gravelly, they should be employed. Then a roof should be erected of boards, and made water-proof, and there should be a door. The cellar should be dark, and then a load of horse manure should be packed against the entrance. Celery placed in the cellar and covered with sand often comes out green, and loses its delicate flavor. The celery can be taken out every day, and is ready for the market, and is wholly unlike the stuff sold in this market. It will be found that the celery put out the first of May is better than when it is stored in November. Mr. Roessle expended \$1,000 in experimenting on celery, and is decidedly in favor of two hillings, and has adopted such a plan in cultivation and blanching as has been described.

As to the soil, Roessle raised celery successfully on an exclusively sandy soil, and any soil that will hold manure and soil around the plant can be used. It can be put in as a second crop, after the harvesting of other vegetables, and it will stay until the frost comes. It is not difficult to cultivate celery after a man has got his hand in.

In reply to several questions, Dr. Robinson said that in packing the celery it should stand up; should say that soil best adapted for peas and potatoes was equally good for celery; think that the roots would be more likely to keep moist were the plants set from six to eight inches apart; the seed should be sown the same as turnips; there was another kind of celery known as celeriac or turnip celery, highly prized by the Germans, who use the bulbs for sauce; seaweed would be a good covering, as celery is fond of saline soil; only one row was necessary in the trench; prefer one good, solid, honest stock to the Boston sprout celery, and the flavor is superior; thought that the plants should be grown in the shade to insure a vigorous growth.

A gentleman formerly residing in Lewis county, in northern New York, where the climate was invariably cold, stated that he had raised excellent celery, and in blanching it he put down stakes and covered them with boards, two feet apart, filling in carefully with earth. He had tried the experiment of leaving the plants out all winter, with excellent results. The profits were enormous, and he had realized from a patch fifteen feet square the sum of \$10, and had plenty beside for his family. The celery was covered with snow during the winter, and came simultaneously with the frost which froze the plants solid.

VITALITY OF CARBUNCULAR GERMS.

By M. PASTEUR.

AT a farm near Senlis, cattle which have died of carbuncular fever twelve years ago have been buried at a certain spot in a walled garden. Samples of the soil were lixiviated and concentrated, and guinea pigs inoculated with the matter died quickly with well-marked symptoms of carbuncle. Of seven sheep allowed experimentally to pass a few hours daily on this spot, two died of the same disease in the course of six weeks, while the rest of the flock from which the seven had been taken remained healthy.

NITROGEN. SYMBOL N. COMBINING WEIGHT, 14.

By T. A. POOLEY, B.Sc., F.C.S.

THIS element, which must next engage our attention, is one which is widely distributed, although not to the same extent as the two elements we have already studied. The mere fact that nitrogen constitutes four-fifths by volume of our atmosphere, makes the study of this element of importance. It is also a constituent of the nitrates of potassium and sodium, large beds of which salts are found in some parts of the world; both nitrates and nitrites are frequently met with in well waters, and nitrogen also occurs in coal and some minerals, and it is an important constituent in the tissues and juices of both plants and animals. The name nitrogen signifies niter producer, and was originally given on account of the occurrence of this element in niter; but French chemists have a far more appropriate name in *azote*, which signifies a depriver of life, and refers to the principal property of nitrogen.

Nitrogen can be easily prepared from atmospheric air, which consists of a mechanical mixture of this element with oxygen, by removing the latter by means of some substance possessing a strong affinity for it. Any combustible body will answer for this purpose, but the choice should be made of one that forms a product soluble in water, so that it can be easily removed. Phosphorus is by far the most convenient, although great care must be taken in handling so inflammable a body; to prepare nitrogen from air, all that is required is to burn a little piece of phosphorus placed in a cup under a bell jar, standing over a basin of water; when the phosphorus is lighted it commences to burn, and combines with the oxygen, eventually removing every trace of this element; the product is phosphoric anhydride, which rapidly combines with and dissolves in the water, forming phosphoric acid. The residual gas, which on cooling will be found to occupy only about four-fifths of the original space, will be pure nitrogen. There are other methods of isolating this element, but their description would be beyond the scope of the present articles.

Nitrogen is a colorless, tasteless, and inodorous gas; it has a specific gravity of 0.972, being slightly lighter than air or oxygen; it is most inert, and only combines directly with other elements with the greatest difficulty; it will neither burn nor will it support combustion, and therefore a lighted taper plunged into a jar of this gas is immediately extinguished; it is also inimical to animal life, but at the same time it is not poisonous, as is seen by the fact that we are continually inhaling it with the air we breathe; an animal placed in an atmosphere of pure nitrogen will soon die, but not by poisoning, but rather by suffocation, due to the absence of the gas oxygen, which is absolutely necessary to sustain life. Although nitrogen will not easily combine with oxygen or hydrogen, several compounds formed from these elements are known, the properties of which we shall in due course refer to, but at the present stage it will be more convenient to study the properties of the atmosphere.

The atmosphere which surrounds our globe and extends to a height of about forty miles is not a chemical compound, but simply a mechanical mixture, the principal gases being oxygen and nitrogen. The following are the proportions by volume and weight of these two constituents:

	By volume.	By weight.
Oxygen	21	23
Nitrogen	79	77
	100	100

This proportion is very uniform in all parts of the world

and at all altitudes. This has been proved by samples having been drawn from valleys, from the summit of high mountains, from above the center of the Atlantic Ocean, all of which possessed identically the same composition so far as the proportion of oxygen and nitrogen is concerned. The combining number of oxygen being 16, and that of nitrogen being 14, it will be seen that these two elements are not present in air in these proportions nor in any simple multiple of these proportions; this fact alone would show that air is not a chemical compound, but it can also be proved experimentally in several ways. A very simple method is to pass some atmospheric air through water, by which a portion is dissolved; on boiling this water the gases will again separate and will then be found to consist of one part of oxygen to two parts of nitrogen. If air were a chemical compound the gases ought to have dissolved in the proportion of twenty-one to seventy-nine, but as oxygen is far more soluble in water than nitrogen, we find that the dissolved gas contains a larger proportion of the first-named element. The presence of oxygen in the atmosphere is proved by the readiness with which certain substances oxidize when placed in it; thus iron rusts, carbon becomes carbonic acid at a red heat, hydrogen is converted into water, phosphorus into phosphoric acid, and the many phenomena of combustion all point to the presence of oxygen; but by the tests already given in our study of oxygen the presence of this element in air can be easily proved.

In addition to the two main constituents, oxygen and nitrogen, air contains certain other constituents which are nearly always present, but in varying proportions, according to the locality and the surrounding circumstances. The amount of aqueous vapor varies very much, but air is never found absolutely dry; the temperature, the season, and the altitude all influence the proportion of moisture; the higher the temperature is the more aqueous vapor will air retain, and if the temperature be then lowered the moisture will separate in the form of small globules. In our atmosphere these variations of temperature, combined with other influences, cause the different meteorological changes resulting in rain, deposition of dew, fog, and cloud, which are so frequent in this country. The amount of moisture in the atmosphere may be approximately determined by an instrument called the "hygrometer," which consists of two thermometers placed side by side, the bulb of one being covered with a piece of linen always kept saturated with moisture. The evaporation of water is always accompanied by a reduction of temperature, and the wet bulb will, therefore, always show a lower reading than the dry bulb, the difference between the two bulbs varying with the quantity of aqueous vapor in the surrounding atmosphere. The hygrometer is a most useful instrument, and the observations made by means of it are of especial value to the maltster, the success of whose operations depends to a great extent on a proper knowledge of the amount of moisture in the atmosphere.

Another important constituent of the atmosphere is carbonic acid, which is always present, but which varies considerably in amount. In the open country, over the middle of the Atlantic, and on high mountains, the quantity of carbonic acid does not exceed two parts in ten thousand parts of air; but in large cities, in crowded rooms, and in the neighborhood of manufactories, the quantity is sometimes as much as twenty parts in ten thousand. Carbonic acid is an essential constituent, for it is from this gas that plants derive their supply of carbon; animals emit carbonic acid and plants reabsorb it, and thus the economy of nature is preserved. In the atmosphere of breweries carbonic acid is generally abundant, in consequence of the large volume which is given off during fermentation. The presence of carbonic acid in the atmosphere can be proved by exposing a little shallow dish of lime water, which rapidly becomes covered with a white film when carbonic acid is present.

Other constituents of the atmosphere are ammonia and nitric acid, which are nearly always present, but often in very minute proportions; in some places sulphureted hydrogen can also occasionally be detected, but it is not a normal constituent, and is due to accidental circumstances.

The chemical composition of the atmosphere is a matter of some importance to both brewer and maltster, especially as regards the quantity of aqueous vapor; but, in addition to the gaseous constituents, there are bodies to be met with in the atmosphere which work the most disastrous changes on such unstable fluids as wort and beer; we allude to the minute germs and organisms which the researches of Pasteur have proved always float about in the air. In some places these germs are much more plentiful than in others, and their effects are then soon visible in the putrefactive changes which ensue. When the idea of Pasteur—of manufacturing beer in an absolutely pure atmosphere—can be practically realized, we may be able to obtain a product which can be indefinitely preserved, but at the present time every vat and cask of beer is a prey to the attacks of these myriads of atmospheric germs for which there is no chemical test, and whose presence is only discovered by the disastrous effects produced by their agency.

Compounds of Nitrogen with Oxygen.

There are several important bodies resulting from the combination of these two elements in different proportions. These compounds cannot be produced by the direct union of nitrogen with oxygen, but they have been isolated by indirect methods. The series is composed of five bodies, of which the following are the names, symbols, and component parts:

Name.	Symbol.	Composition.
		N. O.
Monoxide of Nitrogen....	N ₂ O	28 16
Dioxide of Nitrogen.....	N ₂ O ₂	28 32
Trioxide of Nitrogen.....	N ₂ O ₃	28 48
Tetroxide of Nitrogen....	N ₂ O ₄	28 64
Pentoxide of Nitrogen ..	N ₂ O ₅	28 80

This series will serve as a text for a few remarks on what is known to chemists as the law of multiple proportions, which is to the following effect: That when one body combines with another in several proportions, the higher proportions are always multiples of the first or lower. Thus it will be seen that twenty-eight parts of nitrogen combine with sixteen parts of oxygen; although there are four other combinations containing more oxygen, the proportion of oxygen is found to be a simple multiple of sixteen. This law holds good through the whole range of chemical compounds; in inorganic chemistry the combinations between two elements are usually few in number, and the series we have just given is one of the most extended; but when we come to study organic chemistry we shall find the combinations between the elements far more numerous, but still the law of multiple proportions always holds good.—*Brewers' Guardian.*

THE CHEMISTRY OF BUILDING MATERIALS.

THE science of chemistry enables us to discover the various elementary substances of which compound bodies are formed, and to separate those substances one from the other so as to find exactly the relative proportions of each in any given compound. To do this the chemist must make himself acquainted with various processes which are constantly going on in nature, and the kind of action that takes place when two or more different elements are brought into close contact.

The separation of a body into its constituent elements is called *Analysis*, and is performed by means of certain liquids called *Reagents*, whose action upon other bodies has been carefully ascertained by exact experiments. The principal of these reagents are sulphuric, hydrosulphuric, nitric, hydrochloric, acetic, and tartaric acids; the alkalis, ammonia, potash, and soda, with some of their salts, as well as various salts of the metals. In addition to these there is the blowpipe, which often enables the chemist to determine the presence of any element by the color it imparts to the flame, and also to reduce many of the compounds of metals to the pure metallic condition.

It is rarely that any elementary substance is found in nature in a pure or uncombined state, all the metals, with only two or three exceptions, existing in the earth in combination with other elements, such as oxygen, sulphur, and phosphorus. This arises from the affinity, or tendency to combine, which all elements possess in a greater or less degree. Take, for example, the metal calcium, which is the chief component of all marbles and limestones; this is never found in a pure state, but always in combination with oxygen, forming the material known as lime; and this compound is generally in combination with either carbon, sulphur, phosphorus, silicon, or some similar element, forming the carbonate, sulphate, phosphate, or silicate of lime. Thus, a piece of white marble is nearly pure carbonate of lime, and consists of the elements calcium, oxygen, and carbon, all of which are said to be *chemically* combined, their union being of such an intimate nature that the distinctive characteristics of each have disappeared and become merged in an entirely new substance. These elements have also combined together in definite proportions well known to the chemist, so that the exact weight of each element in the compound can be at once predicted as soon as it has been ascertained that the substance is carbonate of lime. Thus, pure lime (calcic oxide) always contains forty parts by weight of calcium and sixteen parts of oxygen; carbonic acid, twelve parts of carbon and thirty-two of oxygen; these being combined to form carbonate of lime, give, as its composition, forty of calcium, twelve of carbon, and forty-eight of oxygen. The several numbers, forty, sixteen, and twelve, are the *chemical equivalents*, or as they are sometimes termed, the *atomic weights* of these three elements, and whenever they are found in combination with other elements it is always in some multiple of these numbers.

Elementary substances also combine together to form compounds in a much less intimate degree than what has been just described, and the proportions in which they combine are not definite. This is termed a *mechanical* combination as distinctive from a *chemical* one.

A familiar instance of a *mechanical* mixture exists in atmospheric air, which is composed of three gases capable of being readily separated one from the other, and their proportions varying according to circumstances and localities. Water, on the other hand, is a *chemical* mixture of two gases, which can only be separated by bringing it in close contact with a substance for which one of the gases has a stronger affinity than exists between the two which compose the water, and these gases always combine in exactly similar proportions, so that the quantity of either in any given weight of water is readily found by calculation. Nearly all rocks and minerals are mechanical mixtures of various substances in uncertain proportions, the component substances themselves consisting of elements chemically united. Thus, a piece of dolomite is a mechanical mixture of the carbonates of lime and magnesia, silica, iron, and alumina, in varying proportions, each of which is a chemical compound of two or more elements united in fixed proportions. When, therefore, a chemist finds that a mineral is pure carbonate of lime or carbonate of magnesia, he can determine at once the exact proportions which the several elementary substances bear to each other in that mineral without any further analyses. When, however, it is a mixture of substances like the dolomite, he must separate each from the rest and weigh it before he can determine the proportions of the components.

In the effect of weather upon building materials we have instances of both mechanical and chemical action. Driving rain or running water wears away stone by friction, and carries the particles downward by a mechanical force. When water freezes inside a stone, a great mechanical force is exerted which splits it into fragments. When the atmosphere or water contains acids, their action upon stone is a chemical one, and the particles are dissolved and form a new compound. The same is the case with most of the metals exposed to weather—a chemical union taking place between the metal and the oxygen or sulphur existing in the air, and a coating of a totally different material being formed upon the surface of the metal, by which its strength and utility are often greatly impaired.

Change of temperature produces a mechanical action on most materials, metals being expanded in proportion as the temperature rises, while woods are generally contracted by heat, on account of the moisture therein being evaporated.

Having thus briefly noticed the general principles of chemical science, let us now examine in detail its bearings on the materials in common use for building purposes.

STONES.

Under this head we include building stones, limes, mortars, cements, brick, marble, and all other minerals used in construction (except metals and metallic ores). These vary considerably in hardness as well as composition. Granite, basalt, serpentine, porphyry, and marble are the hardest and most difficult to work, having been subjected to great heat in their formation. The limestones and sandstones form a numerous class, usually known under the definite name of *freestones*, but they vary greatly in hardness, composition, and durability, some of the limestones being too hard to work and only fit for burning into lime, while others are soft enough to be cut with a knife. All these stones consist of mechanical combinations, in greatly varying proportions, of some or all, of the following chemical substances—namely: 1, silica; 2, alumina; 3, lime; 4, magnesia; 5, potash; 6, manganese; 7, iron; which generally exist as oxides, carbonates, or sulphates. Before entering upon the description of stones themselves, it will be necessary to give a brief explanation of the characteristics of the above-named sub-