

are daily being discovered, will lead to further results. The interesting caprylic ethers, which M. Bouis has lately discovered, are remarkable from their extremely aromatic odor, (thus the acetate of caprylic oxide possesses an odor as strong as it is agreeable,) and promise, if they can be obtained in larger quantities, to yield new materials for perfumery.—*Ann. der Chem. und Pharm.*, vol. LXXXI, p. 87.

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*On the Expansion of some Solid Bodies by Heat.* By HERMANN KOPP.\*

The method of experiment adopted by Prof. Kopp in his laborious and valuable investigation is to ascertain the specific gravities of a body when immersed in fluids of various temperatures, and thence, by means of the known expansion of the fluid, to determine the cubic expansion of the body. A flask was taken furnished with a carefully ground glass stopper; and the first point to be ascertained was, "what weight of water, freed from air, and at different temperatures, was the flask able to contain?" For low temperatures, the flask and its contained water were placed in a large vessel filled with the same fluid, the temperature of which was shown by two thermometers immersed in it. When it was certain that the flask had assumed the temperature of the surrounding water, the stopper (which was preserved at the same temperature,) was set on, the flask dried, and then carefully weighed. For temperatures of 40° or 50° C., the flask was immersed in a large beaker filled with water, which again was immersed in a second larger beaker, also full of water; the latter was heated, and after some time the water surrounding the flask acquired a uniform temperature of the required height; the glass stopper, which up to this time had been preserved in water of the same temperature, was now set on, the flask removed, dried, and weighed as before. When the quantity of boiling water held by the flask was to be ascertained, the latter was properly fixed in the neck of a large bolt-head, in which a quantity of water was kept violently boiling. The flask was here surrounded by steam, and precautions were taken to prevent any inconvenient loss of heat by radiation or by contact with the surrounding air.

Having ascertained the amount of water embraced by the flask at numerous temperatures, a proceeding exactly similar was followed to ascertain the specific gravity of the substance. The flask with the substance alone was first weighed; the flask was then filled with water, the air completely expelled by boiling, and then the weight of the known quantity of solid substance, plus the weight of the water necessary to fill the flask at various temperatures, was ascertained.

Suppose the weight of the flask of water at the temperature  $t^0$  to be  $W$ , the weight of the solid substance to be examined to be  $P$ , and the weight of the water and substance which together filled the flask at  $t^0$  to be  $S$ , then we have

$$\frac{P}{W-(S-P)} = D_t$$

where  $D_t$  expresses the specific gravity of the substance referred to water of the temperature  $t^0$  as unit. Further, is  $\frac{D_t}{V_t} = D_0$  = the specific gravity

\* From the Lond., Edinb., and Dublin Philosoph. Magazine, April, 1852.

of the solid substance at  $t^0$  referred to water at  $0^0$  as unit, where  $V_t$  expresses the volume which one volume of water at  $0^0$  assumes on being heated to  $t^0$ .

Supposing that for two temperatures  $t$  and  $t'$ , the former of which is lower than the latter, the specific gravities  $D_0$  and  $D_0'$  respectively be found, then is the cubic expansion of the body

$$= \frac{1}{t' - t} \cdot \left( \frac{D_0}{D_0'} - 1 \right)$$

The expansion of water by heat was made the subject of special inquiry, and numerous substances were examined whose linear expansion had been determined by other methods and other men; the agreement between M. Kopp's results and those already determined furnishes a proof that the method pursued and precautions taken may be relied on.

We here transcribe a tabular statement of M. Kopp's results, premising that each is the mean of several experiments:—

Substance,	Formula.	Cubic expansion for $1^0$ .	Determined by means of
Copper,	Cu	0.000051	Water.
Lead,	Pb	0.000089	"
Tin,	Sn	0.000069	"
Iron,	Fe	0.000037	Mercury.
Zinc,	Zn	0.000089	Water.
Cadmium,	Cd	0.000094	"
Bismuth,	Bi	0.000040	"
Antimony,	Sb	0.000033	"
Sulphur,	S	0.000183	"
Galena,	PbS	0.000068	"
Zinc blende,	ZnS	0.000036	"
Iron pyrites,	FeS <sup>2</sup>	0.000034	"
Rutile,	TiO <sup>2</sup>	0.000032	"
Oxide of tin,	SnO <sup>2</sup>	0.000016	"
Oxide of iron,	Fe <sup>2</sup> O <sup>3</sup>	0.000040	"
Magnetic ore,	Fe <sup>3</sup> O <sup>4</sup>	0.000029	"
Fluor spar,	CaFl	0.000062	"
Arragonite,	CaO, CO <sup>2</sup>	0.000065	"
Calcareous spar,	CaO, CO <sup>2</sup>	0.000018	"
Bitter spar,	CaO, CO <sup>2</sup> + MgO, CO <sup>2</sup>	0.000035	"
Carbonate of iron,	Fe (Mn, Mg) O, CO <sup>2</sup>	0.000035	"
Heavy spar,	BaO, SO <sup>3</sup>	0.000058	"
Celestine,	SrO, SO <sup>3</sup>	0.000061	"
Quartz,	SiO <sup>3</sup>	{ 0.000042	"
		{ 0.000039	Mercury.
Orthoklas,	{ KO, SiO <sup>3</sup> + Al <sup>2</sup> O <sup>3</sup> ,	{ 0.000026	Water.
	{ 3SiO <sup>3</sup>	{ 0.000017	Mercury.
Glass, soft soda glass,		0.000026	Water.
Glass, soft soda glass, another kind,		0.000024	Mercury.
Glass, hard potash glass,		0.000021	Mercury.

Taking every possibility of error into account, M. Kopp considers that we may infer with certainty from the preceding numbers, that the expansion of solid substances is by no means determined by their chemical nature. The difference between the coefficients of expansion for arragonite and calcareous spar is so great as to destroy all hope of establishing any relation of the kind. Neither does the expansion appear to depend altogether on the arrangement of the atoms; for although bitter

spar and carbonate of iron agree, and heavy spar differs but little from celestine, in the cases of carbonate of iron and carbonate of lime, and of rutile and oxide of tin, no such agreement exists. The table further shows that there are many non-metallic substances which expand as much under the action of heat as the metals themselves.—*Ann. der Chem. und Pharm.*, Vol. LXXXI, No. 1, p. 1-67.

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*Description of a New Method of Preparing Negative Photographic Paper.*

By M. GUSTAVE LECRAY.\*

Persons who are engaged in the process of photography on paper, are well aware of the difficulty of obtaining paper of a good quality, and suitably adapted to receive uniformly the requisite chemical preparations.

After having made a great number of trials, I have succeeded in meeting this difficulty by the use of a size adapted, I may say, to any kind of paper.

Paper thus prepared so much facilitates the photographic process, and helps to assure a satisfactory result, that I make no doubt it will be generally adopted.

The substance used for this size is virgin wax, which is kept at a temperature of 100° centigrade, in a large flat vessel, and the paper is immersed therein until completely saturated with the wax. The sheet of paper is then withdrawn, and laid between several pieces of blotting paper, over which a moderately heated iron is passed, which causes the blotting paper to absorb the superfluous wax. If the paper is properly prepared, there will be no gloss whatever on its surface, and it will be perfectly transparent.

The waxed paper is then immersed in a warm solution, composed as follows:

1000	parts	of rice water.
40	"	sugar of milk.
15	"	iodide of potassium.
0.80	"	cyanide of potassium.
0.50	"	fluoride of potassium.

The sheet of paper should be laid in this solution for half an hour, and it may then be withdrawn, and hung up to dry.

The paper is then immersed in a clear solution of aceto-nitrate of silver, which is thus formed:

300	parts	distilled water.
20	"	azotate of silver.
24	"	crystallizable acetic acid.
5	"	animal charcoal.

The animal charcoal serves to render the paper more susceptible to receive impressions, and decolorizes the solutions when they have been previously used. The paper should remain three minutes in this solution, and in order to insure contact with the liquid, the two sides of the sheet should be rubbed over with a brush. The paper is then washed several times with distilled water, and well dried between pieces of blotting paper. Paper thus prepared may be taken immediately into the dark chamber, and it is not necessary to subject the image to the action of

\* From the London Mechanics' Magazine, for January, 1852.