

TABLE II.

Animals Interchanged.

Rabbit B exposed to polarised light.
Rabbit A exposed to unpolarised light.

Animal.	Weight.	Ratio in dark B/A.	Ratio in light B/A.	Ratio B/A in dark after exposure to light.
Rabbit B .	569 gm.	1.009 : 1	1.022 : 1	0.867 : 1
Rabbit A .	553 „			

Note.—The weight of both the rabbits increased during the course of the experiments.

TABLE III.

Guinea-pig A exposed to polarised light.
Guinea-pig B exposed to unpolarised light.

Animal.	Weight.	Ratio in dark A/B.	Ratio in light A/B.	Ratio A/B in dark after exposure to light.
Guinea-pig A .	473 gm.	0.881 : 1	0.969 : 1	..
Guinea-pig B .	517 „			

Note.—The animals were white in colour, but there was a big dark brown patch on the side of guinea-pig B.

From Tables I. and II. it would appear that when the animals were placed in the dark after exposure to light the order of their metabolic activities was reversed, that is, the animal exposed to the polarised light showed diminished activity compared to its fellow exposed to the ordinary light. This would seem to suggest that there is compensatory rest after the increased metabolic activity induced by the polarised radiations.

Further work is in progress.

S. S. BHATNAGAR.
R. B. LAL.
K. N. MATHUR.

University Chemical Laboratories,
University of the Punjab,
Lahore, India.

Energy Levels of the Carbon Monoxide Molecule.

In a recent letter to NATURE (vol. 117, p. 376, 1926), Dr. R. C. Johnson shows that the third positive carbon bands are related to those recently discovered by Cameron (*Phil. Mag.* (7) 1, p. 405, 1926), and that the final states of the Cameron bands are identical with the final states of the fourth positive carbon bands. As the fourth positive bands are known to belong to the neutral carbon monoxide molecule from Leifson's absorption experiments (*Astro. Jour.*, 63, 73, 1926), Johnson concludes that Cameron's bands and the third positive bands also belong to the neutral carbon monoxide molecule. We have recently completed some experiments on the excitation of the carbon monoxide spectra by electron impacts which support the views of Johnson, and they enable us to extend the scheme of energy levels so that it includes all of the bands of carbon monoxide.

We employed hot cathode discharge tubes and measured the excitation potentials of the several systems by a photographic method. A part of the third positive bands appear at 10.2 volts in agreement with the energy level assigned to them by Johnson, but another set appears at 11.1 volts or at a 0.9 volt higher level. These bands were shown to have the same final states as the set which appears first, and when so analysed, indicate that they originate in a

single state 8258 cm^{-1} above the first set. This difference in levels corresponds to 1.02 volts, in agreement with the difference in their measured excitation potentials. As this difference is rather large to be ascribed to a vibrational shift, we have concluded that the second set constitutes a different system, having final states identical with those of the third positive system but originating in an electronic level 1.02 volts higher than the zero vibrational level of the third positive bands. We shall refer to these bands as the 3A system. Their structure is quite different from the others, whereas they would be expected to be similar if they all belonged to the same system. The following bands constitute the 3A system: $\lambda 2295.2, 2389.0, 2489.9, 2597.1, 2711.35\text{A}.$

Having now separated one set of bands from the third positive system, it is possible to arrange the remaining bands into two series having the same final states and having initial states differing by 2210 cm^{-1} , which difference can be ascribed to a vibrational shift. Thus there are two initial vibrational levels for the third positive system and only one for the 3A system. When the molecule is in such highly excited states it cannot suffer very large nuclear displacements. The same thing is illustrated by the few initial states of the Ångström system.

The third positive bands have usually been ascribed to carbon dioxide, instead of to carbon monoxide, because it was believed that they are of too complex structure to belong to a simple diatomic molecule. However, their relation to the Cameron bands points strongly to carbon monoxide as their origin, as suggested by Johnson. Further evidence that carbon monoxide, and not carbon dioxide, is the origin of these bands has been obtained by the writers in collaboration with Prof. E. F. Barker of this laboratory. Carefully prepared and purified carbon dioxide was excited by electron impacts in a three electrode discharge tube through which the gas was caused to flow at a constant rate (Barker and Duffendack, *Phys. Rev.*, 26, 339, 1925). The gas passed through the region of excitation before it could come into contact with the filament, and oxide coated platinum filaments were used in order to reduce the amount of thermal dissociation, and so the amount of dissociation products that could find their way into the region of excitation was negligible.

With this apparatus, the bands of the third positive system were not observed unless a considerable voltage was applied to the electrodes. When they did appear (and they were always of feeble intensity) they were invariably accompanied by the Ångström bands. Their presence under these conditions can be accounted for by the dissociation that occurs in the discharge at high voltages. When, however, the flow of gas was stopped and the stagnant gas excited in the tube, these bands and the Ångström bands appeared strongly in the discharge at much lower voltages. At the same time the pressure in the tube increased, indicating that the carbon dioxide was being dissociated by thermal action at the filament. It is concluded from these experiments that the third positive bands, like the Ångström bands, belong to the neutral molecule of carbon monoxide.

In possessing the two parallel sets of electronic energy levels, carbon monoxide is, so far as the writers are aware, unique. It probably means that the molecule has two distinct types of spectral terms corresponding to different types of electronic orbits. It may be worth while to consider, as an hypothesis, that one set of levels is made up of triplet terms and the other of singlet terms in analogy with the term scheme for the 'corresponding atom.'

In pursuance of this idea, it would be concluded that the complex structure of the third positive bands may be due to the overlapping of bands from the several levels of the triplet terms. Separations of the order of magnitude as occur in the triplet terms of Mg would result in a superposition of the bands from the several levels and cause an apparent complexity of fine structure. The diminution in the triplet separations in the higher terms would result in a simplification of the structure of the bands originating at these levels, and this may account for the simpler nature of the bands of the 3A system. On the other hand, the singlet levels would produce bands of greater simplicity like those of the Ångström and fourth positive systems.

O. S. DUFFENDACK.
GERALD W. FOX.

University of Michigan,
May 30.

Hydrogen as Anion.

NOR every one can entertain the wild and woolly west—it is some feat! Still, I should be better pleased, if, instead of entertaining Prof. Lewis, I had led him to be serious and consider the depth of crime he is guilty of in aspersing the character of hydrogen as he has done. Being subversive of all that chemists have taught, the doctrine he preaches, that it is the analogue of fluorine and can act as an *anion* and as bigamist, is not one to be put forward in the light and airy manner he adopts—without considering the consequences. If its effect were confined to the Pacific coast, we here might regard such speculation with complacency—following the example of the Professor's countryman, who, during the civil war, expressed his readiness, rather than that it should come to an end to his disadvantage, to see every drop of blood shed from every vein of every one of his wife's relations. When, however, the morals of Cambridge and Oxford suffer, especially when one whom I long sought to train in the ways of righteousness, whose hand and eye work I have always greatly admired, preaches it as gospel in the tabernacles of Belgian, British and French chemists, I feel bound to protest. Men of his type, with an ever waxing clerical diathesis, are dangerous to society, when they begin to imagine and preach heresy—their acolytes tend to take them seriously, not realising that they are but acting the Huck Finn to some distant Tom Sawyer.

Let us admit that to-day chemistry is mainly a Huck Finn-Tom Sawyer business: any one who was present at the recent Faraday Society discussion on explosions and has listened to talks on tautomerism and polarity at the Chemical Society must see that such is now our condition. We just "let-on": the laboratory is fast passing into insignificance, the close study of *materia chimica* is a practice of the past, the judicial spirit is gone, engulfed in the Scandinavian wave, jesuitry prevails instead.

Prof. Lewis merely "lets on": he has no solid ground of evidence. His contention involves the assumption that calcium hydride is an electrolyte. Hittorf's early definition: "Electrolyte sind Salze" still remains the one concise and consistent statement concerning the facts. No pure binary hydride has yet been shown by valid evidence to be an electrolyte, let alone a salt. Prof. Lewis very properly raps me over the knuckles on account of my reference to potassium—an obvious howler. Incidentally, let me say, nothing is more strange than the way in which blunders are unconsciously made in writing and, being made, remain undetected until after an interval—only recently, when filing my letter, did I suddenly realise what a fool I had made of myself.

Prof. Lewis might, however, have taken the hint I gave him. The Bardwell experiment was not made with the metallic hydride but with a solution of the hydride in an eutectic mixture of lithium and potassium chlorides—both electrolytes. Is it not rational to suppose that only the chloride was electrolysed and that hydrogen was but the product of a secondary change? In other words, that it was displaced by the 'nascent' chlorine—hence its appearance at the anode. Bardwell makes no reference to an evolution or appearance of chlorine but calmly assumes that the hydride acts as the electrolyte. Even Prof. Lewis, I imagine, will not contend that the chlorides are unaffected by the current.

Hydrogen, however, will take care of itself. What concerns me is the future of our science. All my life, an advocate of training in the use of scientific method, I find little or no evidence in our ranks of the complete intellectual probity the practice of the method involves. The young student goes to the university in full honesty of purpose, his parents expecting that he will be trained for his life-work. Instead of science he finds nescience. The consequences are already seen to be disastrous both to scientific and industrial progress. Men who are both rational and reasonable, with some breadth of knowledge and outlook, observant and reflective, fit to take charge of posts of importance and responsibility, are not to be found among young chemists to-day. The wrong type of man is being forced into the profession and, even when one of the right type comes forward, the superficial training that is given but unfits him for the service of the world.

HENRY E. ARMSTRONG.

The Sensitivity of Selenium Cells.

MR. THORNE BAKER'S observations on the enhanced light sensitivity of selenium cells actuated by alternating, instead of direct, current (NATURE, June 19, p. 858), are possibly related to some phenomena investigated recently by Mr. J. W. Avery and myself. We have found that selenium cells of a particular type (those made to the design of Prof. H. Thirring) display, when used in the ordinary way with direct current, appreciable and persistent polarisation effects. Almost accidentally it was discovered that this polarisation disappeared as a consequence of prolonged exposure of the cell to the operation of a drying agent. By the same process the 'dark' conductance of the cell was reduced in the proportion of about 4 to 1, while the 'light' conductance was scarcely altered. The dried cell had thus become much more sensitive to light. We have attributed both the polarisation observed and a large part of the 'dark' conductance of the undried cell to the presence of a film of water in parallel with the selenium between the electrodes, and our observations agree quantitatively with this assumption.

We have also obtained some evidence of the existence of a much more transient polarisation in the desiccated cell, leading to a difference of conductance according to whether alternating or direct current is used, but this work is, for the present, incomplete. What has been established is that quite apart from the question of current alternation, the sensitivity of certain selenium cells, and probably of others, can be greatly increased by the simple process of thorough drying. The record of our work on this subject has been completed for publication and will, it is hoped, appear shortly.

A. O. RANKINE.

Imperial College of Science and Technology,
South Kensington, S.W.7, June 20.