A SHORT ESSAY

ON

PRACTICAL EXPERIMENTAL PHILOSOPHY,

ITS USE AND ABUSE.

BY THE WIFE OF

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INTRODUCTION.

About two years ago I published an Essay entitled 'A Short Sketch about Washing Linen,' and in the following year a sequel entitled 'Science applied to the Washing of Linen and to its Effects upon Health,' in which I asked my scientific friends to help me to discover what were the deleterious compounds and processes which in the modern system are found to destroy our linen and injure our health.

The replies I received to these appeals were most gratifying and gave me important hints. But my health began to suffer from my chemical experiments; and my kind medical and chemical advisers, Dr. Paget of Cambridge and the late lamented Dr. Allen Miller of King's College, London, urged me to discontinue my labours on this subject. Dr. Miller kindly undertook to make any analyses that I wished for, and entreated me not to go on with testing linen so washed, as I could not do it without the risk of seriously imperilling my health.

On February 9, 1869, Dr. Miller addressed me in the following words: 'Do not make too many *chemical experiments.* Here is a piece of good advice gratis for you, and I am afraid you will only follow it so far as pleases you.'

My reply was that I would accept with gratitude his generous offer of doing any analyses for me in his laboratory, but, at the same time, that so long as I lived I would never rest until I found out what it was that had caused me such suffering. That nobody but a scientific laundress (meaning myself) could find out the wants and appliances of laundresses and supply a remedy; that my illness was a new disease; that no medical man could treat my complaints properly. They are called in, not to listen to what has caused the complaint, but to cure it. If inflammation in the eyes exists they must treat it as inflammation, and the same with respect to all other well known diseases. I had his full permission to make any use of his name that I pleased. As all that he did for me only proves that, joined to a thorough knowledge of chemical science, he had the kindest heart, and only made use of his talents for the good of others, and thought little of doing good to himself. I am pleased to acknowledge that since his death I have pursued my chemical investigations without any other aid; and, if there is any truth in my statement, the thanks of the public must be given to this great and good man. I do not mean to say that he would have bestowed so much of his valuable time in rendering me such a service if he had not felt sure that I was capable of understanding him, knowing that the elements of chemistry had been implanted in my mind by a thorough master of the subject, the late Professor Cumming, and that the elements of chemistry I had been taught by him in early life enabled me to state a chemical enquiry in language he could understand. On January 5, 1869, I received the following letter from him: 'I have seen your letters to which you refer as having been waiting for me a day or two at

King's College. I *understand* EXACTLY what you wish to have explained, and will do it for you with pleasure. I was quite glad to see your handwriting this morning, for I feared you had been overtasking yourself with your chemical experiments and had made yourself really ill, and I felt anxious about you.'

PRACTICAL

EXPERIMENTAL PHILOSOPHY

&c.

WHAT IS SODA?

CHLORIDE OF SODIUM.

Sea salt or culinary salt (chloride of sodium) is not an artificial product, but is found even lavishly prepared and stored up in the earth by Nature.'—*Knapp's Chemistry.*

SODA, by uniting with a variety of acids, forms a variety of salts; but I will speak to you of that one only which is the most extensively used, and which therefore interests us the most. Culinary or common salt is a compound of soda and muriatic acid. It is very extensively distributed over the earth under various aspects; the ocean is the great reservoir where it exists in solution. The quantity of saline ingredients contained in the sea, says a deservedly popular writer (the late Mr. Mudie) amounts to 400,000,000,000,000,000 (four hundred thousand billions) cubic feet, which if piled into a single cube would form a mass 140 miles long, as many broad, and as many high; or otherwise disposed, it would cover the whole of Europe—islands, seas, and all—to the height of the summit of Mont Blanc, which, as your geography tells you, is somewhere about 16,000 feet high. The whole of this enormous mass of salt, however, is not the muriate of soda, for other salts exist also in the sea; it nevertheless forms by far the greater portion of the mass. Besides the sea there are salt lakes, though these are comparatively small in number. They are found in almost every country of Europe, as also in Asia, Africa, and America.

In several places salt is found in large masses, either hidden at great depths in the earth or at the surface, or forming hills of considerable height; sometimes it is met with as an efflorescence.

SODA.

Historical, 1789; Common Salt; Artificial Soda from Chloride of Sodium (Common Salt).

The present mode of carrying on this important manufacture, and now very generally adopted, was the invention of Leblanc, and first carried out by him and his partners, Dize and Shée, in France. As is well known this discovery created an era in the history of manufactures, but the manner in which it was made public does honour to the genuine and magnanimous patriotism which animated in those times of danger the flower of the French nation. Before the revolution of 1789 no other kind of soda was known in France but that obtained from marine plants, and this for the greater part was imported from the coast of Spain. The wars of the Republic with nearly the whole of Europe, by annihilating trade put a stop to this and other equally important resources for native industry; amongst others the importation of potash was stopped. Although in cases of need soda may be replaced by potash in the manufacture of soap, and for the purposes of the dyer and bleacher, &c., yet the prosperity of these branches of manufacture at a time when the very existence of the Republic was at stake was as of little importance as the fall of a single soldier in a skirmish.

All the potash which could be obtained in France was immediately applied to the manufacture of salt-petre, for the expulsion of the enemy superseded all minor cares.

Necessity is the mother of great deeds; and the Republic mastered the difficulty by an unprecedented development of internal power. The Committee of Public Safety, incited by the proposition of a manufacturer of the name of Carny in the year 11, called upon all citizens in a special proclamation to place in the hands of Commissioners within two decades, for the benefit of the Republic without regard to all private ends and speculations, whatever plans and methods of preparing soda might be known to them. The report of the Commissioners upon all the numerous plans proposed by disinterested manufacturers declared the process of Leblanc to be the simplest and best calculated for an extensive scale of manufacture; a decision, the justness of which has been proved by fifty years' experience; no essential improvements having been made in the process. It consists in converting chloride of sodium (sea salt) into sulphate of soda (Glauber's salt) and in the further decomposition of that salt.

Soda works require a scientific chemist to watch the chemical changes, and carefully extract the poisonous compounds contained in chloride of sodium, which are used for chemical and medical purposes. With all their care poisonous fumes will escape from all salt works. From a chimney 495 feet high the poisonous fumes spread devastation all around. Vegetation was destroyed and also the health of the unfortunate inhabitants of the district.

CRUDE SODA.

As it leaves the furnace the crude soda is too firm and solid to be easily dissolved out with water; it must, therefore, be crushed under upright mill-stones, and sifted or loosened, or made soluble by hot vapours. With this view, the mass is sprinkled within a tolerably hot furnace, where, in the atmosphere of vapour, it soon swells up, and falls to pieces. In the subsequent treatment with warm water, carbonate of soda and the other soluble salts are taken up, and the compound of lime with sulphuret of calcium (the metallic base of lime), remains.

ON CHLORIDE OF LIME,

So abundantly used in our households at the present time. The opinion of a French chemist: 'The French suffer more than the English in health, on account of the quantities of chloride of lime used to take the stains out of linen.' Why should chloride of lime injure the health? How is it made? What are its ingredients?

CHLORINE, SODA, AND POTASH.

Chlorine is a gaseous substance discovered by Scheele in 1774, but its elementary nature was first established by Davy in 1810, who proposed to abolish the unwieldly and inaccurate terms dephlogisticated muriatic acid and oxymuriatic acid, which had been applied to it, and to substitute a name derived from its most striking physical quality, namely its greenish yellow colour. The name *chlorine* (from χλωρός, green) is now universally adopted.

SEA SALT

(Chloride of Sodium)

Is the great natural source of chlorine. When required in large quantities for the purpose of the manufacturer it is made by pouring diluted sulphuric acid on a mixture of common salt and oxide of manganese contained in a large leaden vessel. The decomposition which ensues will be understood from the following statement.

Sea Salt (Chloride of Sodium)	{ Chlorine { Sodium	Chlorine
Sulphuric Acid		{ Sulphate of { Soda
Peroxide of Manganese	{ Oxygen { Protoxide of Manganese	
Sulphuric Acid		{ Sulphate of { Manganese

SULPHURIC ACID.

Sulphuric acid (vitriol) is composed of sulphur and oxygen.

SULPHATE OF SODA.

May be obtained from the residue left in the manufacture of hydrochloric acid by neutralising it with carbonate of soda and crystallising from solution of water.

HYDROCHLORIC ACID

May be obtained by the following process: *—take of

Chloride of sodium, dried . .	48 ounces.
Sulphuric acid	44 *fluid* ounces.
Water	36 ,,
Distilled water	50 ,,

MANGANESE

Manganese is a metal which has such a strong affinity to oxygen that it is never found in a state of a regulus.

The oxides of manganese are most useful minerals, from which, however, the metal is never extracted, they being used in their natural state. From these chlorine gas is obtained, the value of which, for disinfecting hospitals, prisons, &c. is justly appreciated.

Chlorine is also a powerful disinfectant; unlike other substances used for fumigation, such as brown-paper, vinegar, and scents, which merely disguise the ill odours or the mephitic atmosphere, chlorine absolutely destroys them. It is probable that most ill odours

* See 'British Pharmacopœia,' 1867.

are compounds of hydrogen ; hence the chlorine enters into combination with the hydrogen, forming muriatic acid, and the other substance, whatever it may be, to which the hydrogen communicates virulence, falls harmless. The use of chlorine as a disinfectant requires care. It should be used in the form of *bleaching powder*, mixed with water and exposed to the air in shallow vessels, if possible on a high shelf. The powder (chloride of lime) is gradually decomposed by the carbonic acid of the atmosphere, and the chlorine being evolved falls slowly down and is diffused through the room. It must, however, be particularly borne in mind that chlorine in any form must only be used as an aid to proper ventilation. It is a necessary condition of health that our houses and rooms be properly ventilated, and there is no substitute for ventilation any more than for washing or for general cleanliness. Chlorine, like medicine, ought to be used on special occasions and under advice. In a sick room, where proper ventilation is often difficult, chlorine liberated in very minute quantities will often be found singularly refreshing; but in this as in all other cases of fumigation with chlorine, all metals, such as fenders, fire-irons, &c, ought to be removed, for these become speedily tarnished by the action of chlorine. When employed for disinfecting the wards of hospitals, &c., a pound of chloride of lime should be mixed with water in a hand basin and a pound measure of hydrochloric acid be poured upon it. The persons employed in the preparation of the materials should tie a wet sponge over the nostrils before going into the rooms. In the preparation of this gas care must be taken not to allow it to escape in any quantity, as it is very suffocating, producing cough and irritation when inhaled only to a small extent.

Chlorine may also be readily procured by pouring strong muriatic acid upon finely powdered black oxide of manganese contained in a retort or flask and applying a gentle heat.

BLACK WAD.

This is an old English name for hydrated peroxide of manganese.

PEROXIDE.

That oxide of a given base containing the greatest quantity of oxygen.

CHLOROFORM.

Chloroform is prepared upon a large scale by continuously distilling good commercial chloride of lime, water, and alcohol. The whole product distils over with the first portion of water. When this vapour is inhaled it produces insensibility more rapidly and effectually than other vapours, hence its use in the performance of painful surgical operations. When a few drops are placed upon the hand evaporation speedily goes on, and produces a great degree of cold. Professor Brande says, 'When poured upon water the greater part sinks in globules, which are of a milky white appearance when the chloroform is not perfectly free from alcohol. It is so little soluble in water that three drops added to nine ounces of distilled water and well shaken did not wholly disappear, although they imparted a strong odour to the liquid.

Another important use of chlorine is in the preparation of bleaching powders.

BLEACHING POWDERS.

Mr. Tennant of Glasgow took out a patent in 1798 for a method of making a saturated solution of *chloride of lime* for bleaching purposes, perfectly successful, but not new. Tennant, however, was led by subsequent investigations to a method of *impregnating lime in a dry state with chlorine*, thus producing the celebrated *bleaching powder*.

The chlorine is obtained from common salt (chloride of sodium), by the action of black oxide of manganese and sulphuric acid.

ON ATMOSPHERIC AIR.

As the sea contains a little of everything that is soluble in water, so the atmosphere contains a little of everything capable of existing in the gaseous form at common temperatures. Ammonia is always present, and is supposed to be the source of nitrogen in plants. While in crowded cities, and in the neighbourhood of gas-works, smelting furnaces, sewers, stagnant pools, sulphur springs, &c., there is much local contamination of the air from the presence of different gases. Various forms of infection, malaria, and marsh-miasma probably arise from the presence of noxious gases in the *air*. Berzelius states that, in the first experiments which he made upon seleniuretted hydrogen, he let up into his nostrils a bubble about the size of a pea. 'It deprived me so completely of the sense of smell that I could apply a bottle of concentrated ammonia to my nose without perceiving any odour. After five or six hours I began to recover the sense of smell, but a severe catarrh remained for about fifteen days.'

On another occasion a little of the *gas accidentally escaped.* It produced a sharp sensation in the nose, red eyes, and a dry and painful cough which at length was succeeded by expectoration, tasting like the vapour from a boiling solution of corrosive sublimate. 'These symptoms were removed by a blister to my chest. The quantity of seleniuretted hydrogen gas which on each of these occasions entered into my organs of respiration, was much smaller than would have been required of any other inorganic substance whatever, to produce similar effects.'

Dr. Prout quotes these facts to show how small a quantity of accidental ingredients diffused in the atmosphere may produce powerful effects in the human system, and may even be the origin of influenza and other epidemic disorders.

When I wrote my 'Science applied to the Washing of Linen' I was not aware of the various chemical combinations which enter into the powders and other modern cleansing materials which are asserted to be, by their inventors, perfectly harmless, but which, on the contrary, when exposed to heat, as they must be when employed in the processes of the laundry, emit fumes of the most poisonous nature, which, when inhaled by the laundresses, generate internal injuries to the lungs and throat, blister the feet and hands, and paralyze them.

It was my ignorance of scientific chemistry which caused the serious sufferings which I underwent ; for although I was told by my medical advisers that I had inhaled poisonous fumes, I was ignorant of the source and nature of these fumes.

Afterwards I consulted all the best books of manufacturing and medical chemistry, and thus became aware of the care and caution employed and enjoined in the preparation of the chemical materials composed and employed by the manufacturers and the medical profession.

For example, I may mention the care and caution which all chemists enjoin in the preparation of the ingredients for making chlorine into bleaching powder.

The workmen are ordered to tie wet handkerchiefs over their mouths before they enter the workshop. I did not know anything about chloride of lime; I was only told it was an invaluable disinfectant. But when I was informed that the French suffered more in health than the English in consequence of the greater use they made of chloride of lime employed in washing linen sent to a common laundress, I have no doubt but that my illness was caused by the chloride of lime; by constantly pouring boiling water on linen dipped in chloride of lime to deodorise it; by adding the powders which contain the same ingredients, and also an unlimited quantity of soda used in washing with hard water. My surmises were right. We were overdone with soda by the modern system of washing linen.—See 'Science Applied.'

It is not surprising that our health as well as our linen is injured by the modern system of washing and purification of our drains, when uneducated laundresses and domestic servants use this disinfectant so freely. Chloride of lime can be bought for a penny a pound in *powder*. We have nothing to do but to add a certain quantity of water to make it into chloride of lime. Our linen is dipped into it to take out the stains, and purify it from infectious disorders. Many laundresses after washing the linen, powder it with lime to whiten it, and then hang it up to dry. Chlorine stains the linen yellow like a mordant in dyeing, which compels the laundresses to use powder blue to disguise the unsightly appearance of linen so stained. Even highly educated women may and do injure their health from their ignorance of the elements of chemistry, and often shut the doors and windows so that none of this invaluable disinfectant may escape into the outer air.

It was this ignorance of scientific chemistry which caused me such serious sufferings; for although I was told I had enhaled posionous fumes, I was ignorant of the nature of these fumes. But I have now learnt that it was sulphuric acid (vitriol) which burnt my hands and feet, and blistered my tongue and throat. It was the constantly inhaling chloride of lime which deadened my circulation. It was the chlorine which tarnished my guard ring. It was the muriatic acid which shivered my wedding ring.

Why are so many female domestic servants out of place, in London, at the present time from poisoned fingers?

This fact is easily accounted for. They are obstinately bent upon putting an unlimited quantity of soda in the water used for cleansing the house; they say they must and will have it, they cannot do their *dirty* work without it. Chloride of sodium, the lime and inert matter in the cheap soap, and hydrogen, make *chloride of lime*; so that they not only poison and injure their hands, but in like manner injure our paint and floor-cloths.

Why are the helps to laundresses injured in health by the modern system of washing linen? I have in my employment at the present time an honest, industrious woman. She had been laundress for seven years in a public establishment for taking in washing. When the washing powders were introduced she fell ill. She had inhaled poisonous vapours, which injured her lungs, and her fingers were paralyzed. She must have earnt high wages, as she is a most skilful laundress, and can get up linen with her poor maimed hands in a first-rate style. As I consider myself a good judge of her work, and as she has washed for me under my own superintendence in London, my opinion of her merits may be implicitly relied on.

It is the chloride of lime which paralyses the unhappy helps to laundresses, and unfits them for work, if it does not cause them to fall down dead whilst at work, from an early hour to a late one, all day and every day. They cannot escape from it as I did, and yet how I suffered, as Dr. Miller justly described my state of health as the distressing symptoms under which I laboured. This fact fully proves, if proof were needed, the advantages of knowledge, and the disadvantages of ignorance, if we apply our knowledge to a good and useful purpose.

The elements of every branch of knowledge are unfortunately the most difficult to acquire, because we are unacquainted with its nomenclature. The learning of our letters, the connecting of these letters into syllables, the combining of syllables for the formation of words in the construction of sentences, appear in early years almost insurmountable difficulties ; but we did overcome them : and in like manner we should in a very short time overcome the difficulties in learning the alphabet of any complicated science. In order to vanquish the repugnance we naturally feel to learn the elementary part, we must be first stimulated by a prospect of the pleasure which the knowledge of the subject will afford us, or the profitable use we may make of it. Having pointed out the evil and the cause, I must try if some remedy cannot be found to cure, or at least to mitigate, the destructive elements lately introduced into domestic economy.

Philosophers have observed in the material world two great antagonist powers—attraction and repulsion. They are, so to say, the sympathy and the antipathy of matter. The first of these powers, or attraction, is that which draws together molecules of the same, or of different natures; in the first case it is called attraction of aggregation—by it the particles of a body, whether simple or compound, are mutually attracted and cohere. The attraction that exists between particles of different natures is called affinity; a power commissioned to operate unceasingly those wonderful metamorphoses by means of which the leaves of the mulberry-tree are converted into silk, the juice of the grape into nectar, alum and lime into sapphire, aeriform substances into fluids, and fluids into solids; in a word it is by the play of affinities that minerals are changed into vegetables. Matter is indestructible, and corruption but the first step towards a new transformation. The seed perishes only to resuscitate in the form of a flower, the flower fades but to change into fruit.

Independent of the antipathy of certain substances to a connection with others, there is one which, if it could, would keep them all for ever disunited; this great repulsive force is called *caloric*, supposed by some to be a fluid of infinite rarity, but which in fact is known only by its effects. It insinuates itself between the particles of bodies, and urges them beyond the sphere of their mutual attraction. A striking instance of attraction, is the strong affinity exhibited by potassium and oxygen, the former being never found but united with the latter. For many centuries the compound was considered a simple substance, under the name of pure or caustic potash. The scrutinising eye of modern science, however, discovered the truth; Davy, calling to his assistance the power of galvanism, effected their separation. Potassium is a *white* and beautiful metal, while oxygen is the most energetic of material substances. The latter may be likened to a vain inconstant youth, who, conscious of his importance, forms companionships often without attachment, which he quits without regret for new connections. His greatest predilection is for potassium, and not without reason; for such is the ardent attachment of potassium for this flighty and capricious being, that he seizes him wherever he finds him, and should this happen to be in certain company, as for instance with hydrogen, his jealousy knows no bounds; heedless of éclat, he literally sets fire to water, and in the midst of the conflagration vanishes from sight with his beloved friend. But to leave all metaphor, such is the affinity of potassium for oxygen, that when the former is thrown upon water, it seizes the oxygen of the latter with such avidity that the mass inflames, and being dissolved by the water disappears.

WHAT IS CAMPHOR?

Camphor is the produce of the *Laurus camphora*, or Camphor Laurel, of Japan or China. The roots and wood are chopped up and boiled with water in an iron vessel, to which an earthen head containing straw is adapted; and the camphor sublimes and condenses on the straw. In China, the chopped branches are boiled in water till the camphor begins to adhere to the stirrer; the liquor is then strained, and the camphor concretes on standing; it is afterwards mixed with finely powdered earth and sublimed from one metallic vessel to another. Two kinds of unrefined or crude camphor are known in commerce. Dutch, or Japan camphor, also called tub camphor from the circumstances of its being brought from Batavia and reported to be the produce of Japan in tubs covered with matting, each surrounded by a second tub secured on the outside by hoops of twisted cane. Crude camphor very much resembles moist sugar before it is cleaned; it is refined and converted into the beautiful well known article sold in the shops, by sublimation. Camphor is a white and semi-transparent solid of a crystalline fracture, a peculiar fragrant odour, and a warm, pungent, and somewhat bitterish taste, accompanied with a sense of coldness on the tongue. It is soft and tough, but can be readily pulverised if moistened with a few drops of spirits of wine. It evaporates in the air at ordinary temperatures, and gradually sublimes in close vessels and attaches itself to the surface the most exposed to the light. If a vessel exhausted of air and containing a piece of camphor be exposed to the direct rays of the sun, these crystals will be formed speedily. When small pieces of perfectly clean camphor are allowed to fall upon the surface of pure water, they rotate and move about with great rapidity, sometimes for several hours together ; but if whilst the camphor is rotating, the surface of the water be touched with any greasy substance (a glass rod dipped in turpentine answers best) all the floating particles quickly dart back and are instantly deprived of all motion. The motions of the camphor are accelerated by placing the glass in vacuo. Camphor fuses at 347° and boils at 399°, when it may be distilled without decomposition. Camphor is sparingly soluble in water ; it is very soluble in alcohol, ether, acetic acid, sulphuret of carbon, and some other substances. Considerable use is made of camphor in medicine both as an external and internal remedy ; but it ought never to be taken internally except under medical advice. A dose of two scruples appears to be sufficient to cause death.

ON SOME NEWLY DISCOVERED PROPERTIES OF CAMPHOR.

The disinfectant qualities of camphor are well known to all chemists, but the properties I am about to describe are not mentioned in any of the books which profess to treat of this substance and its uses.

I myself was led to their discovery quite accidentally in the following manner. While staying at St. Leonards in January 1869, for the benefit of my health, I was preparing to test some linen, when I found the smell of it so offensive that I sprinkled some powdered camphor upon it. But having exhausted my stock of this substance, I went out into a chemist's shop to buy some more. He told me he did not keep it ready powdered, but would prepare some and send it to me. I replied, 'Give me some in lumps, and I will powder it for myself, as I am in a great hurry.' He said, 'You cannot do it without adding spirits of wine.' When I got home I took a bit of camphor and rubbed it on my hands, as I liked the smell of it—I had already rubbed my hands with soap—I then observed a beautiful white lather on my hands, which I washed off, and beat the suds in the basin. As I was using cold hard water, I was rather astonished to find that the more I beat the higher the lather rose; it overflowed the basin. I was still better pleased to find that my hands, which had been burnt and injured by my previous experiments, when wiped dry felt quite soft. I thought I would not waste the beautiful sud, but try the effect of it on a bloody pocket handkerchief without touching it with my hands. I had no sooner poured the sud on the linen than one large spot of blood dried up and left no trace of its existence, except a small crumb of dirt, which I picked off with a pin. I then gave it two or three whirls with a stick, rinsed it in clean cold water, and hung it up to dry in the air. When dry, it was beautifully white and clean. As I had been so kindly requested not to continue my chemical experiments and fancying that such a change could not be effected without some cause, and that perhaps as two poisons when united become harmless, in like manner two substances which appeared to me harmless, might when united, form a poison, I therefore waited until my kind experimentalist had time to come and see me wash. His opinion was that I could do myself no possible harm in making any experiments I pleased; that there could be no doubt about the fact, but that he could not account for it. I offered to give him a piece of my soap, and also a lump of my camphor, but he said, 'No, thank you, I should prefer having this pretty little piece which you have been using, and also the same piece of soap,' evidently not believing that I had not done something surreptitiously.

'Mrs. Willis! you must do something!' In his opinion, it was so absurdly simple, and at the same time so useful and important a discovery, that I ought not to keep it secret. How was I to make it generally known; nobody could do it unless I showed them how. I did not believe he could make the same sud that I did, although I showed him how I did it, and tried to teach him. He replied, 'That is very true, you certainly have very dexterous fingers and a quick perception of any chemical change.' Having gained his permission and being nothing daunted, I continued my experiments, and finally succeeded in consolidating these beautiful soap bubbles. When so consolidated I tried the effect on coloured articles, and washed a bit of blue ribbon which was rather the worse for wear. This at once became 'rajeuni.' I then washed an embroidered smoking cap with a purple velvet crown, the colour of a beautiful violet, that came out of the basin better than new; the pile all raised, the white, black, yellow, pink, brown, blue, dark and light, green, dark and light, did not run into each other, but came out brighter and clearer than when I first worked it.

ANALYSIS OF CAMPHOR.

According to Dr. Ure's 'Analysis,' 100 parts of camphor contain 77·38 carbon, 11·14 hydrogen, and 11·48 oxygen.

My opinion is that the chemical change takes place when the potassium in the soap seizes on the oxygen and sets fire to the hydrogen.

My success as a scientific laundress no longer puzzles me.

Diamonds, rubies, emeralds, sapphires, and all the gems of the earth assist me in my arduous labours of cleansing and purifying linen. Are they not all carbon ?

ON CARBON.

Carbon, an elementary substance of first-rate importance in chemistry, both organic and inorganic, and also in the useful arts.

It is very widely diffused throughout the kingdom of nature, and exists under an immense variety of forms.

The purest form of carbon is the *diamond*, which is found throughout the range of the Ghauts in India, at Golconda, in Borneo, in Brazil, and latterly at the Cape of Good Hope. The Brazilian mines are said to furnish from 10 to 13 pounds weight of diamonds every year, of which not more than from 800 to 900 carats are fit for jewellery.

The diamond is the hardest of gems. It is a non-conductor of electricity; it is not acted on by any solvent, nor is it affected by heat only, for it may be heated to whiteness in a covered crucible without injury; it burns in the open air at and about the melting point of silver, charcoal sometimes appearing on its surface, and it is entirely converted into carbonic acid gas. According to a recent experiment, when exposed to the very high temperature produced by a Bunsen's battery of 100 plates, or by a condensed mixture of carbonic oxide and oxygen gas, the diamond fuses, and is converted into a mass resembling coke; its specific gravity is thereby reduced from 3·336 to 2·678.

Charcoal is another well-known form of carbon. It is obtained in abundance by the destructive distillation of various organic products, and its appearance and properties vary with its source. If a chip of wood be ignited, the volatile matters burn away with flame, and the carbon that remains retains for some time a red glow; but if, as soon as the flame be extinguished, the chip be inserted in a narrow glass tube, so as to cut off the supply of oxygen, the carbon or charcoal will cool without burning away.

Charcoal may be prepared by heating to redness pieces of wood in a close vessel, or in a crucible filled up with sand, so as to protect the wood from the destructive action of the oxygen of the air.

When all the volatile matters have been expelled the charcoal remains as a black, brittle, porous mass. A very pure charcoal may be obtained by heating in close vessels sugar, and some other substances which do not contain nitrogen; and by passing the vapours of certain hydrocarbons, and of oils, alcohol, and ether through porcelain tubes raised to a white heat, carbon is deposited in a very pure form.

Charcoal is a black, brittle, insoluble, inodorous, tasteless substance.

It is a good conductor of electricity, but a bad conductor of heat.

It burns with great ease in oxygen gas, but does not change by the action of air and moisture of common temperatures.

When pure, it is infusible at all known temperatures.

One of its most valuable properties is that of destroying the smell and taste of a variety of vegetable and animal substances, and of abstracting certain substances dissolved in fluids.

Piles are charred at the end before driving, and the coat of charcoal protects them from decay. Water casks are charred on the inside to preserve the water sweet, and charcoal thrown into putrid water will take away the offensive character.

Water contaminated with sulphuretted hydrogen is entirely deprived of that offensive gas if shaken up with well-burned charcoal.

Charcoal deprives many solutions of colour, and hence is most extensively used in refining sugar.

Charcoal dust has been used as a polishing powder, and it gives a fine polish when rubbed on metals. This property does not belong to every kind of charcoal.

Aqueous vapour is greedily absorbed by newly made charcoal, and the absorption both of this and of the gases depends in some way upon the mechanical texture of the charcoal, and varies in different woods.

Thus it has been found that by a week's exposure charcoal made from—

Lignum-vitæ	gained	9·6 per cent.
Fir	„	13· „
Box	„	14· „
Beech	„	16·3 „
Oak	„	16·5 „
Mahogany	„	18· „

Wood charcoal contains about one-fiftieth its weight of alkaline and earthy salts, which remain in the form of an ash after its combustion; but the quantity and quality of this ash varies in different trees and plants.

For investigations into the modern system of washing linen, my path appeared to lie in trying to improve myself in chemistry, as I had been in early life interested in that subject. It had always been a pleasure to me to watch chemical changes; in making preserves for instance, or boiling sugar to a crack, &c. &c., if you do not stop at the right time, or when *the chemical change* takes place, the sugar returns to its primitive state (molasses); so in making casts with plaster of Paris, if you are not quick in observing *the chemical change* it turns to stone before you can pour it into the mould. In preparing medicines the Pharmacopœia tells us what care must be taken in mixing and separating drugs, or they might kill more patients than they cured. In metallurgy, in purifying gold, or other metals, the chemical change must be carefully watched to enable you to separate the pure metal from its alloys.

My kind friend, the late Dr. Miller, entreated me not to go on making chemical experiments. I was not to think it was any trouble to him to make any analysis for me that I wished, as he would do it for me with pleasure. All I was allowed to do was to read any chemical treatises I could get hold of, in order to make known my wants as a scientific laundress. I was surrounded by noxious gases and poisonous acids, hydrocyanic, oxalic, muriatic, arsenic, &c. When I came to lime I wandered out of my road and pursued a far pleasanter path; lime pointed to 'minerals and their uses.' Chemistry informed me that camphor contained hydrogen, oxygen, and carbon. Mineralogy enlightened me by showing me that the diamond is the only pure unadulterated carbon. If we take away hydrogen and oxygen from camphor, there only remains pure carbon to mix with a fresh supply of hydrogen and the other cleansing properties contained in the best soap.

Although my husband does not pretend to be a scientific chemist, he has helped me in my investigations far better than a master of any one branch of science could do, for he has taught me to value mathematics, and apply geometry in almost every branch of domestic economy, and fine art. No man or woman can excel in any science or fine art unless they learn the grammar of these sciences. That grammar is the elementary part of pure mathematics. That study is the only one which teaches us to think. It is quite a mistake to suppose that we can excel in any subject unless we first learn to arrange our ideas in a clear mathematical form. All females ought to be taught arithmetic, to enable them to be economical managers and sum up their household expenses with accuracy and without fear of making an erroneous balance.

CONCLUSION.

I have been encouraged to publish this 'Essay on Practical Experimental Philosophy' from the encouragement and support I derived from that great and good man the late William Allen Miller, M.D., D.C.L., F.R.S., &c. &c., Professor of Chemistry at King's College, Strand, London.

Quotations from some of his letters:—

'Saturday, January 16, 1869.

'I hope to see you this afternoon to tell you about the washing powders.'

'June 7, 1869.

'I am glad to hear that you are making satisfactory progress with your investigation, and shall be very glad to call and hear what you have been doing.'

'October 1869.

'Mrs. Willis is quite right in her chemistry. Linen washed by the modern system at a common laundry would not only *aggravate* but *generate* scarlet fever, typhus fever, small-pox, and all irruptive disorders, more easily contracted than cured.'

'W. ALLEN MILLER, M.D.

'D.C.L. of Oxford and Cambridge, V.P.R.S.'

INFECTION FROM THE LAUNDRY.

Experiments have recently been conducted at the Birmingham Children's Hospital which point most conclusively to the fact that scarlet fever is communicated in numberless cases through the medium of the laundry. It has always been a recognised fact with medical men that the clothing of fever patients is a medium of infection; but it is only now the important fact has been elicited that the mixing of such clothes with others in the wash is an active agent in the spread of the disease. The experiments at the Children's Hospital have resulted in the establishment of a very important matter, viz., that when the clothes of the patients in the infectious ward are washed separately from those of the other patients, those other patients do not incur scarlet fever. The observation of members of the faculty having been drawn to this fact, they carried out the principle still further, and watched its development with the narrowest care. Amongst the results it was established that the patients in the ward over the laundry were more frequently attacked than those in distant wards.

It was the washing at home with good soap, rain water, and pure spring water, in *unlimited quantities*, and no soda, which has restored my health.

Dear little children, don't be afraid, take firm hold of grandmamma's hand, cling to her, put your soft arms round her neck; under the blessing of our Heavenly Father and Physician, she will try and save you from your fearful sufferings.

If I have done good work, if I deserve the thanks, blessings, and praises so abundantly showered down on me, I owe it all to the loving teaching throughout my life of men of sound learning and professors of true science rightly applied. A ray of light from their pure torch has spread its beams on me, and guided me through the perils, dangers, and darkness which surrounded me.

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