have been constructed with care, they appear well. Some buildings erected with building blocks or large bricks made of lime and sand under pressure have proved worthless.

To erect walls of concrete, the essential thing is to secure good mortar in which to imbed the gravel and larger pieces of stone. The mortar should be made of cement and sand (the cement fresh from the kiln and tested as to its setting quality); and the sand should be sharp quartz perfectly clean and free from loam.

Clean sand will not soil the hand. Sand may be freed from loam by washing. Place the sand in a shallow box 4 or 6 feet square, or larger, and flood with water, stirring the sand with a hoe. The loam will discolor the water and flow off with it. Keep stirring and flooding until the water runs off colorless. The sand is then clean.

Combine the dry cement with the sand in the proportion of one measure of cement to two of sand, thoroughly mix them dry, and just before use add water enough to make a thin paste. To this paste add the gravel and small stones, and stir them about until the surfaces of the gravel and stones are all covered with the paste, taking care that no more of the stone filling is added than the paste will coat. The mass, thoroughly compounded, should be immediately carried and deposited within the boxes upon the wall, and the boxes allowed to remain until the concrete is set. The time for setting will depend upon the quality of the cement, but ought not to exceed from 6 to 12 hours. The proportions between the cement and sand should vary, in accordance with the quality of the sand, from two to five measures of sand to one of cement. There should be enough cement to coat the sand on all its surfaces.

Concrete is quite as good as stone for the foundations. The quantity of gravel used will depend upon its coarseness, usually about twice as much gravel as sand. It is better that the gravel be of various sizes. The resultant concrete will measure no more than the gravel measures; the cement and sand are lost in the interstices between the stones. The cost of concrete will depend upon the cost of the materials of which it is composed and the labor. These vary in different localities, but may be estimated from the above data.

MADDER, VEGETABLE AND CHEMICAL.

The ordinary red pigments used in dyeing and calico printing have heretofore been derived from the roots of the madder plant, cultivated in Turkey, France, and to some extent in the United States. By steeping and fermentation the roots are made to yield fine needle crystals of yellow color, termed alizarine. If this substance is administered to animals, certain peculiar results are alleged to follow. For example, the bones of pigs are made red; a red circle is produced around the iris of the eyes of pigeons; cows give reddish milk and the cream yields red tinted butter. It has been suggested that ladies who wish for red hair should swallow alizarine. But then it might also make their teeth red, and perhaps over-tinge their complexions.

The cultivation of madder is very extensive, thousands of acres of land being given up to the crops, while the preparation of the root forms an important branch of industry. But the onward march of chemical discovery is likely to effect a change, and there is every probability that the occupation of the madder root grubber will soon be gone.

Alizarine, one of the coloring principles of madder, is now extensively produced by chemical means from coal. When bituminous coal is distilled in the production of illuminating gas, coal tar comes over with the gas.

This tar, when again distilled, yields a variety of substances, which are separated by the application of different degrees of heat. For example, the light, brilliant-looking naphtha liquid known as benzole first comes over from the tar. If to this benzole nitric acid is added, the product is nitro-benzole, a peculiar red oil, having the odor of bitter almonds. Distil this with water, acetic acid and iron filings, and aniline is produced. The aniline is in turn refined, treated with preparations of arsenic and other substances, the results being the production of the magnificent series of colors known as aniline dyes. Among the last substances distilled over from coal tar is anthracene, consisting, when pure, of bluish-white crystals. A tun of coal yields about one pound of anthracene. The latter, when treated with manganese, sulphuric acid, bromine, potash and hydrochloric acid, yields alizarine, identical in nearly all of its properties with the alizarine of madder roots.

By the mixture of carbon and hydrogen in certain proportions, the chemists have artificially produced anthracene, from which, in turn, alizarine may be evolved. Thus are the productions of the vegetable world imitated in the laboratory.

The discovery of alizarine in coal tar is credited to Graebe and Liebermann, German chemists, in 1868, since which time the processes for its production, on a commercial scale, have been successfully and extensively introduced. In Germany there are at present some twelve large manufactories of alizarine from coal tar, and the product, which is rapidly increasing, is now 22,000 hundredweight per annum, valued at $2,000,000.

Germany also supplies the world with aniline colors.

THE STAR SHOWER OF AUGUST 10.

We hope that our readers will not forget to look for this well known star shower, which appears to radiate from the constellation *Perseus*. On the 10th of August, the earth annually passes for about six hours through the belt of meteors which originally formed a part of comet III, 1862, returning once in a hundred and twenty years.

It is estimated that four hundred million shooting stars daily traverse the atmosphere, adding, perhaps, a thousand pounds to the earth's mass. These bodies move in space as dust clouds or nebulæ. When they come within the sun's attraction, the nebula assumes the form of a comet, under the influence of gravitation, and the comet is gradually drawn out by the same force into a ring revolving round the sun in the same orbit and periodic time as the original comet.

The star showers bring us specimens from the remotest realms of space; sometimes meteoric irons, containing occluded hydrogen from the atmosphere in which the fragment was last heated; at other times, meteoric stones containing hydrocarbons and phosphorus.

Aerolites contain oxygen, nitrogen, phosphorus, sulphur, carbon, silicon, hydrogen, copper, iron, cobalt, nickel, manganese, magnesium, aluminum, etc., probably most if not all of the terrestrial elements. Their weight is generally inconsiderable, but varies up to fifteen tuns. The loud report which attends the fall of the larger masses is caused by the air rushing into the vacuum in rear of the projectile when it reaches our atmosphere.

PROPERTIES OF SATURATED STEAM.

We have recently received an inquiry, from one of our correspondents, as to the boiling point of water at different pressures; and we propose, in this article, to give the formula asked for, with several others. Nearly all the properties of saturated steam have been carefully investigated by M. Régnault, of France, and tables have been prepared from his researches. These tables, in very convenient form, adapted to English measures, may be found in Charles T. Porter's work on the steam engine indicator—a book which contains much useful information, in addition. The formulas by which these tables are computed are somewhat complex, but we will endeavor to render them as simple as possible, and we trust that our readers will find them both interesting and valuable.

In a previous article, we have spoken of the absolute zero, or theoretical temperature at which all heat motion ceases. This temperature is used in making calculations of the pressure of steam, because water forms vapor of appreciable tension at all temperatures except that of absolute zero. We will use the same notation in all the formulas, and will first explain the meaning of the terms: T = temperature of the steam as shown by the thermometer, on Fahrenheit's scale. t = absolute temperature of the steam = 461·2° + T, because the absolute zero is fixed by theory at 461·2° below 0° Fahrenheit. P = pressure of steam, in pounds, per square inch. p = pressure of steam in pounds per square foot = P × 144. L = units of latent heat per pound of steam at the pressure P. When water is converted into steam, a portion of the heat applied is used in the work done in producing a change of state. This heat is not indicated by the thermometer, and is called latent heat. A unit of heat is the number of degrees necessary to raise the temperature of a pound of water one degree. l = units of latent heat, in foot pounds of energy, per cubic foot of space occupied by the steam at the pressure P. The amount of heat that will raise the temperature of a pound of water one degree, if converted into work, will raise a pound weight through a distance of 772 feet; conversely, to find the units of heat that will be produced by the conversion of 1 foot pounds of energy, this quantity must be divided by 772. W = weight of cubic foot of steam at pressure P. V = number of cubic feet occupied by a pound of steam at pressure P.

We will now give the formulas, working out an example for each case.

1. To find the boiling point of water at a given pressure,

$$t = 1 \div \left(\sqrt{\frac{8{\cdot}2591 - \log.p}{396944} + \frac{(2731{\cdot}62)^2}{4 \times (396944)^2}} - \frac{2731{\cdot}62}{2 \times 396944}\right).$$

Or, to find the absolute temperature of the boiling point at any pressure, subtract the logarithm of the pressure per square foot from 8·2591, divide the difference by 396944, add the quotient of the square of 2731·62 divided by four times the square of 396944, take the square root of the sum, subtract the quotient of 2731·62 divided by twice 396944, and divide unity by the quantity so obtained.

EXAMPLE.—P = 30, p = 30 × 144 = 4320,

$$t = 1 \div \left(\sqrt{\frac{8{\cdot}2591 - \log.4320}{396944} + \frac{(2731{\cdot}62)^2}{4 \times (396944)^2}} - \frac{2731{\cdot}62}{2 \times 396944}\right) = 711^\circ.6.$$

Then the temperature of the boiling point, on Fahrenheit's scale, is 711·6° — 461·2° = 250·4°.

2. To find the pressure of steam, knowing the boiling point,

$$\log.p = 8{\cdot}2591 - \frac{2731{\cdot}62}{t} - \frac{396944}{t^2}.$$

Or, the logarithm of the pressure per square foot for the boiling point whose absolute temperature is t, is found by subtracting from 8·2591 the quotient of 2731·62 divided by the absolute temperature of the boiling point, and the quotient of 396944 divided by the square of the absolute temperature.

EXAMPLE.—Temperature of the steam by thermometer = 265·8°. Absolute temperature = 265·8° + 461·2° = 727°.

$$\log.\ p = 8{\cdot}2591 - \frac{2731{\cdot}62}{727} - \frac{396944}{(727)^2} = 3{\cdot}75077.$$

From a logarithmic table, we determine p = 5633·4, and the pressure per square inch = 5633·4 ÷ 144 = 39·12 pounds.

3. To find the latent heat of evaporation:

$$L = 1091{\cdot}7 - 0{\cdot}695(T - 32^\circ) - 0{\cdot}000000103\ (T - 39{\cdot}1^\circ.)$$

Translating this expression, we have, the number of units of latent heat in steam at the temperature T is found by subtracting from 1091·7, 0·695 times the difference between the temperature and 32°, and 0·000000103 times the difference between the temperature and 39·1°.

EXAMPLE.—T = 321°, L = 1091·7 — 0·695(321° — 32°) — 0·000000103(321° — 39·1°) = 890·8.

4. To find the latent heat of evaporation in foot pounds of energy, per cubic foot of space:

$$l = p\left(\frac{2731{\cdot}62}{t} + \frac{2 \times 296944}{t^2}\right) \times 2{\cdot}3026,$$

which may be thus expressed: To find the latent heat of evaporation in foot pounds of energy, per cubic foot of space, add the quotient of 2731·62 divided by the absolute temperature, to the quotient of twice 396944 divided by the square of the absolute temperature, and multiply the same by the product of the pressure per square foot multiplied by 2·3026.

EXAMPLE.—P = 79·03, p = 79·03 × 144 = 11380. The temperature corresponding to this pressure is T = 311°, t = 311° + 461·2° = 772·2°, $l = 11380 \times \left(\frac{2731{\cdot}62}{772{\cdot}2} + \frac{2 \times 396944}{(772{\cdot}2)^2}\right) \times 2{\cdot}3026 = 127500.$

5. To find the weight of a cubic foot at the pressure P.

Were steam a perfect gas, the pressure would vary inversely as the volume, and the weight of a cubic foot could be readily ascertained. Experimental researches in the density of steam have not been sufficiently extended to enable a relation to be established between the pressure and volume. Approximately, the pressure varies inversely as the tenth power of the ninth root of the volume. More exactly, the weight of a cubic foot of steam can be obtained, indirectly, from the latent heat, and we will give the formula for its computation in this way: l ÷ 772 = latent heat, in heat units, of a cubic foot of steam at pressure P.

$\frac{l}{772 \times W}$ = units of latent heat in a pound of steam at pressure P. But according to our notation, this is equal to L. Hence, $\frac{l}{772 \times W} = L$. Solving this equation for W we obtain, $W = \frac{l}{772 \times L}$.

EXAMPLE.—L = 916·6, l = 88740, $W = \frac{88740}{772 \times 916{\cdot}6} = {\cdot}1579$ pounds.

6. To find the space in cubic feet occupied by a pound of steam at any pressure.

$V = \frac{1}{W}$. Or, to find the volume of a pound of steam at the pressure P, divide one by the weight of a cubic foot.

EXAMPLE.—W = ·08285, $V = \frac{1}{{\cdot}08285} = 12{\cdot}07$ cubic feet. It will be observed that these formulas are progressive, the results obtained from one being needed for substitution in the next.

7. To find the hight of a column of mercury at a temperature of 32° Fahrenheit, corresponding to a given pressure per square inch.

RULE: Multiply the pressure by 2·037.

EXAMPLE.—For 30 pounds pressure, the hight of the mercury must be 30 × 2·037 = 61·11 inches.

Mercury expands 0·0010085 of its volume for every degree of increased temperature. Hence, for any temperature other than 32°, a correction must be applied.

EXAMPLE.—Suppose that, in the preceding example, the temperature of the mercury had been 80°. Then the expansion would be 61·11 × 0·0010085 × (80—32) = 2·95 inches, and the hight of the column of mercury corresponding to 30 pounds pressure would be 61·11 + 2·95 = 64·06 inches.

The results obtained in the preceding formulæ are for the case in which water boils in the open air at 212° Fahrenheit, the barometer standing at 29·913 inches.

SCIENTIFIC AND PRACTICAL INFORMATION.

COATING FABRICS WITH TIN.

According to Richard Jacobsen, linen and cotton goods may be covered with a thick and flexible film of tin, which gives to them a very silvery appearance. The method to be adopted is as follows: Ordinary commercial zinc dust is rubbed up with a solution of egg albumen to a thin paste, and applied to the goods with a brush or roller. When dry, this coating is fixed by coagulating the albumen with steam, and the fabric is then placed in a solution of bichloride of tin. The tin is precipitated upon the zinc in a very finely divided state. The stuff is then washed with water, and, after drying, put through the finishing machine, when the tin comes out with a brilliant luster. A very beautiful effect may be produced by printing different designs in this way, or applying the material with stencil plates, and its use may be extended to decorations. It is even possible that this strong, elegant, and waterproof material may yet replace tin foil for packing certain articles.

PHOSPHO-TUNGSTIC ACID.

This acid was first discovered by Scheibler. Its crystalline form depends upon the manner of its preparation, being either beautiful, regular octahedra, with strong refractive power for light and the sparkle of a diamond, very soluble in water and efflorescent in air; or it occurs in cubical crystals. Both forms of acid have a property, which is possessed also by the phospho-molybdic acid, of precipitating the natural organic bases from acid solutions, no matter how dilute. A clearly perceptible precipitate is formed in a solution of 1 part strychnin in 200,000 of water, while 1 part quinine is precipitated in 100,000 of solution. The precipitate when first formed is very bulky, but, if left a short time in the acid solution, it becomes thicker and may be filtered out and washed.

Phospho-tungstic acid is very important in toxicology and in judicial chemistry for detecting the alkaloids, since it can be safely trusted for separating them from large quantities of the liquid, and thus preparing them for further tests. It can also be used with advantage for the preparation of separate alkaloids.