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THE INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE

Annual Report For 1953-54

THE INDIAN ASSOCIATION FOR THE
CULTIVATION OF SCIENCE

ANNUAL REPORT FOR 1953-54

Jadavpur, Calcutta-32

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- Professor-Member* — Prof. P. Ray, M.A., F.N.I.

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THE
INDIAN ASSOCIATION
FOR THE
CULTIVATION OF SCIENCE

ANNUAL REPORT FOR 1953-54

I. GENERAL

During the year under review, the six research departments, the library, the workshop and the administrative office continued to function actively for the third year in the new research laboratory buildings of the Association at Jadavpur. The installation of the passenger lift and the construction of part of the first floor of the main research building, undertaken during the last financial year, were completed. Steps were also taken to increase the inadequate workshop space by undertaking to build two additional bays, which will now enable doubling of the workshop space at present available.

Five Year Plan

At the beginning of 1953, the Director realized that the research laboratories of the Association were inadequately equipped with apparatus and equipments. Hitherto the Association had received capital grants towards construction of the research buildings, but little or nothing for equipping the laboratories along modern lines. The building programme of the Association, as originally planned in 1946, was also carried out only partly by the end of 1952-53. For example, the major portion of the workshop and store, the first floor of the two wings of the main research building, a hostel for research students, and quarters for Director, Professors, Registrar and other staff were some of the urgent items of construction which could not be undertaken for want of funds.

In September 1953, the Director prepared a memorandum giving details of (1) Association's original plan of development submitted to the Government of India in 1946, when the Government decided to accept the plan and provide necessary financial assistance, both recurring and non-recurring, (2) the extent to which the original plan had been carried out and what remained to be done,

and (3) fresh suggestions for carrying out the remaining part of the programme. This memorandum of the Director and his suggestions were considered by the Finance Committee of the Association at a meeting held on 23.9.53 at Delhi. The Committee generally approved of the Director's suggestions and recommended that a plan of development for the second five-year plan period of the Government of India be prepared in the light of the proposals submitted in the Director's memorandum. In October, 1953, the Association also received a request from the Government of India in the Ministry of Natural Resources and Scientific Research to submit to them the programme of work and development for the coming five years, giving details of financial implications.

Pursuant to the above recommendations of the Finance Committee and the request of the Government of India, the Association prepared a Five Year Plan of Development, covering the financial years 1954-59. The plan was considered and discussed at the meetings of the Council held on 9.12.53 and 29.3.54. In its finally approved form, the Plan envisages, for the existing departments, expansion of facilities with respect to equipment and staff with a view to consolidating the present research activities and also improving the level of efficiency, but does not involve establishment of any new department. It has further been recommended that consequential increase in expenditure on account of existing establishment, laboratory expenditures etc. should continue to be shown as being met by the Government of India recurring grant-in-aid as at present, and that increase in expenditure on account of development of the Association's activities with a view to improving its level of efficiency should be shown as being met by the Government of India to the extent of two-third of such increase and by the Government of West Bengal to the extent of the remaining one-third. The financial implications of the Plan are summarized in the following tables.

Need for Non-Recurring Grants—1954-59

Year.	Equipments, Standard references Books etc.	Land and Building.
1954-55	2,44,300	} 4,49,000 (including the sum of Rs. 1,15,000/- as further probable liability on account of land)
1955-56	1,92,200	
1956-57	2,74,150	
1957-58	2,65,300	
1958-59	1,62,250	
Total	Rs. 11,38,200	Rs. 17,71,393

Need for Recurring Grant—1954-59

Year.	Grants for Laboratory Workshop, Library, General Services and Miscellaneous.	Establishment.	Total.
1954-55	1,33,817	3,31,813	4,65,630
1955-56	1,51,022	3,69,841	5,20,863
1956-57	2,00,792	5,10,102	7,10,894
1957-58	2,08,132	5,44,458	7,52,790
1958-59	2,16,132	5,61,283	7,77,415
Total	9,09,895	23,17,697	32,27,592

Table showing proportion of the non-recurring grants requested from the Govt. of India and the Govt. of West Bengal and their yearly break-down.

(A)

Equipments, Standard reference Books etc.

	Govt. of India 2/3rd share	Govt. of West Bengal 1/3rd share
1954-55	1,62,866	81,434
1955-56	1,28,132	64,067
1956-57	1,82,766	91,384
1957-58	1,76,866	88,434
1958-59	1,08,170	54,081
	Rs. 7,58,800	Rs. 3,79,400

Total Rs. 11,38,200

(B)

Land and Building.

	Govt. of India 2/3rd share	Govt. of West Bengal 1/3rd share
1954-56	2,99,333	1,49,667
1956-59	8,81,595	4,40,798
	Rs. 11,80,928	Rs. 5,90,465

Total Rs. 17,71,393

Table showing proposed Recurring Expenditures—1954-59 and the proportion of the grants requested from the Government of India and the Government of West Bengal and their yearly break-down.

	Grants for Laboratory, Workshop, Library, General Services & Miscellaneous.		Establishment (Salary D. A., P. F., etc.)						Total Recurring Grant required.	
	Existing.	Additional requirements to improve the level of efficiency.	Share of the Govt. of India and the Govt. of West Bengal on basis of 2/3rd and 1/3rd of the increase separately.		Existing.	Additional requirements to improve the level of efficiency.	Share of the Govt. of India and the Govt. of West Bengal on basis of 2/3rd and 1/3rd of the increase separately.		Total.	
			India Govt.	W. Bengal Govt.			India Govt.	W. Bengal Govt.	India Govt.	West Bengal.
1954-55	1,33,817	—	—	—	3,23,763	8,050	5,366	2,684	5,366	2,684
1955-56	1,43,022	8,000	5,333	2,667	3,34,250	35,591	23,727	11,864	29,060	14,531
1956-57	1,50,292	50,500	33,667	16,833	3,44,493	1,65,609	1,10,406	55,203	1,44,073	72,036
1957-58	1,56,132	53,000	35,334	17,666	3,54,238	1,90,420	1,26,947	63,473	1,62,281	81,139
1958-59	1,60,632	55,500	37,000	18,500	3,61,775	1,99,500	1,33,005	66,503	1,70,005	85,003
	7,42,895	1,67,000	1,11,334	55,666	17,18,519	5,99,170	3,99,451	1,99,727	5,10,785	2,55,393

Total recurring grant-in-aid to be provided for by the Government of India and the Government of West Bengal during the years 1954 to 1959.

	1954-55	1955-56	1956-57	1957-58	1958-59
Government of India ..	4,62,946	5,06,332	6,38,858	6,71,651	6,92,412
Government of West Bengal ..	2,684	14,531	72,036	81,139	85,003
Total ..	4,65,630	5,20,863	7,10,894	7,52,790	7,77,415

(9)

Land Acquisition

It was reported last year that, in respect of the L. A. (valuation) cases filed at the instance of a number of referring claimants for determination of valuation of land acquired by the L. A. Collector for and on behalf of the Association, the L. A. Judge decided on much higher compensation rate ranging from Rs. 1,000/- to Rs. 1,500/- per katha than what the Collector had awarded, that is, Rs. 700/- per katha. The decree involved the Association in a liability of Rs. 1,35,566/-. The Government of India was pleased to grant the sum of Rs. 90,378/- and the Government of West Bengal the sum of Rs. 45,188/- which enabled the Association to meet the above liability on account of land acquisition. The Council of the Association placed on record their grateful thanks to the Central and the West Bengal Governments for their generous help in a difficult financial situation in which the Association was placed following the adverse decision of the Court.

Visitors

During the year under review, several distinguished foreign scientists and delegates of a number of foreign missions visited the laboratories of the Association. The distinguished visitors included Mr. Whyte Bullar, Mr. Dean Wendt, Prof. Harold Peterson and Mr. Martin Cramer of the American Technical Cooperation Administration; Prof. F. J. M. Stratton of the Cambridge University; Academician I. N. Nazarov, S. Mergelian and K. T. Poroshin from the U.S.S.R.; Dr. Norman P. Allen of the National Physical Laboratory, U.K.; Dr. Julian Huxley, former Director-General of UNESCO; Dr. Arthur H. Compton, Chancellor, Washington University, St. Louis, and Mrs. Compton; Dr. W. A. Shimer and Mrs. Shimer, of the World Brotherhood, Honolulu, Hawaii.

Council, Fellow Election, Deaths, Enrolment and resignation of Members

The annual election of Ordinary Members of the Council was held as usual during the months of April and May, 1953 and the result announced at the Annual General Meeting of the Association held on July 31, 1953.

Prof. P. C. Mahanti, Dr. K. S. Krishnan and Sri Ramani Mohan Roy were elected Ordinary Members of the Council. Prof. S. K. Mitra and Dr. K. S. Krishnan were elected Vice-Presidents of the Association. The Council appointed Dr. B. B. Dey as Ordinary Member of the Council in the vacancy caused by the death of Dr. Syama Prasad Mookerjee and Dr. Hiralal Roy and Sri Birendra Kumar Bhowmik as Ordinary Members of the Council in the vacancy caused by the election of Prof. S. K. Mitra and Dr. K. S. Krishnan as Vice-Presidents. The National Institute of Sciences of India nominated Dr. K. N. Bagchi and Dr. S. L. Hora, and the Government of India Sri M. S. Bhatnagar, Joint Secretary to the Government of India, Ministry of Finance, on the Council of the Association for 1953-54. Hon'ble Mr. Justice R. P. Mookerjee was elected Trustee-Member and Prof. P. Ray was appointed Professor-Member of the Council.

Dr. S. Bhagabantam was elected an Ordinary Fellow of the Association in the last Annual General Meeting.

During the year under review, death was reported of Dr. Syama Prasad Mookerjee, Member, House of the People, Life Member and formerly Vice-President, Fellow under special clause and Ordinary Member of the Council of the Association; Dr. Girindra Sekhar Bose; Sri A. K. Ganguli; and Dr. Gopal Chandra Chatterjee, all Life Members of the Association. The Council of the Association at its various meetings condoled the death of the above members of the Association and recalled the conspicuous services rendered by them in their respective field of activities. Copies of resolutions expressing deep sense of sorrow and loss at their death were conveyed to the members of the bereaved family.

During the year under review 17 gentlemen were elected, of whom 15 were admitted, as Life Members of the Association. During the same period 11 gentlemen were elected and 12 gentlemen admitted as Ordinary Members of the Association. 7 gentlemen voluntarily resigned their membership.

Meetings of the Council and Committees

During the year under review, besides the Annual General Meeting, five meetings of the Council, four of the Finance Committee, eight of the Staff Committee and two meetings of the Construction Committee were held. The Selection Committees met twice and there were seven meetings of the Appointing Boards. Furthermore, two meetings of the Publication Committee, one of the Board of Editors of the *Indian Journal of Physics* and one of the Committee for making recommendations for the appointment of Ripon Professorship, Coochbehar Professorship etc. were held.

Research Departments, Appointments, Retirements etc.

The six research departments continued their research activities with full personnel as in the previous year. The Department of X-rays and Magnetism was renamed the Department of General Physics, X-rays and Magnetism. It was reported last year that Dr. K. Banerjee, M. L. S. Professor of Physics, went on leave to join the Allahabad University as Professor of Physics. Dr. Banerjee resigned his Professorship of the Association on the expiry of his leave. Dr. S. C. Sirkar, Professor of General Physics, was appointed M. L. S. Professor of Physics in place of Dr. K. Banerjee and Dr. B. N. Srivastava of the University of Lucknow was appointed Professor of General Physics at the Association in place of Prof. S. C. Sirkar. Dr. A. Bose was promoted to the post of Readership in Physics in the Department of General Physics, X-rays and Magnetism. Dr. Sadhan Basu, who was on study leave in the U. S. A., joined his duties during the year under review. Dr. Mihir Nath Das, Research Officer (temporary) to the Department of Physical Chemistry was offered a post-doctoral fellowship in the University of Rochester, U.S.A. Two scholars of the Association, Dr. Nakuleswar Kundu and Sri Naba Kumar Bhattacharyya, both of the Department of Organic Chemistry, were offered post-

doctoral fellowships, the former for work in the Department of Chemistry in the North-Western University, Evanston, Illinois, and the latter for work in the Department of Chemistry of the Iowa State College, U.S.A. Sri P. N. Rao, another scholar of the Department of Organic Chemistry, has been selected for the award of a Fellowship by the United States Educational Foundation in India.

During the year under review, death was reported of Sri Sushil Ranjan Das Gupta, Steno-typist to the Registrar's office, and Sri Nani Gopal Saha, Senior Research Scholar to the Department of Physical Chemistry.

Research Schemes

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

- (1) Construction of Osmometers suitable for high polymer research;
 - (2) Construction of light scattering apparatus for measurement of molecular weight, size and shape of high polymers;
 - (3) Studies of thermodynamic properties of high polymer solutions,—all the three schemes under Prof. S. R. Palit;
- and, (4) Thermal Diffusion and inter-diffusion of gases—under Prof. B. N. Srivastava.

The first three schemes were continued from the previous year. The fourth scheme was previously established under Dr. Srivastava at the Lucknow University and later on transferred to the Association on the investigator-in-charge having joined the Association.

Development Scheme for Research Training Facilities under the Scientific Man Power Committee.—This scheme initiated by the Ministry of Natural Resources and Scientific Research was continued from the previous year and was in the third year of its operation. 8 Senior and 6 Junior research scholars worked under the scheme in the following departments:—2 senior and 2 junior scholars in the Department of General Physics, X-rays and Magnetism; 1 senior and 2 junior scholars each in the Departments of Optics and Physical Chemistry; and 4 senior scholars in the Department of Organic Chemistry. The Association greatly benefited from the institution of the Scientific Man-Power scholarships. About 30 scholars received higher research training under the scheme, of whom about 14 scholars received appointments in other organizations. A number of scholars also submitted thesis for doctorate degrees.

Doctorate Degrees awarded to Research Workers during the year

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

Sri A. K. Ray, of the Department of Optics, for work 'On the Origin

of low frequency Raman lines in crystals of some aromatic organic compounds';

Sri N. K. Bhattacharyya, of the Department of Organic Chemistry for work on "Studies in Sesquiterpenes and Polycyclic Aromatic Hydrocarbons".

Coochbehar and Ripon Professorships, Joykissen Mookerjee Medal, Mahendra Lal Sircar Memorial and other lectures and symposium

On the recommendation of a Committee constituted for recommending names for appointment of Ripon and Coochbehar Professorships and for award of Joykissen Gold Medal, Sir John Woodburn Medal etc., the Council offered the Coochbehar Professorship of the Association to Dr. J. N. Roy, Dr. T. R. Seshadri and Dr. P. C. Guha for the year 1949, 1950 and 1951 respectively; the Ripon Professorship to Prof. N. R. Sen and Dr. B. S. Guha for the year 1951 and 1952.

Dr. G. I. Finch and Dr. D. M. Bose were recommended for the award of the Association's Joykissen Mookerjee Gold Medal for the year 1950 and 1951 respectively.

The name of Dr. Dilip Kumar Banerjee was recommended for the award of Sir John Wood-burn Medal for 1950.

Dr. J. N. Roy delivered a course of three lectures as Coochbehar Professor on 'Carbohydrate metabolism and the role of some plant nucleotides in the phosphorylation of glucose, curariform drugs and their action and anaesthetics'.

Prof. T. R. Seshadri delivered a course of two lectures on 'A Line of investigation in the field of plant drugs and insecticides'.

During the year under review, Dr. S. K. Banerjee, Dr. M. S. Krishnan and Dr. D. S. Kothari, previously appointed Ripon Professors of the Association for the year 1948, 1949 and 1950 respectively, delivered a course of lectures on the following subjects:—

Dr. S. K. Banerjee—"The Himalayan Earthquakes";

Dr. M. S. Krishnan—"The ancient Indian iron ore and its manufacture, the iron ore deposits in India, and the modern iron industry in India and its future prospects";

Dr. D. S. Kothari—"Recent advances in statistical thermodynamics".

Dr. G. I. Finch who was awarded the Joykissen Mookerjee Gold Medal of the Association for the year 1950 delivered a course of three lectures on "Electron optics and study of surfaces, crystal growth in electro deposition and in surface reactions, and polish, mechanical wear and lubrication".

Sir John Wood-burn Medal of 1950 was awarded to Dr. Dilip Kumar Banerjee who delivered a lecture on 'Steroid synthesis'.

Dr. J. C. Ghosh, the President of the Association, delivered the Memorial Lecture on 'Petroleum industry with special reference to India' on the occasion

of the 50th death anniversary of late Dr. Mahendra Lal Sircar, the Founder of the Association.

During the year under review, the Association also organized a symposium on 'High Polymers including Rubbers, Resins, Plastics and Fibres'. The symposium was attended by active workers in the field from a number of organizations and institutes from outside Calcutta in addition to workers in and around Calcutta. The symposium was followed by a three-day summer course on the subject.

New Publication Section

During the year under review, the Council considered a proposal from the Director for the establishment of a Publication Section of the Association for undertaking publication of books, monographs, treatises etc. on scientific subjects in English and Indian languages with a view to popularizing and disseminating the knowledge of sciences in the country in fulfilment of one of the favourite objectives of the Founder. The Council approved of the principle, set up a Publication Section and appointed a Publication Committee. On the recommendation of the Publication Committee, the Council approved of the publication of two books during the year under review, e.g., "Bijnaner Itihas"—by Sri S. N. Sen and "Nuclear Induction"—by Dr. A. K. Saha and Sri T. P. Das. The Government of West Bengal has been pleased to grant a sum of Rs. 13,500/- towards the publication cost of the book 'Bijnaner Itihas' which is now in the press. Negotiations are under way, both with the Government of India and the Government of West Bengal, for suitable book grants for undertaking the printing of the work "Nuclear Induction". During the year, the printing of the monograph 'Non-aqueous Titration' by Dr. S. R. Palit, Dr. M. N. Das and Sri G. R. Somayajulu, previously approved by the Council for publication, was nearly complete.

Library

303 books were added to the Library stock during the year. The Association subscribed to 74 journals and received 72 periodicals in exchange of the *Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science*. The Library also received the issues of 65 bulletins and periodicals as complementary copies. The list of those books and periodicals is appended elsewhere in this report.

Indian Journal of Physics and Proceedings of the I.A.C.S.

During the period April 1953—March 1954, 13 issues of the *Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science* were published, of which 12 issues belonged to Vol. 27 (1953) and one to Vol. 28 (1954). The arrear in publication was thus reduced by one month.

The year of the journal continued to be the calendar year. During 1953, 73 papers were received, as against 110 in the preceeding year. Of these, 54 papers were accepted for publication after editorial revision. In the 1953

volume (vol. 27) 79 papers were published, 36 of which were carried over from the previous year, and 43 from the year under review. These comprised 632 pages and 30 plates, as against 683 pages and 40 plates in the previous year. The remaining 11 accepted papers have been published in the 1954 volume.

The number of subscribers in 1953 was 150 through the Indian Physical Society, 79 others in India (including Pakistan and Ceylon), and 220 in foreign countries. The corresponding figures in 1952 were 150, 68 and 187 respectively. The number of copies sent in exchange of other journals was 98; and 147 copies were sent to members of the Association and various distinguished scientific institutions as gift copies.

The Board of Editors consisted of the following members:—Prof. K. Banerjee, Dr. D. M. Bose, Prof. S. N. Bose, Prof. K. R. Dixit, Prof. S. K. Mitra, Prof. P. Ray, Prof. K. R. Rao, Prof. M. N. Saha and Prof. S. C. Sirkar (Secretary).

Donations and Grants-in-aid

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

Government of India—

Recurring grant for 1953-54	Rs. 3,98,000-0-0
(as against Rs. 3,40,000/- received during 1952-53)	
Contribution towards Dearness Allowance to employees of the Association	Rs. 19,900-0-0
Non-recurring grant towards purchase of apparatus and equipments	Rs. 1,35,000-0-0
Non-recurring grant towards payment of the enhanced cost of land acquisition as per Court's decree	Rs. 90,378-0-0
Non-recurring grant for Development Scheme for research training facilities of the Scientific Man-Power Committee	Rs. 19,365-2-0

Government of West Bengal—

Non-recurring grant towards payment of the enhanced cost of land acquisition as per Court's decree	Rs. 45,188-0-0
Non-recurring grant towards publication of 'Bijnaner Itihas'	Rs. 13,500-0-0
Non-recurring grant for construction of additional bay of the workshop	Rs. 10,000-0-0

C. S. I. R. Grants for the following Schemes—

(1) Construction of Osmometer suitable for high Polymer Research	Rs. 2,277-8-0
(2) Construction of Light Scattering Apparatus for the measurement of molecular weight, size and shape of High Polymers	Rs. 3,275-2-0

(3) Studies on Thermodynamic Properties of High Polymer Solution	Rs.	2,270-0-0
Contribution received from the Indian Physical Society towards publication of the Indian Journal of Physics	Rs.	800-0-0

Acknowledgements

The Council wish to record their deep appreciation and sincerest thanks to Dr. J. C. Ghosh, the retiring President, for his invaluable services to the cause of advancement of the Association. The Council also express their appreciation and thanks to Dr. K. Biswas, Sri N. N. Sen, Dr. M. S. Krishnan, Dr. B. B. Dey, Dr. H. L. Roy and Sri B. K. Bhowmick, the retiring Ordinary Members of the Council, to Dr. S. L. Hora and Dr. K. N. Bagchi, retiring nominees of the National Institute of Sciences of India and to Prof. P. Ray, retiring 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, the Board of Editors, Editorial Collaborators and Referees for their voluntary services.

Our thanks are also due to the University of Calcutta for printing the *Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science* free of cost.

II. RESEARCH WORK CARRIED OUT IN THE DEPARTMENTS DURING THE FINANCIAL YEAR 1953-54.

A. DEPARTMENT OF GENERAL PHYSICS, X-RAYS AND MAGNETISM

The following programme of work has been undertaken in the different sections of the department.

- I. *General Physics*:
 - (1) Transport properties of matter;
 - (2) Thermodynamics of irreversible processes;
 - (3) Low temperature physics.
- II. *X-Rays*:
 - (4) X-ray crystallography;
 - (5) Study of low angle scattering;
 - (6) X-ray study of coal;
 - (7) X-ray study of glass.
- III. *Magnetism*:
 - (8) Crystal magnetism;
 - (9) Cryogenics;
 - (10) Properties of semi-conductors.

Transport Properties of Matter

Investigations on transport properties of matter have been started with the appointment of the new professor who had been carrying on researches on this subject for some time. B. N. Srivastava read two papers at the Indian Science Congress Session at Hyderabad in January 1954 on this subject. In the first paper the performance of the thermal diffusion column has been critically examined and compared with the theory of Furry, Jones and Onsager by taking into account the variation of the thermal diffusion constant and of the elementary transport coefficients with temperature. It has been shown that the agreement between theory and experiment becomes more satisfactory when this variation is taken into account.

In the second paper the apparatus for measuring the absolute conductivity of gases with the help of a conductivity cell using the thick wire method of Kannuluik has been described and conductivity of argon-neon mixtures measured for different concentrations. It has been shown that the results are in agreement with the 12:6 power model of the intermolecular potential but not with the inverse power model.

Towards the end of the year under report, S. C. Saxena joined the Association under a research scheme of the Council of Scientific and Industrial Research entitled 'Thermal diffusion and inter-diffusion of gases'. He has designed the conductivity analyzer, the gas mixing apparatus and the thermostat and the construction work is in progress. He is also calculating the error involved in using the first approximation expression for the thermal diffusion

ratio of a binary gaseous mixture. It may be mentioned that the theoretical expression has not yet been calculated to a higher order of approximation than the first.

Thermodynamics of Irreversible Processes

Investigation on this subject has been started by B. N. Srivastava who has applied the theory of the thermodynamics of irreversible processes to investigate the phenomenon of thermal effusion for a substance capable of existing in two isomeric forms. Assuming the velocity of transformation to be finite, expressions have been obtained, giving the departure from the thermodynamical equilibrium values of the various parameters. These results are compared with those obtained by de Groot, Gorter and others for liquid helium, assuming thermodynamical equilibrium in each chamber. These studies can be readily extended to the investigation of chemical equilibria of a dissociating gas.

Low Temperature Physics

It is proposed to start work at liquid helium temperatures and for this purpose a helium liquefier has been constructed at Oxford under the supervision of Prof. B. N. Srivastava. The liquefier has been tested and is shortly expected to arrive.

X-ray Crystallography

The determination of the crystal structure of fluoranthene undertaken by S. C. Chakravarti has been continued. From morphological and x-ray studies the correct unit cell dimensions were found out to be $a=18.46 \text{ \AA}$, $b=6.205 \text{ \AA}$, $c=22.11 \text{ \AA}$ and $\beta=121^\circ 45'$ and the number of molecules per unit cell to be 8. Normal beam and equi-inclination Weissenberg pictures have been taken by him to determine the space-group as well as the crystal structure. From conditions of extinction of (hkl) planes observed in Weissenberg pictures, the space-group for the crystal was found out to be C_{2h}^5 . Further work on Fourier analysis is in progress.

The setting up of a low temperature camera having a non-rotating crystal mount has been undertaken by S. C. Chakravarti and is nearing completion.

X-ray studies on phthalic acid has been continued by D. M. Chakraborty. The cell dimensions were determined and from morphological and x-ray study the correct unit cell dimensions were found out to be $a=5.05 \text{ \AA}$, $b=14.03 \text{ \AA}$ and $c=9.325 \text{ \AA}$ and $\beta=93^\circ 30'$ and the number of molecules per unit cell equal to 4. From the extinction conditions of the (hkl) planes observed in the Weissenberg x-ray pictures two space-groups, namely C_{2h}^6 and C_s^4 were possible. Pyroelectric tests carried out by him confirmed the absence of a centre of symmetry and hence the proper space-group must be C_s^4 . Work on Fourier analysis is still in progress.

Study of vegetable fibres was undertaken by B. K. Banerjee and D. M. Chakraborty with a view to obtaining information about the micellar and intermicellar zones. With the incrustation of metals like gold and silver by

chemical treatment in the form of colloidal gold and colloidal silver in the fibre-framework, the dimensions of the inter-micellar zones of some fibres (namely chukai, Allissima, Sida and Mesta) were obtained. From different observations and particle size measurements, it was shown by them that the width of (1) the crystalline regions were about $50 \text{ \AA} - 60 \text{ \AA}$, (2) the inter-micellar regions were about $77 \text{ \AA} - 102 \text{ \AA}$ and (3) capillary spaces were about 10 \AA . General x-ray fibre diagrams were also studied in detail.

A recording photometer is being designed and constructed by D. M. Chakraborty and is nearing completion.

During the period under review, the complete phase-transformations of (1) the two monohydrated iron-oxide minerals, Limonite and Goethite, (2) anhydrous borax, (3) anhydrous Na_2SO_4 , (4) orthoboric acid by thermal treatments have been studied by D. R. Dasgupta with the help of thermal, differential thermal, and x-ray methods of analyses. The methods of Hesse and Lipson were applied by him to find out the crystal classes of some of the phase-transformation products. The action of catalytic agents on the phase-transformation of some substances is under investigation.

Study of low angle scattering

The investigation of low angle x-ray scattering has been continued by B. K. Banerjee and D. R. Dasgupta with the object of getting some informations about the size, shape and other details of the colloidal particles and micelles of the substances like rubber, fibres, amorphous and vitreous substances, both organic and inorganic. Considerable progress has been made in the above direction.

X-ray study of coal

Work started by G. B. Mitra on the identification of minerals in coal and the correlation of coal seams with their mineral contents was completed.

N. N. Gupta has completed calculation of radial distribution of carbon atoms in high pressure carbonized organic substances like saw dust and shellac at 500°C by the application of the technique of Fourier transformation in Bragg's equation. The results of the distribution numbers obtained by him are 4, 4 and 4 at distances, 1.50 A.U., 2.12 A.U. and 3.00 A.U. around any of the carbon atoms taken as centre of the concentric spheres of distribution. These values suggest a plane squared structure of carbon atoms which occupy the corners of many small unit squares. A probable explanation of this structure from the standpoint of the Quantum Theory of valence is in progress. Further work on radial distribution in other carbonized products is also in progress.

X-ray study of glass

The work in this line has been continued by Dr. B. K. Banerji, the I.C.I. Research Fellow, on the following problems:—

(i) *Studies on red-coloured silver glass.*—The red colour has been deve-

loped in borate and phosphate glass by controlling the process of formation of the above glass specimens without the presence of halide. The silver crystallites in the above specimens have been identified by X-ray diffraction study.

(ii) *Study of metal film on glass surface.*—The nature of the adherent film of different metals such as silver, copper, platinum and gold deposited on glass surface by chemical method as well as by the pyrolysis method, has been studied. It has been found that the size of the particle composing the film is of colloidal dimension and with temperature treatment, the metallic reflection of the film diminishes considerably and ultimately a transparent glass is formed having a distinct coloration different from the original specimen. The vitreous characteristics are found retained in the case of gold, silver and platinum specimens, whereas in the case of copper, the partial devitrification of the glassy matrix takes place.

Crystal Magnetism

It has been suggested (vide last year's report) that the magnetic anisotropies in a series of isomorphous salts should serve as an indication of the changes of the long range structure and the electric field (mainly asymmetric in nature) from salt to salt and with temperature. To study this effect, the elaborate and systematic programme of work which has already been undertaken by A. Bose is continued over a wide range of temperatures. The results obtained so far have been analyzed by him from an entirely new outlook.

An accurate determination of the magnetic anisotropy of paramagnetic crystals of the iron group elements, undertaken in the previous year in connection with the estimation of the effects of long range crystalline electric fields, was continued by S. K. Datta in the year under review. Magneocrystalline data were obtained on thirty-eight crystals and a paper embodying the results has been communicated for publication. Measurements on the temperature variation of anisotropy was carried out by him from about 85°K to 400°K for 14 crystals and investigation on others is in progress.

Some mixed crystals of Tutton series containing para- and diamagnetic components in different proportions have been prepared and their magnetic measurements are being carried out by Miss Juthika Sen.

S. K. Dutta Roy has developed a new simple and efficient electro-dynamic method of measuring magnetic fields, which with reasonable precautions can give an accuracy of about 5 parts in 10,000. It depends upon measuring the maximum couple exerted by the magnetic field upon a small current carrying coil suspended with a fine torsion fibre. The instrument has now become a standard device for measuring field in this laboratory with high accuracy in connection with our magnetic programme of work.

an accuracy of about 0.1%. Slight uncertainties in positioning the specimen has been practically eliminated by calculating and profiling a certain simple measuring the absolute susceptibilities of crystals as well as powders etc., with

Dutta Roy has now adapted a Curie balance, by modifying it suitably, for

yet effective shape of pole-pieces to make the magnetic force upon the specimen constant (to within 0.1%) over a wide region. With its help he has already measured the absolute susceptibilities of about a dozen alums containing Cr^{+++} and Fe^{+++} . He has prepared a large number of rare alums and is engaged in preparing more of these, which is expected to throw much light on their magnetic behaviour. He has also completed an automatic cryostat for his studies of these alums at low temperatures.

The study of the susceptibilities of the solutions of salts of iron group of metals at different concentrations and different temperatures has been undertaken by A. Chaudhury. For such a study the original magnetic balance of Dutta has been improved upon so as to make it more sensitive and the design of the pole-pieces has been so modified as to keep the product of the magnetic field and the gradient appreciably constant over a fairly wide region.

Cryogenics

Hydrogen liquefier, about which good progress was reported last year, has been completed by A. Bose and A. K. Dutta during the year under review. The component parts such as the valves, heat exchangers, metallic dewars, vacuum siphon lines, diffusion pumps, etc. have all been constructed here. With its help measurements on the properties of crystals at these low temperatures can be taken while the actual liquefaction is taking place. Liquefaction takes place after about ten minutes of starting the flow of high pressure gas from a commercial cylinder.

Air liquefaction by using a multistage turbine, as has been suggested by A. Bose, is being undertaken by Miss Juthika Sen. Theoretical calculations regarding such an apparatus have already been completed by her and the construction of different parts is in progress. Preliminary experiments with a model expander are now being carried out.

Semi-Conductors

Experimental and theoretical studies on the electrical, thermal and magnetic properties of crystals of graphite have been continued by A. K. Dutta. An attempt has been made to explain its said properties from an entirely new angle, and the success of the method can be judged by the fact that it not only explains all the electric and magnetic properties but can also account for the hitherto unexplained value of the electronic specific heat of graphite.

In order to show that the change of electrical conductivity of graphite crystals for currents along the basal plane with thickness is only an apparent one, a new method of measuring electrical conductivities, in which the problem of making electrical contacts has altogether been avoided, has been developed by Chaudhury and Dutta. This method depends upon the observation of the damping experienced by a specimen oscillating in a uniform magnetic field. The value of conductivity obtained by this method is comparable to that obtained by other methods and the above suggestion that the effect of thickness is only apparent has also been proved.

Miscellaneous

(1) A number of samples of shells sent by Sri K. Roy of the Damodar Valley Corporation for their identification have been studied here with the help of x-rays.

(2) Dr. S. Kumar of the Central Glass and Ceramic Research Institute took some magnetic measurements here on some samples prepared by him.

List of papers published during the year.

1. Space-Group of Fluoranthene—by S. C. Chakravarti, *Acta. Cryst.*, **7**, April, (1954).
2. Some Improvements in Hadding Tube—by G. B. Mitra and D. M. Chakraborty, *Jr. Sc. Inst.*, **31**, 30, (1954).
3. Unit cell dimensions of Phthalic acid—by D. M. Chakraborty, *Sc. & Culture*, **19**, p. 505, (1954).
4. An X-ray study of ortho-phthalic acid—by D. M. Chakraborty, *Ind. Jour. Phys.*, **28**, 129, (1954).
5. X-ray study of glass fibres—by B. K. Banerjee, *J. Am. Ceram. Soc.*, **36**, 294, (1953).
6. Study on the state of dispersoid in the colloidal coloured glasses—by B. K. Banerjee, *J. Am. Ceram. Soc.*, **20**, 19, (1953).
7. Study of colloidal coloured silver glasses—by B. K. Banerjee, *Proc. Nat. Inst. Sc.*, **19**, 495, (1953).
8. Study of colloidal coloured silica glasses—by B. K. Banerjee, *Proc. Nat. Inst. Sc.*, **19**, 491, (1953).
9. Crystal Class of Na_2SO_4 , III—by D. R. Dasgupta, *J. Chem. Phys.*, **21**, 2097, (1953).
10. An X-ray study of Na_2SO_4 , III—by D. R. Dasgupta, *Acta. Cryst.*, **7**, 275, (1954).
11. Comparative influence of short and long range crystalline electric fields on the magnetic behaviour of the salts of the iron group of elements, Part III—by A. Bose and S. C. Mitra, *Ind. Jour. Phys.*, **27**, 95, (1953).
12. Accurate determination of the torsion constant of quartz fibres—by S. K. Dutta, *Ind. Jour. Phys.*, **27**, 155, (1953).
13. Problems of Fraunhofer scattering by an optically continuous transparent screen and its possible applications—by N. N. Gupta, *Proc. Nat. Inst. Sc.*, **19**, 511-517, (1953).
14. Identification of minerals in coal—by G. B. Mitra, *Fuel in Science & Practice*.

Papers in the press.

1. Investigation of the Performance of Thermal Diffusion Column—by B. N. Srivastava & R. C. Srivastava, *Physica*.
2. Study of metal film on glass surfaces—by B. K. Banerjee, *Proc. Nat. Inst. Sc.*
3. Study of red-coloured silver glass—by B. K. Banerjee, *J. Am. Ceram. Soc.*
4. A new Electrodynamic method of measuring magnetic fields—by S. K. Dutta Roy, *Ind. Jour. Phys.*

5. An accurate determination of the magnetic anisotropies of the hydrated salts of the iron group of elements—by S. K. Dutta, *Ind. Jour. Phys.*
6. Electrical Conductivity of single crystals of graphite in the basal plane and a new method of measuring the electrical conductivity—by A. Chaudhury and A. K. Dutta, *Ind. Jour. Phys.*

B. DEPARTMENT OF OPTICS

The investigations carried out in the Department during the year 1953-54 can be classified under the following headings:—

- (1) Ultraviolet absorption spectra of organic substances in the solid state at low temperatures;
- (2) Raman spectra of some organic compounds in the solid state at low temperatures;
- (3) Raman spectra of organic compounds in the vapour state;
- (4) Raman spectra of liquids and solutions;
- (5) Relaxation time of polar molecules in the liquid state;
- (6) Absorption of U.H.F. radiowaves by organic liquids;
- (7) Absorption of microwaves by organic liquids, and
- (8) Cosmic rays.

Ultraviolet absorption spectra of organic substances in the solid state at low temperatures

In continuation of his previous work, A. R. Deb studied the ultraviolet absorption spectra of phenetole, *n*-butylbenzoate, α -chloronaphthalene and α -bromonaphthalene in different states and at different temperatures including that of liquid oxygen. In the case of phenetole each of the broad bands exhibited by the liquid state split up into four bands when the liquid is solidified and cooled to -180°C . All these new bands can be assigned to some vibrational transitions. In the case of butylbenzoate no such splitting occurs at -180°C . α -Chloronaphthalene and α -bromonaphthalene exhibit both in the liquid and solid states a new faint band system on the long wavelength side of the usual intense system exhibited by the substances in the vapour state. The vibrational frequency derived from the bands is found to alter in both the cases with solidification of the substances. The whole band system also shifts towards longer wavelengths with solidification and cooling down to -180°C .

Similar investigations were carried out also by (Miss) Usharani Guha Biswas who studied the ultraviolet absorption spectra of ortho-, meta-, para-toluidine in the liquid state and in the solid state at -180°C . The spectra were also compared with those for the vapour state. It was observed that the bands do not become narrower at low temperatures and this behaviour is found to be opposite to that observed in the case of substituted benzenes containing chlorine as a substituent.

Raman spectra of organic compounds in the solid state at low temperatures . .

The Raman spectra of ortho- and para-chlorotoluene in the solid state at -180°C were investigated by S. B. Sanyal and the results were compared with those for the liquid state. The new lines which appear in the low frequency region with solidification of these two liquids are much feebler than those due to *p*-dichlorobenzene. Some of the prominent lines undergo changes with solidification, showing increase in the influence of intermolecular field with solidification,

The Raman spectra of 1, 1, 1- and 1, 1, 2-trichloroethane in the solid state at -180°C were studied by D. C. Biswas. It is observed that in the former case all the Raman lines persist in the solid state while in the latter case two intense lines disappear with solidification of the liquid. He also studied the Raman spectra of ortho- and para-chlorophenol in the solid state at different temperatures. Microphotometric records show that the intensity of some of the new lines in the low-frequency region increases with lowering of temperature of the crystals to -180°C . The shift of some of the prominent Raman lines with solidification is more spectacular in the case of the ortho compound than in the case of the para compound.

Raman spectra of organic substances in the vapour state

The Raman spectra of 1, 2-dichloroethane and 1, 1, 2-trichloroethane in the vapour state were studied by M. Mazumder who concluded from the results that in the former case a catastrophic change in the ratio of the number of the two types of molecules present in the liquid state takes place with the change from liquid to vapour state and this is ascribed to influence of strong intermolecular field in the liquid state. In the other case also some interesting changes in the spectra occur with vaporization.

Raman spectra of liquids and solutions

The rotational wing due to liquid oxygen was studied carefully by G. S. Kastha who observed that the intensity-distribution in the wing has a maximum at about 50 cm^{-1} from the Rayleigh line as pointed out by B. Saha (1940). The various probable causes for the failure of some recent workers to observe this maximum have been discussed by him.

S. B. Banerjee has studied the Raman spectra of solutions of ethylene dichloride in cyclohexane and heptane of different concentrations and it has been observed that the ratio of the intensities of the lines 654 and 754 cm^{-1} changes gradually with change of concentration of the solution.

Relaxation time of polar molecules in the liquid state

It was pointed out by Sirkar (1953) that the assumption made by previous workers that a distribution of relaxation time exists in some polar liquids was not supported by results obtained by D. K. Ghosh (1953) who observed more than one discrete absorption maximum in each of the liquids studied by him. It was further shown that if the liquid consists of monomers and dimers it is not possible to derive a simple relation connecting frequency of maximum absorption and the time of relaxation.

Absorption of U.H.F. radiowaves by organic liquids

The absorption of radiowaves of frequencies in the range 250 — 920 Mc/sec in benzyl alcohol, benzyl chloride and benzyl amine at different temperatures has been studied by D. K. Ghosh. Each of the latter two liquids exhibits two absorption maxima in this range corresponding to the monomeric and dimeric molecules. It is pointed out that in these cases the time of relaxation is not continuous, but it has more than one discrete value.

Absorption of microwaves by organic liquids

The absorption 3.3 cm microwaves in chloroform and ethylene dichloride at different temperatures was studied by Sirkar and Ghosh (1953) and in each case the radius of the rotor was calculated from Debye's theory. The calculated value of the radius was found to be of the order of 1.54 A.U. It was pointed out that in the case of ethylene dichloride the absorption is due to rotation of C-Cl group about C-C bond. D. K. Ghosh extended the investigation to other liquids such as ethylene bromide, glycerine, benzyl alcohol, benzyl chloride and benzyl amine. It was observed that the wavelengths of maximum absorption actually observed do not agree with these calculated from Cole and Cole equation. In the case of latter three liquids the absorption is due to rotation of substituent groups about the C-C bond.

Cosmic rays

S. B. Roy and R. B. Chakravarti studied the number of events in which a neutral particle in cosmic rays produced in a lead absorber either one charged meson or more moving along different paths. They used a threefold anticoincidence counter circuit and shielded only the topmost counter with anticoincidence counters to reduce the number of spurious counts due to side showers, and the number of anticoincidences was recorded first with 2.5 cm of lead above the topmost anticoincidence counters and then with about 24 cm of such absorbing layer. It was observed that the number of anticoincidence counts diminished by about $.35\%$ of the total number of charged mesons recorded with the same coincidence circuit when the thickness of the topmost absorber

was increased from 2.5cm to 24cm. This diminution is assumed to represent also the percentage of the events mentioned above.

List of papers published during 1943-54.

1. On the Raman spectrum of monomeric methyl methacrylate at -180°C —by S. C. Sirkar and N. K. Roy, *J. Chem. Phys.*, **21**, 938, (1953).
2. Raman spectra of methylmethacrylate in the solid state at -180°C —by N. K. Roy, *Ind. J. Phys.*, **27**, 167, (1953).
3. On the electronic spectra of dibenzyl, diphenylmethane and ethyl benzoate in the solid state at -180°C —by A. R. Deb, *Ind. J. Phys.*, **27**, 183, (1953).
4. Absorption of U.H.F. radiowaves in the range 250-920 Mc/sec by substituted benzenes. III—by Dilip Kumar Ghosh, *Ind. J. Phys.*, **27**, 285, (1953).
5. Ultraviolet absorption spectra of diphenyl in the liquid and solid states—by A. R. Deb, *Ind. J. Phys.*, **27**, 305, (1953).
6. On the Raman spectra of solutions of 1, 2, 3-trichloropropane—by T. A. Hariharan, *Ind. J. Phys.*, **27**, 323, (1953).
7. The Raman spectra of 1, 1, 1- and 1, 1, 2-trichloroethane in the solid state at -180°C —by D. C. Biswas, *Ind. J. Phys.*, **27**, 379, (1953).
8. On the Raman spectra of 1, 2-dichloroethane and 1, 1, 2-trichloroethane in the vapour state—by Monomohan Mazumder, *Ind. J. Phys.*, **27**, 406, (1953).
9. On the Raman spectra and fluorescence of ortho- and para-chlorotoluene in the solid state—by S. B. Sanyal, *Ind. J. Phys.*, **27**, 447, (1953).
10. The ultraviolet absorption spectra of phenetole and *n*-butylbenzoate in different states—by A. R. Deb, *Ind. J. Phys.*, **27**, 457, (1953).
11. Absorption of 3.3cm microwaves in chloroform and ethylene dichloride in the liquid state—by S. C. Sirkar and D. K. Ghosh, *Jour. Chem. Phys.*, **21**, 1614, (1953).
12. On the relaxation time of polar molecules in the liquid state—by S. C. Sirkar, *Ind. J. Phys.*, **27**, 475, (1953).
13. On the absorption maxima exhibited by some organic liquids in the microwave region. I—by Dilip Kumar Ghosh, *Ind. J. Phys.*, **27**, 511, 1953).
14. On the ultraviolet absorption spectra of toluidines in the liquid and solid states—by (Miss) Usha Rani Guha Biswas, *Ind. J. Phys.*, **27**, 603, (1953).
15. The ultraviolet absorption spectra of α -chloronaphthalene and α -bromonaphthalene in different states—by A. R. Deb, *Ind. J. Phys.*, **28**, 21, (1954).
16. Raman spectra of ortho- and para-chlorophenol in the solid state at low temperatures—by D. C. Biswas, *Ind. J. Phys.*, **28**, 85, (1954).

Papers in the press.

1. On the time of relaxation of some organic molecules in pure liquid state—by Dilip Kumar Ghosh, *Ind. J. Phys.*
2. On the Raman spectra of ethylene dichloride in solution of different strengths—by Sukhendu Bikash Banerjee, *Ind. J. Phys.*
3. On the production of charged meson-pairs by neutral particles in cosmic rays—by S. B. Roy and R. B. Chakravarti, *Ind. J. Phys.*
4. On the rotational wing in the Raman spectrum of liquid oxygen—by G. S. Kastha, *Ind. J. Phys.*

C. DEPARTMENT OF THEORETICAL PHYSICS

In the year under report, Messrs. A. K. Ray Chaudhuri, S. N. Biswas, N. C. Sil, M. L. Chaudhury, C. C. Banerji and P. Banerji (the latter two as part-time workers) have worked in the following lines:

- (1) Meson field theories and nuclear scattering;
- (2) Born approximation and its connection with covariant perturbation theory;
- (3) Capture of electron by ion passing through gases;
- (4) Cosmology;
- (5) Nuclear shell structure model.

Meson Field Theories and Nuclear Scattering

The high energy experiments on proton-proton scattering show that the differential cross section is very nearly independent of the angle of scattering and further the value of the total cross section does not appreciably vary with the energy of the incident particle. It has not been possible to explain the above two features of the p-p scattering on the basis of a nuclear interaction which can be derived from field theoretical considerations. Various phenomenological potentials between two nucleons have been proposed, of them the 'hard core' model of Jastrow gives better agreement with experimental observations than any other. However on theoretical grounds, it has not been possible to justify the existence of a 'hard core' in the case of the singlet state as suggested by Jastrow, though it is understandable why it is necessary to assume a 'hard core' for the singlet state; in the singlet state the tensor force term vanishes, only the central force term remains; but the central force term alone will give highly anisotropic scattering which will be contrary to experimental observations. To obviate this contradiction, Jastrow assumes for the singlet a 'hard core' potential which gives isotropic scattering. It has been suggested by D. Basu that the δ -function potential which occurs naturally in the field theoretical interaction may be regarded as the analogue of the 'hard core' potential which Jastrow assumes ad-hoc in the singlet state only.

Previously the occurrence of the δ -function term in the nuclear interaction potential has been considered undesirable as such its elimination has been effected by suitable modification of the interaction Lagrangian. It is shown that the inclusion (and not elimination) of the δ -function term in the pseudoscalar interaction helps to explain the isotropy of scattering of one nucleon by another and the fact that the scattering cross section is independent of the energy of the incident particle. C. C. Banerji has shown that if the differential cross section for the p-p scattering is calculated with the tensor part of the pseudoscalar interaction, it agrees reasonably well with the experimental data at 340 Mev. Further the tensor force alone explains qualitatively the independence of the scattering cross section with energies of the incident particles.

However, the tensor force term does not give any scattering in the singlet state. P. Banerji has considered the relative contributions of the different parts of the tensor force ($S_{12} e^{-\chi r}/\chi r^2$ and $S_{12} e^{-\chi r}/\chi^2 r^3$, S_{12} being the tensor force operator) to the isotropy of p-p scattering and he has found that the interaction potential term which contains $1/r^3$ singularity shows at high energies a better tendency towards qualitative isotropy than that due to other terms. C. C. Banerji finds that the tensor force term of the pseudoscalar interaction which involves the sum of $1/r$, $1/r^2$ and $1/r^3$ singularities gives better agreement with experimental results at 340 Mev than what has been obtained by P. Banerji with the $1/r^3$ term alone.

An iterative procedure has been developed by S. N. Biswas for the solution of Heitler's integral equation on radiation reaction in scattering processes. The method is applied in pion-nucleon scattering. In the scattering of positive pion by neutron it is shown that the result agrees with those obtained earlier by using some other methods. The energy dependence and angular distribution of the scattering cross section have also been studied.

Born approximation and its connection with covariant perturbation theory

S. N. Biswas has demonstrated the equivalence of the Born approximation to the covariant perturbation theory by considering the scattering of fast electrons by the coulomb field of the atomic nuclei. It is shown that the usual second Born approximation gives the same result as obtained from the covariant theory.

Capture of electron by ion passing through gases

N. C. Sil has considered the problem of the capture of electrons by positive ions while passing through a gas consisting of hydrogen-like atoms. Brinkman and Kramers gave the first satisfactory quantum mechanical treatment of the case in which the ion captures in its 1s orbit an electron which was originally in the 1s orbit of the atom constituting the gaseous matter. In connection with the explanation of the origin of He-lines in the solar corona, Saha and Basu (1946) first took up the case of capture into excited orbits and gave calculations for the 1s to 2p capture cross section. Sil has further extended the method of Brinkman and Kramers to the more general case of capture of the electron in arbitrary excited orbits. Contrary to the view of Brinkman and Kramers it is found that the probability of capture in orbits with the azimuthal quantum number $l > 0$ is of considerable importance specially for low energy of the incident particle. Moreover it is shown that the expression given by Brinkman and Kramers for 1s to ns capture cross section is approximate being only the first term of a series expression for the same. For very high energy of the incident particle he has found for the total cross section of capture in the orbits with principal quantum number n an inverse n^3 formula as given also by Oppenheimer. The results of his investigation for the special case of 1s to ns capture are given in a paper shortly to be published in *Indian*

Journal of Physics. The results for the general case will be reported elsewhere.

Cosmology

The observation that the light from distant nebulae suffers a red shift varying approximately linearly with distance has found a natural explanation in the expanding cosmological models of general relativity. These models are usually assumed to be isotropic and homogeneous and if one traces the history of these models backwards in time, one finds that they originate from a singular state of infinite density and give a value 2.5×10^9 years for the time scale from that state. However, this age is appreciably less than that demanded by numerous geological and astrophysical evidences. Further the occurrence of a singular state in the career of the universe raises great conceptual difficulties.

To see whether these difficulties can be removed if one considers a more general relativistic cosmological model, A. K. Raychaudhuri has investigated the temporal behaviour in general rotating universe. It has been found that one can indeed obtain a model which is free from any singular state. Further a class of models have a state of minimum volume where the physical conditions approximate closely to those postulated in the Alpher-Bethe-Gamow theory of the origin and abundance of different atomic species. These results are in course of publication.

Nuclear shell structure model

M. L. Chaudhury is studying the theories of the nuclear shell structure model and Bohr's liquid drop model with a view to finding common ground for the two different approaches. While, on one hand, striking agreement for spin, magic numbers, isomerism and magnetic moments have been obtained for a large number of nuclei on the spin orbit coupling model of Haxel, Mayer *et al*, on the other hand the binding energy, nuclear reaction and fission and the quadrupole moment are explained better by the liquid drop model than by the shell structure model.

List of papers published during the year.

1. Proton-Proton Scattering at High Energies—by Probuddha Banerjee, *Ind. Jour. Phys.*, **27**, 557, (1953).
2. The Solution of Heitler's Integral Equation by Iteration Method—by S. N. Biswas, *Phys. Rev.*, **91**, 1026, (1953).

Papers in the Press.

1. Pseudoscalar Interaction and Proton-Proton Scattering—by D. Basu, *Ind. Jour. Phys.*
2. The Solution of Heitler's Integral Equation by Iteration Method—by S. N. Biswas, *Phys. Rev.*, **94**, June (1954).
3. Born Approximation and its Connection with Covariant Perturbation Theory—by S. N. Biswas, *Ind. Jour. Phys.*
4. Electron Capture by Ions Passing Through Gases—by N. C. Sil, *Ind. Jour. Phys.*
5. Proton-Proton Scattering at 340 Mev.—by C. C. Banerjee, *Ind. Jour. Phys.*

D. DEPARTMENT OF PHYSICAL CHEMISTRY

Work on the following lines is in progress in the Laboratory during the year under review.

High polymer chemistry

- (1) Chain Transfer in Vinyl Polymerization;
- (2) Copolymerization;
- (3) Kinetics and Chain Transfer Studies in Hydrogen Peroxide Initiated Polymerization;
- (4) Vinyl Polymerization with Metallic Soaps;
- (5) Kinetics and Chain Transfer Studies with substituted Peroxide & Azonitriles;
- (6) Synthesis of Hydro Peroxides and their use in Polymerization;
- (7) Polymerization in the Aqueous Phase;
- (8) Physico Chemical Studies on Cellulose Compounds;
- (9) Polyelectrolytes;
- (10) Studies on Reaction Kinetics;
- (11) Fractionation and Distribution of Polymers.

General physical chemistry

- (12) Kinetics of the Decomposition of Peroxides;
- (13) Studies in Cosolvency;
- (14) Non-aqueous Titration;
- (15) Alkalimetric Determination of Mercury;
- (16) Dipole Moment Measurements.

Chain transfer in vinyl polymerization

S. K. Das has completed his investigations on chain transfer of vinyl acetate, using various hydrocarbons, alcohols, ketones and chlorinated solvents. The results are in agreement with the α -hydrogen theory. S. K. Das and S. R. Chatterjee have extended their investigations on chain transfer to another monomer, *viz.*, acrylonitrile. The results can be satisfactorily explained by means of the α -hydrogen theory, in the case of hydrocarbons, alcohols, ketones and esters. With halogenated solvents, however, quite unexpected results are obtained. It is found that carbon tetrachloride which is usually an extremely powerful chain transferring agent is as resistant to an attack by the free radical of acrylonitrile as a hydrocarbon like benzene.

Copolymerization

S. K. Das and S. R. Chatterjee have also determined the ϕ -constant of Melville in the copolymerization of styrene-methyl methacrylate and styrene-methyl acrylate by using an equation deduced by S. R. Palit. This equation enables one to determine the various cross constants r_1 , r_2 , δ_1 , δ_2 and $(C_{M_{12}} + C_{M_{21}})$ in copolymerization by means of simple rate and D. P. measurements. The values obtained from these equations show general agreement with those determined by various workers in this field.

Kinetics and chain transfer studies in hydrogen peroxide initiated polymerization

U. S. Nandi has extended his previous work on the study of the kinetics and chain transfer coefficients of vinyl monomers in the hydrogen peroxide catalyzed systems to various other monomers both in bulk and in solutions at different temperatures. In this connection special attention has been given to the determination of the chain transfer coefficient of the solvent in the catalyzed system.

Following this work, a developed method for the evaluation of solvent transfer in the catalysed system has been predicted and it has been found to be successful in all systems so far studied.

Work on polymerization in mixed solvent has also been undertaken and is in progress.

Vinyl polymerization with metallic soaps

In continuation of his work with metallic soaps A. K. Choudhury carried on polymerization with aluminium laurate and it was found that unlike ferric soap it has got no pronounced catalytic effect.

Kinetics and chain transfer studies with substituted peroxides and azonitriles

In continuation of his work with substituted peroxides, late N. G. Saha carried out investigations with other vinyl monomers both in bulk and in solutions of solvents. The nitro peroxides in this connection were found to behave abnormally with respect to other peroxides.

Work with nine azonitriles as initiator in the polymerization of vinyl monomers were also completed and the ideal behaviour of these catalysts was also established.

Synthesis of hydroperoxides and their use in polymerization

The synthesis of hydroperoxides has been undertaken by A. K. Choudhury. Rates of initiation, kinetics and chain transfer studies have been carried out in the bulk polymerization of methyl methacrylate at different temperatures.

Polymerization in the aqueous phase

The X-ray initiated polymerization of vinyl monomers in the aqueous phase has been undertaken by A. K. Choudhury. Preliminary experiments have been performed and the work is in further progress.

Physico-chemical studies on cellulose compounds

D. K. Roy Chowdhury has prepared lauroyl, caprynyl and caproyl esters of methyl ethyl cellulose. During the substitution of these groups it has been observed that degree of polymerization of methyl ethyl cellulose remains the

same. From the viscometric and osmometric data of these compounds some interesting results on molecular size and shape have been found.

Under C. S. I. R. scheme he has finished the construction and calibration of seven osmometers. These osmometers are now being used for the determination of molecular weights of copolymers of different monomers, polyelectrolytes and other synthetic polymers prepared in this laboratory.

Polyelectrolytes

The polyelectrolytic properties of the copolymers of vinyl acetate-maleic acid and also of vinyl alcohol-maleic acid have been studied by A. K. Sircar. He has also completed his work on sodium arabate. The work performed essentially confirms the folding unfolding theory originally advanced by Fuoss. Work on some more natural gums, *e.g.*, gum tragacanth and agaragar has been undertaken in order to study their polyelectrolytic properties and is being continued.

Studies on reaction kinetics

A. K. Sircar has carried out investigations on the kinetics of hydration of vinyl acetate-maleic anhydride copolymer. It has been found that the size of the polymer does not affect the rate of hydrolysis very much and the rate of hydration of the copolymer differs very little from that of the single monomeric unit (succinic anhydride) which is structurally akin to the reacting unit in the copolymer. Work on the kinetics of the system polyvinyl pyridine and alkyl halide is in progress.

Fractionation and distribution of polymers

To determine the molecular weight distribution of polystyrene, fractionation experiments have been performed by D. K. Roy Chowdhury and S. R. Chatterjee. The molecular weight distributions of the different samples of polystyrene polymerized at 80°C with the solvents in different proportions have been determined. From the data of fractionation experiments the integral and differential distribution curves have been drawn. The experimental data obtained are in good agreement with the theoretical distribution equation of high polymers recently deduced by S. R. Palit and K. C. Majumdar.

Kinetics of the decomposition of peroxide

The study of the decomposition of peroxide by U. S. Nandi and late N. G. Saha has also been continued and work with substituted benzoyl peroxides, fatty acid peroxides is in progress.

Studies in cosolvency

S. R. Somayajulu has studied the solubility of anthracene, phenanthrene etc., in the binary systems iodoethane or iodobenzene, cyclohexane or cyclohexene. In most cases the solubility has been found to be maximum at an optimum composition of the mixed solvent. These results have been attributed to be due to the Lewis acid-base nature of the components of the ternary sys-

tems and a mechanism has been suggested. The work has now been extended to polymers like polyacrylonitrile.

Non-aqueous titration

Work is in progress to find out the effect of the cosolvents in increasing the sharpness of the end point in the glycolic titration of inorganic and organic bases.

Alkalimetric determination of mercury

A method for the estimation of mercury which depends on the fact that mercury is not precipitated on the addition of alkali in the presence of amides has been developed by Somayajulu. The method has been found to give satisfactory results in the presence of many interfering anions and cations.

Dipole moment measurements

Accuracy of the measurement of dielectric constant has been improved upon by adding a mixture stage instead of using a receiver in the heterodyne beat oscillator.

At present work is being carried on to study the solvent effect in the measurement of dipole moment by S. K. Sen. A method has also been derived to study the temperature effect in the measurement of dipole moment.

List of papers published during the year.

1. Osmotic behaviour of sodium salts of polyuronide hemicellulose from jute—by S. K. Das, P. C. Das Gupta and Sadhan Basu, *J. Sci. Ind. Res.*, **12B**, 146, (1953).
2. A preliminary note on the direct determination of Melville's ϕ constant in copolymerizations—by S. K. Das and S. R. Palit, *Chem. and Ind.*, (Lond.), **129**, (1954).
3. Alkalimetric determination of mercury and its separation from other heavy metals—by M. N. Das, *Anal. Chem.*, **25**, 1406, (1953).
4. Some application of glycolic titration. Part I. Estimation of organic bases—by M. N. Das and S. R. Palit, *J. Ind. Chem. Soc.*, **31**, 34, (1954).
5. Some application of glycolic titration. Part II. Estimation of salts of organic acids—by M. N. Das, *J. Ind. Chem. Soc.*, **31**, 39, (1954).
6. Calculation of partial molal volume at infinite dilution from refraction data—by A. K. Sirkar and S. R. Palit, *Ind. Jour. of Physics*, **27**, 610, (1953).

Papers in the Press.

1. Cross constants in copolymerization. I. On the occurrence of minimum in copolymerization—by S. R. Palit, *Trans. Farad. Soc.*, (1954).
2. Studies in chain transfer. III. Determination of chain transfer coefficient from catalysed polymerization data—by S. R. Palit, U. S. Nandi and N. G. Saha, *J. Poly. Sci.*, (1954).
3. Kinetics of hydration of vinyl acetate—maleic anhydride copolymerization—by A. K. Sirkar and S. R. Palit, *J. Sci. Ind. Res.*, (1954).

4. Effect of chain transfer on the distribution of molecular weight of high polymers. I.—by S. R. Palit and K. C. Majumdar, *Ind. Jour. of Physics*, (1954).
5. Hydrogen peroxide as initiator of vinyl polymerization. Pt. I. Kinetic studies—by U. S. Nandi and S. R. Palit, *J. Poly Sci.*, (1954).
6. Studies in cosolvency, Pt. V. Lewis-acid character of iodocompounds in enhancing the solubility of anthracene in hydrocarbon solvents—by G. R. Somayajulu and S. R. Palit, *J. Phys. Chem.*, (1954).
7. Solubilization by detergent mixtures—by S. R. Palit and V. Venkateswarlu, *J. Chem. Soc.*, (Lond.), (1954).
8. Determination of unsaturated compounds with mercuric acetate—by M. N. Das, *Anal. Chem.*, (1954).
9. Non-aqueous titration—by S. R. Palit, M. N. Das and G. R. Somayajulu; A monograph on glycolic titration.
10. Studies in chain transfer Pt. IV—Catalysed polymerization of vinyl acetate—by S. R. Palit and S. K. Das, *Proc. Roy. Soc.*, (1954).
11. Hydrogen peroxide as initiator in vinyl polymerization in homogeneous system. Pt. II. Chain Transfer studies—by U. S. Nandi and S. R. Palit; Invited paper in the International Symposium of Macromolecular Chemistry.
12. Kinetics of oxidation of amines by hydrogen peroxide—by U. S. Nandi and S. R. Palit, *Proc. Nat. Acad. Sci.*, (1954).
13. The general theory underlying the determination of kinetic constants of chain transfer during polymerization—by S. R. Palit, *Proc. Nat. Acad. Sci.*, (1954).
14. Molecular weight distribution of benzyl cellulose—by H. B. Roy, *J. Ind. Chem. Soc.*, (1954).
15. Molecular state of benzyl cellulose—by H. B. Roy, *J. Ind. Chem. Soc.*, (1954).

E. DEPARTMENT OF ORGANIC CHEMISTRY

The researches in this Department have been reoriented considerably to include the chemical investigations of resinous substances occurring in nature.

As part of this programme the work is being actively carried out in the following sections:

Diterpenoids:

A long-term project on the elucidation of the stereochemistry of diterpenoid resin acids and their important degradation products was undertaken some time ago. The researches of Ruzicka and his collaborators, Vocke, Barton etc. have clarified the structure of important diterpenoid resin acids in all essential details. The recent work of Jacobsen has cast some doubt on the hitherto accepted stereochemistry of A/C ring junction.

K. N. S. Sastry, A Das Gupta and U. Ghatak are engaged in experiments which are expected to enable us to make a choice in favour of *cis* or *trans* locking on the A/C ring structure of the abietic acid molecule. Das Gupta's line of attack is *via* the lactone of Fleck and Palkin. Sastry and Ghatak are accumulating evidence in favour of a *trans* structure or otherwise of the

C_{12} -tricarboxylic acid, a degradation product of abietic acid. It is felt that the elucidation of the stereochemistry of the C_{12} -tricarboxylic acid would provide the most conclusive proof of the stereochemistry of the A/C ring fusion of abietic acid. They are in this connection developing an improved method for the preparation of the C_{12} -tricarboxylic acid from abietic acid which is obtained in very poor yield by the existing methods.

N. Saha has developed a new general method for the synthesis of the tricyclic C_1 -ketones. He has also successfully completed two series of model experiments for the introduction of such substituents as are present in the C_1 -position of the abietic acid molecule. Application of one of the methods on his synthetic C_1 -ketone has given the corresponding analogue of abietic acid. His work has hitherto been communicated in the form of a small note in *Science and Culture*. The full paper will be communicated soon. Already, different laboratories of the Western countries have shown interest in the methods he has developed and has asked for reprints of his published note from abroad. These series of investigations constitute a part of his D. Phil. thesis submitted in December, 1953.

P. N. Rao's successful synthesis of C_{12} -tricarboxylic acid was repeated last year. He made a comparison of his synthetic acid with the natural C_{12} -tricarboxylic acid obtained by the oxidation of abietic acid and has come to the conclusion that they are different showing that his acid is a stereoisomer of the natural acid. He has also provided arguments in favour of a *cis-meso*-structure for his synthetic acid.

Ruzicka and his collaborators prepared two monoesters of the C_{11} -tricarboxylic acid obtained by the oxidation of abietic acid. His arguments in favour of assigned structures are based on analogy and experimental proofs were lacking. Rao studied the I. R. spectra of the anhydrides prepared from the two monoesters and provided sound experimental evidence in favour of the structure assigned by Ruzicka. The structures of these esters are very important in the sense that Barton made theoretical calculations of the thermodynamic dissociation constants on the basis of the assigned structure and provided the only evidence in favour of the *trans-meso*-structure for the C_{11} -tricarboxylic acid. This constitutes a part of the D.Phil. thesis submitted by P. N. Rao in December, 1953.

Dicyclic terpenes

P. B. Talukdar's new synthesis of camphononic acid, a degradation product of camphor, was described in last year's report. Employing this compound as the starting point he has developed a new stereospecific synthesis of dl-homocamphoric acid. His synthesis is the only completely unambiguous synthesis of camphor so far developed. Following an analogous route, Talukdar has also completed a synthesis of dl-homoapocamphoric acid. The comprehensive details of this work have been incorporated in the D.Phil. thesis submitted by P. B. Talukdar in December, 1953. This series of investi-

gations has already been communicated for publication as already mentioned. Because of a few recent publications by Woodward and his collaborators, the chemistry of santonin has recently acquired importance and synthetic attempts are being actively carried out in different laboratories. P. Dutt and N. R. Ghosh are actively engaged in developing a stereospecific synthesis and some interesting results have already been obtained. The details of these investigations are being worked out and a short note has already been published indicating the line of approach. Preliminary investigations on triterpenoids are also in progress with a view to developing a suitable method for building this complex ring-system in the laboratory.

Steroids

Considerable attempt is being directed to develop a stereospecific synthesis of steroidal nucleus and the technique using liquid ammonia for the preparation of important intermediates has been considerably improved. A part of this programme has been successfully carried out by P. K. Datta and incorporated in his D.Phil. thesis (December, 1953) which comprises the results of the synthetic attempts on C_{13} -acid isolated by Wieland. A simpler scheme for the introduction of 11-keto group of cortisone are also being explored. N. K. Bhattacharyya, D. K. Datta and P. K. Datta are actively engaged in this programme.

Preparation of steroid intermediates through oxidation of tetrahydrophenanthrenes is being continued by M. Ghoshal. His results would also throw light on the mechanism of oxidation of such compounds.

Polynuclear aromatic hydrocarbons

A convenient five-step synthesis of pyrene was described last year by N. Saha. During the course of this year, his method has been extended by him and B. Sinha to the synthesis of carcinogens of this series. This constitutes the remaining part of the D.Phil. thesis submitted by N. Saha.

Miscellaneous

Picrotoxin, on degradation, furnishes a dicarboxylic acid $C_{12}H_{14}O_4$. Its structure was established long ago but no synthesis of this compound was available upto now. M. Ghoshal has developed a method which has resulted in a synthesis of this important degradation product. He is now engaged in the synthesis of the compound $C_{15}H_{18}O_4$, another degradation product of picrotoxin of a more complex nature. B. K. Ganguly has completed an extensive programme of mapping out the U. V. absorption spectra of benzo- α - & γ -pyrones. He has been able to correlate the absorption characteristics with the corresponding chromophoric structures. His results will be of immense value in the characterization of these compounds. Correlation of the chemical structures with I. R. absorption characteristics for all important synthetic compounds is being compiled with the help of foreign laboratories.

K. Sen continued his study of Dieckmann cyclization reactions. He is now engaged in the study of the potentiometric titration of β -keto-esters. It is expected from the results obtained, he would be able to deduce rules to predict the course of Dieckmann cyclization reactions.

The department could not as yet take up the publication of all results so far obtained in different lines, but it is being gradually released for publication, but some of the more important points have been published in note forms to maintain priority in the particular lines. Appended herewith are the lists of published papers and notes and also of the papers communicated for publication.

List of papers published during the year.

1. Experiments on the Synthesis of Santonin—by P. C. Dutta, *Science & Culture*, **19**, 165, (1953).
2. A New Synthesis of Homoapocamphoric acid—by P. B. Talukdar, and P. Bagchi, *ibid*, **19**, 201, (1953).
3. Unambiguous Synthesis of dl-Homocamphoric Acid—by P. B. Talukdar and P. Bagchi, *ibid*, **19**, 416, (1954).
4. Synthesis of 4-keto-7-methoxy-1:2:3:4-tetrahydrophenanthrene—by M. Ghoshal and P. Bagchi, *ibid*, **19**, 49, (1953).
5. Study on the C₁₁-Tricarboxylic Acid from Abietic Acid—by P. N. Rao and P. Bagchi, *ibid*, 267, (1953).
6. Synthesis of Stereoisomer of C₁₂-acid, a degradation product of Abietic Acid—by P. N. Rao and P. Bagchi, *Science & Culture*, 507 (1954).
7. Synthesis of $\alpha\alpha$ -Dimethylhomoisophthalic Acid—by N. K. Bhattacharyya, *ibid*, **19**, 462, (1954).
8. Dieckmann cyclization of Triethyl Pentan-1:2:5-tricarboxylate—by K. Sen and P. Bagchi, *ibid*, **19**, 312, (1953).
9. Synthesis of Gross Structure of Zinziberene—by N. K. Bhattacharyya and S. M. Mukherji, *J. Amer. Chem. Soc.*, **75**, 4698, (1953).
10. Friedel-Crafts Reaction Involving Unsaturated Ketones and Esters. II.—by N. K. Bhattacharyya, O. P. Vig, S. Singh and S. M. Mukherji, *J. Org. Chem.*, **18**, 1499, (1953).

Papers in the Press.

1. Synthetic Investigation in the Camphor series Part I. A New Synthesis of Camphononic Acid—by P. B. Talukdar and P. Bagchi, *J. Org. Chem.*
2. Synthetic Investigations in the Camphor series. Part II. Total Synthesis of dl-Homocamphoric Acid—by P. B. Talukdar and P. Bagchi, *J. Org. Chem.*
3. Synthetic Investigations in the camphor series. Part III. New Synthesis of dl-Homoapocamphoric Acid—by P. B. Talukdar and P. Bagchi, *J. Org. Chem.*
4. Synthetic Investigations in the camphor series. Part IV. Study of Intramolecular cyclization of Triethyl 2-Methylhexan-2:3:6-tricarboxylate—by P. B. Talukdar and P. Bagchi, *J. Org. Chem.*
5. Studies on Resin Acids, Part I. Synthesis of a Stereoisomer of the C₁₂H₁₈O₆ Tricarboxylic Acid from Abietic Acid—by P. N. Rao and P. Bagchi, *J. Org. Chem.*

6. Succinylation of 2-Methoxynaphthalene—by M. Ghoshal and P. Bagchi, *Science & Culture*.
7. Dieckmann cyclization of Triethyl 1-Methylpentan-1:2:5-tricarboxylate—by K. Sen and P. Bagchi, *Science & Culture*.
8. The Study of the Friedel-Crafts Reaction between Methylheptenone and Toluene—by N. K. Bhattacharyya, *Science & Culture*.

F. DEPARTMENT OF INORGANIC CHEMISTRY

Two main branches of Inorganic Chemistry in which work is being specially carried out in this Department are:—(1) Chemistry of Co-ordination Complexes, and (2) Analytical Chemistry—both classical and instrumental.

Under the chemistry of co-ordination complexes, researches are conducted both on the preparative aspect as well as on the study and determination of the structure of these complexes, relating to the nature of the chemical bond and the problem of valency. A variety of metallic complexes with different organic reagents or ligands have been prepared and their properties studied by physico-chemical methods. The mechanism of the formation of these complexes is also under investigation. The study of *cis-trans* isomerism of copper complexes constitutes a special feature of this present line of investigation. A series of copper biguanide complexes have been obtained in two differently coloured modifications with identical composition. The cause and nature of this difference have presented an interesting problem of investigation. Preparation of selenite co-ordination complexes, very few of which are known, forms another subject of special study in this laboratory. A few such compounds have already been prepared. A study of the complex compounds of benzamidoxime with copper, nickel, cobalt and palladium has revealed many new interesting points relating to valency and structure of these complexes. The formation and the stability of the complex compounds of diglycyl-hydroxamic acid with transitional elements are under investigation.

Under analytical chemistry the use of organic reagents for inorganic analysis forms the main subject of study. In this connection, mention may be made of the critical review of the various colorimetric methods for the estimation of titanium, chromium, uranium and palladium, that is being made in this laboratory under the auspices of the Analytical Reactions Committee of the International Union of Pure and Applied Chemistry. A spectrophotometric examination of the various colorimetric methods, proposed for the estimation of these elements, has just been completed. A new method for the colorimetric estimation of titanium with salicylhydroxamic acid has been developed and studied spectrophotometrically with very good results. The reddish brown colour developed by this reagent with titanium solution permits the determination of an extremely small quantity of titanium. O-hydroxy acetophenoneoxime has been found to give coloured complexes with many metallic elements, and these are now being examined for the colorimetric estimation of the metals concerned.

An aromatic amidoxime, salicylamidoxime, has been employed for the gravimetric estimation of many transitional elements and for their separation, as well as for the colorimetric estimation of uranium and iron. Dithiobiuret has been used as a reagent for the estimation and separation of copper from many other metals. Biguanide acid sulphate has been found to give a very useful primary standard for acid-base titration.

Shri Ajit Kumar Mukherjee, the senior research scholar of the department has submitted his thesis for the degree of Doctor of Philosophy of the University of Calcutta. Shri Debabrata Banerjea is going to submit his thesis for the D.Phil. degree in July next.

List of papers published during the year.

1. A note on the sexidentate cobaltic complexes—by Ajit Kumar Mukherjee, *Science & Culture*, **19**, 107-08.
2. Salicylaldehyde glycine hydroxamic acid as colorimetric reagent for iron—by Ajit Kumar Mukherjee, *Proc. Indian Sc. Congress Assoc. Part III*, 47-48, (1954).
3. Resorcyaldoxime as an organic reagent—by Ajit Kumar Mukherjee, *Proc. Indian Sc. Congress Assoc., ibid.*
4. Inner-metallic complexes of salicylaldimino hydroxamic acid—by Ajit Kumar Mukherjee, *Proc. Indian Sc. Congress Assoc., ibid.*
5. Salicylamidoxime as an analytical reagent—by Debabrata Banerjea, *Proc. Indian Sc. Congress Assoc. Part III*, **47**, (1954).
6. A note on the colorimetric estimation of uranium and iron—by Debabrata Banerjea, *Science & Culture*, **19**, 466, (1954).
7. Complexones in Chemistry—by Debabrata Banerjea, *Science & Culture*, **18**, 558, (1953).
8. A critical review on the colorimetric methods of estimation of uranium—by Amiya Kumar Chakraborty and J. Xavier, *Proc. Indian Sc. Congress Assoc. Part III*, (1954).
9. Use of biguanide sulphate as a reagent—by Asit Kumar Roy, *Science & Culture*, **19**, 568, (1954).

M. N. SAHA,

Director.

LIST OF BOOKS AND JOURNALS ADDED DURING 1953-54.

A. LIST OF BOOKS.

Authors.	Titles.
1. Sarton, G.	.. A History of science vol. 1.
2. Moller, C.	.. Theory of relativity.
3. Tolman, R. C.	.. Principles of statistical mechanics.
4. Zimmermann, E. W.	.. World resources and industries.
5. Sarton, G.	.. Introduction to the History of science vol. 3 pt. 1.
6. McBain, J. W.	.. Colloid Science.
7. Alfrey, T; Bohrer, J. J. and Mark, H.	.. Copolymerization (High Polymers vol. 8).
8. Bergmann, E. D.	.. Isomerism and isomerization of organic compounds.
9. Sarton, G.	.. Introduction to the History of Science vol 2 pt. 1, 2; vol. 3 pt. 2. vol. 1.
10. Hamos, L. V.	.. An x-ray microanalyzer camera.
11. Barksdale, J.	.. Titanium.
12. Adam Hilger Ltd.	.. Iron arc chart 1-8.
13. Vail, J. G.	.. Soluble silicates vol. 1: Chemistry. do do vol. 2: Technology.
14. Boundy, R. H.; Boyer, R. F. & Etoesser, S. M. (Edt.)	.. Styrene: Its polymers, copolymers and deriva- tives.
15. Simonsen, Sir J. & Barton, D. H. R.	.. Terpenes vol. 3.
16. Rogosinski, W. W.	.. Volume and integral.
17. Muchmore, R. B.	.. Essentials of microwaves.
18. Rutherford, D. E.	.. Substitutional analysis.
19. Infeld, L.	.. Albert Einstein: His work and its influence on on our world.
20. Janossy, L.	.. Cosmic Rays.
21. Coulson, C. A.	.. Valence.
22. Ferrar, W. L.	.. Finite matrices.
23. Baker, J. Wm.	.. Hyper-conjugation.
24. Massey, H. S. W. & Burhop, E. H. S.	.. Electronic and ionic impact phenomena.
25. Evans, U. R.	.. Metallic corrosion passivity and protection.
26. Hartshorne, N. H. & Stuart, A.	.. Crystals and the polarising microscope. 2nd edn.
27. Audrieth, L. F. & Klein- berg, J.	.. Non-Aqueous solvents.
28. Mason, B.	.. Principles of geochemistry.
29. Hadamard, J.	.. Psychology of invention in the mathematical field.
30. Weyl, H.	.. Philosophy of mathematics and natural science.
31. Durrant, P. J.	.. General and Inorganic chemistry. 2nd ed.
32. Barnett, E. de Barry and Wilson, C. L.	.. Inorganic chemistry.
33. Bell, R. J. T.	.. An elementary treatise on coordinate geometry of three dimensions. 3rd edn.
34. Kolthoff, I. M. & Sandell, E. B.	.. Text book of quantitative inorganic analysis. 3rd edn.
35. Hooper, A.	.. River mathematics.
36. Hirst, A. W.	.. Introduction to electrical machines. 2nd ed.
37. Bell, R. P.	.. Acids and bases: their quantitative behaviour.
38. Fieser, L. F.	.. Experiments in organic chemistry. 2nd. ed.
39. Cowie, G. A.	.. Potash: Its production and place in crop nutri- tion.
40. Govt. of India, Reports of Indian Tariff Board	.. On the continuance of protection to the paper and paper pulp industry 1947.
41. —do—	.. On the continuance of protection to the Artifi- cial silk and cotton and artificial silk mixed fabrics industry 1949.
42. —do—	.. On the continuance of protection to the Ferro- silicon industry 1949.
43. —do—	.. On the continuance of protection to the electric motors industry 1949.

Authors.	Titles.
44. Govt. of India, Reports of Indian Tariff Board ..	On the glass industry 1950.
45. —do— ..	On the soda ash industry 1949.
46. —do— ..	On the continuance of protection to the biromates industry 1949.
47. —do— ..	On the works cost of hot metal (Iron for steel-making and fair ex-works prices of pig iron (basic and foundry grades) 1949.
48. —do— ..	On the fair retention prices of steel produced by the Mysore iron and steel works, Bhadravati 1949.
49. —do— ..	On the continuance of protection to the iron and steel industry, 1947.
50. —do— ..	On the motor vehicle battery industry 1948.
51. —do— ..	On the fair retention prices of steel 1951.
52. Bevan, Aneurin ..	In place of fear.
53. Audrieth, L. F. (Ed.) ..	Inorganic syntheses vol. 3.
54. Weinstock, R. ..	Calculus of variations, with applications to physics and engineering.
55. Morse, P. M. ..	Vibration and sound.
56. Sneddon, I. N. ..	Fourier transforms.
57. Lass, Harry ..	Vector and tensor analysis.
58. Nehari, Z. ..	Conformal mapping.
59. Munroe, M. E. ..	Theory of probability.
60. Glasstone, S; Laidler, K. J. and Eyring, H. ..	Theory of rate processes.
61. Porter, J. G. ..	Comets and meteor streams.
62. Harang, L. ..	Aurorae vol. 1.
63. Blatt, J. M. & Weisskopf, V. F. ..	Theoretical nuclear physics.
64. Yoe, J. H. & Sarver, L. A. ..	Organic analytical reagents.
65. Hillebrand, Dr. W. F. and Lundell, Dr. G. E. F. ..	Applied inorganic analysis. 2nd ed.
66. Murnaghan, F. D. ..	Introduction to applied mathematics.
67. Hurd, D. T. ..	An Introduction to the chemistry of the hydrades.
68. Treadwell, F. P. ..	Analytical chemistry, vol. 2, 9th Eng. edn.
69. Waggaman, Wm. H. ..	Phosphoric acid, phosphates and phosphetic fertilizers, 2nd ed.
70. Sax, N. I. ..	Hand book of dangerous materials.
71. Latimer, W. M. ..	Oxidation states of the elements and their potentials in aqueous solutions.
72. Walton, H. F. ..	Principles and methods of chemical analysis.
73. Monier-Williams, G. W. ..	Trace elements in food.
74. Govt. of India ..	Report of the Committee on conservation of metallurgical coal pt. 1 & 2.
75. —do— ..	Report of the working party for coal industry.
76. University College of Science and Technology ..	Souvenir physics students Reunion '53, Calcutta University.
77. Millikan, A. ..	Autobiography of Robert A. Millikan.
78. Burger, A. ..	Medicinal chemistry vols. 1. & 2.
79. Courant, R. & Hilbert, D. ..	Methoden der mathematischen physik, vols. I & 2.
80. Turnbull, H. W. ..	Theory of equations, 5th edn.
81. Stoll, R. R. ..	Linear algebra and matrix theory. 1st edn.
82. Calcutta University ..	Applied physics Alumni Annual 1951-52.
83. Coolidge, J. L. ..	Elements of non-euclidean geometry.
84. Caratheodory, C. ..	Conformal representation, 2nd ed.
85. Besant, W. H. & Ramsay, A. S. ..	A treatise on hydromechanics. pt. 1.
86. Prandtl, L. ..	Essentials of fluid dynamics.
87. Binder, R. C. ..	Fluid mechanics. 2nd ed.
88. Stuart, H. A. ..	Die Struktur des freien molekuls.
89. Elderfield, R. C. (Edt.) ..	Heterocyclic compounds, vol. 3.
90. Gilman, H. (Edt.) ..	Organic chemistry (An advanced treatise) Vols. 3 & 4.
91. Jacobson, N. ..	Lectures in abstract algebra vol. 1.

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92. Hopf, Eberhard ..	Mathematical problems of radiative equilibrium.
93. National Bureau of Standards ..	Microbiological deterioration of organic materials: Its prevention and methods of test. NBS: Misc. Pub. 188.
94. —do— ..	Standard samples and reference standards issued by the National Bureau of Standards: Supplement to NBS Circular 398.
95. —do— ..	Hydraulic research in the United States. Misc. Pub. 201.
96. —do— ..	Table and mollier chart for ammonia below 60°P. NBS Circular No. 472.
97. —do— ..	Automotive antifreezes. NBS Circular No. 474.
98. —do— ..	Establishment and maintenance of the electrical units. NBS Circular No. 475.
99. —do— ..	Testing of hydrometers. NBS Circular No. 477.
100. —do— ..	Unified screw thread standards. NBS Circular No. 479.
101. —do— ..	Fundamental techniques in the frequency adjustment of quartz crystals. NBS Circular No. 480.
102. —do— ..	Testing by the National Bureau of Standards Policy, General information, fee schedule NBS Circular No. 483.
103. —do— ..	Spectrophotometry. NBS Circular No. 484.
104. —do— ..	Nickel and its alloys. NBS Circular No. 485.
105. —do— ..	Control of odors. NBS Circular No. 491.
106. —do— ..	Development of the National Bureau of Standards casting resin. NBS Circular No. 493.
107. —do— ..	Solders and soldering. NBS Circular No. 492.
108. —do— ..	Battery additives. NBS Circular No. 504.
109. —do— ..	Preservation of the declaration of independence and the constitution of the United States. NBS Circular No. 505.
110. —do— ..	X-ray calibration of radiation survey meters, pocket chambers, and dosimeters. NBS Circular No. 507.
111. —do— ..	Bibliography of books and published reports on Gas turbines jet propulsion and rocket power plants. NBS Circular No. 509.
112. —do— ..	Hydrogen embrittlement of steel. NBS Circular No. 511.
113. —do— ..	Bibliography on the measurements of gas temperature. NBS Circular No. 513.
114. —do— ..	Energy and angle distribution of the photoprotons from deuterium. NBS Circular 515.
115. —do— ..	Selection of hearing aids. NBS Circular 516.
116. —do— ..	Calibration of commercial radio field-strength meters at the National Bureau of Standards. NBS Circular 517.
117. —do— ..	Printed circuit techniques: An adhesive tape-resistor system. NBS Circular 530.
118. —do— ..	Hearing aids. NBS Circular 534.
119. —do— ..	An Annotated bibliography of selected references on the solid-state reactions of the Uranium Oxides. NBS Circular 535.
120. —do— ..	Radio frequency power measurement, NBS Circular 536.
121. —do— ..	Protective display lighting of historical documents. NBS Circular 538.
122. —do— ..	Safe handling of radioactive isotopes. NBS Handbook 42.
123. —do— ..	Radiological monitoring methods and instruments. NBS Handbook 51.
124. —do— ..	Code for protection against lightning. NBS Handbook 46.
125. —do— ..	Control and removal of radioactive contamination in laboratories. NBS Handbook 48.
126. —do— ..	1950 Supplement to screw-thread standards for Federal services 1944. 1950 Supplement to Handbook H 28.

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128. —do— ..	Nomograms for obtaining the compound composition of hydrated limes from the oxide analysis. Mics. Pub. 196.
129. —do— ..	Fire tests of bulb-type carbon-tetrachloride fire extinguishers. Misc. Pub. 197.
130. —do— ..	Report of the thirty-fifth National conference on weights and measures. Misc. Pub. 199.
131. Milne-Thomson, L. M. ..	Theoretical hydrodynamics, 2nd edn.
132. Dwinell, J. H. ..	Principles of aerodynamics, 1st edn.
133. Institute of Physics ..	Some aspects of fluid flow.
134. Drysdale, C. V. & others ..	Mechanical properties of fluids. 2nd edn.
135. Tomicek, O. ..	Chemical indicators.
136. Cook, J. W. (Edt.) ..	Progress in organic chemistry, vol. 1.
137. Pollard, H. ..	Theory of algebraic numbers.
138. National Bureau of Standards ..	Annual Report 1952. Misc. Pub. 207.
139. Finck, J. L. ..	Thermodynamics from a generalized standpoint.
140. Stickland, A. C. (Edt.) ..	Reports on progress in physics, vol. 10, 1953.
141. Ramsey, A. S. ..	A Treatise on Hydromechanics part. 2.
142. National Bureau of Standards ..	Report of the 37th National Conference on weights and measures, 1952. Misc. Pub. 207.
143. Shockley, Wm. ..	Electronics and holes in semiconductors.
144. Lamb, Sri. H. ..	Hydrodynamics, 6th edn.
145. National Bureau of Standards ..	Weights and measures case reference book, NBS Circular No. 450.
146. UNESCO ..	Race concept.
147. Einstein, A. ..	Meaning of relativity.
148. ..	Gmelins handbuch der anorganische chemie Schwefel Hydride und oxycte des schwefels.
149. National Academy of Sciences of India ..	Symposium on the chemistry of hydrous oxides, 1952.
150. Wolf, A. ..	A History of science, technology and philosophy in the 18th century.
151. Kolthoff, I. M. & Lingane, J. J. ..	Polarography, vols. 1, 2; 2nd edn.
152. Bruggencate, P. Ten. ..	Astronomy, Astrophysics and cosmogony FIAT Review of German Science 1939-1946.
153. Goubau, G. & Zenneck, J. ..	Electronics incl. Fundamental emission phenomena. Part 2, FIAT Review of German Science 1939-1946.
154. Manske, R. H. F. & Holmes, H. L. (Edt.) ..	Alkaloids: Chemistry and Physiology. vol. 1.
155. Venkataraman, K. ..	Chemistry of synthetic dyes, vols. 1, 2.
156. Berl, W. G. (Edt.) ..	Physical methods in chemical analysis.
157. Walker, R. J. ..	Algebraic curves.
158. Candler, A. C. ..	Atomic spectra and the vector model, vol. 2.
159. Boyd, P. P. and Downing, H. H. ..	Analytic geometry.
160. Block, R. J.; Lestrangle, R. & Zweig, G. ..	Paper chromatography. A laboratory manual.
161. National Bureau of Standards ..	Mass spectroscopy in physics research. NBS Circular 522.
162. Caro, H. Trans. by Sen, S. P.; Biswas. H. ..	Development of the coal-tar colour industry.
163. Union Internationale de Physique pure et Appliquee ..	Colloque de thermodynamique.
164. Castle, Frank ..	Five-figure logarithmic and other tables.
165. Pryde, J. (Edt.) ..	Chambers's Seven-figure logarithms of numbers up to 100000.
166. Hughes, D. J. ..	Pile neutron research.
167. Bitter, Francis ..	Nuclear physics.
168. Addison-Wesley Pub. Co. Inc. ..	A-W chart of nuclear data. (Reprint of Appendix 5, of Nuclear physics by Francis Bitter of MIT).
169. Washer, F. E. & Gardner, I. C. ..	Method for determining the resolving power of photographic lenses, NBS Circular No. 533.

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170. National Bureau of Standards ..	Maximum permissible amounts of radioisotopes in the human body and maximum permissible concentrations in air and water, NBS Hand book 52.
171. Killeffer, D. H. & Linz, A. ..	Molybdenum compounds (their chemistry and technology).
172. Elderfield, R. C. (Edt.) ..	Heterocyclic compounds Vol. 4. Quinoline, Isoquinoline and their benzo derivatives.
173. Das Gupta, P. C. ..	Studies on cellulosic polyelectrolytes.
174. Sen, J. N. ..	Chain transfer and solvent effect in addition polymerization.
175. Das, M. N. ..	Acid-Base titration in glycolic solvent media and reaction of Bromine and iodine with sodium acetate—study of reaction kinetics.
176. Mukherjee, S. ..	Ionic antagonism in cation exchange and other reactions in colloidal solutions of clay minerals.
177. Banerjee, N. N. ..	Studies on composition, structure and physico-chemical properties of Buffalo horn, and development of moulding powders from it.
178. Halder, B. C. ..	Studies on imperfect complexes in solution and thermometric studies on basic sulphate formation of Cd, Cu, Zn, Ni, Co, Mn, & Be.
179. Choudhury, P. K. ..	Studies in cellulose acetate.
180. Gupta, A. P. ..	Studies on the production of thermo-setting moulding powders from jute waste.
181. Vedantam, Venkateswarlu ..	Studies on solubilization of water in non-polar solvents by cationic detergents.
182. Sen Gupta, R. ..	Studies on the kinetics of vinyl polymerization.
183. Justice, J. D. and Nelson, Samuel J. ..	Intrinsic viscosity of polystyrene in solvent mixtures.
184. Dacca University ..	On titrations of some complex polybasic acids.
185. —do— ..	Determination of vapour pressure of saturated solution of ammonium bicarbonate.
186. —do— ..	A study of the solid solutions of cobalt sulphate and magnesium sulphate.
187. —do— ..	Vapour pressure of metaldehyde.
188. —do— ..	Studies on preparation and properties of tetramethylammonium-alums.
189. Kherra, R. P. ..	A New approach to the study of passivity of: Iron and stainless steel and other metals in HNO ₃ .
190. Allander, C. G. ..	Untersuchung des adsorptionsvorganges in adsorbentenschichten mit linearer adsorptionsisotherme.
191. Maryott, A. A. and Buckley, F. ..	Table of dielectric constants and electric dipole moments of substances in the gaseous state. NBS Circular 537.
192. Bass, A. M. and Broida, H. P. ..	A Spectrophotometric atlas of the 2 Σ + - Σ II transition of OH. NBS Circular 541.
193. Rickard, T. A. ..	Man and metals vols. 1 and 2.
194. Brown, G. I. ..	A simple guide to modern valency theory.
195. Morton, R. A. ..	Application of absorption spectra to the study of vitamins, Hormones and coenzymes.
196. McLachlan, N. W. ..	Modern operational calculus.
197. Krauskopf, K. B. ..	Fundamentals of physical science.
198. Ingersoll, L. R.; Martin, M. J. & Rouse, T. A. ..	A Laboratory manual of experiments in physics. 6th edn.
199. Bates, L. F. ..	Modern magnetism, 3rd edn.
200. Roy, H. N. ..	Studies on Benzyl cellulose.
201. Doty, P. & Ehrlich, G. ..	Polymeric electrolytes.
202. Hey, Max H. ..	An Index of mineral species and varieties.
203. Margenau, H. & Murphy, G. M. ..	Mathematics of physics and chemistry.
204. Ledermann, W. ..	Introduction to the theory of finite groups.
205. Baldwin, R. B. ..	Face of the moon.
206. Lehmann, C. H. ..	Analytic geometry.
207. Frazer, R. A.; Duncan, W. J. & Collar, A. R. ..	Elementary matrices and some applications to dynamics and differential equations.

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208. Cahn, R. S. (Edt.)	Annual Reports on the Progress of chemistry for 1952, vol. 49.
209. Comrie, L. J. (Edt.)	Barlow's tables. 4th edn.
210. McKie, D.	Antoine Lavoisien.
211. Birks, J. B.	Scintillation counters.
212. Jeffreys, H.	The Earth: Its origin, history and physical constitution. 3rd edn.
213. National Bureau of Standards	Supplementary list of publications of the National Bureau of Standards. July 1, 1947 to June 30, 1952.
214. Illing, V. C. (Edt.)	World's oilfields (Science of Petroleum vol. 6 part. 1).
215. Margenau, H.; Watson, Wm. W. & Montgomery, C. G.	Physics; principles and applications. 2nd edn.
216. Von Laue, M.	Materiewellen und ihre interferenzen.
217. Goldstein, S. (Edt.)	Modern Developments in fluid dynamics. vols. 1 & 2.
218. Aller, L. H.	Astrophysics.
219. Macduffee, C. C.	Theory of matrices.
220. Morecock, Earle M.	Alternating-Current circuits.
221. Kirshenbaum, I.	Physical properties and analysis of heavy water. 1st edn.
222. Douglass, R. D. Zeldin, S. D.	Analytic geometry. 1st edn.
223. Butler, Charles H. and Wren, F. Lynwood	Teaching of secondary mathematics. 2nd edn.
224. Ore, O.	Number theory and its history. 1st edn.
225. Felsing, W. A. & Watt, G. W.	General chemistry.
226. Siskind, C. S.	Electrical machines direct and alternating current. 1st edn.
227. Craig, H. V.	Vector and tensor analysis, 1st edn.
228. Uspensky, J. V. & Heaslet, M. A.	Elementary number theory.
229. Osgood, W. F. & Graustein, W. C.	Plane and solid analytic geometry.
230. National Bureau of Standards	Electrochemical constants. NBS Circular 524.
231. Kleman, Bengt.	Investigations in the Band-spectra of some diatomic hydrides.
232. Van Royen, W. and Bowles, O.	Mineral resources of the world.
233. Allis, W. P. & Herlin, M. A.	Thermodynamics and statistical mechanics.
234. Brindley, G. W. (Edt.)	X-ray identification and crystal structures of clay minerals.
235. Jalan, K. D.	Unemployment in India.
236.	Gmelins handbuch der anorganischen chemie Schwefel, Teil A. Lieferung 3.
237. Cauchois, Y. & Mott, N. F.	Les spectres de Rayons x et la structure electronique de la matiere.
238. Madras University	University of Madras Calendar for 1953-54, vol. 1.
239. National Bureau of Standards	Graphs of the compton energy-angle relationship and the Klein-Nishina formula from 10 Kev. to 500 Mev. NBS Circular 542.
240. Segre, E. (Edt.)	Experimental nuclear physics, vol. 1.
241. Bleuler, E. & Goldsmith, G. J.	Experimental nucleonics, 1952.
242. Annual Reviews, Inc.	Annual Review of Nuclear Science, vol. 2, 1953.
243. Flagg, J. F.	Organic reagents used in gravimetric and volumetric analysis.
244. U. S. Information Service	Films. Filmstrips. Slides.
245. Drummond, D. G. (Edt.)	Practice of electron microscopy. (March 1950; Journal of the Royal Microscopical Society, vol. 70).
246. National Bureau of Standards	Reference data for orienting quartz plates by x-ray diffraction. NBS Circular 543.

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248. Govt. of India	Report of the Salt expert committee.
249. INSDOC	Indian National Scientific Documentation Centre Commonwealth Index of Translations 6th list 1953. (two copies).
250. Rollefson, G. K. (Edt.)	Annual Review of Physical Chemistry, vols. 2-4.
251. Shoenberg, D.	Superconductivity, 2nd edn.
252. National Bureau of Standards	Recommendation for the disposal of carbon-14 wastes. Handbook 53.
253. Council of Scientific and Industrial Research, India	Organisation and functions.
254. National Bureau of Standards	Safe handling of cadavers containing radioactive isotopes. Handbook 56.
255. Govt. of India	National Library of India Golden Jubilee, Souvenir volume 1953.
256. Branch, G. E. K. and Calvin, M.	Theory of organic chemistry; An advanced course.
257. Phillips, E. G.	A course of analysis, 2nd edn. 1950.
258. Smart, W. M.	Text-book on spherical astronomy, 4th edn.
259. National Bureau of Standards	Methods of measuring humidity and testing hygrometers. Circular 512.
260. Govt. of India	Report of the planning committee for geophysics.
261. U. S. Govt.	Resources for freedom, vol. 1, Foundations for growth and security, 1952. vol. 2, Outlook for key commodities, 1952. vol. 3, Outlook for energy sources, 1952. vol. 4, Promise of technology, 1952. vol. 5, Selected reports to the commission '52.
262. Yust, W. (Edt.)	Britannica books of the year 1949, 1950, 1952, 1953.
263. Denbigh, K. G.	Thermodynamics of the steady state.
264. Awbery, J. H.	A Text book of heat.
265. Roberts, J. K.	Heat and thermodynamics, 4th edn.
266. Bosworth, Dr. R. C. L.	Heat transfer phenomena.
267. Planning Commission	Progress of the plan: A short survey of the working of the five year plan from April 1951 to September 1953.
268. Luck, J. M. (Edt.)	Annual Review of Biochemistry, vol. 22, 1953.
269. Backerley, J. G. (Edt.)	Annual Review of Nuclear Science, vol. 3, 1953.
270. Davenport, H.	Higher arithmetic: An introduction to the theory of number.
271. Burkill, J. C.	Lebesgue integral.
272. Kraitchik, M.	Mathematical Recreations.
273. Buckley, H. E.	Crystal growth.
274. London, F.	Superfluids, vol. 1. Microscopic theory of superconductivity.
275. Late Worthing, A. & Geffner, J.	Treatment of experimental data.
276. Smith, R. A.	Physical principles of thermodynamics. A treatise for students of theoretical and experimental physics.
277. Reimann, A. L.	Vacuum technique.
278. Glowatzki, E.	Tafel der Jacobischen elliptischen funktion
279. Waldmeier, M.	Radiowellen aus dem weltraum.
280. Simon, F. E.; Kurti, N. Allen, J. F. & Mendelssohn	Low temperature physics. (Four lectures).
281. Chalmers, B. (Edt.)	Progress in Metal Physics, vols. 1, 2, 3, 4.
282. Verma, A. R.	Crystal growth and dislocations.
283. Richardson, E. G.	Ultrasonic physics.
284. Von Laue, M.	Theorie der supraleitung.
285.	Gmellins handbuch der anorganischen chemie Selen, 8 Auf, Sys. No. 10, Teil. A, Lief. 3.
286. Jakob, M. & Hawkins, G. A.	Elements of heat transfer and insulation.
287. Landsberg, H. E. (Edt.)	Advances in geophysics, vol. 1.

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288. National Bureau of Standards ..	Report of the thirty-eighth National conference on weights and measures. 1953, Misc. Pub. 209.
289. Calcutta University ..	Calcutta University Act 1951 with first statutes, etc.
290. National Bureau of Standards ..	Polymer degradation mechanisms. NBS Circular No. 525.
291. Calcutta University ..	Calcutta University Amendments to Regulations since the publication of the regulation 1951 edition up to 31st January 1954.
292. ..	Gmelins handbuch der anorganischen chemie Gold: 8 Auf. Sys. No. 62, Lief. 2. 1954.
293. Baitsell, G. A. (Edt.) ..	Science in Progress, 8th series, 1953.
294. De L'UR.S.I. ..	International council of scientific unions. Mixed commission on the ionosphere.
295. Grew, K. E. & Ibbs, T. L. ..	Thermal diffusion in gases.
296. Chapman, S. & Cowling, T. G. ..	Mathematical theory of non-uniform gases.
297. Squire, C. ..	Low temperature physics.
298. Slater, J. C. ..	Quantum theory of matter.
299. Fabry, C. (Tr. by Harkes)	Elements of thermodynamics.
300. Hall, J. A. ..	Practical thermometry.
301. Jaynes, E. T. ..	Ferroelectricity.
302. Quenouille, M. H. ..	Design and analysis of experiment.
303. Segre, E. (Edt.) ..	Experimental nuclear physics, vol. 2.

B. List of additional periodicals and bulletins received on Exchange basis.

1. Agra University Journal of Research.
2. Australian Journal of Physics.
3. Czechoslovak Journal of Physics.
4. Glasnik matematicko-Fizickii astronomski.
5. Izvestiya Akademii Nauk SSSR.
6. Proceedings of the Imperial Academy, Japan.
7. Yokohama Mathematical Journal.
8. Annual Report of the Bose Institute.

C. List of additional periodicals and bulletins received on Subscription basis.

1. Bulletin of the Society Francaise de Mineralogie.
2. Geophysics.
3. Journal of the Institute of Petroleum.
4. Resins-Rubbers-Plastics.
5. British Abstracts B I, II.

D. List of additional periodicals and bulletins received as complimentary copies.

1. Acta Scholae Medicinalis Universitatis in Kioto.
2. Abhandlungen der Deutschen Akademie der Wissenschaften Zu Berlin:
Klasse für Gesellschaftswissenschaften.
3. —do— Math. Natur.
4. —do— Spra-lit-und Kunst.
5. Academie Polonaise des Sciences et des letters: Comptes Rendus.
6. Acta Chemica Scandinavica.
7. American Reporter.
8. Arkiv for Geofysik.
9. Arztliche Forschung.
10. Australian Journal of Agricultural Research.
11. Avtomaticheskaya Izdatelstvo Svarka.
12. Bibliography of Scientific Publications of South Asia.
13. Bulletin de L'Academie Polonaise des Sciences.
14. Bulletin de la Societe des Mathematiciens et Physiciens de la R. P. de Serbie.

15. Bulletin International de L'Academie Polonaise des Sciences et des Letters:
Math: Sci. Naturelles: Philologie.
16. CSIR.
17. Ciba Monographs.
18. College of Engineering Magazine.
19. Commonwealth To-day.
20. Council for Scientific & Industrial Research—Annual Report. (Australia).
21. Courier.
22. The Deaf in India.
23. Deutsche Akad. Der Wissenschaften Zu Berlin Vortrage und Schriften.
24. General Radio Experimenter.
25. Half-yearly Journal of the Mysore University: A & B.
26. Indian Assoc. of Analysts & Analytical Chemists: Bulletin.
27. Indian Central Tobacco Committee; Annual Report.
28. Indian Lac Research Institute.
29. Indian Journal of Meteorology & Geophysics.
30. Indian Journal of Physics.
31. Indian Journal of Power & River Valley Development.
32. Indian Science News Assoc. Annual Report.
33. Istanbul Teknik Universitesi Bulteni.
34. Japan Science Review.
35. Journal of the Institute of Polytechnics Osaka city Univ: Sr. Math.
36. The Laboratory.
37. Manufacturer.
38. McGraw-Hill Digest.
39. Memoirs of the Indian Meteorological Depart.
40. Mie Medical Journal, Japan.
41. Nagoya Mathematical Journal.
42. Notas de Fisica.
43. Priroda.
44. Proceedings of the Egyptian Academy of Sciences.
45. Proceedings of the National Academy of Sciences, India.
46. Science of Light.
47. Scientific Papers of the College of General Education University of Tokyo.
48. Scientific Report Indian Agricultural Research Institute.
49. Sitzungsberichte der deutschen Akademie der Wissenschaften
Zu Berlin: Math.-Natur. Klasse.
50. —do— : Sprachen-Lit.
51. —do— : Klasse fur Gesellschaftswissenschaften.
52. Sitzungsberichte der Mathematische-naturwissenschaftlichen Klasse.
53. Sitzungsberichte der Akademie der Wissenschaften Klasse fur Medizinische
Wissenschaften.
54. Spanish Cultural Index.
55. Technical Education News.
56. Telecommunications.
57. Unesco Bulletin for Libraries.
58. Unesco Official Bulletin.
59. Universidad Nacional de la Plata Facultad de Ciencias Fisicomatematicas:
Revista. Serie Segunda.
60. Vestnik Akademii Nauk SSSR.
61. Visnik Akademia Nauk.
62. Weekly Newsletter.
63. Wissenschaftliche Annalen.
64. WMO Bulletin.
65. Zhoornal Fizichyeskoi Himu.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES—1954-55

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

RECEIPTS

Heads of Receipts	Actual 1952-53	Budget 1953-54	Revised Budget 1953-54	Budget 1954-55	Remarks
	Rs.	Rs.	Rs.	Rs.	
I. Govt. of India					
1. Grant-in-aid	3,40,000	3,98,000	3,98,000	4,26,000	
2. Contribution to D.A.	17,000	19,900	19,900	21,300	
II. Other Receipts					
1. Interest from General Fund	495	500	500	500	
2. Ordinary Membership Subscription	945	1,000	1,120	1,000	
3. Life Membership fee	250	1,000	5,750	1,000	
4. Rent	5,190	—	55	—	
5. Indian Journal of Physics	6,431	8,000	8,000	8,000	
6. Miscellaneous	474	2,000	486	1,000	
III. Contribution from M.L.S. & V.L.M. Prof. Fund	8,445	8,420	8,420	8,420	
	<u>3,79,229</u>	<u>4,38,820</u>	<u>4,42,231</u>	<u>4,67,220</u>	
IV. Revoted amount of previous years (1951-52 and 1952-53) carried over for expenditure during 1953-54		22,554	24,504	—	
V. Interest @ 1% per annum on the loan of Rs. 5,00,000/- with effect from 28.3.50 to 7.4.53 (ref. Govt. of India, Ministry of N.R. & S.R. letter No. 12(5)/53-SRII dated March 18, 1954 and the Finance Committee recommendation No. 1 dated 23.9.53 and approved by the Council dated 9.12.53)					
Rs. 15,151/-					
do on Rs. 3,50,000/- from 8.4.53 to 27.3.55*	Rs. 6,903/-				
	Rs. 22,054/-			22,054(1)	
				130(2)	
Total ..	3,79,229	4,61,374	4,66,735	4,89,404	

* Rs. 1,50,000/- paid back on 8.4.53.
 (1) Govt. of India be requested to provide for this sum.
 (2) Deficit for 1954-55.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

BUDGET ESTIMATES—1954-55

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

EXPENDITURES

Heads of Expenditure	Actual 1952-53	Original Budget Estimates 1953-54	Revised Budget 1953-54	Budget Estimates 1954-55	Remarks
	Rs.	Rs.	Rs.	Rs.	
I. Establishment					
1. Salary					
Director and his staff	4,900 0 0	28,800	27,980	30,329	
Dept. of General Physics, X-rays & Magnetism	34,556 5 0	37,811	23,046	33,790	
Dept. of Optics	32,516 0 0	29,240	25,478	29,981	
Theoretical Physics	19,525 12 0	19,960	20,000	21,086	
Physical Chemistry	30,168 13 0	29,613	25,412	29,847	
Organic Chemistry	21,303 1 0	27,719	27,486	28,411	* Addition for new posts.
Inorganic Chemistry	12,421 14 0	26,201	25,133	1,800*	
Library	6,035 8 0	3,913	4,014	26,738	
Workshop	19,349 11 0	13,390	13,039	4,405	
Administration	35,404 3 0	25,784	25,541	13,921	
	2,16,181 3 0(1)	2,42,431	2,17,129	2,51,403	(1) Including D.A. and ad hoc D.A.
2. Dearness Allowance	—	51,434	45,925	50,941	
Do Ad-hoc	—	4,320	3,884	3,480*	
3. Provident Fund Contribution	10,493 0 0	15,702	13,241	4,260	
Do (revoted)	—	—	1,216	420*	
	2,26,674 3 0	3,13,887	2,81,395	3,26,204	
II. Laboratory Grants					
Dept. of General Physics, X-rays and Magnetism					
Recurring					
Do (revoted)	7,360 5 6	6,000	7,000	7,500	
Special					
Do (revoted)	1,724 1 6	—	100	—	
Do (1951-52)	—	—	1,885	—	
	—	—	25	—	
	2,35,758 10 0	3,19,887	2,90,405	3,33,704	

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

Heads of Expenditure	Actual 1952-53	Original Budget Estimates 1953-54	Revised Budget 1953-54	Budget Estimates 1954-55	Remarks
	Rs.	Rs.	Rs.	Rs.	
Brought Forward	2,35,758 10 0	3,19,887	2,90,405	3,33,704	
Dept. of Optics					
Recurring	5,705 11 0	6,000	7,300	6,000	
Do (revoted)	—	—	58	—	
Special	2,160 13 6	—	—	—	
Do (revoted)	—	—	263	—	
Dept. of Theoretical Physics					
Recurring	1,181 12 6	3,000	3,300	1,500	
Do (revoted)	—	—	1,578	—	
Special	85 13 6	—	—	—	
Do (revoted)	—	—	—	—	
Dept. of Physical Chemistry					
Recurring	5,030 1 6	6,000	7,369	6,000	
Do (revoted)	—	—	267	—	
Special	3,567 12 6	—	—	—	
Do (revoted)	—	—	—	—	
Dept. of Organic Chemistry					
Recurring	6,247 10 3	6,000	7,000	6,000	
Do (revoted)	—	—	200	—	
Special	2,461 13 6	—	—	—	
Do (revoted)	—	—	215	—	
Dept. of Inorganic Chemistry					
Recurring	5,483 2 6	6,000	7,000	6,000	
Do (revoted)	—	—	700	—	
Special	5,091 7 6	—	—	—	
Do (revoted)	—	—	15	—	
Do (revoted 1951-52)	—	—	174	—	
III. Library					
Recurring	4,814 11 0	10,500	11,000	10,500	
Do (revoted)	—	—	8,193	—	
Special	7,218 0 0	—	—	—	
Do (revoted)	—	—	—	—	
Do (1951-52)	—	—	643	—	
	2,84,807 7 3	3,57,387	3,45,680	3,69,704	

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

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

Heads of Expenditure	Actual 1952-53	Original Budget Estimates 1953-54	Revised Budget 1953-54	Budget Estimates 1954-55	Remarks
	Rs.	Rs.	Rs.	Rs.	
Brought Forward	2,84,807 7 3	3,57,387	3,45,680	3,69,704	
IV. Workshop					
Recurring	6,715 14 6	5,000	5,500	5,000	
Do (revoted)	—	—	425	—	
Special	591 0 0	—	—	—	
Do (revoted)	—	—	52	—	
Do (1951-52)	—	—	203	—	
V. Indian Journal of Physics	17,105 14 0	17,000	17,000	20,209	
Do (revoted)	—	—	660	—	
VI. Life and Institutional Membership					
Fund	—	1,000	5,750	1,000	
To Corpus M.L.S. Prof. Fund on account of Savings for the leave of the M.L.S. Professor	—	—	4,280	—	
VII. Laboratory Services, General Expenses and miscellaneous etc.	50,105 0 3	57,000	78,519	71,437	
Do (revoted)	—	—	7,959	—	
Suspense, advances (excluding those under construction)	7,317 5 6	—	—	—	
Interest @ 1% on the loan of Rs. 5,00,000 payable to the Govt. of India from 28.3.50 to 7.4.53 and on Rs. 3,50,000 from 8.4.53 to 27.3.55	—	—	—	22,054	
Amount revoted from 1952-53 for expen- diture during 1953-54	—	22,554	—	—	
	<u>3,66,642 9 6</u>	<u>4,59,941</u>	<u>4,66,028</u>	<u>4,89,404</u>	

FOR THE CULTIVATION OF SCIENCE

as at 31st March 1954.

ASSETS.	Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
<i>Scientific Instrument & Laboratory</i>									
<i>Fittings—</i>									
General Physics, X-Ray & Magnetism Department									
Brought Forward	1,50,770	8	0						
Less Depreciation @ 5%	7,538	9	0	1,43,231	15	0			
Added this year	..	..	..	7,285	1	0	1,50,517	0	0
Optics Department									
Brought Forward	40,873	9	6						
Less Depreciation @ 5%	2,043	11	0	38,829	14	6			
Added this year	..	..	..	18,656	5	3	57,486	3	9
Physical Chemistry Department									
Brought Forward	20,058	7	0						
Less Depreciation @ 5%	1,002	15	0	19,055	8	0			
Added this year	..	..	..	11,624	4	3	30,679	12	3
Organic Chemistry Department									
Brought Forward	17,656	8	0						
Less Depreciation @ 5%	882	13	0	16,773	11	0			
Added this year	..	..	..	10,603	3	9	27,376	14	9
Theoretical Physics Department									
Brought Forward	12,738	9	3						
Less Depreciation @ 5%	636	15	0	12,101	10	3			
Added this year	..	..	..	1,772	9	6	13,874	3	9
Botany Department									
Brought Forward	..	..	..				150	0	0
Inorganic Chemistry Department									
Brought Forward	16,199	8	6						
Less Depreciation @ 5%	810	0	0	15,389	8	6			
Added this year	..	..	..	17,801	12	6	33,191	5	0
Workshop									
Brought Forward	56,619	14	9						
Less Depreciation @ 5%	2,831	0	0	53,788	14	9			
Added this year	..	..	..	3,881	15	0	57,670	13	9
<i>Tools & Implements—</i>									
Brought Forward	..	..	..	1,039	0	0			
Less Depreciation @ 5%	..	..	..	52	0	0	987	0	0
<i>Furniture, Fixture & Fittings—</i>									
Brought Forward	43,311	0	3						
Less Depreciation @ 10%	4,331	2	0	38,979	14	3			
Added this year	..	..	..	11,665	2	9	50,645	1	0
				Carried Over Rs. 4,22,578 6 3					

INDIAN ASSOCIATION

Balance Sheet

LIABILITIES.	Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward							32,24,687	7	4
<i>Amount due to</i>									
(i) C.S.I.R. Employees' Provident Fund				273	11	0			
(ii) M.L.S. Professorship Fund				1,000	0	0			
(iii) Provident Fund				124	12	0			
(iv) Cooch Behar Professorship Fund				6	9	0			
(v) Unpaid Scholarship				20	0	0	1,425	0	0
<i>Loan from Government of India</i> (Secured against Land & Building per contra) as per last account				5,80,000	0	0			
Less repaid				1,50,000	0	0	4,30,000	0	0

Carried Over Rs. 36,56,112 7 4

FOR THE CULTIVATION OF SCIENCE

as at 31st March 1954.

ASSETS.	Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.	
Brought Forward ..							4,22,578	6	3	
<i>Vehicles—</i>										
Brought Forward ..				161	14	9				
Less Depreciation @ 10% ..				16	4	0	145	10	9	
<i>Library—</i>										
Brought Forward ..	1,24,124	4	6							
Less Depreciation @ 2% ..	2,482	8	0							
				1,21,641	12	6				
Added this year ..				19,315	11	3	1,40,957	7	9	
<i>Sanitary & Gas Fittings</i> ..							698	6	0	
<i>Electrical Fittings & Equipments</i> ..							3,067	0	6	
<i>Investments (in 3% G.P. Notes lodged with Imperial Bank of India) as per last account</i>										
Mahendralal Sircar Professorship Fund ..				1,49,500	0	0				
Viharilal Mitra Fund ..				1,32,000	0	0				
Ripon Professorship Fund ..				25,000	0	0				
Hare Professorship Fund ..				1,500	0	0				
Cooch Behar Professorship Fund ..				33,000	0	0				
Victoria Professorship Fund ..				1,500	0	0				
Jaykissen Mukherjee Gold Medal Fund ..				13,400	0	0				
Dr. Bimala Churn Law Gold Medal Fund ..				7,000	0	0				
Dr. Sircar Research Medal Fund ..				5,000	0	0				
Woodburn Medal Fund ..				1,500	0	0				
Nikunja Garabini Prize Fund ..				1,000	0	0				
Jatindra Chandra Prize Fund ..				1,000	0	0				
General Fund ..				16,500	0	0				
Building Fund ..				9,500	0	0	3,97,400	0	0	
Market Value Rs.										
<i>Security Deposit—</i>										
Brought Forward ..										
Calcutta Electric Supply Corporation Limited ..				1,597	12	9				
Oriental Gas Co. ..				40	0	0				
Thomas Cooke ..				150	0	0	1,787	12	9	
<i>Advances & Suspense (Net)</i> ..										
<i>Land, at cost</i>							19,981	0	6	
Brought Forward ..				4,34,556	11	2				
Additions during the year ..				94,440	11	9	5,28,997	6	11	
<i>Building Construction, at cost</i>										
Brought Forward ..				14,57,177	1	6				
Additions during the year ..				1,81,436	12	3	16,38,613	13	9	
							Carried Over Rs.	31,54,227	1	2

INDIAN ASSOCIATION

Balance Sheet

LIABILITIES.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward				36,56,112	7	4
Rs. 36,56,112 7 4						

We have to report that we have audited the above Balance Sheet as at 31st March, 1954 and the annexed Receipts and Payments Accounts for the year ending on that date of the Indian Association for the Cultivation of Science, with the books of accounts produced. Subject to our separate report of even date addressed to the Members, we are of opinion that the said Balance Sheet and the Receipts and Payments Accounts are drawn up in conformity with the law and exhibit a true and correct view of the state of affairs of the Association. In our opinion the books have been kept by the Association as required by law.

CALCUTTA:
6, Hastings Street,
The 19th July, 1954.

G. BASU & CO.,
CHARTERED ACCOUNTANTS
AUDITORS.

FOR THE CULTIVATION OF SCIENCE

as at 31st March 1954.

ASSETS.	Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward							31,54,227	1	2
<i>Amount due from</i>									
Council of Scientific & Industrial Research									
(i) Scheme for Construction of Light Scattering Apparatus etc.									
Expenses during the year		6,490	5	3					
Less Brought Forward	587	5	3						
Received during the year	3,275	2	0	3,862	7	3	2,627	14	0
(ii) High Polymer Expenses during the year		4,567	10	9					
Less Brought Forward	193	6	9						
Received during the year	2,307	8	0	2,500	14	9	2,066	12	0
(iii) Thermodynamic Properties Expenses during the year		4,266	11	0					
Less Brought Forward	438	4	9						
Received during the year	2,270	0	0	2,708	4	9	1,558	6	3
<i>Closing Balances—</i>									
Imprest							1,050	0	0
In Hand including Cheques							1,23,399	1	0
At Imperial Bank of India on Current Account							3,26,183	4	11
At Bank on Building Maintenance Fund Account							45,000	0	0
							4,95,632	5	11

Rs. 36,56,112 7 4

INDIAN ASSOCIATION

Receipts and Payments Accounts for

RECEIPTS.	Rs.	As.	P.	Rs.	As.	P.
<i>To Opening Balance:</i>						
Imprest Cash	1,050	0	0			
At Imperial Bank of India on Current Account	4,89,356	1	3			
At Imperial Bank of India on Building Maintenance Fund A/c.	30,000	0	0	5,20,406	1	3
<i>Amount Receivable—</i>						
(a) Land & Buildings						
(Wrongly debited in the previous year to Government of India Grant-in-Aid Recurring)						
	1,00,000	0	0			
(b) Government of West Bengal						
Grant-in-Aid Non-Recurring						
	15,000	0	0			
(c) Government of India						
Contribution towards Dearness Allowance						
	17,000	0	0			
(d) Indian Journal of Physics						
	900	0	0	1,32,900	0	0
<i>Government of India—</i>						
Grant-in-Aid (Recurring)						
	3,98,000	0	0			
Grant-in-Aid (Development Scheme)						
	19,365	2	0			
Grant-in-Aid (Non-Recurring & Equipment)						
	1,35,000	0	0	5,52,365	2	0
<i>Grant-in-Aid for enhanced cost of Land Assessment—</i>						
Government of India						
	90,378	0	0			
Government of West Bengal						
	45,188	0	0	1,35,566	0	0
<i>West Bengal Government—</i>						
Grant-in-Aid (for publication of History of Science)						
	13,500	0	0			
Grant-in-Aid (Construction— Workshop)						
	10,000	0	0	23,500	0	0
<i>Miscellaneous—</i>						
Interest on Investment (General Fund)						
	495	0	0			
Ordinary Membership Subscription						
	1,405	0	0			
Rent						
	55	0	0			
Indian Journal of Physics						
	7,870	2	2			
Life Membership Fees						
	6,000	0	0			
Miscellaneous						
	491	8	0	16,316	10	2
<i>Contribution from M.L.S. & V.L.M. Funds</i>						
				8,420	0	0

Carried Over Rs. 13,89,473 13 5

FOR THE CULTIVATION OF SCIENCE

the year ended 31st March 1954.

PAYMENTS.	Rs.	As.	P.	Rs.	As.	P.
<i>By Establishment:</i>						
Department of General Physics, X-Ray & Magnetism ..	26,898	1	0			
" " Optics ..	30,197	6	0			
" " Theoretical Physics ..	22,894	2	0			
" " Physical Chemistry ..	30,528	12	0			
" " Organic Chemistry ..	32,890	2	0			
" " In-organic Chemistry ..	28,972	3	0			
Library ..	6,329	14	0			
Workshop ..	19,255	10	0			
Administration ..	38,202	3	0			
Director's Office ..	30,110	0	0	2,66,278	5	0
<i>Contribution to Provident Fund ..</i>					11,443	0 0
<i>Laboratory Grants—</i>						
General Physics, X-Ray & Magnetism (Recurring)						
Laboratory Charges	3,083	12	0			
Scientific Instrument	3,134	1	0			
				6,217	13	0
General Physics, X-Ray & Magnetism (Special)						
Laboratory Charges	Nil.					
Scientific Instrument	1,885	1	0	1,885	1	0
					8,102	14 0
Optics (Recurring)						
Laboratory Charges	3,401	8	9			
Scientific Instrument	3,680	8	6			
				7,082	1	3
Optics (Special)						
Laboratory Charges	263	2	0			
Scientific Instrument	Nil.			263	2	0
					7,345	3 3
Theoretical Physics (Recurring)						
Laboratory Charges	137	15	9			
Scientific Instrument	1,772	9	6			
				1,910	9	3
Theoretical Physics (Special)						
Laboratory Charges	Nil.					
Scientific Instrument	Nil.			Nil		
					1,910	9 3
Physical Chemistry (Recurring)						
Laboratory Charges	5,244	2	9			
Scientific Instrument	322	8	3	5,566	11	0
Physical Chemistry (Special)						
Laboratory Charges	Nil.					
Scientific Instrument	Nil.			Nil		
					5,566	11 0
Organic Chemistry (Recurring)						
Laboratory Charges	5,871	11	6			
Scientific Instrument	135	5	0	6,007	0	6
Organic Chemistry (Special)						
Laboratory Charges	5,871	11	6			
Scientific Instrument	2,468	7	3	8,213	11	6
					14,220	12 0
				Carried Over Rs.	3,14,867	6 6

OF SCIENCE **INDIAN ASSOCIATION**

Receipts and Payments Accounts for

RECEIPTS.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward				13,89,473	13	5
<i>Council of Scientific & Industrial Research Grant for</i>						
Construction of Osmometer for High Polymer Research	2,307	8	0			
Construction of Light Scattering Apparatus	3,275	2	0			
Thermodynamic Properties on High Polymer	2,270	0	0	7,852	10	0
<i>Provident Fund Subscription</i>				12,464	7	0
<i>India Government Contribution towards Dearness Allowance</i>				19,900	0	0
<i>M. L. S. Professorship Fund</i>				4,250	0	0
<i>C. S. I. R. Employees' Provident Fund (Net)</i>				181	3	0
<i>Advances (Net)</i>				742	1	9
				Carried Over Rs. 14,34,864 3 2		

Carried Over Rs. 14,34,864 3 2

FOR THE CULTIVATION OF SCIENCE

the year ended 31st March 1954.

PAYMENTS.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward				3,14,867	6	6
In-organic Chemistry (Recurring)						
Laboratory Charges	4,531	0	3			
Scientific Instrument	1,934	0	0			
				6,465	0	3
In-organic Chemistry (Special)						
Laboratory Charges	15	11	3			
Scientific Instrument	165	0	0	180	11	3
					6,645	11 6
<i>Laboratory Grant</i> (Non-Recurring— Equipment)						
General Physics, X-Ray & Magnetism ..				2,265	15	0
Optics				14,975	12	9
Theoretical Physics				Nil.		
Physical Chemistry				11,301	12	0
Organic Chemistry				1,157	0	6
In-organic Chemistry				15,702	12	6
					45,403	4 9
<i>Laboratory Grant</i> (Government of West Bengal)						
In-organic Chemistry					1,077	8 9
<i>Library Grants</i> (Recurring)						
Books & Periodicals	17,269	0	0			
Upkeep	1,180	12	3			
				18,449	12	3
<i>Library Grants</i> (Special)						
Books & Periodicals				Nil.		
Upkeep				Nil.		
					18,449	12 3
<i>Library Grant</i> (Government of West Bengal) Books						
.. .. .					2,046	11 3
<i>Workshop Grant</i> (Recurring)						
Workshop Charges	1,808	6	0			
Instruments	3,829	15	0			
				5,638	5	0
<i>Workshop Grant</i> (Special)						
Workshop Charges				Nil.		
Instruments	52	0	0	52	0	0
					5,690	5 0
<i>Indian Journal of Physics</i>						
Publication Expenses				12,222	3	9
Establishment				5,927	0	0
					18,149	3 9
<i>Contribution to Indian Science News Association</i>					1,000	0 0
				Carried Over Rs.	4,13,329	15 9

FOR THE CULTIVATION OF SCIENCE

the year ended 31st March 1954.

PAYMENTS.	Rs.	As. P.	Rs.	As. P.
Brought Forward			4,13,329	15 9
<i>Miscellaneous</i>				
Electric Fittings	3,067	0 6		
Sanitary & Gas Fittings	698	6 0		
Gas Charges	3,392	12 0		
Electric Charges	8,923	8 9		
Telephone	1,260	6 0		
Printing	2,518	3 3		
Stationery & Contingency	5,808	5 6		
Postage	1,410	10 6		
Advertisement	1,677	7 0		
Municipal Tax	1,230	1 6		
Travelling Allowance for attending meetings	1,664	14 3		
Bank Charges	63	15 0		
Insurance	791	14 0		
Meeting Expenses	271	12 0		
Miscellaneous	4,949	8 6		
Motor Van Upkeep	5,919	7 6		
Provision for Higher Salary & Leave Allowances	4,498	12 0		
Audit Fees	750	0 0		
Indian Science Congress Association	12	4 0	48,919	4 3
Land Acquisition			94,440	11 9
<i>History of Science—Publication Expenses—</i>				
Furniture & Fittings			5,340	7 3
Laboratory Fittings			11,429	5 9
			235	13 0
<i>Construction</i>				
Construction Expenses	82,483	4 0		
Addition to 1st floor	51,336	14 9		
Earth Filling	234	0 0		
Street Lighting	1,900	0 0		
Lift	11,658	1 6		
Lavatory & Bath Room on the 2nd floor	1,500	0 0	1,49,112	4 3
<i>Suspense (Net)</i>			13,121	3 3
<i>Council of Scientific & Industrial Research</i>				
<i>High Polymer:</i>				
Staff	4,307	12 0		
Contingency	259	14 9		
Equipment	Nil.			
	4,567	10 9		

Carried Over Rs. 7,35,929 1 3

FOR THE CULTIVATION OF SCIENCE

the year ended 31st March 1954.

PAYMENTS.	Rs.	As.	P.	Rs.	As.	P.
Brought Forward				7,35,929	1	3
Light Scattering:						
Staff	4,431	15	0			
Contingency	995	0	3			
Equipment	1,063	6	0			
				6,490	5	3
Thermodynamic Properties:						
Staff	3,567	8	0			
Contingency	699	3	0			
Equipment	Nil.			4,266	11	0
				15,324	11	0
<i>Provident Fund Subscription</i>				12,414	7	0
<i>M.L.S. Professorship Fund</i>				4,350	8	0
<i>Development of Research Training Facilities</i>						
General Physics, X-Ray & Magnetism:						
Establishment	5,205	8	0			
Laboratory Charges	Nil.					
Equipment	Nil.					
Contingency	Nil.					
				5,205	8	0
Optics:						
Establishment	3,988	15	0			
Laboratory Charges	Nil.					
Equipment	Nil.					
Contingency	Nil.					
				3,988	15	0
Physical Chemistry:						
Establishment	3,524	7	0			
Laboratory Charges	Nil.					
Equipment	Nil.					
Contingency	Nil.					
				3,524	7	0
Organic Chemistry:						
Establishment	7,862	4	0			
Laboratory Charges	Nil.					
Equipment	Nil.					
Contingency	Nil.			7,862	4	0
				20,581	2	0
<i>Erection of Transformer</i>				132	0	0
<i>Repayment of Loan from Government of India</i>				1,50,000	0	0
<i>Contribution to Association Canteen</i>				500	0	0
<i>Closing Balance</i>						
Imprest			1,050	0	0	
In Hand including Cheques			1,23,399	1	0	
Imperial Bank of India on Current Account			3,26,183	4	11	
At Bank on Building Maintenance Fund Account			45,000	0	0	
				4,95,632	5	11
				14,34,864	3	2

G. BASU & CO.,
 CHARTERED ACCOUNTANTS
 AUDITORS.

RECEIVED IN THE OFFICE OF THE DIRECTOR OF SCIENCE EDUCATION
 UNIVERSITY OF DELHI
 15/04/54
 1954

STATEMENT SHOWING THE BREAK-DOWN OF CONSTRUCTION EXPENDITURES FOR THE YEARS 1948 TO 1954.

ITEMS	As on March 31, 1949	As on March 31, 1950	As on March 31, 1951	As on March 31, 1952	As on March 31, 1953	As on March 31, 1954	Remarks	
A. Construction Expenditure:—								
1. Main Research Building ground floor, Assembly Hall, Library and Central Tower	33,672	6,33,342	—	—	7,16,752	7,63,544 15 3	* Based on approved estimates.	
2. Workshop 1st and 2nd bay	—	—	—	—	36,774*	38,312 15 0		
3. Cryogenic Laboratory	—	—	7,78,151	7,97,551	12,500*	12,500 0 0		
4. Transformer House	—	—	—	—	4,000*	4,000 0 0		
5. Pump & Filter House	—	—	—	—	20,000*	20,000 0 0		
6. Gate Keepers' Lodge	—	—	—	—	5,000*	5,000 0 0		
7. Culverts & Compound Wall	—	—	—	—	—	—		
8. Roads, Surface drains, earth filling and general development	—	—	—	—	29,000*	29,234 0 0		
9. Remuneration to Messrs. Martin Burn and Labour for above work @ 12½% profit	—	35,408	1,22,792	1,34,346	2,19,263**	2,43,898 9 0		**This includes labour and remunera- tion for main build- ing and re- munera- tion for the starred items of work.
10. Sweepers quarters (departmently done)	—	—	—	—	5,000	5,000 0 0		
11. Store Room	5,244	5,244	5,244	5,244	5,244	5,244 0 0		
12. Fencing and fixing	19,990	20,768	20,768	20,768	20,768	20,768 0 0		
13. Electrical fittings, installations, cable laying etc.	—	1,151	41,379	97,124	1,16,665	1,21,254 13 9		
14. Transformer, Rectifier etc. Do Erection	—	12,364	12,364	24,728	43,144	47,644 0 0		
15. Sanitary & Gas fittings	—	11,885	44,897	48,727	62,933	68,732 10 0		
16. Tube Well	—	621	2,621	4,177	4,177	4,177 0 0		
17. Water Softner Plant	—	—	9,013	9,013	10,925	10,925 0 0		
18. Laboratory Fittings & Furniture	—	—	—	29,237	60,013	1,03,104 6 0		
19. Electric Passenger Lift	—	—	—	—	15,760	28,063 10 0		
20. Vehicle Do Petrol etc.	—	9,330	9,330	9,330	9,330	9,330 0 0		
21. Messrs. Chaudhuri & Guha's remuneration	—	5,000	10,000	15,000	23,000	27,200 0 0		
22. Establishment	—	10,233	20,763	26,254	26,254	26,254 0 0		
23. Miscellaneous	3,990	6,602	9,112	22,518	25,622	27,048 5 3		
	62,896	7,51,948	10,86,434	12,45,983	14,90,472	16,39,584 4 3*	Less adjust- ment Rs. 970-6-6.	
B. Land Acquisition	4,34,557	4,34,557	4,34,557	4,34,567	4,34,767	5,29,207 11 9		
C. Security Deposit with Calcutta Electric Supply Corporation	—	—	1,800	1,800	1,800	1,800 0 0		
	4,97,453	11,86,505	15,22,791	16,82,350	19,27,039	21,70,592 0 0		

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