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ALUM IN BAKING POWDERS.

In the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT will be found a communication from G. E. Patrick, Professor of Chemistry in the University of Kansas, giving details of a series of practical tests to determine whether the hydrate of alumina is dissolved by the gastric juice. The question has a vital bearing on the discussion as to the safety of using alum in baking powders. Professor Patrick attacks it without prejudice, by strictly scientific methods, and arrives at results which are certainly gratifying in view of the wide use of alum powders in our kitchens.

Professor Patrick takes his text from the published opinion of a prominent physician, who says, after stating the difficulties attending a thorough mixture of the ingredients of alum baking powders:

"But even if the exact proportions were maintained, the salts formed would retain their injurious properties, as they would dissolve in the gastric juice. The gastric juice contains not only lactic acid, but a large amount of hydrochloric acid, and both the sulphate and hydrate of alumina would be dissolved."

After testing by reference to authorities the statement that the gastric juice contains a large amount of hydrochloric acid, and finding the weight of evidence to be that the quantity is in reality extremely minute, and that little not free, Professor Patrick proceeds to describe his examination of the practical question whether the hydrate of alumina as it exists in bread after baking, when made with alum powders, will be dissolved in the fluids of the alimentary canal.

This question could be determined only by careful tests with living animals. Professor Patrick found cats to be most available. Having made biscuits with an acknowledged alum baking powder, using twelve times the proportion of powder directed on the labels, and employing for each experiment a distinct sample of powder, he fed the biscuits to cats that had fasted from one to two days. The amount eaten in each case was enough to give at least half a teaspoonful of powder to each experiment. After allowing for digestion 20 minutes, 45 minutes, 1 1/2 hours, 2 hours, and 2 1/2 hours, respectively, the cats were killed, and the contents of the stomach and small intestines were carefully examined for dissolved alumina. In each case undissolved hydrate of alumina was found, but of dissolved alumina there was never a trace.

Surprised at the uniformity of these results, and thinking that the organic matter of the flour might have interfered with the solution of the alumina or his detection of it, Professor Patrick made two crucial experiments. In each, two teaspoonfuls of the powder were mixed with water and baked at the ordinary temperature of the oven. The mass was then fed to a cat (under compulsion) and after a specified time the stomach and intestines were examined as before. In neither case was a trace of dissolved alumina discovered.

Similar experiments were then tried with unbaked (gelatinous) hydrate of alumina, and in both cases a trace of dissolved alumina was found; the inference being that it is not safe to eat dough made with alum powder—it should always be baked. Another important practical point was also suggested—namely, that if bread is carelessly mixed or with insufficient water, some of the powder may remain dry and the alum not changed to the hydrate; in which case the effect would probably be injurious.

In order to test this question, and also to furnish a check on the other experiments with biscuits, Professor Patrick had a batch made in which the mixing was less thorough than usual and with less water. These were fed to cats, and subsequent tests developed in every case a trace of dissolved alumina. These experiments, while proving the reliability of those first described, go to show, Professor Patrick thinks, that to insure the entire absence of alum in the bread, the mixing must be done with plenty of water. As a simple precaution it might be well to mix the batter too thin at first, and stiffen it by the addition of pure flour.

Tests of this nature are obviously worth any amount of theory; and if there is no radical difference between the gastric juices of cats and men, it seems to be conclusively established that alum baking powders may be used without injury to health.

THE CAPTIVE BALLOON AT CONEY ISLAND.

Not the least of the many attractions of Coney Island this summer is Mr. King's captive balloon, "Pioneer," the first ascension of which was made on the afternoon of July 1. This balloon is not as large as the Giffard captive balloon at Paris, but is said to be much more perfectly constructed. It is sixty-five feet in diameter, and has a capacity of 150,000 cubic feet. The material is Irish linen in two thicknesses. The basket or car of wicker work weighs 476 lb. Above the balloon is white, to reflect the sun's rays; below it is ornamented with dark red and green, to make it a conspicuous object against the sky. It is inflated with hydrogen, and in calm air shows on the dynamometer a lifting strain of 1,400 lb. The gas is made on the spot by Mr. A. O. Granger, by passing steam over hot iron. Wound about the drum of a very large windlass is 1,215 feet of 1 1/2 inch rope, through the center of which runs a telephone wire. An end of this rope is carried through a trench to the center of the inclosure, where, after passing around a pulley, it is fastened to the balloon. The pulley is attached to the foundation by a universal joint of iron, so that, in whatever direction the balloon may pull, there will be no side strain

on the pulley. A good hold on the sand is secured by the use of four sticks of yellow pine, each 12 feet long and 12 inches square. These are planted horizontally nine feet below the surface, and above them is a well, made of concrete. Across the top of the well lie two other similar timbers, which are strongly fastened to their fellows below by long and thick iron bolts. Mr. King says this foundation will resist a strain of 100,000 lb., while the utmost strain that wind and gas united can exert on the connecting rope of the balloon will not exceed 22,000 lb.

On its trial trip the balloon ascended three or four hundred feet, and shortly afterwards a second trip of seven hundred feet was made. At this height the view was pronounced magnificent by the small party making the first venture. All the ocean approaches of New York harbor were at their feet for a radius of thirty miles; and inland they could see the numerous towns and cities about the bay of New York. Along the Sound to Flushing, up the Hudson River as far as Tarrytown, and the Orange Valley, and other parts of New Jersey as far as Paterson, Perth Amboy, and Long Branch.

THE TELEPHONE AS A LIGHTNING INDICATOR.

Mr. George M. Hopkins, of Brooklyn, N. Y., during a recent thunder storm connected the gas and water pipes of his dwelling with an ordinary Bell telephone, and discovered that the electrical discharges were plainly indicated, either by a sharp crack or by a succession of taps. This occurred when the discharge was so distant that the thunder was inaudible. The sound also seemed to be perceived by the ear before the lightning could be seen. There was a marked difference in the character of the discharges, some that appeared single to the eye were really multiple. Often the discharges would consist of a series, beginning and ending with discharges larger than the rest, thus: — — — — —, sometimes it would be thus: — — — — —, sometimes the reverse, and often a single crack.

The gas and water pipes were used, being the most convenient and at the same time the safest conductors for the purpose. Special apparatus might be devised, having a good ground, and a series of points for gathering the electricity from the air, but in using apparatus of this kind there is always more or less danger.

New Steel Railway Bridge.

A new and splendid railway bridge over the Missouri River, built wholly of steel, has lately been completed and opened for traffic by the Chicago and Alton Railway Co. The bridge is located at Glasgow, Mo. The constructing engineer was Gen. Wm. Sooy Smith. The material was furnished by the Hay Steel Co., of Chicago, and while the structure is stronger than an iron bridge its weight is thirty-three per cent less than it would have been had iron been employed. The time of construction was only one year. The cost, \$450,000. The following are the principal dimensions:

Five spans, 314 3/4 feet each, from center to center of piers, three above and two below grade; all steel; depth of truss, 36 feet center to center of pins. Height of through spans above high water, 50 feet. East approach, iron trestle, 210 feet; two deck spans of iron, 140 feet each, 280 feet; west approach, iron deck span, 140 feet; west approach, iron trestle, 510 feet; west approach, wooden trestle, 864 feet total length of the bridge proper (steel) 1,573 1/4 feet; total length of bridge and approaches, 3,577 1/4 feet.

The Silver Deposits of Leadville, Colorado.

Says a correspondent of the Boston Advertiser: The ore beds vary from one to forty feet in thickness. They are generally undulating like the waves of the ocean, so that the distance from the surface varies with the undulations. The size of a mining claim is in most cases 300 feet inside by 1,500 feet long, being about ten acres in area. The ore known as "hard carbonates" consists of silver mixed with iron or lead. The soft or sand carbonates resemble common road gravel, yellow and red ochre and gray sand. Chlorides of silver are frequently visible in the hard carbonates. The usual size of a shaft is 3 1/2 feet by 7 feet, and is substantially timbered. After the ore deposit has been penetrated, the "main entry," "parallels," and "cross cuts" are excavated, leaving the remaining ore in blocks while the work of exploration is going on. In sinking a shaft we usually penetrate, first, a deposit of gravel or "wash" from 20 to 100 feet in thickness, frequently containing bowlders which have been subjected to abrasion. Not unfrequently a stratum of "cement" a few inches in thickness is encountered, resembling Roxbury pudding stone or an old cemented cellar floor. Next we come to calcite, or porphyry—sometimes soft like "fire clay," either pure white, gray, or red—the latter showing an iron stain. The soft porphyry runs from one inch to several feet in thickness. The hard porphyry is often "picking ground" (i. e., porphyry rock, which can be excavated by means of a pick), but frequently it is blasting or "shooting rock." Following the porphyry is iron ore, varying in thickness and sometimes containing a few ounces of silver. Following the iron we find the "pay ore," more or less rich in silver.

The generally accepted theory is, that this region was once covered with a lake, the waters of which held in solution silver, lead, and iron, which were in time precipitated on the bottom of the lake. The porphyry, gravel, etc., were subsequently deposited. After the precipitation came the age

of disturbance, when by volcanic action or the shrinkage of the earth's crust the deposits became contorted, sometimes tilted or broken like a "chop sea," or gently undulating like the "ground swell" of the ocean.

Farming Implements in Morocco.

An undeveloped yet promising market for farming implements is reported in Morocco by U. S. Vice-Consul John Cobb at Casablanca. In a recent communication that officer, who takes a lively interest in the promotion of American trade, writes that farming implements are much needed in that country, no improvements having been made there in that line since the days of Mohammed the Great, nearly 1,300 years ago. Mr. Cobb believes that our manufacturers will find a large field for operations there, as many of the Moors have money and are particularly fond of useful inventions. They are very conservative, however, and must see an article in use or under conditions in which it can undergo a thorough investigation before they can be made to believe in it. American goods are favorably received by them, and can be made to take the lead. Possibly our manufacturers interested in the export trade may find it worth while to correspond with Mr. Cobb.

PECULIAR STEAM WHISTLING.

Some of our river pilots have become so proficient in the use of the steam whistles of the boats under their charge as to be able to make sounds that are almost articulate in their signification of the wishes or the feelings of the pilots.

Recently a large steamboat, well laden with passengers, was unable to reach its dock on account of a row-boatman who, while leisurely rowing about, had been surprised by the sudden appearance of the steamboat, and in his efforts to get out of its way became confused, and by rowing first one way and then another, annoyed the steamer's pilot; and he, apparently becoming impatient at the delay, expressed his feelings by causing the steamer's whistle to emit a series of short peculiar whistle sounds, which expressed something to the effect of, "Come! come! take one way or another, and get out of my road some time to-day," so plainly that some of the passengers of a neighboring boat noticed it, and one, laughingly referring to the whistling, said: "That is almost equivalent to swearing by steam." The row-boatman seemed to understand it, for he immediately took one way and got out of the steamer's course.

And again the other day we heard the steam siren whistle of one boat caused to salute another, in a most laughably sarcastic manner, as if to say: "Why! how do you do?" The pilot of the other boat endeavored to respond in the same tone, but probably because his boat's whistle was of a different style, he was only able to make it sound something like the first crowing efforts of a chicken.

We have some of the best pilots in the world to manage our river steamboats; and perhaps very few persons think of the great responsibility resting on these men. At times a moment's delay, resulting, perhaps, from sudden sickness or slight mistake of the pilot or engineer, would end in a fearful loss of life and property, and yet accidents rarely occur. We hope, however, that the steam whistling proficiency above mentioned will not lead to any mistakes in regard to the correct interpretation of the established code of whistle signals. L. L. D.

MOLECULAR CHEMISTRY.—No. 4.

H. Schroeder began the study of molecular volumes of solid bodies in 1840, and he has continued it up to the present time. His views, which have been repeatedly modified by his researches extending over so long a period, may be stated as follows in their matured form.

In any mechanical fraction of a uniform mixture, or of a compound, the constituents are contained in exactly the same proportions by weight as they are in the whole mass. The same must hold true for the proportions by volume, provided the given substance is homogeneous. Thus, in detonating gas, made by mixing two volumes of hydrogen with 1 volume of oxygen, we may say that H has the volume 2 and O the volume 1, although in reality both are diffused throughout the space represented by their combined volumes, 3. When the mixture is exploded we get only 2 volumes of H₂O instead of 3. The condensation so produced may be viewed in two ways. We may suppose that the compound is condensed as such, or else that its constituents suffer a change of volume before entering into combination, and that the volume of the compound is the sum of the volumes of its condensed constituents. The law of multiple proportions by weight may thus be made applicable to volumes. Experience has shown that every element varies so much in volume throughout the series of combinations into which it enters, that the volume of its molecule may be 2, 3, 4, 5, 6, etc., times as great in one compound as in another.

Among these numbers the factor 2 predominates just as it does in gases, where, for example, H₂ is first condensed to 1 volume and then combines with O to form 2 volumes instead of 3. In the case of solids these condensations of volume seem to depend on the forces that cause bodies to crystallize, since an element belonging to two bodies that have the same crystalline form (isomorphous bodies) is usually condensed equally in both. In other words, the volumes of elements common to a number of isomorphous bodies are generally the same. The volume of potassium (K) found, as has been explained, by dividing its molecular weight by its density, is 45.8; that of sodium (Na) is 23.9; difference, K - Na = 21.4.

The difference in the volumes of their chlorides, KCl = 37.4 and NaCl = 27.1, is 10.3, or practically one-half the difference of the metallic volumes of K and Na. The same result is obtained from the bromides: KBr = 44.3, NaBr = 33.4; difference, 10.9. And from the iodides: KI = 54, NaI = 43.5; difference, 10.5. Now considering the Cl volume the same in both chlorides, the Br volume the same in both bromides, and the I volume the same in both iodides, it is evident that the metals in these compounds have been condensed to one-half their original volumes.

When other metals are compared in this manner with their isomorphous compounds it was found that in pairs containing strontium and lead, sodium and silver, magnesium and nickel, aluminum and iron, the heavy metals often entered into combination with their volume unchanged, while the light metals were condensed one-half. Schroeder believes that this occurs too frequently to be accidental. In the rhombic sulphates and carbonates of strontium and of lead, in their oxides, in the bromides, chlorides, and iodides of sodium, and of silver, etc., the differences of volume are equal to the unchanged volume of the heavy metal minus one-half the volume of the light one.

While comparing the volumes of numerous compounds in this manner Schroeder was struck by the fact that the oxygen in quartz would have exactly the same volume as the silicon associated with it, on the supposition that the silicon retains the volume that belongs to it in the free state. Finding similar relations in other compounds, he conceived the idea that the molecular volumes of the constituents might have a common measure of which they are all multiples. To this common measure he gives the name of stere. A few examples will illustrate his meaning:

Volume KI = 54.0	KCl = 37.8
NaI = 43.2	NaCl = 27.0
K - Na = 10.8	K - Na = 10.8 = 2 × 5.4
Volume NaI = 43.2	NaCl = 27.0
LiI = 37.8	LiCl = 21.6
Na - Li = 5.4	Na - Li = 5.4 = 1 × 5.4
Volume RbI = 70.2	RbCl = 54.0
KI = 54.0	KCl = 37.8
Rb - K = 16.2	Rb - K = 16.2 = 3 × 5.4

Again, twice the volume of LiCl (2 × 21.6) is equal to the volume of NaI (43.2); twice NaCl (2 × 27.0) = KI (54.0), etc. Hence 1 volume I = 2 volumes Cl, 1 volume Na = 2 volumes Li, and 1 volume K = 2 volumes Na. We have found, then, that these substances, as well as their differences, have a common measure; and this is what Schroeder means by the expression that they have the stere 5.4.

But this is not all. Comparing still further, we get the following differences of volume:

RbI = 70.2	KI = 54.0	NaI = 43.2	LiI = 37.8
RbCl = 54.0	KCl = 37.8	NaCl = 27.0	LiCl = 21.6
I - Cl = 16.2	I - Cl = 16.2	I - Cl = 16.2	I - Cl = 16.2 = 3 × 5.4

In other words, iodine and chlorine have the same stere as the metals with which they are in each case associated. From these and many analogous examples Schroeder has quite recently generalized the proposition: "In every compound a definite volumic measure or stere predominates and causes all the components to subordinate themselves to it."

As many isomorphous bodies, such as KCl and NaCl, magnesite and calcite, potassium sulphate, selenate and chromate, have the same stere, it was natural to connect the latter with the crystalline form. Further extensive research has shown, however, that the stere does not depend directly upon the form; that there are isomorphous bodies with unlike, and heteromorphous bodies with like steres. It was found that the stere of a compound is determined entirely by that of one of its elements, which impresses its own stere on all the rest. The fact that isomorphous bodies so often have equal steres is explained by the reason that their controlling elements are also isosteric. Thus the rhombic carbonates of magnesia, manganese, and lime, are isosteric because Mg, Mn, and Ca have the same stere. From these observations Schroeder deduces the following law, which he calls the steric law: "In every compound the stere of one of the components predominates, in consequence of the forces active during crystallization, and impresses itself upon all the others." For example, the stere of silver (Ag) is 5.14, one-half the volume 10.28, calculated from its density and equivalent. AgCl has a volume of 25.70 or 5 × 5.14; AgI = 41.1, or 8 × 5.14; AgBr = 30.84, or 6 × 5.14; Ag₂O = 30.8, or 6 × 5.14; C₂H₃O₂Ag = 51.4, or 10 × 5.14. All these volumes are exact multiples of the silver stere, and consequently the other elements associated with silver must also have assumed volumes divisible by 5.14, as the law requires.

The steres of all the elements hitherto determined lie between the narrow limits of 5.0 and 6.1. Thus carbon has a stere of 5.11, which it impresses on a series of organic bodies; phosphorus and arsenic cause most of their compounds to assume the stere 5.3, etc.

In Liebig's *Annalen* for 1874, and more recently in the report of the session of the Munich Academy of Sciences, December 1, 1877, Schroeder shows the applicability of his law to five important groups:

1. Silicon, quartz, sillimanite, disthene. Stere, 5.65.
2. Aluminum, corundum, chrysoberyl, diaspore, andalusite. Stere, 5.14.
3. Magnesium, periclase, spinelle, olivine, diopside, humite, and garnets. Stere, 5.52.
4. Oxides and silicates of manganese. Stere, 5.52.
5. Sulphides and arsenides of iron, cobalt, nickel, copper, zinc, and lead.

Those who desire more detailed information on these points are referred to the above memoirs, and also to Liebig's *Annalen* for 1878, and to the Berlin *Chem. Gesell.* for May, 1878.

A very important corollary follows from Schroeder's law. If bodies combine only in whole volumes or steres, we can determine the molecular constitution of solids, because their molecules must contain a sufficient number of atoms to bring out the volume of each constituent as an entire multiple of the controlling stere. Thus the volume of silicon determined from its density was found to be 11.3, and its stere is consequently 5.65. To express the fact that the silicon molecule occupies two steres, Schroeder writes Si₂², the upper right hand exponent representing the number of steres, and the lower the number of atoms. Now the volume of quartz, to which allusion has been made before, is just double that of silicon; consequently it contains four steres, two of which belong to oxygen, and its molecular formula is written Si₂² O₂², with a line over Si to show that the compound is controlled or dominated by the silicon stere. In his calculations Schroeder marks the steres with a line drawn above, and the volumes with a line drawn below the figures; thus, Si₂² O₂² = 4 × 5.65 = 22.6. Take another example:

Corundum Al₂² O₃³ = 5 × 5.14 = 25.7. This means that in corundum, as in most oxides, each oxygen atom occupies one stere; that aluminum is present with one-half its metallic volume, $\frac{10.28}{2} = 5.14$; that the aluminum stere 5.14 impresses itself upon all the atoms present; and that the observed volume of corundum, 25.7, is made up of the equal volumes of five such atoms, two of aluminum and three of oxygen.

But this is not all. If the atomic weights are taken in grammes, the volumes will be expressed in cubic centimeters; thus Ag₂² = 2 × 5.14 = 10.28 means that one atom of silver or 108 grammes occupies a space of 10.28 cubic centimeters, or of two silver steres, each equal to 5.14 c.c.

A few examples will suffice to show the manner of arriving at the molecular formulas of compounds.

The observed volume of chloride of silver is 25.7, as has been stated before. This is equal to five silver steres (5 × 5.14 = 25.7). As two of these belong to the silver present, we have left three for the chlorine, and we write Ag₂² Cl₃³ = 5 × 5.14 = 25.7.

The observed volume of iodide of silver is 41.12, or eight times the silver stere. Subtracting two steres for Ag, there remain six for the iodine, and we have Ag₂² I₆⁶ = 8 × 5.14 = 41.12.

The observed volume of bromide of silver is 30.84, or 6 × 5.14. Our formula is, therefore, Ag₂² Br₆⁶ = 6 × 5.14 = 30.84.

The volumic constitution of the iodides and chlorides of the alkaline metals is determined from the data already given:

K ₂ ² I ₆ ⁶ = 10 × 5.14 = 51.4	K ₂ ² Cl ₃ ³ = 7 × 5.14 = 37.8
Na ₂ ² I ₆ ⁶ = 8 × 5.14 = 43.2	Na ₂ ² Cl ₃ ³ = 5 × 5.14 = 27.0
Li ₂ ² I ₆ ⁶ = 7 × 5.14 = 37.8	Li ₂ ² Cl ₃ ³ = 4 × 5.14 = 21.6

Rubidium was found to contain three steres more than potassium; we have, therefore:

Rb ₂ ² I ₆ ⁶ = 13 × 5.14 = 70.2	Rb ₂ ² Cl ₃ ³ = 10 × 5.14 = 51.4
-----------------------------------------------------------------------------	------------------------------------------------------------------------------

Again, rubidium was found to have double the volume of ammonium, and we must, therefore, write Am₂² Cl₃³ = 13 × 5.14 = 70.2, or twice the observed volume 35.1. The bromides have been calculated in the same way.

The difference in the densities and volumes of the two varieties of cinnabar explained as follows: Amorphous black cinnabar is Hg₂² S₂² = 11 × 5.52 = 60.72, or twice the observed volume 30.36; while red rhombohedral cinnabar is Hg₂² S₂² = 11 × 5.30 = 58.30, or twice the observed volume 29.10. In the black variety the mercury stere predominates, while the red is ruled by the sulphur stere.

Schroeder has the modesty to call his steric law simply a hypothesis, but he believes that it will force its way into general acceptance; and he concludes his memoir with the following general statements. Bodies combine only in whole volumes having whole steres, just as they have only whole atoms. Simple volumic relations are perceived in gases at equal temperatures and pressures, in liquids at temperatures producing an equal tension of their vapors, and in solids when the steres of their controlling elements are ascertained.

C. F. K.

Formation of Coal.

E. Fremy holds that there are several kinds of isomeric cellulose, constituting the skeleton of plants. Coal is not an organized substance. The vegetal impressions presented by coal are produced as in shales or other mineral matters. The chief substances contained in the cells of plants under the double influence of heat and pressure produce bodies having a great analogy to coal. The pigments, the resins, and the fats of leaves, if submitted to heat and pressure, yield compounds which approximate to bitumens. The vegetable matter which gave rise to coal has undergone, first, the peaty fermentation, the coal being then formed by a secondary transformation.

H. W. WILEY finds that one part of uranine in one million parts of water is readily detected by means of the spectroscope.