A Simple and Accurate Method of Deriving the Slope of a Graphed Function

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The following method has been developed to obtain the tangents to a curve accurately and rapidly with no more than a 1- to 2-in. diameter cylindrical rod of Perspex or glass used as a lens.

The rod is laid roughly tangentially to the curve near to the point $P$ at which the slope is required. It is then rolled over the paper till the image of $P$ appears on the axis of the rod. The rod is twisted in the plane of the paper until the image of the part of the curve near $P$ lies exactly along the axis of the rod. The magnification of the cylindrical lens (x 5 or 6) increases the accuracy with which this can be done. But a further check is obtained if a short pencil stroke is made across the curve at $P$; this, viewed through the rod, will appear as a line almost exactly normal to the rod axis, however carelessly the stroke is drawn. This line, therefore, gives a secondary criterion for setting the slope of the rod: the image of the stroke must appear to cut the image of the curve at right angles. The rod is then located over the tangent at $P$, as in Fig. 1.

The slope of the rod can now be measured by rolling it over the paper until it reaches a position where two major reference lines $(x_1y_1$ and $x_2y_2$) intersect near one end of the rod as indicated in Fig. 2. This interaction can be viewed through the rod and the rod rolled till the image of the intersection lies on the axis as shown. Other $x$ and $y$ reference lines on the graph-paper appear as indicated in Fig. 2: those to which the rod is nearest in slope (x axis) are the thicker and the more obliquely distorted by the lens. The slope can now be read off directly. In the case illustrated the slope is 2.7/5, the derivation of this being obvious from Fig. 2.

Acknowledgement is made to the Chief Scientist, Ministry of Supply, for permission to publish this note.

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REFERENCES