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*XLV. An easy Method of making a Phosphorus, that will imbibe and emit Light, like the Bolognian Stone; with Experiments and Observations; by John Canton, M. A. and F. R. S.*

To make the PHOSPHORUS.

Read December 22, 1768. **C**ALCINE some common oyster shells, by keeping them in a good coal fire for half an hour; let the purest part of the calx be pulverized, and sifted; mix with three parts of this powder one part of the flowers of sulphur; let this mixture be rammed into a crucible of about an inch and a half in depth, till it be almost full; and let it be placed in the middle of the fire, where it must be kept red hot for one hour at least, and then set by to cool: when cold, turn it out of the crucible, and cutting, or breaking it to pieces, scrape off, upon trial, the brightest parts; which, if good phosphorus, will be a white powder; and may be preserved by keeping it in a dry phial with a ground stopple.

The quantity of light a little of this phosphorus gives, when first brought into a dark room, after it has been exposed for a few seconds, on the outside of a window to the common light of the day, is sufficient to discover the time by a watch, if the eyes

have been shut, or in the dark, for two or three minutes before.

By this phosphorus celestial objects may be very well represented; as Saturn and his ring, the phases of the Moon, &c. if the figures of them, made of wood, be wetted with the white of an egg, and then covered with the phosphorus. And these figures appear to be as strongly illuminated in the night, by the flash from a near discharge of an electrified bottle, as by the light of the day.

#### EXPERIMENT I.

Having put some of the same parcel of the phosphorus into two glass balls, and sealed them hermetically; I placed one of them on the outside of a window facing the South, that it might be very much exposed to the direct rays of the Sun, where it remained from the 25th of December 1764, to the 25th of December 1765. The other was kept during the same time in darkness. After this, they were both exposed to the light, and carried into a dark room together; where the phosphorus in each appeared equally bright.

#### EXPERIMENT II.

Some of the phosphorus finely powdered, being put into a glass ball, with as much water as would make it adhere to the glass, so as to cover the inside of the ball, which was hermetically sealed, was found gradually to lose its property of imbibing and emitting light, but faster in summer than in winter; so that  
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at the end of the first year, it could not, in the least, be perceived to shine, when taken from the strongest day-light, and carried into a dark room. It was also observed to lose its whiteness by degrees, and to become of a very dark colour, especially on that side of it next to the glass. Some of the phosphorus which was made to stick to the inside of a glass ball hermetically sealed, by means of common spirit of wine, was found after one year to be a little impaired; but some made to stick by means of an ætherial spirit, was found not to be impaired at all.

According to Doctor Nicholas Lemery (in his Course of chymistry, eleventh edition) the exposing the Bolognian stone to the Sun wears it out. But by the first experiment it appears, that a phosphorus of the same kind was not hurt by the Sun in twelve months. Water, indeed, in the second experiment, was found in that time to destroy it. Therefore it is probable, that what the Doctor imputed to the light of the Sun, was caused by the moisture of the air.

### EXPERIMENT III.

I mixed a small quantity of the phosphorus with a considerable quantity of spirit of wine in one glass ball, and with æther in another, and sealed them hermetically. When the balls were shook, each of the fluids appeared like milk; but the phosphorus would soon subside when the balls were at rest, and leave the spirit of wine and æther quite clear. After some months, the spirit of wine was found to be tinged with yellow; but the æther, to this time, remains unaltered. By shaking the balls while they are exposed

to the light, the whole of the fluid in each, will appear luminous when carried into a dark room. The æther gives as much light now, as it did at first; but the spirit of wine a little less.

#### EXPERIMENT IV.

I exposed the dry phosphorus, in one of the glass balls mentioned in the first experiment, to the light of the day, by holding it on the outside of a North window about half a minute; after which it was kept in darkness for two days and a half, and was then found to shine, by putting the glass ball that contained it into a basin of boiling water. On the morrow it was exposed to the light again; and after it had been kept four days and a half in the dark, it gave light when put into boiling water, though not so much as before. In summer, I find, it will not give any light by the heat of boiling water after keeping it fifteen days; but in winter, it will afford a little, after keeping it a month.

#### EXPERIMENT V.

The phosphorus in each of the two glass balls mentioned in the first experiment was illuminated at the same time and to the same degree, and carried into a dark room. One of the balls was immediately put into a basin of boiling water, and thereupon the phosphorus in it became much brighter than that in the other, and continued so for a short time, but parted with its light so fast, that in less than ten minutes it was quite dark. The other phosphorus still gave a considerable degree

degree of light, and remained visible for more than two hours after, when even the heat of the hand would plainly increase its light.

Bolognian phosphorus is said, by Lemery, and also by Musfichenbroek \*, to imbibe less light when hot than when cold, as it appears less bright when carried into a dark room. But this appearance may be caused by its parting with the light it has received faster when in the former state, than when in the latter, according to the last experiment; as it must lose more when hot, than when cold, during the time of conveying it from the place where it takes the light, to a place dark enough to observe it in. And this seems to be the cause also, why Bolognian phosphorus never appears so bright after it has been illuminated, and consequently in some measure heated, by the direct beams of the Sun, as after it has only been exposed, in the shaded open air, to the common light of the day.

#### EXPERIMENT VI.

The balls used in the last experiment were kept in the dark for two days after, and then each at the same time was put into a basin of boiling water in a dark room: that which had parted with its light in the hot water before, was not visible; but the other appeared luminous for a considerable time.

When the phosphorus has once lost as much of the light it had received, as the heat of boiling water will

\* See his *Introductio ad Philosophiam Naturalem*, § 1697. See also § 1704 and 1686.

cause it to part with, it has never after been found, if kept in darkness, to give any more light by that degree of heat. But if it be exposed again to the common light of the day, the experiments may be repeated with the same success as before. This has frequently been done, with some dry phosphorus in glass balls which have been hermetically sealed about four years, without the least injury to the phosphorus; as it appears to be as good now as it was at first.

#### EXPERIMENT VII.

Let one end of a bar of iron of about an inch square, or a poker, be made red hot, and laid horizontally in a darkened room, till by cooling it ceases to shine, or is but barely visible. Then bring a little dry phosphorus, which has been exposed to light in a glass ball hermetically sealed, as near the hot iron as possible, by holding the ball in contact with it; and the phosphorus, though invisible before, will in a few seconds begin to shine; and will discharge its light so very fast as to be entirely exhausted of it in less than a minute; and then will shine no more by the same treatment, till after it has been exposed to light again. By this heat, light received from a candle, or even from the Moon, may be seen several days after. And phosphorus that will afford no more light by the heat of boiling water, will shine again by the heat of the iron. By this heat also, phosphorus which had been kept in darkness more than six months, was found to give a considerable degree of light.

It was the opinion of the great Sir Isaac Newton, that the rays of light are very small bodies emitted from

from shining substances, and not motion propagated through a fluid medium; for several reasons which he has given in his *Opticks*. Notwithstanding which, it has been urged since his time, that light is nothing but a repellent fluid put into very violent vibrations. Now it appears impossible, to me, at least, if light be nothing but motion propagated through a fluid medium, and not particles emitted from the luminous body, to account for the phænomena in the fifth, sixth, and seventh experiments. That a substance should either give light or not, when its parts are agitated by the same degree of heat, according as it has, or has not been exposed to light, for a few seconds of time, more than six months before; seems plainly to indicate a strong attraction between that substance and the particles of light; by which it keeps many of them, in the common heat of the air, a long time, if not always: for the light the phosphorus gives by being heated to a certain degree appears to be caused by its throwing off adventitious particles, and not by any of its own; since its light will decrease and be entirely gone, before the phosphorus will be hot enough to shine of itself, or to emit particles of light from its own body.

A writer against the Newtonian doctrine of light is pressed with a great difficulty, and asks, if it be possible that a particle can move so far as from the Sun to the Earth, and not frequently impinge upon other particles, when, he says, every part of space must contain thousands of them? But this difficulty will nearly vanish, if a very small portion of time be allowed, between the emission of every particle and the

the next following in the same direction. Suppose, for instance, a lucid point of the Sun's surface to emit 150 particles in one second, which are more than sufficient to give continual light to the eye, without the least appearance of intermission; and then the particles, on account of their great velocity, will be behind one another more than 1000 miles, and leave room enough for others to pass, in all directions.