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**THE INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE**

Annual Report for 1957-58

THE INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE

ANNUAL REPORT FOR 1957-58

JADAVPUR, CALCUTTA-32

COUNCIL MEMBERS FOR 1957-58

- President* Hon'ble Mr. Chief Justice P. Chakravartti,
M.A., B.L.
- Vice-Presidents* .. Dr. J. C. Ghosh, D.Sc., F.N.I.,
Sri R. P. Mookerjee, M.A., B.L.
- Director (Offg.)* .. Prof. P. Ray, M.A., F.N.I.
- Members* Sri Birendranath Maitra, M.Sc., F.C.S.,
Dr. P. B. Sarkar, D.Sc.,
Prof. S. K. Mitra, D.Sc., F.R.S.,
Dr. Atmaram, D.Sc., F.N.I.,
Dr. T. Sen, Dr. Eng. (Munich), A.M.M.E., M.I.E.
(India),
Dr. Narendra Nath Saha, M.Sc., Ph.D. (Leeds),
Prof. Nikhil Ranjan Sen, D.Sc., Ph.D.,
Sri Dwijesh Chandra Chakrawarti, M.Sc.,
Sri J. M. Majumder, M.A.,
Dr. P. K. Bose, D.Sc., F.N.I.,
Dr. B. C. Guha, D.Sc., F.N.I.,
Dr. Kanai Lal Saha, M.B.
- Trustee-Member* . Sri R. P. Mookerjee, M.A., B.L.
- Nominees of the National Institute of Sciences of India.* Prof. P. S. Gill, F.N.I., Professor of Physics,
Muslim University, Aligarh.
Dr. Mata Prasad, F.N.I., Vice-Chancellor,
Vikram University, Ujjain.
- Nominees of the Government of India.* The Secretary, Ministry of Natural Resources &
Scientific Research (or his nominee),
Educational Adviser to the Government of India
(or his nominee),
Director-General of Scientific & Industrial Research,
Government of India,
Sri Prem Narain, Deputy Secretary to the
Government of India, Ministry of Finance.
- Nominee of the Government of West Bengal.* Dr. D. M. Sen, M.A., Ph.D.
- Professor-Member* .. Prof. P. C. Dutta, D.Sc.

THE INDIAN ASSOCIATION for the CULTIVATION OF SCIENCE

ANNUAL REPORT FOR 1957-58

1. GENERAL

During the year under review, death was reported of Dr. P. C. Mitra, a Life Member of the Association and a distinguished Indian chemist. The Council condoled his death and conveyed their sympathies to the members of the bereaved family.

Much of the development plans of the Association had to be curtailed owing to the economy drive of the Government of India, the restriction of import of scientific equipments and chemicals from overseas countries, and the non-availability of grants for capital expenditures on buildings and equipments. In July 1957, the Association received a request from the Government of India to revise the building programme in view of the current shortage of building materials, specially cement and steel, and also of the over-all drive for economy. Originally, the Association had submitted estimates for Rs. 7,73,000/- to carry out various items of the building works, which were reduced to Rs. 5,83,000/-. Even then a very little portion of these works could be taken in hand in view of a receipt of only Rs. 30,000/- from the Government of India and no receipt from the State Government of West Bengal for building works. Efforts to obtain equipments and chemicals from overseas countries were greatly handicapped by import restrictions primarily due to shortage of foreign exchange.

Construction Work

As reported in the last annual report, the construction of the first floor of the main research building was undertaken towards the end of 1956-57. During the year under review, the construction works were completed, except the final finishing operation, tenders for electrical and sanitary installations accepted and work thereof started. Work in respect of electrical and sanitary installations to the first floor of the workshop building, whose completion was reported last year, and of equipping the laboratory rooms with benches and furniture, was started in the year under review.

During the year, the question of constructing a hostel for the accommodation of research scholars of the Association received considerable attention of the Council. Several communications were made to the Government of India, renewing the Association's request for a loan towards construction of the proposed hostel, for which applications had been submitted during the previous years. In view of the urgency of accommodating a number of scholars who were appointed from outside the city and were unable to find accommodation elsewhere, arrangement was made, on the recommendation of a committee appointed for the purpose, for temporary accommodation of such scholars on the first floor of the workshop building. In February 1958, the Government of India informed the Association that they had discontinued sanctioning loans for this purpose and regretted their inability to grant any loan for the construction of the hostel.

Reviewing Committee

During the year under review, the Council decided to appoint a Committee to (i) review the work of the Association in (1) the departments it originally had; and (2) the departments added since 1947 under a scheme approved by the Government of India, report on the progress of such work and make recommendations for such modifications, if any, as may be found necessary and/or for consolidation; (ii) make recommendations for such further extension or development, if any, as in the opinion of the Committee, will fit in with the work that is presently being carried on and will be productive of better and more useful results; (iii) offer such advice or make such recommendations as the Committee may consider necessary regarding the administration of the Association; and (iv) make any other suggestion which the Committee may deem fit to make and which, if adopted, will in their opinion, be conducive to the betterment of the Association as a whole.

It was decided that the Committee should consist of an eminent scientist to act as Chairman of the Committee, one nominee of the Government of India, and three other members to be selected out of two panels, one of chemists and the other of physicists. Negotiations are in progress for securing an eminent scientist to act as a Chairman of the Committee.

The Council also appointed a Committee to suggest what additions and alterations in the regulations and by-laws of the Association were immediately necessary for the removal of difficulties in the working of the Association, pending the recommendation of the Reviewing Committee as constituted above. The Committee had one meeting during the year under review.

Council Election, Enrolment and Resignation of Members, Election of Fellows

The annual election of Ordinary Members of the Council was held as usual during the months of April, May and June and the result announced at the

Annual General Meeting of the Association held on August 24, 1957. Mr. Chief Justice P. Chakravartti was elected to the office of the President in place of Sri C. C. Biswas; Dr. T. Sen, Dr. N. N. Saha, Prof. N. R. Sen, Sri Dwijesh Chandra Chakrawarti, Sri J. M. Majumdar, Dr. B. C. Guha, Dr. P. K. Bose and Dr. K. L. Saha were elected Ordinary Members of the Council. The National Institute of Sciences of India nominated Prof. P. S. Gill, Professor of Physics, Muslim University, Aligarh and Dr. Mata Prasad, Vice-Chancellor, Vikram University, Ujjain, and the Government of India Sri Prem Narain, Deputy Financial Adviser, Ministry of Finance, on the Council of the Association for 1957-58. Dr. P. C. Dutta was appointed Professor-Member of the Council. Sri R. P. Mookerjee was appointed in the vacancy in the office of the Vice-President caused by the election of Mr. Chief Justice P. Chakravartti to the office of the President.

The Council offered their warmest felicitations to Dr. D. N. Wadia, a Life Member and Fellow of the Association and formerly a member of the Council of the Association, to Prof. S. K. Mitra, a Life Member, Fellow and Trustee of the Association, a member of the Council and formerly a Vice-President, and to Prof. S. N. Bose, a Life Member and Fellow of the Association, on their being elected to the Fellowships of the Royal Society of London. The Council also conveyed their warmest felicitations to Dr. T. Sen, an Ordinary Member of the Association and member of the Council, on his unanimous election to the Mayoralty of Calcutta for a second term.

During the year under review, one gentleman was elected Life Member, four gentlemen were enrolled and six admitted as Ordinary Members of the Association. During the same period one gentleman resigned his membership, and the membership of seven Ordinary Members ceased for non-payment of subscription for over two years.

At the last Annual General Meeting Dr. M. S. Krishnan was elected an Ordinary Fellow of the Association. Dr. B. C. Guha has been recommended for election to the Fellowship of the Association.

Meeting of Council and Committees

One Annual General Meeting, one Special General Meeting, five meetings of the Council, six of the Finance Committee, twelve of the Staff Committee and seven meetings of the Construction Committee were held during the year. The Selection Committee and Appointing Boards accounted for 27 meetings. Furthermore, there were two meetings of the Fellows and one meeting each of the Board of Editors of the Indian Journal of Physics, the Committee appointed to suggest additions and alterations in the Regulations and By-laws of the Association, and the Committee appointed to consider the question of recognition of the Indian Association for the Cultivation of Science Employees' Association.

Research Departments, Visit to Foreign Countries by Members of Staff and Scholars

During the year under review, Prof. P. Ray, on the recommendation of the Selection Committee, was continued as Officiating Director, subject to the period of his officiating Directorship not exceeding three years from the date of his first appointment in this capacity. The Selection Committee was also requested to continue its efforts towards making a fresh selection for the post of Director and making a recommendation to the Council as early as possible.

The opening of a new Section of Training in High Polymers under the Department of Organic Chemistry was reported last year. During the year, the Staff Committee of the Association reviewed the working of this Section and expressed the opinion that in the present circumstances the creation of a diploma course in High Polymers would not serve any useful purpose and was not likely to attract sufficient number of students for the purpose. The Staff Committee further expressed the view that research in technological aspects of high polymers should be more intensely developed and that, with that end in view, the possibility of integrating all research activities in technological aspects of high polymers under one Department should be explored. A Sub-Committee appointed for the purpose went further into the question and submitted a report to the Council, recommending that (1) the institution of the diploma course be dropped, (2) a new department for researches in applied high polymers be created and (3) the posts and scholarships shown under the section of Training in High Polymers of the Department of Organic Chemistry, and the Rubber and Plastic and Resin Sections of the Department of Physical Chemistry and one post doctoral Fellowship of the Department of Organic Chemistry do constitute the staff of the new Department. The Sub-Committee further recommended that the Department should concentrate mainly on researches on the technological aspects of the following polymers:—

- (i) Rubber, natural and synthetic including isotactic polymers;
- (ii) Plastics including various resins used in paints, fabric finishing and adhesives;
- (iii) Films and wood;
- (iv) Indian gums;
- (v) Pectins from different Indian fruits;
- (vi) Starches from Different Indian cereals;
- (vii) Other polysachharides; and
- (viii) Industrial wastes such as rice-husk, straw etc.

The Council approved of the recommendations and authorized the creation of a new Department for Researches in Applied High Polymers.

The micro-analytical laboratory under the Central Scientific Services under the Director was transferred to the Department of Organic Chemistry. Other research departments continued to function with more or less the same

pattern of staff as obtained in the previous year. Dr. J. N. Sen, Reader in Physical Chemistry, joined the Imperial Chemical Industries (India) Private Ltd. as a Technical Officer and was granted lien on his post for one year. Dr. N. K. Bhattacharyya, Research Officer of the Department of Organic Chemistry left the Association to join the Indian Institute of Technology as a Lecturer in Organic Chemistry.

A number of research workers of the Association received fellowships for prosecuting higher studies and research in overseas countries. Sri P. Bagchi, Reader in High Polymers, received an offer to work as a guest research worker in the laboratories of Prof. Mark in the Brooklyn Polytechnique in the U.S.A. The Association granted him a sum of Rs. 2,500/- towards his travel expenses. Dr. A. K. Sircar, Research Officer (Rubber Section), Department of Physical Chemistry and Dr. Pranbandhu Dutt, Research Assistant, Department of Organic Chemistry, were each awarded a Post-Doctoral Fellowship, the former at the University of Minnesota, U.S.A. and the latter at Oberlin College, Ohio, U.S.A. The Association granted a sum of Rs. 1,500/- to Dr. Sircar and Rs. 1,000/- to Dr. Dutt towards their travel expenses. In each case of sanction of a travel grant mentioned above, the grantee executed a bond to the effect that, on his return from the U.S.A., he will serve the Association for at least a period of two years or in the event of his failing to do so, return the entire amount.

During the year a request was submitted to the Ministry of Natural Resources and Scientific Research for the services of a foreign expert in Theoretical Organic Chemistry with special reference to reaction mechanism, under one of the technical aid programmes.

Research Schemes

C.S.I.R. The Council of Scientific and Industrial Research sanctioned the following schemes for the year under review:—

Under Prof. S. R. Palit as investigator-in-charge:

- (1) Construction of light scattering apparatus for the measurement of molecular weight, size and shape of high polymers;
- (2) Studies on thermodynamic properties of high polymer solutions and binary liquid mixtures;
- (3) Liquid crystalline detergent systems;
- (4) Fundamental studies on the solvent extraction of coal.

The schemes (1) & (2) were continued from the previous year and the schemes (3) and (4) were sanctioned for the first time during the year under review.

Under Prof. B. N. Srivastava as investigator-in-charge:

- (1) Thermal diffusion and interdiffusion of gases, continued from the previous year.

Under Prof. S. C. Sirkar as investigator-in-charge:

- (1) Investigation of crystal structure of frozen organic liquids at low temperature, continued from the previous year.

Under Prof. P. C. Dutta as investigator-in-charge:

- (1) Synthetic studies in diterpenoid resin acids, continued from the previous year.

Under Dr. J. N. Sen and later under Dr. U. S. Nandi as investigator-in-charge:

- (1) Absolute rate constants in polymerization, continued from the previous year.

Development scheme for research training facilities under the Scientific Man Power Committee: This scheme initiated by the Ministry of Natural Resources and Scientific Research, now renamed Ministry of Scientific Research and Cultural Affairs, was in the seventh year of its operation during 1957-58. Under the scheme 15 senior and 6 junior scholars were originally made available, but 6 junior scholarships remained idle in the absence of the Government of India decision to convert these scholarships into senior ones as stated in the previous report.

National Research Fellowship: Dr. U. S. Nandi of the Department of Physical Chemistry continued as the National Research Fellow of the Government of India, Ministry of Education, for part of the year till he was appointed a Research Officer of this Association.

Other Schemes: The scheme on "Synthetic Polyelectrolytes as soil conditioners" of the Indian Council of Agricultural Research, and another scheme on "Styrenation of Shellac" of the Indian Lac Cess Committee, both under Prof. S. R. Palit, were continued from the previous year.

Prof. B. N. Srivastava had under him a scheme on "Design of thermal diffusion column for efficient isotopic separation", sanctioned by the Atomic Energy Commission in 1956-57 and continued during the year under review.

The Director of Public Instruction, Government of Assam renewed the sanction of a scholarship for work during the year under Prof. P. C. Dutta.

The Director of Cinchona, Government of West Bengal sanctioned a scheme, under the supervision of Sri P. Bagehi, for the conversion of quinine to quinidine and isolation of quinidine from cinchona febrifuge.

Doctorate degree awarded to research workers

The following research workers of the Association were admitted to the degree of Doctor of Science and the degree of Doctor of Philosophy (Science) of the Calcutta University during the year under review:—

Sri Dinesh Chandra Biswas, a research scholar of the Department of Optics, was admitted to the D.Sc. degree of the Calcutta University for his work on "Investigation on the Raman spectra and fluorescence spectra of organic compounds".

Sri Dilip Kumar Ghosh, a research scholar of the same department was admitted to the D.Phil (Science) degree for his work on "Investigations on the absorption of ultra high frequency radio waves and micro-waves in polar liquids".

Sri V. A. Moghe, a part-time research worker of the Department of Physical Chemistry, was admitted to the D.Phil (Science) degree of the Calcutta University for his work on "Studies on Solubilization by Cationic Detergents".

Sri Usha Ranjan Ghatak, Sri Nikhil Ranjan Ghosh and Sri Kalyanmoy Sen, research scholars of the Department of Organic Chemistry, were admitted to the D.Phil (Science) degree of the Calcutta University for their work on "Synthesis of alicyclic compounds related to natural products", "Studies on alicyclic compounds, sesquiterpenes", and "Studies in carbocyclic compounds" respectively.

Sri J. Xavier, a Research Assistant of the Department of Inorganic Chemistry, was admitted to the D.Phil (Science) degree of the Calcutta University for his work on "Application of Co-ordination complexes of organic thio-compounds in analytical chemistry".

Sri S. C. Saxena, formerly a research worker of the Department of General Physics and X-rays has been admitted to the D.Phil (Science) degree of the Calcutta University for his work on "Thermal conductivity of binary and ternary rare gas mixture".

Dr. Bhupati Kumar Banerji, who was a research worker of the Association in the Dept. of General Physics, X-rays and Magnetism, was admitted to the D.Sc. degree of the Calcutta University on the basis of his work on "Physico-chemical Studies on glass systems", carried out in the Association.

Cooch-Behar Professorships, Joykissen Mookerjee Medal and Mahendralal Sircar Memorial Lectures

During the year under review, Professor J. O. Hirschfelder, Professor of Chemistry, University of Wisconsin, U.S.A. and Prof. Karl Freudenberg, formerly Director of Chemical Laboratories, Heidelberg University, West Germany were appointed Cooch-Behar Professors of the Association for 1953 and 1954 respectively. Prof. Hirschfelder delivered a course of lectures on "Inter-atomic forces" and "The Anatomy of molecular physics", and Prof. Freudenberg on "Contribution to stereo chemistry" and "The Chemical structure of cellulose and starch".

The Joykissen Mookerjee Gold Medal for 1955 was awarded to Prof. Richard Kuhn, N.L., Director, Institute of Chemistry, Max Planck Institute, Heidelberg, West Germany. On the occasion of the award, Prof. Kuhn delivered a lecture on "The Bifidus factors of human breast milk".

Prof. J. B. S. Haldane, F.R.S. delivered the Memorial Lecture on "Regulation of numbers in animal population" at the 54th Death Anniversary of late Dr. Mahendra Lal Sircar, the Founder of the Association, on February 23, 1958.

General Publications

The publications brought out during the year under review include the second volume of the *Vijnāner Itihās* by Sri S. N. Sen, dealing with the development of sciences in the medieval world up to the beginning of the 17th Century (post-Vedic Indian sciences, the Arab sciences, revival of science and learning in Latin Europe, the European Renaissance and the rise of modern science), and *Freight Tube Float* by Dr. E. Westphal. The University of Delhi selected the first volume of the *Vijnāner Itihās*, adjudged to be the best among the Bengali books submitted, for the award to its author of the Narsingdas Prize of the University for 1957.

General Staff matters

During the year under review, the Provident Fund rules under the By-laws of the Association were suitably amended with a view to giving the lower subordinate staff (bearers, peons, sweepers, malis and like categories of staff) the provident fund benefit from 1957-58. The Government of India were pleased to sanction, with effect from 1957-58, the payment of house rent allowance, at West Bengal Government rates, to the employees of the Association drawing a basic salary up to Rs. 300/- p.m.

Library

The Library stock increased by 194 books during the year under review. 93 journals were subscribed and 127 journals were received in exchange. A further addition was made of 63 journals (periodicals & bulletins) as complimentary copies.

Indian Journal of Physics

During the period from April 1, 1957 to March 31, 1958, 12 issues of the Indian Journal of Physics were published. There were no arrears in publication.

The year of the journal continued to be the calendar year. During the period mentioned above 74 papers and 13 'Letters to the Editors' were received for publication against 96 papers and 21 'Letters to the Editors' in the preceding year. Of these, 55 papers and 8 'Letters' were accepted for publication, 9 papers and 5 'Letters' were rejected by the referees, 3 papers were recalled by the authors and 7 papers were under consideration during the period under

review. Besides these, 15 papers and 4 'Letters' were brought forward from 1956-57. Out of these 70 papers and 12 'Letters' 51 papers and 7 'Letters' were published in the last 9 issues of Vol. 31 (1957) and 19 papers and 2 'Letters' were published in the first three issues of Vol. 32 (1958). Nothing was published in the portion "Proceedings of the Indian Association for the Cultivation of Science". Vol. 31 comprises 68 papers and 11 'Letters' covering 646 pages, besides 20 plates and the Index covering 18 pages. In the previous volume (1956) there were 65 papers and 9 'Letters to the Editors' covering 627 pages, besides 22 plates and the Index covering 17 pages.

The number of subscribers in 1957 was 275 through the Indian Physical Society (at a concessional rate), 96 others in India and 391 in foreign countries. The corresponding figures for 1956 were 250, 81 and 292 respectively. 83 copies of the journal were sent to members of the Association and 127 copies in exchange of other scientific journals.

The Board of Editors for Vol. 31 (1957) consisted of the following members: Prof. R. K. Asundi, Prof. K. Banerjee, Prof. D. M. Bose, Prof. S. N. Bose, Prof. K. R. Dixit, Prof. P. S. Gill, Prof. S. K. Mitra, Prof. P. Ray, Prof. K. R. Rao, Prof. S. C. Sirkar and Prof. B. N. Srivastava. Prof. Sirkar acted as the Hon. Secretary to the Board of Editors.

Visitors

During the year under review several distinguished scientists visited the laboratories of the Association. Among them were: Dr. D. N. Wadia, F.R.S.; Dr. William W. Buechner of the Massachusetts Institute of Technology, Cambridge, Mass. and Dr. & Mrs. Kenneth V. Thimann of the Harvard University, Cambridge, Mass. U.S.A.; Dr. E. G. Richardson, Professor of Physics, King's College, Newcastle-on-Tyne, University of Durham, U.K.; Madame Y. Khouvine, Paris, France; Dr. Anton Peterlin, Prof. J. Stefan Institute, Jugoslavia; Academician V. Baum and Dr. Peshkov, U.S.S.R.; Prof. Richard Kuhn, N.L., Director, Institute of Chemistry, Max Planck Institute, Heidelberg, and Prof. Karl Freudenberg, Heidelberg University, Heidelberg, West Germany.

Grants-in-aid and Donation

We gratefully acknowledge the receipt of the following grants-in-aid, capital and recurring, and on account of the various research schemes, and donation:—

	1957-58	
(A) <i>Government of India</i> —	Rs.	nP.
(1) Recurring, including contribution towards Dearness Allowance	6,44,500	00
(2) Non-recurring	55,000	00

(3)	Grant for Development Scheme for research training facilities of the Scientific Man-Power Committee	14,280	38
(4)	National Research Fellowship	1,200	00
(B) <i>Government of West Bengal—</i>			
(1)	Recurring	50,000	00
(2)	Recurring (sanctioned but payment received during 1958-59)	50,000	00
(C) <i>Council of Scientific & Industrial Research Schemes—</i>			
(1)	Construction of Light Scattering Apparatus for measurement of molecular weight, size and shape of High Polymer	3,540	00
(2)	Studies on thermodynamic properties of High Polymer solution	8,612	00
(3)	Thermal diffusion and inter-diffusion of gas ..	3,925	00
(4)	Crystal Structure of frozen organic liquids at low temperature	4,184	05
(5)	Absolute Value of rate constants in Polymerization	8,200	00
(6)	Synthetic studies of diterpenoid acids etc. ..	6,422	92
(7)	Liquid Crystalline Detergent System ..	6,606	45
(8)	Fundamental studies on the solvent extraction of coal	3,287	62
(D)	Subscription received from the Indian Physical Society in respect of the Indian Journal of Physics	1,650	00
(E)	Grant from Indian Lac Cess Committee ..	1,700	00
(F)	D.A.E.—Design of Thermal diffusion Column for Isotopic Separation	5,982	41
(G)	Grant from the Assam Government for Scholarship	2,150	00
(H)	I.C.A.R.—Scheme for synthetic polyelectrolytes as soil conditioners	2,353	12

Acknowledgements

The Council wish to express their appreciation and thanks to the retiring Ordinary Members of the Council, nominees of the National Institute of Sciences of India and the Government of India and the Professor-Member for their services to the cause of the Association.

The Council also record their thanks to the Board of Trustees, to the Members of the various Selection Committees, Appointing Boards and other Committees of the Association, to the Board of Editors, Editorial Collaborators and Referees for their voluntary services.

II. RESEARCH WORK CARRIED OUT IN THE DEPARTMENTS DURING THE FINANCIAL YEAR 1957-58

A. DEPARTMENT OF GENERAL PHYSICS AND X-RAYS

Work on the following lines was in progress in the different sections of the department during the year under review:

I. *General Physics:*

- (1) Inter-diffusion of gases;
- (2) Thermal diffusion in gas mixtures;
- (3) Thermal conductivity of gas mixtures;
- (4) Low temperature physics;

II. *X-rays:*

- (5) X-ray crystallography;
- (6) X-ray study of alloys;
- (7) Low temperature X-ray work.

Inter-diffusion of gases

Work under the research scheme of the C.S.I.R. on 'Thermal Diffusion and Inter-diffusion of gases' has been continued by K. P. Srivastava. Design and construction of the apparatus for measuring the inter-diffusion of gases have been completed and the apparatus tested for satisfactory working. Experimental observations have been taken for several gas pairs at different temperatures and the results are being worked out with a view to determining the law of molecular interaction between unlike molecules. This is the best method of determining unlike molecular interactions but has been very little utilized due to experimental difficulties.

Design of the apparatus for the measurement of the inter-diffusion of gases using tracer technique has been undertaken by R. Paul and the necessary equipments are being procured.

Thermal diffusion in gas mixtures

Under a scheme sanctioned by the Department of Atomic Energy, an all-metal coaxial tube type thermal diffusion column has been set up by S. N. Srivastava. It employs high precision stainless steel and copper tubes. To keep the two tubes concentric, accurately prepared pyrophelitte spacers have been used. Along with the water circulating system the whole unit has been assembled and suitably mounted. The apparatus has been satisfactorily tested for vacuum tightness and concentricity of the bottom section. Its vertical setting has also been achieved. Other tests are in progress.

Thermal conductivity of gas mixtures

Measurements on the thermal conductivity of some binary mixtures of monatomic and diatomic gases have been carried out by B. N. Srivastava and R. C. Srivastava with a view to testing the accuracy of the expressions recently given for the Eucken factor. The results agree, within limits of experimental error, with the recent formula of Hirschfelder for the conductivity of mixtures of polyatomic gases, provided the experimental value of the Eucken factor for a polyatomic gas is utilized and not the theoretical expression of Hirschfelder. The results are in course of publication. Further experiments with other mixtures are being undertaken by A. K. Barua with a view to obtaining a better understanding of the Eucken factor.

The thermal conductivity of a dissociating gas is a very interesting problem both from the theoretical and the experimental points of view and is likely to yield valuable information regarding exchange of energy between the various energy states of the atoms and the molecules. As the theory for this case is not satisfactorily developed, it is proposed to plan suitable experiments for a proper appreciation of the relevant factors. With this end in view the design of an apparatus for the measurement of the thermal conductivity of dissociating gases has been finalized and its construction is being undertaken by A. K. Barua.

Low temperature physics

The helium liquefier has been completely installed along with its various component units such as the hydrogen circuit, the helium circuit, the vacuum case circuit, the compressor assembly, the gas holder etc. The auxiliary helium purification circuit constructed by us has been tested for satisfactory working. Various automatic controls for the helium circuit have been designed and constructed and are being used for the satisfactory working of the liquefier.

A new apparatus for the purification of high pressure commercial hydrogen has been designed and constructed and introduced in the hydrogen purifying circuit of our combined hydrogen and helium liquefier as a precooler. Using this, the commercial hydrogen manufactured locally was liquefied and by boiling it at a reduced pressure of 16 cm a temperature of 15°K was obtained.

Special types of double-walled, permanently evacuated, all-metal siphons for the transfer of liquid air, liquid oxygen etc. have been designed, constructed and are being used satisfactorily.

A simple liquid air transfer valve for transferring liquid air into a partially evacuated system, has been designed and constructed, and is being used in our laboratory for transferring liquid air.

X-ray crystallography

X-ray study of naphthazarin has been undertaken by P. Srivastava. The unit cell dimensions have been redetermined and are found to be quite different from the earlier measurements on this crystal by Palacois and Salvia. The crystal belongs to the monoclinic system and the number of molecules per unit cell comes out to be 4. From the systematic absence the crystal is assigned the cell contained only 2 molecules which was not supported by the magnetic data space group $P_{2_1/c}$ as against $P_{2_1/n}$, given by the previous workers. Their unit of S. Banerjee while the results of the present investigation are in conformity with the magnetic data. Further work on the molecular structure of this crystal is in progress.

Hydrogen distribution in ammonium ion is a controversial point whether it is isotropic with revolving hydrogens around nitrogen atom or has directed N-H bonds. To investigate this point, work on NH_4Cl has been taken up by B. V. R. Murty. Using the previous available data on the crystal, Fourier synthesis for the experimental determination of scattering factor curves of the different atoms and Fourier difference synthesis for a possible indication of the hydrogen peaks are in progress. To reduce as far as possible the most serious 'Series termination' error it is intended to record all the possible reflections from the crystal within the 'limiting sphere of reflection' for molybdenum radiation and the work in this direction is in progress.

X-ray study of alloys

Abdul Quader and E. M. Gopalakrishna are working in this line. The Unicam high temperature camera has been calibrated upto 700°C using pure silver.

X-ray diffraction and metallographic methods are being used in the study of an industrial aluminium alloy and the investigation is in progress. The study of the binary alloys of Ag-Cd and Cd-Tl has been undertaken. 1:1 Ag-Cd alloy has been prepared and a few more of different compositions are under preparation. X-ray diffraction photographs of 1:4 Al-Cu and 1:1 Ag-Cd have been taken and their study is in progress.

Low temperature X-ray work

The construction of the low temperature Weissenberg camera is in further progress. After completing the stainless steel Dewar, the construction of the entire rotation assembly has been completed including the bearing and the rotation seal assembly. The entire instrument has been mounted on a vertical support and to avoid rigidity between the Dewar and the rotating seal some length of sylphone bellow has been joined between them.

Miscellaneous

Prof. B. N. Srivastava was elected a member of the Commission I of the International Institute of Refrigeration and was invited to attend its meeting in Holland. Mr. R. C. Srivastava, Lecturer, Lucknow University, came to the Association to do research work in the laboratories of the Department during the summer. As a result of this work and some work previously done under the guidance of Prof. B. N. Srivastava, he was awarded the D.Phil. (Science) degree of the Lucknow University.

List of Papers published during the year 1957-58

1. Thermal Conductivity of Binary and Ternary Rare Gas Mixtures—by B. N. Srivastava and S. C. Saxena, *Proc. Phys. Soc.* (London), B, **70**, 369, 1957.
2. Thermal Conductivity of Binary and Ternary Mixtures of He, A & Xe—by S. C. Saxena, *Ind. Jour. Phys.*, **31**, 597, 1957.
3. Formulas for Thermal Conductivity of Ternary Gas Mixtures—by B. N. Srivastava and S. C. Saxena, *Jour. Chem. Phys.*, **27**, 583, 1957.
4. Force constants for like Molecules on Exp-Six Model from Thermal Conductivity—by K. P. Srivastava, *Ind. Jour. Phys.*, **31**, 404, 1957.
5. Intermolecular Potentials for Unlike Interaction on Exp-Six Model—by K. P. Srivastava, *Jour. Chem. Phys.*, **26**, 579, 1957.
6. Unlike Molecular Interactions and Properties of Gas Mixtures—by K. P. Srivastava, *J. Chem. Phys.*, **28**, 543, 1958.
7. X-ray Measurements on Nettle Fibres—by D. M. Chackraburty, *Nature*, **179**, 776, 1957.
8. An X-ray study of Leathers—by D. M. Chackraburty and B. Chakravarty, *Ind. Jour. Phys.*, **32**, 10, 1958.

Paper in the Press

1. X-ray study of Naphthazarin—by P. Srivastava.

B. DEPARTMENT OF MAGNETISM

In course of the year under review, the reorganization work of the department of magnetism visualized in the second 5 year plan was undertaken. Owing to several difficulties in obtaining suitable instruments from abroad this reorganization work had to be mainly confined to investigations in fundamental lines on structural magnetism with special reference to extension of the work already being done in this laboratory on temperature and structure dependence of paramagnetism in crystals. Thus the work visualized in the line of ferromagnetism had to be kept in the background for more suitable times. The expansion and reorganization of work comprised of the following:—

- (1) Development of the techniques of paramagnetic resonance spectroscopy and its application to structural problems of paramagnetic crystals.

- (2) Adoption of X-ray diffraction techniques to the determination of thermal changes in structures of crystals and their application to the study of paramagnetic behaviour of crystals.
- (3) Development of improved techniques of low temperature generation and measurement and their application to study of paramagnetic behaviours.
- (4) Development of new improved techniques in magnetic measurement.

In addition to above development work, those already undertaken in the previous year are also in progress. The summary of the different works are given below.

(a) Paramagnetic anisotropy of dihalides of Cu^{2+} has been undertaken by A. I. P. Singh. In many of these salts the exchange interaction is prominent and gives rise to an antiferromagnetic Curie temperature nearabout liquid helium temperatures. This deviation from Curie Law is superposed on that arising from the thermal expansion of the crystal predicted by Bose in Cu^{2+} salts *et al* (*Proceedings of Royal Society*, Vol. 239, 165, 1957). In addition to this complication the covalency factor in the dihalides is probably greater than in sulphates and selenates of Cu^{2+} . Some preliminary work done by S. K. Datta in this laboratory confirm these views and agree with paramagnetic resonance results.

(b) A. I. P. Singh has also undertaken to measure the paramagnetic behaviours of a number of fluosilicates and chlorostannates of Cu^{2+} . These crystals are rather difficult to prepare but since these have uniaxial (trigonal) symmetry and also contain only one molecule in the unit cell their behaviour is more amenable to theoretical treatment than sulphates, selenates, dihalides, etc. Preliminary measurements by S. K. Datta show that some of these salts have abnormally low anisotropies. This fact increases the difficulties in the present measurements. Singh has also measured the susceptibilities of nearabout 20 samples of substances on request from sister depts. of the Association and from institutes such as Science College, I.I.T., Kharagpur and Science College, Patna. Three students of Agra University deputed by Prof. A. Mookherji were helped to carry on low temperature anisotropy measurements of their samples.

(c) The anisotropy of a large number of Ni^{2+} salts of similar constitution has been studied by S. C. Mitra, S. K. Datta and A. Bose in order to ascertain the effect of long range crystalline fields in these salts. It was found that agreeing with the usual theory there is a large departure from Curie Law in all the Ni^{2+} salts. In accordance with the theory of long range crystalline fields as explained by Bose (International Symposium on Magnetism, 1956, Moscow), deviation of a complicated nature from older theories, in Ni^{2+} salts have been observed by the above workers, dependent upon the structures of the salts and their thermal expansions. The magnetic anisotropy measurements further served to determine uniquely the orientations of the $\text{Ni}^{2+} \cdot 6\text{H}_2\text{O}$ clusters in the

unit cells of these salts and showed that paramagnetic resonance experiments were not sufficient for this purpose in these cases. The crystalline field in these salts were found to vary by about 2 to 12% with temperature between 360°K and 90°K and from salt to salt by as much as 120% in extreme cases. The spin-orbit coupling in Ni^{2+} in crystals was calculated from anisotropy of the salts and agreed to within 5% of the spectroscopic value of -324 cm^{-1} . The resonance method by Oxford workers gave a value nearly 25% lower. It is shown by the work of Bose *et al* that this is too small, and it should be actually about 15% lower. The reason of this 15% low value is attributed to the inclusion of the "covalency factor" in the spin-orbit coupling coefficient as calculated from resonance data.

(d) The work on paramagnetic alums of Ti^{3+} , V^{3+} and Cr^{3+} has been now completed by S. K. Datta Roy and he has also nearly completed the measurement of anisotropic oxalates and acetyl acetones of Cr^{3+} and V^{3+} . These measurements are expected to elucidate the anisotropy of the crystalline electric fields in these salts about which very little is known. A peculiar characteristic of the oxalates is that the magnetic axes of the crystals appear to rotate by as much as 50° or more as the temperature is lowered down to 90°K. Datta Roy's thesis for D.Phil. degree is soon going to be submitted.

(e) The theory of the paramagnetic susceptibility of crystalline salts in which the paramagnetic ion has a close lying group of orbital energy levels at the bottom of the Stark pattern under the crystalline electric field is very difficult to work out with refinement sufficient to compare with the experimental refinements recently reached in our laboratories. A. S. Chakravarty has now completed a refined theory in the case of V^{3+} salts taking into consideration admixtural as well as Boltzmann contributions of upper energy levels. He has also undertaken the refinements in theory in several other complicated cases in which the theoretical position is yet very unsatisfactory. He has also completed the construction of jewel pivot torsion microbalance of high precision, with which he has undertaken the measurement of principal susceptibilities of Cu^{2+} and Ni^{2+} salts, to analyze completely the effect of long range crystalline electric field, so far only studied by the anisotropy method.

(f) The magnetic measurements on a number of oxalates, acetates, formates and propionates of the iron group of ions have been undertaken by P. Ghosh. Most of the salts are difficult to prepare and to crystallize. So Ghosh has undertaken to construct a crystallizing apparatus in which the temperature and saturation conditions of the solutions could be accurately controlled. The method of controlled seeding of crystals is also under consideration.

(g) K. K. Deb and A. S. Chakravarty have undertaken to measure the principal susceptibilities of paramagnetic crystals down to liquid hydrogen temperatures. The range between 90°K and 60°K will be covered by boiling liquid air under reduced pressure in a cryostat which is a modification of the earlier liquid air cryostat by A. Bose already covering the range 300°K to 90°K.

The region between 60°K and 20°K will be covered, with the help of the hydrogen liquefier cryostat designed earlier by A. Bose and A. K. Dutta, by a method of controlled Joule-Thomson cooling of hydrogen gas. The efficiency of production of liquid hydrogen is being enhanced by suitable alteration of design. The construction of a compact spring balance with electrodynamic balancing, electromagnetic damping, automatic crystal setting and electronic magnification is in progress for measuring susceptibilities of crystals at low temperatures.

(h) The study of paramagnetic crystals by the paramagnetic electron resonance as also proton resonance method has been undertaken by J. Bose, R. Bagchi and A. K. Haldar. The components for three resonance spectrographs in the range of 3 cm., 1.5 cm. and 0.8 cm. have been all ordered. Some of these equipments have already arrived and most of them will be available soon. A proton resonance system for both accurate magnetic field measurements as also proton resonance in paramagnetic crystals has been constructed by R. Bagchi. A large powerful electromagnet has been designed by A. Bose and R. Bagchi for electron and proton resonance, with maximum pole gap 6 cm. pole face diameter 15 cm. current 40 amperes at 220V, D.C. and an expected field of 20,000 gauss, with modulation at 50 cycle, 220V, A.C. to a depth of about 1000 gauss.

J. Bose and A. K. Haldar have undertaken to develop a new method of sensitive detection of microwaves by thermocouple.

(i) S. Roy and (Miss) G. Bhowmick are continuing the study of phase transition in some artificial and natural minerals such as lepidocrocite and gothite and the effect of impurities on these transitions. They are also continuing the study of the changes in interplanar distances in graphite on chemical and thermal treatment which are associated with the changes in its electrical properties.

A low temperature camera of special design is under construction to study the thermal expansion properties of paramagnetic crystals and a mathematical correlation of the crystal expansion with the structural and orientative changes (with temperature) in paramagnetic clusters in the unit cells of the crystals is in progress.

(j) A. K. Datta has now completed his correlation of thermal, magnetic, electrical, and X-ray absorption properties of graphite with the energy band structure in this crystal. He is undertaking the application of microwave resonance techniques to study further details of the semiconductor properties.

List of Paper published during the year 1957-58

1. Paramagnetic properties of some salts of the iron group of elements—by A. Bose, *Izvest-Akad, nauk. U.S.S.R.* Ser. Fiz. **21**, 802, 1957.

Papers in the Press

1. Characteristics of free electrons in graphite from a study of its magnetic and other properties, *Physica*.
2. Behaviour of the paramagnetic ions in the single crystals of some similarly constituted salts of the iron group of elements. Part II. Hydrated Ni²⁺ salts—by A. Bose, S. C. Mitra and Sunil K. Datta, *Proc. Roy Soc.*

C. OPTICS DEPARTMENT

The investigations carried out in the Department during the year 1957-58 can be classified under the following headings:—

- (1) Raman spectra of solutions of molecules showing hydrogen bond formation;
- (2) Raman spectra of frozen solutions of substituted benzene and pyridine compounds;
- (3) Raman spectra and rotational isomerism;
- (4) Ultraviolet absorption spectra of pure organic compounds in the vapour, liquid and solid states;
- (5) Ultraviolet absorption spectra of frozen solutions of organic compounds;
- (6) Polarized absorption in the near ultraviolet region in single crystals of organic compounds;
- (7) X-ray analysis of frozen organic compounds;
- (8) X-ray analysis of organic crystals at different temperatures.

Raman spectra of solutions of molecules showing hydrogen bond formation

The Raman spectra of solutions of *o*-chlorophenol in different solvents have been investigated by Deb Kumar Mukherjee. He has observed that the intensity of the line due to O-H valence oscillation increases when the liquid is dissolved in certain solvents and it increases further when the concentration of the solution is diminished. He has concluded from these results that most of the molecules in a very dilute solution in carbon tetrachloride are expected to have the OH group in the trans position and therefore the 6910 cm^{-1} band in the infra red region is to be assigned to the valence oscillation in the O-H group loosely attached to the carbon tetrachloride molecules and not to such oscillations in the O-H group in the cis position as done by previous workers.

Raman spectra of frozen solutions of benzene and pyridine compounds

In continuation of his previous investigations on the Raman spectra of frozen solutions of organic compounds G. S. Kastha has studied the Raman spectra of α - and γ -picoline and of their solutions in alcohol in liquid and solid states. He has concluded from the results that the low-frequency Raman lines observed in the spectra due to the pure substances in the solid state are produced by groups of molecules formed in the solid state and not by the whole lattice and that the strength of the C-C bond in the ring increases with substitution of a hydrogen atom in the ring with a CH_3 group and also when the substance is dissolved in alcohol or is solidified.

Kastha has also studied the Raman spectra of solutions of ethyl benzene, chlorobenzene and bromobenzene in the frozen state at -180°C and has

observed that the low-frequency Raman lines due to the pure crystals disappear in each case when the concentration of the frozen solution is sufficiently low, but at higher concentrations these lines persist with undiminished intensity in the solution of chlorobenzene while they are replaced by a new band in the case of ethyl benzene. He has concluded from these results that only groups of molecules are responsible for the origin of these low-frequency lines and the new band observed in the case of the frozen solution.

Raman spectra and rotational isomerism

M. M. Mazumder has studied the Raman spectra of solutions of ethylene dichloride, ethylene dibromide and ethylene chlorhydrin in ethyl alcohol cooled to temperatures much below the freezing points of these substances but above the freezing point of alcohol. He has observed that in each case the two lines due to the C-Cl or C-Br valence oscillations in the two types of molecules present in the liquid appear with undiminished intensities even when the solution is cooled to a temperature much below the freezing point of the pure liquid but is not allowed to freeze. From these results he has concluded that the disappearance of one of these two lines in each case with freezing of the pure liquid is caused not by the lowering of temperature but by the change of state and that the two forms of the molecule are produced by the intermolecular field in the liquid state due to a random orientation of the surrounding molecules. These results will be published shortly.

He has further studied the Raman spectrum of ethylene dichloride in the vapour state at about 75°C and has measured the ratio of intensities of the two lines, one due to the gauche form and the other due to the trans form of the molecule. He has shown that as this ratio does not differ very much from that for the vapour at 170°C the energy difference calculated by previous workers from the data for a single temperature is not quite correct.

Ultraviolet absorption spectra of pure organic compounds in the vapour, liquid and solid states

The ultraviolet absorption spectra of a large number of aromatic compounds in different states and at different temperatures have been studied by several workers in this Department during the year under review. S. B. Banerjee has studied these spectra due to α -, β - and γ -picoline, ortho- and para-chloroanisole, 1,3,5-trichlorobenzene and 1,2,4-trichlorobenzene in the liquid state and in the solid state at -180°C. In the case of the picolines the two systems of bands due to the $n-\pi^*$ and $\pi-\pi^*$ transitions observed in the spectra due to the substances in the vapour state are replaced by only one system in the spectra due to the liquid and solid states. He has concluded from these results that the molecules form associated groups in the liquid and solid states through the non-bonding electron of nitrogen atom and therefore the system due to $n-\pi^*$ transition disappears. In the case of *o*-chloroanisole also he has observed two systems of bands separated from each other by about 23 A.U. and one of these two systems disappears when the liquid is frozen. He has con-

cluded that probably there are two types of molecules in the liquid state due to the *cis* and *trans* positions of the methoxy group with respect to the chlorine atom of the molecule. In the case of 1,3,5-trichlorobenzene he has observed that the 0,0 band, which is forbidden and is not observed in the spectrum due to the vapour, appears with moderate intensity in the spectra due to the liquid and solid states. He has concluded that the symmetry of the molecule is disturbed by the intermolecular field in the two states of aggregation.

S. B. Banerjee has also studied the ultraviolet absorption spectra of benzylamine and isobutyl benzoate in the vapour, liquid and solid states. He has observed two systems of bands separated by 57 cm^{-1} in the spectrum due to benzylamine in the vapour state and only one system in those due to the liquid and solid states. He has concluded that probably two types of molecules having two orientations of the CH_2NH_2 group produce these two systems.

S. K. Sen has studied the ultraviolet absorption bands of *p*-dimethoxy benzene, *m*-dichlorobenzene and *m*-bromotoluene in the liquid state and in the solid state at different temperatures going down upto about -180°C . In each case the broad and fewer bands given by the liquid become much sharper when the substance is solidified and cooled to -180°C , but in the case of *m*-dichlorobenzene and *m*-bromotoluene each of the bands is split up into three. He has concluded that the upper energy state is split up by the influence of intermolecular forces at -180°C in the latter two cases.

Ultraviolet absorption spectra of frozen solutions of organic compounds

S. B. Roy and S. C. Sirkar have investigated the ultraviolet absorption spectra of frozen solutions of the three dichlorobenzenes in isobutyl alcohol of concentrations 0.2% and 25% at -180°C . It has been observed that in the case of the *ortho*- and *meta*- compounds the splitting of the energy levels observed in the spectra due to the pure crystals does not take place in the spectra due to 0.2% frozen solutions. The spectra due to 25% solution of these two compounds appear to be produced by superposition of the spectra due to 0.2% solution and the pure crystals, but there are discrepancies regarding relative intensities of the bands. The spectrum due to 0.2% solution of *p*-dichlorobenzene, however, is not similar to that due to the vapour. On the other hand it can be analysed into two series of bands, one due to single molecules and the other due to small groups of molecules, the latter spectrum being slightly different from that due to the pure crystals.

S. B. Roy has investigated the influence of environment on the electronic energy level of 1,3,5-trichlorobenzene and 1,3,5-trimethyl benzene by studying the ultraviolet absorption spectra of solutions of these two compounds in isobutyl alcohol, carbon tetrachloride, chloroform and cyclohexane in the liquid and frozen states. It has been observed by him that the forbidden 0,0 band of 1,3,5-trichlorobenzene appears with moderate intensity when the substance is dissolved in solvents having molecules containing hydrogen atoms, but it does

not appear when carbon tetrachloride is used as the solvent. Similarly, the forbidden 0,0 band of 1,3,5-trimethyl benzene appears weakly when chloroform or carbon tetrachloride is used as the solvent, but it does not appear when cyclohexane is used as the solvent. It has been concluded that formation of weak linkages between the chlorine atom of a molecule and the hydrogen atom of a neighbouring molecule is responsible for the distortion of the threefold symmetry of the molecule in some of these solutions.

Polarized absorption in the near ultraviolet region in single crystals of organic compounds

The near ultraviolet absorption spectra of very thin single crystals of *p*-dichlorobenzene with the *c*-axis of the crystal held in the vertical position has been studied by S. C. Sirkar and T. N. Misra and the vertical and horizontal components of the spectrum of light transmitted by the crystals have been recorded by using a double image prism of quartz. It has been observed that the absorption bands in the near ultraviolet region are present in the two components without being shifted much from each other. It has been pointed out that these facts do not agree closely with the predictions of the theory put forward by Davydov according to which the band systems in the two compounds should have been slightly separated from each other.

X-ray analysis of frozen organic compounds

S. G. Biswas and S. C. Sirkar studied the Debye-Scherrer patterns due to frozen toluene and those due to its solutions of strengths 70% and 30% in the frozen state at -180°C . The space group of the crystals of toluene has been determined. The frozen solutions have been found to be amorphous. These results have been correlated with those obtained by earlier workers in the investigations on the Raman spectra of this substance under similar conditions.

The Debye-Scherrer patterns due to frozen chlorobenzene and bromobenzene have been studied by S. G. Biswas who has observed that the patterns resemble those due to fibres. From such patterns he has been able to determine the dimensions of the unit cell unequivocally. He has also measured the density of the frozen compounds and has determined the number of molecules per unit cell and the space group to which these crystals belong.

N. K. Roy has investigated the crystal structure of frozen styrene and has determined the space group of the crystal.

X-ray analysis of organic crystals at different temperatures

The Debye-Scherrer patterns due to diphenyl at 32°C and at -180°C were studied by G. S. R. Krishna Murti and the unit cell dimensions at the two temperatures were determined. These indicated a larger contraction along *a*-axis than along *b*- and *c*-axes with lowering of temperature to -180°C . The angle β also was found to change slightly with the lowering of temperature. He con-

cluded that the molecules turn through a small angle in the unit cell when the temperature is lowered to -180°C .

The Debye-Scherrer patterns of crystals of *p*-nitroaniline at 90°K and at the room temperature have also been studied by Krishna Murti. It has been observed that the unit cell expands slightly along *b*-axis and contracts along the *a*- and *c*-axes when the crystal is cooled to 90°K . He has concluded from these results that with this lowering of temperature strong intermolecular forces turn the molecules a little in the unit cell.

Krishna Murti has further studied the Debye-Scherrer patterns of three different modifications of crystals of anthranilic acid both at the room temperature and at -180°C and has determined the space group of one of these modifications, as it was not known. The coefficients of expansion of all these modifications have also been determined.

List of Papers published during the year 1957-58

1. On the ultraviolet absorption spectra of frozen solutions of dichlorobenzenes in isobutyl alcohol—by S. B. Roy and S. C. Sirkar, *Ind. J. Phys.*, **31**, 177, 1957.
2. Crystal structure of *p*-nitroaniline at different temperatures—by G. S. R. Krishna Murti, *Ind. J. Phys.*, **31**, 353, 1957.
3. Electronic spectra* of benzylamine and isobutyl benzoate in different states and at different temperatures—by S. B. Banerjee, *Ind. J. Phys.*, **31**, 359, 1957.
4. Raman spectra of isomeric picoline in different states and in solutions of ethyl alcohol at different temperatures—by G. S. Kastha, *Ind. J. Phys.*, **31**, 395, 1957.
5. Electronic spectra of trichlorobenzene in the liquid state and in the solid state at -180°C —by S. B. Banerjee, *Ind. J. Phys.*, **31**, 483, 1957.
6. Ultraviolet absorption spectra of 1,3,5-trichlorobenzene and 1,3,5-trimethyl benzene in different solvents and at different temperatures—by S. B. Roy, *Ind. J. Phys.*, **31**, 588, 1957.
7. The crystal structure of anthranilic acid at different temperatures—by G. S. R. Krishna Murti, *Ind. J. Phys.*, **31**, 611, 1957.
8. Raman spectra of frozen solutions of some monosubstituted benzene compounds in ethyl alcohol—by G. S. Kastha, *Ind. J. Phys.*, **31**, 635, 1957.
9. X-ray analysis of frozen pyridine and its solution at -180°C —by S. G. Biswas, *Ind. J. Phys.*, **32**, 13, 1958.
10. X-ray analysis of frozen styrene at -180°C —by N. K. Roy, *Ind. J. Phys.*, **32**, 137, 1958.

Papers in the Press

1. On polarised electronic spectra of single crystals of para dichlorobenzene at -180°C —by S. C. Sirkar and T. N. Misra, *J. Chem. Phys.*
2. On the Raman spectra of solutions of ortho chlorophenol—by Deb Kumar Mukherjee, *Ind. J. Phys.*

D. DEPARTMENT OF THEORETICAL PHYSICS

The investigations carried out in the Department of Theoretical Physics during the year 1957-58 are mainly in the following lines:

- (1) Spin of an electron from five dimensional Wave equation.
- (2) Influence of constant electric and magnetic fields on spin of the particle.
- (3) Electronic energy bands in lattices.
- (4) Cosmology.

Spin of an electron from five dimensional-wave equation

If we assume that the motion of the electron is governed by a five dimensional analogue of the Klein-Gordon equation, then for the case of an electron in a coulomb field one obtains energy levels which contain half-integers. Further the general solution of such an equation leads to the appearance of four quantum numbers, it has been found that the square of the angular momentum operator has eigen values $j(j+1)\hbar^2$ where $j=l+\frac{1}{2}$ the appearance of half integers indicates that spin of the electron has entered into the picture in a subtle way. The investigations on the five dimensional wave equation leads to two conclusions: (i) the introduction of the fifth co-ordinate influences the energy levels of the electron in a same way analogous to the existence of the spin, (ii) an intrinsic angular momentum of the electron of magnitude $\frac{1}{2}\hbar$ appears as a consequence of the solution. It may be remarked here that the connection between the fifth co-ordinate of a particle and its spin is not apparent on theoretical grounds. For the case of scattering of an electron in a coulomb field, the solution of the radial part of the five dimensional wave equation contains half integral quantum numbers which again lends support to the idea that the influence of the fifth co-ordinate is similar to the existence of the spin.

Influence of constant electric and magnetic fields on the spin of the particle

If we assume that the particle obeys the second order equation obtained in the usual way of operating twice the Dirac's linear Hamiltonian, we find that the change of momentum and spin direction of a particle subjected to magnetic and electric fields is the same as for a particle obeying Dirac's first order equation. Often there are certain advantages to work with the second order equation over that of the first order Dirac equation. The idea of the paper is to show how good the second order equation is to represent an electron which is properly represented by the Dirac equation.

Electronic energy bands in lattices

It is almost impossible to find an analytical solution of the one electron problem in a crystalline lattice with Hartree-Fock self consistent potential, that

being so, one has to take recourse to simplified models which have been so long one dimensional. To have more realistic picture, we have studied a three dimensional model and derived a relation between the electronic energy E and the wave vector K . On the same model, we have also investigated the band structure of a model alloy—the results of the band structure of an alloy clearly show a splitting up of bands as conjectured in the theory of anti ferro-magnetism.

Cosmology

In 1955, we published some general relations regarding relativistic cosmology. Shortly afterwards Hukmann and Schucking discussed the behaviour of Newtonian cosmological models obtaining equations closely similar to those given by us. We have found it possible to generalize still further the discussion of Hukmann and Schucking. The results show that corresponding to any relativistic model there is a Newtonian analogue but the converse is not true.

List of Papers published during the year 1957-58

1. The influence of constant electric and magnetic fields on the spin of the particle—by S. Sarkar, *Ind. Jour. Phys.* **32**, 124, 1958.
2. Electronic energy bands in Model three dimensional lattices—by A. Raychaudhuri, *Zeits. f. Physik.*, **148**, 435, 1957.
3. Relativistic and Newtonian Cosmology—by A. Raychaudhuri, *Zeits. f. Astrophysik*, **43**, 161, 1957.
4. Singular state in Relativistic Cosmology—by A. Raychaudhuri, *Phys. Rev.*, **106**, 172, 1957.
5. Spin of An Electron From Five Dimensional Wave Equation—by C. C. Banerjee, *Ind. Jour. Phys.*, **32**, No. 4, 1958.

List of Papers in Press

1. Scattering of Electron from Five Dimensional Wave Equation—by A. K. Mitra, *Ind. Jour. Phys.*

E. DEPARTMENT OF PHYSICAL CHEMISTRY

The investigations carried out in the department during the year under review may be classified under the following headings:—

A. High Polymers.

1. Kinetics and chain transfer;
2. Studies in aqueous polymerization;
3. Built-in-dye polymers;
4. Thermodynamic properties of binary mixtures;
5. Determination of molecular weight, size and shape of high polymers;
6. Determination of absolute rate constants in polymerization;
7. Krillium as soil conditioners.

B. General Physical and Analytical Chemistry.

8. Inter-relationship between physical properties of molecules;
9. Solubilization and liquid crystalline detergent systems;
10. Co-solvency;
11. Non-aqueous titration;
12. Chemical utilization of Ultrasonic waves;
13. Decomposition of peroxides.

C. Rubber.

14. Degradation of rubber.

D. Coal.

15. Fundamental studies on the solvent extraction of coal.

High Polymer Chemistry

Kinetics and chain transfer.

In continuation of his previous investigations A. K. Choudhuri has studied the kinetics and chain transfer behaviour of the monomer methyl isopropenyl ketone in bulk and in different solvents both in absence and presence of initiators.

Studies in the polymerization of ethyl methacrylate and butyl methacrylate are being continued by S. R. Chatterjee and S. N. Khanna, with a view to comparing the effect of different substituent groups on the kinetics and chain transfer in polymerization reaction.

The polymerization of methyl methacrylate initiated by metallic soaps is being continued by V. Lingamurty.

The monomer vinyl chloroacetate has been synthesized by (Miss) N. Banerjee and preliminary investigations have been made about its polymerization behaviour dilatometrically.

Studies in aqueous polymerization.

The aqueous polymerization of vinyl monomers in a redox system using $K_2S_2O_8$ and $Na_2S_2O_4$ has been undertaken by T. Guha and M. Biswas. The polymers are found to be of high molecular weight and the reaction rate very fast. The work is in progress.

Built-in-dye polymers.

In continuation of his previous work Bhaskar Rao has prepared a poly-ampholyte containing aromatic amino and carbonyl groups. The diazo-derivative of the ampholyte is a built-in-dye polymer when coupled with α -naphthol and shows denaturation phenomenon under special conditions. It is suggested that this type of denaturation has some bearing with denaturation of proteins.

Thermodynamic properties of binary mixtures.

Work is being continued in this field by S. N. Bhattacharya and A. V. Anantaraman. The heats of mixing of ethyl benzene+chlorobenzene and

chlorobenzene+xylene have been measured. The excess volume of mixing of these systems has also been determined. Further work on other systems is in progress.

A new technique for the measurement of small intervals of time has been incorporated in the microcalorimeter set up in the laboratory. This is accomplished by making use of a 50 cycles pulse generator and the time could be measured upto 1/50th of a second.

Meanwhile, the construction of the vapor-liquid equilibrium still is under progress.

Determination of molecular weight, size and shape of high polymer.

Determination of molecular weight, size and shape of high polymers is being carried out by N. Sanyal with the help of a light scattering photometer. Some natural polyelectrolytes like gum arabic, gum acacia and gum agar are also being studied.

Determination of absolute rate constants in polymerization in polymerization.

The determination of absolute values of the rate constants in polymerization using intermittent illumination by rotating sector technique is being continued by P. B. Roy Choudhury and V. Lingamurty. The construction of the photopolymerization unit is practically complete and the calibration of the instrument has been undertaken.

Krillium as soil conditioners.

Extensive work is in progress on the preparation of krillium type soil conditioners and studies on their interaction with soils and clays by B. R. Nagar and T. N. Sharma. The results are likely to offer an effective remedy against soil erosion and a valuable tool for fundamental studies of soil and clay minerals.

General Physical and Analytical Chemistry

Interrelationships between physical properties of molecules.

The work on the relationship between physical properties and effective atomic numbers has been continued by G. R. Somayajulu.

Solubilization and liquid crystalline detergent systems.

Work is being carried on mutual solubilization of oils and water by B. Biswas and (Miss) L. V. Asolkar. For elucidation of the mechanism of the phenomenon emphasis is laid on liquid crystalline systems obtained as intermediate in the process. Electrical, optical and thermal properties are being investigated.

Co-solvency.

An apparatus has been assembled by P. Charan Das to determine the solubilities of organic compounds in organic solvents *in situ*. Investigations are now under progress on the phenomenon of co-solvency of anthracene in binary mixtures.

Non-aqueous titration.

An attempt is being made by Ch. Kalidas to determine Hammett's acidity function for various acids in pure ethylene glycol. Work on perchloric acid solutions of ethylene glycol with one indicator, —nitraniline has been completed and is being applied to other indicators.

Chemical utilization of ultrasonic waves.

Theoretical work on the velocity of ultrasonic waves in solutions and liquids is being carried out by S. C. Srivastava. The possibility of chemical utilization of ultrasonic waves is also being investigated and an instrument for the generation of high frequency, high power ultrasonic waves is being designed. This will be utilized for initiating liquid and gas phase polymerization by ultrasonic waves.

Decomposition of peroxides.

Studies in the decomposition of peroxides in different solvents has been undertaken by B. B. Mukherjee. Rate of decomposition of lauroyl peroxide has been studied and further work is in progress.

(C) Rubber*Degradation of rubber.*

In continuation of his previous work the degradation of deproteinised rubber on stirring with carbon tetrachloride in presence of benzoyl peroxide and in absence of light is being investigated by V. L. N. Murty.

A differential thermal analysis of cinchona by-product alkaloids as vulcanization accelerators and antioxidants for rubber is under investigation.

(D) Coal*Fundamental studies on the solvent extraction of coal.*

Work has been undertaken by S. R. Chatterjee with various solvent mixtures to extract the bitumens from different ranks of coal to elucidate the constitution of coal. A special solvent extractor has been designed for the purpose and is under construction.

List of Papers published during the year 1957-58

1. Relationship between Atomic and Ionic Radii III—by G. R. Somayajulu and S. R. Palit, *J. Chem. Phys.*, **26**, 807, 1957.
2. Boiling Points of Homologous Liquids IV—by G. R. Somayajulu, and S. R. Palit, *J. Chem. Soc (London)*, **2540**, 1957.
3. Free Radical Bleaching of Jute Fibres—by S. R. Palit, *Science and Culture*, **22**, 688, 1957.
4. Azobisnitrile as Initiators in Methyl Methacrylate Polymerization—by Late N. G. Saha, U. S. Nandi and S. R. Palit, *J. Chem. Soc.*, **7**, 1958.
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8. Rubber-Plastics Combinations—by A. K. Sircar, *Popular Plastics*, **2**, No. 3, 26, 1957.
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4. Liquid Crystalline Cationic Soap Systems—by B. Biswas, V. A. Moghe and S. R. Palit, *Proceedings of the National Institute of Sciences of India*, 1958.
5. Studies on Synthetic Poly-electrolytes, Copolymers of Vinyl acetate maleic acid and Vinyl alcohol-maleic acid—by A. K. Sircar, *Proceedings of the National Institute of Sciences of India*, 1958.
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F. DEPARTMENT OF ORGANIC CHEMISTRY

As reported in the previous year, investigations are being actively pursued in the field of alicyclic compounds comprising sesquiterpenoids, diterpenoids, triterpenoids and steroids and also in the field of heterocyclics. Elucidation of the structure of some of the natural products is also in active progress.

List of Papers published during the year 1957-58

1. Synthetic studies in resin acids. Part II, Ghatak, Saha and Dutta, *J. Amer. Chem. Soc.*, **79**, 4487, 1957.
2. Synthetic studies in Santonin series, Mahajan, Dutt and Dutta, *J. Chem. Soc.*, 5069 1957.
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5. Synthesis of Dicarboxylic acid $C_{12}H_{14}O_4$ —A degradation product of Picrotoxin. Ghosal, Sinha and Bagchi, *J. Org. Chem.*, **23**, 584, 1958.

6. Studies in Dieckmann Cyclization. Part I, Cyclization of Triethyl Pentane—1,2,5-tricarboxylate. Sen and Bagchi, *J. Org. Chem.*, **23**, 000, 1958.
7. Synthetic studies in resin acids. Ghatak, Saha and Dutta, *Chem. & Ind.*, 51, 1957.

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1. Studies on the Ultraviolet Absorption Spectra of Coumarins and chromones. Part II. Absorption spectra of Hydroxy-coumarins and chromones. Sen and Bagchi *J. Org. Chem.*
2. Studies in Dieckmann cyclization. Part II. Cyclization of triethyl 1-methylpentane—1,2,5-tricarboxylate, Sen and Bagchi, *J. Org. Chem.*
3. Constitution of S. Lactone Rao, Varma, Ghosh and Dutta. *J. Sci. & Ind. Research*, 1958.

G. DEPARTMENT OF INORGANIC CHEMISTRY

Research work in this department was mainly continued on the study of co-ordination complexes and their applications in the field of analytical chemistry.

Physico-chemical investigations on metal chelate complexes of various organic ligands were continued and in some cases their stability constants were determined by photometric as well as by ion-exchange methods.

D. Banerjee has prepared some six-coordinated nitritoammines of bivalent nickel. He has also developed a method for the estimation of titanium spectrophotometrically with salicylamidoxime.

A. K. Chakravorty continued his work on the systematic investigation of the co-ordination complexes of hydroxamic acids, and their applications in analytical chemistry which includes the study of the complexes of tartaro-, citro-, mandelo-, phenoxyaceto-, and dihydro-cinnamyl hydroxamic acids.

In continuation of the work on the metal complexes of biguanides and substituted biguanides, R. L. Dutta has made a complete study of the preparation and properties of copper, nickel, cobalt, palladium and chromium complexes of *n*-hexyl-biguanide and hexamethylene-dibiguanide.

A simple method of synthesis of alkyl substituted guanylurea (dicyandiamidine) with the carboxyl group adjacent to the substituted alkyl group has been developed by R. L. Dutta, and a series of such substituted guanyl ureas, namely, methyl-, ethyl-, iso-propyl-, *n*-butyl, iso-butyl-, iso-amyl-, *n*-hexyl-, benzyl- and methoxy-ethyl- guanyl ureas have been prepared. Metallic complexes such as copper and nickel compounds of these reagents are now under investigation.

Manoj Ray has isolated and studied a number of cationic complexes of tri- and tetra- positive manganese with biguanide and ethylene-dibiguanide. They furnish the first instances of cationic manganese complexes with ligands containing donor N-atoms. The tetra-positive manganese complexes which represent the first cationic complexes of manganese in this valency state are particularly interesting from the magneto-chemical and structural point of view. A study

of the variation of magnetic susceptibility with temperature has indicated the presence of metal-metal bonding in these complexes.

He has also prepared and studied some binuclear complexes of cobalt(III) and chromium(III) with ethylene-dibiguanide. Complex compounds of palladium with ethylene-dibiguanide and a number of mixed complexes of cobalt(III), where biguanides and amines simultaneously co-ordinate with the central metal atom, have also been isolated and studied by him.

In continuation of his work on the analytical use of substituted rubeanic acids J. Xaxier employed di-iso-amyl-rubeanic acid for the spectrophotometric determination of cobalt, nickel and palladium.

Bireswar Banerjee has made a systematic spectrophotometric study on ferrous complexes of quinoline and pyridine carboxylic acids. He is now engaged in the preparation of some interesting quadrivalent vanadium complexes with biguanides.

N. R. Sengupta has prepared and studied the complex compounds of copper, nickel, cobalt and palladium with propanol-, iso-propanol- and sulfamido-phenyl biguanides. A series of deep blue diol-di-Cu-bisbiguanide have been isolated and their properties studied by him.

Sengupta has also determined the acid dissociation constants of the ligands ethanol- and propanol-biguanides and the formation constants of the copper and nickel complexes with the above two ligands.

Asit Kumar Ray has shown that 3- and 5-oximino-methyl salicylic acids and 3- and 5-aldehydo salicylic acids may be used for the estimation of thorium and its separation from the cerite earths. He has estimated iron(III) colorimetrically with these reagents. 3-oximino-methyl salicylic acid has also been employed by him for the determination of zirconium, titanium and uranium, and the composition of its uranyl salt and its stability studied.

D. Banerjee & K. K. Tripathi have made physico-chemical investigations on the kinetics and mechanism of substitution in complexes of palladium(II). They have also studied the nature of the complexes formed by iron(II) with 2-acetyl-pyridoximes and determined their stabilities by spectrophotometric, ion-exchange and pH-methods.

2-acetylpyridoxime has been used by D. Banerjee & K. K. Tripathi as a reagent for the colorimetric determination of copper and iron. They have also estimated cobalt and uranium spectrophotometrically with nicotinamidoxime. Further, use of nicotinamidoxime as a reagent in other analytical methods is under investigation.

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2. Complex compounds of tri- and tetra-positive manganese with biguanides—by Manoj Ray and Priyadarajan Ray, *Science & Culture*, **23**, 158, 1957.
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4. 2-Mercapto—and 2-Methyl-benzimidazole as reagents for silver—by R. L. Dutta, *J. Indian Chem. Soc.*
5. Kinetics and mechanism of substitution in complexes of palladium(II)—by D. Banerjea & K. K. Tripathi, *J. Inorg. Nucl. Chem.*
6. 2-Acetylpyridoxime as a colorimetric reagent for copper and iron—by K. K. Tripathi and D. Banerjea, *Science and Culture*.
7. Analytical applications of complex formation—by D. Banerjea, *J. Chem. Education*.
8. Studies on the metal complexes of hydroxamic acids. Part II. Coloured complexes of iron, vanadium and molybdenum with nicotino hydroxamic acid and their analytical uses—by R. L. Dutta, *J. Indian Chem. Soc.*

P. RAY,
Officiating Director.

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14. Reed, R. & Tuckker, S. H.	Organic chemistry; electronic theory and reaction mechanism.
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22. Tompa, H.	Polymer solutions.
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24. Hiscocks, E. S.	Laboratory administration.
25. Klotz, Irving M.	Chemical thermodynamics; basic theory and methods.
26. Riley, M. W. (Assoc. Ed)	Plastics tooling.
27. Cartmell, E. & Fowles, G. W. A.	Valency and molecular structure.
28. Sillen, L. G. ; Lange, P. W. & Gabrielson, C. O.	Problems in physical chemistry.
29. Lochte, H. L. & Littmann, E. R.	Petroleum acids and bases.
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31. Denbigh, K.	Principles of chemical equilibrium.
32. Harkins, Wm. D.	Physical chemistry of surface films.
33. Prigogine, I.	Introduction to thermodynamics of Irreversible processes.
34. Ukil, Dr. A. C.	18th Acharya Jagadish Ch Bose Memorial lecture and Report of Bose Institute for 1955-56.
35. Band, William.	An Introduction to quantum statistics.
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37. Terman, F. E.	Electronic and radio engineering; 4th ed.

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42. Linstead, R. P.; Elvidge, J. A. & Whalley, Mar- garet.	A course in modern techniques of Organic chemistry.
43. Born, Max.	Physics in my generation.
44. Bennett, H. (Ed-in-ch).	Chemical Formulary, vol. 10.
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47. Brittin, F L.	Radio-Television and electronics handbook.
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186.	Sen, Samarendranath ..	History of Science, vol. 2, 1958.
187.	Beckerley, J. G. (Ed.) ..	Annual Review of Nuclear Science vol. 7, 1957.
188.	Plank, R. (Ed.) ..	Handbuch der Kaltetechnik. Bd. 1.
189.	—do— ..	do. Bd. 2.
190.	—do— ..	do. Bd. 4.
191.	—do— ..	do. Bd. 8.
192.	—do— ..	do. Bd. 9.
193.	U. S. Dept. of Commerce National Bureau of Standards.	Report of the 42nd National conference on weights and measures 1957. Misc. Pub. 222.
194.	Gmelins Handbuch der Anorganischen Chemie.	Kupfer, Sys. No. 6QTeil. B. Lief. 1. Aug. 8, 1958.

JOURNALS SUBSCRIBED DURING 1957-58

1. Acta Crystallographica.
2. Advances in Physics.
3. American Journal of Physics.
4. Analyst.
5. Analytical Abstracts.
6. Analytica Chimica Acta.
7. Analytical Chemistry.
8. Annales de Physique.
9. Annals of Mathematics.
10. Applied Scientific Research A & B.
11. Astrophysical Journal.
12. British Journal of Applied Physics.
13. Bulletin of the Chemical Society of Japan.
14. Canadian Journal of Chemistry.
15. Canadian Journal of Physics.
16. Canadian Journal of Mathematics.
17. Chemical Abstracts.
18. Chemie Analytique.
19. Chemical Reviews.
20. Chemistry and Industry.
21. Comptes Rendus de Seances de L'Academie de Sciences.
22. Current Chemical Papers.
23. Discovery.
24. Discussions of the Faraday Society.
25. Electronics.
26. Experientia.
27. Geophysics.
28. Isis.
29. Journal of the American Chemical Society.
30. Journal of Applied Chemistry.
31. Journal of Applied Physics.
32. Journal of Chemical Education.
33. Journal of Chemical Physics.
34. Journal of Chemical Society (London).
35. Journal of Colloid Science.
36. Journal of Electrochemical Society.
37. Journal of the Institute of Metals.
38. Journal of the Institute of Petroleum.
39. Journal of Inorganic & Nuclear Chemistry.
40. Journal of Nuclear Energy.
41. Journal of Organic Chemistry.
42. Journal of Physical Chemistry.
43. Journal of Polymer Science.
44. Machine Shop Magazine.
45. Mathematical Reviews.
46. Micro Chimica Acta.
47. Nature.
48. Nuclear Physics.
49. Nucleonics.
50. Philosophical Magazine.
51. Phil. Trans. Royal Society of London.
52. Phys. & Chem. of Solids.
53. Physical Review.
54. Proc. National Academy of Sciences of U. S. A.
55. Proc. Physical Society, Sec. A.B.

56. Proc. Royal Inst. of Great Britain.
57. Proc. Royal Society of London, Sec. A.
58. Quarterly Reviews of Chemical Society.
59. Refrigeration Engineering.
60. Research.
61. Resins-Rubbers-Plastics.
62. Reviews of Modern Physics.
63. Rubber Chemistry & Technology.
64. Science Progress.
65. Scientific American.
66. Soviet Physics (JETP).
67. Tetrahedron.
68. Textile Research Journal.
69. Trans. of American Mathematical Society.
70. Transactions of the Faraday Society.
71. Trans. of the Inst. of the Rubber Industry.
72. Vacuum.
73. Osiris.
74. Angewandte Chemie.
75. Annalen der Chemie.
76. Chemische Berichte.
77. Helvetica Chemica Acta.
78. Journal fur Praktische Chemie.
79. Kolloid Zeitschrift.
80. Kunststoffe.
81. Makromolekulare Chemie.
82. Naturwissenschaften.
83. Physikalische Berichte.
84. Seifen-Oele-Fette-Wachse.
85. Zeits. für Angewandte Physik.
86. Zeits. für Anorganische Chemie.
87. Zeits. für Astrophysik.
88. Zeits. für Elektrochemie und Angewandte Physikalische Chemie.
89. Zeits. für Kristallographie.
90. Zeits. für Naturforschung (A & B).
91. Zeits. für Physikalische Chemie.
92. Zeits. für Analytische Chemie.
93. Zeits. für Physik.

JOURNALS RECEIVED IN EXCHANGE DURING 1957-58

1. Acta Physica Academiae Scientiarum Hungaricae.
2. Acta Physica Polonica.
3. Agra University Journal of Research.
4. American Ceramic Society Bulletin.
5. Annalen der Physik.
6. Annales de la Faculties des Sciences de Marseille.
7. Annales de L'Institut Pasteur.
8. Annales de la Societe Scientifique de Bruxells.
9. Applied Mechanics Reviews.
10. Archives des Sciences.
11. Arkiv for Fysik.
12. Arkiv for Matematik.
13. Australian Journal of Agricultural Research.
14. Australian Journal of Chemistry.
15. Australian Journal of Physics.

16. Bell Laboratory Record.
17. Biological Bulletin.
18. Boletin del Centro de Documentacion Cientifica Y Tecnica de Mexico.
19. Bulletin de L'Academie Polonaise des Sciences.
20. Bulletin of the Calcutta Mathematical Society.
21. Bulletin and Records of G. S. I.
22. Bulletin Signaletique, Pt. 1, 2 and Philosophie.
23. Bulletin Scientific.
24. Chemist.
25. Communications from the Kamerlingh Onnes Laboratory of the University of Leiden.
26. Comptes Rendus de L'Academie Bulgare des Sciences.
27. Comptes Rendus des Travaux du Laboratoire Carlsberg Sr. Chimique.
28. Current Science.
29. Czechoslovak Journal of Physics.
30. Det. Kgl. Danske Videnskabernes Selskab: Math-Fysiske Medd.
31. Do Bio. Medd.
32. Det. Kgl. Danske Videnskabernes Selskab: Biologiske Skrifter.
33. Det. Kgl. Mat. Fys. Skr. Dan. Vid. Selsk.
34. Electrotechnology.
35. Endeavour.
36. Energia Nucleare.
37. Geological Survey of India Library Bulletin.
38. Glasnik Matematicke-Fizicki I Astronomski.
39. Helvetica Physica Acta.
40. Indian Journal of Agricultural Science.
41. Indian Journal of Theoretical Physics.
42. Indian Minerals.
43. Industrial & Engineering Chemistry.
44. Insdoc List.
45. Insdoc Report.
46. Iowa State College Journal of Science.
47. Journal de Chmi. Phys. et de Physico-Chim-Bio.
48. Journal de Physique et le Radium.
49. Journal of American Ceramic Society.
50. Journal of the British Institute of Radio Engineers.
51. Journal of Franklin Institute.
52. Journal of Geophysical Research.
53. Journal of the Indian Chemical Society.
54. Journal of the Indian Institute of Science, A & B.
55. Journal of Mathematics and Physics.
56. Journal of the Optical Society of America.
57. Journal of the Physical Society of Japan.
58. Journal of Research of National Bureau of Standards.
59. Journal of Royal Aeronautical Society.
60. Journal of Science Club.
61. Journal of Scientific & Industrial Research A.
62. Journal of Scientific & Industrial Research B & C.
63. Journal of Scientific Instruments.
64. Journal of the Scientific Research Institute, Japan.
65. Koninklijke Nederlandse Akad. Van. Wet: Proc. A. (Math. Sci.).
66. Koninklijke Nederlandse Akad. Van Wet: Proc. B. (Physical Sci.).
67. Koninklijke Nederlandse Akad. Van Wet: Proc. C. (Bio. & Medicine Sci.)
68. Kungl. Tekniska Hogskolans Handlingar.
69. L'Ingenieur Revue Trimestrielle Canadienne.
70. Memoirs of the Faculty of Sciences. Sr. B.
71. Memoirs & Proc. Manchester Literary & Philosophical Society.

72. Natur und Volk.
73. New Zealand Journal of Science & Technology B.
74. Nova Acta Regiae Societatis Scientiarum Upsaliensis.
75. Nuclear Science Abstracts.
76. Osaka Mathematical Journal.
77. Philips Research Reports.
78. Philips Technical Review.
79. Physica.
80. Proc. Cambridge Philosophical Society.
81. Proc. Egyptian Academy of Science.
82. Proc. Indian Academy of Science Sec. A.
83. Proc. Indian Academy of Science Sec. B.
84. Proc. of the Institution of Radio Engineers—Australia.
85. Proc. of the Japan Academy.
86. Proc. National Inst. of Sciences of India A. Physical Sci.
87. Proc. National Inst. of Sciences of India B. Biological Sci.
88. Proc. Physical Society A.
89. Proc. of the Royal Society of Edinburgh Sec. A.
90. Proc. of the Royal Society of Edinburgh Sec. B.
91. Progress of Theoretical Physics.
92. Quarterly Journal of the Royal Meteorological Society.
93. Rendiconti Institute Superiore di Sanita.
94. Research Bulletin of the East Punjab University: Mathematics.
95. Research Bulletin of the East Punjab University: Botany.
96. Research Bulletin of the East Punjab University: Zoology.
97. Research Bulletin of the East Punjab University: Physics.
98. Research Bulletin of the East Punjab University: Chemistry.
99. Revue de Mathematique et de Physique.
100. Review of the Polish Academy of Sciences.
101. Review of Scientific Instruments.
102. Revue de Physique.
103. Revue D'Optique.
104. Rumania To-Day.
105. Sankhya: Indian Journal of Statistics.
106. Science and Culture.
107. Science Reports of the Research Institute: Tohoku Univ. Sr. A.
108. Science Reports of the Tohoku University 1st Sr.
109. Scientia Sinica.
110. Scientific Proc. Royal Dublin Society.
111. Senckenbergiana Lethaea.
112. Senckenbergiana Biologica.
113. Societas Scientiarum Fennica: Commentationes Biologicae.
114. South African Journal of Science.
115. Studii Si Cercetaride Fizica.
116. Tellus.
117. Tohoku Mathematical Journal.
118. Transactions Royal Society of Canada.
119. Ver. Nat. Ges. in Besel.
120. Vierteljahrsschrift der Naturforschenden Gesellschaft in Zurich.
121. Yokohama Mathematical Journal.
122. Automatics & Tele-mechanics.
123. Colloids Journal.
124. Doklady Akad. Nauk SSSR.
125. Journal of Analytical Chemistry.
126. Journal Prikladnoi Chimii.
127. Prikladna Mechanika.

**OTHER PUBLICATIONS RECEIVED AS COMPLIMENTARY ISSUES
DURING 1957-58**

1. Acta Astronomica.
2. Abstracts from Kagakukenkyu. Jo—Homoku.
3. Afinidad.
4. Atom.
5. Bayerische Akademie der Wissenschaften: Math-Natur. W. Klasse.
6. Bulletin of the Inst. Nuclear Sciences, Boris Kidrich.
7. Bulletin Inst. for the Study of the USSR.
8. Bulletin of the Res. Inst. Sr. A (Kerala).
9. C. S. & I. R. News.
10. Central Glass & Ceramic Research Inst. Bulletin.
11. Commonwealth Scientific & Industrial Organisation: Annual Report.
12. Commonwealth Today.
13. The Deaf in India.
14. Education Abstracts.
15. Educational Studies and Documents.
16. French Economic and Technical Bulletin.
17. General Radio Experimenter.
18. Hewlett—Packard Journal (pamphlet).
19. Half-yearly Journal of Mysore University A. B.
20. Hilger Journal.
21. Indian Journal of Meteorology & Geophysics.
22. Indian Journal of Physics. (22A.) Indian Manufacture & Production.
23. Ionospheric Data.
24. Ionospheric Predictions.
25. Istanbul Teknik Universiteli Bulteni.
26. Japan Science Review Mining & Metallurgy.
27. Journal of Association of Applied Physicists C. U.
28. Journal of College of Engineering & Technology, Bengal.
29. Journal of the Inst. of Polytechnics Osaka City University, Sr. A.
30. Journal of the Leather Technologists Association (India).
31. Journal of Mechanical Laboratory of Japan.
32. Journal of Science of the Hiroshima University, Sr. A.
33. Journal of Technology, B. E. College.
34. Kumamoto Journal of Science, Sr. A.
35. Memoirs of Faculty of Technology.
36. Natural Science Report of the Ochanomizu University.
37. Notas de Fisica.
38. Philips Industrial & Electronic Bulletin.
39. Philips Light Bulletin.
40. Philips Serving Science & Industry.
41. Photographie und Forschung.
42. Radio Res. Committee C. S. & I. R.
43. Research Industry.
44. Samvadadhvam.
45. Scientific Papers of the College of General Education. University of Tokyo.
46. Science of Light.
47. Siemens Review.
48. Technical Education News.
49. Transactions of the Bose Research Institute.
50. Unesco Bulletin for Libraries.
51. Unesco Chronicle.
52. University of Illionis Engr. Experiment Station.
53. Vijnan-Karmee.
54. WHO Bulletin.

55. World Veteran.
56. Avtomaticheskai Svarua.
57. Referativnii Zhurnal Phizika.
58. Referativnii Zhurnal Chimia.
59. Trudi Fizicheskogo Institute.
60. Visnik Akademia Nauk USSR.
61. Zhurnal Experimentalnoi Teoreticheskoi Fiziki.
62. Zhoornal Fizichyeskoi Himu.
63. Zhurnal Technicheskoi Fiziki.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES—1958-59

(Excluding grants for C.S.I.R. Schemes, Development of Research Training Facilities etc.)

RECEIPTS

Heads of Receipts	Actuals for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
I. Government of India					
(1) Grant-in-aid	5,97,870	7,35,136	6,87,364	7,80,973	
(2) Contribution to D.A.	30,130	36,756	34,367	39,049	
II. Government of West Bengal					
(1) Grant-in-aid	56,000*	1,26,783	1,01,703	1,44,877	* Received during 1957-58
III. Other receipts					
(1) Interest from General Fund	495	500	500	500	
(2) Ordinary Membership Subscription	1,016	1,200	1,200	1,200	
(3) Life Membership Fee	250	1,000	1,000	500	
(4) Indian Journal of Physics	8,106	8,000	10,000	10,000	
(5) Miscellaneous	365	500	600	500	
(6) Sale of Monographs etc.	379	500	500	500	
(7) Sale of Bijnaner Itihas	5,247	3,500	2,500	3,000	
IV. Contribution from M.L.S. & V.L.M. Prof. Fund ..	8,420	8,420	8,420	8,420	
V. Amount carried over from previous year for meeting outstanding liabilities	36,554	52,807	52,807	—	
	7,44,832	9,75,102	9,00,961	9,89,519	
Surplus	—	—	—	(—) 70	
Total Rs.	—	—	—	9,89,449	

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES—1958-59—GENERAL SUMMARY

(Excluding CSIR Schemes, Scientific Man Power Committee Scheme etc.)

EXPENDITURES

Heads of Expenditure	Actual for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
I. Establishment					
1. Salary					
Director and his staff—Existing	24,538	25,233	25,119	25,245	
Dept. of Central Scientific Services under 5-Yr. Plan	741	5,910	3,063	5,820	
Dept. of General Physics & X-rays—Existing .. .	31,599	21,618	21,020	21,986	
Do. New posts under 5-Yr. Plan .. .		17,560	10,937	20,990	
Dept. of Magnetism—Existing	23,466	15,600	15,383	16,905	
Do. New posts under 5-yr. Plan .. .		14,954	11,135	16,940	
Dept. of Optics—Existing	37,023	30,397	30,675	32,136	
Do. New posts under 5-yr. Plan .. .		9,615	9,201	12,170	
Dept. of Theoretical Physics—Existing .. .	22,514	22,756	22,674	24,009	
Do. New posts under 5-yr. Plan .. .		15,600	9,550	19,075	
Dept. of Physical Chemistry—Existing .. .		33,658	30,880	33,657	
Do. New posts under 5-yr. Plan .. .					
(a) General Physical Chemistry .. .		10,020	8,351	10,148	
(b) Technological Application of High Polymers—Rubber Section .. .	44,320	21,660	15,679	21,445	
(c) Plastic & Resin Section .. .		5,160	3,537	5,760	
(d) Biological Polymers Section .. .		—	—	2,760	
Dept. of Organic Chemistry—Existing .. .		30,413	28,604	29,912	
Do. New posts under 5-yr. Plan .. .	40,440	16,560	10,862	20,620	
(a) General Organic Chemistry .. .		14,520	12,984	15,943	
(b) Training in High Polymers .. .		28,254	19,619	28,774	
Dept. of Inorganic Chemistry—Existing .. .					
Do. New posts under 5-yr. Plan Analytical Laboratory	23,929	9,960	8,253	13,034	
Library—Existing		5,099	5,165	5,345	
Do. New posts under 5-yr. Plan .. .	7,855	960	630	960	
Workshop—Existing		16,276	15,659	16,856	
Do. New posts under 5-yr. Plan .. .	24,593	8,688	7,769	10,142	
Indian Journal of Physics	5,353	4,442	3,951	4,634	
Carried over ..	2,91,371	3,84,913	3,30,700	4,15,266	

Do. Existing	24,593	16,276	15,659	16,856
Do. New posts under 5-yr. Plan	5,353	8,688	7,769	10,142
Indian Journal of Physics		4,442	3,951	4,634
Carried over	2,91,371	3,84,913	3,30,700	4,15,266

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

EXPENDITURE (Contd.)

Heads of Expenditure	Actual for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
Brought Forward ..	2,91,371	3,84,913	3,30,700	4,15,266	
Administration—Existing					
Do. New posts under 5-yr. Plan	49,047	30,427	30,696	32,575	
Do. Publication Section under 5-yr. Plan	2,850	7,812	7,083	9,170	
		1,810	1,747	1,918	
Previous Year's Liability ..	—	—	—	—	
2. Dearness Pay—Existing					
Do. New posts under 5-yr. Plan	(1)	25,964	25,274	26,136	(1) D.P. & D.A. included in actuals for salary.
Dearness Allowance—Existing		20,255	15,547	22,586	
Do. New posts under 5-yr. Plan		33,164	31,533	33,336	
		20,255	15,548	22,586	
3. Provident Fund—Existing					
Do. New posts under 5-yr. Plan	14,813	19,089	16,364	21,001	
		9,853	7,278	11,121	
Previous Year's liability ..	—	3,126	3,126	—	
4. House Rent Allowance—Existing					
Do. New posts under 5-yr. Plan	—	16,716	9,094	9,842	
	—	12,757	6,420	9,888	
5. Local expenses of foreign expert	—	—	—	9,500	
Total Rs. ..	3,56,081	5,86,141	5,00,410	6,24,925	

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE—EXPENDITURE (Contd.)

Heads of Expenditure	Actuals for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
Brought Forward ..	3,56,081	5,86,141	5,00,410	6,24,925	
II. Laboratory Grants					
Dept. of Central Scientific Services					
Recurring	2,161	10,000	5,000	7,000	
Special	—	—	—	—	
Previous Year's liability ..	—	1,418	1,418	—	
Dept. of General Physics & X-rays					
Recurring	9,370	12,000	12,000	12,000	
Special	1,990	—	—	—	
Previous Year's liability ..	4,366	2,895	2,895	—	
Dept. of Magnetism					
Recurring	7,730	12,000	12,000	12,000	
Special	—	—	—	—	
Previous Year's liability ..	—	4,152	4,152	—	
Dept. of Optics					
Recurring	7,592	12,000	12,000	12,000	
Special	—	—	—	—	
Previous Year's liability ..	—	3,355	3,355	—	
Dept. of Theoretical Physics					
Recurring	1,049	3,000	3,000	3,000	
Special	—	—	500	—	
Previous Year's liability ..	200	1,722	1,722	—	
Dept. of Physical Chemistry					
Recurring	7,925	18,000	18,000	24,000	
Special	—	—	—	—	
Previous Year's liability ..	690	1,232	1,232	—	
Dept. of Organic Chemistry					
Recurring	18,075	18,000	18,000	18,000	
Special	—	—	3,000(2)	3,000(2)	(2) For Micro-analytical laboratory to be transferred from the Dept. of Central Scientific Services.
Previous Year's liability ..	200	315	315	—	
Dept. of Inorganic Chemistry					
Recurring	9,504	18,000	18,000	18,000	
Special	—	—	—	—	
Previous Year's liability ..	1,070	7,515	7,515	—	
	<u>4,27,803</u>	<u>7,11,745</u>	<u>6,24,514</u>	<u>7,33,925</u>	

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE—EXPENDITURE (Contd.)

Heads of Expenditure	Actuals for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
Brought Forward ..	4,27,803	7,11,745	6,24,514	7,33,925	
III. Library					
Recurring	24,578	21,000	21,000	21,000	
Special	—	—	—	—	
Previous Year's liability ..	217	1,052	1,052	—	
IV. Workshop					
Recurring	6,245	15,000	15,000	15,000	
Special	—	—	—	—	
Previous Year's liability ..	285	9,074	9,074	—	
V. Indian Journal of Physics					
Publication Expenses	17,496	16,000	19,500	18,000	
Previous Year's liability ..	240	83	83	—	
VI. (a) Publication Expenses (General)					
Publication Expenses	3,376	15,000	15,000	10,000	
Previous Year's liability ..	148	3,284	3,984	—	
(b) To Bijnaner Ithihas Fund	5,247	3,500	2,500	3,000 (3)	(3) Contra entry
VII. To Life Membership & Institutional Membership Fund	250	1,000	1,000	500	
VIII. Laboratory Services, General Expenses & Miscellaneous	1,11,370	1,60,677	1,73,254	1,73,024 (4)	(4) For details see page 50
IX. Suspense, Advances (excluding those under construction, equipments (Non-Rec. etc.))	40,981	—	—	—	
X. Part repayment of loan & Interest	6,500 } 3,500 }	10,000	6,565 } 3,435 }	10,000	
XI. Provision for enabling members of Research Departments to attend meetings, conferences & spend sometime at Research Institutes in foreign countries	1,570	5,000	5,000	5,000	
Total Rs. ..	6,50,006	9,73,115	9,00,961	9,89,449	

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INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES FOR 1958-59

(Laboratory Expenses and General Services)

Heads of Expenditure	Actuals for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
1. Depreciation Fund (Building Maintenance A/C.) ..	45,360	47,300	47,300	61,505(1)	
2. Electric Fittings	5,418	4,000	4,000	6,000	
Do. Revoted	2,027	—	—	—	
Previous Year's liability	—	—	—	—	
3. Furniture	4,714	6,000	12,300	6,000	
Previous Year's liability	1,874	10,006	10,006	—	
4. Gas	3,384	4,000	4,500	4,000	
Previous Year's liability	—	525	525	—	
5. Electricity	8,981	9,500	11,500	10,000	
6. Telephone	1,838	2,000	2,000	2,000	
7. Printing—Letter heads, forms, Ledger etc. ..	974	2,000	2,500	2,000	
Previous Year's liability	297	282	282	—	
8. Stationery & Contingency	6,874	7,000	7,000	7,000	
Previous Year's liability	—	67	67	—	
9. Postage	4,075	2,500	5,000	4,500	
10. Advertisement	5,017	2,500	4,500	5,000	
Previous Year's liability	—	—	—	—	
11. Municipal Tax	1,623	1,700	1,700	2,000	
12. Audit Fee	250	1,000	1,000	1,000	
Do. Revoted	—	—	—	—	
13. Insurance Premium	1,046	1,000	1,150	1,000	
14. Meeting Expenses	701	750	750	750	
	<u>94,453</u>	<u>1,02,130</u>	<u>1,16,080</u>	<u>1,12,755</u>	
					Total
					61,504.09

'As per following items of
Schedule 'C' of the Balance-Sheet
as at March 31, 1957.

Rs. nP.

1. Land Development and Road Construction ..	622.37
1.A. Building ..	24,433.36
2. Workshop Building ..	2,142.78
3. Residential Quarters ..	347.20
4. Electric Installation ..	7,116.98
5. Laboratory Fittings & Furniture ..	12,131.03
6. Plant & Machinery ..	6,581.00
9. Furniture & Fixtures & Fitting ..	5,804.06
10. Lift ..	1,403.62
11. Tube-well ..	222.00
12. Air-conditioning Equipment ..	668.19
13. Sanitary and Gas Fittings ..	31.50

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES FOR—1958-59—Contd.

Heads of Expenditure	Actuals for 1956-57	Original Budget 1957-58	Revised Budget 1957-58	Budget Estimates 1958-59	Remarks
Brought Forward ..	94,453	1,02,130	1,16,080	1,12,755	
15. Indian Science Congress Association Subscription ..	12	12	12	12	
16. (a) For attending Council and Selection Committee meetings, if any.	6,321	5,000	5,000	5,000	
(b) For attending Indian Science Congress and meetings other than meetings of Association, Council or any of its own Committees	—	—	3,000	2,000	
17. Bank Charges	130	150	150	150	
18. Contribution to Indian Science News Association ..	1,000	1,000	1,000	1,000	
19. Motor Van Up-keep	3,323	4,000	4,000	4,000	
Previous Year's liability	—	36	56	—	
20. Miscellaneous	4,523	4,500	5,000	5,000	
Previous Year's liability	260	230	1,969	—	
21. Provision for leave salaries, allowances, higher salaries etc.	518	3,500	500	3,000	(2) As per Schedule 'D' of the Balance-sheet as at March 31, 1957 including items 7, 8, 13, 14, 15, 16 of Schedule 'C'.
22. Contribution to Depreciation Fund for Scientific Instruments & Equipments	—	30,080	30,080	33,707 (2)	
23. Provision for Medical Benefit to Employees	—	5,000	5,000	5,000	
24. Provision for Provident Fund benefit to Employees (Bearers, peons & like staff)	—	2,000	—	—	(3) (3) Provision made under establishment.
25. Contribution to Association Canteen	600	600	600	600	
26. Contribution to Science Association Club	—	100	207	200	
27. Meghnad Saha Memorial Gold Medal	—	600	600	600	
Total Rs. ..	<u>1,11,370</u>	<u>1,60,677</u>	<u>1,73,254</u>	<u>1,73,024</u>	

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

Budget Provision (Non-recurring for 1958-59)

1. The Association approved of the budget estimates for non-recurring grants for 1958-59 as follows:—

Building grants—

Laboratory Benches & General furniture 50,000

Equipment grants—

Purchase of equipments, standard reference books etc.
(Department-wise break-down is given below) .. 4,85,300

Rs. .. 5,35,300

A. Share of the Government of India

Building grant 33,334

Equipment grant 3,23,539

Rs. .. 3,56,873

B. Share of the State Government of West Bengal

Building grant 16,666

Equipment grant 1,61,761

Rs. .. 1,78,427

LOANS.

2. The Association also approved of the submission to the Government of India of a request for loans for the construction of a hostel and of staff quarters as follows:—

Construction of a hostel 1,11,000

Construction of quarters 2,39,000

Rs. .. 3,50,000

*Department-wise break-down of non-recurring grants for purchase of equipments,
standard reference books etc. for 1958-59*

<i>Department</i>	<i>As per 5-Yr. Plan (Original)</i>	<i>Demand as per breakdown</i>	<i>Govt. of India share</i>	<i>Govt. of West Bengal share</i>
Central Sc. Services	50,000	67,000	44,667	22,333
General Physics & X-rays	50,000	67,000	44,667	22,333
Magnetism	49,000	65,600	43,734	21,866
Optics	44,000	58,900	39,267	19,633
Theoretical Physics	—	—	—	—
Physical Chemistry	75,000	1,00,300	66,867	33,433
Organic Chemistry	—	35,000	23,334	11,666
Do. High Polymer	—	20,000	13,334	6,666
Inorganic Chemistry	29,700	39,800	26,534	13,266
Workshop	5,000	6,700	4,467	2,233
Library	15,000	20,000	13,334	6,666
Administration	—	5,000	3,334	1,666
Total	3,17,700	4,85,300	3,23,539	1,61,761

