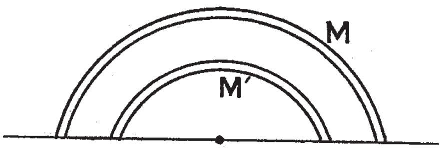
made here and at University College indicate that its specific gravity is about 9, and this figure agrees fairly well with that required for a mineral containing 75 per cent. of thoria.

T. A. HENRY.

Scientific and Technical Department, Imperial Institute, S.W., April 11.

Attraction between Concentric Hemispherical Shells.

BY the usual method of Legendre's functions I have arrived at the following result. If two thin attracting hemispheres, masses M and M′, radii a and a' ($a > a'$), are placed so that the rims lie in one plane and the centres coincide, the resulting attraction is $\frac{1}{4}$ M.M′/a^2.



From this result we conclude that we may replace M′ by any number of thin hemispherical shells (radii $< a$) subject to the conditions that the density of any shell is uniform, and that the total mass of all the shells is M′.

The result is so remarkable and simple that one looks for an elementary proof.

Perhaps some of your readers may be able to suggest one.

GEORGE W. WALKER.

Physical Laboratory, The University, Glasgow, March 28.

MR. G. W. WALKER tells me that he has sent to NATURE his interesting problem of the mutual attraction between two uniform concentric hemispherical shells, bounded by a common diametral plane. The following elementary solution has occurred to me. Call the outer shell A and the inner B. Now let another hemisphere A′ be added to A so that instead of the hemisphere A we have a complete and uniform spherical shell surrounding B. The attraction between the complete sphere and B is zero, if, as is here understood to be the case, the attraction between the particles follows the Newtonian law. Hence the attraction F of A on B is equal and opposite to the attraction of A′ on B. But the force exerted by A′ on B is obviously equal and opposite to the attraction which would be exerted by A on a hemisphere added to B so as to convert it into a complete spherical shell. Hence the force exerted by A on the inner sphere thus completed would be 2F, and this attraction is the same as that which would be exerted on a particle of double the mass of B placed at the centre. The attraction F of A on B is therefore that which would be exerted by A on a particle of mass equal to B placed at the centre, and the same thing holds for the reaction of B on A. Mr. Walker's result is therefore established.

We may go a step beyond the problem as proposed. Let the diametral plane bounding B, the shells remaining concentric, make any angle with the diametral plane bounding A. Then, by the same process of completing the sphere by adding A′ to A, we see that the attraction exerted by A′ on B is equal, and opposite in direction, to that which would be exerted by A on a hemisphere added to B to complete it in its new position. But the attraction of A on the inner sphere thus completed is equal to that which would be exerted by A on a particle of mass equal to twice that of B situated at the centre, and therefore the whole pull exerted on B by A, in any direction, is equal to the force, in that direction, exerted by A, on a particle of mass equal to that of B situated at the centre.

A. GRAY.

The University, Glasgow, April 6.

Curious Formation of Coal.

IN NATURE of January 14 (p. 250) Mr. Henry Hall describes a vertical deposit of a carbonaceous mineral in a wooden trough into which water from a coal mine had been delivered for three years. This interested me very much, as many years ago I described a similar carbonaceous mineral lining vertical cracks in a sandstone near Whangarei, in New Zealand (*Trans.* N.Z. Institute, vol. iii. p. 250, 1871).

I hope that Mr. Hall will make further observations and experiments on this singular phenomenon to see whether he is right in his explanation.

F. W. HUTTON.

Museum, Christchurch, New Zealand, February 25.

Photographic Effect of Radium Rays.

IT is interesting to note how pictures of the portions in relief on coins, medals, &c., can be obtained by means of radium rays. The coin or other object is placed directly in contact with a photographic plate which is enclosed in an envelope opaque to light. A few milligrams of radium bromide, contained in the usual mica-covered box, are placed some distance above the plate, and the whole left for several days. After development it is found that a clearly defined picture is obtained of the portions in relief on the under sides of the coins. Pictures have thus been obtained of the portions in relief on silver coins (half-crown, sixpence, threepence), also of a name engraved on a mother-of-pearl seal. Ten days was the time of exposure when ten milligrams of radium bromide were placed six inches above the plate, and the coin was a threepenny bit. Ten days also in the case of a half-crown when five milligrams were placed $1\frac{1}{2}$ inches above the plate.

This radium effect was first shown at my last lecture on radium at the College of Science, Newcastle, on January 16, and has been shown at my subsequent lectures.

HENRY STROUD.

Durham College of Science, Newcastle-on-Tyne, April 9.

ON THE MEASUREMENT OF CERTAIN VERY SHORT INTERVALS OF TIME.

ACCORDING to the discovery of Kerr, a layer of bisulphide of carbon, bounded by two parallel plates of metal and thus constituting the dielectric of a condenser or leyden, becomes doubly refracting when the leyden is charged. The plates, situated in vertical planes, may be of such dimensions as 18 cm. long, 3 cm. high, and the interval between them may be 0·3 cm., the line of vision being along the length and horizontal. If the polarising and analysing nicols be set to extinction, with their principal planes at 45° to the horizontal, there is revival of light when the leyden is charged. If the leyden remain charged for some time and be then suddenly discharged, and if the light under observation be sensibly instantaneous, it will be visible if the moment of its occurrence be previous to the discharge; if, however, this moment be subsequent to the discharge, the light will be invisible. The question now suggests itself, what will happen if the instantaneous light be that of the spark by which the leyden is discharged? It is evident that the conditions are of extraordinary delicacy, and involve the duration of the spark, however short this may be. The effect requires the simultaneity of light and double refraction, whereas here, until the double refraction begins to fail, there is no light to take advantage of.

The problem thus presented has been very skilfully treated by MM. Abraham and Lemoine (*Ann. de Chimie*, t. xx., p. 264, 1900). The sparks are those obtained by connecting the leyden with a deflagrator and with the terminals of a large Ruhmkorff coil fed with an alternating current. It is known that if the capacity be not too small, several charges and discharges occur during the course of one alternation in the primary, and that while the charges are gradual, the discharges are sudden in the highest degree. If, as in the present case, the capacity is small, it is necessary to submit the poles of the deflagrator to a blast of air, otherwise the leyden goes out of action and the discharge becomes continuous. Under the blast, the number of sparks may amount to several thousands per second of time. In this way the in-

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