solution of potash, etc., present no difference to a child or a savage; neither would their contents be considered anything else than water if they contained a solution of some nitrate, chlorate, sulphate, sugar, strychnine, veratrine, ammonia, cyanide of mercury, and so forth. In like manner, all the metals present what is termed the "metallic aspect;" they all show a great similarity of physical and chemical properties, so that tin, silver, cadmium, zinc, antimony, sodium, magnesium, aluminum, lead, etc., would readily be mistaken one for the other by a child or inexperienced person. Again, the alkaloids, sugars, glucosides, essences, etc., all present a great similarity in their physical and chemical properties, a likeness which extends to their therapeutic qualities also.

Another fact, which has often struck chemical philosophers, but has hitherto baffled all attempts at explanation, is that of all the numerous elements, or simple bodies, which compose our globe, *four alone* are found sufficient to build up the whole of *organic nature*, and to form the thousands upon thousands of substances known as *organic compounds*.

One more fact, which is amply demonstrated by the numerous analyses given in one of our works, is that meteors or aerolites coming from distant regions of space bring no unknown matter to our globe; they are composed of the *same materials* as our earth. It will be seen by what follows that the same materials may possess *different properties*, according to the circumstances in which they are placed.

A phenomenon readily explained by our new atomic theory, though it has hitherto not been accounted for satisfactorily by any hypothesis, is that observed when two substances of heterogeneous natures, such as two metals are brought into contact; an electric current, or electric, calorific, or magnetic manifestations immediately occur.

The old notion that matter is composed of "atoms and spaces" is doubtless correct, and it can be argued successfully that atoms are extremely minute spheres. When one substance is divided by another (as when an apple is cut by a knife), the latter passes between the atoms, for *matter is impenetrable*, that is, say, the same space cannot be occupied at the same time by two groups of matter, or by two substances; one must make room for the other, and the *space between the atoms* is what we designate as *phlogiston*.

The whole question of the atomic constitution of matter is contained in the theory of equal gaseous volumes, or better, of the *combining volumes of matter in the state of gas*. When we consider this subject, we are met at once by a dilemma. Physical experiment having shown that between certain limits of temperature equal gaseous volumes dilate or contract equally for equal amounts of heat or pressure, it was argued that equal volumes of gases contain the *same number of atoms of the same size* and placed at the *same distance* apart. This, of course, implies that the atoms are of *different weights* (for instance, the atom of H weighing 1, that of N weighs 14, etc.)

But it soon came to be seen that this could not be, because in equal volumes of certain compound gases we know that there cannot be an equal number of atoms.

The next supposition was that the atoms in equal gaseous volumes may be of *different sizes*. Thus the atom of H would be 14 times smaller than the atom of N, etc. There is nothing to be said against this hypothesis, except that it does not explain anything; it merely asserts that the atom of N is 14 times as heavy as the atom of H, because it contains 14 times more matter. This notion is, on many accounts, improbable, unphilosophical, and explains nothing. But another proposition, which we shall now put forward, does explain a number of phenomena that otherwise we find it impossible to account for.

This proposition is that equal gaseous volumes contain a *different number of atoms* all of the *same size* and *same weight*. This implies that the atoms are all of the *same nature*, and proclaims the *unity of matter*.

Whatever substance may be under consideration, its atoms are all of the same nature, and they are separated by space, which we call *phlogiston*, a term that implies movement, light, heat, electricity, etc. The greater the amount of *phlogiston*, the greater the *energy* of the system of atoms termed *element*. Thus H is the most energetic system of atoms yet known; it has the greatest amount of *phlogiston*; in other terms, the motion of its atoms is the most extensive.

The matter of all the *elements* is, therefore identical; the *phlogiston alone varies*, that is, the *distance* or *space* between the atoms (considered at rest), or their *extent of motion*.

A chemical *element* is, therefore, a *system of atoms*, the nature or properties of which system depends on its *phlogiston*, and the amount of the latter is deduced directly from the balance—from the *weights which combine together*. Thus, in equal gaseous volumes of H, N, Cl, etc., we admit that there exist, say, 10, 140, 350 atoms of the *same size, same weight, and same nature*; and if we could volatilize without decomposing solid bodies, such as sulphate of iron, for instance, so as to consider them under the same gaseous volume, we should find the same law hold good for them, and that an equal gaseous volume of ferrous sulphate, for example, would give, as compared with the substances above named, 760 atoms of the same nature as those of H, N, or Cl.

It will be seen by this that the *properties of a substance* depend not on different kinds of matter, but on the different amounts of *phlogiston* that separate the atoms and cause them to move in certain set systems. The atomic system called H is different from the atomic system called N, because the atoms of the latter system are separated by less space; the system possesses less *phlogiston*.

We thus see that, as everything depends on gravitation, the systems of atoms (elements) known as iron, oxygen, sulphur, etc., on this globe may possess very different properties on the planets Venus or Jupiter, for instance, on account of the different distances of these planets and our globe from the sun.

Spectral analysis, like the fall of aerolites, proves that the same nature of atoms exists in far off globes as with us; but we see that the properties of a substance depend on its *phlogiston*, which, in its turn, depends on gravitation, so that, although the matter is identical with that of our earth, the physical and chemical properties must be different from what they are upon this globe.

We also see how the whole *organic world* is made up

of a few systems of atoms (elements) only; they are those which contain the *most phlogiston*, and consequently possess the most energy; they constitute the nearest approach to *vitality*.

Again, when two heterogeneous systems of atoms are brought in contact, a vibration ensues such as astronomers have termed *perturbation*; it is caused by a slight *deviation of the movement*, a slight *change in the phlogiston* (which may be temporary or permanent), and is carried away along a "conductor," in the form of what is called an electric current, or otherwise. In *allotropic* bodies the original *phlogiston* is more or less permanently modified; and, could this allotropism be pushed far enough, the "transmutation" of the elements would undoubtedly ensue.

It will be perceived that this theory explains a mass of facts which are not even alluded to in the foregoing notes; and though it leaves unaccounted for a certain number of physical phenomena, these will probably be explained in time without disturbing it.

PROPAGATION OF LIGHT.

By J. H. POYNTING, M.A., and E. F. J. LOVE, B.A., Birmingham.

THE paper describes a new method of proving that the intensity of illumination of a screen varies inversely as the square of the distance from the source. The same experimental arrangement, with slight modification, allows us also to prove the law of absorption of light—a law which, we believe, has hitherto been assumed without verification by experiment. The principle of the method is as follows: Two illum-

THE PROPAGATION OF LIGHT.

inating surfaces at different distances are viewed through a narrow blackened tube, each surface occupying half the field of view. The illuminating powers of the two surfaces are adjusted, till for a given distance of the tube they appear equally bright. They then appear equally bright for any other distance of the tube. This was verified, both for air and for an absorbing medium consisting of a dilute alkaline solution of phenol-phthalein, which colored the transmitted light violet. From this it can be shown that if I be the intensity of illumination of a screen at distance x from the source, the illumination at a distance x is $\frac{I_0 e^{-cx}}{x^2}$. When $c=0$, the medium is transparent.

When c differs from 0, e^{-cx} is the "coefficient of absorption." The experiments were conducted as follows: A rectangular wooden box, A B C D (*vide* Fig.) was constructed, one end being closed by a glass plate, P P. In the other end, a round hole was pierced, through which passed a brass tube, E, F, arranged to slide in a stuffing box, S. As illuminated surfaces, two pieces of opal glass, O O, were used, illuminated by lamps, H H, whose light was made slowly divergent by lenses, L L, the beams being made rectangular by passing through the slits, K K. The zinc screen, Z, prevented light from the lamps on one side from reaching the opal on the other. To prevent glare in the tube, it was well blackened, and diaphragms employed at Q and R; the orifice at E was $\frac{3}{8}$ in., and at F, $\frac{1}{8}$ in. The end, F, was closed by a glass plate. The experiments were made in air, and also in a violet liquid; and by sliding the lamp, H, on the board, M, through a known distance, the limit of error could be determined. The result was demonstrated with an accuracy of about 1 in 1,000.

A NEW THERMOPILE.*

PROFESSOR GEO. FORBES drew attention to a new thermopile, which he exhibited to the meeting. He said that it was hoped that, by lessening the resistance enormously, an increased effect could be obtained. The result seemed to have justified the theoretical conclusion. He said that the instrument consisted of a blunt-ended wedge of antimony placed upon a wedge of

bismuth; very near the thin end of the composite wedge was a horizontal hole, in which was suspended a reflecting needle, as represented in the cut. The instrument is very sensitive as a line thermopile, and is very dead beat in its action, so that it comes to rest rapidly. One of the light mirrors of Mr. White, of Glasgow, is used in it. He could not conceive how any one could use heavier mirrors. He made the needle astatic by another set of magnets. It then proved more sensitive, but not so dead beat.

Professor Fitzgerald wished to know what was the

* Paper read before the British Association, Section A, Birmingham meeting, 1886.

relative delicacy of thermopiles and bolometers. Langley had given preference to bolometers; but Professor Forbes had said that the instrument before them was as sensitive as any other.

Professor Forbes had only been comparing the thermopile before them with other thermopiles. He believed the bolometer to be much more accurate.

Lord Rosse thought Professor Fitzgerald's problem to be worth going into. He (Lord Rosse) was trying to find out what the merits of the bolometer were, and, in looking carefully over Langley's paper, he was disposed to think that the value of the bolometer had been exaggerated. Langley laid great stress upon improvements in his galvanometer. He used the two wings of dragon flies to make it give a dead beat; it then came to rest, after giving two or three oscillations. He (the speaker) used a thermopile of low resistance and large wires, leading down into the observatory.

Lord Rayleigh was under the impression that Langley's improved results were due more to the galvanometer than to the other instrument. For a thin wire linear instrument to investigate the spectrum, perhaps a thermal couple of equally thin wires might be substituted. Once he had tried Lord Rosse's plan of employing a large disk to receive the heat, and to then transfer it to the thermal junction. It answered well.

Lord Rosse said that the comparison Langley had drawn between two methods of estimating the heat of the lunar rays was hardly a fair one. He (the speaker) had a large mirror to work with in the open air, while Langley worked in an observatory. One could hardly draw a comparison between two such sets of radiation experiments.

Professor Forbes added that a modification of this

thermopile had been made by cutting away some of the two metals and replacing them with copper, so that one thick piece of copper was at the top of the couple and another at the bottom, to increase the conductivity.

PRODUCTION OF NICKEL.

ONLY a few years ago, industrial circles were aroused by the discovery in New Caledonia of highly important deposits of nickel. A company was formed in France to work them, acquiring the patents of Garnier, building works for treating the ore and refining the metal at Septemes, near Marseilles, where the vessels from Nourmea discharged. Later these works were abandoned for a plant at Birmingham. The capital was increased, an alliance formed with a great metallurgical establishment at Glasgow to work other metals besides, like chrome, cobalt, antimony, etc. The abundance and the richness of the New Caledonia deposits, and the strong financial backing which the enterprise had, seemed to assure for it a bright future. It was expected that nickel, produced at a low price, would in many directions displace copper, and that the production would keep pace with the steadily growing consumption at gradually declining prices. Such, according to M. Charles du Peloux, in the *Genie Civil*, was the outlook in 1882. Now, the works at Nourmea are closed, and work at the mines is reduced to what is absolutely necessary.

The ore, known as "garnievite," is a hydrosilicate of nickel and magnesia, and is found at a great number of points in Caledonia; in fact, it may be stated that, with the exception of the northeast end, traces of nickel may be found in all parts of the island, which is made up of more or less decomposed eruptive rocks, among which serpentine plays the most important part. The nickel ore is always found in the beds of serpentine. Still, though apparently so abundant, the ore is found in quantity and accessible in workable deposits only at a very few points in the districts along the northeast coast of the island. After examination these rich regions are reduced to three principal districts, named Canala-Méré-Kuana, Thio-Port Bouquet, and Bourindi.

The Thio group is the only one now being worked, and is the best known, and is considerably nearer Nourmea. Although it has been well opened out in all directions during the past six years, it is far from being exhausted. The third district, the Bourindi, is probably justly considered the richest on the island, both for quantity and grade of ore. It is nearest Nourmea, and has not been touched as yet. It is kept as a reserve.

The veins, so far as strike and dip are concerned, are fairly regular, striking north-northeast and south-southwest, and dipping almost vertically. But the contents vary widely and suddenly in grade. The veins are not very persistent, and it is asserted, after an experience which must be considered final, that in depth they do not descend deeper than 300 to 500 feet, that depth even being very rare. The ore is mined by the usual methods, and is hand-sorted at the mine and sacked. M. Du Peloux describes in detail how frequently the ore is handled, evidently disapproving of it. He enumerates that the ore of the Thio district—best equipped with means of transportation—is handled twelve times. This is partly due to the fact that the sacks are taken to the river bank, the bar at the mouth of which they can only cross at flood tide, and that the beach is so shallow that the ore must again be lightered to the sea-going vessels in the offing, who carry it to Nourmea, where the smelting works are located. Thus the irregularity of the ore distribution and the high cost of transportation carry the expense of mining high. To this must be added the scarcity of suitable labor in New Caledonia. Among the force available are, first, those criminals transported who are liberated with residence restricted to the colony. They are lazy and difficult to handle. They get from six to nine francs for eight hours' work. Then there are the natives of the New Hebrides Islands, engaged under supervision of the government for a period of three to five years. Although apparently cheap labor, they cost three francs a day, are unfit to work in the