CHAPTER - 4

VARIATION OF LOAD WITH INDENTATION DIMENSIONS

[NaCl , KCl and KBr]

4.1 INTRODUCTION:

There are two ways of studying quantitatively microhardness of crystalline materials.

i) Variation of applied load (P) with diagonal of indentation mark (d).

ii) Variation of hardness (H) with applied load. The emperical formulae for (i) are usually referred to as Kick's law (1885) /1/ for pyramidal indenters and Meyer's law (1956) /2/ for spherical indenter. Later on Kick's law was modified by Hays and Kendal (1973) /3/. For pyramidal indenter Kick's law between P and d states

$$p = ad^n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where 'a' and 'n' are constants of the material under test. 'a' is usually known as standard hardness. When spherical indenter was used, the above law is referred to as Meyer's law. The hardness number (H) of a material is given by

$$H_i = rp/d^2 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where the constant 'r' depends on the geometry of the identer. For vickers (v) and knoop (k) hardness indenters the subscript 'i' is replaced by 'v' and 'k'.

The combination of the above equations yields

$$H_i = a_1 d^{n-2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$H_i = a_2\, p^{\,n-2/n} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where $a_1 = ra$ .... (5)

and $a_2 = r^{2/n}$ .... (6).

It has been shown that in the case of vickers hardness (Kick's (1885) /1/)the value of the exponent 'n' equals 2 for all indenters that give geometrically similar impressions. Substitution of the value in (5) and (6) gives

$$H = a_1 = ra$$

$$H = a_2 = ra$$

The above equations show that hardness or hardness number is constant and independent of applied loads. In what follows hardness, microindentation hardness or hardness number have identical meanings.

For $n = 2$, (1) and (2) become

$$p = ad^2$$

$$H_i = r\ P/d^2$$

and $H_i = ra$

Theoretically the study of (1) and (2) for $n = 2$ should give similar results. However, there are certain basic differences in these two approaches and hence they are studied and discussed separately in the present work. A large number of workers have studied the variation of 'P' with 'd' and also of 'H' with 'P'. The reported results are quite confusing.

Haneman and Schultz (1941) /4/ from their observations on variations of 'P' with 'd' reported that in the low load region,'n' generally has a value less than 2. Onitsch (1947) /5/ found such low values of n(1 to 2) by observing variation of hardness with load while Grodzinski (1952) /6/ found variation of 'n' values from 1.3 to 4.9. Knoop (1947) /7/ and Bernhardt (1941) /8/ observed an increase in hardness with decrease in load whereas Camphell et al.(1948) /9/ and Mott (1956) /10/ observed a decrease in hardness with decrease in load. Some researchers e.g. Taylor (1948) /11/, Bergsman (1948) /12/ reported no significant change of hardness with load. In view of these different observations, it has become rather difficult to establish any definite relationship of general validity between P and d or H and P. The standard hardness values according to (1) should be constant. However the actual values obtained by different workers revealed disparities amounting to 30 to 50% . Further the hardness values obtained in different load regions show scattered results even though the apparatus had a good mechanical precession.

In view of the conflicting results it is decided to critically reexamine Kick's law by experimentally studying variations of 'P' with 'd' by using Knoop indenter. It is an extension of the work reported by earlier workers on different crystals /13-17/.

Knoop and his associates originally developed the four sided pyramidal indenter for determining the hardness of semibrittle materials (1939) /18/. It was the unique geometry that offered several advantages over the conventional and symmetric indenters such as vickers indenter. For this reason, the knoop hardness testing method has been extensively used in different applications since its development in 1939 /19-23/. One of the features is that, because of its slow shallow depth of penetration, brittle materials like glass or minerals could be indented without causing premature fracture. Another feature is that, due to the non-symmetric indenter shape, the variations in load/hardness along different directions on a given surface can be determined . This was extensively used by Joshi (1989) /24/ on $NaNo_3$ and $CaCo_3$ cleavages and Annie Kuruvila (1992) /25/ on d-AHT single crystals in this laboratory. It was also used by the author to study the hardness of NaCl, KCl and KBr single crystals.

The geometry of the indenter is shown in Fig.4.1 where the included conical angles extending along the major and minor axes of the indenter are 172°30' and 130° respectively. The resulting impression on the surface of the test sample is also shown in Fig. 4.1, where the major diagonal 'L' is known to be about seven times longer than the minor diagonal, W. It is also generally assumed that there is negligible elastic recovery in the major diagonal direction compared to the minor diagonal direction when the indenter is removed (1951) /26/. In addition to the problems associated with elastic recovery, the material near the indenter surface is known to pile up or sink in, depending on the interfacial frictional conditions and the material properties, such as the strain - hardening capacity (1982) /27/. This phenomenon also tends to change the mode of deformation near the indenter surface.

4.2 EXPERIMENTAL :

Single crystals of NaCl, KCl and KBr grown from melt by Kyropoulos method described in chapter-II were used in the present investigation. Every time freshly cleaved samples of approximately equal sizes were used so that a comparison of treated and untreated samples can be easily made without introducing other factors affecting the determination of 'a' and 'n'. Freshly cleaved blocks having dimensions 10 x 6 x 3 mm were fixed on glass plates with non-reacting adhesive. The levelling of the specimen was tested by using a table microscope. The hardness tester described in chapter-II was used to produce indentation on the specimens by using rhomb-based knoop pyramidal indenter. The filar micrometer eyepiece was used to measure the surface dimensions of the indentation mark. In order to avoid the influence of one indentation mark on the other, the distance between two consecutive indentations was maintained atleast four times the diagonal length of the indentation mark, the indentation time for all specimens was kept 15 seconds. The load was varied from 1.25 gm to 160 gm. Care was taken to see that errors introduced during the work of indentation and measurements were avoided or minimized. The indentation marks were produced for different orientations of the longer diagonal of the knoop indenter with respect to direction [100] on the specimen. These orientations were designated by angle 'A' between the reference direction

[100] and the longer diagonal of knoop indentation mark. The direction angles in degrees for which measurements were made are as under :

For all the three crystals,

A = 0, 10, 20, 30, 40, 50, 60, 70, 80, 90.

Due to non-availability of a hot stage and optical components of microscope to be used with it in hardness tester, the indentation work was carried out at room temperature (i.e. at 303°K for all the three crystals) for studying the variations of hardness with temperature. For their thermal treatment crystals of approximately equal sizes were kept in a muffle furnace and the temperature was gradually raised to a desired temperature and kept at this temperature for identical periods running into several hours (24 hr in the present work). They were then quenched to room temperature. The quenching rates were as high as possible and were adjusted so that the quenched crystals maintained their shapes. In the present case the rate of quenching varied from 1.6° c/sec to 11.6° c/sec. These experiments were conducted upto a temperature of 600°C for all the three crystal samples.

4.3 OBSERVATIONS:

The longer diagonals of the knoop indentation marks produced by various loads for different orientations of indenter were measured. It is assumed that there is negligible elastic recovery in the major diagonal directions compared to the minor diagonal direction when the indenter is removed (1951) /23/. Several sets consisting of a large number of observations on freshly cleaved surfaces of thermally treated and/or untreated NaCl, KCl and KBr crystals indented by various loads at room temperature for different orientations of indenter were taken and the observations are recorded in table 4.1 A, 4.1 B, and 4.1 C. All the observations were studied graphically by plotting log d versus log p (Fig. 4.1 a,b,c) for different A's.

4.4 RESULTS AND DISCUSSION ;

4.4.1 Straight line plot of log d Vs. log P :

Taking logarithms on both sides of the equation representing Kick's Law for pyramidal indenter yields :

$$\log p = \log a + n \log d \qquad ......(7)$$

The values of constants 'a' and 'n' can thus be determined from a graph of log d Vs. log p. Since the relation between log p and log d is linear, the graph is a straight line, the slope of this line gives the value of 'n' and the intercept on log p axis gives the value of log a and hence 'a'.

A careful study of the graphs (log d Vs. log p) shows that there are two clearly recognizable straight lines for all the three crystals having different slopes meeting at a kink. These loads will hence forth be referred as the transition loads P_k. The first part of the straight line corresponding to observations taken at low loads up to the room temperature has slope 'n_1' of higher value whereas for the second part of the straight line for higher loads, the slope (n_2) has value less than 2. Since the 'n' values are different in different regions of the graph of log d Vs. log p, being greater in the first region, the 'a' values also vary in two regions being less in the first region of low loads(LLR) and more in the high load region (HLR). For Knoop indentation on cleavage faces of NaCl, KCl and KBr; the values of 'n' and 'a' are recorded in Table 4.3 (A), 4.3(B) and 4.3(C). As mentioned above several workers have reported visible scattering in 'n' values, e.g. Hanemann and Schultz (1941) /4/, Onitsch (1947) /5/, Grodzinski (1952) /6/. However, none has reported the splitting of graphs into two straight lines and their characteristics. The study of the variation of load with diagonal length of vickers indentation mark on faces of different types (c, m, d and o faces) of natural and synthetic barite crystals (1971) /27/ has shown very clearly the existance of two distinctly recognizable straight lines of the graph of log d Vs. log p. Later, Mehta (1972) /28/, Shah (1976) /13/, Acharya (1978) /14/, Patel (1987) /17/ and Joshi (1989) /24/ verified the splitting of the graph of log d Vs. log p on $CaCo_3$, Zn, TGs, d-AHT crystals. In the present investigation the author has verified for NaCl, KCl and KBr, the splitting of the graph into two straight lines using

Knoop Pyramidal indenter. The splitting varies with orientation of the indenter with respect to the crystal lattice. It is thus certain that the splitting of the graph into two straight lines is natural and is due to the varied reactions of the crystal surfaces to different loads used for producing indentations.

The tables 4.3 A, 4.3 B and 4.3 C records the values of a_1, n_1, a_2, n_2, n_{2mod}, b_2 and w_2 for cleavage faces of NaCl, KCl and KBr single crystals at room temperature and at different quenching temperatures and for different orientations of indenter with respect to direction [100]. The straight line in the LLR is characterised by slope n_1 and intercept a_1 whereas the slope and intercept for straight line corresponding to HLR region of applied loads are n_2 and a_2 respectively. Further the plots (Fig. 4.2 a, b & c and Fig. 4.3 a, b & c) according to modified kicks law is also a straight line with slopes and intercepts and newtonian resistance pressures n_{2mod}, b_2 and w_2 respectively. It should be noted that although in the table, the values of the above are given upto four decimal places, the accuracy obtained in the present work is upto two decimal places and is the one which is considered for the present analysis in this and subsequent chapters. A careful study of the table reveals for the cleavage faces of these crystals the following :-

1) with increase in orientation from 0 to 90°, the values of n_1 are decreasing and have minimum values at about 45° orientation and are then increasing at room temperature and at all quenching temperatures. The

variation in values does not appear to be smooth. The values of the intercept a_1 increase with orientation and attain a maximum value at about 45° orientation and then fall at room temperature and at all quenching temperatures.

ii) For the straight line in HLR, the decrease in n_2 values is comparatively less than those observed for n_1 values. However n_2 becomes minimum at about 45° orientation at all quenching temperatures and at room temperature. Further the values of intercept a_2 indicate rapid increase compared to the corresponding increase in a_1 values in LLR. a_2 has a maximum value at about 45° orientation and falls at room temperature and at all quenching temperatures. It is thus clear from the above that n_1 and n_2 decrease with increase in orientation and have minimum value at about 45° orientation whereas the converse is true for a_1 and a_2 values and this behaviour is independent of the temperature i.e., independent of the thermal treatment of the crystals. The direction corresponding to 45° orientation on cleavage faces of NaCl, KCl and KBr is [111] which is one of the important crystallographic directions for these crystals.

Application of modified Kick's law to these crystals has clearly indicated that it is valid in the HLR region of applied loads. In this region the plots of log(P-W) vs. log d are straight lines and intercept b_2, Newtonian resistance pressure w_2 and hence the modified value of slope $n_{2mod.}$ are obtained in the usual way. The $n_{2mod.}$ values are almost constant, and equal to 2, thereby verifying modified Kick's law in HLR. The intercept values (b_2) are decreasing and the values of Newtonian resistance pressure (w_2) are increasing with increase of orientation, A, at all quenching temperatures and room temperature. Further b_2 and w_2 has an extremum value (maximum and minimum) at about 45° orientation.

It is thus clear from the above analysis that the direction [111] corresponding to 45° orientation on cleavage faces of these crystals occupies an important position in the study of Kick's law and modified Kick's law. Further the analysis in HLR is more simple than in LLR.

4.4.2 Interpretation of Constants n_1, a_1, n_2, a_2, b_2, w_2, e_0, e_1 and e_2

Analysis based on Kick's law and modified Kick's law

Instead of giving weightages to individual observations in an experimental work, it is desirable to study graphically the variations in observations. This gives an indication of the average behaviour of a quantity with respect to a change in another quantity, keeping all other parameters in an experiment to have constant values. Hence the plots of (i) n_1 vs. A(Fig. 4.4a,b&c) (ii) a_1 vs. A(Fig. 4.5 a, b & c) (iii) n_2 vs. A (Fig. 4.6 a, b & c) (iv) a_2 vs. A (Fig. 4.7 a, b & c) (v) b_2 vs. A (Fig. 4.8 a, b & c) and (vi) w_2 vs. A (Fig. 4.9 a, b & c) for all quenching temperatures and room temperature are prepared for all these crystal cleavages. In these plots it is necessary to avoid crowding of the curvelinear plots (Fig. 4.4 a, b & c to Fig. 4.9 a, b & c). The scale along the vertical axis is uniformly increased by one unit containing small ten square blocks, whereas the scale along the horizontal axis remains unchanged for all plots. e.g. consider Fig. 4.4a describing for NaCl crystal cleavages, plots of n_1 vs. A for different quenching temperatures and room temperature. The actual scales for different plots are shown in the Fig. 4.4. The above scheme of representing points along vertical axis is carried out for all plots (Fig. 4.4 a, b & c to Fig. 4.9 a, b & c).

The conclusions which are mentioned above by studying from the tables general trend for the variations of n_1, a_1, n_2, a_2, b_2 and w_2 with A are amply supported by these plots. Thus, for all these crystals and for all quenching temperatures and room temperature, the conclusions from the above plots are as follows :-

(1) n_1 and n_2 vary with A and attain minimum values at about 45°. In some of the cases the minimum is sharp whereas for others it is broad. Further n_1 and n_2 for NaCl are noticeably more affected than those for KCl and KBr.

(2) a_1 and a_2 increase with A, attain maximum values and then decrease.

(3) b_2 decreases with A, falls to a minimum value and then increases.

(4) The values of w_2 increase with A, become maximum at A = 45° and then fall.

(5) Spacings between consecutive minima or maxima for different crystals in the above plots (Fig. 4.4a, b & c to Fig. 4.9a, b & c) are different. Even for the same crystal the spacing is not constant but varies in an unpredictable manner.

The above analysis based on the phenomenology of cleavage faces of NaCl, KCl and KBr has clearly indicated that for studying variation of load with diagonal length of the knoop indentation mark, the direction [110] is important and should be considered as a reference direction instead of direction [100] taken in the above discussion. On the basis of this consideration it is desirable to discuss the relative variations of n_1, a_1, n_2, a_2, b_2 and w_2 with A and with temperature. i.e., considering the values of n_1, a_1, n_2, a_2, b_2 and w_2 for A = 45° to be standard and labelling them as n_{10}, a_{10}, n_{20}, a_{20}, b_{20} and w_{20} for all quenching temperatures and room temperature. Hence (n_1/n_{10}), (a_1/a_{10}), (n_2/n_{20}), (a_2/a_{20}), (b_2/b_{20}) and (w_2/w_{20}) (where n_1, a_1, n_2, a_2, b_2 and w_2 correspond with the orientation A, Table-4.4) are plotted versus A for different temperatures and also versus T_Q for different orientations. The study of the first series of plots for NaCl cleavage face (100) namely (i) n_1/n_{10} Vs. A (Fig. 4.10), (ii) a_1/a_{10} Vs. A (Fig. 4.11), (iii) n_2/n_{20} Vs. A (Fig. 4.12), (iv) a_2/a_{20} Vs. A (Fig. 4.13), (v) b_2/b_{20} Vs. A (Fig. 4.14) and (vi) w_2/w_{20} Vs. A (Fig. 4.15) for different temperatures clearly indicates that the direction [110] should be considered as a reference direction and not the direction [100]. This conclusion is supported by the above mentioned corresponding plots (i) to (vi) for cleavage faces of KCl and KBr. These plots are not shown for the reason that they exhibit more or less the same curvelinear form.

The second series of graphs, namely (i) n_1/n_{10} Vs. T_Q, (ii) a_1/a_{10} Vs. T_Q, (iii) n_2/n_{20} Vs. T_Q, (iv) a_2/a_{20} Vs. T_Q, (v) b_2/b_{20} Vs. T_Q and (vi) w_2/w_{20} Vs. T_Q for different orientations have shown unusual behaviour e.g. the variations of n_1/n_{10} (Fig. 4.16) and n_2/n_{20} (Fig. 4.17) with T_Q for different A's are linear. Since the linear behaviour is almost the same for all crystals, only representative plots for one crystal say, NaCl are shown. This also suggests that the direction [110] should be chosen as reference direction. The variations for the remaining quantities are complicated.

It is observed that logarithmic plots yield linear proportionality. The tables 4.5A,B,C; 4.6A,B,C and 4.7A,B,C; present values for log a_1 T_Q, log a_2 T_Q, log b_2 T_Q and log T_Q for different orientations on cleavage faces of NaCl, KCl and KBr crystals. It is found that for these crystals the plots of (i) log a_1 T_Q Vs. log T_Q (Fig. 4.18a, b, c), (ii) log a_2 T_Q Vs. log T_Q(Fig. 4.19a,b, c) and (iii) log b_2 T_Q Vs. log T_Q (Fig. 4.20a, b, c) consist of a series of almost parallel straight lines with almost equal slopes and different intercepts corresponding to different orientations. The plots follow general equation

$$\log g\ T_Q = m \log T_Q + \log C_r \quad \ldots\ldots\ldots\ldots(8)$$

where the variable 'g' may be a_1, a_2, or b_2 and the straight line has slope 'm' and intercept 'C_r' where 'r' denotes a given orientation. Different values of 'r' gives a series of parallel lines. Simplification of the above yields,

$$g\ T_Q^{1-m} = C_r \quad \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Replacement of g by a_1, a_2 and b_2 in the above yields three equations,

$$a_1\ T_Q^{1-m_1} = C_{r1} \quad \ldots\ldots\ldots\ldots\ldots(10)$$

$$a_2\ T_Q^{1-m_2} = C_{r2} \quad \ldots\ldots\ldots\ldots\ldots(11)$$

$$b_2\ T_Q^{1-m_3} = C_{r3} \quad \ldots\ldots\ldots\ldots\ldots(12)$$

where m_1, m_2 and m_3 are the slopes and C_{r1}, C_{r2} and C_{r3} are the intercepts when a_1, a_2 or b_2 is zero. A careful study of each plot indicates the lines are slightly inclined leading to slightly differing values of slopes and intercepts for different orientations. The small change in slopes are around unity.

Further,

(1) For plots of $\log a_1\ T_Q$ Vs. $\log T_Q$, $(1 - m_1)$ values are positive and less than unity for NaCl and

are negative for KCl and KBr [Table - 4.8]. All values are numerically less than unity.

(2) For plots of log a_2 T_Q Vs. log T_Q and log b_2 T_Q Vs. log T_Q the values of $(1 - m_2)$ and $(1 - m_3)$ are negative and less than one for all three crystals [Tables - 4.9 and 4.10].

a_1, a_2 and b_2 are constants of cleavage faces of single crystals of NaCl, KCl and KBr. Further the analysis in LLR of these crystals, i.e. a_1 values, show that $(1 - m_1)$ values for NaCl are positive and for KCl and KBr are negative whereas a_2 and b_2 values corresponding to HLR, show that $(1-m_2)$ and $(1-m_3)$ values are negative for all crystal cleavages. These crystals have identical structures viz. f.c.c. Hence the general trend for purely load - dependent mechanical response should have a common feature for all 'As' and all temperatures namely, values of $(1 - m_1)$, $(1 - m_2)$ or $(1 - m_3)$ for all the crystals should have the same sign. It is hard to explain the positive values of $(1 - m_1)$ for NaCl. This suggests that there are several additional factors such as various types of imperfections and their interactions among themselves and also with the impurities, imperfect quenching, plasticity of these crystals etc. which must be dominating over the purely load-dependant mechanical response. The present analysis based on the physics of static indentation can not explain the positive values of $(1 - m_1)$ for NaCl. In the HLR, the negative values of the exponents $(1 - m_2)$ and $(1 - m_3)$ of T_Q associated with a_2 and b_2 simply indicate that as T_Q increases a_2 and b_2 also increase.

The relation between w_2 and T_Q is not as simple as the one given above between a_1 (or a_2 or b_2) with T_Q. This is expected because in the modified kick's law w_2 is postulated as Newtonian resistance which does not allow plastic deformation.

Analysis based only on observations :

In the above analysis, attempt is made to study variation of applied load with diagonal length of indentation by using Kick's law and modified Kick's law for pyramidal indenter. Instead of this approach one can directly apply graphical analysis to study the variation of load with diagonal length of knoop indentation mark. A plot of P Vs. d is a curve (Fig. 4.21). By using well known curve fitting method, an equation can be obtained. The equation

$$p = e_o + e_1 d + e_2 d^2 \qquad ......(13)$$

fits the curve extremely well. e_o, e_1 and e_2 are constants of the equation. Their values which are independent of the variable under consideration for different 'As' are given in Table - 4.11A, B, C. It is clear that order values of e_o, e_1 and e_2 for NaCl, KCl and KBr are (10^{-2}, 10^{-2}, 10^{-3}) (10^{-2}, 10^{-2}, 10^{-4}), and (10^{-2}, 10^{-2}, 10^{-4}) respectively. e_2 values are numerically small as compared to e_o and e_1 values. Consideration of these values and the above equation indicates e_o

is a constant and its value is of the order of 10^{-2}. Since it is not associated with d or d^2, it can be neglected. Hence the equation reduces to

$$P = e_1 d + e_2 d^2$$

$$\text{or} \quad P/d = e_1 + e_2 d \qquad ....(14)$$

the plot of P/d Vs. d should therefore be a straight line with slope e_2 and intercept e_1 on the negative side of P/d axis when P = 0. The plot (Fig. 4.22) is shown for one crystal say, KBr. However the values of e_2 and e_1 are obtained for all crystals and given in Table - 4.12A, B, C. There is fairly good correlation between these values and the corresponding values obtained from the plot of P Vs. d given in Table - 4.11A, B, C. The above equation can be written as

$$P/d^2 = e_1/d + e_2 \qquad ....(15)$$

Hence a plot of P/d^2 Vs. 1/d should lead to a straight line with slope e_1 and intercept e_2. However the graphical plot (Fig.-4.23) shows that although a major part of the plot is a straight line there is a small curvelinear portion f_1 f_2 f_3. The plot is shown for one crystal and one orientation say, KBr(A=0°). For other crystals the plots are almost similar in form. The values of P and d for the points f_1,f_2 and f_3 determined for all crystals are given in Table - 4.13A, B, C. It is clear from the values of f_1 and f_3 that they indicate range of applied loads and corresponding diagonal length of indentation for which the straight line plot breaks down. Further f_2 values of load and diagonal length correspond to the load and diagonal length at kink which splits the straight line plot of log P Vs. log d (Fig. 4.1 a, b, c) into LLR and HLR. This indicates that although Kick's law is an emperical relation, it is indeed useful in carrying out the analysis of the variation of P with d. However it could not predict the range of applied loads within which the orientation - dependent straight line is not valid. For A = 45°, the diagonal lengths have maximum values for all crystals. From the linear and non-linear character of the graph, it can be said that non-linear portion corresponds to the intermediate load region (ILR) producing deformation influenced by a number of factors such as imperfections, impurities etc. It attains a maximum value at f_2 and then falls to a lower value and after that the linear character again results. The behaviour of crystals in this range of applied load is highly complicated. However, one point has come out clearly, that there are three ranges of applied loads viz., Low Load Region (LLR), Intermediate Load Region (ILR) and High Load Region (HLR). Except at the line of demarcation, these regions are independent so far as the behaviour of crystals are concerned. This information could not be obtained from the plot of log P vs. log d. (Fig. 4.1 a, b & c) which consisted of two straight lines separated by the transition load at the kink. In these, some part of ILR is associated with LLR and the remaining with HLR, giving two straight lines and absence of curvelinear region. It should be remarked here that mathematically the relation (14) is valid to account for the plot of P vs. d. However the combination of P and d (15) made to obtain mathematically a straight line is not possible due to the influence of several unknown factors on the non-linear region of the plot namely f_1 f_2 f_3. The present analysis is however, incapable to throw light on the inner mechanism of crystal responsible for the occurance of f_1 f_2 f_3 in an otherwise linear plot. Further it also indicates the relative importance of coefficients of d^0, d^1 and d^2. It is obvious from the present analysis that coefficient e_2 is more important than e_1 (and also e_0). The numerical value of e_2 is of the order of 10^{-4} for KCl and KBr and is equal to 10^{-3} for NaCl. It is useful to compare the values of a_1, a_2 and b_2 with e_2 for these crystals. A surprising conclusion emerges, viz., that e_2 values are almost the same as those of a_1, a_2 and b_2 for these crystals. It is mentioned above that for Kick's law LLR can not be considered. Hence e_2 values should be compared with a_2 and b_2 values. Since a_2 and b_2 values represent constants which are referred to as **standard hardness** in the literature /3,10/, e_2 values should be considered as constants characteristic of the material of the crystals and are direction - and temperature - dependant

It is also interesting to compare the mathematical validity of equations

(i) $P = ad^n$

(ii) $P = e_0 + e_1d + e_2d^2$

This is done by comparing the percentage variation in the values of d calculated for all crystals on the basis of the above two equations (Table 4.14 A, for KBr). It is useful to note that the percentage deviation for (ii) are more for loads greater than 5 gm than those for (i). This incidently corresponds to the load value of f_1 for all crystals, indicating that the behaviour of crystals is more influenced by factors which can not be analyzed by (ii).

4.4.3 Importance of direction $\langle 110 \rangle$:

In the above studies of the load with diagonal length three approaches were developed : viz. (i) use of Kick's law (ii) use of modified Kick's law and (iii) study of plots of P vs. d without taking help of the above laws. The first approach has clearly shown that two constants are necessary to describe the mechanical response of surface to static indentation. In the present case according to Kick's law they are n_1 and a_1 in LLR and n_2 and a_2 in HLR for these crystals whereas for the modified Kick's law b_2 and w_2 are the contants to be considered. In the LLR some additional factors dominate over the effects of applied loads, therefore n_1 and a_1 can not be considered. However the study has revealed that n_1 has a minimum value and a_1, a maximum value at 45° orientation at all quenching temperatures and room temperature. This orientation corresponds to direction [110]. The projection of direction [111] on a cleavage surface (100) is [110] (Fig. 4.24). Further the arrangements of ions along this direction and direction [111] are the arrays of like ions separated by a constant distance and facing arrays of unlike ions on all sides (Fig. 4.25). Since the ionic charges are identical (positive or negative), there is repulsion among them along these directions. If this is the only factor in the lattice, the repulsive forces will destroy it. However there are attractions due to the proximit of ions of opposite charges. Hence on the whole the lattice is maintained. However the value of a property along this direction is severely affected due to the array of like charges. Looking to the relation between P and d on the basis of Kick's law, for a constant P, if 'n' decreases 'a' must increase so that the product '$a\ d^n$' has a constant value (P). However the physical meaning of 'a' is much different from 'n'. In the literature 'a' is described as **standard hardness**. On the basis of the current analysis the present author feels the use of the above phrase is a misnomer. It should be considered as a constant dependent on direction and temperature and the minimum value of 'n' and the maximum value of 'a' are independent of direction and temperature.

The general conclusion of the above discussion is applicable in the HLR. The decrease in n_1 is accompanied by a corresponding increase in a_1 whereas n_2 has a minimum value and a_2 a maximum value at A = 45° and at all quenching temperatures and room temperature. This simply suggests that the extremum values of n_2 and a_2 are independent of temperature and direction and hence crystal structure. In the present analysis weightage is given to HLR region in view of the fact the modified Kick's law is valid in this region only. i.e., the exponent of d equals 2. In the modified Kick's law the pair of important quantities are 'b' and 'w'. The meaning given by Hays and Kendall/3/ for these quantities are different. 'b' is considered as standard hardness and 'w' is the Newtonian resistance responsible for elastic deformation. However the present analysis shows that these quantities are dependant on temperatures and directions along which they are determined i.e., the crystal structure. Further only along direction [110], 'b_2' and 'w_2' having minimum and maximum values respectively are independent of temperature, and direction. In the case of rhombohedral calcite and sodium nitrate cleavage faces/29,30/, velocities of ordinary and extra ordinary light beams along [110] direction are equal and hence the direction was considered as the one corresponding to homogenity and isotropy. In the present case the values of n_2, a_2, b_2 and w_2 for different orientations and different quenching temperatures and room temperature attain extremum (minimum or maximum) values at A = 45°, i.e., along direction [110], on cleavage faces of these crystals or in general direction $\langle 111 \rangle$ for these crystals. Hence this direction can be considered to be similar to homogeneous and isotropic direction.

In accordance with the above discussions the statements of Kick's law and modified Kick's law should be as follows :

Statement of Kick's Law :

When a crystal face (cleavage face or growth face free from major features or a synthetic polished face) of low indices is statically indented by a pyramidal indenter (Vickers or Knoop) under applied load 'P', a pyramidal indentation with a well defined geometrical shape on surface (square or rhombus) is obtained. The relation between the applied load 'P' and the indentation dimension 'd' is given by

$$P = ad^n$$

where 'n' and 'a' are constants of the material under consideration and 'd' is the average length of the diagonal in case of square. For rhombic shape 'd' is the major diagonal length.

Statement of modified Kick's Law :

Hays and Kendal modified the above statement as under :

The effective load which produces static indentation by a pyramidal indenter is (P - W) for which the variation is proportional to the square of the diagonal length of the indentation mark. In symbolic form it is given by :

$$P - W = bd^2$$

where b is a constant, characteristic of the material and 'W' is the Newtonian resistance pressure which do not allow plastic deformation.

The present analysis has convincingly shown that 'n' and 'a' in Kick's law or 'b' and 'W' in modified Kick's law are not simple constants characteristics of the material but are constants with a deep meaning. They depend on orientation of the pyramidal indenter with respect to a chosen direction on a crystal face and temperature. Hence the statement of these laws must include the above meaning. They can be stated as follows :

When a crystal face (cleavage face or growth face free from major features or a synthetic polished face) of low indices is statically indented by a pyramidal indenter (Vickers or Knoop) under applied load P, a pyramidal indentation with a well defined geometrical shape (square or rhombus) is obtained. The relation between the applied load P and the indentation dimension 'd' is given by

$$P = ad^n$$

where 'd' is the average length of diagonal in the case of square shape. For rhombic shape it is the major diagonal length. 'n' and 'a' are direction and temperature - dependant anisotropic constants and that there is at least one crystallographic direction on the crystal face under consideration in the crystal or corresponding general direction along which 'n' has a minimum value around 2 and 'a' has a maximum value; 'a' can be considered as the index of softness. The above statement of modified Kick's law can also be rewritten as follows :

The effective load which produces static indentation by a pyramidal indenter (Vickers or Knoop) is (P - W) for which the variation is proportional to the square of the diagonal length of the indentation mark. In symbolic form it is given by

$$P - W = bd^2$$

where b and W are direction - and temperature - dependant anisotropic constants and there is at least one crystallographic direction on the crystal face under consideration or a corresponding general direction in the crystal along which 'b' has a minimum value and 'W' has a maximum value.

4.4.4 Mechanical Response of NaCl, KCl and KBr

It is shown above that the direction [110] should be selected as a reference direction instead of direction [100] on a cleavage face of NaCl, KCl and KBr. Accordingly the quantities $(n_1/n_{1o}, a_1/a_{1o})$, $(n_2/n_{2o}, a_2/a_{2o})$ and $(b_2/b_{2o}, w_2/w_{2o})$ were calculated. These quantities are temperature - dependant anisotropic quantities. Instead of representing them as, say n_1/n_{1o}, it is desirable to determine the percentage difference of say $(n_1 - n_{1o})$ divided by n_{1o} i.e. $(n_1/n_{1o} - 1) \times 100$ % should be calculated. This makes the comparative study easier and more meaningful. Hence

$$\left(\frac{n_1 - n_{1o}}{n_{1o}} \times 100\right)$$ etc. are calculated for

different 'A's' and T_q's. It is interesting to compare the plasticity of NaCl and KCl in which anions are identical whereas cations (Na^+ and K^+) are different. All these crystals exhibit six-fold coordination. Further ion-size ratio of a crystal defined as a ratio of crystal radius of cation (r+) to crystal radius of anion (r-) is (r+/r-) = (0.118/0.165) = 0.715 for NaCl whereas for KCl it is (r+/r-) = (0.150/0.165) = 0.8187. Hence ratio of $(r+/r-)_{KCl}$ to $(r+/r-)_{NaCl}$ is (0.8187/0.7151) = 1.14 . It is well-known that a coordination number 6 occurs when 0.732 > r+/r- > 0.414 i.e., when the ion-size ratio is greater than 0.7327 or less than 0.414, the fcc structure gets distorted. For NaCl, the ion-size ratio is 0.7151. Hence structurally NaCl is free from distortion. However for KCl, the above ratio is 0.8187 . KCl is having slightly intrinsic structural distortion. This behaviour should be reflected in the indentation studies of NaCl and KCl cleavage faces. Indentation produces plastic deformation. Hence for a given load, the diagonal length of the indentation mark should be an indication of plasticity of the face and crystal.

A careful comparison of P and d values for these crystals for different orientations and different quenching temperatures and room temperature shows that the diagonal length of the indented cleavage face of KCl (d_{KCl}) is always greater than the corresponding value for NaCl (d_{NaCl}) cleavage face. This is true for all applied loads and for all orientations at room temperature. Representative values of d_{KCl}/d_{NaCl} for a few applied loads and orientations are given in the table :

Applied load P in gm	d_{KCl}/d_{NaCl} Orientations 0°	40°	50°	60°
10	1.472	1.489	1.485	1.492
20	1.393	1.524	1.510	1.479
30	1.406	1.472	1.510	1.465
60	1.422	1.442	1.419	1.462
140	1.419	1.489	1.489	1.428

Further about 45° orientation, (d_{KCl}/d_{NaCl}) has a maximum value because this happens to be the direction [110] or a direction in the family ⟨110⟩ . This clearly indicates that the intrinsic plasticity of KCl is greater than that of NaCl. Further this plasticity arises due to K^+ ions in the crystal lattice. This also suggests that the above consideration should be applicable to the study of mechanical response of indented cleavage surfaces of

i. KCl and KBr

ii. KBr and NaCl.

The data for the above crystals is given below in a tabular form :

Radius of Ions in nm.				Ion-size ratio			Ratio of	
r+		r-		m	n	o		
Na^+	K^+	Cl^-	Br^-	KCl	KBr	NaCl	m/n	n/o
0.118	0.150	0.165	0.181	0.8187	0.8087	0.7151	1.012	1.130

For KCl and KBr crystals, cations are identical but anions are different and ionic radius of chlorine is less than that of bromine.

The representive values of applied loads and d_{KBr}/d_{KCl} for different orientations are shown below :

Applied load	d_{KBr}/d_{KCl} Orientations			
P in gm	0°	40°	50°	60°
10	1.006	1.016	1.018	1.002
20	1.113	0.893	0.909	1.032
30	1.101	1.030	1.030	1.086
60	1.104	1.066	0.957	1.064
140	1.126	1.086	1.035	1.108

The above table clearly shows that cleavage face of KBr crystal is more plastic than that of KCl. Obviously this is due to the fact that size of Br^- ion is greater than that of Cl^-. Thus intrinsic plasticity of cleavage face of KBr is greater than that of KCl.

For KBr and NaCl crystals, cations and anions are different. Since the ratio of $(r+/r-)_{KBr}$: $(r+/r-)_{NaCl}$ is 1.13, i.e., KBr crystal is more plastic than NaCl due to the fact that radius of K^+ is greater than that of Na^+ and also radius of Br^- is greater than that of Cl^-. This conjecture should be supported by the indentation studies of cleavage faces of KBr and NaCl. The representative values of d_{KBr}/d_{NaCl} for different applied loads and different orientations are given below :

Applied load P in gm	d_{KBr}/d_{NaCl} Orientations 0°	40°	50°	60°
10	1.482	1.513	1.513	1.496
20	1.548	1.361	1.374	1.527
30	1.548	1.517	1.100	1.101
60	1.570	1.538	1.531	1.555
140	1.598	1.618	1.442	1.577

It is thus clear from the comparative study of indented cleavage faces of NaCl, KCl and KBr that intrinsic plasticity of KBr cleavages is the maximum whereas that of NaCl is minimum and that plasticity of KCl is in between these crystals. This depends on the coordination number of the crystal structure.

This number is influenced by ion-size ratio. For KCl and NaCl, radius of K^+ and for KCl and KBr, the radius of Br^- play a dominant role. It is also clear from KBr and NaCl that even when ions are different, consideration of ionic radii of cations and anions is important to decide plasticity of crystals.

4.5 CONCLUSIONS:

The following conclusions are drawn from the experimental study of variation of applied load with longer diagonal of the Knoop indentation mark for different orientations and quenching temperature :

(1) For all these three crystals the plot of log d Vs. log P consists of two clearly recognizable straight lines having different slopes (n_1 and n_2) and intercepts (a_1 and a_2) for low loads and high loads respectively. For a given load, 'n' and 'a' are connected in such a way that an increase of 'n' (n_1 or n_2) is always accompained by a decrease in 'a' (a_1 or a_2) and conversily.

(2) The variations in the exponents of 'd' can be eliminated by employing modified Kick's law - where the exponent is nearly equal to 2 and n_2 and a_2 is replaced by b_2 and W_2. This law is applicable only in HLR.

(3) n_1, a_1; n_2, a_2; b_2, W_2 have clear relation with orientation A at all quenching temperatures and room temperature. Along the direction [110] or in general $\langle 111 \rangle$ these quantities have extremum

values which are independent of orientation and temperature.

(4) For studying mechanical response of indented cleavage faces of NaCl, KCl and KBr single crystals, two anisotropic constants are necessary. They are $(n_1/n_{1o}, a_1/a_{1o})$ or $(n_2/n_{2o}, a_2/a_{2o})$ or $(b_2/b_{2o}, w_2/w_{2o})$.

(5) The mathematical analyses of the mechanical response of indented cleavage faces of NaCl, KCl and KBr based on the observations for applied load and indentation dimensions has shown the existence of intermediate load region (ILR) in addition to LLR and HLR.

(6) a_2 and b_2 depend on quenching temperature and follow the relations:

$$a_2 T_Q^{1-m_2} = \text{constant}$$

$$= a_2 T_Q^{k_2}$$

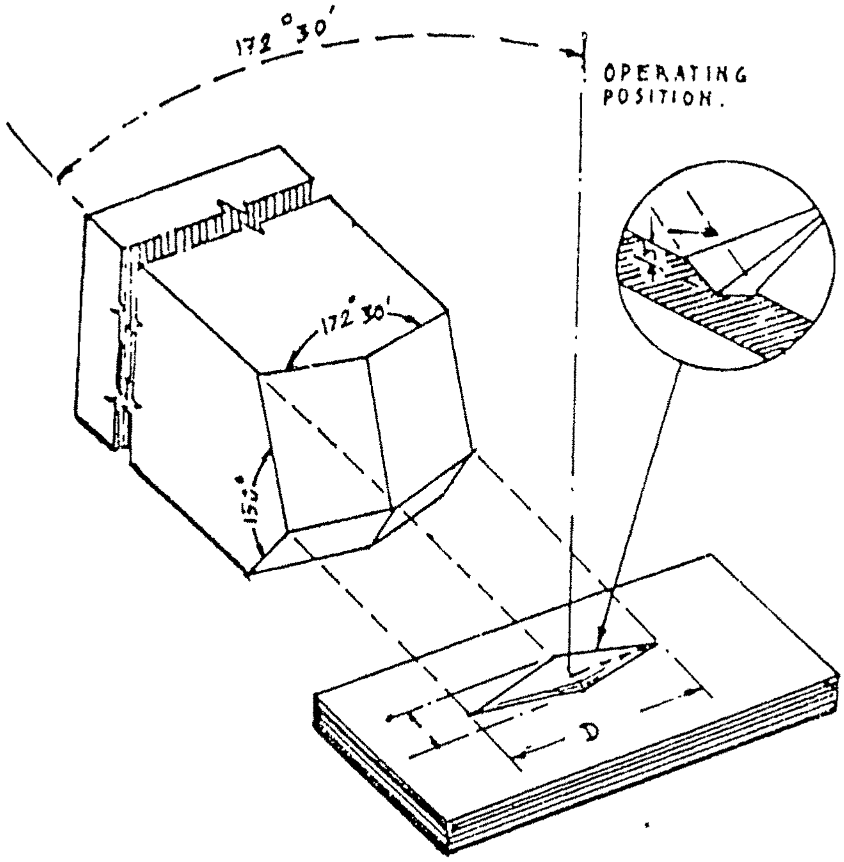
$$b_2 T_Q^{1-m_3} = \text{constant}$$

$$= b_2 T_Q^{k_3}$$

where k_2 and k_3 are negative and less than unity.

(7) The present analysis has clearly shown that the statement of Kick's law and modified Kick's law should be revised.

(8) Comparative study of indented cleavage faces of NaCl, KCl and KBr has clearly indicated that the plasticity of KBr is maximum whereas for NaCl is minimum amongst all the three crystals studied. This is found to be due to different sizes of anions and cations.



Some of the details of the Knoop indenter, together with its impression

Schematic diagram of the Knoop indenter and cylinder of deformation showing positions of force (F), slip direction (SD), slip plane (SP) and axes of rotation (AR and H)

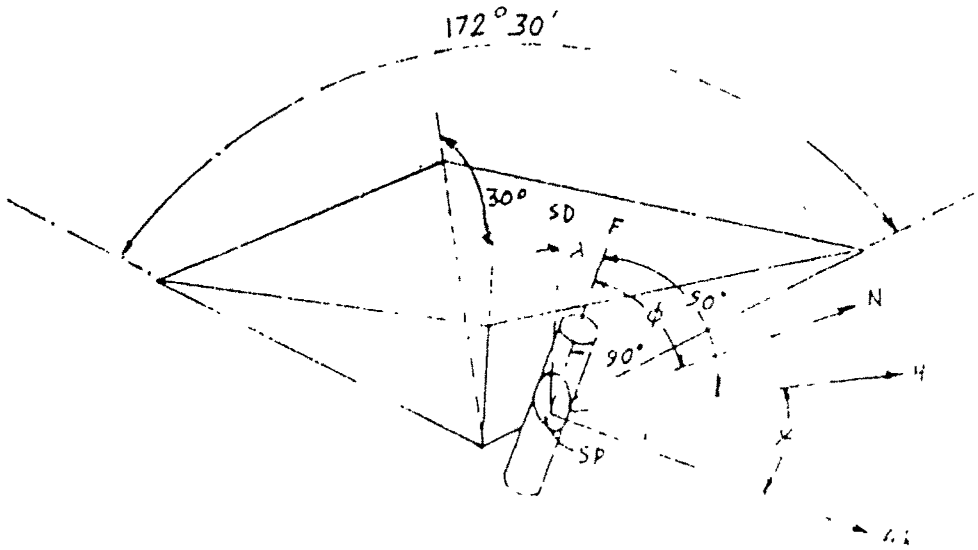


Fig 4·1

TABLE - 4.1 A(I)

FOR NaCl CRYSTALS

ROOM TEMPERATURE = 303°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.488	1.488	1.489	1.497	1.497	1.498	1.498	1.488	1.480	1.480
0.397	1.630	1.636	1.637	1.646	1.648	1.649	1.648	1.637	1.637	1.639
0.574	1.715	1.715	1.719	1.734	1.733	1.736	1.733	1.713	1.718	1.724
0.698	1.764	1.765	1.785	1.786	1.786	1.798	1.784	1.780	1.775	1.781
0.795	1.807	1.796	1.822	1.832	1.836	1.836	1.835	1.824	1.821	1.813
0.875	1.830	1.824	1.855	1.868	1.872	1.874	1.870	1.857	1.834	1.847
0.942	1.870	1.874	1.884	1.896	1.899	1.899	1.898	1.887	1.865	1.874
1.000	1.902	1.906	1.923	1.926	1.930	1.930	1.925	1.913	1.894	1.902
1.051	1.928	1.932	1.940	1.948	1.962	1.962	1.950	1.935	1.922	1.928
1.096	1.953	1.952	1.962	1.968	1.996	1.996	1.972	1.959	1.951	1.951
1.138	1.978	1.974	1.984	1.983	2.018	2.017	1.990	1.983	1.992	1.973
1.176	2.016	2.012	2.014	2.019	2.031	2.032	2.014	2.015	2.001	1.997
1.210	2.027	2.030	2.037	2.033	2.049	2.049	2.033	2.036	2.030	2.028
1.243	2.040	2.047	2.058	2.052	2.071	2.070	2.051	2.056	2.047	2.042
1.273	2.060	2.068	2.072	2.073	2.086	2.085	2.073	2.072	2.067	2.058
1.301	2.079	2.055	2.078	2.087	2.106	2.102	2.086	2.086	2.085	2.074
1.397	2.126	2.129	2.136	2.137	2.158	2.157	2.137	2.136	2.129	2.136
1.477	2.170	2.165	2.177	2.178	2.199	2.198	2.178	2.176	2.166	2.170
1.602	2.232	2.236	2.238	2.245	2.260	2.262	2.248	2.238	2.235	2.233
1.698	2.280	2.286	2.289	2.298	2.310	2.312	2.296	2.289	2.276	2.282
1.778	2.318	2.320	2.331	2.338	2.353	2.355	2.338	2.331	2.328	2.319
1.845	2.355	2.349	2.363	2.371	2.384	2.387	2.371	2.361	2.353	2.355
1.903	2.382	2.383	2.388	2.400	2.413	2.418	2.402	2.391	2.382	2.382
2.00	2.430	2.429	2.448	2.454	2.464	2.468	2.455	2.447	2.430	2.430
2.041	2.448	2.459	2.468	2.472	2.486	2.498	2.481	2.468	2.457	2.448
2.079	2.470	2.476	2.483	2.489	2.508	2.509	2.499	2.483	2.481	2.471
2.146	2.500	2.511	2.520	2.553	2.541	2.542	2.523	2.522	2.511	2.500
2.204	2.530	2.542	2.550	2.552	2.572	2.571	2.552	2.551	2.541	2.530

TABLE - 4.1 A(II)

FOR NaCl CRYSTALS

QUENCHING TEMPERATURE = 473°K

Log P	log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.405	1.495	1.497	1.500	1.504	1.502	1.498	1.497	1.494	1.494
0.397	1.635	1.637	1.648	1.649	1.653	1.652	1.649	1.647	1.641	1.637
0.574	1.724	1.724	1.726	1.733	1.736	1.736	1.733	1.729	1.724	1.722
0.698	1.774	1.778	1.784	1.786	1.798	1.796	1.789	1.786	1.778	1.774
0.795	1.811	1.818	1.828	1.831	1.835	1.836	1.835	1.826	1.821	1.813
0.875	1.840	1.840	1.850	1.863	1.868	1.870	1.872	1.863	1.861	1.845
0.942	1.860	1.862	1.872	1.884	1.880	1.880	1.876	1.870	1.862	1.860
1.000	1.882	1.903	1.913	1.906	1.916	1.916	1.905	1.905	1.903	1.886
1.051	1.917	1.927	1.935	1.930	1.938	1.938	1.930	1.930	1.925	1.972
1.096	1.942	1.951	1.957	1.957	1.974	1.963	1.957	1.953	1.951	1.944
1.138	1.972	1.974	1.990	1.994	1.997	1.997	1.991	1.989	1.975	1.969
1.176	1.990	1.994	2.007	2.014	2.019	2.016	2.014	2.005	1.997	1.990
1.210	2.006	2.018	2.028	2.017	2.031	2.036	2.030	2.028	2.018	2.010
1.243	2.038	2.034	2.045	2.045	2.060	2.057	2.045	2.046	2.034	2.034
1.273	2.059	2.051	2.061	2.061	2.077	2.078	2.061	2.061	2.052	2.052
1.301	2.275	2.076	2.076	2.076	2.089	2.092	2.076	2.076	2.073	2.075
1.397	2.149	2.125	2.129	2.125	2.147	2.147	2.126	2.129	2.129	2.123
1.477	2.163	2.164	2.173	2.173	2.190	2.188	2.177	2.175	2.164	2.163
1.602	2.225	2.224	2.239	2.238	2.253	2.255	2.240	2.238	2.227	2.227
1.698	2.271	2.275	2.284	2.288	2.306	2.306	2.288	2.286	2.275	2.275
1.778	2.313	2.315	2.326	2.329	2.343	2.345	2.371	2.328	2.316	2.313
1.845	2.341	2.349	2.361	2.361	2.381	2.381	2.361	2.363	2.355	2.341
1.903	2.366	2.382	2.388	2.399	2.410	2.410	2.399	2.382	2.386	2.376
2.000	2.423	2.429	2.473	2.451	2.457	2.459	2.454	2.439	2.437	2.423
2.041	2.448	2.459	2.466	2.469	2.479	2.482	2.474	2.463	2.461	2.446
2.079	2.468	2.480	2.485	2.494	2.500	2.500	2.494	2.485	2.482	2.471
2.146	2.497	2.511	2.524	2.534	2.536	2.534	2.529	2.522	2.523	2.512
2.204	2.534	2.528	2.554	2.563	2.564	2.563	2.563	2.556	2.541	2.534

TABLE - 4.1 A(III)

(FOR NaCl)

QUENCHING TEMPERATURE T_q = 573°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.094	1.467	1.473	1.473	1.485	1.485	1.479	1.473	1.473	1.467	1.467
0.397	1.610	1.610	1.601	1.614	1.614	1.635	1.614	1.614	1.607	1.610
0.574	1.682	1.689	1.697	1.711	1.711	1.697	1.689	1.675	1.682	1.675
0.698	1.731	1.717	1.731	1.753	1.775	1.753	1.737	1.731	1.731	1.717
0.795	1.769	1.769	1.772	1.772	1.814	1.814	1.772	1.772	1.769	1.769
0.875	1.830	1.814	1.814	1.814	1.835	1.835	1.833	1.815	1.814	1.830
0.942	1.670	1.861	1.846	1.856	1.856	1.873	1.873	1.846	1.840	1.868
1.000	1.902	1.902	1.903	1.875	1.905	1.905	1.875	1.907	1.902	1.902
1.051	1.928	1.928	1.911	1.930	1.930	1.930	1.932	1.920	1.928	1.913
1.096	1.957	1.955	1.955	1.960	1.962	1.952	1.953	1.958	1.957	1.953
1.138	1.974	1.976	1.972	1.978	1.981	1.979	1.979	1.972	1.976	1.976
1.176	1.990	1.990	1.989	1.996	1.994	1.998	1.994	1.990	1.992	1.987
1.210	2.013	2.012	2.012	2.018	2.018	2.022	2.015	2.013	2.008	2.008
1.243	2.048	2.042	2.045	2.048	2.051	2.048	2.049	2.042	2.040	2.042
1.273	2.054	2.051	2.057	2.059	2.057	2.060	2.060	2.054	2.056	2.054
1.301	2.073	2.074	2.073	2.076	2.076	2.077	2.077	2.074	2.074	2.073
1.397	2.123	2.121	2.126	2.126	2.129	2.131	2.131	2.126	2.177	2.171
1.477	2.152	2.149	2.149	2.167	2.166	2.167	2.166	2.154	2.149	2.152
1.602	2.225	2.225	2.224	2.224	2.227	2.226	2.226	2.221	2.221	2.223
1.698	2.271	2.275	2.227	2.277	2.279	2.279	2.276	2.275	2.269	2.269
1.778	2.313	2.311	2.311	2.310	2.313	2.315	2.315	2.311	2.311	2.313
1.845	2.347	2.349	2.347	2.351	2.362	2.363	2.352	2.351	2.349	2.346
1.903	2.375	2.375	2.380	2.378	2.391	2.391	2.378	2.378	2.375	2.375
2.000	2.426	2.423	2.423	2.426	2.437	2.438	2.428	2.424	2.423	2.423
2.041	2.448	2.452	2.450	2.454	2.478	2.479	2.454	2.455	2.450	2.450
2.079	2.465	2.465	2.467	2.466	2.492	2.492	2.466	2.469	2.469	2.470
2.146	2.496	2.496	2.498	2.497	2.522	2.522	2.499	2.490	2.494	2.494
2.204	2.531	2.534	2.535	2.537	2.538	2.538	2.538	2.535	2.532	2.533

TABLE - 4.1 A(IV)

(FOR NaCl)

QUENCHING TEMPERATURE T_q = 673°K

Log P	<── Log d ──>									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.096	1.440	1.440	1.460	1.470	1.480	1.480	1.470	1.460	1.460	1.440
0.397	1.560	1.560	1.560	1.560	1.580	1.580	1.560	1.570	1.570	1.560
0.574	1.660	1.660	1.660	1.670	1.680	1.680	1.690	1.670	1.660	1.640
0.698	1.710	1.710	1.720	1.720	1.720	1.720	1.710	1.710	1.710	1.700
0.798	1.770	1.770	1.780	1.780	1.790	1.790	1.780	1.780	1.770	1.760
0.875	1.820	1.820	1.830	1.830	1.840	1.840	1.830	1.830	1.820	1.820
0.942	1.850	1.850	1.860	1.860	1.870	1.870	1.860	1.860	1.850	1.850
1.000	1.890	1.890	1.900	1.900	1.910	1.910	1.900	1.890	1.890	1.890
1.051	1.920	1.920	1.930	1.940	1.930	1.930	1.930	1.940	1.920	1.920
1.096	1.957	1.957	1.960	1.962	1.964	1.966	1.962	1.960	1.953	1.957
1.138	1.968	1.974	1.976	1.976	1.978	1.981	1.981	1.974	1.976	1.968
1.176	1.990	1.987	1.994	1.996	1.994	1.995	1.990	1.994	1.987	1.990
1.210	2.012	2.012	2.017	2.017	2.018	2.020	2.015	2.012	2.015	2.012
1.243	2.048	2.042	2.042	2.043	2.045	2.045	2.045	2.045	2.042	2.043
1.273	2.060	2.060	2.057	2.063	2.065	2.065	2.060	2.057	2.059	2.054
1.301	2.065	2.070	2.067	2.067	2.070	2.076	2.077	2.070	2.067	2.063
1.397	2.105	2.119	2.118	2.123	2.123	2.121	2.118	2.118	2.118	2.105
1.477	2.149	2.149	2.154	2.155	2.155	2.127	2.154	2.149	2.147	2.147
1.602	2.211	2.221	2.219	2.223	2.223	2.225	2.223	2.217	2.217	2.215
1.698	2.255	2.269	2.272	2.275	2.276	2.276	2.273	2.245	2.241	2.268
1.778	2.296	2.304	2.304	2.307	2.320	2.320	2.311	2.309	2.306	2.302
1.845	2.339	2.338	2.339	2.339	2.353	2.353	2.344	2.343	2.338	2.295
1.903	2.368	2.369	2.371	2.375	2.374	2.371	2.371	2.369	2.368	2.368
2.000	2.418	2.419	2.416	2.423	2.426	2.426	2.424	2.423	2.422	2.419
2.041	2.436	2.446	2.448	2.450	2.450	2.452	2.451	2.448	2.445	2.448
2.079	2.465	2.465	2.466	2.469	2.469	2.469	2.467	2.467	2.469	2.466
2.146	2.493	2.496	2.497	2.498	2.498	2.496	2.493	2.493	2.491	2.491
2.204	2.527	2.527	2.529	2.530	2.531	2.531	2.531	2.527	2.527	2.528

TABLE - 4.1 A(V)

(FOR NaCl)

QUENCHING TEMPERATURE T_q = 773°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.096	1.430	1.440	1.440	1.440	1.460	1.460	1.440	1.430	1.430	1.430
0.397	1.560	1.560	1.590	1.620	1.630	1.630	1.620	1.600	1.590	1.580
0.574	1.600	1.670	1.690	1.690	1.710	1.710	1.700	1.700	1.680	1.660
0.698	1.770	1.720	1.740	1.750	1.750	1.760	1.740	1.740	1.720	1.720
0.795	1.760	1.770	1.780	1.790	1.800	1.800	1.790	1.790	1.780	1.770
0.895	1.810	1.820	1.830	1.840	1.850	1.860	1.850	1.840	1.840	1.830
0.942	1.860	1.860	1.880	1.880	1.880	1.880	1.880	1.870	1.870	1.860
1.000	1.880	1.890	1.900	1.900	1.900	1.910	1.900	1.900	1.890	1.890
1.051	1.920	1.920	1.930	1.940	1.940	1.920	1.920	1.920	1.910	1.910
1.096	1.945	1.949	1.949	1.953	1.953	1.953	1.945	1.949	1.945	1.943
1.138	1.972	1.972	1.976	1.978	1.978	1.979	1.972	1.974	1.976	1.968
1.176	1.989	1.987	1.987	1.994	1.990	1.994	1.994	1.990	1.989	1.989
1.210	2.008	2.008	2.012	2.013	2.013	2.012	2.005	2.006	2.003	2.008
1.243	2.031	2.035	2.033	2.038	2.038	2.040	2.038	2.035	2.037	2.035
1.273	2.034	2.054	2.054	2.060	2.057	2.060	2.060	2.057	2.034	2.034
1.301	2.052	2.067	2.067	2.073	2.073	2.074	2.073	2.067	2.073	2.048
1.397	2.098	2.106	2.113	2.113	2.121	2.121	2.118	2.114	2.115	2.100
1.477	2.152	2.149	2.150	2.154	2.155	2.157	2.157	2.150	2.153	2.149
1.602	2.204	2.212	2.212	2.214	2.219	2.219	2.214	2.214	2.215	2.204
1.698	2.234	2.252	2.269	2.275	2.275	2.277	2.275	2.276	2.272	2.249
1.778	2.321	2.302	2.304	2.304	2.307	2.308	2.304	2.304	2.302	2.286
1.845	2.341	2.329	2.339	2.341	2.343	2.344	2.344	2.341	2.341	2.318
1.903	2.350	2.350	2.374	2.374	2.373	2.373	2.374	2.369	2.369	2.348
2.000	2.399	2.413	2.424	2.423	2.424	2.423	2.422	2.422	2.419	2.399
2.041	2.422	2.432	2.443	2.443	2.446	2.446	2.444	2.443	2.443	2.421
2.079	2.453	2.453	2.405	2.469	2.469	2.466	2.467	2.467	2.465	2.454
2.146	2.483	2.483	2.493	2.493	2.496	2.496	2.496	2.494	2.493	2.482
2.204	2.527	2.526	2.527	2.530	2.529	2.530	2.530	2.528	2.528	2.526

TABLE - 4.1 A(VI)

(FOR NaCl)

QUENCHING TEMPERATURE T_q = 873°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.096	1.390	1.400	1.400	1.420	1.430	1.420	1.400	1.400	1.390	1.390
0.397	1.550	1.560	1.560	1.560	1.570	1.570	1.560	1.560	1.550	1.550
0.574	1.640	1.640	1.640	1.650	1.660	1.670	1.640	1.640	1.640	1.640
0.698	1.700	1.700	1.710	1.720	1.720	1.730	1.720	1.710	1.700	1.700
0.795	1.750	1.760	1.770	1.780	1.790	1.790	1.780	1.780	1.760	1.760
0.875	1.800	1.810	1.820	1.830	1.840	1.840	1.830	1.820	1.800	1.800
0.942	1.850	1.860	1.860	1.870	1.880	1.880	1.870	1.870	1.850	1.850
1.000	1.870	1.880	1.880	1.890	1.910	1.910	1.900	1.890	1.880	1.870
1.051	1.890	1.900	1.900	1.910	1.920	1.930	1.910	1.900	1.890	1.890
1.096	1.910	1.920	1.930	1.930	1.940	1.940	1.930	1.920	1.920	1.910
1.138	1.930	1.940	1.950	1.960	1.960	1.970	1.960	1.950	1.940	1.940
1.176	1.960	1.960	1.970	1.980	1.990	1.990	1.980	1.960	1.960	1.950
1.210	1.980	1.980	1.990	2.010	2.010	2.010	2.000	1.990	1.980	1.980
1.243	1.990	1.990	2.000	2.010	2.020	2.020	2.020	2.010	2.000	1.980
1.273	2.010	2.020	2.020	2.030	2.040	2.040	2.030	2.020	2.010	2.010
1.301	2.030	2.040	2.040	2.050	2.050	2.050	2.050	2.040	2.040	2.030
1.397	2.080	2.080	2.090	2.100	2.100	2.110	2.100	2.090	2.080	2.070
1.477	2.110	2.120	2.120	2.130	2.130	2.140	2.130	2.130	2.120	2.110
1.602	2.170	2.180	2.180	2.190	2.200	2.200	2.180	2.180	2.170	2.170
1.698	2.220	2.230	2.230	2.240	2.240	2.240	2.240	2.230	2.230	2.220
1.778	2.270	2.270	2.280	2.280	2.290	2.290	2.290	2.280	2.270	2.270
1.845	2.300	2.310	2.310	2.320	2.320	2.320	2.320	2.310	2.310	2.300
1.903	2.330	2.330	2.340	2.340	2.350	2.350	2.350	2.340	2.340	2.330
2.000	2.380	2.390	2.390	2.400	2.400	2.400	2.390	2.390	2.390	2.380
2.041	2.410	2.420	2.420	2.430	2.440	2.440	2.430	2.430	2.420	2.420
2.079	2.440	2.440	2.440	2.450	2.450	2.450	2.450	2.440	2.440	2.440
2.146	2.460	2.460	2.470	2.470	2.470	2.480	2.470	2.470	2.460	2.460
2.204	2.500	2.510	2.510	2.510	2.520	2.520	2.510	2.510	2.510	2.500

TABLE - 4.1 B(I)

(FOR KCl)

ROOM TEMPERATURE = 303°K

Log P	log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.096	1.623	1.623	1.626	1.639	1.664	1.664	1.648	1.626	1.625	1.623
0.397	1.756	1.756	1.773	1.793	1.798	1.798	1.791	1.791	1.757	1.758
0.574	1.841	1.883	1.843	1.864	1.887	1.887	1.864	1.844	1.841	1.847
0.698	1.909	1.916	1.926	1.931	1.954	1.956	1.933	1.932	1.914	1.903
0.795	1.964	1.955	1.972	1.980	1.995	1.997	1.981	1.975	1.955	1.958
0.875	2.001	2.011	2.037	2.036	2.038	2.038	2.037	2.037	2.015	2.003
0.942	2.048	2.043	2.050	2.067	2.076	2.076	2.065	2.051	2.048	2.048
1.000	2.070	2.075	2.082	2.103	2.103	2.102	2.099	2.082	2.075	2.067
1.051	2.104	2.123	2.127	2.127	2.127	2.127	2.127	2.121	2.121	2.104
1.096	2.129	2.138	2.147	2.152	2.156	2.158	2.150	2.147	2.138	2.129
1.138	2.149	2.150	2.152	2.174	2.177	2.177	2.172	2.171	2.159	2.138
1.176	2.154	2.171	2.179	2.194	2.202	2.202	2.194	2.187	2.171	2.165
1.210	2.181	2.189	2.197	2.208	2.220	2.218	2.208	2.195	2.183	2.181
1.243	2.194	2.198	2.203	2.215	2.242	2.242	2.213	2.206	2.211	2.194
1.273	2.216	2.213	2.218	2.232	2.261	2.261	2.232	2.214	2.213	2.216
1.301	2.223	2.227	2.247	2.257	2.289	2.281	2.256	2.250	2.227	2.223
1.397	2.273	2.275	2.296	2.305	2.338	2.338	2.305	2.294	2.275	2.276
1.472	2.318	2.323	2.340	2.352	2.367	2.377	2.344	2.344	2.339	2.318
1.602	2.381	2.410	2.423	2.415	2.425	2.426	2.421	2.404	2.390	2.381
1.698	2.428	2.452	2.457	2.466	2.472	2.467	2.463	2.456	2.446	2.428
1.778	2.471	2.491	2.666	2.506	2.512	2.507	2.503	2.491	2.491	2.471
1.845	2.500	2.525	2.531	2.647	2.559	2.559	2.547	2.530	2.524	2.503
1.903	2.530	2.554	2.557	2.603	2.587	2.586	2.603	2.576	2.554	2.530
2.000	2.580	2.601	2.606	2.631	2.633	2.631	2.631	2.606	2.602	2.580
2.041	2.601	2.617	2.619	2.644	2.647	2.643	2.644	2.619	2.617	2.601
2.079	2.621	2.635	2.640	2.664	2.667	2.667	2.663	2.640	2.635	2.618
2.146	2.652	2.673	2.673	2.727	2.714	2.715	2.698	2.677	2.673	2.654
2.204	2.687	2.703	2.705	2.727	2.744	2.744	2.724	2.724	2.706	2.691

TABLE - 4.1 B(II)

(FOR KCl)

QUENCHING TEMPERATURE = 473°K

Log P	<——— log d ———>									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.096	1.623	1.635	1.639	1.675	1.667	1.660	1.652	1.635	1.627	1.627
0.397	1.775	1.775	1.792	1.809	1.825	1.820	1.803	1.792	1.792	1.780
0.574	1.856	1.863	1.880	1.893	1.900	1.910	1.889	1.889	1.870	1.856
0.698	1.916	1.932	1.944	1.957	1.960	1.960	1.945	1.928	1.916	1.911
0.795	1.957	1.972	1.972	1.987	2.000	2.010	1.990	1.979	1.964	1.953
0.875	1.998	2.015	2.035	2.038	2.040	2.050	2.028	2.018	2.008	1.994
0.942	2.025	2.042	2.045	2.054	2.070	2.060	2.048	2.049	2.045	2.028
1.000	2.048	2.060	2.073	2.079	2.090	2.100	2.084	2.073	2.070	2.045
1.051	2.070	2.084	2.096	2.107	2.115	2.110	2.107	2.102	2.081	2.070
1.096	2.099	2.107	2.118	2.129	2.140	2.140	2.129	2.118	2.107	2.099
1.138	2.121	2.129	2.139	2.152	2.160	2.160	2.154	2.142	2.129	2.123
1.176	2.144	2.154	2.166	2.181	2.190	2.190	2.178	2.166	2.152	2.142
1.210	2.164	2.176	2.181	2.192	2.210	2.200	2.190	2.181	2.181	2.164
1.243	2.181	2.192	2.208	2.221	2.230	2.230	2.214	2.203	2.201	2.185
1.273	2.201	2.198	2.233	2.242	2.250	2.240	2.235	2.221	2.212	2.197
1.301	2.219	2.231	2.242	2.256	2.270	2.270	2.261	2.250	2.233	2.223
1.397	2.269	2.275	2.290	2.302	2.320	2.320	2.306	2.290	2.271	2.267
1.477	2.314	2.333	2.344	2.355	2.360	2.360	2.341	2.328	2.323	2.311
1.602	2.377	2.387	2.399	2.418	2.430	2.420	2.414	2.401	2.388	2.380
1.698	2.427	2.441	2.453	2.464	2.480	2.480	2.457	2.445	2.435	2.428
1.778	2.466	2.475	2.490	2.502	2.510	2.510	2.500	2.492	2.471	2.467
1.845	2.504	2.513	2.523	2.532	2.550	2.550	2.540	2.525	2.513	2.502
1.903	2.529	2.539	2.553	2.574	2.590	2.580	2.568	2.551	2.535	2.530
2.000	2.584	2.600	2.609	2.623	2.640	2.640	2.627	2.610	2.598	2.583
2.041	2.610	2.620	2.633	2.643	2.660	2.660	2.644	2.643	2.620	2.609
2.079	2.633	2.644	2.659	2.668	2.680	2.680	2.666	2.659	2.648	2.638
2.146	2.669	2.683	2.697	2.711	2.720	2.720	2.711	2.702	2.686	2.668
2.204	2.701	2.709	2.718	2.738	2.760	2.750	2.737	2.717	2.711	2.700

TABLE - 4.1 B(III)

(FOR KCl)

QUENCHING TEMPERATURE = 573°K

Log P	log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.605	1.627	1.645	1.649	1.651	1.651	1.650	1.648	1.630	1.604
0.397	1.755	1.770	1.769	1.784	1.800	1.800	1.783	1.769	1.770	1.755
0.574	1.841	1.843	1.859	1.872	1.875	1.876	1.872	1.859	1.842	1.841
0.698	1.906	1.911	1.927	1.931	1.936	1.936	1.931	1.937	1.911	1.906
0.795	1.945	1.951	1.956	1.971	1.977	1.977	1.971	1.956	1.950	1.945
0.875	1.982	1.996	2.012	2.014	2.970	2.018	2.014	2.013	1.996	1.982
0.942	2.008	2.020	2.023	2.050	2.045	2.047	2.049	2.023	2.020	2.009
1.000	2.037	2.043	2.051	2.059	2.067	2.067	2.060	2.052	2.043	2.037
1.051	2.058	2.065	2.078	2.087	2.096	2.097	2.097	2.086	2.078	2.058
1.096	2.080	2.088	2.098	2.111	2.117	2.118	2.110	2.098	2.087	2.080
1.138	2.102	2.110	2.119	2.142	2.140	2.139	2.140	2.138	2.111	2.102
1.176	2.127	2.134	2.146	2.158	2.167	2.166	2.157	2.146	2.134	2.128
1.210	2.150	2.154	2.160	2.171	2.182	2.184	2.171	2.159	2.154	2.151
1.243	2.160	2.172	2.185	2.198	2.202	2.202	2.200	2.184	2.172	2.160
1.273	2.283	2.191	2.211	2.217	2.223	2.223	2.217	2.211	2.191	2.184
1.301	2.199	2.210	2.217	2.230	2.241	2.242	2.230	2.216	2.191	2.199
1.397	2.248	2.254	2.267	2.276	2.291	2.291	2.276	2.427	2.267	2.248
1.477	2.293	2.307	2.315	2.326	2.335	2.338	2.328	2.315	2.307	2.293
1.602	2.354	2.360	2.377	2.389	2.396	2.396	2.388	2.379	2.360	2.354
1.698	2.408	2.420	2.428	2.437	2.440	2.446	2.436	2.428	2.420	2.408
1.778	2.447	2.460	2.468	2.476	2.486	2.486	2.476	2.468	2.460	2.448
1.845	2.483	2.491	2.500	2.506	2.525	2.524	2.567	2.500	2.492	2.483
1.903	2.508	2.518	2.528	2.546	2.559	2.560	2.546	2.528	2.518	2.508
2.000	2.557	2.576	2.584	2.595	2.605	2.606	2.595	2.582	2.576	2.552
2.041	2.588	2.596	2.612	2.599	2.631	2.632	2.599	2.611	2.599	2.588
2.079	2.611	2.624	2.620	2.641	2.652	2.652	2.643	2.619	2.623	2.611
2.146	2.647	2.656	2.663	2.681	2.691	2.691	2.679	2.663	2.656	2.647
2.204	2.677	2.688	2.693	2.702	2.721	2.722	2.703	2.693	2.688	2.677

TABLE - 4.1 B(IV)

(FOR KCL)

QUENCHING TEMPERATURE = 673°K

Log P	<———— log d ————>									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.588	1.605	1.621	1.625	1.628	1.628	1.625	1.622	1.605	1.588
0.397	1.736	1.748	1.746	1.764	1.776	1.777	1.764	1.746	1.748	1.736
0.574	1.824	1.826	1.839	1.849	1.850	1.850	1.849	1.839	1.827	1.824
0.698	1.886	1.891	1.906	1.911	1.922	1.922	1.910	1.906	1.891	1.886
0.795	1.930	1.932	1.939	1.949	1.957	1.957	1.949	1.959	1.931	1.931
0.875	1.964	1.975	1.990	1.994	1.998	1.998	1.993	1.990	1.976	1.964
0.942	1.990	2.000	2.004	2.031	2.024	2.045	2.032	2.004	2.000	1.990
1.000	2.020	2.025	2.033	2.040	2.047	2.046	2.040	2.033	2.076	2.019
1.051	2.044	2.049	2.059	2.068	2.075	2.075	2.068	2.059	2.048	2.043
1.096	2.063	2.071	2.080	2.093	2.097	2.097	2.093	2.097	2.071	2.063
1.138	2.084	2.093	2.101	2.111	2.119	2.119	2.111	2.101	2.093	2.084
1.176	2.109	2.116	2.125	2.137	2.146	2.146	2.137	2.125	2.115	2.109
1.210	2.131	2.134	2.140	2.145	2.161	2.162	2.145	2.140	2.133	2.131
1.243	2.142	2.152	2.165	2.179	2.180	2.180	2.199	2.165	2.152	2.142
1.273	2.163	2.172	2.180	2.196	2.200	2.200	2.197	2.180	2.173	2.163
1.301	2.179	2.187	2.196	2.209	2.217	2.218	2.209	2.196	2.187	2.179
1.397	2.227	2.235	2.247	2.258	2.268	2.268	2.258	2.247	2.235	2.228
1.477	2.273	2.287	2.296	2.302	2.310	2.310	2.302	2.296	2.287	2.273
1.602	2.335	2.338	2.358	2.366	3.373	2.372	2.366	2.358	2.338	2.335
1.698	2.387	2.398	2.408	2.414	2.426	2.426	2.413	2.408	2.398	2.386
1.778	2.426	2.438	2.446	2.454	2.465	2.465	2.454	2.446	2.438	2.426
1.845	2.466	2.470	2.480	2.489	2.501	2.502	2.480	2.480	2.470	2.466
1.903	2.495	2.499	2.509	2.518	2.530	2.531	2.518	2.509	2.499	2.495
2.000	2.538	2.552	2.563	2.572	2.581	2.582	2.572	2.563	2.552	2.538
2.041	2.566	2.577	2.589	2.578	2.605	2.605	2.579	2.590	2.578	2.566
2.079	2.588	2.607	2.598	2.617	2.627	2.626	2.616	2.599	2.602	2.588
2.146	2.626	2.635	2.640	2.655	2.664	2.664	2.655	2.641	2.635	2.646
2.204	2.655	2.667	2.671	2.680	2.695	2.695	2.680	2.671	2.667	2.655

TABLE - 4.1 B(V)

(FOR KCl)

QUENCHING TEMPERATURE = 773°K

Log P	log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.572	1.588	1.599	1.605	1.609	1.609	1.605	1.599	1.588	1.572
0.397	1.720	1.729	1.729	1.746	1.757	1.759	1.746	1.730	1.730	1.731
0.574	1.807	1.808	1.820	1.832	1.844	1.844	1.832	1.819	1.807	1.807
0.698	1.870	1.871	1.886	1.892	1.901	1.901	1.891	1.886	1.871	1.570
0.795	1.915	1.910	1.923	1.951	1.939	1.939	1.950	1.923	1.910	1.915
0.875	1.949	1.957	1.970	1.975	1.980	1.981	1.974	1.970	1.958	1.950
0.942	1.975	1.987	1.988	2.016	2.004	2.004	2.015	1.998	1.987	1.974
1.000	2.005	2.008	2.016	2.022	2.027	2.027	2.022	2.016	2.008	2.006
1.051	2.030	2.032	2.041	2.051	2.055	2.055	2.052	2.041	2.032	2.031
1.096	2.049	2.053	2.063	2.074	2.077	2.077	2.075	2.063	2.053	2.049
1.138	2.067	2.076	2.083	2.092	2.099	2.099	2.092	2.083	2.076	2.067
1.176	2.092	2.097	2.109	2.117	2.127	2.127	2.117	2.109	2.097	2.092
1.210	2.116	2.116	2.125	2.128	2.144	2.144	2.128	2.125	2.116	2.116
1.243	2.125	2.133	2.147	2.161	2.166	2.166	2.147	2.146	2.150	2.126
1.273	2.147	2.153	2.163	2.178	2.182	2.182	2.178	2.163	2.153	2.146
1.301	2.162	2.170	2.177	2.190	2.198	2.198	2.190	2.178	2.170	2.162
1.397	2.209	2.218	2.225	2.239	2.246	2.246	2.239	2.224	2.219	2.209
1.477	2.255	2.269	2.276	2.283	2.289	2.288	2.289	2.276	2.269	2.255
1.602	2.317	2.321	2.338	2.344	2.352	2.351	2.344	2.338	2.320	2.317
1.698	2.369	2.380	2.389	2.392	2.406	2.405	2.392	2.389	2.380	2.369
1.778	2.408	2.420	2.426	2.433	2.443	2.445	2.432	2.427	2.420	2.408
1.845	2.448	2.452	2.459	2.464	2.481	2.480	2.464	2.459	2.452	2.448
1.903	2.474	2.479	2.488	2.500	2.516	2.517	2.500	2.488	2.478	2.474
2.000	2.521	2.532	2.542	2.551	2.561	2.562	2.550	2.542	2.531	2.520
2.041	2.547	2.558	2.564	2.560	2.583	2.584	2.560	2.564	2.557	2.547
2.079	2.570	2.579	2.579	2.598	2.604	2.605	2.598	2.579	2.579	2.570
2.146	2.605	2.615	2.621	2.631	2.642	2.642	2.631	2.620	2.616	2.605
2.204	2.635	2.647	2.651	2.659	2.671	2.671	2.659	2.651	2.647	2.634

TABLE -4.1 B(VI)

(FOR KCl)

QUENCHING TEMPERATURE = 873°K

Log P	<——— log d ———>									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.554	1.568	1.580	1.586	1.597	1.596	1.586	1.579	1.569	1.554
0.397	1.702	1.718	1.711	1.726	1.738	1.739	1.726	1.711	1.718	1.702
0.574	1.793	1.793	1.793	1.799	1.814	1.824	1.824	1.814	1.793	1.793
0.698	1.854	1.855	1.866	1.873	1.882	1.882	1.873	1.866	1.855	1.854
0.795	1.890	1.911	1.907	1.931	1.923	1.923	1.930	1.915	1.911	1.890
0.875	1.932	1.943	1.952	1.957	1.961	1.961	1.957	1.952	1.942	1.932
0.942	1.961	1.971	1.971	2.000	1.986	1.986	1.999	1.972	1.971	1.961
1.000	1.992	1.994	1.999	2.006	2.010	2.010	2.006	1.999	1.993	1.992
1.051	2.015	2.018	2.025	2.038	2.037	2.037	2.038	2.026	2.018	2.015
1.096	2.057	2.045	2.047	2.059	2.061	2.061	2.059	2.047	2.045	2.037
1.138	2.055	2.064	2.066	2.079	2.081	2.081	2.079	2.066	2.064	2.055
1.176	2.076	2.081	2.091	2.099	2.112	2.110	2.099	2.092	2.082	2.077
1.210	2.102	2.101	2.109	2.110	2.126	2.125	2.126	2.109	2.101	2.102
1.243	2.112	2.115	2.132	2.143	2.147	2.147	2.143	2.132	2.115	2.112
1.273	2.137	2.136	2.146	2.159	2.163	2.164	2.159	2.146	2.136	2.132
1.301	2.146	2.155	2.161	2.170	2.179	2.179	2.173	2.162	2.155	2.145
1.397	2.193	2.202	2.207	2.221	2.228	2.228	2.221	2.207	2.202	2.193
1.477	2.238	2.249	2.258	2.264	2.269	2.269	2.264	2.258	2.249	2.237
1.602	2.300	2.304	2.320	2.325	2.331	2.331	2.325	2.320	2.304	2.299
1.698	2.353	2.363	2.371	2.374	2.387	2.387	2.374	2.371	2.362	2.352
1.778	2.392	2.403	2.409	2.412	2.421	2.421	2.413	2.409	2.403	2.392
1.845	2.434	2.435	2.442	2.448	2.461	2.461	2.448	2.442	2.435	2.434
1.903	2.459	2.463	2.470	2.481	2.494	2.494	2.481	2.470	2.463	2.459
2.000	2.504	2.513	2.523	2.530	2.552	2.552	2.530	2.523	2.513	2.503
2.041	2.532	2.540	2.544	2.546	2.563	2.564	2.546	2.544	2.540	2.532
2.079	2.552	2.561	2.561	2.580	2.583	2.583	2.580	2.561	2.562	2.552
2.146	2.587	2.598	2.600	2.612	2.620	2.620	2.612	2.600	2.598	2.586
2.204	2.618	2.631	2.632	2.641	2.650	2.650	2.640	2.632	2.630	2.618

TABLE - 4.1 C(I)

(FOR KBr)

ROOM TEMPERATURE T = 303°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.690	1.689	1.700	1.700	1.710	1.710	1.700	1.700	1.690	1.690
0.397	1.840	1.840	1.840	1.850	1.850	1.850	1.850	1.840	1.840	1.840
0.574	1.911	1.910	1.920	1.920	1.930	1.930	1.920	1.920	1.910	1.910
0.698	1.968	1.970	1.970	1.980	1.980	1.980	1.970	1.970	1.980	1.960
0.795	2.008	2.008	2.010	2.020	2.020	2.030	2.020	2.010	2.010	2.000
0.875	2.047	2.041	2.050	2.050	2.060	2.060	2.050	2.050	2.040	2.050
0.942	2.067	2.067	2.070	2.080	2.080	2.080	2.070	2.070	2.070	2.070
1.000	2.073	2.079	2.072	2.102	2.110	2.110	2.100	2.080	2.080	2.070
1.051	2.090	2.090	2.102	2.120	2.130	2.130	2.120	2.100	2.090	2.090
1.096	2.130	2.113	2.121	2.140	2.160	2.160	2.140	2.120	2.110	2.130
1.138	2.159	2.160	2.140	2.150	2.170	2.180	2.150	2.140	2.260	2.160
1.176	2.185	2.190	2.162	2.170	2.190	2.190	2.170	2.160	2.190	2.190
1.210	2.208	2.210	2.200	2.180	2.200	2.200	2.180	2.200	2.210	2.210
1.243	2.229	2.230	2.230	2.200	2.210	2.210	2.210	2.230	2.230	2.230
1.273	2.258	2.260	2.270	2.240	2.220	2.220	2.240	2.270	2.260	2.260
1.301	2.269	2.270	2.280	2.270	2.240	2.240	2.700	2.280	2.270	2.270
1.397	2.319	2.320	2.330	2.330	2.330	2.330	2.330	2.330	2.320	2.320
1.477	2.360	2.360	2.370	2.380	2.380	2.390	2.380	2.270	2.360	2.360
1.602	2.425	2.430	2.430	2.440	2.450	2.450	2.440	2.430	2.430	2.430
1.698	2.470	2.470	2.480	2.490	2.490	2.500	2.490	2.480	2.470	2.470
1.778	2.514	2.520	2.520	2.530	2.540	2.540	2.530	2.520	2.520	2.510
1.845	2.547	2.550	2.560	2.560	2.570	2.570	2.560	2.560	2.550	2.550
1.903	2.574	2.570	2.580	2.590	2.600	2.600	2.590	2.580	2.570	2.570
2.000	2.627	2.630	2.630	2.640	2.640	2.640	2.640	2.630	2.630	2.630
2.041	2.648	2.650	2.650	2.670	2.672	2.670	2.670	2.650	2.650	2.650
2.079	2.666	2.670	2.670	2.680	2.686	2.690	2.680	2.670	2.670	2.670
2.146	2.703	2.710	2.710	2.750	2.750	2.730	2.750	2.710	2.710	2.700

TABLE - 4.1 C(II)

(FOR KBr)

QUENCHING TEMPERATURE = 473°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.737	1.740	1.744	1.740	1.737	1.737	1.740	1.744	1.744	1.740
0.397	1.840	1.840	1.850	1.850	1.850	1.855	1.850	1.850	1.850	1.840
0.574	1.910	1.910	1.910	1.920	1.930	1.930	1.920	1.910	1.890	1.910
0.698	1.932	1.940	1.940	1.970	1.968	1.968	1.970	1.940	1.944	1.940
0.795	1.985	1.980	1.987	2.010	2.008	2.010	2.010	1.987	1.970	1.985
0.875	2.010	2.005	2.020	2.050	2.037	2.037	2.050	2.020	2.007	2.020
0.942	2.030	2.028	2.030	2.070	2.062	2.070	2.070	2.030	2.028	2.030
1.000	2.060	2.060	2.080	2.090	2.104	2.100	2.090	2.080	2.060	2.060
1.051	2.099	2.102	2.102	2.113	2.126	2.110	2.104	2.102	2.102	2.090
1.090	2.130	2.129	2.121	2.130	2.144	2.140	2.130	2.121	2.129	2.140
1.138	2.156	2.162	2.134	2.140	2.162	2.145	2.140	2.134	2.162	2.150
1.176	2.184	2.182	2.179	2.180	2.170	2.158	2.180	2.179	2.182	2.180
1.210	2.204	2.209	2.202	2.203	2.185	2.204	2.203	2.207	2.209	2.200
1.243	2.220	2.214	2.215	2.219	2.214	2.214	2.219	2.219	2.214	2.220
1.273	2.235	2.237	2.228	2.231	2.240	2.240	2.231	2.230	2.237	2.235
1.301	2.249	2.255	2.249	2.251	2.257	2.251	2.250	2.241	2.255	2.249
1.397	2.300	2.307	2.298	2.310	2.319	2.257	2.310	2.298	2.307	2.308
1.477	2.340	2.334	2.343	2.350	2.360	2.350	2.350	2.343	2.334	2.340
1.602	2.405	2.410	2.400	2.420	2.423	2.423	2.420	2.400	2.410	2.400
1.698	2.457	2.461	2.463	2.466	2.470	2.470	2.466	2.463	2.461	2.450
1.778	2.508	2.508	2.506	2.506	2.506	2.506	2.506	2.506	2.508	2.508
1.845	2.531	2.534	2.541	2.543	2.546	2.546	2.543	2.541	2.534	2.530
1.903	2.563	2.562	2.567	2.567	2.569	2.569	2.567	2.567	2.562	2.563
2.000	2.619	2.623	2.618	2.625	2.629	2.629	2.625	2.618	2.623	2.619
2.041	2.632	2.635	2.633	2.650	2.650	2.650	2.650	2.633	2.635	2.632
2.079	2.661	2.661	2.653	2.669	2.664	2.664	2.669	2.657	2.661	2.661
2.146	2.694	2.700	2.695	2.697	2.697	2.697	2.697	2.695	2.705	2.694

TABLE - 4.1 C(III)

(FOR KBr)

QUENCHING TEMPERATURE = 573°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.740	1.737	1.741	1.740	1.750	1.750	1.750	1.740	1.740	1.737
0.397	1.870	1.870	1.880	1.880	1.880	1.880	1.870	1.870	1.870	1.870
0.574	1.950	1.950	1.950	1.970	1.970	1.970	1.960	1.960	1.960	1.960
0.698	1.970	1.970	1.970	1.980	1.980	1.980	1.970	1.970	1.965	1.965
0.795	1.990	1.990	1.990	2.000	2.030	2.040	2.000	2.010	1.990	1.990
0.875	2.020	2.030	2.020	2.040	2.040	2.035	2.020	2.030	2.030	2.020
0.942	2.050	2.050	2.060	2.055	2.050	2.060	2.050	2.060	2.050	2.040
1.000	2.090	2.090	2.100	2.100	2.110	2.110	2.095	2.095	2.095	2.090
1.051	2.120	2.120	2.130	2.135	2.140	2.140	2.140	2.120	2.120	2.110
1.096	2.140	2.140	2.150	2.140	2.155	2.155	2.150	2.150	2.140	2.135
1.198	2.170	2.165	2.160	2.170	2.175	2.180	2.170	2.160	2.165	2.165
1.176	2.200	2.210	2.210	2.230	2.240	2.240	2.230	2.210	2.210	2.200
1.210	2.205	2.205	2.205	2.240	2.250	2.250	2.203	2.204	2.204	2.205
1.243	2.250	2.250	2.250	2.260	2.270	2.270	2.260	2.250	2.250	2.250
1.273	2.260	2.260	2.270	2.270	2.280	2.280	2.270	2.260	2.260	2.260
1.301	2.270	2.280	2.280	2.290	2.300	2.300	2.290	2.290	2.280	2.270
1.397	2.310	2.324	2.328	2.339	2.349	2.349	2.336	2.333	2.323	2.316
1.477	2.360	2.350	2.370	2.380	2.390	2.390	2.370	2.370	2.360	2.360
1.602	2.405	2.410	2.400	2.420	2.423	2.420	2.420	2.400	2.400	2.410
1.698	2.480	2.457	2.461	2.460	2.470	2.480	2.475	2.467	2.460	2.450
1.778	2.530	2.530	2.540	2.540	2.540	2.545	2.530	2.530	2.530	2.520
1.845	2.550	2.550	2.560	2.560	2.570	2.570	2.560	2.550	2.550	2.540
1.903	2.570	2.575	2.580	2.580	2.580	2.575	2.580	2.570	2.570	2.570
2.000	2.620	2.620	2.625	2.630	2.630	2.630	2.625	2.620	2.620	2.610
2.041	2.640	2.640	2.645	2.650	2.650	2.660	2.660	2.650	2.640	2.640
2.079	2.670	2.670	2.680	2.680	2.680	2.680	2.675	2.670	2.670	2.670
2.146	2.690	2.700	2.710	2.700	2.720	2.720	2.730	2.710	2.700	2.690

TABLE - 4.1 C(IV)

(FOR KBr)

QUENCHING TEMPERATURE = 673°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.097	1.740	1.740	1.742	1.750	1.750	1.745	1.742	1.743	1.740	1.757
0.397	1.870	1.870	1.870	1.850	1.880	1.880	1.880	1.870	1.870	1.870
0.574	1.950	1.950	1.960	1.970	1.970	1.980	1.960	1.960	1.950	1.950
0.698	1.970	1.975	1.975	1.980	1.980	1.985	1.975	1.970	1.970	1.965
0.795	1.990	2.000	2.000	2.010	2.040	2.030	2.010	2.000	2.000	1.990
0.875	2.070	2.030	2.040	2.040	2.045	2.045	2.030	2.030	2.020	2.020
0.942	2.050	2.050	2.060	2.060	2.065	2,065	2.055	2.050	2.050	2.050
1.000	2.100	2.110	2.110	2.130	2.140	2.130	2.120	2.110	2.110	2.100
1.051	2.140	2.140	2.145	2.150	2.160	2.160	2.140	2.140	2.130	2.130
1.096	2.150	2.150	2.155	2.160	2.170	2.170	2.160	2.150	2.150	2.140
1.138	2.170	2.170	2.170	2.175	2.180	2.185	2.190	2.175	2.175	2.170
1.176	2.200	2.220	2.220	2.230	2.240	2.240	2.230	2.220	2.220	2.210
1.210	2.210	2.215	2.220	2.240	2.260	2.260	2.240	2.230	2.220	2.210
1.243	2.260	2.270	2.270	2.280	2.280	2.285	2.265	2.265	2.260	2.260
1.275	2.280	2.285	2.285	2.290	2.290	2.230	2.230	2.290	2.280	2.280
1.301	2.290	2.290	2.290	2.230	2.310	2.310	2.300	2.300	2.290	2.290
1.397	2.325	2.310	2.330	2.350	2.350	2.350	2.340	2.330	2.330	2.320
1.477	2.365	2.315	2.370	2.390	2.390	2.390	2.380	2.370	2.370	2.360
1.602	2.411	2.440	2.450	2.465	2.460	2.460	2.470	2.440	2.430	2.440
1.698	2.480	2.480	2.490	2.490	2.510	2.490	2.480	2.480	2.480	2.487
1.778	2.530	2.530	2.550	2.550	2.560	2.560	2.550	2.540	2.540	2.530
1.845	2.560	2.560	2.570	2.570	2.580	2.585	2.570	2.570	2.560	2.560
1.903	2.570	2.575	2.580	2.580	2.595	2.595	2.580	2.580	2.575	2.570
2.000	2.630	2.630	2.630	2.640	2.645	2.645	2.630	2.630	2.625	2.625
2.041	2.640	2.640	2.650	2.670	2.670	2.680	2.680	2.670	2.670	2.650
2.079	2.671	2.673	2.674	2.675	2.675	2.677	2.677	2.675	2.673	2.671
2.146	2.690	2.710	2.710	2.720	2.720	2.730	2.740	2.720	2.700	2.700

TABLE - 4.1 C(V)

(FOR KBr)

QUENCHING TEMPERATURE = 773°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80	AA=90°
0.097	1.610	1.592	1.597	1.619	1.623	1.623	1.606	1.610	1.592	1.597
0.397	1.744	1.744	1.744	1.756	1.756	1.759	1.705	1.750	1.744	1.756
0.574	1.830	1.833	1.830	1.841	1.841	1.846	1.841	1.830	1.835	1.835
0.698	1.898	1.896	1.896	1.902	1.909	1.907	1.911	1.898	1.898	1.900
0.795	1.953	1.953	1.959	1.957	1.964	1.962	1.960	1.960	1.953	1.949
0.875	1.998	1.994	1.994	2.001	2.001	2.005	2.005	1.994	1.998	1.994
0.942	2.042	2.045	2.038	2.046	2.048	2.045	2.035	2.038	2.038	2.042
1.000	2.067	2.073	2.073	2.073	2.070	2.079	2.080	2.070	2.064	2.106
1.051	2.090	2.087	2.096	2.104	2.104	2.096	2.096	2.107	2.107	2.115
1.096	2.118	2.123	2.123	2.121	2.129	2.129	2.123	2.121	2.121	2.125
1.138	2.136	2.134	2.139	2.147	2.148	2.144	2.146	2.139	2.134	2.139
2.176	2.154	2.159	2.159	2.164	2.164	2.154	2.154	2.156	2.152	2.152
1.210	2.169	2.174	2.174	2.176	2.178	2.181	2.178	2.174	1.169	1.167
1.243	2.188	2.183	2.188	2.190	2.190	2.190	2.185	2.185	1.181	2.190
1.273	2.201	2.201	2.201	2.206	2.208	2.208	2.209	2.203	2.203	2.201
1.301	2.219	2.212	2.214	2.219	2.223	2.223	2.219	2.219	2.214	2.212
1.397	2.263	2.269	2.271	2.273	2.273	2.265	2.267	2.263	2.265	2.261
1.477	2.309	2.307	2.311	2.311	2.318	2.318	2.313	2.313	2.309	2.306
1.602	2.375	2.375	2.374	2.377	2.381	2.381	2.378	2.387	2.374	2.374
1.698	2.423	2.423	2.426	2.426	2.431	2.428	2.426	2.426	2.422	2.422
1.778	2.460	2.463	2.463	2.464	2.466	2.468	2.465	2.465	2.460	2.459
1.845	2.494	2.491	2.492	2.494	2.498	2.498	2.494	2.493	2.491	2.491
1.903	2.525	2.527	2.529	2.529	2.530	2.531	2.528	2.528	2.525	2.524
2.000	2.573	2.574	2.574	2.579	2.581	2.581	2.578	2.578	2.576	2.576
2.041	2.596	2.596	2.597	2.597	2.600	2.601	2.598	2.597	2.595	2.594
2.079	2.614	2.615	2.617	2.617	2.619	2.619	2.617	2.615	2.615	2.614
2.146	2.655	2.655	2.656	2.659	2.660	2.661	2.659	2.650	2.654	2.656

TABLE - 4.1 C(VI)

(FOR KBr)

QUENCHING TEMPERATURE = 873°K

Log P	Log d									
	A=0°	A=10°	A=20°	A=30°	A=40°	A=50°	A=60°	A=70°	A=80°	A=90°
0.090	1.610	1.601	1.610	1.619	1.627	1.627	1.610	1.614	1.610	1.601
0.390	1.750	1.762	1.762	1.775	1.775	1.769	1.766	1.756	1.744	1.744
0.570	1.835	1.836	1.841	1.841	1.846	1.841	1.830	1.825	1.830	1.825
0.690	1.889	1.889	1.893	1.894	1.898	1.893	1.891	1.889	1.889	1.891
0.790	1.934	1.937	1.941	1.941	1.941	1.936	1.932	1.932	1.932	1.928
0.870	1.978	1.976	1.979	1.979	1.987	1.987	1.981	1.979	1.976	1.976
0.940	2.018	2.018	2.025	2.029	2.029	2.030	2.055	2.022	2.018	2.022
1.000	2.049	2.051	2.051	2.056	2.057	2.060	2.057	2.051	2.051	2.045
1.050	2.084	2.086	2.082	2.086	2.091	2.090	2.082	2.079	2.076	2.079
1.090	2.099	2.099	2.097	2.102	2.106	2.104	2.103	2.096	2.099	2.102
1.130	2.119	2.118	2.117	2.121	2.126	2.123	2.123	2.121	2.121	2.118
1.170	2.139	2.144	2.143	2.148	2.148	2.149	2.147	2.144	2.144	2.144
0.210	2.154	2.152	2.154	2.156	2.160	2.160	2.158	2.157	2.157	2.154
1.240	2.177	2.181	2.181	2.187	2.183	2.184	2.181	2.180	2.174	2.174
1.270	2.190	2.190	2.192	2.197	2.199	2.197	2.192	2.192	2.190	2.190
1.300	2.206	2.203	2.202	2.210	2.210	2.212	2.217	2.212	2.210	2.203
1.390	2.258	2.263	2.261	2.263	2.267	2.268	2.265	2.261	2.258	2.259
1.470	2.296	2.300	2.299	2.303	2.302	2.304	2.300	2.300	2.295	2.295
1.600	2.359	2.358	2.363	2.363	2.365	2.366	2.363	2.361	2.361	2.360
1.690	2.410	2.412	2.412	2.411	2.414	2.414	2.415	2.414	2.427	2.411
1.770	2.448	2.450	2.450	2.452	2.452	2.452	2.450	2.449	2.446	2.446
1.890	2.481	2.486	2.483	2.482	2.485	2.485	2.456	2.484	2.482	2.478
1.900	2.512	2.513	2.514	2.515	2.515	2.514	2.513	2.514	2.511	2.511
2.000	2.561	2.562	2.562	2.564	2.565	2.565	2.568	2.563	2.561	2.561
2.040	2.582	2.581	2.582	2.584	2.584	2.585	2.583	2.583	2.581	2.581
2.070	2.605	2.607	2.607	2.608	2.608	2.607	2.605	2.605	2.604	2.604
2.140	2.647	2.649	2.649	2.648	2.650	2.651	2.651	2.648	2.647	2.647

TABLE - 4.2 A

NaCl

Room Temperature

Angle = 0°

P in gm	d in μ	Log P	Log d	$d^2 \times 10^3$	$d^{n2} \times 10^3$	(P - W)	Log(P-W)
1.25	30.80	0.096	1.488	0.948	0.575	-	-
2.50	42.71	0.397	1.630	1.824	1.054	1.184	0.073
3.75	51.91	0.574	1.715	2.695	1.514	2.434	0.386
5.00	58.13	0.698	1.764	3.378	1.867	3.684	0.566
6.25	64.17	0.795	1.807	4.117	2.242	4.934	0.693
7.50	67.62	0.875	1.830	4.572	2.471	6.184	0.791
8.75	74.75	0.942	1.870	5.603	2.984	7.434	0.871
10.00	79.98	1.000	1.902	6.394	3.372	8.684	0.938
11.25	84.86	1.051	1.928	7.201	3.765	9.934	0.992
12.50	89.76	1.096	1.953	8.056	4.178	11.184	1.048
13.75	95.06	1.138	1.978	9.036	4.647	12.434	1.094
15.00	103.82	1.176	2.016	10.778	5.472	13.684	1.136
16.25	106.46	1.210	2.027	11.334	5.733	14.934	1.174
17.50	110.16	1.243	2.040	12.135	6.108	16.184	1.209
18.75	115.01	1.273	2.060	13.237	6.621	17.434	1.241
20.00	120.04	1.301	2.079	14.410	7.162	18.684	1.271
25.00	133.70	1.397	2.126	17.875	8.746	23.684	1.374
30.00	147.96	1.477	2.170	21.892	10.554	28.684	1.457
40.00	170.85	1.602	2.232	29.189	13.780	38.684	1.587
50.00	191.80	1.698	2.280	36.787	17.676	48.684	1.687
60.00	208.39	1.778	2.318	43.426	19.915	58.684	1.768
70.00	226.88	1.845	2.355	51.474	23.315	68.684	1.836
80.00	241.31	1.903	2.382	58.230	26.139	78.684	1.895
100.00	269.38	2.000	2.430	72.564	32.054	98.684	1.994
110.00	280.70	2.041	2.448	78.792	34.590	108.684	2.036
120.00	295.80	2.079	2.470	87.497	38.126	118.684	2.079
140.00	316.40	2.146	2.500	100.100	43.195	138.684	2.142
160.00	339.46	2.204	2.530	115.230	49.210	158.684	2.200

TABLE - 4.2 B

KCl

Room Temperature

Angle = 0°

P in gm	d in μ	log P	log d	$d^2 x 10^3$	$d^{-n_2} x 10^3$	(P-W)	log(P-W)
1.25	42.014	0.096	1.623	1.765	1.415		
2.50	57.016	0.397	1.756	3.250	2.560		
3.75	69.358	0.574	1.841	4.810	3.746	1.909	0.280
5.00	81.096	0.698	1.909	6.576	5.074	3.159	0.400
6.25	92.044	0.795	1.964	8.472	6.488	4.409	0.644
7.50	100.230	0.875	2.001	10.046	7.654	5.659	0.752
8.75	111.683	0.942	2.048	12.473	9.443	6.909	0.839
10.00	117.480	1.000	2.070	13.801	10.418	8.159	0.916
11.25	127.057	1.051	2.102	16.143	12.130	9.409	0.973
12.50	134.648	1.096	2.129	18.130	13.576	10.659	1.027
13.75	140.928	1.138	2.149	19.860	14.832	11.909	1.075
15.00	142.560	1.176	2.154	20.323	15.167	13.159	1.119
16.25	151.705	1.210	2.181	23.014	17.112	14.409	1.158
17.50	156.314	1.243	2.194	24.434	18.136	15.659	1.194
18.75	164.437	1.273	2.216	27.039	20.010	16.909	1.228
20.00	167.109	1.301	2.223	27.925	20.646	18.159	1.259
25.00	187.499	1.397	2.273	35.155	25.816	23.159	1.364
30.00	207.969	1.477	2.318	43.251	31.567	28.159	1.449
40.00	240.436	1.602	2.381	57.809	41.833	38.159	1.581
50.00	267.916	1.698	2.428	71.778	51.611	48.159	1.682
60.00	295.801	1.778	2.471	87.498	62.547	58.139	1.764
70.00	316.227	1.841	2.500	99.999	71.202	68.159	1.833
80.00	338.844	1.903	2.530	114.815	81.419	78.189	1.892
100.00	380.189	2.000	2.580	144.543	101.807	98.159	1.991
110.00	399.024	2.041	2.601	159.220	111.825	108.159	2.034
120.00	417.830	2.079	2.621	174.581	122.281	118.159	2.072
140.00	448.745	2.146	2.652	201.372	140.453	138.159	2.140
160.00	486.407	2.204	2.687	236.591	164.235	158.189	2.199

TABLE - 4.2 C

KBr

Room Temperature

Angle = 0°

P in gm	d in μ	Log P	Log d	$d^2 x10^3$	$d^{n2} x10^3$	(P - W)	Log(P - W)
1.25	48.96	0.09	1.69	2.39	1.337	-	-
2.50	68.54	0.39	1.84	4.70	2.490	0.88	-
3.75	81.60	0.57	1.91	6.55	3.440	2.13	0.329
5.00	93.02	0.69	1.97	8.65	4.384	3.38	0.529
6.25	102.00	0.79	2.01	10.40	5.198	4.63	6.665
7.50	110.16	0.88	2.05	12.14	5.991	5.88	0.769
8.75	116.68	0.94	2.07	13.61	6.667	7.13	0.853
10.00	118.32	1.00	2.07	13.99	6.841	8.38	0.923
11.25	123.116	1.05	2.09	15.18	7.374	9.63	0.983
12.5	135.05	1.09	2.13	18.24	8.737	10.88	1.030
13.75	144.43	1.14	2.15	20.86	9.893	12.13	1.080
15.00	153.41	1.18	2.19	23.53	11.060	13.38	1.120
16.25	161.57	1.21	2.21	26.10	12.170	14.63	1.160
17.50	169.73	1.24	2.23	28.81	13.335	15.88	1.200
20.00	186.04	1.30	2.27	34.61	15.800	18.38	1.260
25.00	208.89	1.40	2.32	43.64	19.582	23.38	1.360
30.00	229.29	1.48	2.36	52.58	23.210	28.38	1.450
40.00	266.02	1.60	2.43	70.76	30.620	38.38	1.580
50.00	297.02	1.69	2.47	88.25	37.540	48.38	1.680
60.00	326.40	1.78	2.51	106.54	44.710	58.38	1.760
70.00	352.51	1.85	2.55	124.21	51.550	68.38	1.830
80.00	375.36	1.90	2.57	140.89	57.900	78.38	1.890
100.00	424.30	2.00	2.63	180.03	72.640	98.38	1.990
110.00	444.70	2.04	2.65	197.75	79.236	108.38	2.030
120.00	464.30	2.08	2.67	215.57	85.817	118.38	2.070
140.00	505.10	2.70	2.70	255.13	100.289	138.38	2.140

TABLE 4.3 A

NaCl

1. Room Temperature = 303°K

Angle	n_1 obs.	$a_1 \times 10^{-3}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.366	1.65	1.854	2.00	1.3157	1.4187	3.295
10	2.251	1.9	1.812	2.01	3.458	1.4185	4.1988
20	2.253	1.9	1.801	2.20	5.301	1.3069	4.079
30	2.112	1.85	1.794	2.10	5.310	1.2345	3.8875
40	2.00	2.00	1.223	2.00	6.112	1.1170	5.449
50	2.10	1.95	1.730	2.00	6.115	1.1161	4.952
60	2.115	1.85	1.785	2.110	5.304	1.2345	3.934
70	2.251	1.92	1.785	2.01	6.654	1.3145	4.0612
80	2.253	1.90	1.800	2.00	4.453	1.4185	4.3923
90	2.360	1.60	1.851	2.00	2.456	1.4210	3.5258

2. Quenching Temperature = 473°K

Angle	n_1 obs.	$a_1 \times 10^{-3}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.325	1.685	1.843	2.1	1.425	1.4055	3.537
10	2.250	1.858	1.821	2.102	2.568	1.4406	3.993
20	2.301	1.951	1.801	2.00	4.851	1.3703	4.2719
30	2.157	1.923	1.775	1.98	5.441	1.2579	4.4765
40	2.10	1.945	1.701	1.98	5.616	1.1166	6.341
50	2.05	1.945	1.700	2.01	6.010	1.1736	6.0812
60	2.185	1.915	1.784	2.00	5.335	1.2649	4.159
70	2.311	1.920	1.800	2.00	4.725	1.3036	4.005
80	2.30	1.800	1.821	2.100	4.01	1.3914	3.993
90	2.355	1.705	1.840	2.100	2.518	1.4406	3.7505

Contd.Table-4.3 A

3. Quenching Temperature = 573°K

Angle	n_1 obs	$a_1 x 10^{-3}$	n_2 obs.	n_2 mod	w_2	$b_2 x 10^{-3}$	$a_2 x 10^{-3}$
0	2.335	1.70	1.861	2.12	1.325	1.5812	3.197
10	2.301	1.721	1.811	2.02	1.998	1.4758	4.0618
20	2.221	1.632	1.790	2.00	3.861	1.4898	4.654
30	2.220	1.953	1.800	2.01	4.441	1.3633	4.0047
40	2.185	1.983	1.774	2.05	5.448	1.3001	4.4125
50	2.180	1.981	1.770	2.05	5.401	1.222	4.4752
60	2.250	1.964	1.801	2.00	5.00	1.2509	3.928
70	2.314	1.851	1.790	2.00	3.991	1.3703	4.512
80	2.305	1.731	1.800	2.01	2.158	1.539	4.509
90	2.338	1.700	1.851	2.10	1.64	1.6022	3.563

4. Quenching Temperature = 673°K

Angle	n_1 obs.	$a_1 x 10^{-3}$	n_2 obs	n_2 mod.	w_2	$b_2 x 10^{-3}$	$a_2 x 10^{-3}$
0	2.44	1.750	1.8478	2.095	2.611	1.546	3.804
10	2.35	1.740	1.8371	2.04	2.549	1.4213	3.670
20	2.285	1.841	1.837	2.001	4.635	1.4758	3.547
30	2.275	1.891	1.800	2.00	4.385	1.4055	4.1466
40	2.20	1.92	1.798	1.98	6.311	1.3036	3.999
50	2.19	1.91	1.800	2.00	5.55	1.3268	3.973
60	2.290	1.885	1.812	2.05	4.394	1.4055	3.9167
70	2.345	1.854	1.8411	1.986	4.635	1.5756	3.9226
80	2.40	1.790	1.8400	2.00	2.540	1.6079	3.665
90	2.45	1.720	1.8519	2.01	2.554	1.6247	3.6366

Contd...Table - 4.3 A

5. Quenching Temperature = 773°K

Angle	n_1 obs	$a_1 \times 10^{-3}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.30	1.74	1.864	1.924	2.845	1.577	3.2996
10	2.25	1.738	1.821	2.101	2.662	1.608	4.1811
20	2.378	1.780	1.774	2.00	3.841	1.4364	5.305
30	2.178	1.885	1.8292	2.00	3.745	1.4506	3.7885
40	2.14	1.890	1.811	1.99	4.012	1.3521	3.9387
50	2.14	1.889	1.799	2.01	4.414	1.3271	4.0932
60	2.185	1.800	1.830	2.01	4.011	1.3688	3.6708
70	2.310	1.794	1.847	2.00	3.994	1.3694	3.541
80	2.30	1.745	1.824	1.98	3.845	1.568	4.146
90	2.325	1.740	1.805	2.00	2.581	1.5359	3.4103

6. Quenching Temperature = 873°K

Angle	n_1 obs.	$a_1 \times 10^{-3}$	n_2 obs.	n_2 mod	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.312	1.775	1.852	2.00	1.99	1.6075	3.728
10	2.30	1.721	1.827	1.99	2.75	1.485	4.2188
20	2.28	1.818	1.819	2.00	1.848	1.484	4.323
30	2.27	1.820	1.778	2.015	2.667	1.4677	5.1184
40	2.18	1.900	1.779	2.017	3.754	1.3966	4.9118
50	2.185	1.891	1.812	2.010	3.441	1.3791	4.1179
60	2.30	1.827	1.847	2.00	2.616	1.4669	3.4392
70	2.285	1.754	1.843	1.99	2.112	1.5089	3.6878
80	2.310	1.761	1.857	2.00	2.665	1.6051	3.5535
90	2.341	1.772	1.864	2.01	2.000	1.6247	3.4684

TABLE 4.3 B

KCl

1. Room Temperature = 303°K

Angle	n_1 obs.	$a_1 x10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 x10^{-3}$	$a_2 x10^{-3}$
0	2.335	3.651	1.941	2.010	1.841	0.7556	1.1463
10	2.330	3.701	1.864	2.001	2.224	0.7871	1.9169
20	2.291	4.102	1.774	1.994	3.338	0.7417	2.9759
30	2.270	4.341	1.825	2.000	3.141	0.7109	2.1452
40	2.154	4.619	1.8289	1.995	2.851	0.6144	1.8401
50	2.150	4.624	1.854	2.000	2.991	0.5982	1.6884
60	2.190	4.452	1.827	2.000	3.008	0.6428	2.1194
70	2.285	4.202	1.785	1.9841	2.985	0.7209	3.3303
80	2.334	3.808	1.844	2.006	1.771	0.7185	2.079
90	2.335	3.775	1.901	2.001	1.651	0.7756	1.5708

2. Quenching Temperature = 473°K

Angle	n_1 obs.	$a_1 x10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 x10^{-3}$	$a_2 x10^{-3}$
0	2.341	3.884	1.8492	2.0014	1.665	0.7438	2.0536
10	2.310	4.1814	1.8511	2.011	1.958	0.7205	2.0194
20	2.281	4.3645	1.779	2.001	2.011	0.7738	2.8767
30	2.221	4.571	1.767	1.999	2.5851	0.6996	2.822
40	2.154	4.7614	1.7592	1.987	2.6651	0.0944	2.841
50	2.141	4.771	1.7600	1.998	2.7191	0.6759	2.6339
60	2.159	4.7551	1.8112	2.000	2.3535	0.6197	2.1537
70	2.245	4.1619	1.8338	2.000	1.9979	0.7730	2.0411
80	2.300	40991	1.8585	2.023	1.9691	0.7842	1.7859
90	2.338	3.8981	1.8601	2.011	1.8854	0.7354	1.8424

Contd. Table - 4.3 B

3. Quenching Temperature = 573°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.285	3.8614	1.8541	1.901	2.015	0.7495	1.9705
10	2.315	4.1975	1.8604	1.992	2.1859	0.7791	1.9644
20	2.211	4.3505	1.8100	2.015	1.6691	0.7166	2.5229
30	2.194	4.544	1.8015	2.000	1.8585	0.7629	2.6559
40	2.144	4.8919	1.7918	2.1515	2.8841	0.7021	2.4545
50	2.155	4.8836	1.7765	2.0014	2.9141	0.7040	2.728
60	2.241	4.6741	1.8119	2.000	2.0189	0.765	2.4041
70	2.265	4.150	1.8238	1.9901	2.0559	0.7868	2.3639
80	2.310	4.1515	1.8665	2.000	1.6197	0.8572	1.9413
90	2.334	3.8836	1.8615	2.000	2.0158	0.8446	1.6855

4. Quenching Temperature = 673°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.3015	3.8236	1.8781	2.0001	1.9600	0.8071	1.7674
10	2.2185	3.8861	1.8661	2.0109	2.0178	0.772	1.7747
20	2.3341	4.3761	1.8231	1.9971	2.3451	0.7429	2.2246
30	2.2008	4.5138	1.7919	1.9910	2.0851	0.7162	2.5378
40	2.1741	4.7515	1.7898	2.0110	3.4141	0.7253	2.479
50	2.1661	4.8048	1.7816	2.1047	2.8561	0.6926	2.6206
60	2.2101	4.4671	1.7901	2.000	2.8617	0.7158	2.6019
70	2.2857	4.2161	1.8231	1.9085	1.9861	0.7910	2.264
80	2.3319	4.0373	1.8717	2.0018	2.6017	0.7703	1.7881
90	2.3137	3.831	1.8691	2.000	2.0101	0.7973	1.8696

Contd...Table - 4.3 B

5. Quenching Temperature = 773°K

Angel	n_1 obs.	$a_1 x10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 x10^{-3}$	$a_2 x10^{-3}$
0	2.3159	3.3411	1.8666	2.000	2.2859	0.8827	2.1024
10	2.2008	3.8564	1.8650	2.0101	3.0101	0.8516	2.0548
20	2.2818	4.1241	1.7979	2.1000	2.8619	0.8543	3.0146
30	2.2119	4.3151	1.8118	1.9980	3.3901	0.8266	2.6798
40	2.1919	4.4147	1.7517	1.9900	3.4010	0.7825	3.5024
50	2.2010	4.4275	1.7719	2.000	3.909	0.7882	3.1921
60	2.2219	4.3717	1.7918	2.0001	2.7918	0.8262	2.9701
70	2.3131	4.1575	1.8019	2.0212	2.500	0.8486	2.8824
80	2.3231	3.7156	1.8481	1.9985	1.9856	0.8676	2.6301
90	2.3219	3.3311	1.8666	1.9901	2.2561	0.8898	2.0613

6. Quenching Temperature = 873°K

Angle	n_1 obs.	$a_1 x10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 x10^{-3}$	$a_2 x10^{-3}$
0	2.3361	3.991	1.9101	2.010	1.9561	0.9358	1.6934
10	2.3131	4.117	1.8919	2.000	1.9516	0.9259	1.8489
20	2.2979	4.4171	1.8781	1.9985	2.3434	0.9149	1.9674
30	2.3001	4.441	1.7971	2.000	3.0019	0.9035	3.0338
40	2.1981	4.9159	1.7674	2.000	4.1010	0.8399	3.549
50	2.1771	5.001	1.7512	2.0101	3.8561	0.8424	3.8684
60	2.2724	4.334	1.7949	2.000	2.8661	0.8564	3.000
70	2.3010	4.2115	1.8384	1.9919	2.5158	0.9036	2.4314
80	2.3232	4.127	1.8719	1.9990	2.1669	0.935	2.1017
90	2.3435	3.8141	1.8981	2.000	1.9961	0.9363	1.8381

TABLE 4.3 C

KBr

1. Room Temperature = 303°K

Angle	$n_1$obs.	a_1x10^{-4}	n_2 obs	n_2 mod.	w_2	b_2x10^{-3}	a_2x10^{-3}
0	2.417	2.001	1.850	2.1460	1.6167	0.5939	1.5754
10	2.317	2.0151	1.800	2.0000	1.9975	0.5635	2.0345
20	2.246	2.1575	1.840	2.0000	1.5165	0.5314	1.5028
30	2.309	2.2140	1.7910	1.9985	3.0851	0.486	1.774
40	2.225	2.4171	1.7516	1.9900	2.6160	0.4411	2.203
50	2.301	2.5017	1.7476	2.0002	2.1178	0.4452	2.2045
60	2.301	2.3015	1.7756	1.9817	2.3431	0.492	1.9625
70	2.335	2.2017	1.8661	1.9990	2.6178	0.5353	1.2705
80	2.330	2.0100	1.8674	2.0102	3.1518	0.5662	1.3822
90	2.400	2.0004	1.8644	2.0000	1.6597	0.6055	1.4473

2. Quenching Temperature = 473°K

Angle	n_1 obs.	a_1x10^{-4}	n_2 obs.	n_2 mod.	w_2	b_2x10^{-3}	a_2x10^{-3}
0	2.386	1.9571	1.8671	2.000	2.018	0.6396	1.6022
10	2.351	1.978	1.8481	2.1351	0.9575	0.5985	1.7548
20	2.221	2.0441	1.8386	2.000	1.6718	0.5565	1.8338
30	2.251	2.1416	1.7964	1.9971	2.3536	0.4925	2.0576
40	2.200	2.3141	1.7878	1.9971	2.5000	0.4913	2.0005
50	2.2015	2.3476	1.7769	1.9900	2.7600	0.4919	2.1706
60	2.3010	2.2070	1.7964	2.000	3.1819	0.5329	2.1097
70	2.3131	2.1970	1.8461	2.0201	1.7178	0.5353	1.5352
80	2.3675	2.0100	1.8481	2.0500	2.1561	0.6325	1.7555
90	2.3868	1.9676	1.8648	2.000	2.0185	0.6467	1.6327

Contd...Table-4.3 C

3. Quenching Temperature = 573°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	a_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.3856	1.9784	1.8601	2.100	0.9161	0.5900	1.5043
10	2.2917	1.9971	1.8515	2.000	1.3875	0.5693	1.5568
20	2.3015	2.2185	1.8220	1.9910	1.2000	0.5563	1.8201
30	2.1567	2.3575	1.7875	1.9960	2.415	0.5271	2.1748
40	2.2000	2.4141	1.7791	2.0101	2.1861	0.4446	1.7801
50	2.2019	2.4561	1.7791	2.000	2.5315	0.4452	1.7388
60	2.2875	2.3275	1.7875	1.9978	1.9917	0.4913	1.8442
70	2.8161	2.1895	1.8390	1.9900	1.8865	0.4919	1.4863
80	2.3567	2.1015	1.8515	2.000	2.6371	0.5069	1.5183
90	2.4000	1.9974	1.8505	2.000	3.0000	0.5753	1.5492

4. Quenching Temperature = 673°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.3361	1.9978	1.8310	2.000	1.1585	0.562	1.7128
10	2.3431	2.0818	1.8500	2.0101	1.3900	0.5142	1.4196
20	2.2285	2.1518	1.8308	1.9910	1.8518	0.5081	1.5305
30	2.2148	2.3714	1.8000	2.000	2.0180	0.4311	1.6943
40	2.1785	2.6461	1.7791	2.000	2.5000	2.4296	1.7284
50	2.200	2.6560	1.7791	2.011	2.1916	0.4042	1.7301
60	2.3017	2.3518	1.8010	1.990	2.750	0.4311	1.6422
70	2.3136	2.1878	1.8410	2.1040	1.9516	0.4861	1.4504
80	2.3317	2.0818	1.8586	2.000	1.8616	0.519	1.3394
90	2.3400	2.0158	1.8310	2.000	1.1690	0.5541	1.7128

Contd...Table-4.3 C

5. Quenching Temperature = 773°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.401	2.0178	1.8551	2.0000	1.7561	0.6723	1.7917
10	2.3386	2.1781	1.8431	1.9900	2.0517	0.6477	1.7917
20	2.3561	2.2240	1.8265	2.0101	0.9567	0.6294	1.9287
30	2.2861	2.3815	1.7961	2.0000	1.0000	0.5752	2.1796
40	2.2190	2.4171	1.7756	2.1050	2.3585	0.5353	2.2928
50	2.2200	2.4181	1.7756	1.9985	2.3561	0.5382	2.2192
60	2.3010	2.3675	1.8000	2.0000	3.0000	0.5777	2.046
70	2.3561	2.2017	1.8265	2.0000	1.8757	0.6294	1.8893
80	2.3671	2.1818	1.8540	1.9990	2.0171	0.6484	1.388
90	2.401	2.0171	1.8551	2.0000	1.7600	0.6793	1.7917

6. Quenching Temperature = 873°K

Angle	n_1 obs.	$a_1 \times 10^{-4}$	n_2 obs.	n_2 mod.	w_2	$b_2 \times 10^{-3}$	$a_2 \times 10^{-3}$
0	2.421	2.1185	1.8715	2.000	1.3251	0.746	1.1555
10	2.3135	2.2275	1.8281	2.000	2.050	0.7254	2.0927
20	2.3090	2.3174	1.7917	1.999	2.1600	0.6920	2.4482
30	2.2896	2.5565	1.7784	2.000	2.8500	0.6395	2.5604
40	2.2500	2.6171	1.7680	2.0101	2.900	0.6017	2.660
50	2.2500	2.6167	1.7680	2.0101	3.003	0.6017	2.660
60	2.3000	2.5717	1.7891	2.000	2.085	0.6491	2.4558
70	2.3172	2.4015	1.7990	1.999	2.1050	0.7248	2.3535
80	2.3340	2.2851	1.8391	2.000	1.9616	0.741	1.9928
90	2.4100	2.1160	1.8685	2.000	2.000	0.746	1.7836

TABLE - 4.4

NaCl

1. From : n_1 Vs A graph n_1/n_{10}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	1.1859	1.1311	1.1321	1.0613	1.0050	1.00	1.055	1.0628	1.1311	1.1311	1.185
473	1.1317	1.0975	1.122	1.0521	1.0243	1.000	1.000	1.0658	1.1273	1.1219	1.1489
573	1.0837	1.0702	1.0330	1.0325	1.0162	1.000	1.0139	1.0465	1.0762	1.072	1.087
673	1.109	1.068	1.0386	1.0340	1.00	1.00	0.9954	1.0409	1.0659	1.0909	1.1136
773	1.079	1.0563	1.0882	1.0225	1.0046	1.000	1.0046	1.0258	1.0845	1.0798	1.0915
873	1.0547	1.0502	1.0410	1.0365	0.9954	1.000	0.9977	1.050	1.0433	1.0547	1.0689

2. From : a_1 Vs A graph a_1/a_{10}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	0.8291	0.9547	0.9547	0.9264	1.0050	1.000	0.9798	0.9296	0.964	0.9547	0.8040
473	0.8659	0.9577	1.0056	0.9912	1.0025	1.000	1.0025	0.9871	0.9896	0.9278	0.8788
573	0.8585	0.8691	0.8242	0.9863	1.0015	1.000	1.0005	0.9919	0.9348	0.874	0.8585
673	0.9162	0.9109	0.9638	0.9905	1.0052	1.000	1.000	0.9869	0.9706	0.9371	0.9005
773	0.9255	0.9244	0.9468	1.0026	1.0053	1.000	1.0047	0.9574	0.9543	0.9281	0.9255
873	0.9102	0.8825	0.9323	0.9333	0.9743	1.000	0.9697	0.9369	0.8994	0.9030	0.9087

Contd... Table-4.4

3. From : n_2 Vs A graph n_2/n_{20}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	1.0818	1.0596	1.0531	1.0491	1.0076	1.00	1.0116	1.0438	1.0438	1.0526	1.0824
473	1.0887	1.0575	1.0656	1.0502	1.0065	1.00	1.0059	1.056	1.0650	1.0775	1.0887
573	1.062	1.0348	1.0228	1.0285	1.0137	1.000	1.0114	1.0291	1.0228	1.0285	1.0577
673	1.057	1.055	1.0557	1.0344	1.0333	1.000	1.0344	1.0413	1.0581	1.0574	1.0643
773	1.044	1.023	0.9966	1.0276	1.0174	1.00	1.0106	1.0280	1.0376	1.0247	1.0477
873	1.033	1.0206	1.0162	0.9932	0.9938	1.000	1.0122	1.0318	1.0296	1.0374	1.0413

4. From : a_2 Vs A graph a_2/a_{20}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	0.568	0.7239	0.7032	0.6702	0.9394	1.000	0.8937	0.6817	0.7003	0.7572	0.6084
473	0.562	0.6368	0.6813	0.7139	1.0113	1.000	0.9698	0.6633	0.6387	0.6368	0.5981
573	0.720	0.1948	1.0481	0.9019	0.9938	1.000	1.0079	0.8846	1.0162	1.0155	0.8024
673	0.951	0.9175	0.8867	1.0366	0.9997	1.000	0.9932	0.9791	0.9806	0.9162	0.9091
773	0.8288	1.0505	1.3442	0.9518	0.9896	1.000	1.0284	0.9223	0.8896	1.0417	0.8568
873	0.7734	0.8752	0.8968	1.0619	1.0190	1.000	0.841	0.7135	0.7651	0.7372	0.7195

Contd...Table-4.4

5. From : b_2 Vs A graph b_2/b_{20}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	1.278	1.2779	1.1773	1.1121	1.0063	1.000	1.0054	1.1121	1.1842	1.2779	1.2801
473	1.266	1.2978	1.2345	1.1332	1.0059	1.000	1.0572	1.1395	1.1744	1.2535	1.2978
573	1.2751	1.1901	1.2014	1.0994	1.0484	1.000	0.9859	1.0081	1.1050	1.2411	1.2920
673	1.189	1.0933	1.1352	1.0811	1.0027	1.000	1.0206	1.0811	1.212	1.2368	1.2497
773	1.1716	1.200	1.0719	1.082	1.0090	1.000	0.9903	1.0214	1.0219	1.1701	1.1461
873	1.1819	1.0919	1.0911	1.0791	1.0269	1.000	1.0140	1.0786	1.1094	1.1802	1.1946

6. From : w_2 Vs A graph w_2/w_{20}

Temp.	Angle → 0	10	20	30	40	45	50	60	70	80	90
R.T.	0.2112	0.5577	0.855	0.8564	0.9858	1.000	0.9862	0.8554	1.0732	0.7182	0.3961
473	0.2375	0.428	0.8085	0.9068	0.936	1.000	1.0016	0.8891	0.7875	0.6683	0.4196
573	0.2409	0.3632	0.702	0.8074	0.9905	1.000	0.982	0.9090	0.7256	0.3923	0.2981
673	0.4280	0.4178	0.7598	0.7188	1.0345	1.000	0.9098	0.7203	0.7598	0.4163	0.4186
773	0.6322	0.5915	0.8535	0.8322	0.8915	1.000	0.9808	0.8913	0.8875	0.8544	0.5735
873	0.5527	0.7638	0.5133	0.7408	1.0427	1.000	0.9558	0.7216	0.5866	0.7402	0.5555

TABLE - 4.5 A

NaCl

Log T_q	Log $a_1 T_q$ → 0	10	20	30	40	50	60	70	80	90
2.4814	-0.30	-0.2390	-2.390	-0.2513	-0.2175	-0.2285	-0.2513	-0.2352	-0.2390	-0.3144
2.6748	-0.0985	-0.0560	-0.0348	-0.0411	-0.0362	-0.0362	-0.0429	-0.0418	-0.0698	-0.0934
2.7581	-0.0113	-0.0060	-0.0291	0.0488	0.0554	0.0550	0.0512	0.0255	-0.0035	-0.0113
2.8280	0.0710	0.0685	0.0930	0.1047	0.1193	0.1090	0.1033	0.0961	0.0808	0.0635
2.8881	0.1287	0.1282	0.1385	0.1634	0.1646	0.1644	0.1434	0.1420	0.1299	0.1287
2.9410	0.1902	0.1767	0.2006	0.2010	0.2197	0.2177	0.2027	0.1850	0.1867	0.1894

TABLE - 4.5 B

KCl

Log T_q	Log $a_1 T_q$ → 0	10	20	30	40	50	60	70	80	90
2.4814	-0.9561	-0.9502	-0.9055	-0.8809	-0.8540	-0.8335	-0.8700	-0.8951	-0.9328	-0.9416
2.6748	-0.7358	-0.7038	-0.6852	-0.6051	-0.6474	-0.6465	-0.6469	-0.7059	0.7124	0.7342
2.7581	-0.6551	-0.6257	-0.6033	-0.5844	-0.5524	-0.5531	-0.5721	-0.6237	-0.6236	-0.6526
2.8280	-0.5895	-0.5824	-0.5309	-0.5175	-0.4951	-0.4903	-0.5219	-0.5470	-0.5639	-0.5886
2.8881	-0.5879	-0.5256	-0.4965	-0.4768	-0.4669	-0.4657	-0.4712	-0.4930	-0.5418	-0.5892
2.9410	-0.4579	-0.4444	-0.4138	-0.4115	-0.3674	-0.3599	-0.4222	-0.4346	-0.4483	-0.4776

TABLE - 4.5 C

KBr

Log T_q	Log $a_1 T_q$ 0	10	20	30	40	50	60	70	80	90
2,4814	-1.1731	-1.2142	-1.1847	-1.1733	-1.1352	-1.1204	-1.1566	-1.1759	-1.2153	-1.2175
2.6748	-1.0335	-1.0289	-1.0146	-0.9945	-0.9607	-0.9546	-0.9093	-0.9833	-1.0219	-1.0313
2.7581	-0.9456	-0.9464	-0.8959	-0.8694	-0.8591	-0.8516	-0.8750	-0.9015	-0.9185	-0.9414
2.8280	-0.8716	-0.8537	-0.8393	-0.7970	-0.7493	-0.7477	-0.8007	-0.8321	-0.8537	-0.7009
2.8881	-0.8071	-0.7737	-0.7646	-0.7350	-0.7285	-0.7283	-0.7376	-0.7692	-0.7731	-0.8071
2.9410	-0.733	-0.7112	-0.6940	-0.6514	-0.6411	-0.6413	-0.6488	-0.6785	-0.7000	-0.7334

TABLE - 4.6 A

NaCl

Log T_q	Log $a_2 T_q$ 0	10	20	30	40	50	60	70	80	90
2.4814	-0.0007	0.1045	0.0919	0.0711	0.2177	0.1762	0.0762	0.0902	0.124	0.0292
2.6748	0.2234	0.2761	0.3054	0.3257	0.4770	0.4586	0.2938	0.2774	0.2761	0.2489
2.7581	0.2628	0.3668	0.4259	0.3602	0.4028	0.4089	0.3523	0.4125	0.4122	0.3099
2.8280	0.4082	0.3926	0.3778	0.4456	0.4299	0.4271	0.4208	0.4215	0.392	0.3886
2.8880	0.4065	0.5094	0.6128	0.4665	0.4834	0.5002	0.4528	0.4373	0.5058	0.4209
2.941	0.5124	0.5661	0.5767	0.6501	0.6321	0.5556	0.4774	0.5076	0.4916	0.4810

TABLE - 4.6.B

KCl

Log T_q					Log $a_2 T_q$					
	0	10	20	30	40	50	60	70	80	90
2.4814	-0.4593	-0.2361	-0.0450	-0.1871	-0.2537	-0.2911	-0.1924	-0.0058	-0.2007	-0.3226
2.6748	-0.0127	-0.0200	+0.1339	+0.1254	+0.1283	+0.0953	+0.0079	-0.0152	-0.0735	-0.0598
2.7581	+0.0526	+0.0512	+0.1598	+0.1820	+0.2285	+0.1939	+0.1390	+0.1316	+0.0461	-0.0152
2.8280	+0.0752	+0.0769	+0.1751	+0.2323	+0.222	+0.2463	+2530	+0.1828	+0.0803	+0.0996
2.8881	+0.2108	+0.2007	+0.3673	+0.3161	+0.4324	+0.3922	+0.3609	+0.3428	+0.3081	0.2022
2.941	+0.1696	0.2077	+0.2348	+0.4228	+0.4911	+0.5285	0.419	0.3273	+0.2634	0.2053

TABLE - 4.6 C

KBr

Log T_q					Log $a_2 T_q$					
	0	10	20	30	40	50	60	70	80	90
2.4814	-0.3212	-0.2102	-0.3418	-0.2696	-0.1755	-0.1753	-0.2258	-0.4147	-0.378	-0.358
2.6748	-0.1204	-0.0811	-0.0619	-0.0119	-0.0240	+0.0113	-0.0010	-0.0858	-0.0808	-0.0112
2.7581	-0.0645	-0.0498	+0.0182	+0.0853	+0.0085	+0.0017	+0.0239	-0.0698	-0.0605	-0.0517
2.8280	+0.0615	-0.0200	+0.0127	+0.0569	+0.0655	+0.0660	+0.0433	-0.0106	-0.0452	+0.0615
2.8881	+0.1412	0.1439	0.1732	+0.2264	0.2483	+0.2343	+0.199	+0.1630	0.0305	0.1412
2.941	+0.0035	0.2615	0.3298	0.3492	0.3658	0.3658	0.3310	0.3126	0.2403	0.1921

TABLE - 4.7 A

NaCl

Log T_q	Log b_2T_q → 0	10	20	30	40	50	60	70	80	90
2.4814	-0.3668	-0.3668	-0.4026	-0.4272	-0.4705	-0.4708	-0.4272	-0.3999	-0.3668	-0.3659
2.6748	-0.1774	-0.1655	-0.1884	-0.2258	-0.2774	-0.2558	-0.2233	-0.2101	-0.1818	-0.1655
2.7581	-0.0429	-0.0730	-0.0689	-0.1073	-0.1279	-0.1547	-0.1449	-0.1052	-0.0546	-0.0371
2.8280	0.0171	0.0193	0.0031	-0.0243	-0.0494	-0.0293	-0.0243	0.0252	0.0340	0.0386
2.8881	0.0851	0.0944	0.0453	0.0495	0.0191	0.0110	0.0242	0.0245	0.0835	0.0751
2.9410	0.1470	0.1127	0.1124	0.1074	0.0858	0.0805	0.1071	0.1194	0.1464	0.1516

TABLE - 4.7 B

KCl

Log T_q	Log b_2T_q → 0	10	20	30	40	50	60	70	80	90
2.4814	-0.6402	-0.6225	-0.6483	-0.6662	-0.7301	-0.7417	-0.7104	-0.6606	-0.6621	-0.6289
2.6748	-0.4536	-0.4639	-0.4365	-0.4802	-0.4855	-0.4952	-0.5329	-0.4369	-0.4307	-0.4586
2.7581	-0.3670	-0.3502	-0.3865	-0.3593	-0.3954	-0.3942	-0.3581	-0.3459	-0.3087	-0.3151
2.8280	-0.2650	-0.2842	-0.3010	-0.3169	-0.3114	-0.3315	-0.3171	-0.2738	-0.2853	-0.2703
2.8881	-0.1660	-0.1815	-0.1802	-0.1945	-0.2183	-0.2151	-0.1947	-0.1831	-0.1735	-0.1625
2.9410	-0.0878	-0.0924	-0.0976	-0.1030	-0.1347	-0.1334	-0.1263	-0.1030	-0.0881	-0.0875

TABLE - 4.7 C

KBr

Log T_q	Log b_2T_q →									
	0	10	20	30	40	50	60	70	80	90
2.4814	-0.7468	-0.7676	-0.7931	-0.8319	-0.8740	-0.8700	-0.8265	-0.7899	-0.7655	-0.7364
2.6714	-0.5192	-0.5480	-0.5796	-0.6327	-0.6337	-0.6332	-0.5984	-0.5965	-0.5240	-0.5144
2.7581	-0.4709	-0.4865	-0.4965	-0.5199	-0.5938	-0.5932	-0.5504	-0.5499	-0.5369	-0.4819
2.8280	-0.4222	-0.4608	-0.4661	-0.5374	-0.5389	-0.5653	-0.5374	-0.4852	-0.4568	-0.4283
2.8881	-0.2842	-0.3004	-0.3128	-0.3520	-0.3832	-0.3808	-0.3501	-0.3128	-0.2997	-0.2797
2.9410	-0.1862	-0.1981	-0.2185	-0.2531	-0.2796	-0.2796	-0.2466	-0.1987	-0.1891	-0.1862

TABLE - 4.8

From the plot of Log a_1T_q Vs Log T_q

NaCl

	0	10	20	30	40	50	60	70	80	90
Slope (m_1)	1.000	0.923	0.857	0.857	0.854	0.854	0.854	0.857	0.923	1.000
($1 - m_1$)	0	0.077	0.142	0.142	0.142	0.142	0.142	0.143	0.077	0
Intercept $\times 10^{-3}$	1.730	2.900	4.891	4.891	4.891	4.891	4.891	4.891	2.900	1.730

KCl

	0	10	20	30	40	50	60	70	80	90
Slope (m_1)	1.000	1.000	1.062	1.062	1.100	1.100	1.062	1.062	1.000	1.000
($1 - m_1$)	0	0	-0.062	-0.062	-0.100	-0.100	-0.062	-0.062	0	0
Intercept $\times 10^{-3}$	4.000	3.800	2.300	2.300	1.660	1.660	2.300	2.300	3.800	4.000

KBr

	0	10	20	30	40	50	60	70	80	90
Slope (m_1)	1.111	1.111	1.000	1.000	1.000	1.000	1.000	1.000	1.111	1.111
($1 - m_1$)	-0.111	-0.111	0	0	0	0	0	0	-0.111	-0.111
Intercept $\times 10^{-3}$	3.530	3.530	6.700	6.700	6.160	6.160	6.160	6.160	3.530	3.530

TABLE - 4.9

From the plot of Log a_2T_q Vs Log T_q

NaCl

	0	10	20	30	40	50	60	70	80	90
Slope m_2	1.142	1.090	1.090	1.090	1.000	1.000	1.090	1.090	1.090	1.142
$(1 - m_2)$	-0.142	-0.090	-0.090	-0.090	0	0	-0.090	-0.090	-0.090	-0.142
Intercept $\times 10^{-3}$	1.464	2.271	2.434	2.434	4.897	4.897	2.434	2.434	2.271	1.464

KCl

	0	10	20	30	40	50	60	70	80	90
Slope m_2	1.205	1.205	1.117	1.056	1.000	1.000	1.056	1.117	1.205	1.205
$(1 - m_2)$	-0.205	-0.205	-0.117	-0.056	0	0	-0.056	-0.117	-0.205	-0.205
Intercept $\times 10^{-3}$	1.560	1.560	1.985	2.015	3.156	3.156	2.015	1.985	1.560	1.560

KBr

	0	10	20	30	40	50	60	70	80	90
Slope m_2	1.125	1.071	1.071	1.000	1.000	1.000	1.000	1.071	1.071	1.125
$(1 - m_2)$	-0.125	-0.071	-0.071	0	0	0	0	-0.071	-0.071	-0.125
Intercept $\times 10^{-3}$	0.750	1.311	1.311	2.290	2.290	2.290	2.290	1.311	1.311	0.750

TABLE - 4.10

From the Plot of Log b_2T_q Vs Log T_q

NaCl

	0	10	20	30	40	50	60	70	80	90
Slope m_3	1.11	1.11	1.11	1.00	1.111	1.111	1.00	1.111	1.11	1.11
$(1 - m_3)$	-0.11	-0.11	-0.11	0	-0.11	-0.11	0	-0.11	-0.11	-0.11
Intercept $\times 10^{-4}$	7.47	7.47	7.413	13.0	5.9	5.9	13.7	7.413	7.47	7.47

KCl

Slope m_3	1.4	1.4	1.375	1.375	1.285	1.285	1.375	1.375	1.4	1.4
$(1 - m_3)$	-0.4	-0.4	-0.375	-0.375	-0,265	-0.285	-0.375	-0.375	-0.4	-0.4
Intercept $\times 10^{-5}$	6.17	6.17	6.65	6.65	11.52	11.52	6.65	6.65	6.17	6.17

KBr

Slope m_3	1.25	1.20	1.14	1.00	1.00	1.00	1.00	1.14	1.20	1.25
$(1 - m_3)$	-0.25	-0.20	-0.14	0	0	0	0	-0.14	-0.20	-0.25
Intercept $\times 10^{-4}$	1.33	1.73	2.26	5.62	5.12	5.12	5.62	2.26	1.73	1.33

TABLE - 4.11 A

VALUES OF e_0, e_1 and e_2 FOR DIFFERENT ORIENTATIONS

NaCl

Orientation A	Value of (e_0)	Value of (e_1) $\times 10^{-3}$	Value of (e_2) $\times 10^{-3}$
0	0.5646	7.7159	1.3465
10	0.4598	9.4855	1.3678
20	0.5384	8.7010	1.3535
30	0.6641	6.4054	1.3568
40	0.8509	3.5028	1.3472
50	0.7349	5.3494	1.3359
60	0.4646	9.5891	1.3447
70	0.8500	1.7994	1.3776
80	0.5937	8.2640	1.3618
90	0.4946	7.7663	1.3828

TABLE - 4.11 B

VALUES OF e_0, e_1 and e_2 FOR DIFFERENT ORIENTATIONS

KCl

Orientation A	Value of (e_0)	Value of (e_1) $\times 10^{-2}$	Value of (e_2) $\times 10^{-4}$
0	-2.3668	5.3441	6.2887
10	-2.4267	5.3689	6.2782
20	-2.5893	5.6897	6.1366
30	-2.8489	5.6931	6.1449
40	-3.0865	5.8830	6.0503
50	-3.0865	5.8830	6.0503
60	-2.4575	5.2875	6.1558
70	-2.4727	5.5083	6.1995
80	-2.7652	5.6566	6.2014
90	-2.6547	5.4721	6.2956

TABLE - 4.11 C

VALUES OF e_0, e_1 and e_2 FOR DIFFERENT ORIENTATIONS

KBr

Orientation A	Value of (e_0)	Value of (e_1) $\times 10^{-2}$	Value of (e_2) 10^{-4}
0	-0.3757	1.6208	5.2039
10	-0.2369	1.5366	5.1766
20	-0.2478	1.5318	5.0873
30	-2.3176	4.5707	4.1646
40	-1.7153	3.7366	4.2745
50	-1.7259	3.7511	4.2567
60	-2.2161	4.4644	4.1820
70	-0.2568	1.4155	5.1112
80	-0.1685	1.4524	5.1951
90	-0.1748	1.4413	5.2329

TABLE - 4.12 A

VALUES OF e_1 AND e_2 FROM THE PLOT OF P/d Vs d

NaCl

Orientation	$e_1 \times 10^{-2}$	$e_2 \times 10^{-3}$
0	2.02	1.333
10	2.047	1.310
20	2.157	1.300
30	2.440	1.287
40	2.541	1.266
50	2.557	1.257
60	2.487	1.278
70	2.344	1.307
80	2.147	1.345
90	2.001	1.447

TABLE - 4.12 B

VALUES OF e_1 AND e_2 FROM THE PLOT OF P/d Vs d

KCl

Orientation	$e_1 \times 10^{-2}$	$e_2 \times 10^{-4}$
0	4.917	7.248
10	5.019	7.018
20	5.307	6.917
30	5.441	6.741
40	5.667	6.189
50	5.601	5.997
60	5.417	6.214
70	5.337	6.707
80	5.337	6.707
90	4.885	7.018

TABLE - 4.12 C

VALUES OF e_1 AND e_2 FROM THE PLOT OF P/d Vs d

KBr

Orientation	$e_1 \times 10^{-2}$	$e_2 \times 10^{-4}$
0	0.814	5.429
10	1.242	5.286
20	1.00	5.200
30	3.732	5.067
40	4.125	4.935
50	3.981	4.315
60	3.61	5.098
70	2.91	5.198
80	1.428	5.323
90	1.071	5.714

TABLE - 4.13 A

VALUES OF 'P' AND 'd' AT 'f_1', 'f_2' AND 'f_3' FROM THE PLOT OF P/d^2 Vs $\frac{1}{d}$.

NaCl

Orientation	f_1		f_3		Range (f_1 - f_3)		f_2		Load at kink
A	P in gm	d in μ	P in gm	d in μ	$P_{f_1}-P_{f_3}$	$d_{f_1}-d_{f_3}$	P in gm	d in μ	
0	12.10	100.00	5.08	63.29	7.01	36.71	8.71	80.60	6.0
10	12.10	100.00	4.92	62.5	7.17	36.71	9.00	81.96	6.9
20	12.69	104.16	5.13	64.10	7.55	40.06	9.55	84.74	8.5
30	13.95	111.11	5.23	65.78	8.71	45.32	10.28	89.28	9.3
40	17.42	128.20	5.86	71.42	11.55	56.77	11.82	98.03	9.7
50	18.17	131.57	5.93	72.46	12.24	59.11	12.10	100.00	10.5
60	13.95	111.11	5.23	65.75	8.71	45.35	10.28	89.75	9.7
70	13.70	108.69	5.86	68.49	7.83	40.20	9.40	84.74	9.5
80	12.49	102.04	4.88	62.5	7.61	39.54	9.30	83.33	8.0
90	12.00	100.00	4.90	62.5	7.03	37.5	9.07	81.96	8.4

TABLE - 4.13 B

VALUES OF 'P' AND 'd' AT 'f_1', 'f_2' AND 'f_3' FROM THE PLOT OF P/d^2 Vs $\frac{1}{d}$.

KCl

Orientation	f_1		f_3		Range(f_1 - f_3)		f_2		Load at
A	P in gm	d in u	P in gm	d in u	$P_{f_1}-P_{f_3}$	$d_{f_1}-d_{f_3}$	P in gm	d in u	kink
0	11.89	116.28	2.43	53.19	9.46	63.08	5.10	71.42	5.0
10	10.51	108.69	2.59	55.55	7.92	53.15	5.10	71.42	5.3
20	11.76	116.28	2.67	56.81	9.08	59.46	7.58	86.20	6.9
30	13.44	125.00	3.16	62.50	10.27	62.50	8.69	96.15	7.5
40	14.54	131.57	3.24	64.10	11.29	67.46	8.74	98.03	8.5
50	13.57	128.80	3.75	68.49	10.21	59.71	8.74	98.03	8.5
60	13.80	128.20	3.41	65.78	10.38	62.41	8.84	98.03	8.0
70	12.64	121.95	2.58	56.17	10.05	65.77	5.40	73.52	6.0
80	8.90	100.00	2.65	55.55	6.24	44.44	5.45	70.42	5.4
90	10.37	111.11	2.45	53.76	7.91	57.34	5.15	71.42	5.4

TABLE - 4.13 C

VALUES OF 'P' AND 'd' AT 'f_1','f_2' AND 'f_3' FROM THE PLOT OF P/d^2 Vs $\frac{1}{d}$.

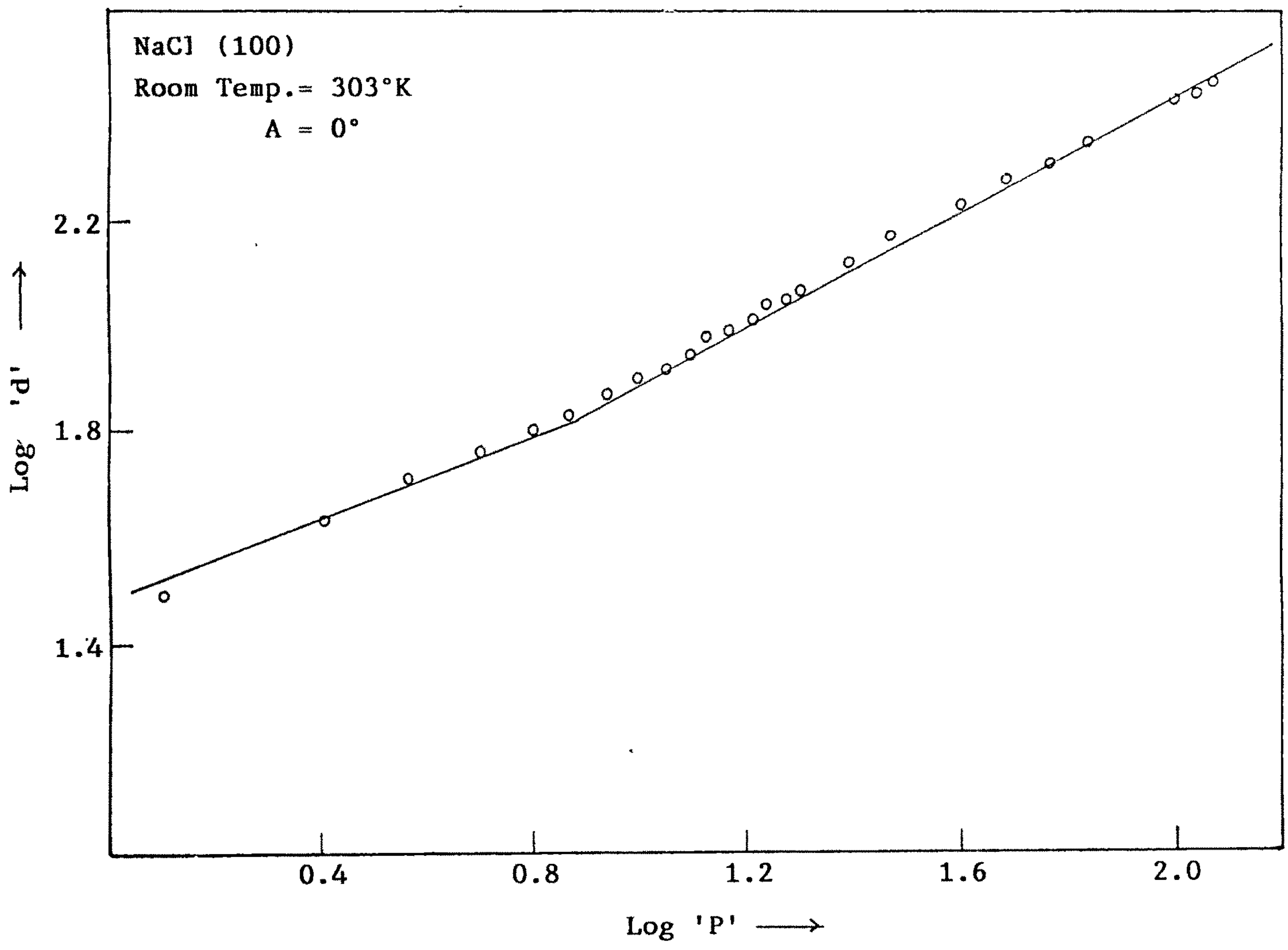
KBr

Orientation	f_1		f_3		Range (f_1 - f_3)		f_2		Load at kink
A	P in gm	d in μ	P in gm	d in μ	$P_{f_1} - P_{f_3}$	$d_{f_1} - d_{f_3}$	P in gm	d in μ	
0	20.29	188.67	4.97	83.45	15.31	95.22	11.27	123.45	8.51
10	19.20	185.18	5.07	14.12	14.12	89.95	12.16	128.16	8.60
20	19.93	188.68	5:07	94.33	14.86	94.33	13.69	136.98	12.30
30	25.67	222.22	5.08	96.15	20.50	126.06	16.06	151.51	13.15
40	29.47	238.09	3.16	78.74	26.31	159.35	18.88	166.66	15.00
50	29.44	243.99	3.12	77.51	26.61	166.38	18.88	166.66	15.15
60	27.37	227.27	4.00	86.95	23.36	140.31	16.29	151.51	13.61
70	18.86	185.18	4.71	91.74	14.24	93.44	14.08	138.88	12.14
80	21.07	192.30	4.79	90.90	16.28	101.39	12.48	129.87	9.00
90	19.17	181.81	4.09	85.47	15.08	96.34	11.43	123.45	8.50

TABLE - 4.14

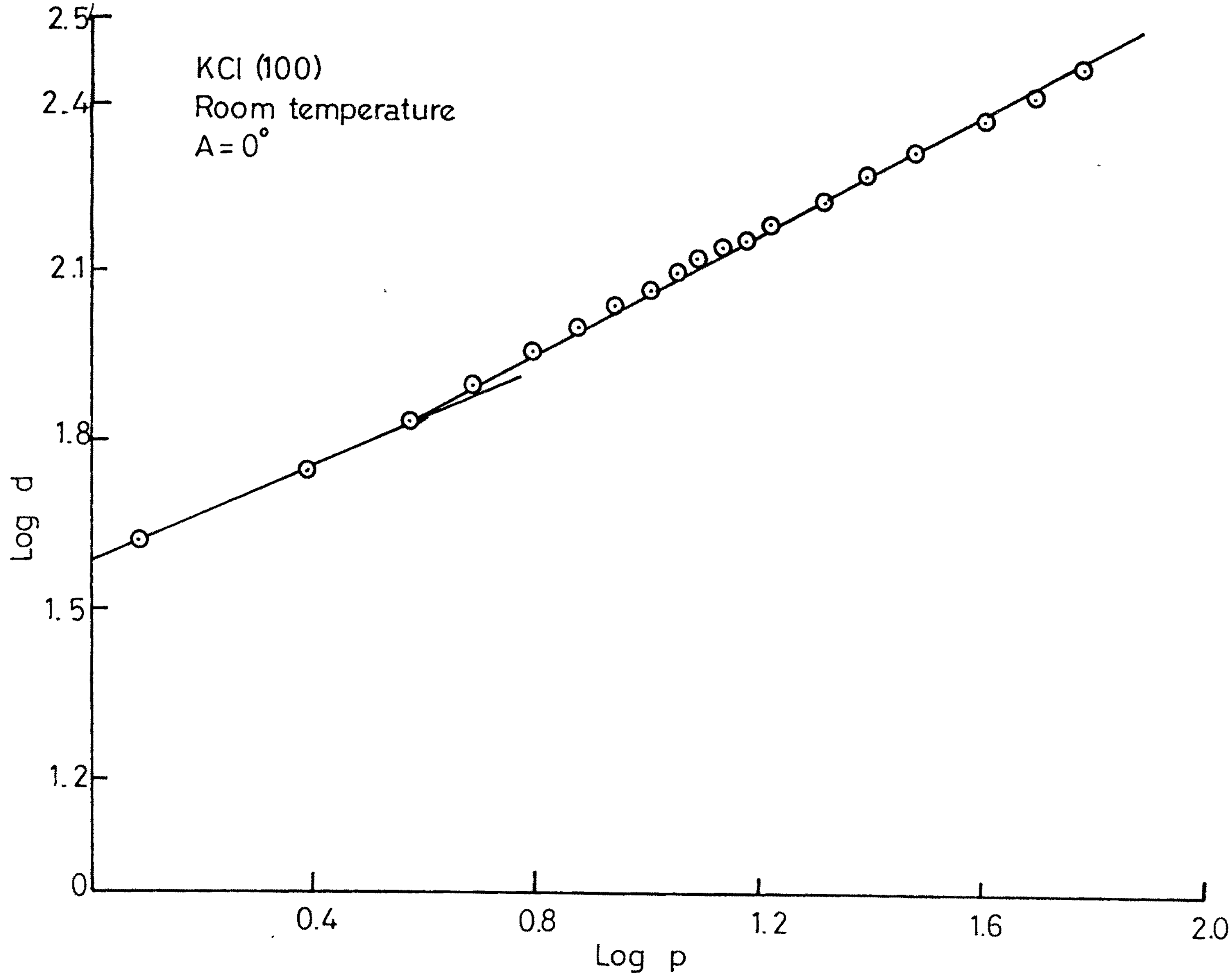
KBr

		(a) $P = ad^n$		(b) $P = e_0+e_1d+e_2d^2$	
P	$d_{obs.}$	$d_{cal.}$	% devia.	$d_{cal.}$	% devia.
1.25	48.96	45.36	-7.94	48.39	-1.18
2.50	68.54	64.49	-6.28	67.01	-2.28
3.75	81.60	79.24	-2.98	81.68	0.09
5.00	93.02	91.70	-1.44	94.19	1.24
6.25	102.00	102.71	0.69	105.28	3.12
7.50	110.16	112.68	2.24	115.35	4.50
8.75	116.68	121.85	4.24	124.63	6.38
10.00	118.32	130.40	9.26	133.28	11.22
11.25	123.22	138.44	10.99	146.05	15.63
12.50	135.05	146.05	7.53	149.14	9.45
13.75	144.43	153.29	5.78	151.26	4.52
15.00	153.41	160.22	4.25	163.22	6.18
16.25	161.57	166.87	3.18	170.25	5.09
17.50	169.73	173.27	2.04	176.74	3.97
18.75	181.15	179.45	-0.95	182.98	0.99
20.00	186.05	185.42	-0.34	189.06	1.59
20.00	186.05	185.42	-0.34	189.06	1.59
25.00	208.90	207.67	-0.59	211.61	1.28
30.00	229.30	227.82	-0.65	232.02	1.17
40.00	266.02	263.65	-0.89	268.29	1.17
50.00	297.02	295.28	-0.59	300.27	1.08
60.00	326.40	323.96	-0.75	329.20	0.85
80.00	375.36	379.92	1.20	380.59	1.37
100.00	424.30	419.91	-1.04	425.88	0.37
110.00	444.70	440.74	-0.89	446.82	0.47
120.00	464.30	460.65	-0.79	466.84	0.54
140.00	505.10	498.17	-1.39	504.51	-0.11



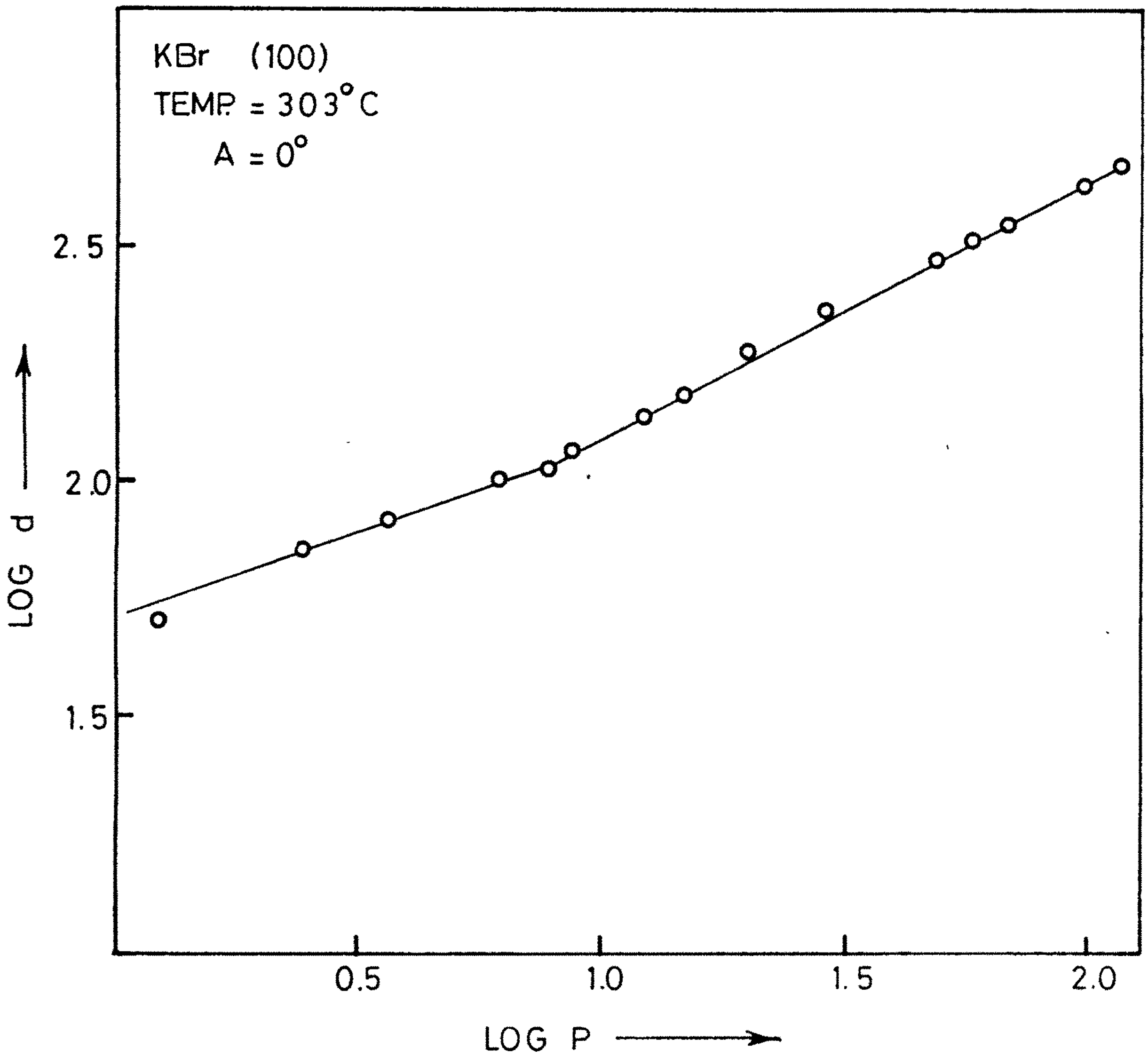
Plot of Log 'd' Vs Log 'P'

Fig. No. : 4.1 a



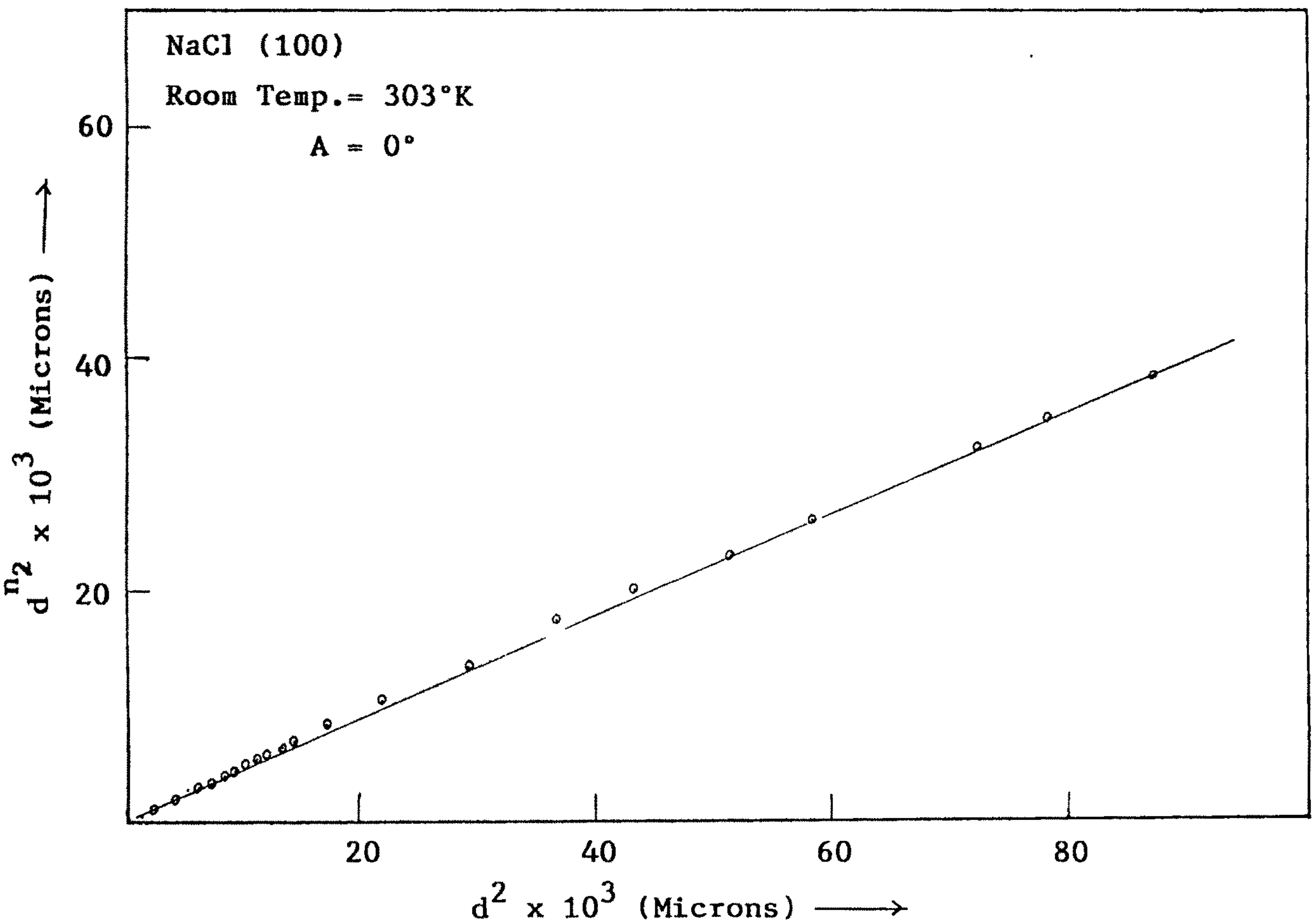
Plot of log d Vs. log p

Fig. 4.1b



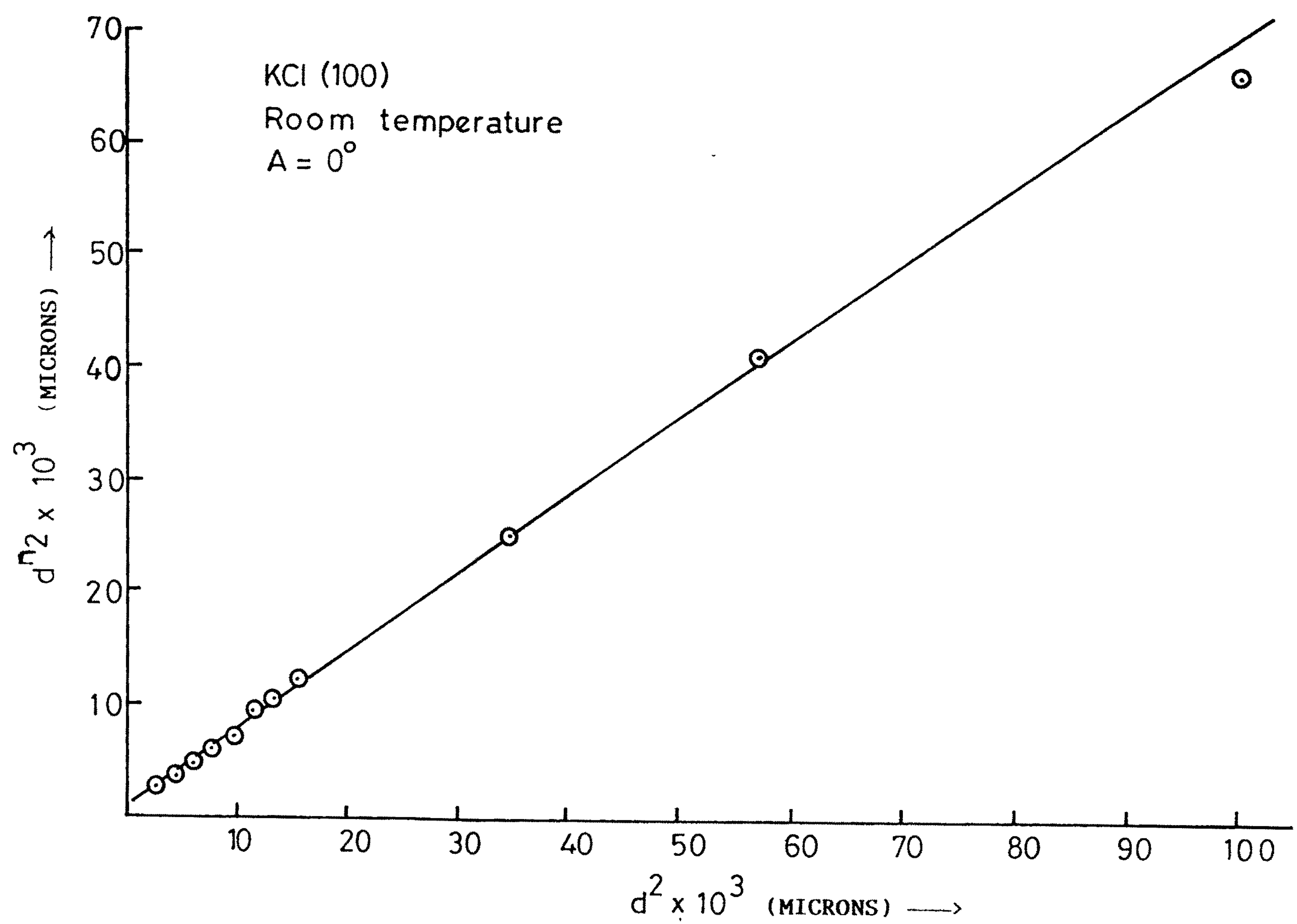
PLOT OF LOG d Vs. LOG P

Fig. 4 1c.



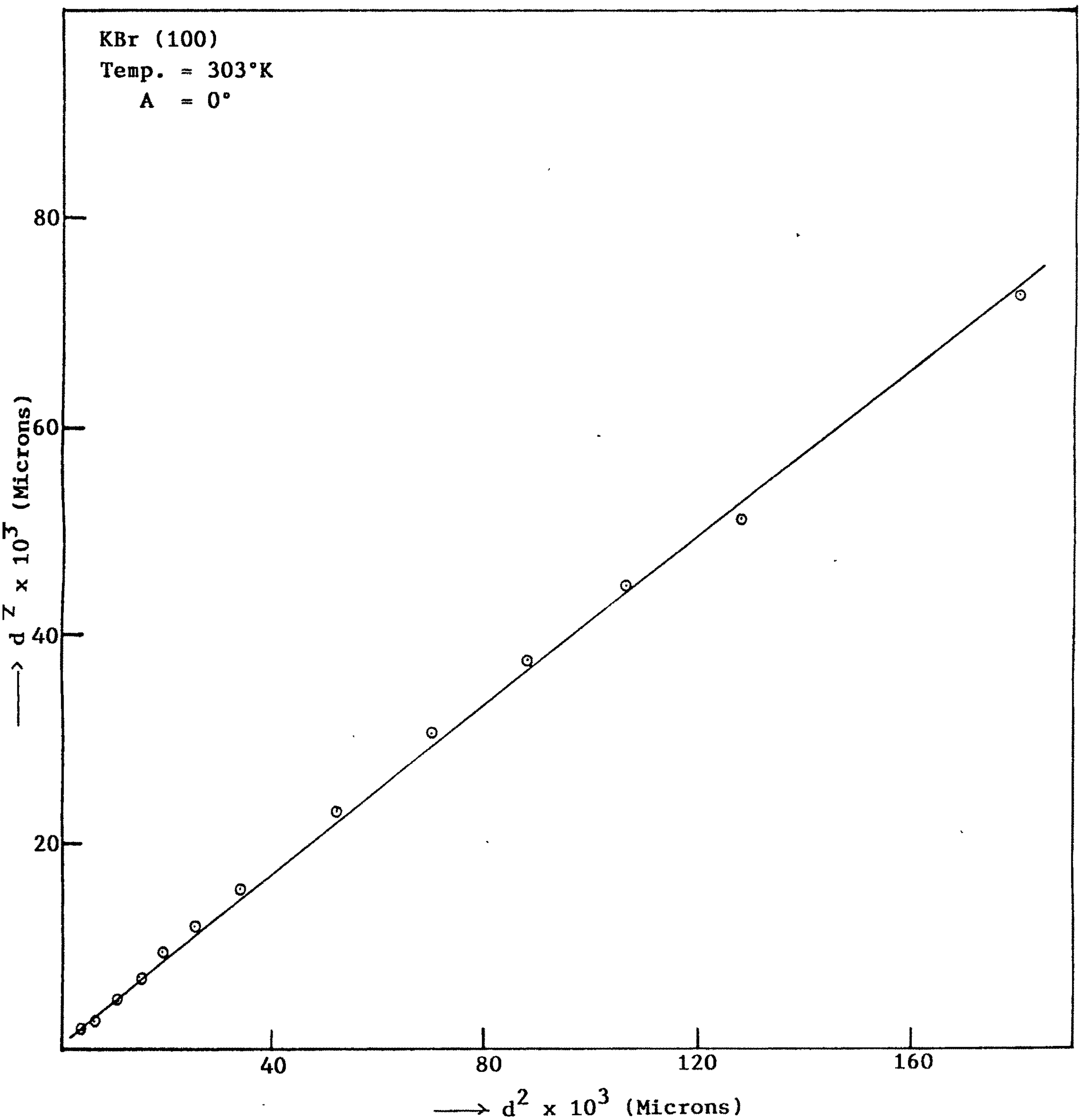
Plot of 'd^{n_2}' Vs 'd^2'

Fig. No. : 4.2 a



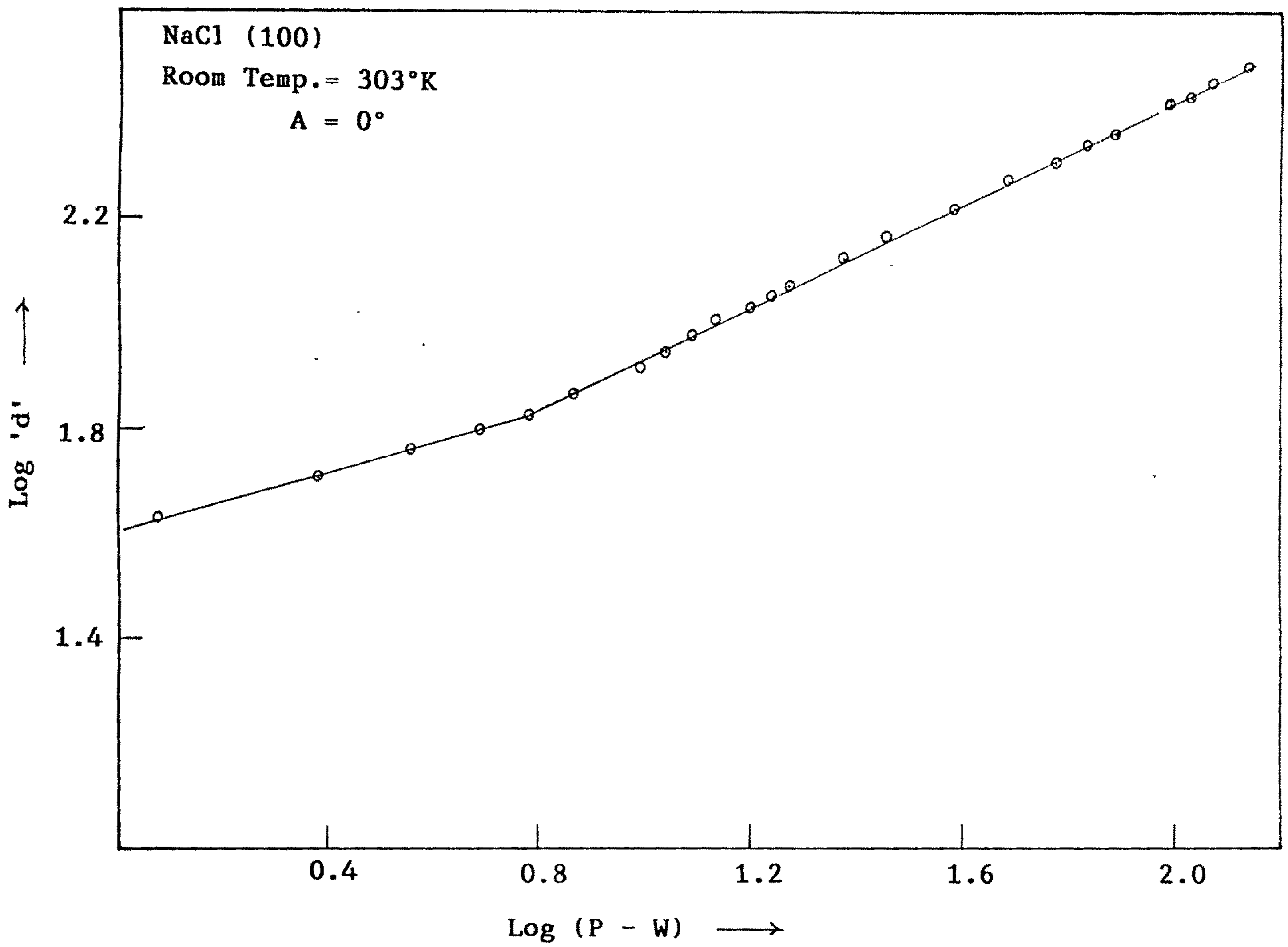
Plot of d^{n2} Vs. d^2

Fig. 4.2b



Plot of d^{n_2} Vs d^2

Fig. No.: 4.2 c



Plot of Log 'd' Vs Log (P - W)

Fig. No.: 4.3 a

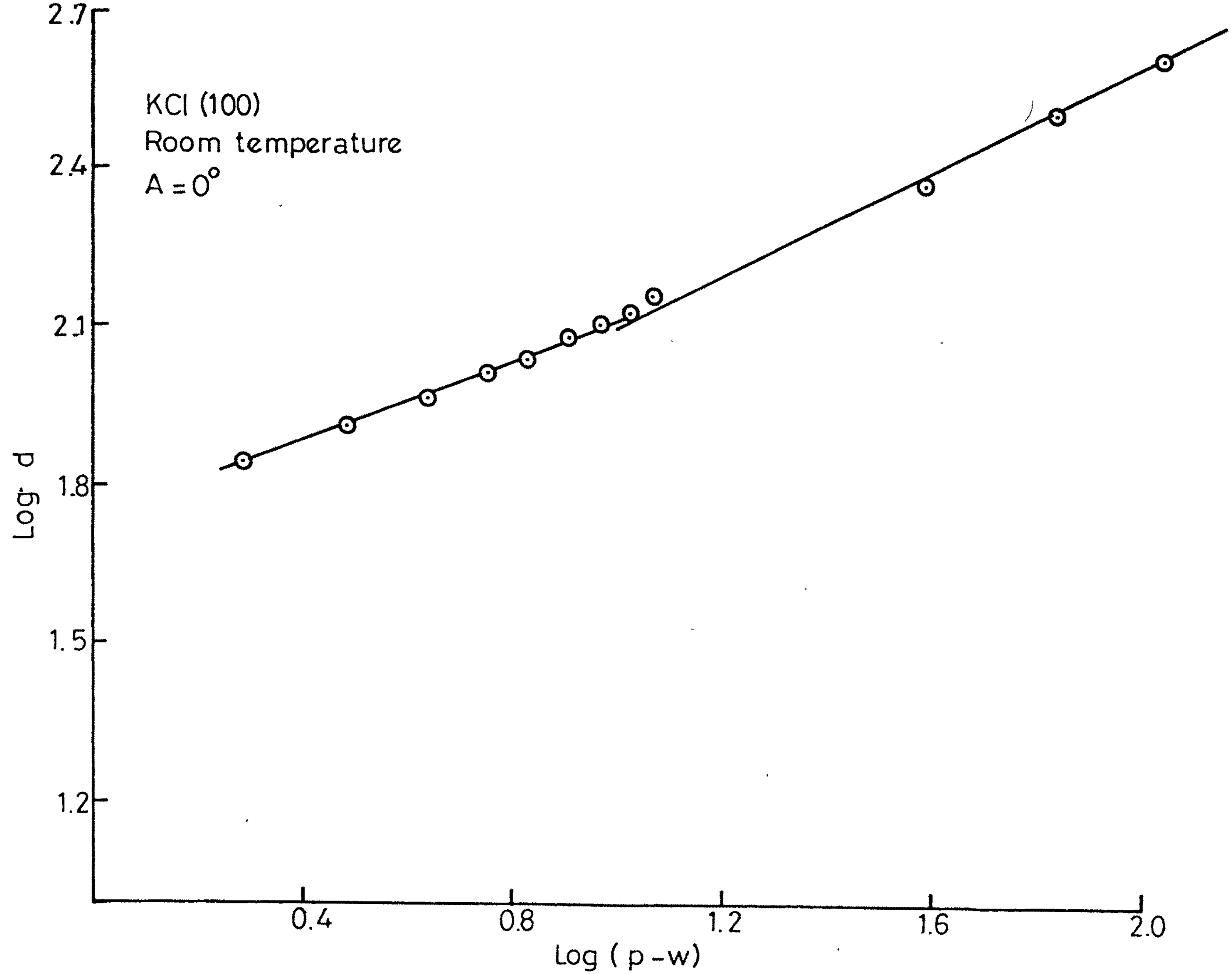
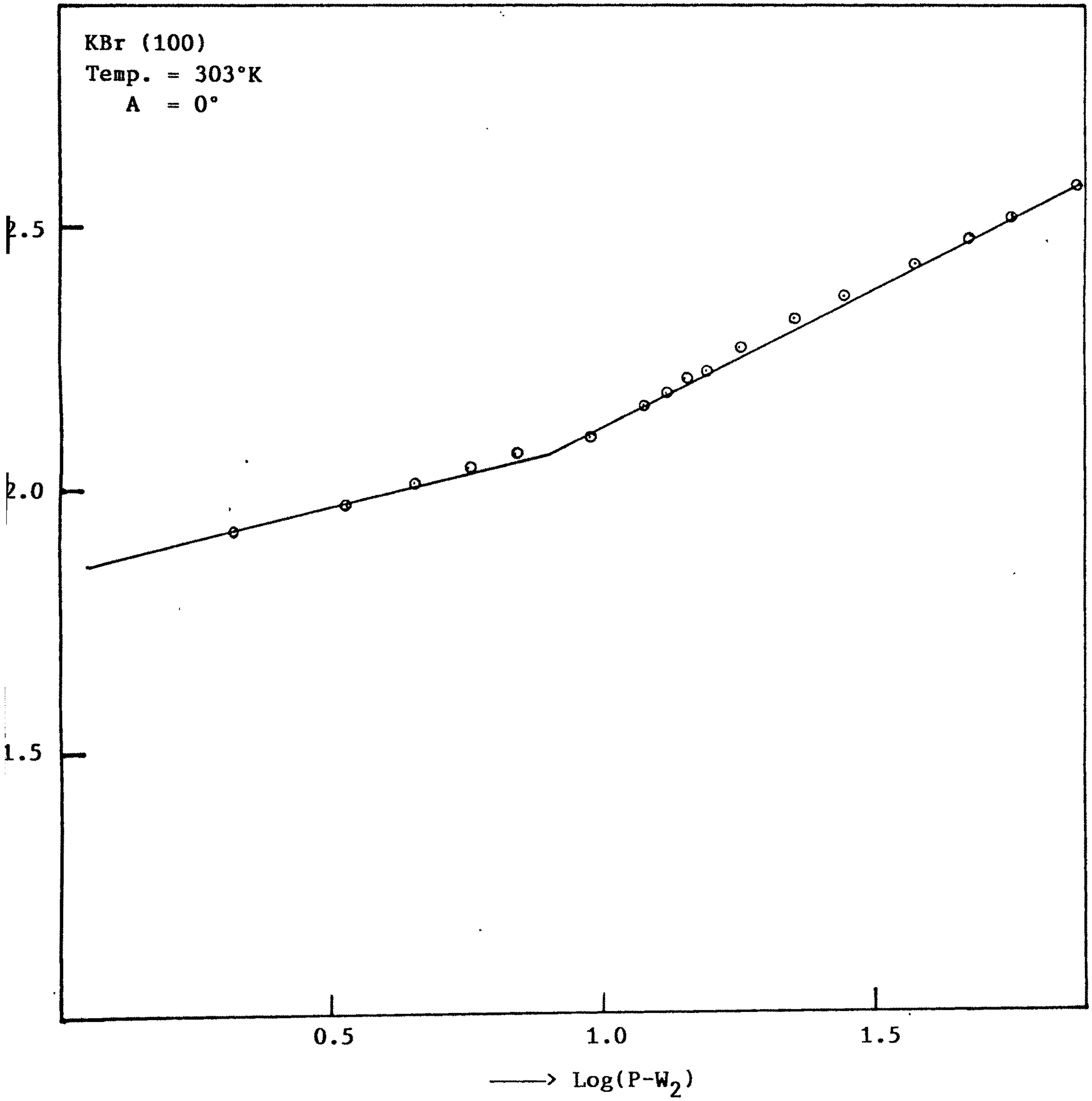
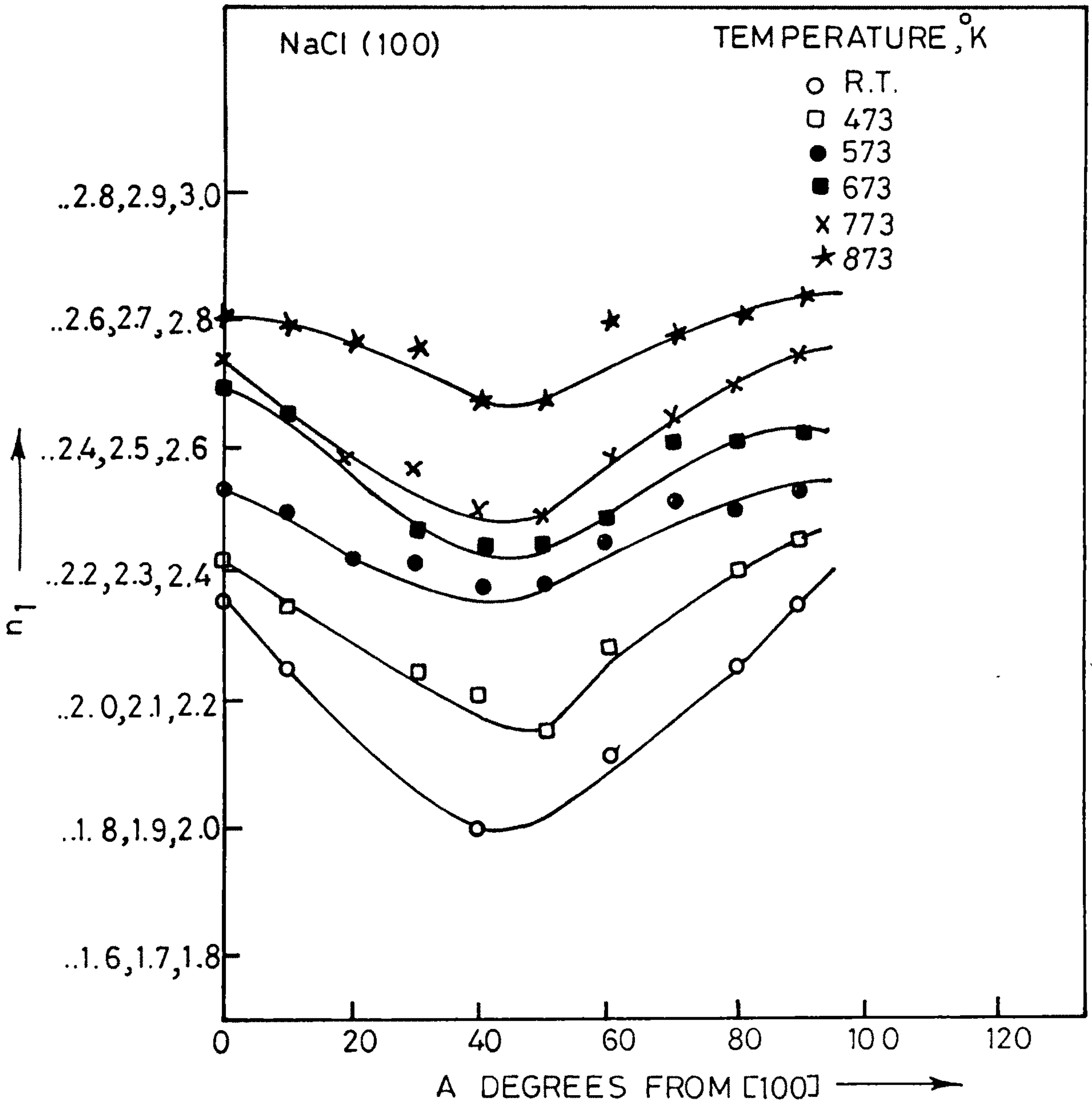


Fig.Plot of log d Vs. log (p-w)
Fig. 4. 3b

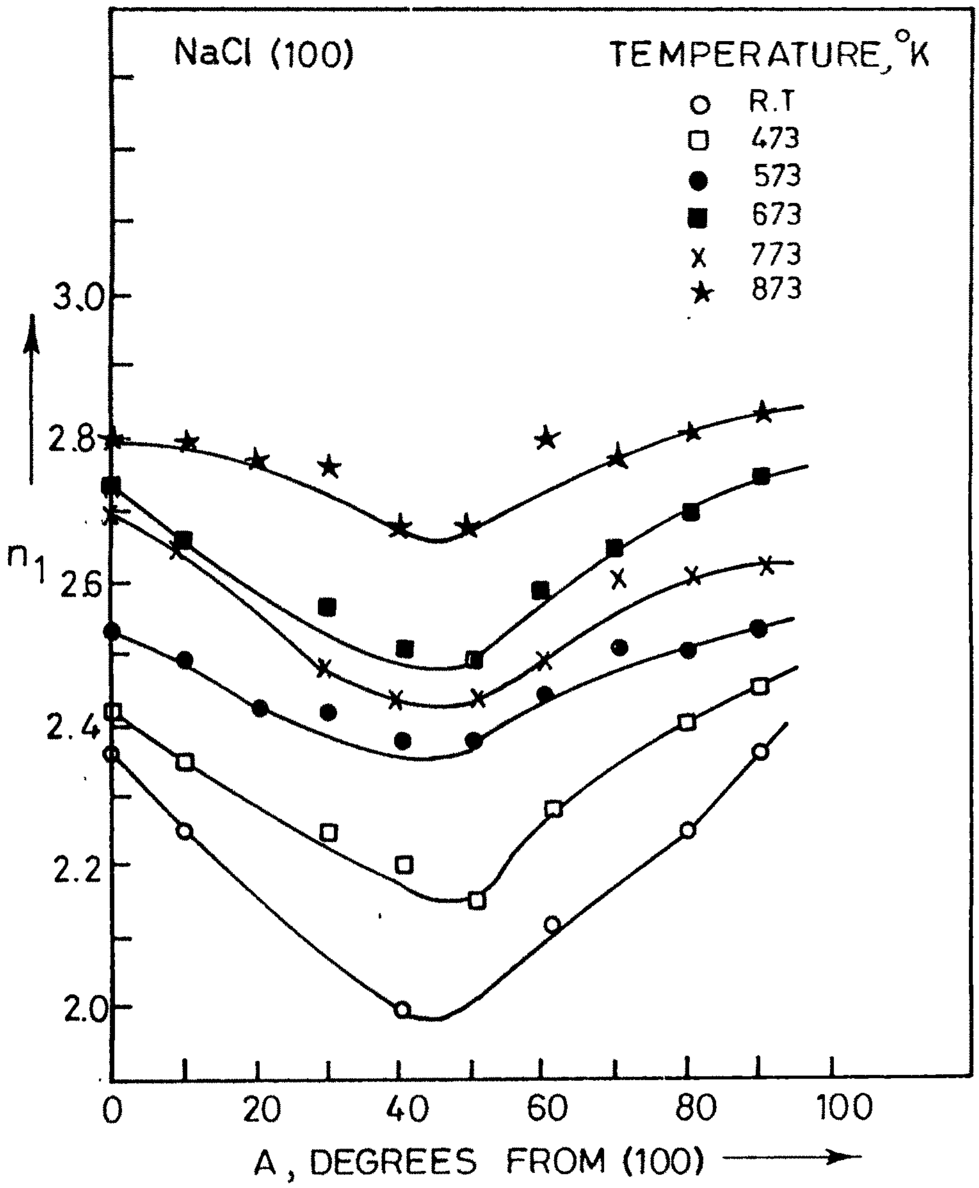


Plot of Log d Vs Log $(P-W_2)$
Fig.No.: 4.3 c



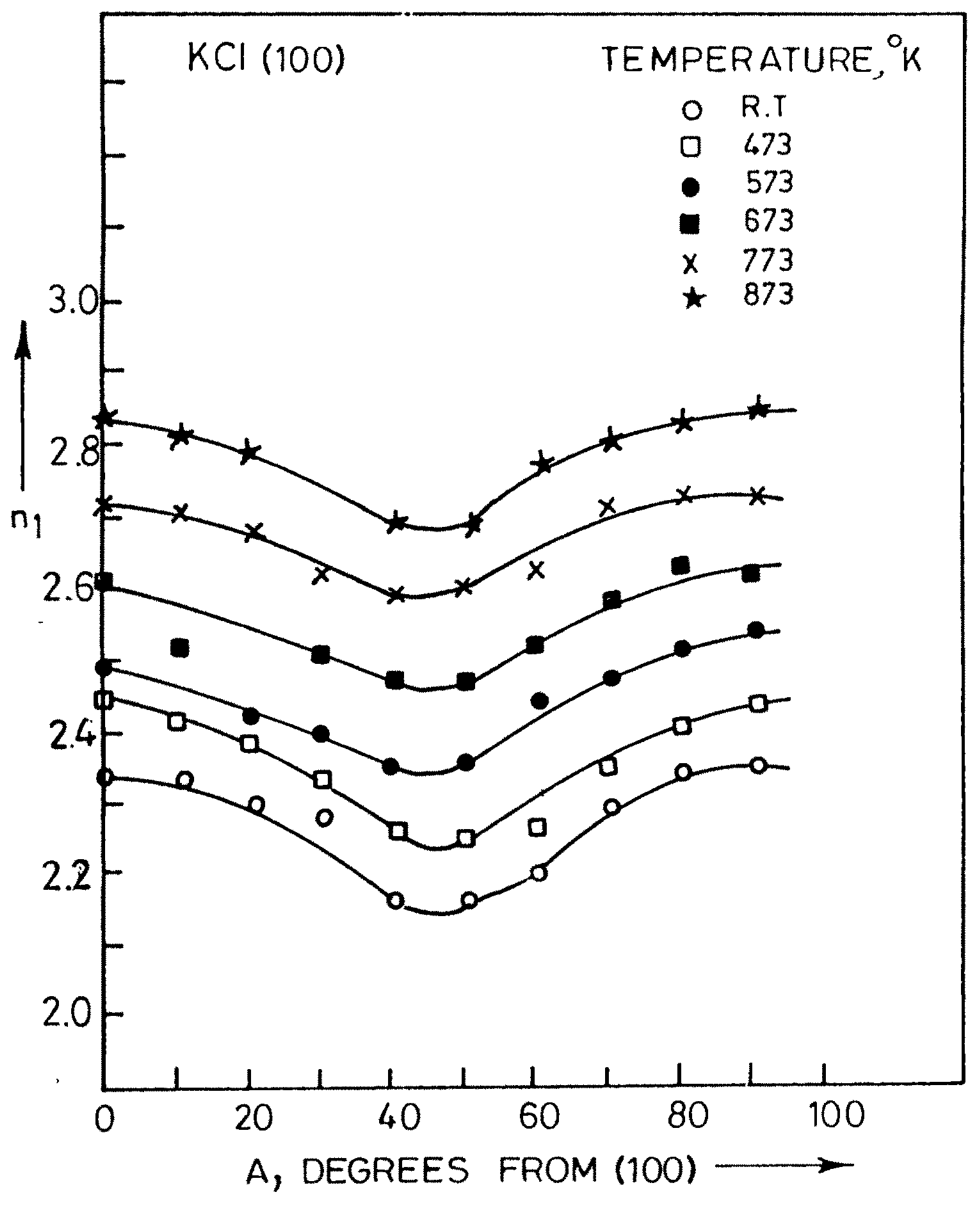
PLOT OF n_1 Vs. A

Fig. 4.4



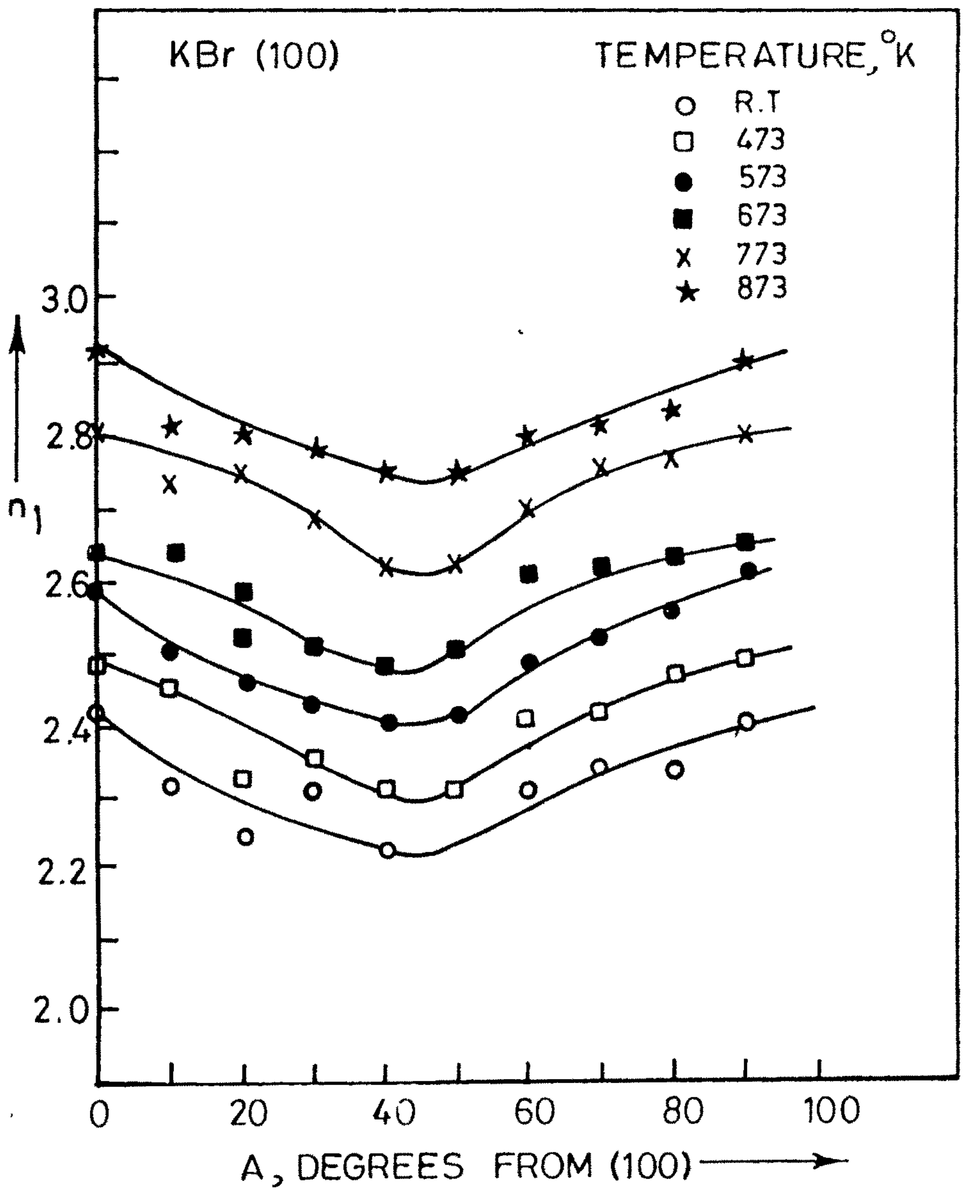
PLOT OF n_1 Vs. A.

Fig. 4.4a



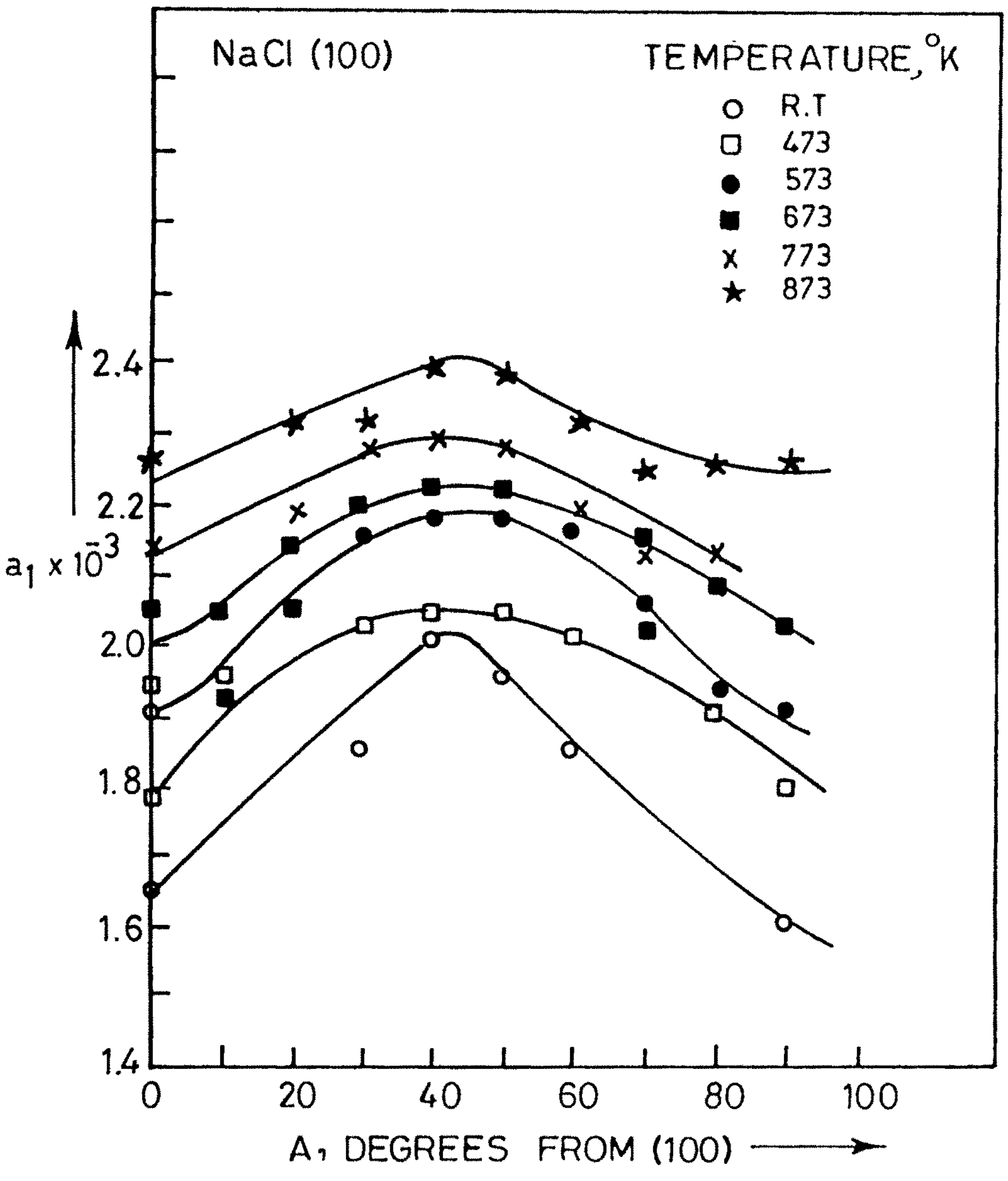
PLOT OF n_1 Vs. A.

Fig. 4.4b



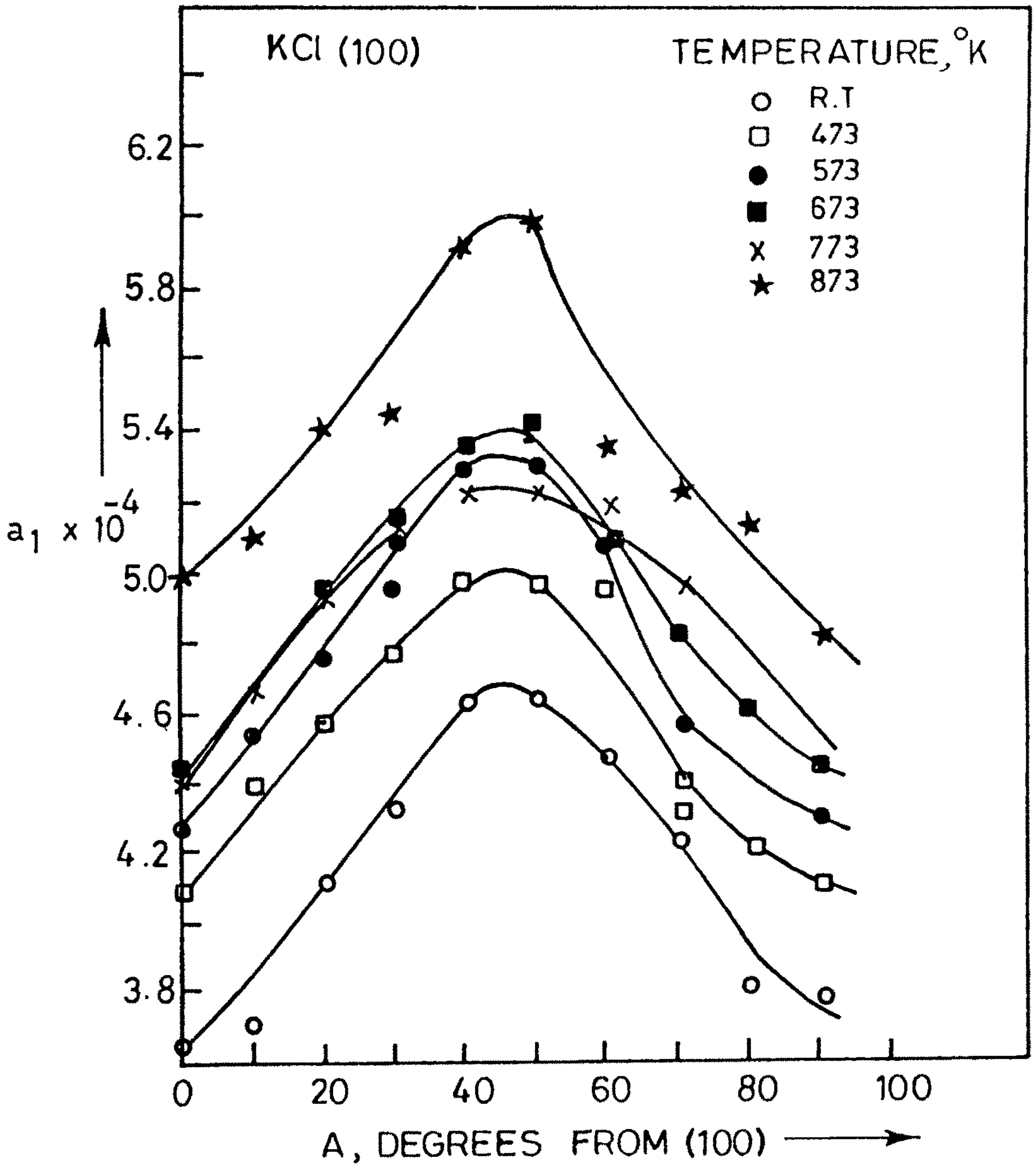
PLOT OF n_1 Vs. A.

Fig. 4.4c.



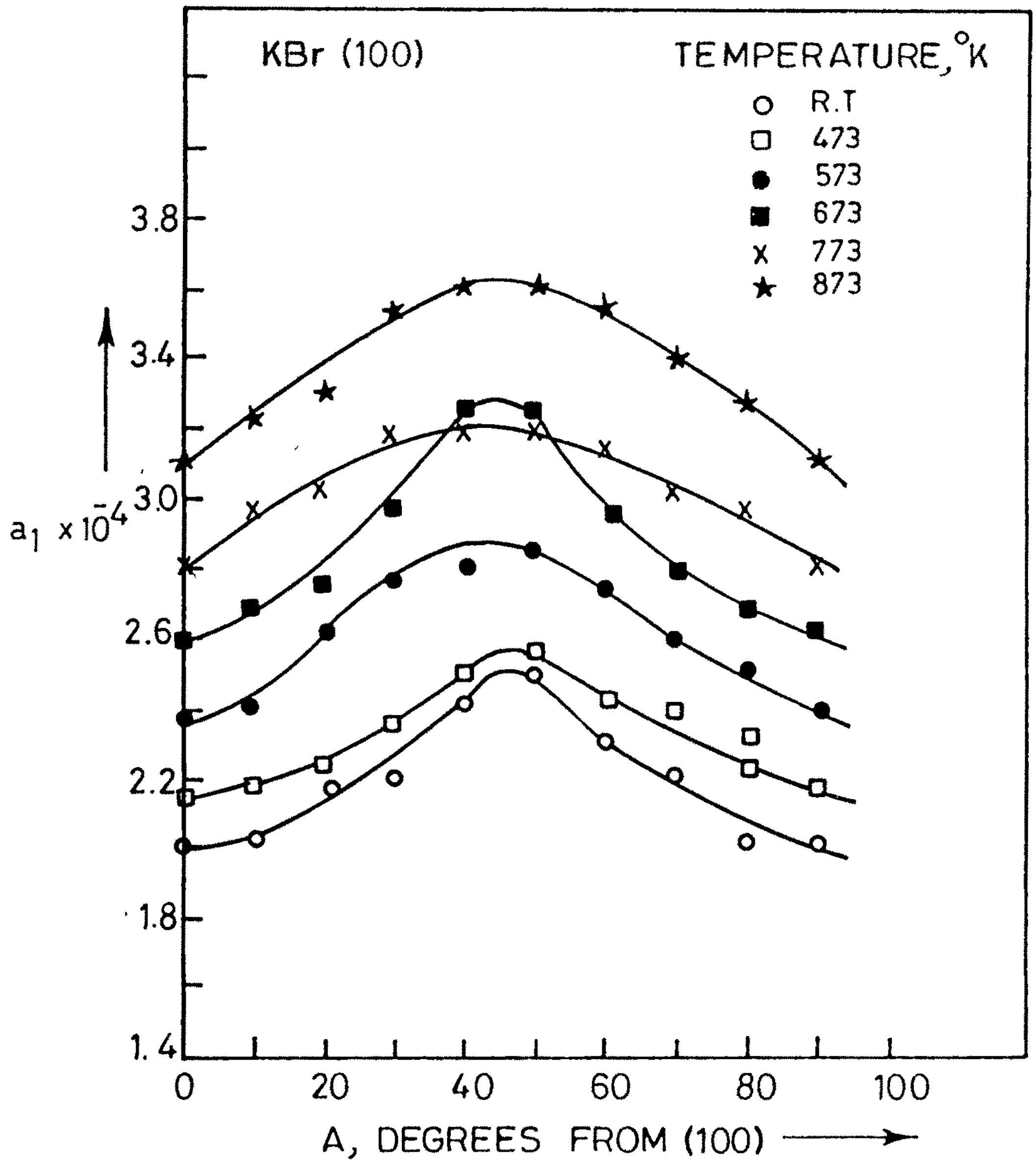
PLOT OF a_1 Vs. A.

Fig. 4.5a.



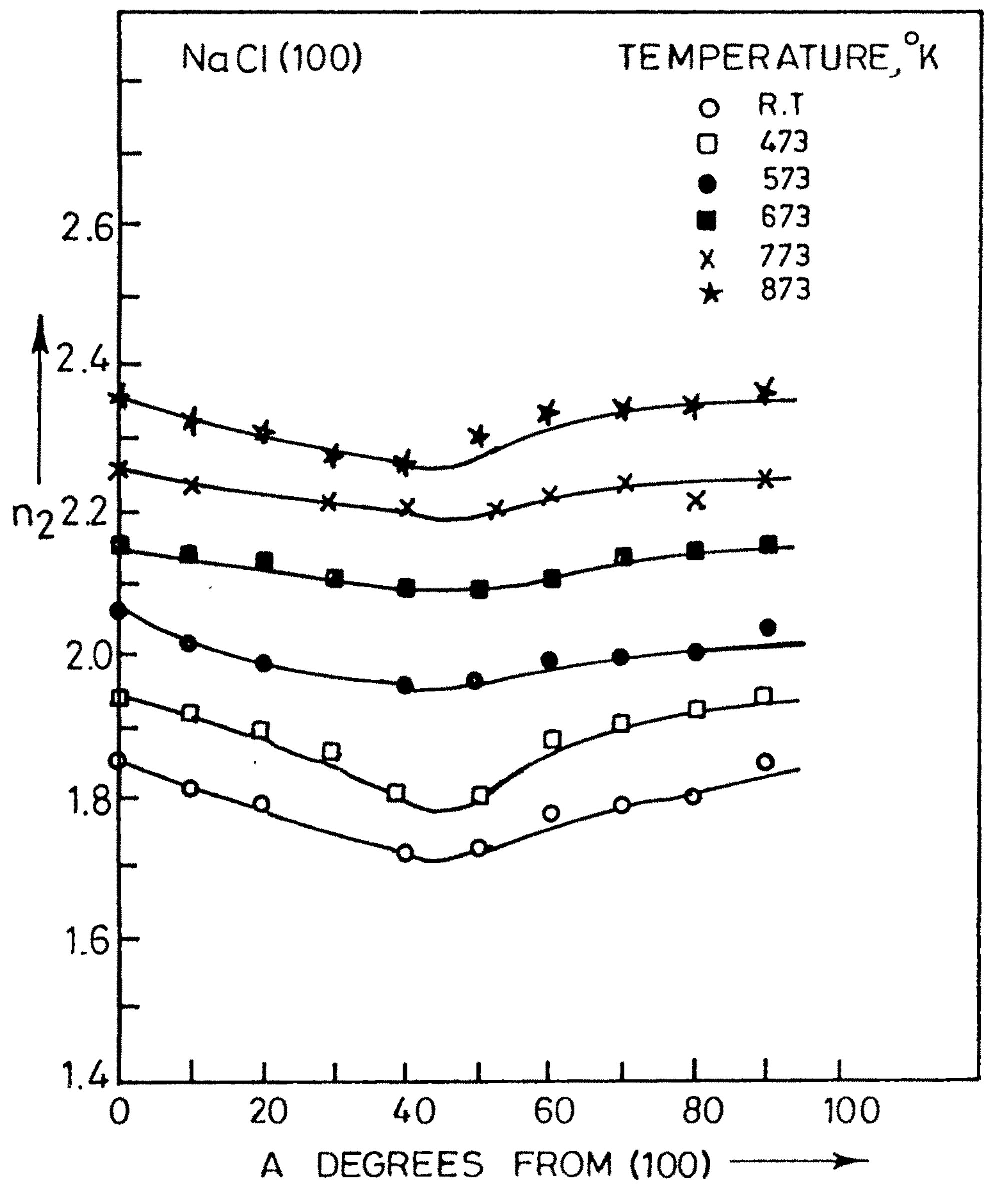
PLOT OF a_1 Vs. A.

Fig. 4.5b.



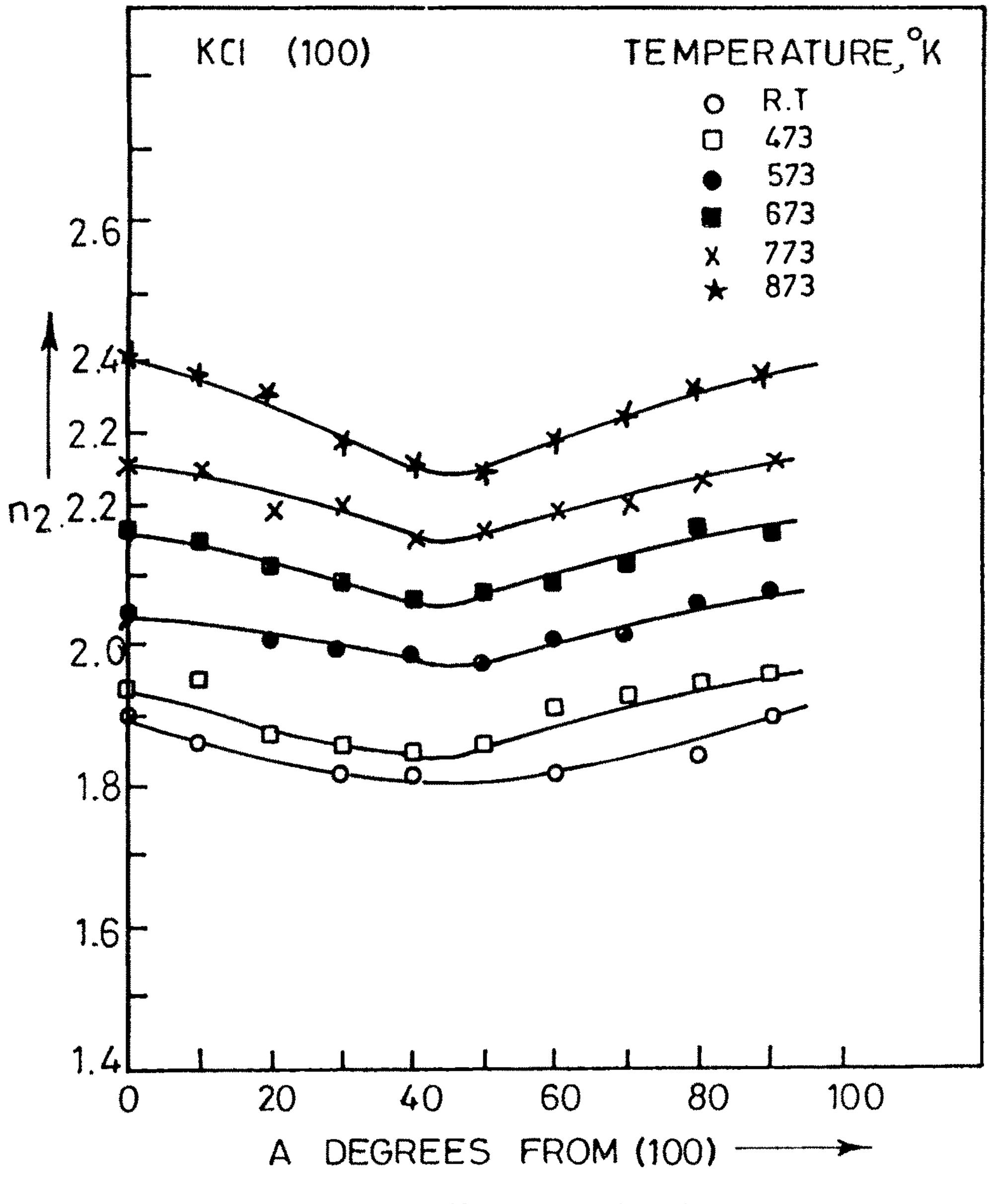
PLOT OF a_1 Vs. A.

Fig. 4.5c.



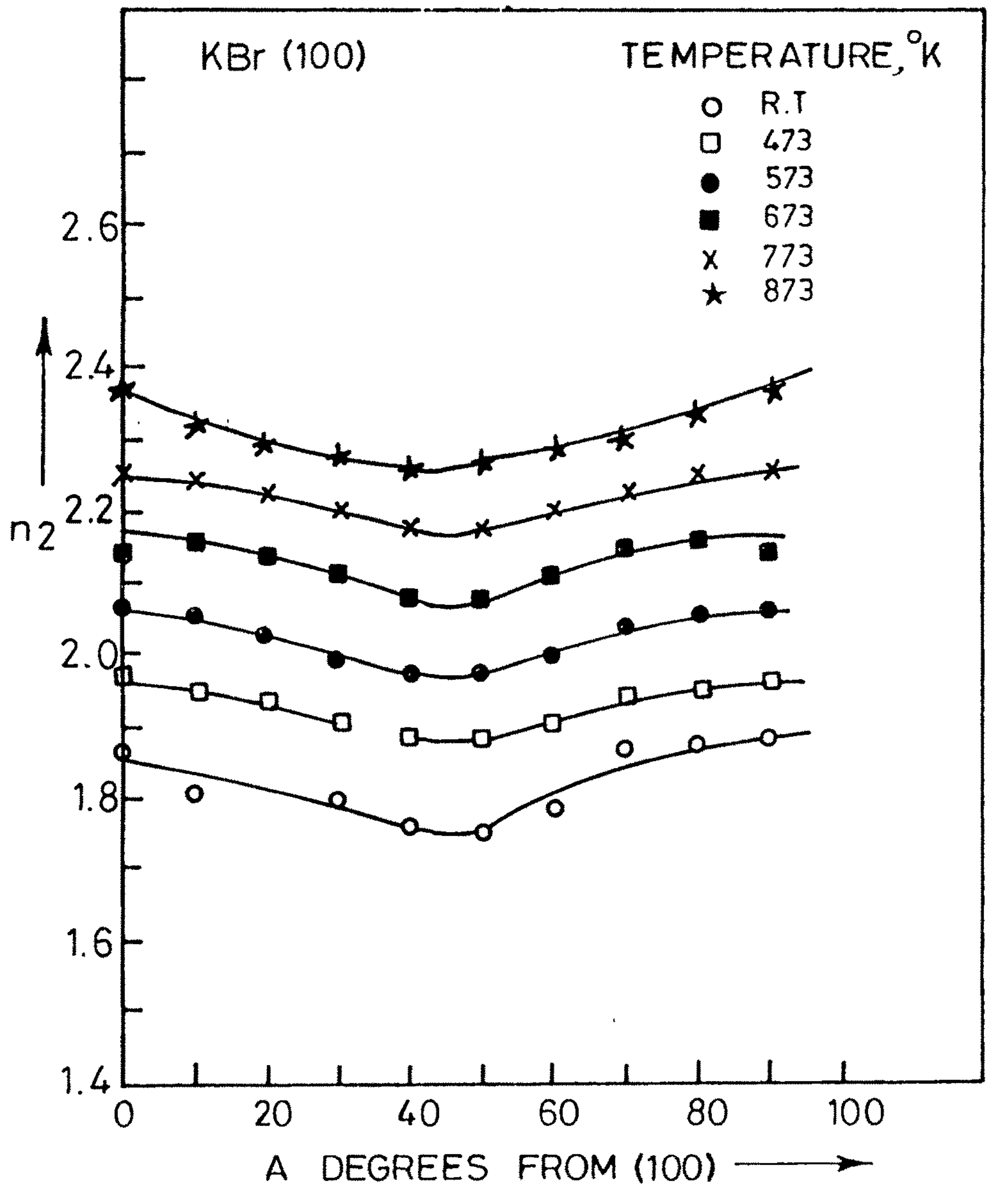
PLOT OF n_2 Vs. A.

Fig. 4.6a.



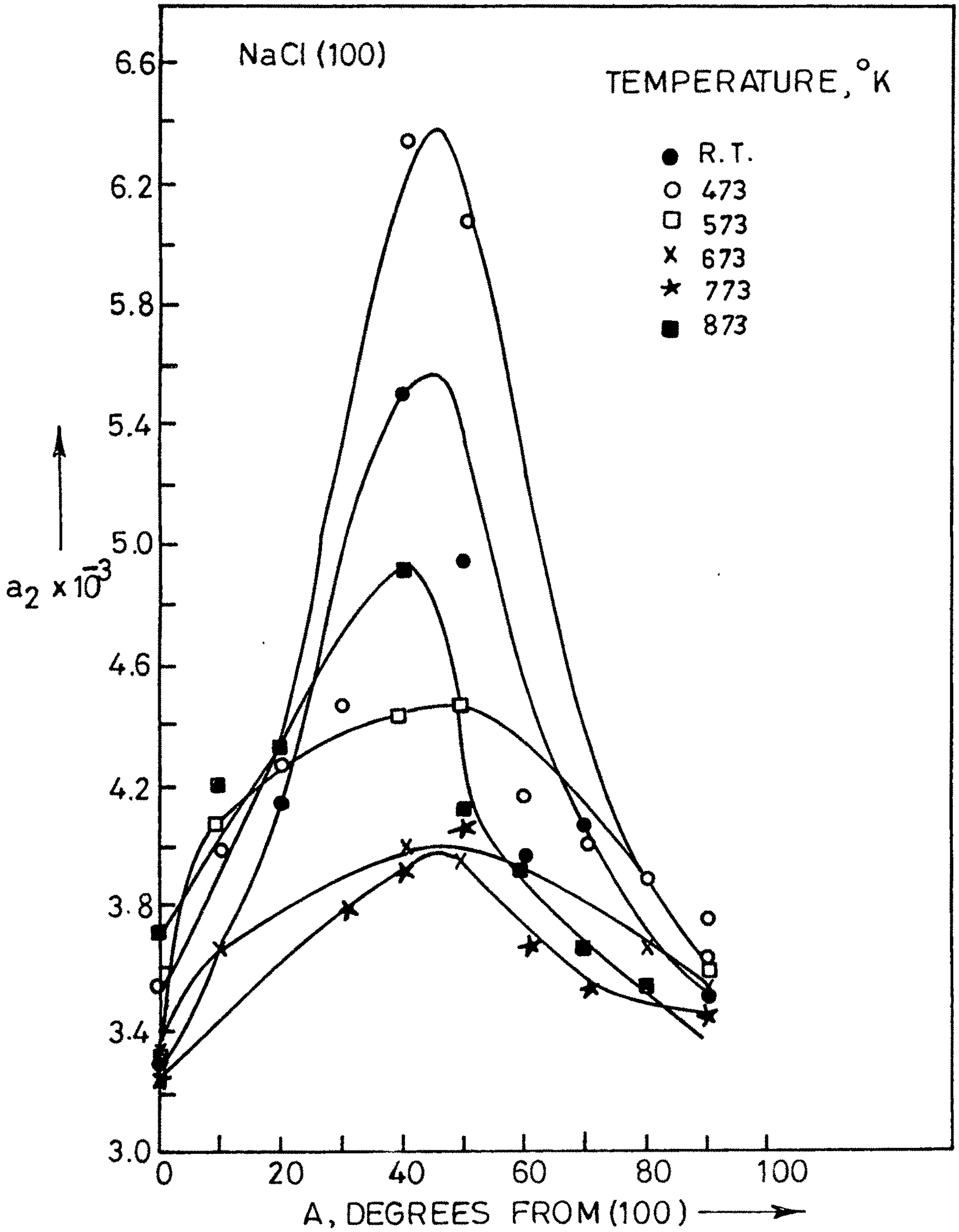
PLOT OF n_2 Vs. A.

Fig. 4.6 b.



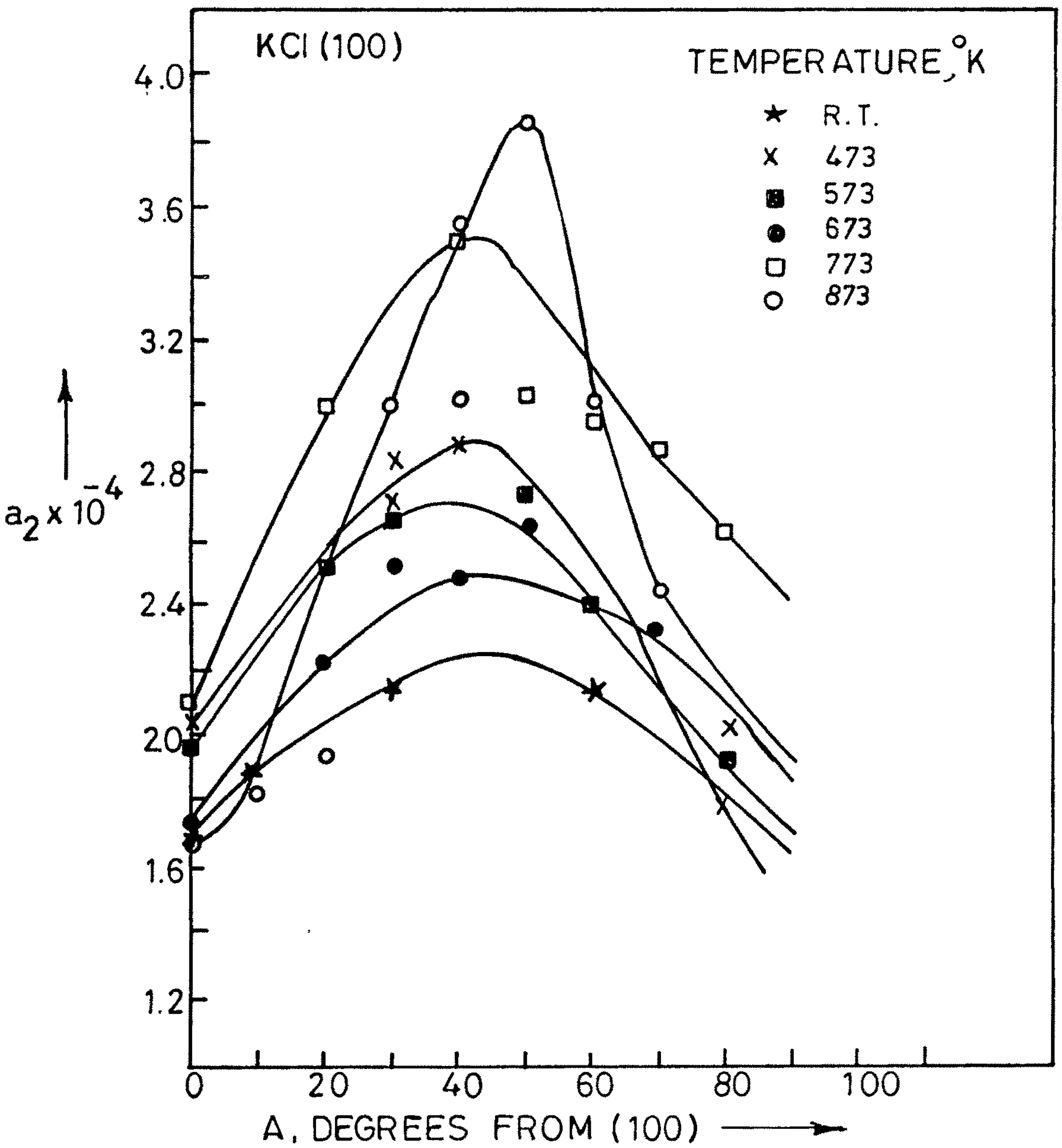
PLOT OF n_2 Vs. A.

Fig. 4.6c.



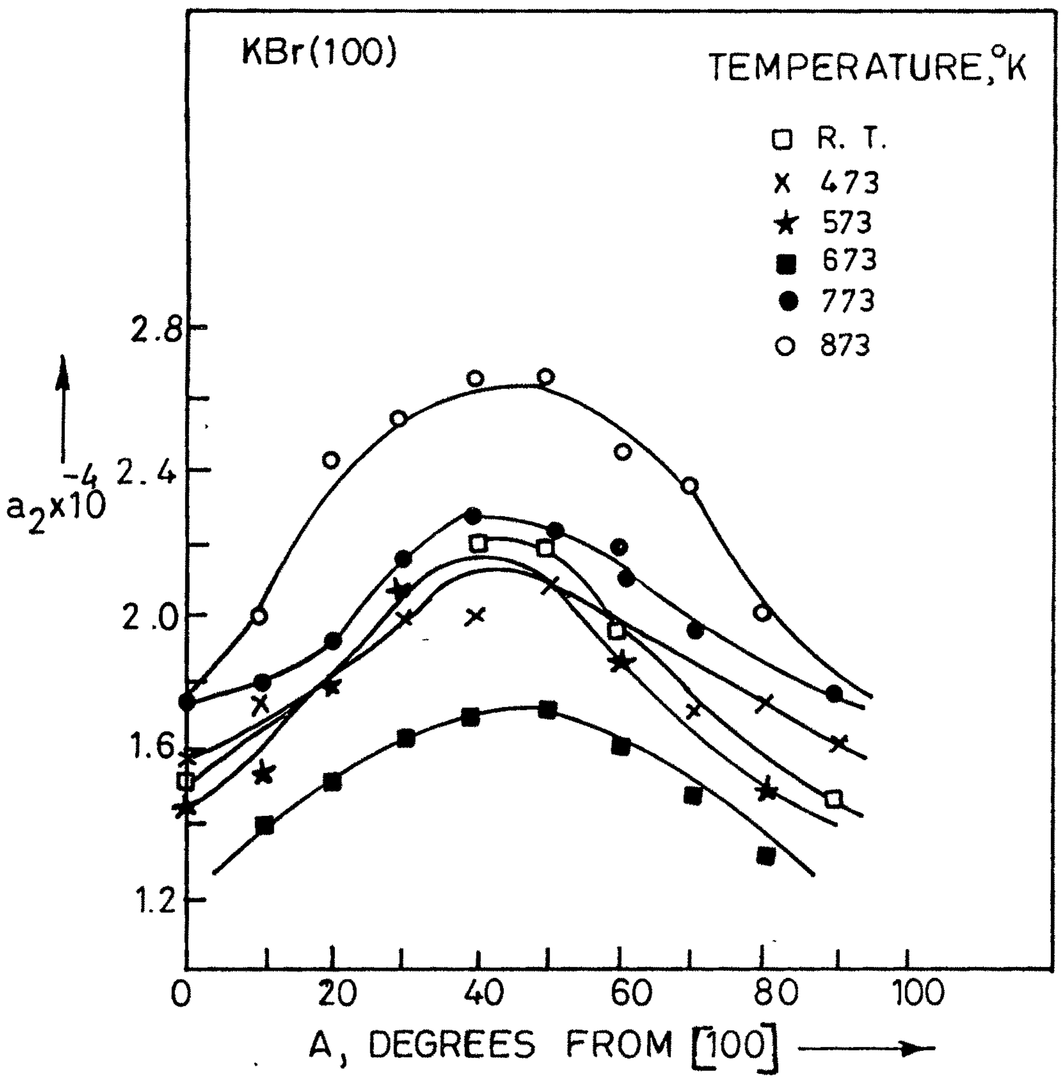
PLOT OF a_2 Vs. A

Fig. 4.7a.



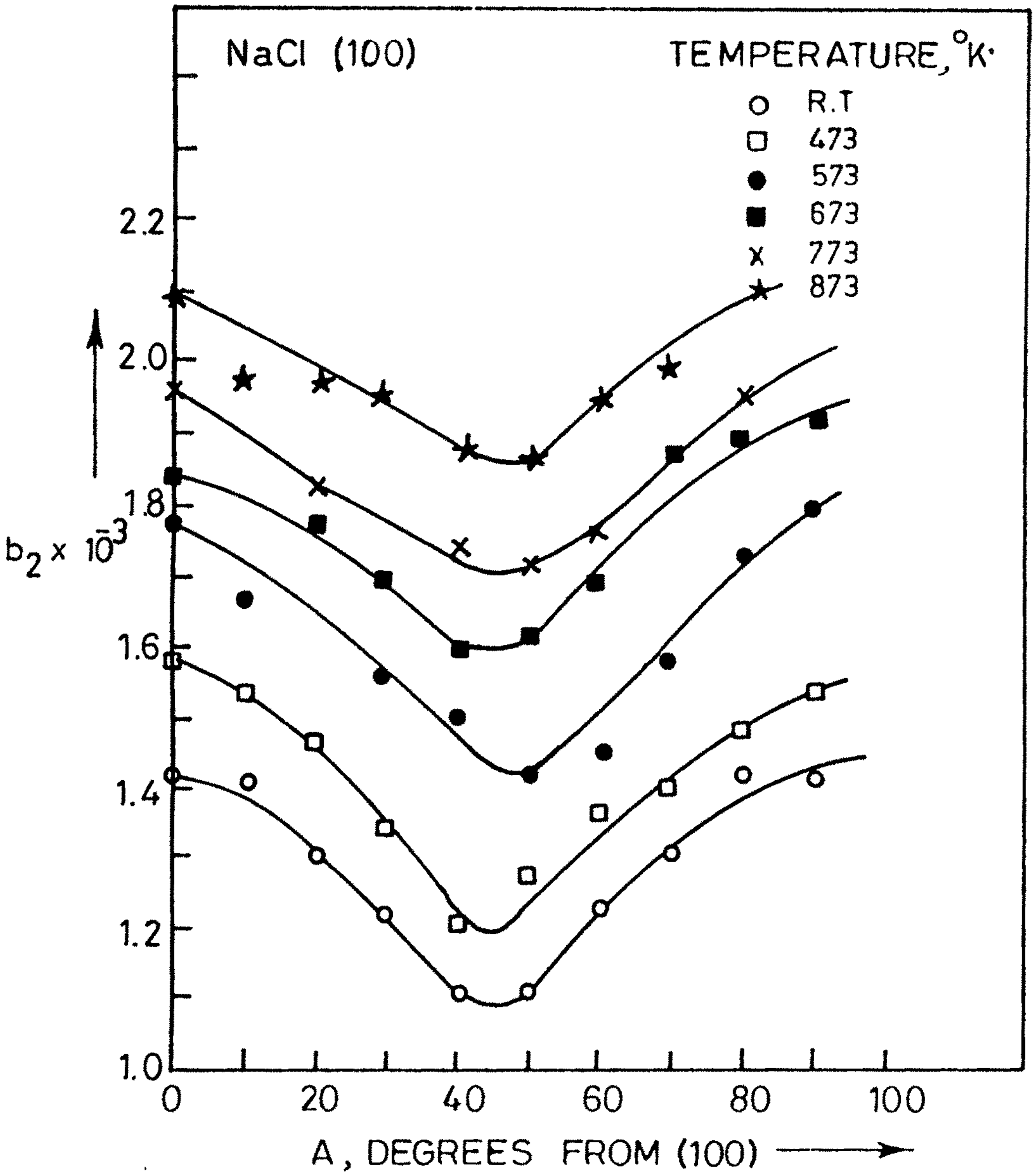
PLOT OF a_2 Vs. A.

Fig. 4.7b.



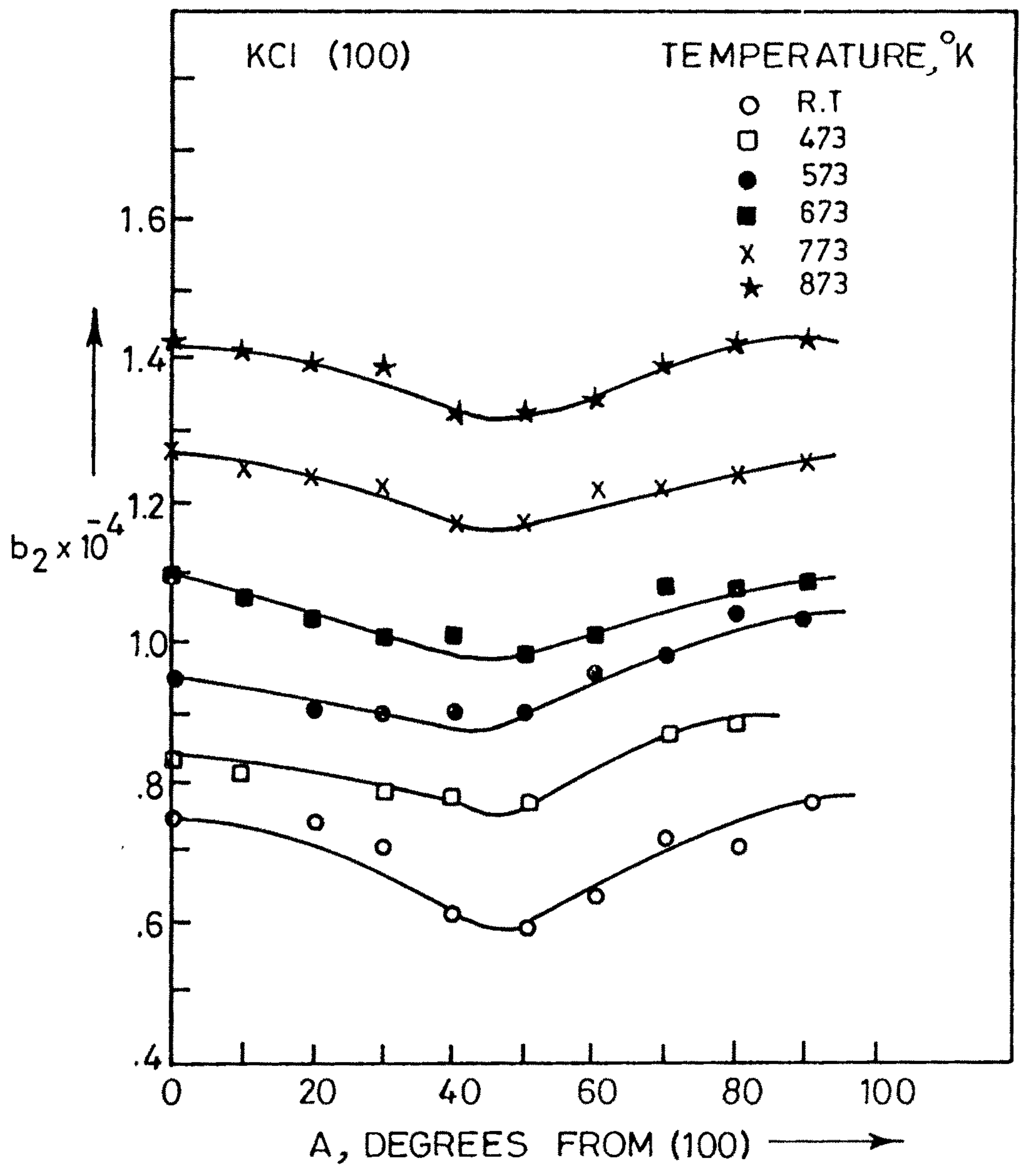
PLOT OF a_2 Vs. A.

Fig. 4.7c.



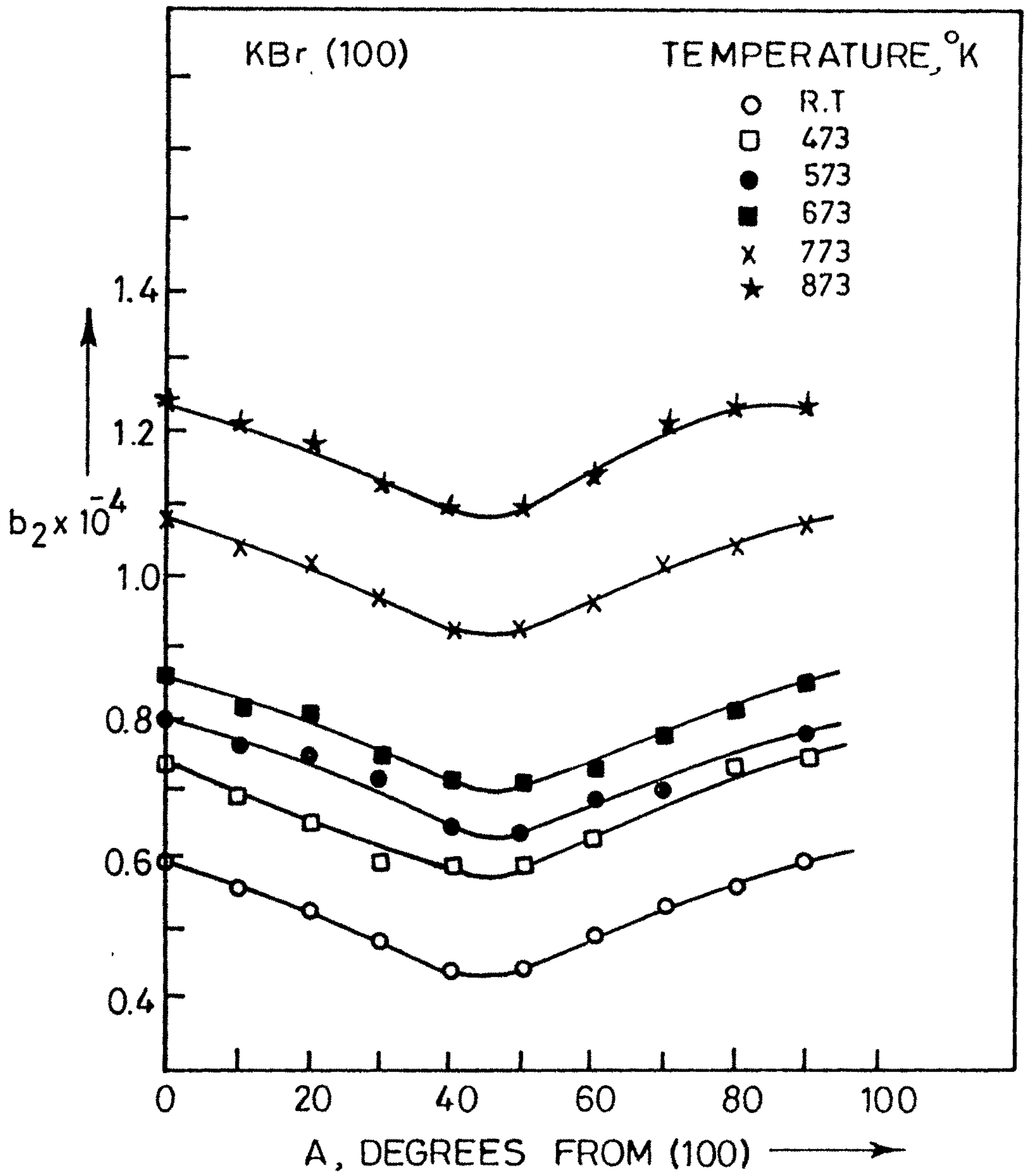
PLOT OF b_2 Vs. A.

Fig. 4.8 a.



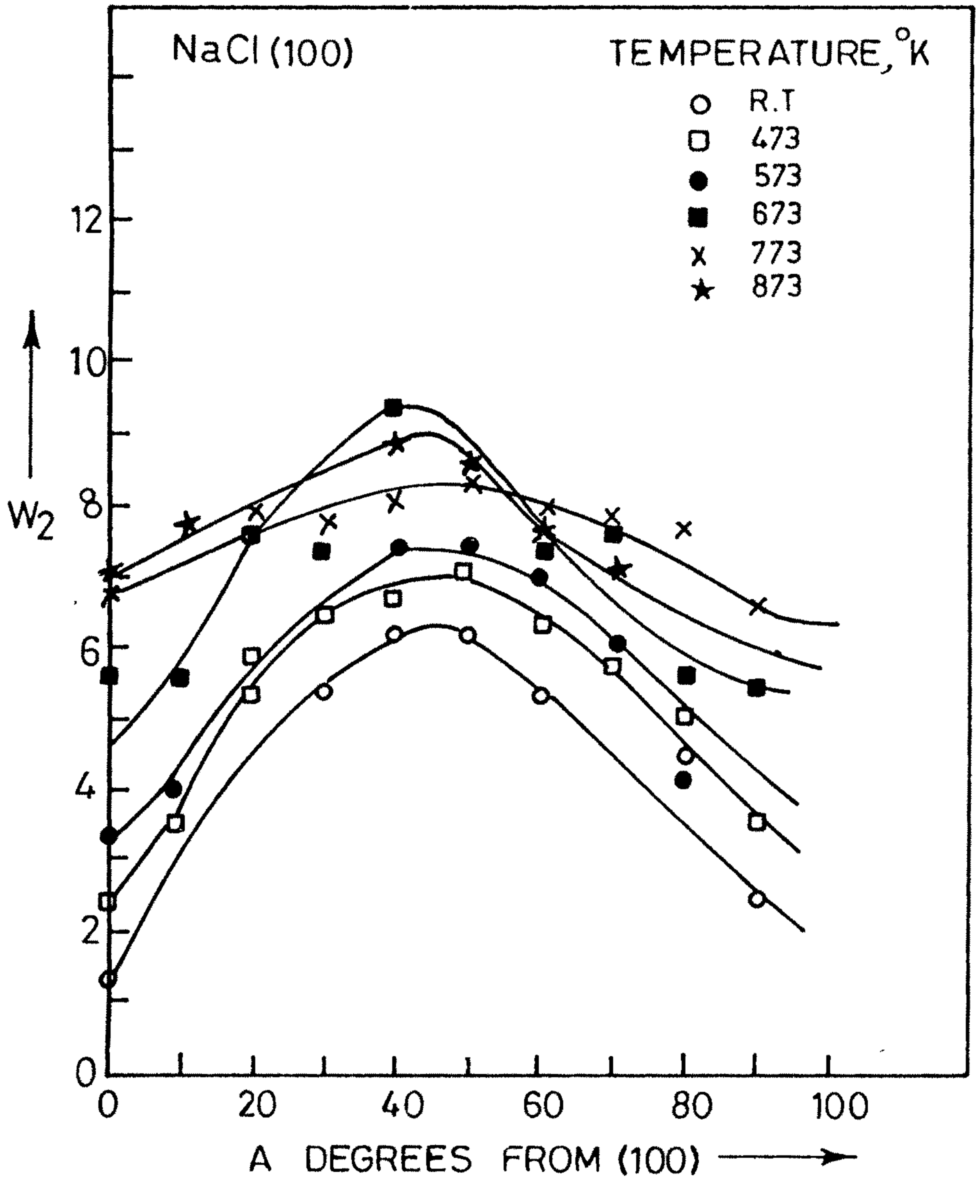
PLOT OF b_2 Vs. A.

Fig. 4.8b



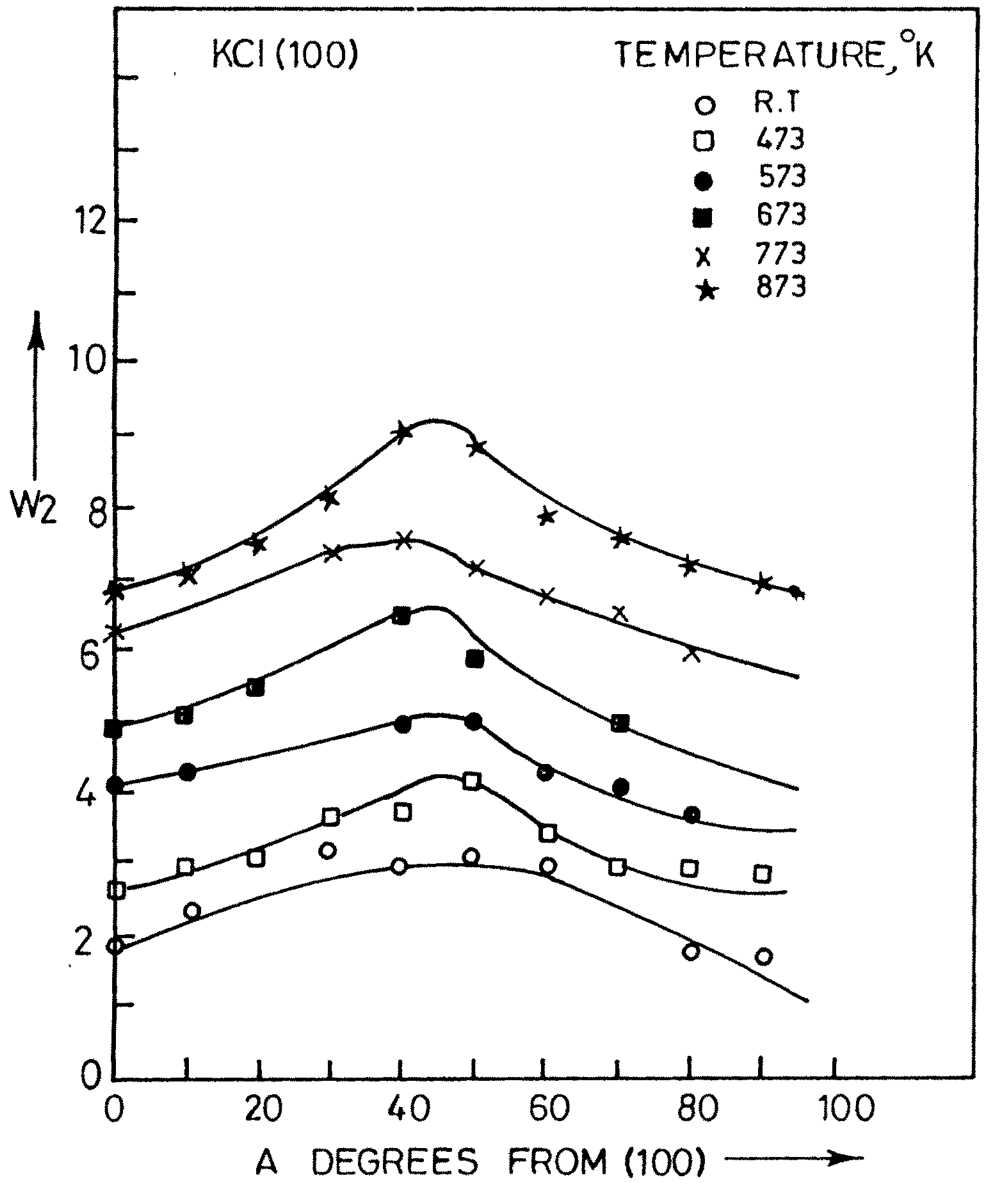
PLOT OF b_2 Vs. A.

Fig. 4.8 c



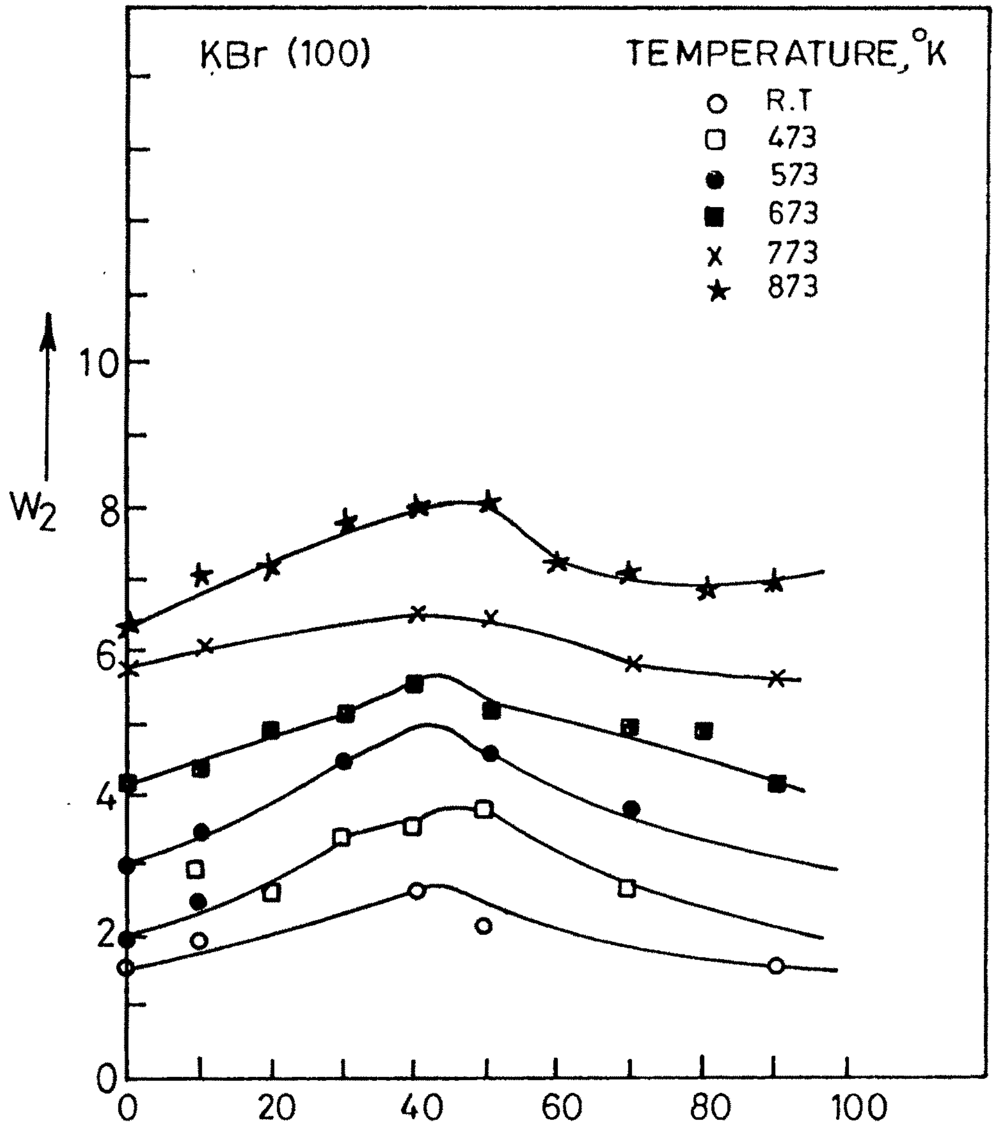
PLOT OF W_2 Vs. A.

Fig. 4.9a.



PLOT OF W_2 Vs. A.

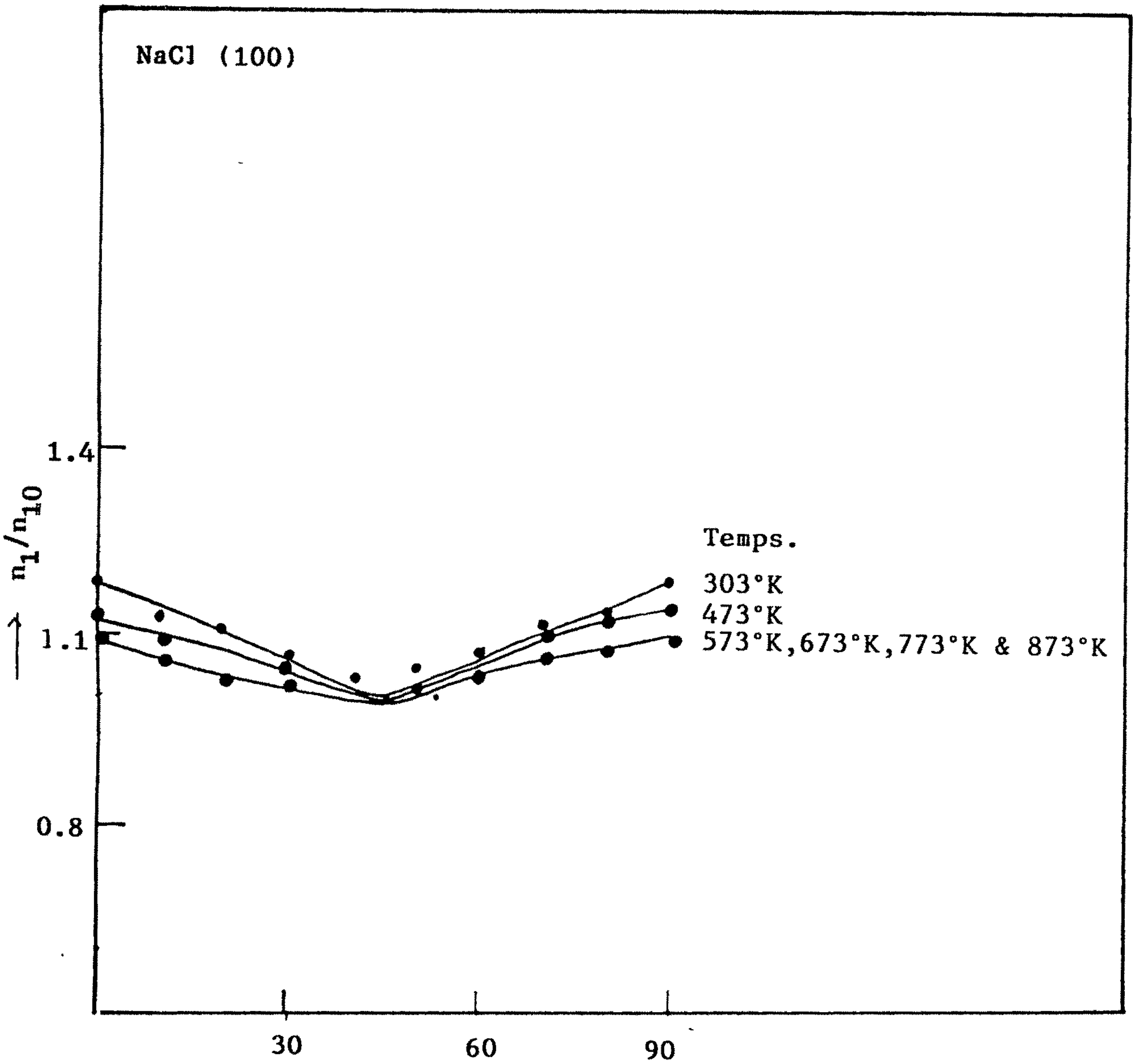
Fig 4.9 b.



A DEGREES FROM (100) →

PLOT OF W_2 Vs. A.

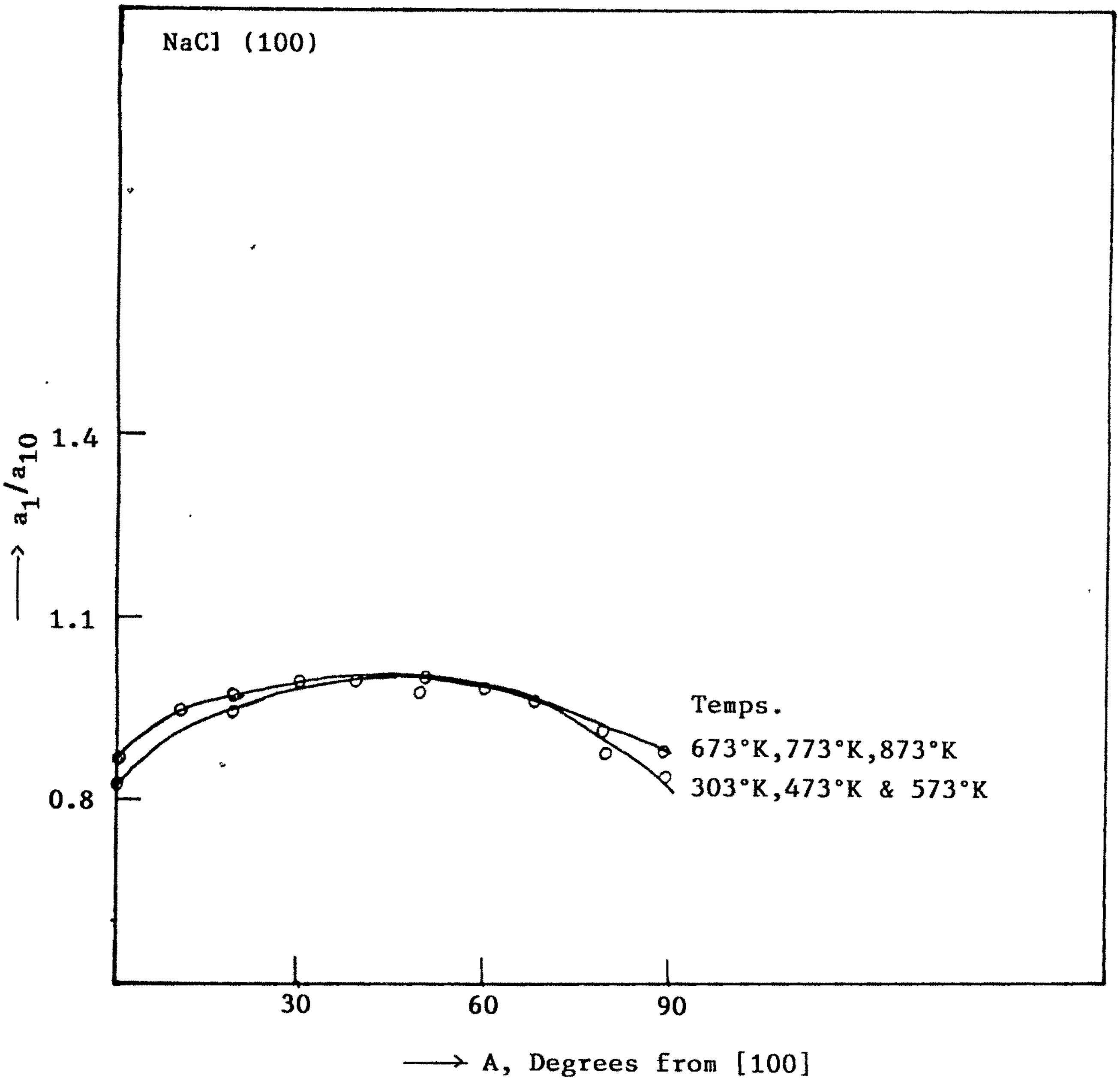
Fig. 4.9 c.



⟶ A, Degrees from [100]

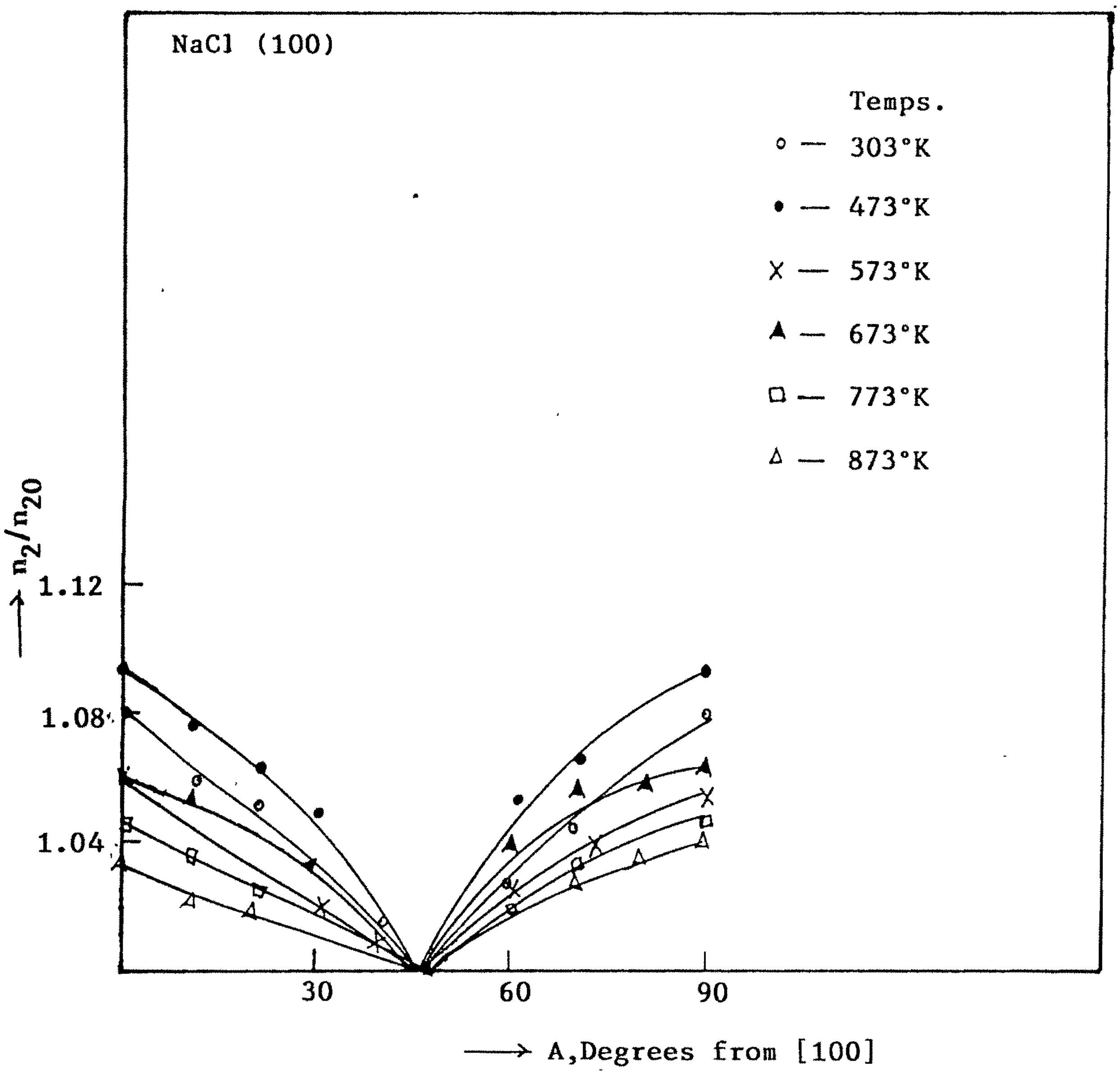
Plot of $\frac{n_1}{n_{10}}$ Vs A

Fig. No. : 4.10



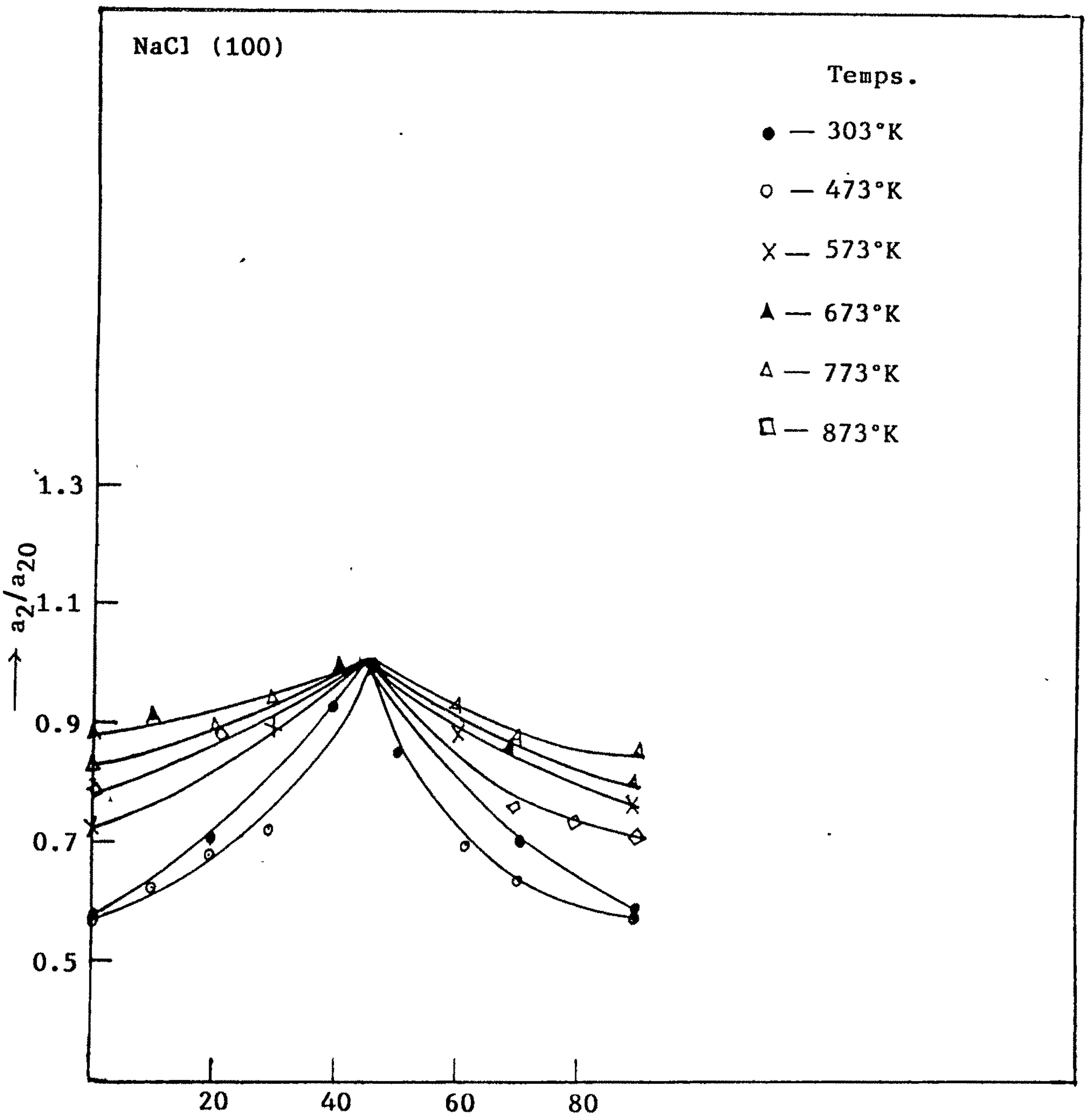
Plot of $\frac{a_1}{a_{10}}$ Vs A

Fig, No.: 4.11



Plot of $\frac{n_2}{n_{20}}$ Vs A

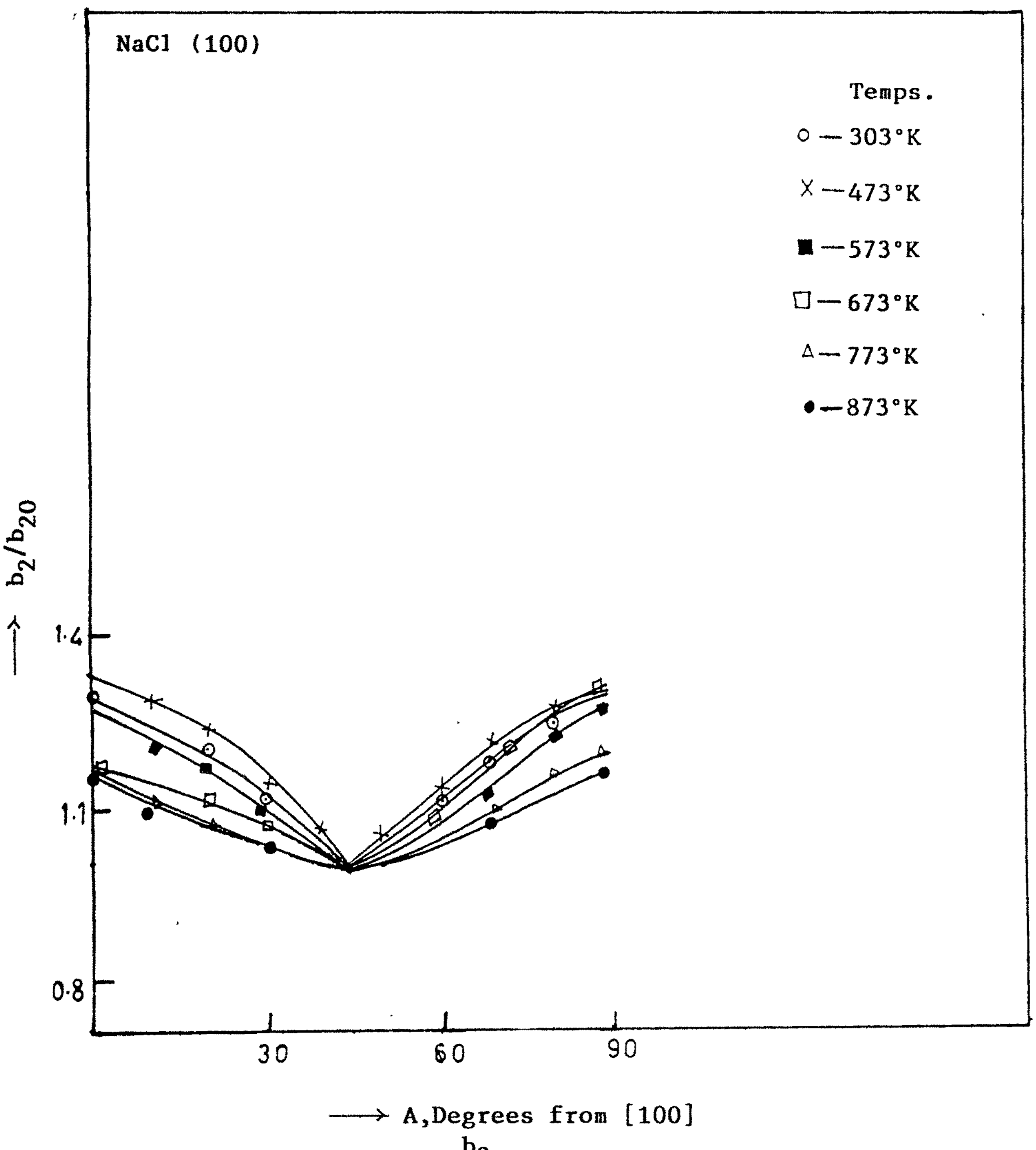
Fig. No.: 4.12



→ A, Degrees from [100]

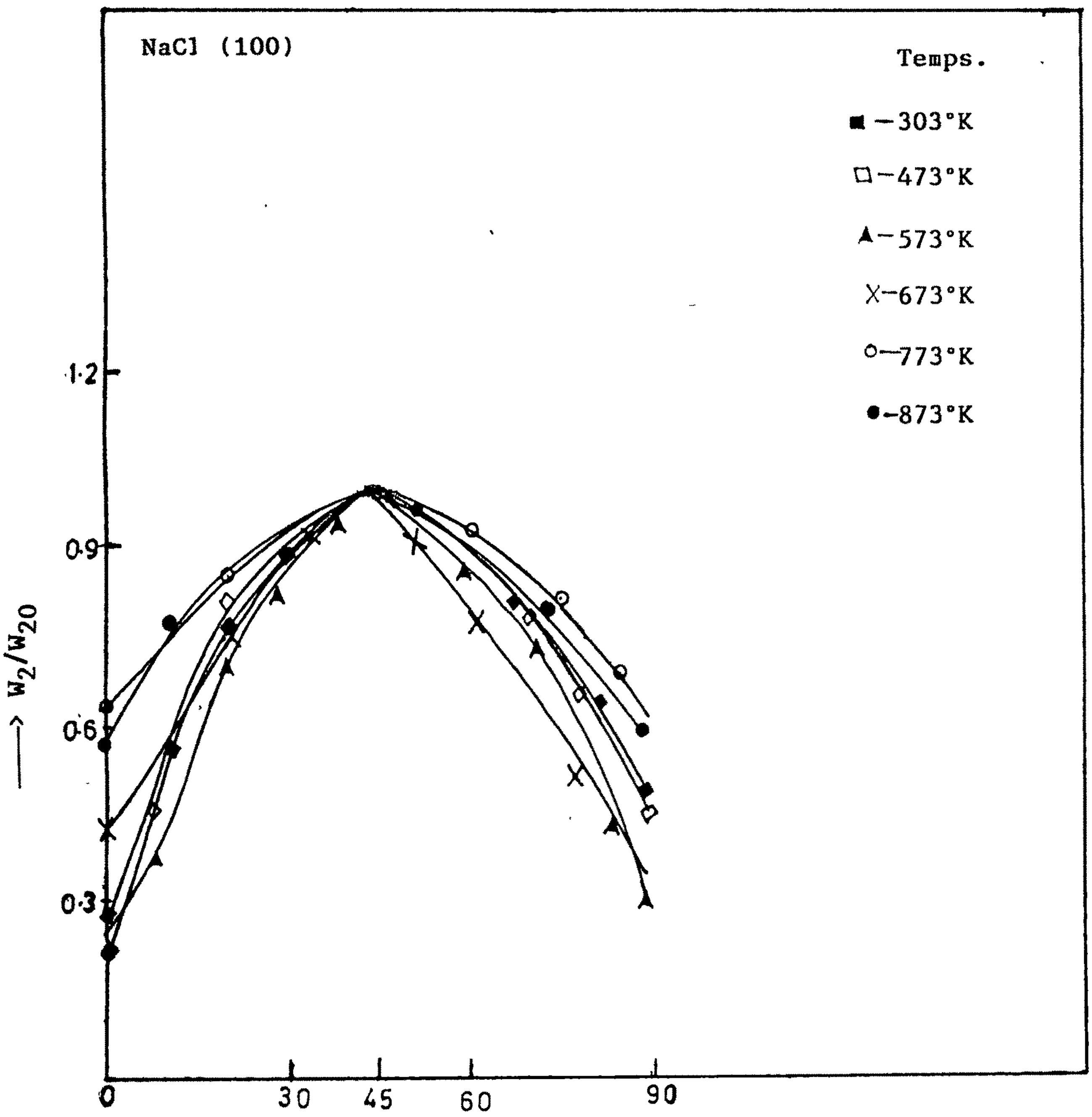
Plot of $\frac{a_2}{a_{20}}$ Vs A

Fig. No.: 4.13



Plot of $\frac{b_2}{b_{20}}$ Vs A

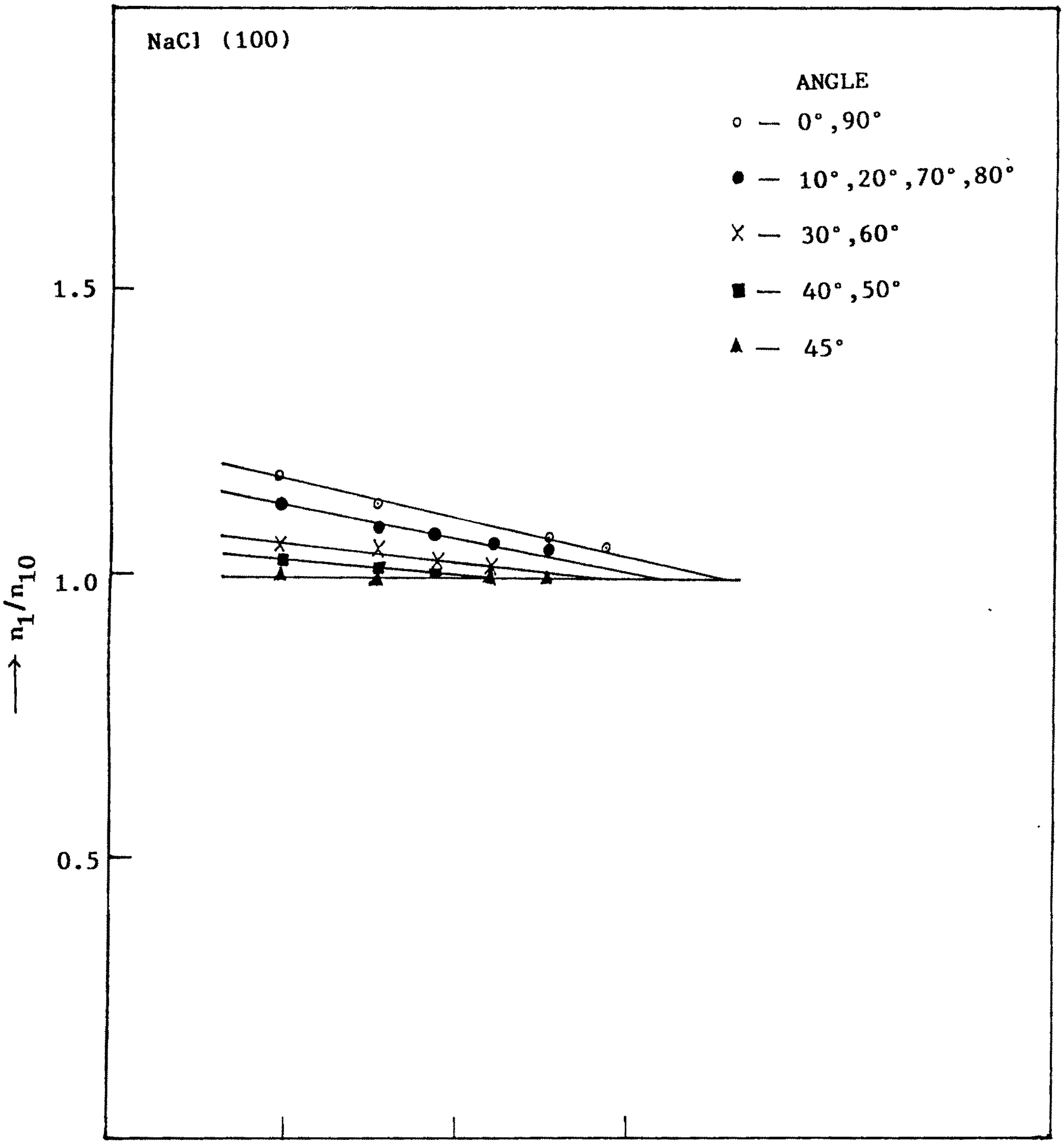
Fig. No. : 4.14



→ A, Degrees from [100]

Plot of $\frac{W_2}{W_{20}}$ Vs A

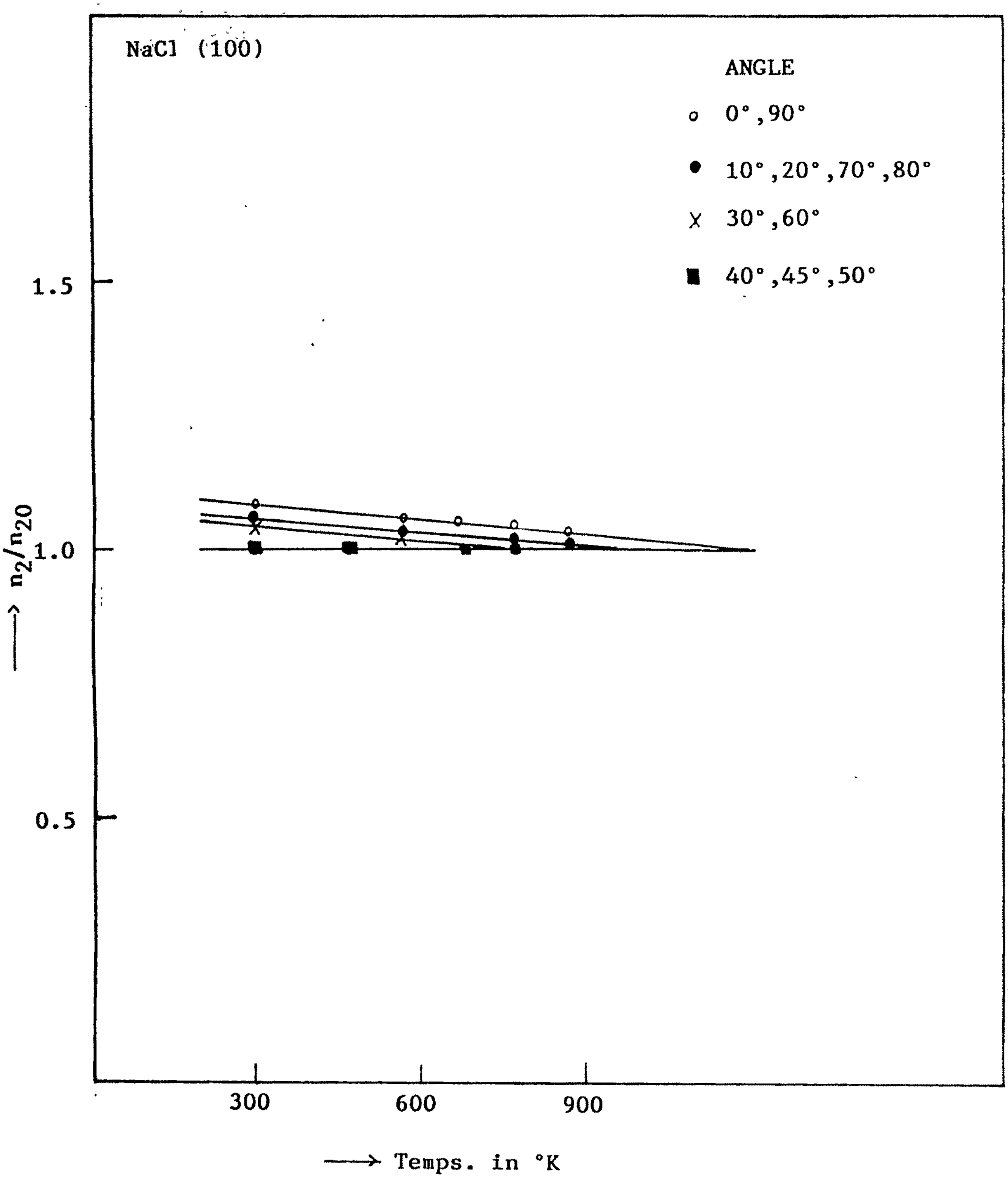
Fig. No.: 4.15



→ Temps. in °K

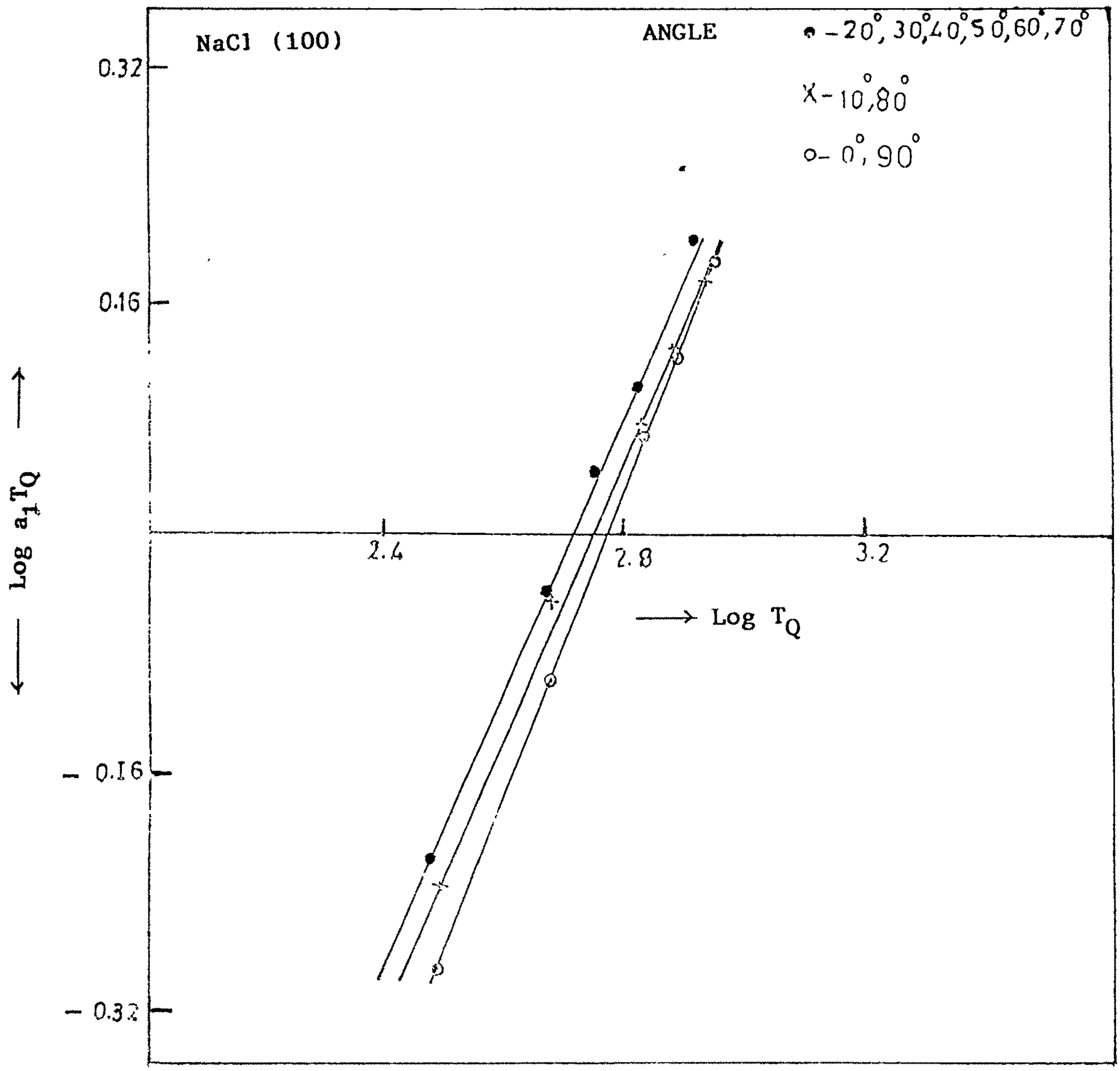
Plot of $\frac{n_1}{n_{10}}$ Vs Temps.

Fig. No. : 4.16



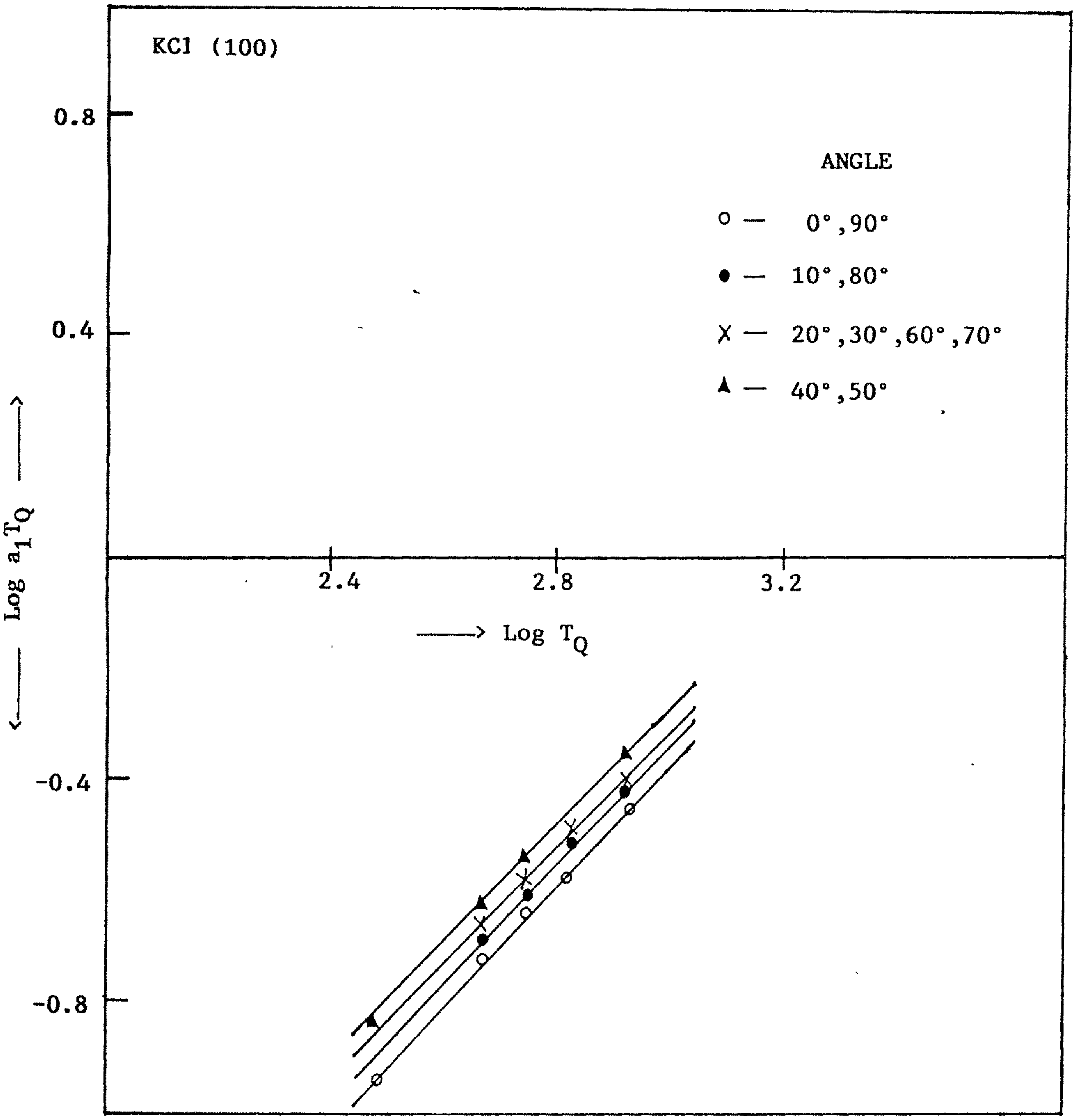
Plot of $\frac{n_2}{n_{20}}$ Vs Temps.

Fig. No.: 4.17



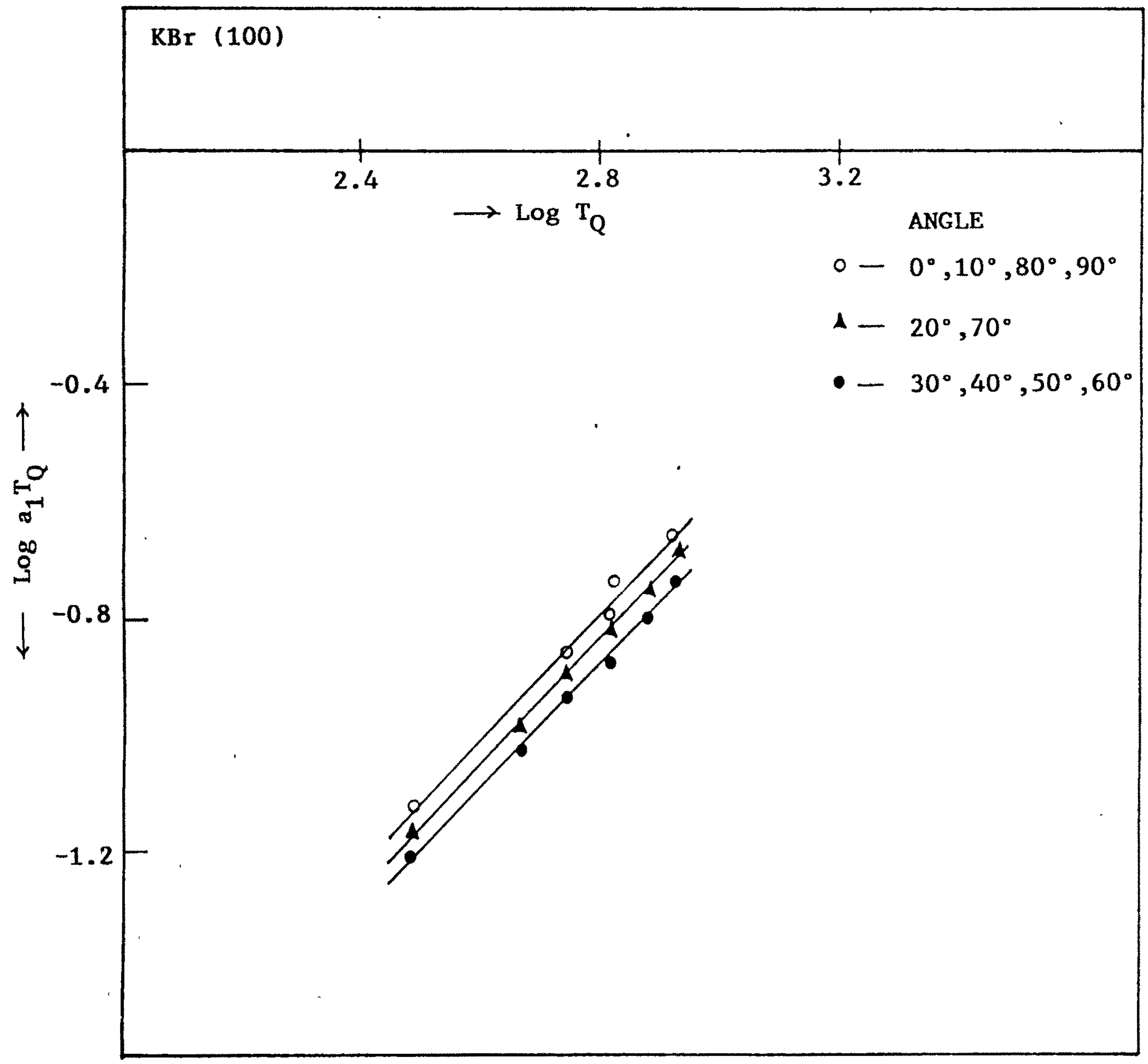
Plot of Log a_1T_Q Vs Log T_Q

Fig. No. : 4.18 a



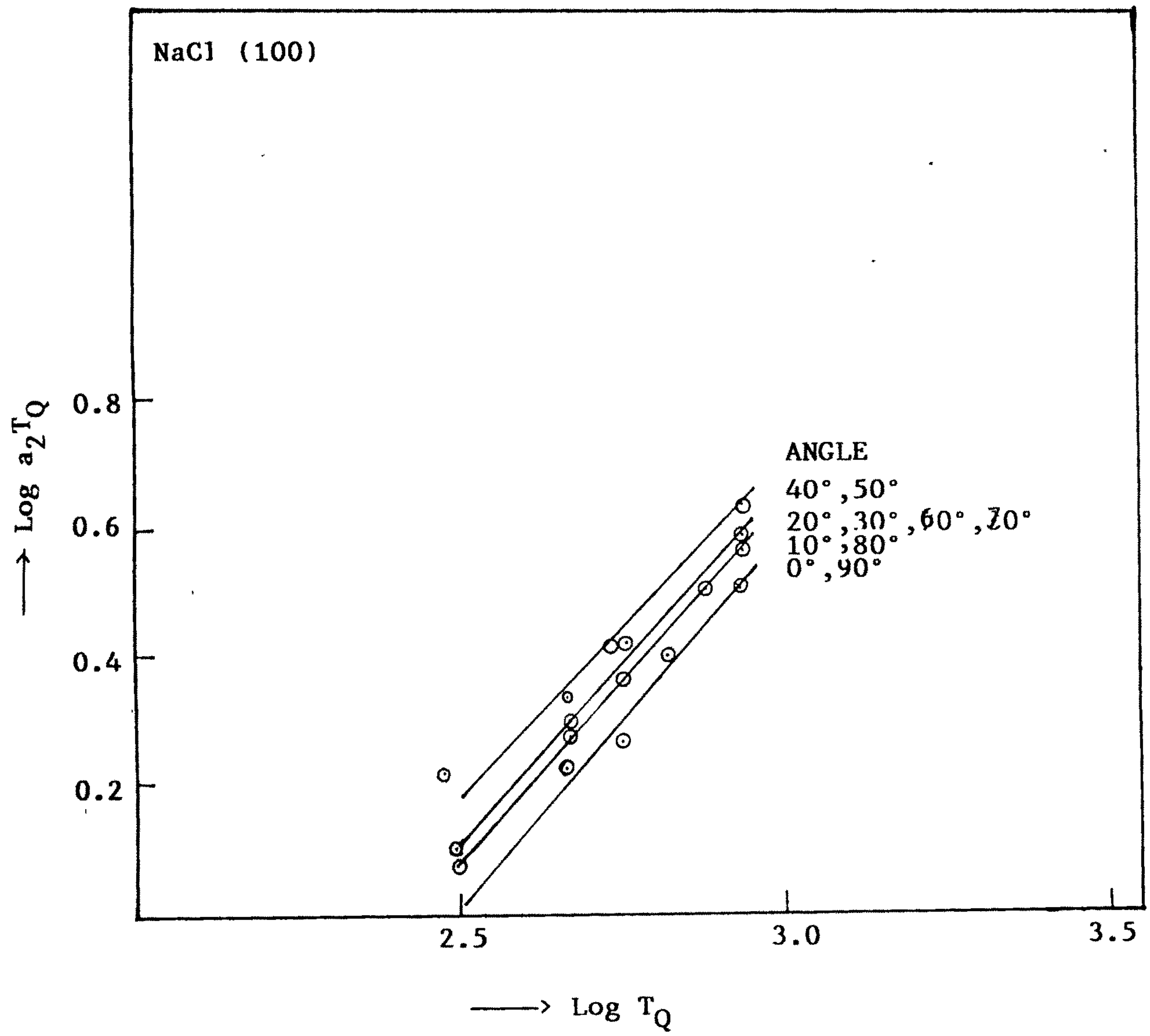
Plot of Log a_1 T_Q Vs Log T_Q

Fig.No.: 4.18 b



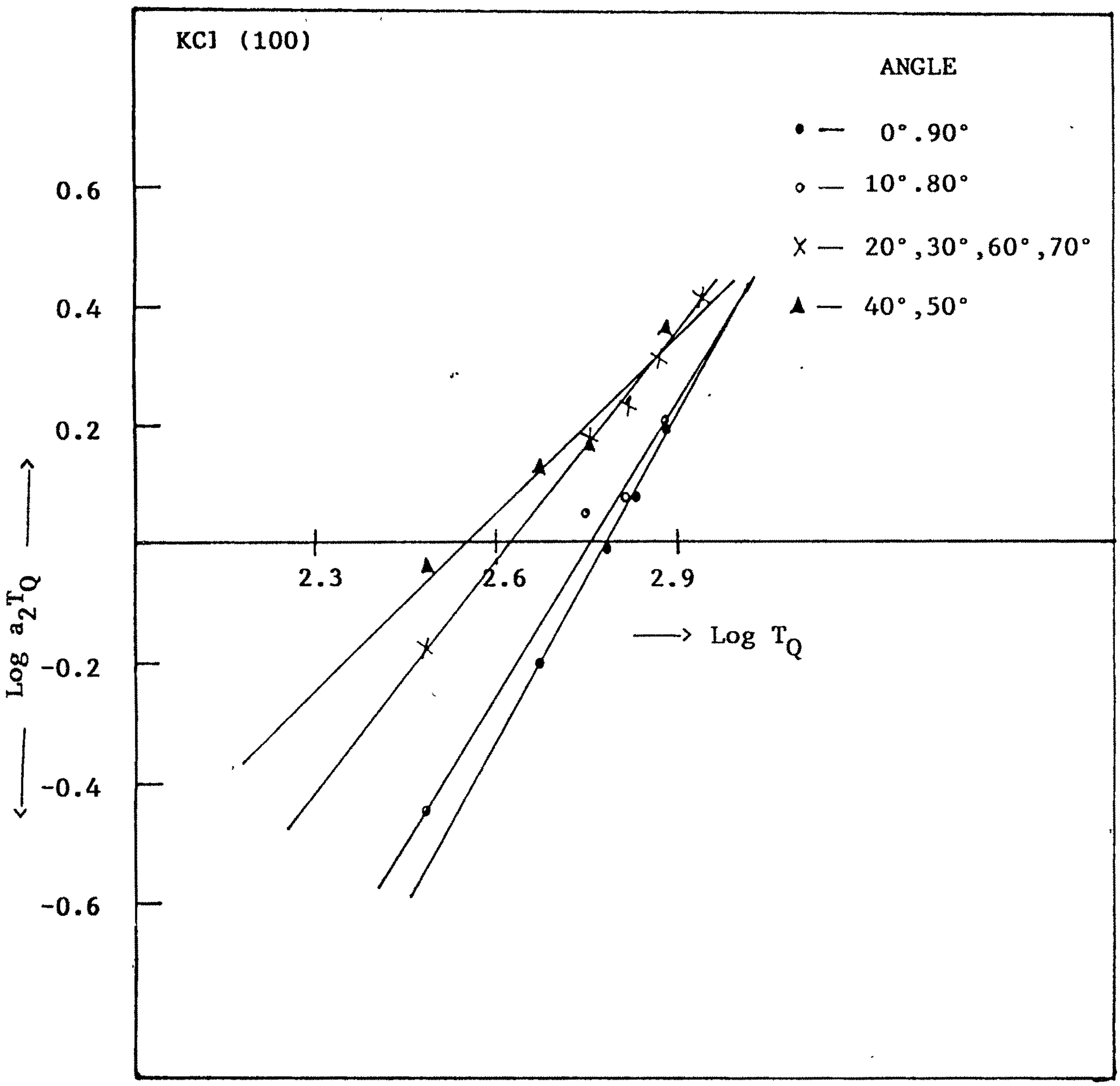
Plot of Log a_1T_Q Vs Log T_Q

Fig.No.: 4.18 c



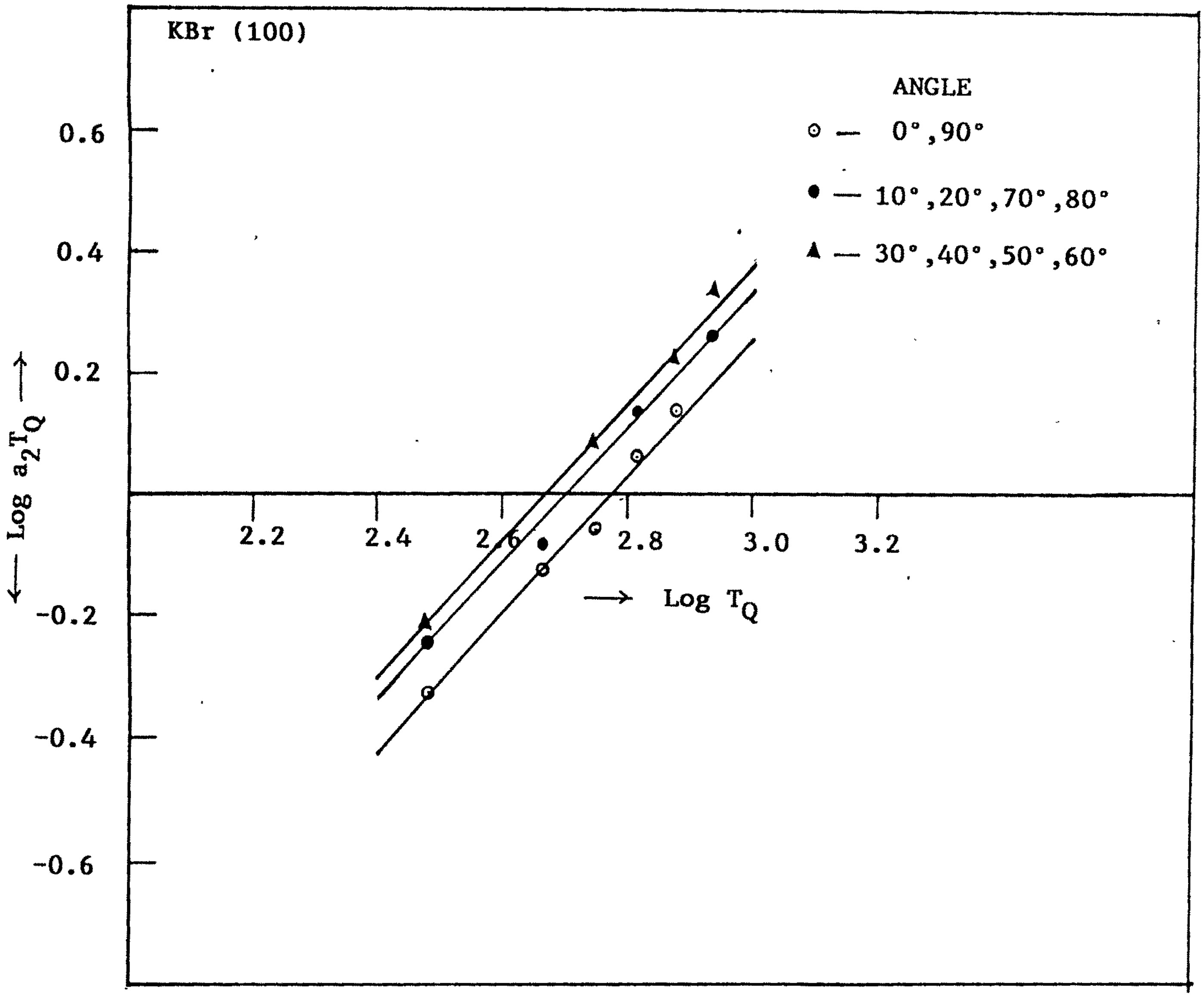
Plot of Log a_2T_Q Vs Log T_Q

Fig. No.: 4-19 a



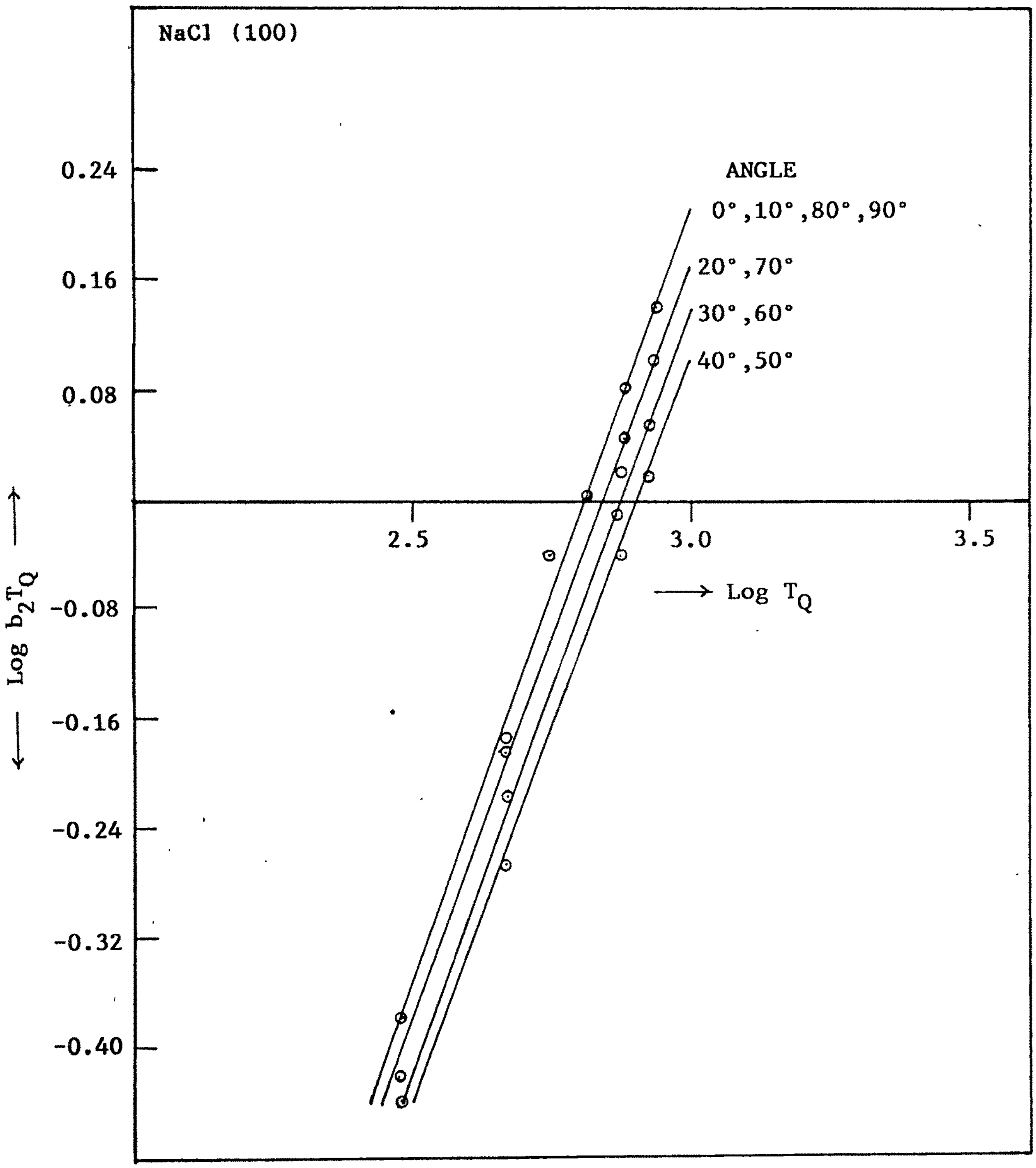
Plot of Log a_2T_Q Vs Log T_Q

Fig.No.: 4.19b



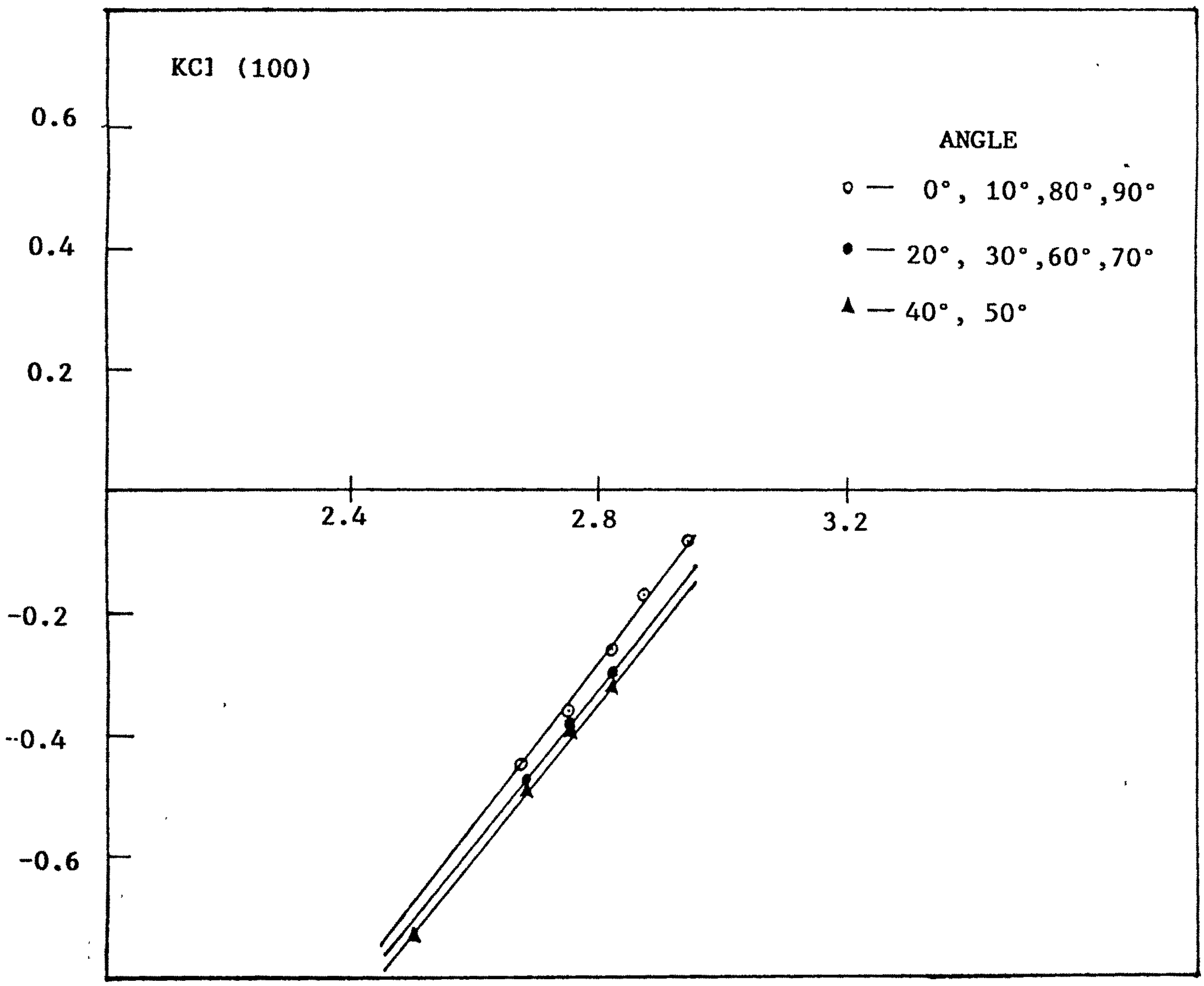
Plot of Log a_2T_Q Vs Log T_Q

Fig.No.: 4.19 c



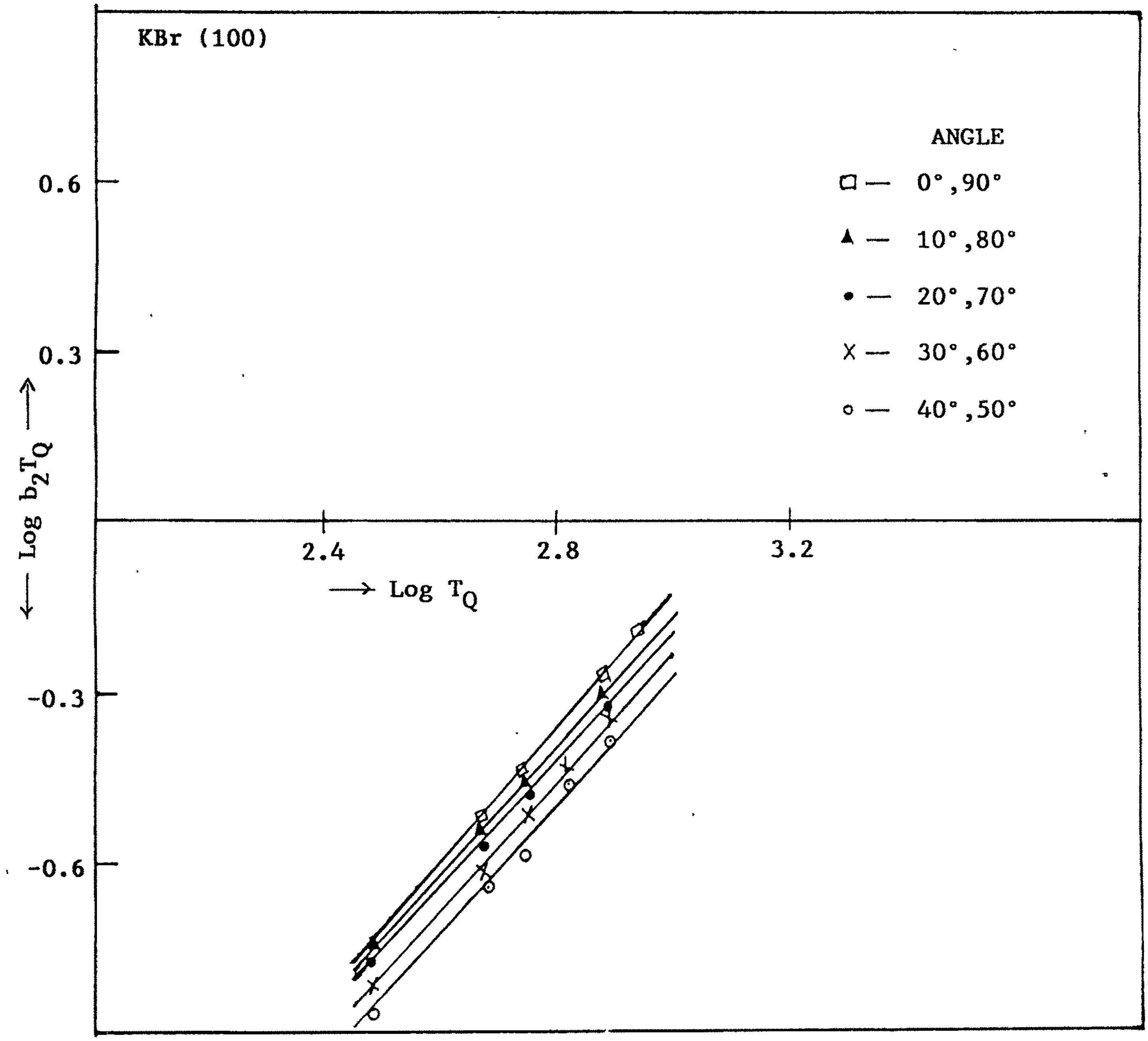
Plot of Log b_2T_Q Vs Log T_Q

Fig. No. : 4.20 a



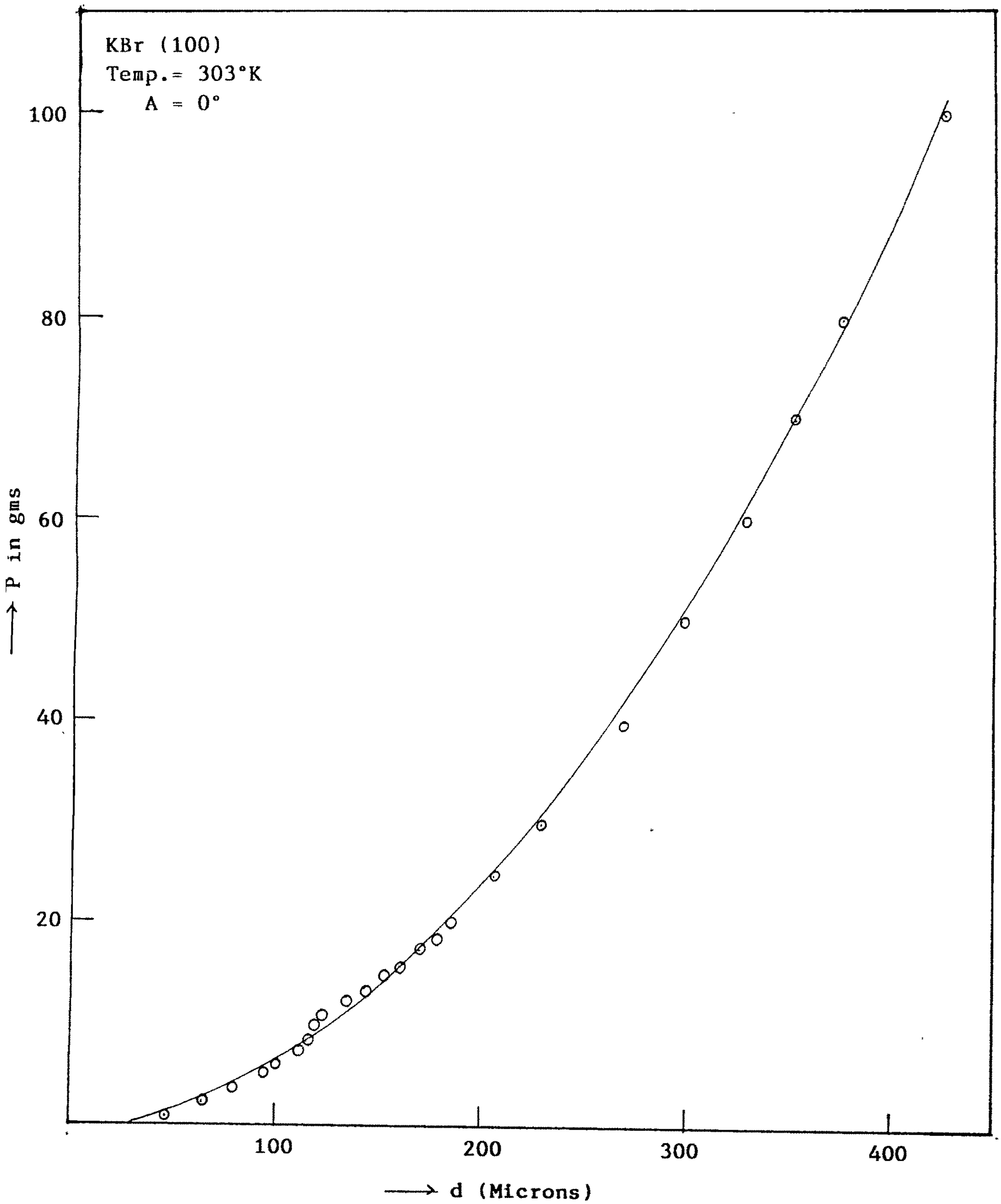
Plot of Log b_2 T_Q Vs Log T_Q

Fig.No.: 4.20 b



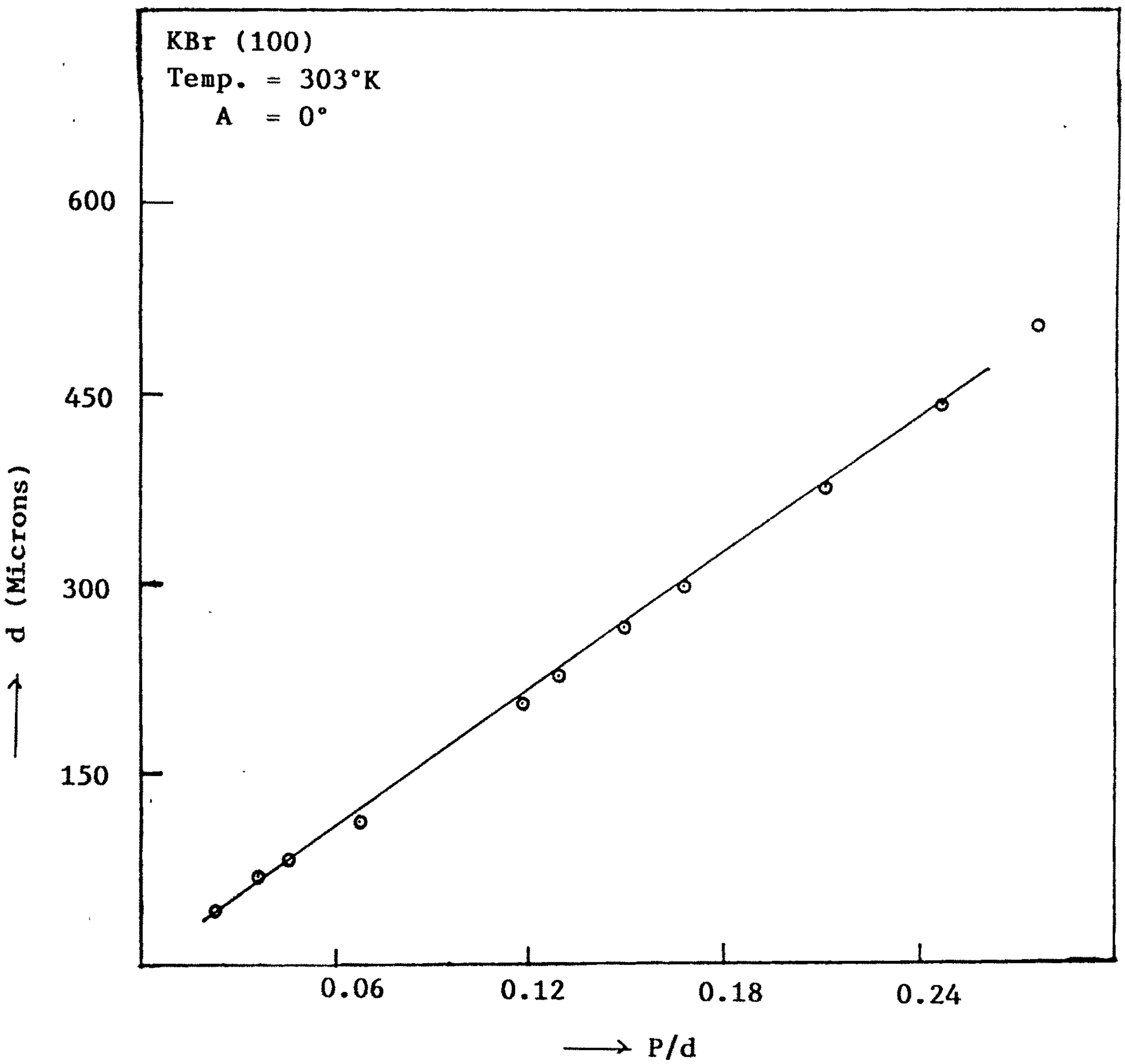
Plot of Log b_2T_Q Vs Log T_Q

Fig.No.: 4.20 c



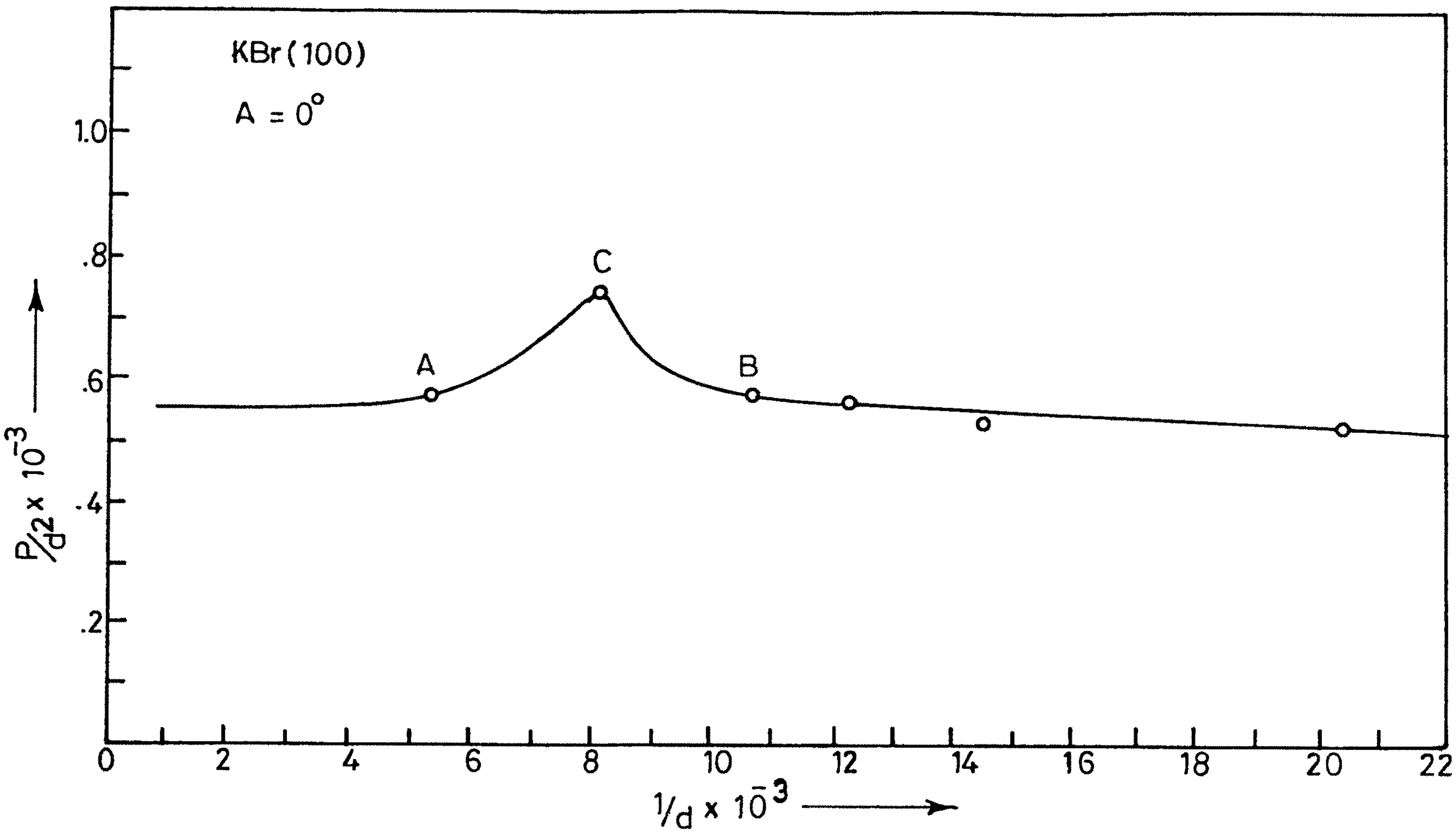
Plot of P Vs d

Fig.No.: 4.21



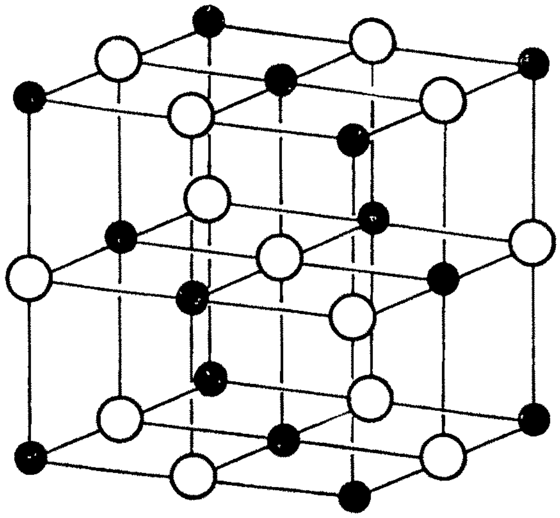
Plot of d Vs P/d

Fig.No.: 4.22



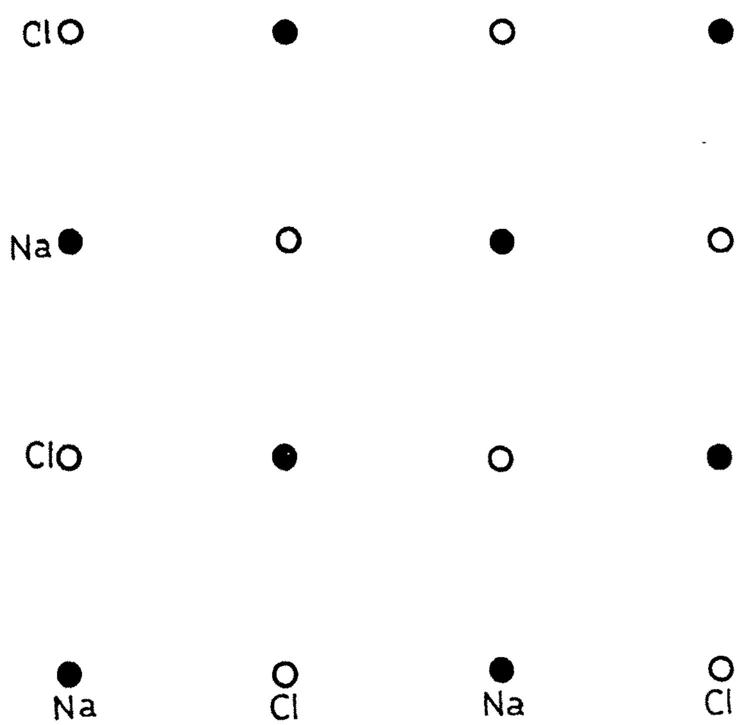
PLOT OF P/d^2 Vs. $1/d$

Fig. 4.23



THE CONVENTIONAL UNIT CELL FOR THE SODIUM CHLORIDE STRUCTURE. THE LARGE AND SMALL SPHERES REPRESENT TWO DIFFERENT TYPES OF ATOMS.

Fig. 4.24



(100) PLANE OF NaCl CRYSTAL

Fig. 4.25

REFERENCES :

1. Kick, F., Das Ge Setzder proportionalen Winderstande und Science Ans Wanddring (Leipzig Felix ed.) (1885).

2. Meyer, L., Quated in 'Microindentation Hardness Testing', Butterworths Scientific publications, London, Ch.1, (1956).

3. Hays, C. & Kendal, E. G., Metallography, 6, 275 (1973).

4. Haneman, H. & Schultz, F. Metalkunde, 33, 122 (1947)

5. Quitsch, E. M., Microsckopic, 2, 131 (1947).

6. Grodzinski, P., Schwaiz, arch. angew wiss, 18, 282 (1952).

7. Knoop, F., Tech. Blatter, 27, 472-80 (1937).

8. Bernhardt, E. O., Z. Metalkunde, 33, 135-44 (1941).

9. Camphell, R.F., Henderson and Donleavy, M. R., Trans. Amer. Soc. Metals, 40, 954, (1948).

10. Mott, B. W., 'Microindentation Hardness Testing' Butterworths Scientific Publications, London, Ch. 1 (1956).

11. Taylor, E. W., J. Inst. Metals, 74, 493-500 (1948).

12. Bergsman, E. W., Metal Progress, 54, 183-88 (1948).

13. Shah, R. T., Ph.D. Thesis, M. S. University of Baroda, Baroda (1976).

14. Acharya, C. T., Ph.D. Thesis, M.S.University of Baroda, Baroda (1978).

15. Bhagia, L. J., Ph.D. Thesis, M.S. University of Baroda, Baroda (1982).

16. Shah, A. J., Ph.D. Thesis, M.S.University of Baroda, Baroda (1984).

17. Patel M. B., Ph.D. Thesis, M. S. University of Baroda, Baroda (1987).

18. Knoop, F., Peters, C. G., & Emerson, W. B., J. Res. Mat. Bur. Std., 23, 39 (1939).

19. Winchell, H., Am. Mineralogist, 30, 583 (1945).

20. Thibault, N. W. and Nyquist, H. L., Trans. ASM; 38, 331 (1947).

21. Tarasov, L. P. and Thibault, N. W., Trans. ASM; 38, 331 (1947).

22. Daniels, F. W. and Dunn, C. G., Trans. ASM. 41, 419 (1949).

23. Tabor, D., The hardness of Metals, Oxford University Press, 100 (1951).

24. Joshi, D. R., Ph. D. Thesis, M. S. University of Baroda, Baroda (1989).

25. Annie Kuruvilla, Ph. D. Thesis, M. S.University of Baroda, Baroda (1992).

26. Fukuchi & Watanabe, W., J. Jpn. Inst. Met. (Japan)., 46, 12-16 (1982).

27. Saraf, C. L., Ph. D. Thesis, M. S. University of Baroda, Baroda (1971).

28. Mehta, B. J., Ph. D. Thesis, M. S. University of Baroda, Baroda (1972).

29. Joshi, D. R. & Pandya, J. R., Cryst. Res. Technol., 26, 433-440 (1991).

30. Joshi, D. R. & Pandya, J. R., Cryst. Res. Technol., 28, 103-109, (1993).