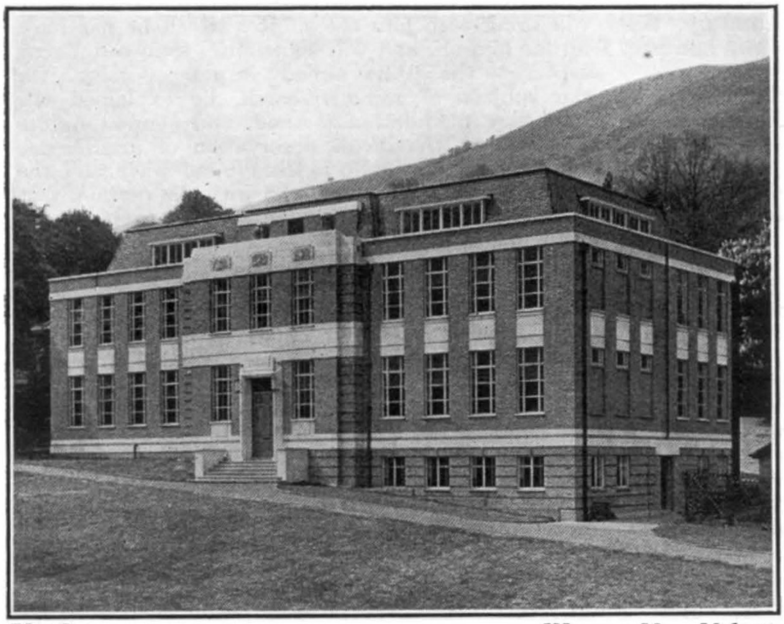
from panels concealed in the plaster of the ceiling. Ample fume-cupboards, worked by suction-fans on the roof of the building, are provided. There is a vacuum installation with fourteen points in the different rooms and a hot-water supply to certain sinks.

The advanced chemistry room has desk accommodation for twelve and is to be used both for practical work and for lecturing to small classes of senior boys. There is a glass-working table and a large ventilated combustion-hood, fittings which are also present in the large Fifth Form laboratory. The elementary laboratory has desk accommodation as well as bench space for twenty-four boys. The lecture room has a fume-cupboard, an epidiascope and a fixed mirror-galvanometer with ground-glass scale, the leads being taken to terminals on the lecture bench.



Photo] [*Norman May, Malvern*
PRESTON SCIENCE SCHOOL, MALVERN COLLEGE.

The first floor is intended for the teaching of physics. There are three teaching laboratories, an optical dark room, a photographic dark room which is very fully equipped, a workshop with rectifier plant, a smaller lecture room and a room for storage on this floor. The lecture room has an equipment similar to that of the room on the floor below, except that in addition there is a transformer for supplying an alternating current arc. The advanced laboratory has slate shelves built into the walls for supporting instruments which must be protected from vibration, and a beam is built into the angle of the walls for Young's modulus experiments. All the physics rooms have a variety of benches and tables to which gas, electric light and power are supplied. The surfaces of the tables are free from taps or any other obstruction.

The second floor has four rooms in all, two of which are designed for the teaching of biology. One of them is fully equipped for lecturing and dissection, there being a particularly useful device for washing and cleaning dissecting boards. The other room is arranged primarily for botanical work. These two rooms are connected by a small preparation and store room. A third room on this floor contains four aquaria, a large sink, working benches, drawers, shelves and bookcases ; it is to be used by boys interested in natural history, for arranging, investigating and storing their specimens. The remaining room, which is furnished as a library, contains about six hundred scientific books and many periodicals.

The architects of the building were Messrs. George Hubbard and Son, of 45 New Bond Street, London, and the fittings were designed by Messrs. Munby and Smith, of 9 Old Square, Lincoln's Inn, London.

The Structure of Benzene*

FOR many years attempts were made to explain the peculiarities of aromatic compounds by making various special hypotheses relating to the benzene nucleus. It is a satisfactory feature of the present situation that the theory of benzene is simply a special—and specially important—case of an established general extension of valency theory, and that this extension uses essentially the same physical principles as are applied in the interpretation of valency itself. These are the postulates of the 'new' quantum theory (fundamentally the principle of complementality), which provide at once a physical basis for the forces of valency, and for such departures from the ordinary valency rules as are illustrated so strikingly in the parent of the aromatic series.

From an experimental point of view, we are concerned to establish the correct stereochemical model for benzene, and to discover, also in a quantitative way, as much as possible about the internal forces which maintain that model. Theory creates a predilection for a model of plane, regular hexagonal symmetry, because theory works out most simply if such a model be first assumed. The available experimental methods for the determination of a molecular model are (1) by X-ray or electron interferometry, (2) from rotation-vibration or vibration-electronic spectra. The interferometric method indicates the plane, regular model to a rather close degree of approximation, but the spectroscopic method, which is particularly sensitive, and eminently suitable for application to this problem, was at first claimed to establish a contrary conclusion. For this

* Substance of the Bakerian Lecture to the Royal Society, delivered by Prof. C. K. Ingold, F.R.S., on June 16.

reason, and also because the spectroscopic method, by giving vibration frequencies, supplies direct information about the internal forces, this method has been recently pursued by Angus, Bailey, Wilson and others; and it has been employed in relation not only to ordinary benzene, but also to benzenes in which a part or the whole of the hydrogen is present in the form of deuterium.

This use of deuterium greatly increases the amount of information obtainable from the spectra; for isotopic substitution leaves the whole force-system of the molecule unchanged, wherefore the vibrations which are responsible for the observed frequencies can be identified by comparing the frequency shifts caused by isotopic substitution with those calculated from the known changes of atomic mass under the assumption of unaltered forces (Teller). Four spectra are studied: Raman scattering, infra-red absorption, ultra-violet fluorescence, and ultra-violet resonance emission. All give information concerning the molecular form and vibrations of the ground state of the molecule. Five benzenes have been examined moderately completely, whilst two others (formulæ in parentheses) are under examination: C_6H_6, C_6H_5D, $1:4$-$C_6H_4D_2$, $1:3:5$-$C_6H_3D_3$, ($1:2:4:5$-$C_6H_2D_4$), (C_6HD_5), C_6D_6.

By a comparison of frequency shifts and other spectroscopic characteristics amongst the spectra of these compounds, the frequencies of a large number of vibration-forms have been identified. From this information, with the aid of spectroscopic rules which depend ultimately on a consideration of the physical mechanism of production of the various spectra, it is possible unequivocally to establish the plane, regular model for the isolated (gaseous) benzene molecule. The previously claimed contrary indication is explained as due to the use (or accidental presence) of liquid, wherein the intermolecular forces are sufficient to deform the molecules to a spectroscopically significant extent. An approximate specification of the internal forces could be made at present, but in order to render such a specification complete with respect to harmonic forces, we require further identified frequencies, wherefore the extension involving $C_6H_2D_4$ and C_6HD_5 is necessary.

A Stone Age Rock-Shelter in South Africa

OAKHURST rock-shelter, situated in an enclosed valley on a farm thirteen miles east of the town of George, Cape Province, South Africa, four miles from the Indian Ocean, and two from the coastal lakes, has been excavated by Mr. A. J. H. Goodwin (*Trans. R. Soc. S. Africa*, 25, 3; 1938). Between February 1932 and February 1935, six visits were paid to the cave, varying in duration from a month to a week, during which the excavation was carried out.

The shelter, which is some sixty feet in length and about twenty-five feet deep at surface level, is divided into two parts. Of these, the inner is separated from the outer and southern portion by a hanging buttress of rock. There is a talus on the southern and eastern sides. The inner portion of the shelter has been left undisturbed for future examination. It is anticipated that much richer deposits will be found here, judging from the midden material which had washed out under the buttress. The outer portion has been excavated down to the base of the deposits. These were of considerable thickness, the total depth excavated being one hundred and twenty-six inches.

The shelter is situated in a dense forest, about twenty feet above a stream in a high sandstone overhanging cliff of schistose quartz-bearing sandstone. It is approached by an old elephant path. Nearby were rock paintings in red, partially obliterated and not clear enough to photograph, and game pits.

A large amount of skeletal material was found in the deposits. The bones had been much disturbed by root action; while digging for subsequent interments had frequently interfered with earlier burials. It was, therefore, possible to distinguish with certainty eighteen graves only. There had been many more, but the contents were commingled, and at times it was difficult to distinguish grave furniture from introduced material. The skeletal remains had also suffered much from the pressure of gravestones. The greater number of burials occurred at a depth of between fifty and sixty inches from the surface, while a space of some seven by five feet included more than half the graves. As the later people buried at a depth of thirty inches, and the earlier at a depth of fifteen inches only, the graves for the most part occurred at approximately the same level.

The major part of the deposits consists of decayed vegetable matter with a high percentage of wood ash. In addition there are vast quantities of shell present throughout the deposit, this in the upper layers constituting a great part of the bulk. Until the deposits had been built up to some height the shelter could not have afforded much protection against the weather. Hence in the early layers there is evidence of temporary occupation only—the remains of one-night fires and burnt bones. With the advent of Smithfield *B* man, occupation takes on a more permanent character. The prevailing stone used by all the occupants of the cave was white quartz, probably from a vein of quartz, one hundred yards away, which has been quarried. Chalcedony and agates were also used, brought from neighbouring beaches.

The uppermost three feet of the deposit consists generally of Wilton material. In the top nine inches only was pottery, below this at a depth of thirty-six inches was a normal Wilton culture, in which stone crescents in white quartz and chalcedony are common. Following this short normal phase (that is, above it), comes a long period in which shell crescents (*Mytillus edulis*), the first shell implements to be described in South Africa, take the place of stone. Apart from this diversion from stone to shell, there is little change, save for the addition of pottery in the latest phase.

Among the ornaments nacre was rare; but vast numbers of ostrich-shell beads were retrieved. In addition there was a single cowrie shell, and a number of naturally bored shells had been brought to the cave, presumably for ornaments. A hippopotamus tusk and one ivory bead were found, as well as