QUALITATIVE ANALYSIS FOR AMATEURS.*

The fascinating science of chemistry has interested many an ingenious youth, and coaxed the pennies from his pocket to buy the reagents for some beautiful experiment. . . . . The drug clerk of a country store, the amateur or empiric photographer or artist, the apprentice in a machine-shop, the "devil" of a printing-office, or the ambitious teacher of a rural school, desires to repeat the experiments he has so often heard of but never seen. When he has gained a more thorough knowledge of chemistry, and a deeper love for the science, he wants to analyse something. He picks up an alloy, the composition of which he would like to know; he wants to test the purity of salt he is using; or he is curious about the effects of certain chemicals upon the materials he works with; or, accidentally, he produces some beautiful salt to which he is a stranger, and he desires to analyse it. If he is able to buy or borrow the huge treatise of Frosenius, he is discouraged by its apparant intricacy, and the long, tedious methods. If a cautious teacher lead him slowly through a systematic course of recitations, opening but one avenue at a time to his eager gaze, he would slowly and more surely master it than by spasmodic efforts to embrace the whole. One of the greatest drawbacks to self-instruction is this tendency to advance too rapidly, skimming over or skipping the uninteresting, but essential details. By presenting each month a few accurately described, and very simple reactions, followed by examples for practice, we hope to enable those who cannot have the advantages of teacher or laboratory to gain an insight into mysteries of qualitative analysis.

Let us first consider what is needed in the way of

Apparatus and Chemicals.

The following list includes all the most important items:—Alcohol lamp, or Bunsen burner for gas, funnels, test-tubes, test-tube stand, test-tube brush, filter paper, glass tubing, empty bottles for reagents, ammonic carbonate, 2oz.; ammonic chloride, 2oz.; ammonia (aqua), 4oz.; baric chloride, 2oz.; baric nitrate, 1oz.; hydrochloric acid, 8oz.; nitric acid, 8oz.; potassic hydrate, 1oz.; sulphuric acid, 8oz.; ferrocyanide of potassium, 1oz.; potassic bichromate, 1oz.; phosphate of soda, 1oz.; oxalic acid, 1oz.; sulphur and paraffine. All, except the acids, may be kept in ordinary cork-stopped bottles to be found about the house, if well cleansed and furnished with new corks. An ordinary candle, which affords heat enough for many operations, or a kerosene lamp, made to burn without a chimney, can be used instead of alcohol, but deposits much soot. If gas is to be had, a piece of gas-pipe 3in. or 4in. long is to be fitted with a cork. Into this cork insert a glass-tube drawn out at one end, and bent at right angles, and with the fine end projecting into the gas-pipe. Two other pieces of glass tubing, bent at right angles, but not drawn out, are to be inserted in the same cork, so that the three form a tripod to support the piece of gas-pipe vertically. A piece of rubber tubing, from the outer end of the first tube to a common burner, supplies the gas. By varying the length of tube and size of opening, a colourless flame, burning only at the upper end of the gas-pipe, is obtained. This substitute for a Bunsen burner gives great heat, and deposits no soot.

Test-tubes should be 4in. to 6in. long, and a dozen will answer to begin with. A stand to hold them upright is easily made of wood or tin. A box 3½in. to 5½in. deep, with holes in the lid, can be used if necessary. A rag on a stick supplies the place of a brush to clean test-tubes.

Funnels should be of glass or porcelain. If tin is used, it should be protected by a film of paraffine.

Filter paper resembles blotting-paper, being unsised, and allows a solution to flow through, but keeps back solids. It is cut in circles, folded twice to form a quadrant, then opened so that it fits the funnel, there being three thicknesses of paper on one side, and one on the other.

We are now ready to proceed with the *Analysis of Metals.*

First Group.

Lead, mercury, and *silver* are the only metals whose chlorides are not soluble in acids. Dissolve a piece of lead pipe, a bullet, shot, or type, in nitric acid (which must be *pure*) in a test-tube. Filter the solution by lining the inside of your funnel with filter-paper and letting the solution, diluted with water, flow through it. The portion that goes through the filter is called the *filtrate.* Divide this into four parts: to one add hydrochloric acid, to the second sulphuric acid, to the third potassic bichromate. Make a note of the results thus:—

	HCl.	H^2SO^4	$K_2Cr^2O_7$
Plumbic nitrate.	White precipitate.	White precipitate.	Yellow precipitate.

Pour off the acid from the white precipitate formed by hydrochloric acid, and water and boil in a test-tube; the precipitate dissolves in hot water.

Dissolve a small bit of real silver, or an old fashioned ten-cent piece, in nitric acid; dilute, and filter. The blue colour is due to copper. Divide the filtrate into four parts, and add the same reagents as before, and note the results under the others. The precipitate with hydrochloric acid is also white, and dissolves in ammonia, but not in boiling water.

Scrape a little of the amalgam from the back of a broken mirror and dissolve slowly in cold dilute nitric acid; filter and proceed as before. Again a white precipitate is formed by hydrochloric acid, but this time it is insoluble, both in water and in ammonia.

Mix the solutions of the three metals; filter if cloudy, and add hydrochloric acid; a white precipitate. Filter and preserve the precipitate. Pour water on it; boil and filter; to the filtrate add potassic bichromate or sulphuric acid. The one produces a yellow, the other a white precipitate, indicating lead.

Wash the residue on the filter; put it in a clean test-tube; add ammonia to dissolve the silver; boil and filter. To the filtrate add nitric acid, and the white chloride of silver reappears. The black, insoluble residue is mercury.

These reactions, and the method of separating lead, silver, and mercury (sub-oxide salts), are briefly expressed in the following table:—

Separating Metals of Group 1.

Precipitated by hydrochloric acid: chloride of lead, silver, mercury. Add water and boil.

Solution:	Residue:
Lead.	Silver and Mercury.
Add $K^2Cr^2O_7$	Boil with Ammonia.
Yellow precip.	

Solution:	Residue:
Silver.	Mercury
Add HNO_3	Insoluble.
White precip.	

*By E. J. Hallock, A. M., in the *Boston Journal of Chemistry.*

ON ENERGY.

By Professor Robert Stawell Ball, A. M., LL.D.

The science of Energy, which has been developed within the last twenty-five years, appears to have a grand future, as intimately connected with astronomy, mechanics, light, heat, magnetism, electricity, even with life itself: it leads us back through periods, compared with which, geological time is nothing, and looking forward like a time-telescope, points out the ultimate destiny of the universe.

Energy is the capacity for raising weights. The distinction between force and energy is that:—Energy is the product of a force and a distance. The unit of energy is the energy required to overcome the unit of force through the unit of distance. Energy can be stored in a rapidly moving fly-wheel, as can be demonstrated by experiment. Energy is also stored in any body moving rapidly, as, for example, a cannon ball; energy of this kind is termed "kinetic energy." A steam-engine is a means of turning into mechanical work, a portion of the energy contained in the coal consumed in the furnace. Heat may be turned into mechanical work in other ways; for example, by a thermo-electric battery. The energy stored up in coal, gunpowder, or a compressed spring, is denominated "potential energy." Food and fuel are both forms of potential