the centre of gravity of the displacement when the ship is inclined. Draw OM perpendicular to *ac.* Then, after the inclination, the line OM will be vertical. From F and G draw FT and GV, perpendicular to OM, and from G draw GZ parallel to MO, cutting FT in Z.

Now, when the ship has inclined so that the point O be­comes the centre of gravity of the displacement, the up­ward pressure of the water acts on the then vertical line OM, with a force equal to the weight of the ship, because it supports that weight ; that is to say, with a force equal to the displacement, which we will represent by D. But the axis of revolution is the point G the centre of gravity, and GV being drawn from this point perpendicular to the direc­tion OM in which the force acts, D the displacement multi­plied by GV, its perpendicular distance from the axis of ro­tation, will be the force exerted to right the ship, or make it resume its upright position. But, by the construction, D × GV = D × FT — D × FZ.

Now D × FT is the horizontal moment of the displacement produced by the transfer of the solid from the weather to the lee side of the middle line ; it is therefore equal to the horizontal moment *bl,* and consequently we have the effort to right the ship, or the moment of stability, as it is called, *= b*I — D × FZ.

But if *s* be taken = sin. of inclination,

FZ = s × rad. FG, or if FG = d, then moment of stability = *bl — D∙d∙s.*

Hence, in order to calculate the actual moment of stabi­lity of a vessel at a given angle of inclination,

1. Assume an inclined load water-section, cutting the horizontal load water-section at an angle of which *s* is the sine ; and suppose the assumed inclined and the horizontal load water-sections to intersect each other in their common intersection with the longitudinal vertical section of the ship.
2. Find, by the methods of approximation, the solid con­tents of the two prismatic solids of immersion and emersion, intercepted between the segments of the inclined and the horizontal load water-sections.
3. Find, by the method of approximating to the area of plane surfaces, the area of the above-mentioned assumed inclined section.
4. Find the value of DS (fig. 1), which has been shown to l>e equal to the difference between the contents of the pris­matic solids of immersion and emersion, already found, di­vided by the product of the area of the assumed inclined section, into *s,* the sine of the angle of inclination.
5. Through the point S draw a section parallel to the as­sumed inclined section; find in each vertical transverse sec­tion the areas of each of the sections of the true prismatic solids of immersion and emersion ; and also find the horizon­tal moments of these areas from the point S.
6. Find the horizontal distance of the centre of gravity of the whole emerged solid from S, assuming the emerged solid to be equal to half the sum of the two solids of immer­sion and emersion, which are intercepted between the seg­ments of the assumed inclined load water-section and the horizontal load water-section.
7. Find also the horizontal distance of the centre of gra­vity of the whole immersed solid from S, assuming the im­mersed solid to be equal to half the sum of the same two solids of immersion and emersion.
8. Add these two distances together ; their sum will be the horizontal distance between the centres of gravity of the solids of immersion and emersion. Take the product of this distance multiplied into half the sum of the solids of immersion and emersion, and we shall have the value of the positive part of the expression for the moment of stability, or the value of *bl.*
9. The product of three quantities, the displacement, the distance between the centres of gravity of the ship and of

the displacement, and the sine of the angle of inclination, will give the value of the negative part of the expression.

10. Subtract the value of the negative part of the ex­pression from that of the positive part, and the remainder will be the value of the expression for the moment of sta­bility of the ship at the given angle of inclination.

It will be seen that the calculation of the moment of stability of a ship is very laborious. Several of the steps above enumerated in order, will, however, have been al­ready taken for other purposes. The calculations may be considerably shortened by assuming a value for the distance DS, or the distance that the point S is from the middle line of the ship. We have already described the method of as­certaining this distance correctly, but generally it may be assumed to be about two or three tenths of a foot at first ; and if the solids of immersion and emersion arc not found to he equal, or very nearly so, with that assumption, another point must be taken, either within or without the former, accord­ing as the solid of immersion or emersion is the lesser. If *e* be the difference between the two solids, and *a* the area of the first assumed inclined section, if *x* be the perpendi­cular distance between the true inclined section and the section we have assumed, *ax* will cqual *c* nearly, or *x =* which distance must be set off perpendicularly to the as­sumed section, and we obtain the correct position of the point S.

In order to determine the distance *d* between the centre of gravity of the ship and the centre of gravity of the dis­placement, the distance of the centre of gravity of the ship above or below the load water-line must be ascertained. To avoid the labour attendant on obtaining the position of this point by calculation, it may be determined experi­mentally in each class of ships of war when fully stowed and equipped.

*Method of ascertaining the centre of Gravity of a Ship by Experiment.*

We shall describe two methods of performing this expe­riment. The first of these was proposed by Chapman, and he strongly recommended that it should be made on ships of all classes. The principle on which it is founded is as follows. Various weights on board are removed in a trans­verse direction, so as to cause the ship to incline ; and the momentum of the total weight so removed will necessarily be equal to the moment of stability. Now the momentum of the weight removed will be equal to the product of the weights, the distance they are removed in a transverse di­rection, and the cosine of the angle of inclination ; which quantity, therefore, is equal to the moment of stability. If W represent the weights, *a* the distance they are removed, and *c* the cosine of the angle of inclination ; then, *bl — Dds* being the expression for the moment of stability, we have this equation,

W∙*a· c = b*I *—* Dds,

therefore *d = b*I - W ∙ *a ∙ e / Ds*

in which *d,* the distance between the centre of gravity of the ship and the centre of gravity of the displacement, is the only unknown quantity, and may therefore easily be found.

We shall now describe the method by which this expe­riment was applied to determine the centre of gravity of her majesty’s ship sl∞p Scylla, of eighteen guns, and which was originally an eighteen-gun brig. She was lying in Portsmouth harbour in May 1830, under the command of Captain Hindmarsh, at whose request the experiment was performed, by the late Mr Morgan of the School of Naval Architecture, then a foreman of her majesty’s dock-yard at Portsmouth, assisted by the writer of the present article.