hexahydro-benzol in bulk, by hydrogenation of benzene, is as yet in its infancy, but has a certain future owing to the utility of the product as a volatile fuel for internal-combustion engines. The fact that it is a single compound gives it marked advantages over petrol as a fuel for air transit, since the variability of petrol is a distinct drawback in the case of a fuel upon which such rigorous demands are necessary.

The development of the fine chemical industry in this country involves also an extended use of catalytic reactions. The successful production of synthetic indigo was facilitated by the discovery of the catalytic acceleration of the oxidation of naphthalene by mercuric sulphate, discovered owing to the breakage of a thermometer bulb in the reaction mixture. The production of dye intermediates involves, more and more, the aid of catalysis. Especially, however, in the large-scale preparation of solvents will catalysis contribute convincingly to success. Industrial alcohol may be cited in illustration. Every method by which this important solvent is produced is catalytic. The ordinary process of fermentation and distillation involves the participation of the living catalysts, the enzymes and ferments. The production of alcohol from potato and rice starch is a combined process of hydrolysis and fermentation with the catalytic action of acids followed by enzymes. Similarly, alcohol of the future will be obtained by catalytic degradation of the cellulose content of wood waste, or, synthetically, from acetylene and ethylene, by processes of catalytic hydration and hydrogenation. The potentialities of alcohol as a fuel in the future must not be forgotten, in view of the increasing consumption and prospective exhaustion of oil-fuel reserves. In the meantime these latter, as a result of more rigid scientific control, are being more economically utilised. The "cracking" of oils to yield the more volatile fractions usable in motor-engines is a modern development, the catalytic features of which have not, as yet, been completely realised.

From alcohol as starting-point, catalysis is involved in the production of acetic acid and acetone, the solvents largely required in the preparation of aeroplane dopes and varnishes. From methyl alcohol, a distillation product of wood, catalytic oxidation or dehydrogenation in presence of metallic copper yields formaldehyde, a powerful germicide and disinfectant, and itself the starting-point in the manufacture of bakelite, the artificial vulcanite or amber, a polymerised product formed under the influence of catalytic agents, and increasingly produced for use in electrical insulators and for fancy articles. The demand for formaldehyde is already so great that investigations are in progress with the object of production from sources other than methyl alcohol. The hydrocarbon methane has been suggested in this connection. A process of fractional oxidation of methane should yield formaldehyde. Alcohols and organic acids of varied complexity may be largely utilised in the production of synthetic essential oils and perfumes by processes of catalytic condensation.

The catalogue is not exhaustive, but sufficient has been said to show the paramount importance of catalysis in modern chemical industry. It is evident, therefore, that the modern curriculum of theoretical chemistry should concern itself largely with the scientific principles involved in catalytic reactions. An extended experience with catalysis, both pure and applied, has demonstrated that, from a complete realisation of the theoretical aspects of the problem, progress in the application follows the more rapidly and the more certainly. It is astonishing to note the facility with which new progress is attained by the employment of the scientific principles which have been acquired in a totally different application of catalysis to industrial progress. The records of certain of the Government Departments of investigative work, during the last few years, would be instructive in this regard. The need, therefore, is urgent for a well-trained force of young students, versed in the fundamentals of this modern branch of chemistry, and equipped to take their place in the further developments which lie so close at hand. There are manifold possibilities ahead—numerous processes and agencies catalytic awaiting the facile brain and hand of the investigator.

HUGH S. TAYLOR.

## *FROSTS AND AGRICULTURE IN THE UNITED STATES.*

THE United States Department of Agriculture has recently issued a publication on "Frost and the Growing Season." This consists of a series of maps in colours and some diagrams from which the probable date of the last frost in spring and the earliest in autumn may be seen at a glance. An article on a paper by Mr. W. G. Reed on this subject appeared in the issue of NATURE for May 23, 1918, and the present publication is also by the same author.

Frosts are divided into three classes: "light," "heavy," and "killing." The first two terms apply to the amount of the deposit in the form of hoar-frost; the last only is dealt with in the paper, and is defined on an occasion on which the screen temperature fell below 32° F. In a country like the United States there is naturally great variation in the length of the period that is free from frost; not only is there variation in latitude from Florida to the Canadian border, but there is also much difference in the height above mean sea-level. The local topography is also important, for while, in general, frost is more prevalent at the greater altitudes, yet locally a small elevation will prevent a frost, and in enclosed valleys the hill-sides and the hill-tops may be less subject to frosts than the valley bottoms.

Frost records are available from about four thousand regular stations of the Weather Bureau, and of these about six hundred have a twenty years' record. The most noteworthy feature of the

critical frost dates is their extreme irregularity. Thus at Peoria, Ill., with a fifty-nine years' record, the latest frost in spring covers a period of nearly fifty days, and the earliest in autumn a period of forty days. The maps are based upon the average dates.

The mountainous character of the country in the western portion of the United States, and the fact that the stations are mostly situated on the lower slopes of the mountains, make mapping very difficult, and it is pointed out that only a general idea of the conditions can be given. For practical purposes this position of the stations should not matter, as they would naturally be in those parts where cultivation was most prevalent.

It appears from the maps that there is no part of the United States except Key West where a frost may not occur, and the line showing a frost in half the years—that is, the line showing the position where a frost is just as likely to occur once in the winter as not to occur—excludes only a small part of Florida and reaches down to latiture 26° N. The line for the last frost before March 1 cuts off the peninsula of Florida and fringes the southern coast as far as New Orleans. In the north frosts are common until the middle of May or even June 1, and in the higher parts of the west, which are only used for grazing, they occur after June 1.

The earliest frost in autumn does not occur until after December 1 in Florida and in parts of the south-west. On the north-western frontier frost may be expected about the middle of September. About one-quarter to one-third of the whole country has a period of 210 consecutive days free from frost, but in the mountainous regions of the west there is a good deal of country in which the period is barely half as long.

Some smaller maps give information as to the frequency of frosts in the different districts one, two, or more weeks before or after the average dates. The whole paper is most interesting, and should be very useful to agriculturists in the United States. W. H. D.

## NOTES.

THERE was a certain inevitableness in the nomination of Mr. Arthur James Balfour for the Chancellorship of Cambridge University. The fact that Mr. Balfour has consented to be so nominated in succession to his late brother-in-law has everywhere been received with enthusiasm. In the history of Cambridge, statesmen, administrators, literary men, and philosophers have succeeded one after another in the roll of Chancellors, but in Mr. Balfour, the most celebrated of living graduates of Cambridge University, all are combined in one man. Mr. Balfour is one of the two honorary fellows of Trinity College, the other being the Right Hon. G. O. Trevelyan. Mr. Balfour was educated at Eton, and entered Trinity College in the late 'sixties. He took his degree in the Moral Sciences Tripos of 1896, in the same year as Dr. Percy Gardner, now the professor of archæology at Oxford. The Balfour family has been most intimately associated with Cambridge; his younger brother Francis, who unhappily perished in the Alps in 1882, was a man of the highest scientific distinction, one who was leading zoologists along new lines of thought; another brother, Gerald, was a fellow of Trinity; one of his sisters married Prof. Henry Sidgwick, and was for many years Principal of Newnham College; and another sister married Lord Rayleigh, whose recent death has deprived the University of a generous Chancellor and a great pioneer in modern physics. A reference to "Who's Who" will show not only the list of honorary degrees, too long to be quoted here, which have been conferred upon Mr. Balfour, but also that he has constantly taken the lead on various boards and committees connected with education. He has been Lord Rector of St. Andrews University, Lord Rector of Glasgow University, and he is Chancellor of Edinburgh University. The announcement that so distinguished a man and scholar has consented to be nominated for the post of Chancellor has met with widespread sympathy and hope amongst the members of the Senate.

ENTOMOLOGISTS, it appears, have not yet solved the problem of what becomes of the house-fly in winter-time. The popular idea that when the cold season comes the house-flies, or such of them as do not die off, retire to some quiet nook or cranny in the house and, like dormice, sleep undisturbed through the winter is still entertained in some scientific and other respectable quarters, although no trustworthy evidence has been found to support it. There are flies and flies; and, as Dr. L. O. Howard was, we believe, the first to suggest, no evidence relating to the hibernation of the house-fly can be trusted until it has first been submitted to expert examination. Since that suggestion was made, a large amount of evidence has been submitted to experts, and now they are almost unanimously agreed that the hibernating house-fly is a wholly mythical creature. But the house-fly must get through the winter somehow, and if not in its perfect state as a fly, then in some other stage or stages of its life, or else we should not be troubled with the pestilent brood year after year in succession. Before the entomologist can tell us exactly how, it looks as if he will need the help of the sanitary officer, the stable-boy, the farm labourer, or even of the Boy Scout, rather than that of the ordinary householder. The search for larvæ and pupæ of the fly is not an easy one, and often involves a great amount of physical labour. In summer-time the pupæ are frequently to be found living at a depth of 2 ft. under the surface of the soil within half a yard of a manure heap. Dr. Gordon Hewitt has searched for them in such places, and in every other likely place, in winter-time, and has never succeeded in finding any alive. But because he, and possibly a few others, have made it and failed, it can scarcely be said that a search of that kind has been exhausted, and that we must fall back upon the hibernating adult fly as the only alternative. There may be no definite hibernating stage in the life of the fly. The insect may continue to breed in the winter, not exactly as it does in the summer or autumn, but at a greatly retarded rate, each stage being more or less prolonged. This probably does not happen to any extent under natural conditions in this country, but the number of places in which it can happen, and probably does happen, under special conditions may be quite sufficient to account for the perpetuation of the fly.

THE officers and other members of council of the Röntgen Society for the session 1919–20 are as follows:—*President:* Dr. Sidney Russ. *Hon. Secretaries:* Dr. Robert Knox and Dr. R. W. A. Salmond. *Hon. Treasurer:* Mr. Geoffrey Pearce. *Hon.*