	2.35
2.90	0.04	0.03	2.44
2.60	0.03	0.03	2.54
2.35	0.03	0.04	2.63
2.00	0.03	0.04	2.78
1.80	0.02	0.04	2.88

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
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lnval	1	2.10	2.21	2.35	2.44	2.54	2.63	2.78	2.88
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slope = 0.0111



compound : M temperature : 21  
sample no. : 8 no. of cases : 8  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.30	0.05	0.01	2.09
3.70	0.05	0.02	2.22
3.25	0.04	0.02	2.34
2.85	0.04	0.03	2.46
2.48	0.03	0.03	2.58
2.17	0.03	0.04	2.71
1.88	0.02	0.04	2.84
1.67	0.02	0.04	2.95

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
------	-------	-------	-------	-------	-------	-------	-------	-------

lnval	2.09	2.22	2.34	2.46	2.58	2.71	2.84	2.95
-------	------	------	------	------	------	------	------	------

slope = 0.0124



compound : M tempreture : 21  
sample no. : 9 no. of cases : 8  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.30	0.05	0.01	2.09
3.70	0.05	0.02	2.22
3.25	0.04	0.02	2.34
2.85	0.04	0.03	2.46
2.50	0.03	0.03	2.58
2.20	0.03	0.04	2.70
1.80	0.02	0.04	2.88
1.70	0.02	0.04	2.94

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00
lnval	2.09	2.22	2.34	2.46	2.58	2.70	2.88	2.94
slope	0.0125							



compound : H tempreature : 21

sample no. : 10 no. of cases : 8  
alpha : 0.0500, beta : 0.4442, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.30	0.05	0.01	2.09
3.70	0.05	0.02	2.22
3.30	0.04	0.02	2.32
2.85	0.04	0.03	2.46
2.50	0.03	0.03	2.58
2.20	0.03	0.04	2.70
1.80	0.02	0.04	2.88
1.70	0.02	0.04	2.94

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	
lnval	1	2.09	2.22	2.32	2.46	2.58	2.70	2.88	2.94

slope = 0.0125

report of std for H at 21 degrees

std = 0.0000038

summary of slopes and the inverse of the tempreature

slopes : 0.012396, 0.012539, 0.012518, 0.012471, 0.012450, 0.010910, 0.011106, 0.012406, 0.012455, 0.012504,  
inverse of tempreature : 0.003401



compound : H tempreture : 29  
sample no. : 1 no. of cases : 9  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
5.00	0.06	0.00	2.25
3.55	0.04	0.02	2.56
3.35	0.04	0.02	2.61
2.90	0.04	0.03	2.74
2.45	0.03	0.03	2.90
2.05	0.03	0.04	3.07
1.80	0.02	0.04	3.20
1.50	0.02	0.05	3.37
1.40	0.02	0.05	3.44

report of (x,y) values and slope

time	5.06	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.03
lnval	2.25	2.56	2.61	2.74	2.90	3.07	3.20	3.37	3.44
slope	=	0.0291							

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compound : M tempreature : 29

sample no. : 2 no. of cases : 9

alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv ==	ht ==	x =	lnval =====
5.00	0.06	0.00	2.25
3.55	0.04	0.02	2.56
3.40	0.04	0.02	2.60
2.90	0.04	0.03	2.74
2.45	0.03	0.03	2.90
2.15	0.03	0.04	3.03
1.80	0.02	0.04	3.20
1.45	0.02	0.05	3.41
1.40	0.02	0.05	3.44

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00
lnval	2.25	2.56	2.60	2.74	2.90	3.03	3.20	3.41	3.44
slope	0.0293								



compound : H temperature : 29  
sample no. : 3 no. of cases : 9  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
5.00	0.06	0.00	2.25
3.55	0.04	0.02	2.56
3.41	0.04	0.02	2.59
2.89	0.04	0.03	2.75
2.45	0.03	0.03	2.90
2.15	0.03	0.04	3.03
1.80	0.02	0.04	3.20
1.45	0.02	0.05	3.41
1.40	0.02	0.05	3.44

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00
lnval	2.25	2.56	2.59	2.75	2.90	3.03	3.20	3.41	3.44
slope	0.0294								



compound : H tempreture : 29  
sample no. : 4 no. of cases : 9  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
3.95	0.05	0.02	2.46
2.95	0.04	0.03	2.73
2.50	0.03	0.03	2.88
2.15	0.03	0.04	3.03
1.85	0.02	0.04	3.17
1.58	0.02	0.04	3.32
1.32	0.02	0.05	3.50
1.20	0.01	0.05	3.59
0.90	0.01	0.05	3.87

report of (x,y) values and slope

time	10.00	20.00	25.03	30.01	35.00	39.88	45.03	50.04	60.00
Inv1	2.46	2.73	2.88	3.03	3.17	3.32	3.50	3.59	3.87
slope =	0.0286								



compound : H tempreature : 29  
sample no. : 5 no. of cases : 9  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
3.95	0.05	0.02	2.46
2.95	0.04	0.03	2.73
2.51	0.03	0.03	2.88
2.15	0.03	0.04	3.03
1.80	0.02	0.04	3.20
1.55	0.02	0.05	3.34
1.30	0.02	0.05	3.51
1.20	0.01	0.05	3.59
1.90	0.01	0.05	3.87

report of (x, y) values and slope

time	10.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	60.00
lnval	2.46	2.73	2.88	3.03	3.20	3.34	3.51	3.59	3.87
slope	0.0287								



compound : H temprature : 29  
sample no. : 6 no. of cases : 9  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lval
==	==	=	=====
3.95	0.05	0.02	2.46
2.95	0.04	0.03	2.73
2.50	0.03	0.03	2.88
2.15	0.03	0.04	3.03
1.80	0.02	0.04	3.20
1.55	0.02	0.05	3.34
1.30	0.02	0.05	3.51
1.20	0.01	0.05	3.59
0.90	0.01	0.05	3.87

report of (x,y) values and slope

time	10.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	60.00
lval	2.46	2.73	2.88	3.03	3.20	3.34	3.51	3.59	3.87

slope = 0.0287



compound : M      temprature : 29  
sample no. : 7      no. of cases : 8  
alpha : 0.0500,    beta : 0.5922,    delta : 0.0645

vv	ht	x	inval
==	==	=	=====
3.85	0.05	0.02	2.48
2.72	0.03	0.03	2.80
2.05	0.03	0.04	3.07
1.67	0.02	0.04	3.27
1.48	0.02	0.05	3.39
1.27	0.02	0.05	3.53
1.10	0.01	0.05	3.67
0.93	0.01	0.05	3.84

report of (x,y) values and slope

time	10.00	20.00	30.00	35.00	40.00	45.00	50.00	55.00
inval	2.48	2.80	3.07	3.27	3.39	3.53	3.67	3.84
slope	=	0.0298						



compound : H temperature : 29  
sample no. : 8 no. of cases : 8  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
3.85	0.05	0.02	2.48
2.75	0.03	0.03	2.79
2.05	0.03	0.04	3.07
1.70	0.02	0.04	3.25
1.45	0.02	0.05	3.41
1.30	0.02	0.05	3.51
1.10	0.01	0.05	3.67
0.90	0.01	0.05	3.87

report of (x,y) values and slope

time	10.00	20.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.48	2.79	3.07	3.25	3.41	3.51	3.67	3.87

slope = 0.0302



compound : H temperature : 29  
sample no. : 9 no. of cases : 8  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
3.85	0.05	0.02	2.48
2.75	0.03	0.03	2.79
2.00	0.03	0.04	3.10
1.70	0.02	0.04	3.25
1.45	0.02	0.05	3.41
1.25	0.02	0.05	3.55
1.10	0.01	0.05	3.67
0.90	0.01	0.05	3.87

report of (x,y) values and slope

time	10.00	20.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.48	2.79	3.10	3.25	3.41	3.55	3.67	3.87
slope =	0.0304							



compound : H tempreature : 29

sample no. : 10 no. of cases : 6

alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv ==	ht ==	x =	inval =====
3.85	0.05	0.02	2.48
2.75	0.03	0.03	2.79
2.00	0.03	0.04	3.10
1.50	0.02	0.05	3.37
1.10	0.01	0.05	3.67
0.90	0.01	0.05	3.87

report of (x,y) values and slope

time | 10.00 | 20.00 | 30.00 | 40.00 | 50.00 | 55.00 |

inval | 2.48 | 2.79 | 3.10 | 3.37 | 3.67 | 3.87 |

slope = 0.0302

report of std for H at 29 degrees

std = 0.0000045

summary of slopes and the inverse of the tempreature

slopes : 0.029083, 0.029343, 0.029350, 0.028596, 0.028739, 0.028719, 0.029802, 0.030214, 0.030352, 0.030229,

inverse of tempreture : 0.003311



compound : M      tempreture : 38  
sample no. : 1      no. of cases : 11  
alpha : 0.0500,    beta : 0.5922,    delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.40	0.06	0.01	2.36
3.55	0.04	0.02	2.56
2.95	0.04	0.03	2.73
2.40	0.03	0.03	2.92
2.05	0.03	0.04	3.07
1.65	0.02	0.04	3.28
1.32	0.02	0.05	3.50
1.08	0.01	0.05	3.69
0.90	0.01	0.05	3.87
0.75	0.01	0.06	4.05
0.60	0.01	0.06	4.27

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.11
lnval	2.36	2.56	2.73	2.92	3.07	3.28	3.50	3.69	3.87	4.05	4.27
slope											



compound : H tempreature : 38  
sample no. : 2 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.40	0.06	0.01	2.36
3.55	0.04	0.02	2.56
2.96	0.04	0.03	2.73
2.39	0.03	0.03	2.93
2.00	0.03	0.04	3.10
1.73	0.02	0.04	3.23
1.35	0.02	0.05	3.47
1.05	0.01	0.05	3.72
0.95	0.01	0.05	3.82
0.65	0.01	0.06	4.19
0.50	0.01	0.06	4.45

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.36	2.56	2.73	2.93	3.10	3.23	3.47	3.72	3.82	4.19	4.45
slope											



compound : M      tempreture :      38  
sample no. :    3      no. of cases :    11  
alpha :    0.0500,    beta :    0.5922,    delta :    0.0645

vv	ht	x	lnval
==	==	=	=====
4.45	0.06	0.01	2.35
3.68	0.05	0.02	2.52
3.00	0.04	0.03	2.71
2.50	0.03	0.03	2.88
2.05	0.03	0.04	3.07
1.63	0.02	0.04	3.29
1.40	0.02	0.05	3.44
1.15	0.01	0.05	3.63
0.95	0.01	0.05	3.82
0.80	0.01	0.05	3.98
0.65	0.01	0.06	4.19

report of (x,y) values and slope

time	5.07	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.35	2.52	2.71	2.88	3.07	3.29	3.44	3.63	3.82	3.98	4.19
slope											



compound : H tempreature : 38  
sample no. : 4 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.45	0.06	0.01	2.35
3.65	0.05	0.02	2.53
3.00	0.04	0.03	2.71
2.51	0.03	0.03	2.88
2.04	0.03	0.04	3.08
1.65	0.02	0.04	3.28
1.35	0.02	0.05	3.47
1.10	0.01	0.05	3.67
0.95	0.01	0.05	3.82
0.81	0.01	0.05	3.97
0.94	0.01	0.05	3.83

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
Inval	2.35	2.53	2.71	2.88	3.08	3.28	3.47	3.67	3.82	3.97	3.83
slope =	0.0335										

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compound : H tempreture : 38  
sample no. : 6 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.40	0.06	0.01	2.36
3.60	0.04	0.02	2.54
2.90	0.04	0.03	2.74
2.35	0.03	0.04	2.94
1.90	0.02	0.04	3.14
1.60	0.02	0.04	3.31
1.25	0.02	0.05	3.55
1.05	0.01	0.05	3.72
0.88	0.01	0.05	3.89
0.67	0.01	0.06	4.16
0.58	0.01	0.06	4.30

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
Inv1	2.36	1	2.54	1	2.74	1	2.94	1	3.14	1	3.31
slope											



compound : H temperature : 38  
sample no. : 5 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

VV	ht	X	Inval
==	==	=	=====
4.40	0.06	0.01	2.36
3.60	0.04	0.02	2.54
2.96	0.04	0.03	2.73
2.38	0.03	0.03	2.93
2.01	0.03	0.04	3.09
1.75	0.02	0.04	3.22
1.35	0.02	0.05	3.47
1.05	0.01	0.05	3.72
1.00	0.01	0.05	3.77
0.60	0.01	0.06	4.27
0.60	0.06	4.27	

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
Inv1	2.36	2.54	2.73	2.93	3.09	3.22	3.47	3.72	3.77	4.27	4.27
slope =	0.0391										



compound : M tempreature : 38  
sample no. : 7 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.40	0.06	0.01	2.36
3.60	0.04	0.02	2.54
2.94	0.04	0.03	2.73
2.26	0.03	0.04	2.98
1.90	0.02	0.04	3.14
1.62	0.02	0.04	3.30
1.30	0.02	0.05	3.51
1.00	0.01	0.05	3.77
0.90	0.01	0.05	3.87
0.65	0.01	0.06	4.19
0.60	0.01	0.06	4.27

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.36	2.54	2.73	2.98	3.14	3.30	3.51	3.77	3.87	4.19	4.27
slope											



compound : H temperature : 38  
sample no. : 8 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.40	0.06	0.01	2.36
3.60	0.04	0.02	2.54
3.00	0.04	0.03	2.71
2.20	0.03	0.04	3.01
1.98	0.02	0.04	3.11
1.62	0.02	0.04	3.30
1.30	0.02	0.05	3.51
1.05	0.01	0.05	3.72
0.85	0.01	0.05	3.93
0.65	0.01	0.06	4.19
0.60	0.01	0.06	4.27

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.36	2.54	2.71	3.01	3.11	3.30	3.51	3.72	3.93	4.19	4.27
slope	0.0392										



compound : M tempreature : 38  
sample no. : 9 no. of cases : 11  
alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	lnval
==	==	=	=====
4.41	0.06	0.01	2.36
3.59	0.04	0.02	2.55
3.00	0.04	0.03	2.71
2.23	0.03	0.04	2.99
1.92	0.02	0.04	3.13
1.60	0.02	0.04	3.31
1.30	0.02	0.05	3.51
1.00	0.01	0.05	3.77
0.88	0.01	0.05	3.89
0.67	0.01	0.06	4.16
0.58	0.01	0.06	4.30

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
lnval	2.36	2.55	2.71	2.99	3.13	3.31	3.51	3.77	3.89	4.16	4.30
slope	0.0393										



compound : H tempreature : 38

sample no. : 10 no. of cases : 11

alpha : 0.0500, beta : 0.5922, delta : 0.0645

vv	ht	x	Inval
==	==	=	=====
4.41	0.06	0.01	2.36
3.57	0.04	0.02	2.55
2.95	0.04	0.03	2.73
2.40	0.03	0.03	2.92
2.05	0.03	0.04	3.07
1.68	0.02	0.04	3.26
1.30	0.02	0.05	3.51
1.10	0.01	0.05	3.67
0.91	0.01	0.05	3.86
0.74	0.01	0.06	4.06
0.58	0.01	0.06	4.30

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	1	25.00	1	30.00	1	35.00	1	40.00	1	45.00	1	50.00	1	55.00	1	
lnval	1	2.36	1	2.55	1	2.73	1	2.92	1	3.07	1	3.26	1	3.51	1	3.67	1	3.86	1	4.06	1
slope	=	0.0383																			

report of std for H at 38 degrees

std = 0.0000372

summary of slopes and the inverse of the tempreature

slopes : 0.037937, 0.040366, 0.036765, 0.033532, 0.039118, 0.039203, 0.039035, 0.039249, 0.039317, 0.038333,  
inverse of tempreature : 0.003215



compound : N tempreature : 60  
sample no. : 1 no. of cases : 6  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lval
==	==	=	=====
2.55	0.01	0.00	1.07
2.40	0.01	0.00	1.11
2.25	0.01	0.00	1.16
2.15	0.01	0.00	1.19
1.95	0.01	0.00	1.26
1.85	0.01	0.00	1.29

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	350.00
lval	1.07	1.11	1.16	1.19	1.26	1.29
slope	0.0009					



compound : N      tempreture :      60

sample no. : 6      no. of cases : 6

alpha : 0.0180,    beta : 0.0343,    delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.50	0.01	0.00	1.08
2.37	0.01	0.00	1.12
2.20	0.01	0.00	1.17
2.10	0.01	0.00	1.20
1.91	0.01	0.00	1.27
1.82	0.01	0.00	1.31

report of (x,y) values and slope

time | 100.00 | 150.00 | 200.00 | 250.00 | 300.00 | 350.00 |

lnval | 1.08 | 1.12 | 1.17 | 1.20 | 1.27 | 1.31 |

slope = 0.0009

report of std for N      at 60 degrees

std = 0.0000000

summary of slopes and the inverse of the tempreture

slopes : 0.000899, 0.000899, 0.000923, 0.000833, 0.000881, 0.000908,  
inverse of tempreture : 0.003003



compound : N tempreture : 60  
sample no. : 5 no. of cases : 6  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.50	0.01	0.00	1.08
2.40	0.01	0.00	1.11
2.30	0.01	0.00	1.14
2.15	0.01	0.00	1.19
1.97	0.01	0.00	1.25
1.83	0.01	0.00	1.30

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	350.00
lnval	1.08	1.11	1.14	1.19	1.25	1.30
slope	0.0009					



compound : N tempreature : 60  
sample no. : 4 no. of cases : 6  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.50	0.01	0.00	1.08
2.35	0.01	0.00	1.13
2.30	0.01	0.00	1.14
2.12	0.01	0.00	1.20
1.98	0.01	0.00	1.24
1.85	0.01	0.00	1.29

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	350.00
lnval	1.08	1.13	1.14	1.20	1.24	1.29

slope = 0.0008



compound : N tempreature : 60  
sample no. : 3 no. of cases : 6  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lval
==	==	=	=====
2.50	0.01	0.00	1.08
2.35	0.01	0.00	1.13
2.25	0.01	0.00	1.16
2.10	0.01	0.00	1.20
1.92	0.01	0.00	1.27
1.80	0.01	0.00	1.31

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	350.00
lval	1.08	1.13	1.16	1.20	1.27	1.31

slope = 0.0009



compound : N tempreature : 60  
sample no. : 2 no. of cases : 6  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.55	0.01	0.00	1.07
2.40	0.01	0.00	1.11
2.25	0.01	0.00	1.16
2.15	0.01	0.00	1.19
1.95	0.01	0.00	1.26
1.85	0.01	0.00	1.29

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	350.00
lnval	1.07	1.11	1.16	1.19	1.26	1.29
slope						
	0.0009					

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compound : N tempreature : 65  
sample no. : 6 no. of cases : 5  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	Inval
==	==	=	=====
2.50	0.01	0.00	1.08
2.30	0.01	0.00	1.14
2.05	0.01	0.00	1.22
1.82	0.01	0.00	1.31
1.63	0.01	0.00	1.39

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00
intval	1	1.08	1.14	1.22	1.31
slope	=	0.0015			

report of std for N at 65 degrees

std = 0.0000000

summary of slopes and the inverse of the tempreature

slopes : 0.001466, 0.001533, 0.001517, 0.001481, 0.001398, 0.001540,  
inverse of tempreature : 0.002959



compound : N tempreature : 65  
sample no. : 5 no. of cases : 5  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lval
==	==	=	=====
2.55	0.01	0.00	1.07
2.20	0.01	0.00	1.17
1.95	0.01	0.00	1.26
1.83	0.01	0.00	1.30
1.70	0.01	0.00	1.36

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00
lval	1.07	1.17	1.26	1.30	1.36

slope = 0.0014

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R. L. CRAIN INC.

compound : N temperature : 65

sample no. : 4 no. of cases : 5

alpha : 0.0180, beta : 0.0343, delta : 0.0122

v <sub>y</sub>	ht	x	lnval
==	==	=	=====
2.48	0.01	0.00	1.09
2.27	0.01	0.00	1.15
2.00	0.01	0.00	1.24
1.80	0.01	0.00	1.31
1.65	0.01	0.00	1.38

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	1
lnval	1.09	1.15	1.24	1.31	1.38	1

slope = 0.0015



compound ; N temperature ; 65  
sample no. ; 3 no. of cases ; 5  
alpha ; 0.0180, beta ; 0.0343, delta ; 0.0122

vv	ht	x	Inval
==	==	=	=====
2.50	0.01	0.00	1.08
2.27	0.01	0.00	1.15
1.55	0.01	0.01	1.42
1.85	0.01	0.00	1.29
1.62	0.01	0.00	1.39

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	1
Inv1	1.08	1.15	1.42	1.29	1.39	1

slope = 0.0015



compound : N tempreature : 65  
sample no. : 2 no. of cases : 5  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.53	0.01	0.00	1.08
2.27	0.01	0.00	1.15
2.05	0.01	0.00	1.22
1.80	0.01	0.00	1.31
1.65	0.01	0.00	1.38

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00
lnval	1.08	1.15	1.22	1.31	1.38

slope = 0.0015



compound : N temperature : 65  
sample no. : 1 no. of cases : 5  
alpha : 0.0180, beta : 0.0343, delta : 0.0122

vv	ht	x	lnval
==	==	=	=====
2.50	0.01	0.00	1.08
2.25	0.01	0.00	1.16
2.02	0.01	0.00	1.23
1.83	0.01	0.00	1.30
1.65	0.01	0.00	1.38

report of (x,y) values and slope

time	100.00	150.00	200.00	250.00	300.00	1
lnval	1.08	1.16	1.23	1.30	1.38	1

slope = 0.0015



compound : N tempreature : 70

sample no. : 6 no. of cases : 6

alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	Inval
==	==	=	=====
4.51	0.02	0.00	0.34
4.17	0.02	0.00	0.36
3.87	0.02	0.00	0.38
3.54	0.02	0.00	0.41
3.20	0.01	0.01	0.45
2.98	0.01	0.01	0.47

report of (x,y) values and slope

time	1	20.00	40.00	60.00	80.00	100.00	120.00	1					
Inv1	1	0.34	1	0.36	1	0.38	1	0.41	1	0.45	1	0.47	1

slope = 0.0014

report of std for N at 70 degrees

std = 0.0000000

summary of slopes and the inverse of the tempreature

slopes	: 0.001380, 0.001380, 0.001418, 0.001393, 0.001363, 0.001391,
inverse of tempreature	: 0.002915

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100%

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100% COTTON 100% POLYESTER 100% POLYESTER

compound : N temperature : 70  
sample no. : 5 no. of cases : 6  
alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	lnval
==	==	=	=====
4.50	0.02	0.00	0.34
4.17	0.02	0.00	0.36
3.90	0.02	0.00	0.38
3.55	0.02	0.00	0.41
3.18	0.01	0.01	0.45
3.02	0.01	0.01	0.47

report of (x,y) values and slope

time	20.00	40.00	60.00	80.00	100.00	120.00
lnval	0.34	0.36	0.38	0.41	0.45	0.47
slope	0.0014					



compound : N tempreature : 70  
sample no. : 4 no. of cases : 6  
alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	lnval
==	==	=	=====
4.50	0.02	0.00	0.34
4.21	0.02	0.00	0.36
3.90	0.02	0.00	0.38
3.61	0.02	0.00	0.40
3.20	0.01	0.01	0.45
2.98	0.01	0.01	0.47

report of (x,y) values and slope

time	20.00	40.00	60.00	80.00	100.00	120.00	140.00
lnval	0.34	0.36	0.38	0.40	0.45	0.47	
slope							



compound : N tempreature : 70  
sample no. : 3 no. of cases : 6  
alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	lnval
==	==	=	=====
4.50	0.02	0.00	0.34
4.20	0.02	0.00	0.36
3.90	0.02	0.00	0.38
3.60	0.02	0.00	0.40
3.20	0.01	0.01	0.45
2.95	0.01	0.01	0.48

report of (x,y) values and slope

time	20.00	40.00	60.00	80.00	100.00	120.00	140.00
lnval	0.34	0.36	0.38	0.40	0.45	0.48	1.00
slope	0.0014						



compound : N tempreature : 70  
sample no. : 2 no. of cases : 6  
alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	Inval
==	==	=	=====
4.50	0.02	0.00	0.34
4.20	0.02	0.00	0.36
3.90	0.02	0.00	0.38
3.55	0.02	0.00	0.41
3.20	0.01	0.01	0.45
3.00	0.01	0.01	0.47

report of (x,y) values and slope

time	20.00	40.00	60.00	80.00	100.00	120.00	140.00
lnval	0.34	0.36	0.38	0.41	0.45	0.47	
slope							0.0014



compound : N temperature : 70  
sample no. : 1 no. of cases : 6  
alpha : 0.0180, beta : 0.0285, delta : 0.0204

vv	ht	x	lnval
==	==	=	=====
4.50	0.02	0.00	0.34
4.20	0.02	0.00	0.36
3.90	0.02	0.00	0.38
3.55	0.02	0.00	0.41
3.20	0.01	0.01	0.45
3.00	0.01	0.01	0.47

report of (x,y) values and slope

time	20.00	40.00	60.00	80.00	100.00	120.00
lnval	0.34	0.36	0.38	0.41	0.45	0.47
slope	0.0014					



RRRRRRRRR AA TT ;  
RRRRRRRRR AA TT ;  
RRRRRRRRR AA TT ;

VAX/VMS	498793146	OUT2	12-NOV-1984	13:13	TTFS:	12-NOV-1984	13:13	DISK\$USERPACK2:[498793146.GEORGE]OUT2.DAT;1
VAX/VMS	498793146	OUT2	12-NOV-1984	13:13	TTFS:	12-NOV-1984	13:13	DISK\$USERPACK2:[498793146.GEORGE]OUT2.DAT;1
VAX/VMS	498793146	OUT2	12-NOV-1984	13:13	TTFS:	12-NOV-1984	13:13	DISK\$USERPACK2:[498793146.GEORGE]OUT2.DAT;1

4	4	999	888	7777	999	333	1	4	4	666
4	4	9	8	7	9	3	11	4	4	6
4	4	9	8	7	9	3	1	4	4	6
44444	99999	888	777	9999	333	1	44444	6666	6666	6666
4	9	8	8	9	3	1	4	4	6	6
4	999	888	777	999	333	111	4	4	6	6

compound : MFP temperature : 22  
sample no. : 1 no. of cases : 10

report of (x,y) values and slope

time	1	5.11	1	10.04	1	15.00	1	20.00	1	25.00	1	30.01	1	35.02	1	40.00	1	50.00	1	55.00	1
Inval	1	0.11	1	0.24	1	0.38	1	0.51	1	0.67	1	0.79	1	0.95	1	1.06	1	1.32	1	1.49	1
SLOPE =	0.0275																				

The calculated value is : 0.0210

compound : MFP temperature : 22  
sample no. : 2 no. of cases : 11

report of (x,y) values and slope

time	1	5.00	1	10.02	1	15.02	1	20.08	1	25.00	1	30.00	1	35.00	1	40.00	1	45.00	1	50.00	1	55.10	1
Inval	1	0.09	1	0.20	1	0.32	1	0.46	1	0.59	1	0.73	1	0.85	1	0.99	1	1.12	1	1.25	1	1.44	1
SLOPE =	0.0266																						

1	0.162	1	00.024	1	00.00	1	50.01	1	50.00	1	50.00
1	0.125	1	00.020	1	00.00	1	32.022	1	32.000	1	32.000
1	0.125	1	00.020	1	00.00	1	30.050	1	30.000	1	30.000
1	0.125	1	00.020	1	00.00	1	28.060	1	28.000	1	28.000
1	0.125	1	00.020	1	00.00	1	26.070	1	26.000	1	26.000
1	0.125	1	00.020	1	00.00	1	24.080	1	24.000	1	24.000
1	0.125	1	00.020	1	00.00	1	22.090	1	22.000	1	22.000
1	0.125	1	00.020	1	00.00	1	20.100	1	20.000	1	20.000
1	0.125	1	00.020	1	00.00	1	18.110	1	18.000	1	18.000
1	0.125	1	00.020	1	00.00	1	16.120	1	16.000	1	16.000
1	0.125	1	00.020	1	00.00	1	14.130	1	14.000	1	14.000
1	0.125	1	00.020	1	00.00	1	12.140	1	12.000	1	12.000
1	0.125	1	00.020	1	00.00	1	10.150	1	10.000	1	10.000
1	0.125	1	00.020	1	00.00	1	8.160	1	8.000	1	8.000
1	0.125	1	00.020	1	00.00	1	6.170	1	6.000	1	6.000
1	0.125	1	00.020	1	00.00	1	4.180	1	4.000	1	4.000
1	0.125	1	00.020	1	00.00	1	2.190	1	2.000	1	2.000
1	0.125	1	00.020	1	00.00	1	0.200	1	0.000	1	0.000

base blue surface (any) 40 ft wide

base 40 ft wide 1 ft high

compound : MfP tempreature : 22

sample no. : 3 no. of cases : 11

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00											
Inval	1	0.09	1	0.20	1	0.32	1	0.47	1	0.59	1	0.73	1	0.85	1	0.98	1	1.12	1	1.25	1	1.44	1

SLOPE = 0.0266

The calculated value is : 0.0210

195

compound : MfP tempreature : 22

sample no. : 4 no. of cases : 11

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00											
Inval	1	0.09	1	0.20	1	0.32	1	0.46	1	0.59	1	0.73	1	0.84	1	0.98	1	1.12	1	1.25	1	1.44	1

LAST	1	90.0	1	0.25	1	0.40	1	0.20	1	0.55	1	0.80	1	0.80	1	1.15	1	2.25	1	44.1
FIRST	1	2.00	1	0.01	1	0.20	1	0.00	1	0.50	1	0.00	1	0.00	1	0.00	1	0.00	1	44.1
SECOND	1	0.20	1	0.00	1	0.20	1	0.00	1	0.50	1	0.00	1	0.00	1	0.00	1	0.00	1	44.1
THIRD	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	44.1
FOURTH	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	44.1

SHEET 4 OF 4 (X42) ASSEMBLE AND STICK

STICKING LINE 4, Q, R, S, T, U, V, W, X, Y, Z

CROSSING LINE 4, Q, R, S, T, U, V, W, X, Y, Z

compound : Mfp tempreature : 22  
sample no. : 5 no. of cases : 11

196

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	
Inval	1	0.09	0.20	0.32	0.46	0.59	0.71	0.85	0.99	1.18	1.18	1.44

SLOPE = 0.0265

The calculated value is : 0.0210

compound : Mfp tempreature : 22

sample no. : 6 no. of cases : 11

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	
Inval	1	0.08	0.21	0.35	0.49	0.58	0.75	0.88	0.98	1.12	1.25	1.44

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CHRONIQUE DE LA GUERRE D'INDÉPENDANCE 37

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LAW AND POLICY

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TOAST 1 0.02 1 0.52 1 0.55 1 0.57 1 0.58 1 0.59 1 0.62 1 0.63 1 0.64 1 0.65 1

compound : MfP tempreture : 22  
sample no. : 7 no. of cases : 11

197

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00												
Inval	1	0.08	1	0.21	1	0.35	1	0.48	1	0.59	1	0.75	1	0.87	1	0.98	1	1.12	1	1.22	1	1.44	1

SLOPE = 0.0262

The calculated value is : 0.0210

compound : MfP tempreture : 22

sample no. : 8 no. of cases : 11

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00												
Inval	1	0.08	1	0.21	1	0.35	1	0.49	1	0.59	1	0.75	1	0.88	1	0.98	1	1.12	1	1.22	1	1.43	1

THE BIBLICAL THEOLOGY OF THE SEVENTH DAY ADVENTISTS

ANSWERING THE CALL OF GOD

CONCLUDING COMMENTS

COMPARING WATER USE IN FERTILISER USE

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compound : Mfp tempreature : 22  
sample no. : 9 no. of cases : 11

198

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00												
Inval	1	0.11	1	0.24	1	0.37	1	0.50	1	0.67	1	0.79	1	1.00	1	1.12	1	1.22	1	1.32	1	1.47	1
SLOPE =		0.0277																					

The calculated value is : 0.0210

compound : Mfp tempreature : 22

sample no. : 10 no. of cases : 11

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00											
Inval	1	0.11	1	0.24	1	0.36	1	0.51	1	0.67	1	0.78	1	0.99	1	1.12	1	1.23	1	1.35	1	1.49	1

SCHLESINGER AND HANSON

卷之三

政治小説の歴史

THE INFLUENCE OF THE ENVIRONMENT ON

卷之三

compound; at the temperature:

131 132 133 134 135 136 137 138 139 140 141 142 143

THE LIBRARY OF THE UNIVERSITY OF TORONTO

report of (x,y) values and slope

compound ;	Hg	tempreature ;	28
sample no. ;	2	no. of cases ;	11

199



compound : MfP temprture : 28

sample no. : 3 no. of cases : 11

200

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	1	25.00	1	30.00	1	35.00	1	40.00	1	45.00	1	50.00	1	55.00			
Inval	1	0.13	1	0.31	1	0.49	1	0.69	1	0.91	1	1.08	1	1.31	1	1.50	1	1.74	1	2.00	1	2.00

SLOPE = 0.0399

The calculated value is : 0.0368

report of (x,y) values and slope

compound : MfP temprture : 28

sample no. : 4 no. of cases : 11

200

time	1	5.00	10.00	15.00	20.00	1	25.00	1	30.00	1	35.00	1	40.00	1	45.17	1	50.00	1	55.00			
Inval	1	0.13	1	0.30	1	0.49	1	0.69	1	0.88	1	1.12	1	1.28	1	1.53	1	1.63	1	1.86	1	2.08

SEARCHED (initials) DATE SEARCHED

SERIALIZED (initials) DATE SERIALIZED

INDEXED (initials) DATE INDEXED

FILED (initials)

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1912

compound : MTP temperature : 28  
sample no. : 5 no. of cases : 11

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
inval	0.13	0.30	0.51	0.67	0.88	1.12	1.28	1.53	1.68	1.93	2.08
SLOPE =	0.0399										

The calculated value is : 0.0368

compound : MTP temprature : 28

sample no. : 6 no. of cases : 11

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00
inval	0.13	0.30	0.49	0.69	0.88	1.12	1.28	1.53	1.68	1.93	2.08
SLOPE =	0.0400										

The calculated value is : 0.0368

## PART II - OIL &amp; GAS

TRAILER	3.17	7.20	2.43	3.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00

TOTAL OF THE ABOVE SHIPMENTS

RECEIVED FROM CARRIER

TWO HUNDRED FORTY-FIVE DOLLARS

AND SEVEN CENTS

TRAILER	3.17	7.20	2.43	3.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00
TRAILER	2.00	18.00	1.50	2.00

RECEIVED FROM CARRIER

TWO HUNDRED FORTY-FIVE DOLLARS

AND SEVEN CENTS

compound : MFP tempreature : 38  
sample no. : 1 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00
Inval	0.30	0.73	1.19	1.58	2.01	2.38	2.96
SLOPE = 0.0864							

The calculated value is : 0.0622

compound : MFP tempreature : 38

sample no. : 2 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00
Inval	0.30	0.72	1.19	1.58	2.01	2.38	2.96
SLOPE = 0.0864							

The calculated value is : 0.0622

8000 1 20000.00 1 0000 1 0000

40000 1 10000 1 10000 1 10000

10000 1 10000 1 10000 1 10000

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2

compound : MTP tempreture : 38  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00
Inval	0.30	0.73	1.19	1.56	2.01	2.38	2.96
SLOPE =	0.0864						

The calculated value is : 0.0622

compound : MTP tempreture : 38

sample no. : 4 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00
Inval	0.29	0.74	1.15	1.54	1.94	2.18	2.78
SLOPE =	0.0794						

The calculated value is : 0.0622



compound : MHP tempreature : 38  
sample no. : 5 no. of cases : 7

report of  $(x,y)$  values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	
Inval	1	0.23	1	0.73	1	1.18	1	1.55
SLOPE =		0.0799				1.94	1	2.21

The calculated value is : 0.0622

compound : MHP tempreature : 38

sample no. : 6 no. of cases : 7

report of  $(x,y)$  values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	
Inval	1	0.29	1	0.73	1	1.19	1	1.55
SLOPE =		0.0203				2.00	1	2.27

The calculated value is : 0.0622

卷之三

卷之三

1.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 2.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 3.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 4.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 5.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 6.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 7.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 8.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 9.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$   
 10.  $\frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$

卷之三

卷之三十一

00.26 1 00.27 1 00.28 1 00.29 1 00.30 1 00.31 1 00.32 1 00.33 1 00.34 1 00.35 1 00.36 1 00.37 1 00.38 1 00.39 1 00.40 1 00.41 1 00.42 1 00.43 1 00.44 1 00.45 1 00.46 1 00.47 1 00.48 1 00.49 1 00.50 1 00.51 1 00.52 1 00.53 1 00.54 1 00.55 1 00.56 1 00.57 1 00.58 1 00.59 1 00.60 1 00.61 1 00.62 1 00.63 1 00.64 1 00.65 1 00.66 1 00.67 1 00.68 1 00.69 1 00.70 1 00.71 1 00.72 1 00.73 1 00.74 1 00.75 1 00.76 1 00.77 1 00.78 1 00.79 1 00.80 1 00.81 1 00.82 1 00.83 1 00.84 1 00.85 1 00.86 1 00.87 1 00.88 1 00.89 1 00.90 1 00.91 1 00.92 1 00.93 1 00.94 1 00.95 1 00.96 1 00.97 1 00.98 1 00.99 1 00.100 1

卷之三

4

compound : M+P temperature : 38  
sample no. : 7 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00								
inval	1	0.30	1	0.73	1	1.19	1	1.56	1	1.98	1	2.38	1	2.78	1

SLOPE = 0.0823

The calculated value is : 0.0622

compound : M+P temperature : 38

sample no. : 8 no. of cases : 7

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	25.00	30.00	35.00							
inval	1	0.18	1	0.74	1	1.17	1	1.54	1	2.01	1	2.27	1	2.78	1

SLOPE = 0.0837

The calculated value is : 0.0622

100% of the amount of the bill is due at time of delivery  
and 10% is due 30 days after delivery.

Delivery is made at the port of destination.

100% of the amount of the bill is due at time of delivery  
and 10% is due 30 days after delivery.  
Delivery is made at the port of destination.

compound : MHP temprature : 38  
sample no. : 9 no. of cases : 7

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00							
Inval	1	0.29	1	0.81	1	1.15	1	1.53	1	1.97	1	2.33	1	2.88
SLPDE	=	0.0831												

The calculated value is : 0.0622

compound : MHP temprature : 38

sample no. : 10 no. of cases : 7

report of (x,y) values and slope

time	1	5.00	10.00	15.00	20.00	25.00	30.00	35.00						
Inval	1	0.29	1	0.70	1	1.14	1	1.54	1	2.01	1	2.27	1	2.85
SLPDE	=	0.0835												

The calculated value is : 0.0622

36 2 60421302 1 60421302

37 4 60421302 1 60421302

38 1 60421302 1 60421302  
39 1 60421302 1 60421302  
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2

compound : HtN tempreture : 21  
sample no. : 1 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.04	0.09	0.14	0.17	0.22	0.28	0.34

SLOPE = 0.0049

The calculated value is : 0.0117

compound : HtN tempreture : 21

sample no. : 2 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.08	0.09	0.14	0.17	0.22	0.28	0.34

SLOPE = 0.0044

The calculated value is : 0.0117

100% Sulfuric acid - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

100% Sulfuric acid - 100% water

100% Acetone - 100% water

100% Ethanol - 100% water  
100% Methanol - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

100% Sulfuric acid - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

100% Sulfuric acid - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water  
100% Acetone - 100% water  
100% Ethanol - 100% water  
100% Methanol - 100% water

compound : H<sub>2</sub>N tempreature : 21  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	-0.01	0.09	0.13	0.16	0.21	0.28	0.34
SLOPE	=	0.0054					

The calculated value is : 0.0117

compound : H<sub>2</sub>N tempreature : 21

sample no. : 4 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.04	0.09	0.13	0.18	0.24	0.28	-0.06
SLOPE	=	0.0006					

The calculated value is : 0.0117

$\bar{P}(D) = 0.0000$

compound : HtN tempreture : 21  
sample no. : 5 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.04	0.09	0.14	0.18	0.23	0.28	-0.05
SLPDE =	0.0006						

The calculated value is : 0.0117

compound : HtN tempreture : 21

sample no. : 6 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.04	0.09	0.14	0.18	0.23	0.28	-0.06
SLPDE =	0.0007						

The calculated value is : 0.0117

2

LEADERSHIP IN A CHANGING WORLD

卷之三

LITERATURE AND THE CULTURE OF THE RENAISSANCE 13

卷之三

卷之三

$\pi_2(0) = \pi_2(1)P_1$ .  
 $\pi_2(0) = P_1\pi_2(1)$ .  
 $P_1\pi_2(1)P_1 = \pi_2(1)P_1$ .  
 $\pi_2(1)P_1 = \pi_2(1)$ .  
 $\pi_2(1) = \pi_2(1)$ .

compound : M+N tempreature : 21  
sample no. : 7 no. of cases : 7

report of (x,y) values and slope

time	1	10.00		20.00		30.00		40.00		50.00		60.00		70.00	
Inval	1	0.04		0.09		0.14		0.08		0.23		0.29		0.34	
SLOPE =	0.0049														

The calculated value is : 0.0117

compound : M+N tempreature : 21

sample no. : 8 no. of cases : 7

report of (x,y) values and slope

time	1	10.00		20.00		30.00		40.00		50.00		60.00		70.00	
Inval	1	0.04		0.09		0.14		0.18		0.23		0.29		0.34	
SLOPE =	0.0049														

The calculated value is : 0.0117

94055 EUGS

QUARTER 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36 1 70.00 1 12.36

REPORT DATE: 1965-06-25 BY: 12000

RECORDED BY: 12000

REF ID: R1965062500012000

compound : HgN temperature : 21  
sample no. : 9 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	0.04	0.09	0.14	0.18	0.24	0.29	0.33
SLOPE	=	0.0049					

The calculated value is : 0.0117

compound : HgN temperature : 21

sample no. : 10 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	0.04	0.09	0.13	0.18	0.24	0.28	-0.05
SLOPE	=	0.0007					

The calculated value is : 0.0117

RECEIVED - 1968-06-12  
R. L. CRAIN INC.

RECEIVED - 1968-06-12  
R. L. CRAIN INC.  
4705 E. 11th St. - Oklahoma City, Okla. 73104  
304-220-3000  
100.00  
40.00  
20.00  
20.00  
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RECEIVED - 1968-06-12  
R. L. CRAIN INC.

RECEIVED - 1968-06-12  
R. L. CRAIN INC.  
4705 E. 11th St. - Oklahoma City, Okla. 73104  
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100.00  
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R. L. CRAIN INC.  
4705 E. 11th St. - Oklahoma City, Okla. 73104  
304-220-3000  
100.00  
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10.00

compound : H<sub>2</sub>N tempreature ; 29  
sample no. ; 1 no. of cases ; 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00								
Inval	1	0.16	1	0.34	1	0.48	1	0.65	1	0.77	1	0.93	1	1.04	1
SLOPE =	0.0146														

The calculated value is : 0.0212

compound : H<sub>2</sub>N tempreature ; 29

sample no. ; 2 no. of cases ; 7

report of (x,y) values and slope

time	1	10.00	20.00	30.00	40.00	50.00	60.00	70.00							
Inval	1	0.15	1	0.34	1	0.48	1	0.64	1	0.77	1	0.90	1	1.07	1
SLOPE =	0.0149														

The calculated value is : 0.0212

STATEMENT OF DEBT

STATEMENT OF DEBT  
TO THE STATE OF CALIFORNIA  
FOR THE MONTH OF JUNE, 1968  
AMOUNT DUE: \$5,000.00

STATEMENT OF DEBT

STATEMENT OF DEBT  
TO THE STATE OF CALIFORNIA  
FOR THE MONTH OF JUNE, 1968  
AMOUNT DUE: \$5,000.00

STATEMENT OF DEBT

STATEMENT OF DEBT  
TO THE STATE OF CALIFORNIA  
FOR THE MONTH OF JUNE, 1968  
AMOUNT DUE: \$5,000.00

STATEMENT OF DEBT

STATEMENT OF DEBT  
TO THE STATE OF CALIFORNIA  
FOR THE MONTH OF JUNE, 1968  
AMOUNT DUE: \$5,000.00

STATEMENT OF DEBT

STATEMENT OF DEBT  
TO THE STATE OF CALIFORNIA  
FOR THE MONTH OF JUNE, 1968  
AMOUNT DUE: \$5,000.00

compound : HtN tempreature : 29  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00								
Inval	1	0.15	1	0.35	1	0.48	1	0.64	1	0.82	1	0.90	1	1.05	1
SLOPE =	0.0148														

The calculated value is : 0.0212

compound : HtN tempreature : 29  
sample no. : 4 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00								
Inval	1	0.16	1	0.34	1	0.47	1	0.64	1	0.81	1	0.90	1	1.04	1
SLOPE =	0.0146														

The calculated value is : 0.0212

STUDY OF OILS

TABLE I  
TIME OF THERMAL DECOMPOSITION OF POLY(1,3-PHENYLENE TERPHENYL)

TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)

TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)  
TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)  
TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)

TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)  
TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)  
TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)

TEST OIL 100% POLY(1,3-PHENYLENE TERPHENYL)

compound : MHN tempreture : 29  
sample no. : 5 no. of cases : 7

report of (x,y) values and slope

time	1	10.00	1	20.00	1	30.00	1	40.00	1	50.00	1	60.00	1	70.00	1
Inval	1	0.16	1	0.34	1	0.48	1	0.65	1	0.81	1	0.90	1	1.07	1
SLOPE = 0.0149															

The calculated value is : 0.0212

compound : MHN tempreture : 29

sample no. : 6 no. of cases : 7

report of (x,y) values and slope

time	1	10.00	1	20.00	1	30.00	1	40.00	1	50.00	1	60.00	1	70.00	1
Inval	1	0.15	1	0.34	1	0.47	1	0.64	1	0.81	1	0.90	1	1.08	1
SLOPE = 0.0152															

The calculated value is : 0.0212

## 2500' - 2000'

ASST 1 3.73 1 2.17 1 1.93 1 2.07 1 2.07 1  
TURF 1 4.5 1 1.9 1 1.9 1 1.9 1 1.9 1  
LGR, C. 1 0.4 1 0.4 1 0.4 1 0.4 1 0.4 1

## 3000' - 3500'

ASST 1 3.73 1 2.17 1 1.93 1 2.07 1 2.07 1

## 4000' - 4500'

ASST 1 3.73 1 2.17 1 1.93 1 2.07 1 2.07 1

ASST 1 3.73 1 2.17 1 1.93 1 2.07 1 2.07 1

compound : HtN temperature : 29  
sample no. : 7 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.14	0.35	0.48	0.65	0.77	0.93	1.10
SLOPE =	0.0154						

The calculated value is : 0.0212

compound : HtN temperature : 29

sample no. : 8 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.14	0.33	0.49	0.63	0.76	0.92	1.05
SLOPE =	0.0149						

The calculated value is : 0.0212

100% - 100% - 100%  
100% - 100% - 100%

100% - 100% - 100%  
100% - 100% - 100%  
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compound : HtN temperature : 29  
sample no. : 9 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00							
lnval	1	0.14	1	0.33	1	0.47	1	0.65	1	0.81	1	0.95	1	1.08
SLOPE =	0.0157													

The calculated value is : 0.0212

compound : HtN temperature : 29

sample no. : 10 no. of cases : 7

report of (x,y) values and slope

time	1	10.00	20.00	30.00	40.00	50.00	60.00	70.00						
lnval	1	0.14	1	0.33	1	0.47	1	0.45	1	0.82	1	0.95	1	1.10
SLOPE =	0.0159													

The calculated value is : 0.0212

（註）此處指的不是「政治」，而是「社會」。

TIME - 10 AM P.M. 10 PM

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"GOD IS DEAD": 1900-1940

THEORY AND PRACTICE IN THE FIELD OF POLYMER ENGINEERING

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PROBLEMS OF THE ANTIQUE TRADE

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compound : H<sub>2</sub>N temperature : 37  
sample no. : 1 no. of cases : 8

report of (x,y) values and slope

time	1	5.00	1	10.00	1	15.00	1	20.00	1	25.00	1	30.00	1	35.00	1	40.00	1
Inval	1	0.13	1	0.26	1	0.39	1	0.53	1	0.65	1	0.74	1	0.93	1	1.04	1
SLOPE =	0.0259																

The calculated value is : 0.0279

compound : H<sub>2</sub>N temperature : 37

sample no. : 2 no. of cases : 8

report of (x,y) values and slope

time	1	5.00	1	10.00	1	15.00	1	20.00	1	25.00	1	30.00	1	35.00	1	40.00	1
Inval	1	0.13	1	0.25	1	0.39	1	0.51	1	0.65	1	0.77	1	0.93	1	1.02	1
SLOPE =	0.0259																

The calculated value is : 0.0279

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SHEET NO. 000000

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PRINTED IN U.S.A. BY THE GOVERNMENT OF THE UNITED STATES OF AMERICA

compound : HgN temperature : 37  
sample no. : 3 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Inval	0.14	0.26	0.38	0.56	0.65	0.75	0.92	1.02
SLOPE =	0.0255							

The calculated value is : 0.0279

compound : HgN temperature : 37

sample no. : 4 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Inval	0.13	0.24	0.38	0.51	0.65	0.74	0.90	1.01
SLOPE =	0.0254							

The calculated value is : 0.0279

2

SUGAR - 5 PINTS

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

SUGAR - 5 PINTS

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

DATE 10-21-90  
TIME 2 PM  
WEIGHT 2000  
SUGAR 500  
WATER 1500  
LEAVES 1000  
TOTAL 4500

compound : HgN temprature : 37

sample no. : 5 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	
Inval	0.13	0.24	0.38	0.51	0.65	0.74	0.89	1.02	
SLOPE =	0.0256								

The calculated value is : 0.0279

compound : HgN temprature : 37

sample no. : 6 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	
Inval	0.14	0.24	0.38	0.50	0.65	0.73	0.89	1.01	
SLOPE =	0.0252								

The calculated value is : 0.0279

2

$$g_{\text{eff}} = 2.004$$

Soil Gas Analysis - Nitrate and Chlorate

總計：15 + 10 = 25  
15 + 10 = 25

LITERATURE REVIEW

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2.2. *Proof of Theorem 1*

compound : HgN tempreature : 37  
sample no. : 7 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Inval	0.13	0.25	0.38	0.51	0.64	0.74	0.88	1.07
SLOPE =	0.0261							

The calculated value is : 0.0279

compound : HgN tempreature : 37

sample no. : 8 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
Inval	0.10	0.24	0.37	0.51	0.61	0.77	0.90	1.07
SLOPE =	0.0270							

The calculated value is : 0.0279

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BECAUSE I DON'T WANT TO GET KILLED BY A GUN.

TABLE I  
DISTRIBUTION OF THE VARIOUS TYPES OF  
TUMORS IN THE BRAIN AND SPINAL CORD

200-000-34012

compound : HtN tempreature : 37  
sample no. : 9 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
inval	0.12	0.22	0.37	0.51	0.63	0.79	0.88	1.05
SLOPE	=	0.0267						

The calculated value is : 0.0279

compound : HtN tempreature : 37

sample no. : 10 no. of cases : 8

report of (x,y) values and slope

time	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
inval	0.12	0.22	0.37	0.50	0.63	0.77	0.89	1.06
SLOPE	=	0.0268						

The calculated value is : 0.0279

100% - CASHIER'S CHECK - DRAFT - BANKER'S CHECK  
20% - CHECKS - MONEY ORDERS - CERTIFICATES OF DEPOSIT

100% - CASHIER'S CHECK - DRAFT - BANKER'S CHECK  
20% - CHECKS - MONEY ORDERS - CERTIFICATES OF DEPOSIT

100% - CASHIER'S CHECK - DRAFT - BANKER'S CHECK

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20% - CHECKS - MONEY ORDERS - CERTIFICATES OF DEPOSIT

100% - CASHIER'S CHECK - DRAFT - BANKER'S CHECK

100% - CASHIER'S CHECK - DRAFT - BANKER'S CHECK  
20% - CHECKS - MONEY ORDERS - CERTIFICATES OF DEPOSIT

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100% -  
20%

compound : NH<sub>3</sub> temprature : 21  
sample no. : 1 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	-0.00	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07
SLOPE	= -0.0011						

The calculated value is : -0.0002

compound : NH<sub>3</sub> temprature : 21

sample no. : 2 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	-0.00	-0.01	-0.02	-0.04	-0.05	-0.06	-0.07
SLOPE	= -0.0011						

The calculated value is : -0.0002

（三）「白雲」詩歌的美學價值

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THE ESTIMATE OF THE TRADITION

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compound : NtP temprature : 21  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	10.00		20.00		30.00		40.00		50.00		60.00		70.00	
Inval	-0.01		-0.01		-0.03		-0.04		-0.05		-0.06		-0.07	
SLOPE =	-0.0011													

The calculated value is : -0.0002

compound : NtP temprature : 21

sample no. : 4 no. of cases : 7

report of (x,y) values and slope

time	10.00		20.00		30.00		40.00		50.00		60.00		70.00	
Inval	-0.01		-0.02		-0.03		-0.04		-0.05		-0.06		-0.07	
SLOPE =	-0.0010													

The calculated value is : -0.0002

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compound : NtP tempreature ; 21  
sample no. : 5 no. of cases ; 7

report of (x,y) values and slope

time !	10.00	!	20.00	!	30.00	!	40.00	!	50.00	!	60.00	!	70.00	!
inval !	-0.01	!	-0.02	!	-0.03	!	-0.04	!	-0.05	!	-0.06	!	-0.07	!
SLOPE =	-0.0010													

The calculated value is ; -0.0002

compound : NtP tempreature ; 21

sample no. ; 6 no. of cases ; 7

report of (x,y) values and slope

time !	10.00	!	20.00	!	30.00	!	40.00	!	50.00	!	60.00	!	70.00	!
inval !	-0.01	!	-0.02	!	-0.03	!	-0.04	!	-0.05	!	-0.06	!	-0.07	!
SLOPE =	-0.0010													

The calculated value is ; -0.0002

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compound : NtP tempreture ; 21  
sample no. ; 7 no. of cases ; 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval 1	-0.01	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07
SLOPE =	-0.0011						

The calculated value is : -0.0002

compound : NtP tempreture ; 21

sample no. ; 8 no. of cases ; 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval 1	-0.01	-0.02	-0.03	-0.04	-0.04	-0.06	-0.07
SLOPE =	-0.0010						

The calculated value is : -0.0002

100% O<sub>2</sub>      100% N<sub>2</sub>      50% O<sub>2</sub>      25% O<sub>2</sub>  
 100% CO<sub>2</sub>      100% H<sub>2</sub>O      50% CO<sub>2</sub>      25% CO<sub>2</sub>

SOLVENT				SOLVENT			
100% O <sub>2</sub>				100% N <sub>2</sub>			
100% CO <sub>2</sub>				100% H <sub>2</sub> O			
50% O <sub>2</sub>				50% N <sub>2</sub>			
50% CO <sub>2</sub>				50% H <sub>2</sub> O			
25% O <sub>2</sub>				25% N <sub>2</sub>			
25% CO <sub>2</sub>				25% H <sub>2</sub> O			

SOLVENT				SOLVENT			
100% O <sub>2</sub>				100% N <sub>2</sub>			
100% CO <sub>2</sub>				100% H <sub>2</sub> O			
50% O <sub>2</sub>				50% N <sub>2</sub>			
50% CO <sub>2</sub>				50% H <sub>2</sub> O			
25% O <sub>2</sub>				25% N <sub>2</sub>			
25% CO <sub>2</sub>				25% H <sub>2</sub> O			

25% O<sub>2</sub>      25% N<sub>2</sub>      50% H<sub>2</sub>O      50% CO<sub>2</sub>

compound : NtP temperature : 21

sample no. : 9 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07
SLOPE =	-0.0010						

The calculated value is : -0.0002

compound : NtP temperature : 21

sample no. : 10 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	-0.01	-0.02	-0.03	-0.04	-0.04	-0.06	-0.07
SLOPE =	-0.0010						

The calculated value is : -0.0002

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TOTAL = 0.0000 + 0.0000

compound : NtP tempreature : 29  
sample no. : 1 no. of cases : 8

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	
lnval	1	0.06	0.14	0.21	0.32	0.40	0.49	0.60	0.74

SLOPE = 0.0094

The calculated value is : 0.0131

compound : NtP tempreature : 29

sample no. : 2 no. of cases : 8

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	
lnval	1	0.05	0.14	0.23	0.32	0.40	0.48	0.62	0.72

SLOPE = 0.0094

The calculated value is : 0.0131

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Group	Mean	SD	N	Significance
Control	1.00	0.00	10	
Group A	1.00	0.00	10	
Group B	1.00	0.00	10	
Group C	1.00	0.00	10	
Group D	1.00	0.00	10	
Group E	1.00	0.00	10	
Group F	1.00	0.00	10	
Group G	1.00	0.00	10	
Group H	1.00	0.00	10	
Group I	1.00	0.00	10	
Group J	1.00	0.00	10	
Group K	1.00	0.00	10	
Group L	1.00	0.00	10	
Group M	1.00	0.00	10	
Group N	1.00	0.00	10	
Group O	1.00	0.00	10	
Group P	1.00	0.00	10	
Group Q	1.00	0.00	10	
Group R	1.00	0.00	10	
Group S	1.00	0.00	10	
Group T	1.00	0.00	10	
Group U	1.00	0.00	10	
Group V	1.00	0.00	10	
Group W	1.00	0.00	10	
Group X	1.00	0.00	10	
Group Y	1.00	0.00	10	
Group Z	1.00	0.00	10	

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compound : NtP tempreature : 29  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
inval	0.06	0.14	0.20	0.32	0.39	0.48	0.60
SLOPE	=	0.0089					

The calculated value is : 0.0131

compound : NtP tempreature : 29

sample no. : 4 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
inval	0.05	0.14	0.23	0.32	0.39	0.47	0.62
SLOPE	=	0.0090					

The calculated value is : 0.0131

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For the first two terms in the expansion of  $\hat{f}_n$ , we have  $\hat{f}_n = \frac{1}{\sqrt{n}} \sum_{j=1}^n f_j + \frac{1}{\sqrt{n}} \sum_{j=1}^n \epsilon_j$ .

IGV (International Group of Visual Artists) was founded in 1970 by a group of artists.

TIME 1 10:05 10:05 10:05 10:05

compound : NH<sub>3</sub> tempreature : 29  
sample no. : 5 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Invai	0.05	0.14	0.20	0.30	0.37	0.49	1.09
SLOPE	=	0.0142					

The calculated value is : 0.0131

compound : NH<sub>3</sub> tempreature : 29

sample no. : 6 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Invai	0.05	0.14	0.23	0.31	0.40	0.49	0.61
SLOPE	=	0.0091					

The calculated value is : 0.0131

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192  
The following table gives the results of the experiments.

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compound : NtP tempreature : 29  
sample no. : 7 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inv1	0.06	0.14	0.23	0.31	0.40	0.48	0.59

SLOPE = 0.0086

The calculated value is : 0.0131

compound : NtP tempreature : 29

sample no. : 8 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inv1	0.06	0.14	0.23	0.30	0.40	0.49	0.59

SLOPE = 0.0087

The calculated value is : 0.0131

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compound : NtP temperature : 29  
sample no. : 9 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.05	0.14	0.23	0.30	0.40	0.48	0.61
SLOPE	=	0.0090					

The calculated value is : 0.0131

compound : NtP temperature : 29

sample no. : 10 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	0.05	0.14	0.23	0.30	0.41	0.48	0.60
SLOPE	=	0.0090					

The calculated value is : 0.0131

For example, if  $\mathcal{L} = \mathcal{L}_0$ , then  $\mathcal{L}^{\text{opt}} = \mathcal{L}_0$  and  $\mathcal{L}^{\text{opt}} \subset \mathcal{L}$ . If  $\mathcal{L} = \mathcal{L}_0 \cup \mathcal{L}'$ , then  $\mathcal{L}^{\text{opt}} = \mathcal{L}_0$  and  $\mathcal{L}^{\text{opt}} \subset \mathcal{L}$ . If  $\mathcal{L} = \mathcal{L}_0 \cup \mathcal{L}'$  and  $\mathcal{L}' \neq \emptyset$ , then  $\mathcal{L}^{\text{opt}} = \mathcal{L}_0 \cup \mathcal{L}'$  and  $\mathcal{L}^{\text{opt}} \subset \mathcal{L}$ .

THE HISTORY OF THE CHURCH IN CHINA

THE JOURNAL OF CLIMATE

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CATHERINE DIBBLE: A CLOSER LOOK

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WILHELM DIETRICH'S SINGING

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compound : NtP tempreature : 39  
sample no. : 1 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00	
Inval	1	0.17	0.40	0.57	0.76	0.92	1.11	1.40
SLOPE	=	0.0195						

The calculated value is : 0.0298

compound : NtP tempreature : 39

sample no. : 2 no. of cases : 7

report of (x,y) values and slope

time	1	10.00	20.00	30.00	40.00	50.00	60.00	70.00
Inval	1	0.17	0.40	0.55	0.78	0.91	1.11	1.49
SLOPE	=	0.0204						

The calculated value is : 0.0298

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compound : NtP temprature : 39  
sample no. : 3 no. of cases : 7

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	70.00
lnval	0.16	0.40	0.57	0.76	0.92	1.11	1.36
SLOPE	=	0.0191					

The calculated value is : 0.0298

compound : NtP temprature : 39

sample no. : 4 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00
lnval	0.18	0.39	0.59	0.76	0.98	1.20
SLOPE	=	0.0201				

The calculated value is : 0.0298

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compound : NtP tempreature : 39  
sample no. : 5 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00
lnval	1 0.18	1 0.39	1 0.58	1 0.75	1 0.98	1 1.22
SLOPE =	0.0205					

The calculated value is : 0.0298

compound : NtP tempreature : 39

sample no. : 6 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00
lnval	1 0.18	1 0.38	1 0.59	1 0.76	1 0.97	1 1.21
SLOPE =	0.0203					

The calculated value is : 0.0298

NOTES AND COMMENTS

1. 100% of the 1000 ft. of 60 ft. thick sandstone is present in the 1000 ft. of the 60 ft. thick sandstone.

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compound : NH<sub>3</sub> tempreature : 39  
sample no. : 9 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00
Inval	1	0.17	0.39	0.59	0.74	0.89
SLOPE	=	0.0177				

The calculated value is : 0.0298

compound : NH<sub>3</sub> tempreature : 39

sample no. : 10 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00
Inval	1	0.18	0.39	0.58	0.72	1.08
SLOPE	=	0.0210				

The calculated value is : 0.0298

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compound : NH<sub>3</sub> tempreture : 39  
sample no. : 7 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	
lnval	1	0.17	0.39	0.55	0.74	0.92	1.24
SLOPE	=	0.0203					

The calculated value is : 0.0298

compound : NH<sub>3</sub> tempreture : 39

sample no. : 8 no. of cases : 6

report of (x,y) values and slope

time	10.00	20.00	30.00	40.00	50.00	60.00	
lnval	1	0.17	0.40	0.59	0.76	0.92	1.08
SLOPE	=	0.0179					

The calculated value is : 0.0298

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