it obliterates the radiation between two of the lines which are due to that hydrogen. . . . If more than one hydroxyl group be pre­sent, we doubt if any direct effect is produced beyond that produced by one hydroxyl group, except a possible greater general absorption ; a good example of this will be found in cinnamic alcohol and phenyl- propyl alcohol, which give the same spectra as far as the special absorptions are concerned. . . . Hitherto we have only taken into account oxygen which is not contained in the radical ; when it is so contained it appears to act differently, always supposing hydrogen to be present as well. We need only refer to the spectrum of aldehyde, which is inclined to be linear rather than banded, or rather the bands are bounded by absolute lines, and are more defined than when oxygen is more loosely bonded.”

“An inspection of our maps will show that the radical of a body is represented by certain well-marked bands, some differing in position according as it is bonded with hydrogen, or a halogen, or with carbon, oxygen, or nitrogen. There seem to be characteristic bands, however, of any one series of radicals between 1000 and about 1100, which would indicate what may be called the central hydrocarbon group, to which other radicals may be bonded. The clue to the composition of a body, however, would seem to lie between λ 700 and λ 1000. Certain radicals have a distinctive absorption about λ 700 together with others about λ 900, and if the first be visible it almost follows that the distinctive mark of the radical with which it is connected will be found. Thus in the ethyl series we find an absorption at 740, and a characteristic band, one edge of which is at 892 and the other at 920. If we find a body containing the 740 absorption and a band with the most refrangible edge commencing at 892, or with the least refrangible edge terminating at 920, we may be pretty sure that we have an ethyl radical present. So with any of the aromatic group ; the crucial line is at 867. If that line be connected with a band we may feel certain that some derivative of benzine is present. The benzyl group show this remarkably well, since we see that phenyl is present, as is also methyl. It will be advantageous if the spectra of ammonia, benzine, aniline, and dimethyl aniline be com­pared, when the remarkable coincidences will at once become apparent, as also the different weighting of the molecule. The spectrum of nitro-benzine is also worth comparing with benzine and nitric acid. . . . In our own minds there lingers no doubt as to the easy detection of any radical which we have examined, . . . and it seems highly probable by this delicate mode of analysis that the hypothetical position of any hydrogen which is replaced may be identified, a point which is of prime importance in organic chemistry. The detection of the presence of chlorine or bromine or iodine in a compound is at present undecided, and it may well be that we may have to look for its effects in a different part of the spectrum. The only trace we can find at present is in ethyl bromide, in which the radical baud about 900 is curtailed in one wing. The difference between amyl iodide and amyl bromide is not sufficiently marked to be of any value. ”

The absorption spectra of the didymium and cobalt salts afford many striking examples of the complicated effects of solution and combination in the spectra. It is impossible to explain these with­out the help of illustrations, and we must refer the reader, therefore, to the original papers.@@1 Some very interesting changes have been noticed in the position of absorption bands when certain colouring matters are dissolved in different liquids. Characteristic absorp­tion bands appear for each colouring matter in slightly different positions according to the solvent. Hagenbach, Kraus, Kundt,@@2 and Claes@@3 have studied the question. In a preliminary examina­tion Professor Kundt had come to the conclusion that solvents displaced absorption bands towards the red in the order of their dispersive powers ; but the examination of a greater number of cases has led him to recognize that no generally valid rule can be laid down. At the same time highly dispersive media, like bisul­phide of carbon, always displace a band most towards the red end, while with liquids of small dispersion, like water, alcohol, and ether, the band always appears more refrangible than with other solvents ; and as a general rule the order of displacement is approximately that of dispersive power.

*Relations of the Spectra of Different Elements.*

Various efforts have been made to connect together the spectra of different elements. In these attempts it is generally assumed that certain lines in one spectrum corre­spond to certain lines in another spectrum, and the ques­tion is raised whether the atom with the higher atomic weight has its corresponding lines more or less refrangible.

No definite judgment can as yet be given as to the success of these efforts. Lecoq de Boisbaudran has led the way in these speculations, and some of the similarities in different spectra pointed out by him are certainly of value. But whether his conclusion, that the spectra of the alkalis and alkaline earths when classed according to their refran- gibilities are placed as their chemical properties in the order of their atomic weight,” will stand the test of further research remains to be seen. Ciamician@@4 has also pub­lished a number of suggestive speculations on the question, and Hartley@@5 has extended the comparison to the ultra­violet rays.

When metallic spectra are examined it is often found that some line appears to belong to more than one metal. This is often due to a common impurity of the metals ; but such impurities do not account for all coincidences. The question has been raised whether these coincidences do not point to a common constituent in the different elements which show the same line. If this view is correct, we should have to assume that the electric spark decom­poses the metals, and that the spectrum we observe is not the spectrum of the metal but that of its constituents. Further investigation has shown, however, that in nearly all cases the assumed coincidences were apparent only. With higher resolving powers it was found that the lines did not occupy exactly the same place. With the large numbers of lines shown by the spectra of most of the metals some very close coincidences must be expected by the doctrine of chances. The few coincidences which our most powerful spectroscopes have not been able to resolve are in all probability accidental only. (a. s\*.)

SPEECH-SOUNDS, the sounds actually used for the conveyance of thought by speech. See Phonetics.

1. *Symbolization.—*It is necessary to have some system of writing speech-sounds, in order to talk of them. The system used in the present article is the palaeotype of the present writer’s *Early English Pronunciation.* All letters or words thus written will be enclosed in (). The following preliminary list of the ordinary sounds, with examples, will render what follows intelligible. For an alphabetical list, see art. 20.

*English.—*1. b*ee*t b*ai*t b*aa* b*ough*t b*oa*t b*oo*t (biit b*ee*t b*aa* bAAt b*oo*t buut). 2. kn*i*t n*e*t gn*a*t kn*o*t n*u*t n*oo*k (n*i*t net næt nɔt nǝt n*u*k). 3. f*i*le f*oi*l f*ow*l *fuel* (fa'il fɔ'*i*l fa'ul fĭuu'*i*l). 4. *h*ay (h*ee*). 5. *p*ea *b*ee, *t*oe *d*oe*,* *c*ape *g*ape (pii bii, t*oo* d*oo*, k*ee*p g*ee*p). 6. *wh*ey *w*ay, *f*eel *v*eal, *th*in *th*en*,* *s*eal *z*eal, *r*u*sh r*ou*ge, h*ue *y*ou (wh*ee* w*ee*, fiil viil, th*i*n dhen, siil ziil, rǝsh ruuzh, Jhĭuu Juu). 7. ea*r* *r*ing, gu*ll* litt*le* (iiɹ r*i*q, gǝl l*i*t’l). 8. su*m* chas*m*, su*n* op*en*, sung (sǝm kæz’m, sǝn *oo*p’n, sǝq). 9. chest jest (tɟest dɟest).

*Foreign.—*F French, g German, it Italian. 10. b*ê*te f, l*â*che F, n*ò* it, d*û* F, f*eu F,* v*eu*f F, v*in* F, v*en*t f, v*on*t f, *un* f, s*oi*n f, s*oi* F, l*ui* f (bEEt, l*aa*sh, no, dyy, f*ǝ*, vœf, veΛ, vaΛ, voΛ, œΛ, sŭeΛ, sŭa, lyí). 11. da*ch* tei*ch*, ta*g*e siege, *w*ahl, all g (dakh táikjh, taaghe, ziigjhe, bhaal). 12. pag*li*a it, beso*gn*e F (pà·ljà, b*ǝ̯*zonj).

*2. Nature of Speech-Sounds.—*Speech-sounds result from shocks given to the air by the organs of speech, received by the drumskin of the ear, and transmitted to the auditory nerves in the cochlea. The apparatus is explained by Helm­holtz, who deals with musical sounds. But speech is not musical, and its sounds are much obliterated when rendered musical.@@6 An original quality of tone generated by the vocal chords is modified by the cavities through which it passes, as explained by Helmholtz *(Sensations of Tone)* on the principle of resonance. There are three ways in which speech-sounds may be produced—(1) by the air in the mouth, without additional breathing, by smacks and clicks ; (2) by drawing in air, as orally in chirps, whistles, sobs, gasps, and nasally in snuffles, snores ; (3) by expelling air, as in the greater number of speech-sounds. The last are

@@@1 Bunsen, “On the Inversion of the Bands in the Didymium Absorp­tion Spectra,” *Phil. Mαg.,* xxviii. p. 246 (1864), and xxxii. p. 177 (1866); Russell, “On the Absorption Spectra of Cobalt Salts,” *Proc. Roy. Soc.,* xxxii. p. 258 (1881).

*@@@*2 *Wied. Ann.,* iv. p. 34 (1878).

@@@3 *Wied. Ann.,* iii. p. 389 (1878).

@@@4 Wien. Ber., lxxviii. (1878).

@@@5 Journal Chem. Soc., September 1883. @@@6 Ellis, Speech in Song, sect. iv.