(four papers, also five papers combined with section 1); (3) physical chemistry and chemistry of magmas, volcanic waters and volcanic gases (eighteen papers); (4) palæovolcanology and plutonism (fourteen papers).

Altogether fifty-five contributions were submitted to the Association from fourteen countries, distributed as follows: U.S.S.R. 15, United States 8, France 6, Japan 6, Australia 4, Great Britain 4, Belgium, Italy, Portugal and Switzerland 2 each, India, Mexico, Netherlands and Norway 1 each. Of these contributions forty-three were read and discussed. In addition, two papers on lunar volcanoes were submitted. Prof. A. Rittmann's presidential address dealt with the geochemistry of basalts and the mechanism of their eruption. The national reports on recent volcanic activity were contributed by Australia, India, Japan, Mexico, United States, U.S.S.R.

Several joint symposia also were held on the subjects of: (1) isotope geology and experimental petrology; (2) the age of minerals, Pre-Cambrian rocks and meteorites; (3) island arcs and the ocean floor.

Two discussions were held under the combined auspices of the International Association of Volcanology, the International Association of Seismology and the Geochemical Commission of the International Union of Pure and Applied Chemistry, on the question of the position of geochemistry within the International Union of Geodesy and Geophysics and other international scientific unions. As a result, a request was made to the Council of the International Union of Geodesy and Geophysics for the establishment of an *ad hoc* committee on 'Geochemical Problems'. The function of the committee would be: (1) to arrange meetings in the field of geochemistry under the auspices of the committee, or under the joint sponsorship of the committee and other sections of the Union; (2) to promote the furtherance of geochemistry by investigating the possibility of a relationship between the International Union of Geodesy and Geophysics, the International Union of Pure and Applied Chemistry, and any other international body in the field of geology which may be formed.

During the Assembly two volcanological colour films of outstanding interest were shown, illustrating a spectacular basaltic eruption in Hawaii, and also the remarkable achievements of the Belgian expedition which recently studied the lake of molten lava far down in the crater of the Congolese volcano Nyiragongo.

The president, Prof. A. Rittmann (Catania University), announced a decision, taken jointly by the Department of Volcanology of Catania University in Sicily and the Belgian National Centre of Volcanology, to explore the possibility of creating an International Institution for Volcanological Research in Catania, close to Etna.

The Association expressed approval of the Executive Committee's plan to hold two symposia before the next General Assembly, the first to be on the formation of ignimbrites, hyaloclastites and related deposits, and to be held in Catania during October 1961, and the second on the prediction of time and place of volcanic eruptions and the relationship between magmas and the nature of volcanic eruptions, to be held in Tokyo (Japan) during May–June 1962.

The Association also approved the proposal that a *Bulletin of Volcanic Eruptions* should be instituted. Such a publication, recording briefly current volcanic phenomena, should appear up to four times a year, and it should be distributed to National Sub-Committees for Volcanology and to certain individuals. It is anticipated that the Volcanological Society of Japan will agree to undertake and finance publication and distribution.

Office bearers for the triennium 1960–63 were elected as follows: *president*, Prof. A. Rittmann (Switzerland); *vice-presidents*, Prof. V. I. Vlodavetz (U.S.S.R.) and Mr. Gordon A. Macdonald (United States); *secretary*, Prof. F. Penta (Italy); *chairman of Section I*, Dr. M. Neumann van Padang (Netherlands); *chairman of Section II*, Dr. G. S. Gorshkov (U.S.S.R.); *chairman of Section III*, Prof. H. Kuno (Japan); *chairman of Section IV*, Prof. B. Gèze (France).

UNIVERSITY DEVELOPMENT IN BRITAIN

THE statement issued by the Association of University Teachers on the problems of university development is one which should be carefully studied by all who are concerned with policy-making in this vitally important field*.

The Association is concerned about the arbitrary way the University Grants Committee has recommended that university expansion should cater for two scientists against one entrant for all other faculties, including medicine and agriculture, and asks that this matter be reconsidered.

Agreeing with the University Grants Committee's estimate that the number of university students in Britain by 1970 should be about 170,000, the Association believes that present standards of entrance to the university should be maintained, and is of the opinion that there should be sufficient applicants of quality to maintain that standard for at least 170,000 places, and that this figure may have to be exceeded.

To cater for the additional 70,000 students for whom places will have to be found in the next ten years, a major operation will be required. This can be done by increasing the size of existing universities or by founding new ones. Recognizing all the attendant dangers to institutions which grow too large, the Association recommends that at least six new universities should be started during the next two years.

The arguments for new universities are strong. Their building cost can be shown to be no greater than that of expanding existing universities, while the difficulty and cost of acquiring land must be less. The contribution that they can make in terms of variations in teaching methods and added range of research is considerable. There should be a deliberate

* "Some Problems of University Development". Pp. 7. (London: Association of University Teachers, 21 Dawson Place, W.2, 1960.) 1*s*. 6*d*.

policy of preserving the pattern of university life to be found in the smaller and medium-sized universities; this cannot be achieved without creating new universities.

It has been argued that because new universities have to be created and built, no appreciable contribution can result during the next decade. The Association believes that this depends on the urgency of the approach to the problem.

The Association makes a clear recommendation that new universities should be planned from the beginning for what is regarded as their likely size. Thus, a university planned for 3,000–3,500 should start with the appropriate building plans, which may be phased but should not require subsequent revision. A maximum of 4,500 should leave ample scope for later expansion to accommodate whatever specialism an individual university may adopt. The new campus should be built with all the buildings going up simultaneously. The intake in each of the first three years might be 750–800 undergraduates, building up in the three following years to 900, leaving the balance for postgraduate places. To do this requires an approach to planning and construction comparable with large industrial organizations.

The planning of the university itself as a centre of research and learning should be approached in an equally dynamic fashion. There is no time for a consultative committee to work out the charter for each university and its range of subjects. The experience gained in the creation of universities in North Staffordshire and at Brighton should be drawn on immediately, and a draft charter should be devised for each university which would be expressed in terms allowing a flexible approach by the universities concerned, and each such charter should be revised at the end of ten years.

To meet the urgency of the situation, it is suggested that the vice-chancellor, the deans of faculties, the librarian and the senior administrative officers be appointed immediately the university is created, the heads of departments should be appointed eighteen months before the first students are admitted, and other staff should be recruited during the ensuing period. An approach of this nature would enable a university to open its doors four years after the decision to create it, and seven years from the decision being taken one could expect to find 2,500 students in residence, and 3,000 ten years later. If this procedure were followed for six or more new universities, there would be a solution to the likely balance of demand before the end of the 1960's.

The Association believes that the new universities should be located in towns with not less than 50,000–100,000 population. They should be broadly based, and not of the character of either a liberal arts college or a two-faculty university. There should be opportunities for the individual development of rarer faculties. In each there should be found arts, social science, science and applied science. The applied sciences should be linked with the region in which the university is established.

GENERAL RELATIVITY AND LORENTZ-INVARIANT THEORIES OF GRAVITATIONS

By Dr. G. J. WHITROW and Dr. G. E. MORDUCH
Department of Mathematics, Imperial College of Science and Technology, London

DESPITE the initial successes of Einstein's general theory of relativity, attempts to produce a satisfactory Lorentz-invariant theory of gravitation have persisted until the present day. The three well-known Einstein tests are all obtained from the Schwarzschild metric, that is the general relativity solution of the one-body problem. There has been no direct confirmation of the field equations of the theory; but in time it should prove possible to test the results of the two-body problem in the theory as far as terms of order $1/c^2$.

Although more cogent in its æsthetic and general intellectual appeal than rival theories, general relativity is not unique in the results it predicts for the motion of perihelion, deflexion of light-rays and gravitational red-shift in the one-body problem. The same results are obtained in some Lorentz-invariant theories of gravitation. No general analysis has previously been made of these theories, nor have the results predicted by them been systematically compared with the corresponding formulæ derived from general relativity. We have therefore recently made a thorough review of Lorentz-invariant theories, and the details of our analysis will be published later. It is the object of the present communication to present our principal conclusions.

We have considered seven possible tests in all: the three well-known tests obtained for the one-body problem; the secular acceleration of the centre of mass and the advance of periastron in the two-body problem; and the two additional effects introduced into the one-body problem when the axial rotation of the central body is taken into account. The formulæ for these effects have all been obtained previously in general relativity, at least to order $1/c^2$. Corresponding formulæ for some of these effects have previously been obtained in some Lorentz-invariant theories. We have derived the required formulæ for all the theories that we have considered.

Before setting out the comparative tables of results, we must explain our method of classifying Lorentz-invariant theories, which includes some not previously discussed. Attention is, of course, restricted to theories which satisfy the condition that they reduce to the Newtonian form when c is replaced by infinity. (The basic reason for seeking to replace the Newtonian theory of gravitation is that the theory is applicable only when c can be taken as effectively infinite.) First we consider in turn theories in which the gravitational potential is (i) a scalar, (ii) a vector and (iii) a second-order tensor.