will appear later). For brevity I designate the spark gaps thus :—

- (N) Gap between negative knob terminal of Wimshurst and coiled wire to kathode.
- (K) Gap between coiled wire to kathode and the kathode external wire loop.
- (P) Gap between positive knob terminal of Wimshurst and coiled wire to anode.
- (A) Gap between coiled wire to anode and the anode's external wire loop.

Experiment i.—Make N and P about $\frac{1}{8}$ ". A exceedingly small, and K about $\frac{1}{4}$ ". The result, when the machine is being turned by hand as quickly as is convenient, is a series of discharges, during each of which the tube flashes out a brilliant, almost orange-green, giving on my fluorescent screen a light so bright as to be trying to the eyes; the hand will show at once that X₃-rays are being emitted, and with this arrangement I have shown the ordinary shadow experiments to a large room-full at once. Three or four persons can see at the same time the back-bone and ribs of a man if a little care is taken to exclude extraneous light; and what I expect will interest a great many people who are not scientific, I have seen (to put it popularly, though of course incorrectly) through a brick wall, *i.e.* through $8\frac{1}{2}$ inches of solid brick. To speak exactly—the rays which come through the brick are sufficiently powerful to show dullish flashes on the screen, and a piece of platinum foil placed just behind the screen is distinctly visible, though badly defined, during the flashes. It is necessary, of course, to be careful to avoid any ordinary light reaching the screen, or any X-rays from reaching it except through the wall; but the experiment has been performed carefully many times now, and there is no doubt whatever as to the power of the rays from even my small tubes to penetrate this thickness of brick. These X₃-rays have wonderful penetrating power, and experiments with them are well worth making. The X-light is able to penetrate a little over $1\frac{1}{2}$ " of glass, and 3" of water easily, and 37" of wood.

In this experiment, unless the spark gaps are adjusted carefully (and the measurements I give are only intended as a rough guide), sparks pass along the outside of the tube in a way which at first made me anxious for the tube's life; but so long as the tube's loops are nearer to the coiled wires than any other part of the tube, experience teaches me there is no danger. Even during the passage of these external and noisy sparks, there is a discharge inside the tube sufficient to show a faint and very transparent hand shadow on the screen, the bones being scarcely distinguishable from the flesh—these being the most transparent shadows I have yet seen.

Experiment ii.—Arrange so that A is exceedingly small, and N and P about equal, and so that the discharge by long sparks along the tube and outside it are just avoided; then take a piece of thoroughly wet string, and fasten one end of it to the kathode loop, and the other to the end of the coiled kathode wire (a few strands of lamp-wick answer even better), and move the kathode coiled wire away from the tube's neighbourhood, carrying (of course) one end of the string with it until there is no direct sparking through the air, and all the discharge goes through the string. If the radiation from the tube be now examined by the screen with the hand held close behind it, the shadow of the flesh will be very dark indeed, and the bones scarcely visible; in fact, it is fairly easy to secure a quite black shadow whilst the rest of the screen is brightly illuminated. These are, therefore, the X₂-rays. By shortening the string gradually the shadow changes, the flesh becoming more and more transparent, the bones' shadows remaining black for some time, until when the direct disruptive discharge through the air begins the X₃-rays are immediately restored, and the radiation penetrates easily both flesh and bone. Thus, by "loading" the circuit more or less, the character of the radiation is altered. We know that the discharge of a Leyden jar is oscillatory, and the frequency of vibration very high, also that the frequency is lowered and the oscillations damped by the use of a wet string or other resistance placed in the jar's discharge circuit; hence it appears reasonable to suppose that it is this slackening of the electrical oscillations which produces the corresponding change in the X-rays, and that this slackening can be produced by altering resistance outside as well as inside the tube, at any point, perhaps, in the circuit, so long as the discharge is kept disruptive in character. In this experiment the discharge through the three spark gaps, and so through the whole circuit, is certainly disruptive; but the influence of the wet string on the whole circuit, including, of course, these gaps, is shown strikingly by

the altered appearance and sound of the sparks at N and P. The wet string, therefore, causes the tube to produce rays of the same kind as the heating of the tube, and if heat increases the general conductivity, it would seem that the wet string must do the same thing. It is, besides, obvious that the wet string takes the place of a rather wide air gap, and it can be very easily proved by experiment that the air gap possesses the greater resistance. Hence it might be thought that the vibrations in the case of air would be more slowly executed; but in these experiments we have to do, not with the ordinary resistances of air and wet string, but with their resistances during the disruptive discharge; to put it into popular language, the air can stand a great electrical stress without giving way, but when once its initial and great resistance is overcome, its resistance may be for the time very greatly diminished, so that the electricity surges backwards and forwards, it may be, many millions of times in a second; whereas in the case of the wet string, although it opposes at first far less than the air, yet its resistance never breaks down completely, for this very reason. The air and the string may be compared in this respect to an oak and a reed in a gale of wind; the reed, though it bends still resists, is always resisting, and the more it is bent the more it resists; the oak stands unmoved till it is broken or uprooted, and its resistance overcome. That the oscillatory discharge is necessary for the production of the X-rays I feel no doubt, though it would be an extremely interesting experiment for any one, who had the means and leisure, to try whether they could be produced by a so-called continuous current from a battery. A very few thousands of cells would seem likely to be necessary; but if any one should construct a tube according to the hints and instructions given in this letter, I think that the number which would be found necessary might be a good deal less. The discharge of a Wimshurst without Leydens, and with the four spark gaps nil, is still disruptive, though I expect less so when (unlike mine) the plates have no metal buttons and sectors on them; the rotating mirror, I believe, shows that even the silent brush discharge is disruptive—certainly the thin blue sparks are so, and the discharges from the revolving plates on to the combs and between the two plates themselves, are all disruptive.

Experiment iii.—The spark gaps being arranged as in Experiment ii., instead of the wet string the secondary circuit of my $4\frac{1}{2}$ " spark induction coil was inserted, the rays given off by the tube were then X₁-rays, which gave most exquisitely bright and clear pictures on the screen, whilst at the same time the discharge through the coil gave rise to very decided Hertz effects for a considerable distance. It is clear that a rheostat of some fine wire of high resistance would be convenient to use with a tube, and that by its means we could adjust the kind of X-ray evolved very nicely.

The nature of the spark discharges at N and P during the emission of the X-rays deserves close attention. At times the spark seems like a string of equidistant silver beads strung on a bluish violet thread, and suggests stationary waves. Perhaps I may add that my work is necessarily interrupted for some weeks at least. I hope that any one who finds in this letter suggestions he would like to follow up experimentally, will not fail to carry out his wishes. The form of kathode I should recommend is a concave mirror focused on the anode, the outer rim being bent back so that the edge is well concealed behind the mirror, a section through the centre of the mirror face having a form something like a very shallow sign of Aries.

Eton College, July 24.

T. C. PORTER.

Extension of the Visible Spectrum.

REFERRING to the interesting letter on the above subject, from Prof. Oliver Lodge and Mr. B. Davies, in your issue for the 29th ult., I should like to mention that I have observed a similar extension of the visible spectrum when thrown upon a fluorescent screen of barium platino-cyanide. I may add that a screen of this description becomes brilliantly luminescent when brought into the vicinity of the brush discharge from a large Wimshurst machine, or, better still, from a Tesla coil. In the latter case the fluorescent surface will become luminescent at a considerable distance from the electrical discharge, if facing the latter; but if the screen is held with its opaque backing towards the discharge, the platino-cyanide will only luminesce if actually penetrated by the streamers of the discharge.

This screen will also fluoresce brightly at several yards distance from an ordinary Geissler vacuum tube.

A striking contrast is afforded by placing a piece of plain white paper over a portion of the screen, and observing the whole by the light either of a Geissler tube or of the Tesla brush.

Under these conditions the white paper will appear very dark, while the fluorescent surface is brilliantly luminous.

A. A. C. SWINTON.

66 Victoria Street, London, S.W., November 3.

IN continuation of our letter of October 29, we find that a reflexion grating does not show the bands so well as a quartz prism, because metals, e.g. silver-on-glass, do not reflect all this kind of light completely except at grazing incidence. The furthest band shown by a Rowland grating at incidence 45° has wave-length 2200 tenth-metres, whereas the extreme ultra-violet usually quoted (the Fraunhofer line U) is 2948 tenth-metres, and the bright bands shown by quinine are about 3250 and 3830 respectively. With a quartz prism the fluorescence caused by light of shorter wave-length than 2200 can be seen. But it is quite possible that Sir George Stokes in 1852 saw as far as we can see to-day.

OLIVER J. LODGE.

November 7.

BENJAMIN DAVIES.

Osmotic Pressure.

AS Mr. Whetham has called attention in your columns to my attempt to give a mechanical hypothesis for osmotic pressure, in the October number of the *Philosophical Magazine*, perhaps you will allow me to give some explanation of my somewhat faulty use of the term "dissociation hypothesis," which, as Prof. Ramsay has pointed out to me, may easily be misunderstood. I have used the term to signify not the separation of the ions in electrolytes, but rather the freedom of the solute molecules in non-electrolytes, and of the atoms in electrolytes—their dissociation, in fact, from the molecules of solvent. It appears to me that in some statements of the facts of osmotic pressure, the idea is strongly suggested that the molecules or atoms of the solute are moving about among the molecules of the solvent, and, as far as pressure at any rate is concerned, dissociated from them, and producing an independent effect, the osmotic pressure being directly due to the solute. My aim is to show that we may more reasonably account for the facts by supposing that the solute molecules or atoms are associated with the solvent molecules, entering into some kind of more or less unstable combination with them, and that the solution is not to be regarded as consisting of two parts producing independent pressures. The extra osmotic pressure is, of course, due to the solute in one sense, in that it would not exist without it; but it is an indirect effect, due to the modified compound molecules formed. The first effect is a decrease in "mobility" of the solution, so that the exchange in the two directions through a semi-permeable membrane is unequal, and it is only rendered equal when the solution is put under the extra pressure which we call osmotic pressure.

Mr. Whetham has shown, in a very simple way, that my hypothesis does not necessarily conflict with the facts of electrolysis, and that the idea of dissociation of the ions from each other may easily be reconciled with it.

J. H. POYNTING.

Mason College, Birmingham, October 31.

"Purple Patches."

I SHOULD be very glad if I could obtain information as to the cause and nature of certain "purple patches" which I have noticed from time to time for many years past, but have been unable to get explained. The patches in question occur during, or immediately after, rain, on the pavement or roadway; dashes of vivid purple, or rather violet, varying in size from small splashes or drops to patches as large as the palm of one's hand, but most commonly they are about the size of a shilling. When quite fresh, sometimes a little clot is observable in the centre of the splash. Sometimes I find one patch completely isolated, sometimes two or three in close proximity; sometimes, again, numerous little drops scattered over a certain space; once I counted twenty or thirty tiny dashes in about ten yards of pavement. When quite wet the violet colour can be rubbed up with a handkerchief or paper, which it stains as with "aniline purple" dye, as it does the pavement, and when once dry it is quite ineradicable, and lasts till it is worn away by exposure, or the feet of passers-by. I observe it to occur chiefly during warm rain after a dry or cold spell; never during dry weather, whether in summer or winter. During the past hot summer there was none to be

found, but directly the weather changed in July, I saw it in various localities. This was also the case in the long cold winter of 1895, when on the breaking up of the frost there were plentiful patches to be seen up and down the streets; there was also a complete absence during the following summer, till the drought gave, and then again I found this appearance recur. I naturally observe it most in Bath, where I live; but it is not at all confined to one place or situation. I have found good specimens at such widely different places as the doorway of a hotel at Oban; the Castle Hill, Edinburgh; railway platform at Morecambe; doorstep at Windermere; in streets and roads at Cambridge, Bude, Penzance, St. Ives, Clevedon; once in a London street (Pall Mall East), and once some was found in a cold water bath.

I have from time to time made inquiries from various people who I thought would know, but have not been fortunate enough to meet any scientific person who has observed it. But one learned professor to whom I described the "patches," suggested whether "purple bacteria" would prove a solution to the mystery, and recommended me to inquire through the medium of your columns. I should be much obliged if some one would enlighten me, or mention some authority to whom I could refer.

A. PEDDER.

13 Somerset Place, Bath, October 27.

Note on "*Plasmodiophora brassicæ*."

ALTHOUGH it is well known that *Plasmodiophora brassicæ* attacks the great majority of cruciferous plants, yet no instance of the common Shepherd's purse (*Capsella bursa-pastoris*, D.C.) being attacked is recorded in this country. Thus Massee (*Proc. Roy. Soc.*, vol. lvii.) quotes the Shepherd's purse as being reported by Halsted to be attacked in America, but says "It has not been observed to be diseased in this country, although one of our commonest weeds." During the past summer my attention was drawn to some plants of *Capsella* with swollen roots, growing in a sandy field near Coventry, on land upon which crops of swedes and turnips were grown in the usual rotation, and I had no difficulty in finding several additional specimens. These roots, on examination, were found to have the characteristic plasmodium in their cells. The Shepherd's purse must now be numbered among the plants in this country which provide a home for *Plasmodiophora*, and probably help it to maintain its existence in the ground from year to year, thus proving a possible source of injury to cruciferous crops.

The length of time for which *Plasmodiophora* can retain its vitality in the soil in the absence of any cruciferous plants, is still a matter of uncertainty. In order to ascertain this, in November 1893, I established a series of experiments (fully described in my annual report to the Newcastle Farmers' Club, 1895), intended to extend over a period of six years. In these experiments, six beds (A-F) and six large 18-inch flower-pots (A-F) were prepared, and each strongly infected with pieces of turnip badly diseased with "Finger-and-Toe," one bed and one flower-pot being sown with turnips each successive spring. The beds and pots acted as duplicate experiments, and the soil in both remained unmanured, and was carefully guarded from the intrusion of *Plasmodiophora*, while all cruciferous plants were rigidly excluded.

In 1894, in both pot A and bed A "Finger-and-Toe" appeared; in 1895, in the pot B "Finger-and-Toe" was found upon four plants out of six; and in the bed B, 8 per cent. were diseased. In 1896 the same result was strikingly shown; after a period of three years, the bed C and pot C were still found to be diseased, four out of five plants being affected in the latter, and 10 per cent. in the former. Massee had previously shown that the germs of disease retain their vitality for two years, and my experiment this year shows that this period can be increased to at least three years.

M. C. POTTER.

Durham College of Science, Newcastle-upon-Tyne, October 24.

Sparrows and Wheat.

IN vol. vii. part iii. p. 522 of the *Journal* of the Royal Agricultural Society it is stated that, in the Leicester district, Rivett's wheat is much grown, the reason being that sparrows do not attack it, while they do other varieties. Can any of your readers assign a cause for the exemption from attack of this particular variety? It is most curious if correct; and the authority quoted apparently is a good one.

F. G. BROOK-FOX.

Port Navis Cove, Penryn, Cornwall, November 1.