a trace of dissolved nitrate of bismuth is added to the solution, an excess of hydrate of soda will produce a black precipitate of binoxide of bismuth. The metal when treated with nitric acid, gives white, insoluble binoxide of tin.

B. *In a borax bead*, which is colored faintly bluish by oxide of copper, the smallest traces of a tin compound can be detected with great certainty, since the bead, in the *lower reducing flame*, is colored reddish-brown and ruby-red, as was stated under copper compounds.

(To be continued.)

HOVER'S CARBONIZED PAPER.

BY HECTOR ORR, Esq.

Read at the Meeting of the Franklin Institute, February 19th, 1868.

THE consumption of paper in the United States, for writing and printing purposes, is enormous; far exceeding the proportion of a similar population in any other part of the world. The demand for printing-paper alone is so immense, that this variety of the article has overshadowed all others, and seems to have nearly monopolized the attention of manufacturers. The selection and preparation of the material, and the finishing of the surface, have drawn out much ingenuity and skill; yet the application of color in the process of printing is a simpler operation than that employed by the smallest school boy in his first lesson in writing. In printing, we place a definite amount of coloring matter, in a state of minute mechanical division, upon a contrasting surface, simply laying the ink on, and leaving it to harden by the slow absorption of its fluid parts.

In writing, however, in addition to all other adaptations, a chemical action is indispensable; we need the contact of both air and light to make the record legible and lasting. Writing with ink, is, in fact, a minute dyeing process, in which a particular color is both produced and fixed by chemical affinity. Yet these conditions seem to have had but little consideration from paper makers. The demand for material has become so urgent that other substances beside linen have been pressed into service. The bleaching salts, made necessary by the use of discolored stock, disturbs the shade of the ink, while the shorter fibre of cotton produces a *piling* on the surface, to allay

which various devices have been resorted to, which leave the sheet glassy and almost unimpressible by the ink.

Indeed, when we examine the actual process of paper making, we are surprised at the unlikely means there employed for the desired end. Our paper is literally *felt*, or matted pulp, of several varieties of vegetable fibre,—the natural union of whose particles has been changed by friction and immersion in water, and the material then brought into artificial contact through farther agitation by ingenious machinery, thus interlacing the fibres,—and which, starting at the trough as a wet *cobweb*, by means of heat and graduated pressure, in a few moments ends in finished paper, such as we are all familiar with.

Almost the only difference made by the manufacturer between printing paper and writing paper, thus far, has been the application to the latter of a glutinous wash or sizing, which presents a moderate resistance to fluids, and thus restricts the ink to the exact track of the pen's point, but which, at the same time, causes the ink to stand upon the surface for some time, and while hindering it from spreading, increases the danger of blotting.

On such a substance, so prepared, to find ourselves tracing a fine steel point for hours together without tripping, and *staining* in thousands of delicate characters, each definite and peculiar, is almost wonderful; while the new material employed in pens (a finely sensitive metal), drying and condensing the ink sooner on the pen than on the paper, and requiring a fluid almost colorless when applied, seems to bring the difficulty to an aggravating height. And it is just at this exhaustion of our patience that relief appears in the shape of this CARBONIZED PAPER.

Our writing ink (with trifling variations of proportions), is a compound of sulphate of iron, extract of galls, and gum, held in mechanical union by soft water. When this fluid is applied to the paper, as hitherto made, the following chemical action ensues: the oxygen of the atmosphere forms gallic acid with the tannin of the galls, which, in turn, unites with the iron of the copperas, forming a black precipitate (the per-gallate of iron), and the sulphuric acid, thus set free, enters the body of the paper, while the water passes off by evaporation.

Now this presence of sulphuric acid in the tissue of the paper is not a desirable result. At least it promises no good, and may produce harm. It adds nothing to the permanence of the color, and it may eventually act injuriously upon the very fibre of the paper.

In the Carbonized Paper, however, a new agent is introduced which acts both promptly and powerfully. The carbonate, equally diffused through the whole mass of the paper, is seized on with avidity by the sulphuric acid, forming a sulphate which at ordinary temperature may be considered a permanent compound, while the iron thus suddenly released, unites immediately with the gallic acid, producing the deep, black color so desirable in ink; and the carbonic acid, displaced from the carbonate, may be said to put the sulphuric acid under bonds for good behavior, and yet have no hurtful reaction itself upon either the ink or paper.

It is rarely that we find even a radical improvement on a former practice at once so happily adjust its operation, and carry palpable advantage through all its ramifications.

I have already alluded to the process of letter-press printing as distinguished from handwriting. Printers, hitherto, have had no such assistance in applying their color as this invention offers to the penman; but I am not without hope that it may yet be extended to the art which preserves and promotes all others.

From an earlier period than I can specify, printers have chosen to "work" their paper in a damp condition, having a moderate quantity of water equally diffused through each sheet. In the anxious round of a day's work full of nice practical details, though continued for a lifetime, few will find opportunity or inclination for a philosophical examination of the particular process employed. I have been unable to satisfy myself that this wetting of the paper does anything more than slightly turn back the texture towards its former condition of pulp, raising a minute nap perpendicularly and spreading the fibres horizontally (I have frequently known sheets to spread one inch in twenty-four). Into this new surface the types bury themselves and undergo a slight *wiping* under the pressure, and then when the water is afterwards driven out by evaporation, the fibres knit over the ink, and each sheet also receiving heavy pressure between smooth pasteboards, the nap is laid down, and the ink is thus held mechanically on the paper. This is the best account I can give why our finely printed books do not soil in handling, as a damp newspaper does when fresh from the press.

The public in general is perhaps not aware of the advance in speed that letter press printing has attained in our age. Within my own experience we have passed from five hundred impressions

per hour, to *twenty thousand* impressions in the same time from a single surface!

In this rapid movement, we are thwarted principally by the crude mechanical application of color already described. The "second impression" (that applied to the opposite side of the sheet), following so rapidly after the first, that the ink has no time to seat itself in the paper, and hence "sets off" (as we say) on the tympan sheet, which soon becomes soiled and blurs the first impression.

I therefore think that if we could establish a chemical action between the paper and the ink, this grave impediment would be at least abated. We then need apply less color, and that in a more fluid condition than now, and have it adhere more firmly to the surface.

As the process is a Philadelphia invention, I hope our scientific members will spare it a little thought. This is part of my excuse for thus presenting it. I have presumed also a little on the consideration due our old brother printer whose name our Institute has chosen for its special distinction. And here I will leave the matter for the present.

METHOD OF QUALITATIVE ANALYSIS OF ANIMAL AND VEGETABLE COLORING MATTERS BY THE SPECTRUM MICROSCOPE.

By H. C. SORBY, F. R. S., &c.

(Concluded from page 205.)

From the Proceedings of the Royal Society, No. 92.

20. *Sub-groups.*

Since the narrow absorption-bands are decidedly the most important means of identification, it appears to me that we cannot do better than adopt subdivisions founded on *their number*. We may thus divide each group A, B, and C into sub-groups, in which the neutral aqueous solutions exhibit 0, 1, 2, 3, &c. decided absorption-bands. Sometimes one of them may be so obscure that we may hesitate whether it should be counted or not; but practically this is no very serious objection, if we decide to reckon only distinct bands, and to look on the fainter as important merely in identifying individual colors. If no absorption-band can be seen in the neutral solution, we may take into account those seen when more or less ammonia is added; and if none occur in either case, we may make use of those seen in the alcoholic solution when neutral, and after the addition of ammonia. Whenever in this order of experiments