

of compressions. Considering, then, gas and petrol engines as air engines, the theory is very simple. There are three symmetrical cycles of compression air engines. It is interesting to note that for equal compressions it does not matter whether Carnot cycle, constant volume, or constant pressure engines be used—the theoretical efficiency is the same. It has been found in practice that a first-class modern engine operating on the constant-volume cycle will give in indicated power 0.7 of the heat which a perfect air engine would give under the same conditions of compression, proportions, &c. Thus an engine having an air-engine efficiency of 0.5 will give indicated work  $0.5 \times 0.7 = 0.35$ , of all the heat given to it.

The air standard has proved its utility as a guide to the engineer for twenty-five years now, and has been adopted by a committee appointed by the Institution of Civil Engineers on the standards of efficiency in internal-combustion engines. To enable further progress to be made, however, it is now necessary to know more of the actual properties of the working fluid.

The earlier experiments made by the lecturer, and subsequent experiments made by Oliver in America, and by Messrs. Bairstow and Alexander in this country, were only in strictness applicable to the behaviour of highly heated gases in a closed vessel. No means of obtaining a cooling curve in an engine cylinder had been proposed.

At the beginning of 1905 the lecturer designed a new method, and made a considerable number of experiments on a 50-horse-power gas engine. By altering the valve arrangements of the engine so that when desired both inlet charge valve and exhaust valve can be held closed, diagrams were obtained from which a cooling curve was calculated.

In this method no gases are allowed to exhaust from the cylinder. The piston accordingly compresses the whole contents into the compression space, and the temperature which has fallen by expansion rises by compression. A point is touched on a vertical line from the end of the card. On expanding, a line below the first compression line is traced, then another compression line is obtained, and so on; a series of compression and expansion lines is obtained, each terminating under compression at certain specific points.

In this way a cooling curve is obtained which shows the real temperature drop upon the expanding and compressing lines. From this curve, by somewhat troublesome calculations, the mean apparent specific heat of the charge can be obtained for each expanding line. A curve of specific heats so obtained was shown.

These numbers give a very fair indication of the heat loss incurred in the cylinder, and the cooling curves show that for the whole stroke the mean temperature of the whole enclosing walls is about  $70^{\circ}$  C. when the water-jacket is cold and about  $200^{\circ}$  C. when the water-jacket is hot, but for the inner part of the stroke, the first three-tenths of the stroke, the mean temperature is much higher— $170^{\circ}$  C. when cold and  $400^{\circ}$  C. when hot.

This method of investigation gives a more accurate knowledge of the properties of the working fluid, so far as the thermodynamics of the engine are concerned, and it enables us to make an entire heat balance-sheet from the diagram only. Full-load diagrams taken from the engine have been examined by this method, and account for 105 thermal units, when the calorimeter shows 106 thermal units to be present. The method appears capable of very considerable accuracy.

Prof. Hopkinson has attacked the problem of heat loss to the closed vessel by another method, using a calorimeter by which the heat leaving the hot gases at any time is measured electrically, while at the same time the pressure is indicated. This arrangement promises to give important information as to the rate of loss in gaseous explosions, from which observations some deductions may be drawn as to specific heat and as to time of termination of combustion.

The lecturer is continuing investigations on various sizes of engines with a new form of optical indicator. An indicator card taken with this instrument was shown. The appearance of this indicator card is most interesting. There is slight discontinuity in the rising line, and just as maximum pressure is approached the indicator begins

to oscillate rapidly through a small distance. These oscillations continue all down the explosion stroke, die out gradually, and do not terminate until the end of the compression stroke. The period of the oscillations is about 600 per second; the amplitude gradually decreases until it has practically ceased at the end of the first compression.

The period of the indicator is about 200 to the second, so far as ordinary piston displacement is concerned. From this it follows that considerable pressure disturbances within the cylinder must have occasioned the oscillation. In this particular engine, the explosion is always accompanied by a peculiar whistling sound, which seems to start just about the time the diagrams show the beginning of the oscillations, that is, immediately after ignition. It is somewhat difficult to account for this peculiar action, but it appears to have some connection with the discontinuous nature of combustion of a mixture of inflammable gas or vapour with air. This was illustrated by an experiment in which inflammable mixture was ignited at the open end of a long tube. The flame travels back along the tube, accompanied at first by a low, roaring sound, which increases in intensity as the end of the tube is reached, terminating in a loud snap. When this occurs, the flame flashes back again, and there is obvious oscillation of some kind proceeding. It is not known why the mixture flame burns in this way, but this particular roaring or whistling seems to occur only when combustion is going on, and is noticed in all pressure flames in the open air. It appears highly probable, then, that wherever this oscillation goes on combustion is still proceeding.

Experiments have also been made by Messrs. Holborn and Austen on the specific heat of air and carbonic acid by an entirely different method, and there is reason to hope that as a result of experiments which are progressing in this country and on the Continent the whole question will be cleared up in the next few years in a satisfactory manner.

As one who has given thirty years' study to the practical and scientific problems involved in this matter, it is exceedingly gratifying to find a great and increasing interest in the subject which will lead to the complete investigation of the complex properties of the working fluid.

#### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. W. PEDDIE, lecturer in natural philosophy in the University of Edinburgh, has been appointed to the Harris chair of physics in University College, Dundee, in succession to Prof. Kuenen.

PROF. MIALI, F.R.S., who was appointed professor of biology in the Yorkshire College of Science in 1876, is retiring from his chair in the University of Leeds at the end of the present session. We understand that the council has decided to establish separate chairs of zoology and botany, and will shortly proceed to appoint professors of these subjects.

THE province of Saskatchewan is only eighteen months old, but already (says the *Times*) it is devoting its resources to the establishment of a State university. A Bill just introduced by the Provincial Government in the Legislative Assembly at Regina provides for the incorporation of such a university under a chancellor, convocation, senate, board of governors, and council. The number and nature of the faculties to be established will be decided by the university senate. The maintenance of the university is to be provided out of the general revenues of the province and also by a percentage of the net receipts of the province under the Succession Duties Ordinance.

THERE has been serious divergence of opinion for more than two years as to the policy of the Marine Biological Association of the West of Scotland. This association was founded in order, according to the first article of its constitution, to investigate the marine fauna and flora of the Clyde sea area, to maintain a biological station at Millport or other suitable locality, and generally to foster and encourage biological research. At the annual meeting of the association on March 27 an amendment was carried by a majority of one vote "that while approving generally

of the report, the meeting does not approve of the staff being employed in biological survey." The chairman, Dr. Rottenburg, Prof. Bower, Prof. Graham Kerr, Prof. Lawrie, Dr. Teacher, Mr. E. J. Bles, Mr. Todd, the honorary secretary, and other members of the general committee then tendered their resignations and withdrew from the meeting.

THE council of the Association of Teachers in Technical Institutions recently appointed a committee to report upon the mathematical syllabuses of the Board of Education, and the recommendations of the committee have been embodied in an "outline of suggested syllabuses" which has been sent by the council to the Secretary of the Board of Education. Several principles guided the council in drawing up its suggestions. It urges that there should be a progressive development in pure geometry, analytical geometry and analysis in each of the six stages into which the examinations of the Board are divided; that the six stages should give a homogeneous and comprehensive education in the main principles of the science; and that the course of work for honours examinations should be such as to place the student in a position to undertake original investigations should he desire to do so. It is a hopeful sign that teachers are able to lay before the Board of Education their views as to what it is reasonable and desirable to expect of candidates in examinations, and we have no doubt the Board will give the suggestions the consideration they deserve. Certain of the recommendations will be improved, no doubt, by submission to revision, but the cooperation of teachers with outside authorities in the examination of students deserves every encouragement.

ACCORDING to an address delivered by Miss Hoskyns-Abraham in the Memorial Hall, Manchester, and published by the Manchester and Salford Sanitary Association, the system of popular education now current needs radical amendment in order to prevent further physical degeneration on the part of the lower-class population of the country. The system now in vogue is regarded as essentially non-hygienic, especially so far as infants and young children are concerned. The maintenance of silence and order in infant schools (formerly regarded as a piece of mental discipline) is condemned, and in lieu of this it is urged that the pupils should be put to play in a large empty apartment with "a heap of sand in one corner and a tub of water in another." It may be pointed out that much the same results could be attained without expense by allowing the children to play in the old-fashioned way in the streets or lanes. Nearly as drastic amendments are proposed in the curriculum for older pupils; while it is also urged that these should be kept at school until a considerably later age than is now the practice. Neither is the education of teachers anything like perfect, one of the elements lacking being "skilled observation of children and skilful handling of them in accordance with what has been observed."

SOCIETIES AND ACADEMIES.

LONDON.

**Royal Society**, November 1, 1906.—"On Intravascular Coagulation in Albinoes and Pigmented Animals, and on the Behaviour of the Nucleo-proteids of Testes in Solution in the Production of Intravascular Coagulation." By G. P. **Mudge**. Communicated by Dr. A. D. Waller, F.R.S.

(1) When albinoes are injected with a solution of nucleo-proteid derived from a pigmented animal, a certain number of them, about 9 per cent., absolutely fail to clot, while about 7 per cent. give a qualified clotting, the remainder giving a typical intravascular coagulation of more or less extensive development.

(2) When albinoes are similarly injected with a solution of nucleo-proteid, but derived from albinoes, no absolute failure of coagulation occurs, and it is very doubtful if any qualified ones do. The great majority clot as distinctly as do pigmented individuals.

(3) When pigmented rabbits are injected with solutions of nucleo-proteids, derived from albinoes or with those

derived from pigmented individuals, no failures of coagulation occur.

(4) The Himalayan rabbit, in respect of its reaction to injected nucleo-proteids, behaves like the complete albino. This rabbit, though resembling the Norway hare in its winter coat, in which condition Pickering failed to obtain intravascular coagulation, differs from it in having pink (unpigmented) instead of pigmented eyes, and in never becoming periodically wholly pigmented. It cannot, therefore, be used as corroborative evidence of Pickering's conclusion with respect to the Norway hare.

(5) Failures to coagulate, when they occur, are due to inherent qualities of the individuals and not to weakening in the activity of the solutions used.

(6) Albinoes require a larger mean dose per kilogram of body weight of injected nucleo-proteid to cause death by intravascular coagulation than do pigmented animals, the relative resisting powers of the pigmented and albino individuals being as 1 to 1.5 respectively.

(7) Both albino and pigmented individuals are more resistant to nucleo-proteids, obtained from individuals of their own race, than they are to those obtained from the alternative source.

(8) The activity of a solution of nucleo-proteid, prepared from spermatid glands, decreases (but not quite uniformly) as the maturity (weight) of the gland increases.

(9) Solutions of nucleo-proteids, prepared from heavier (maturer) spermatid glands, undergo a progressive loss of activity with increasing period of keeping, i.e. from one to twenty days. But solutions derived from lighter (immature) glands undergo a fluctuating variation in activity, falling off on the second day after preparation and rising again on the fifth to seventh, and thence exhibiting a progressive fall.

January 24.—"Note on the Application of Van der Waals's Equation to Solutions." By the Earl of **Berkeley**. Communicated by Prof. J. Larmor, Sec.R.S.

The author attempts to apply Van der Waals's equation of state to the results of direct measurements of osmotic pressure at 0° C. Various modifications of this equation were tried without success, but by the introduction of a third constant two equations were found that fit the experimental numbers.

The equations are:—

$$(A/v - p + a/v^2)(v - b) = RT \dots \dots \dots (1)$$

$$(A/v + p - a/v^2)(v - b) = RT \dots \dots \dots (2)$$

where *p* is the osmotic pressure, R and T the gas constant and the absolute temperature respectively, while the *v* of equation (1) is the volume of water which contains 1 gram molecule of solute, and the *v* of equation (2) is the volume of solution containing the gram molecule.

It is pointed out that both equations give impossible values for the critical points; but on plotting the graph of equation (1) for the different substances, it is found that in each case the point at which *dp/dv* = 0 and the osmotic pressure decreases with increase of concentration may be within the reach of experiment. Decrease of osmotic pressure with increase of concentration implies physical instability and change of state, hence it is suggested that when *dp/dv* = 0 the limit of supersaturation has been reached, and the solute must crystallise out.

It is shown that a solution has two osmotic pressures; the second osmotic pressure (which would only be manifested directly if one could find a semi-permeable membrane permeable to the *solute*) is connected with the freezing point of the solution in a manner similar to that which connects the crystallising point and the ordinary osmotic pressure.

"On the Presence of Europium in Stars." By Joseph **Lunt**. Communicated by Sir David Gill, K.C.B., F.R.S.

Having obtained, from measures on the calcium line λ 4435.851 in the spectra of α Boötis and β Geminorum, radial-velocity values which were not in accord with those obtained from other stellar lines, the author suspected that the line near λ 4435.8 in the stars named was not a "pure" one. The resulting radial velocity was such as would be given by a "disturbing" line very close to the calcium line and at about λ 4435.753. Reference to records of laboratory spectra showed him that Exner