whose graphic shapes are straight lines, hence the name. Next are quadratic equations. These also have two unknowns, and are to the second power. Their graphic shapes are lines of one curve; this curve can be closed, as in circles and ellipses, or open, as in parabolas and hyperbolas. Cubic and quadratic equations have unknowns to the third and fourth powers, respectively. Graphs of cubic equations have two curves, of the fourth have three curves. Combinations of quadratic and linear equations are quite common, and consist of any equations having a common solution, or even, in special cases, having no common solution. Fourth are polar co-ordinates. These are drawn on special graph paper, which consists of equally-spaced concentric circles, and lines radiating from the center at degree intervals. The graphs shown in this model indicate r with reference to the sine and cosine of variant angle O.

Graphs of the trigonometric functions are drawn on ordinary graph paper, with the distance from 0° to 180° equal to one radian, or 3.14 times the distance from zero to one. Shown are the graphs of the functions sine, cosine, tangent, and cotangent, of angles 0° to 360°. Secant and cosecant, the respective reciprocals or cosine and sine, are not depicted. They will have a value of one when sine and cosine are one, or infinity when their reciprocals' values are zero.

Equations having three unknowns are the final dimensional group of graphs. These take many forms: plane, in which the three unknowns are in the first power; sphere; ellipsoid, formed by revolving a plane ellipse about either the X or Z axis; paraboloid, which may be formed by revolving a parabola about one of the three axes, in which case it is a paraboloid of revolution, or else prescribing an ellipse with its outer extremities, in which case it is an elliptic paraboloid (demonstrated); hyperboloid: of one sheet if the plane hyperbolas rotate about one of the axes of two sheets if each revolves separately about the axis; cone, formed, like the paraboloid, with a triangle.

Equations having more than three unknowns cannot be solved by graphic means, for it is beyond the limit of human capabilities to visualize more than three mutually perpendicular lines. Such equations must be solved with a system of equations.

The demonstration of these graphs is especially adapted for classroom use, making clear the relationships and differences of the various graphs.

## BASIC POINTS IN THE CLASSIFICATION OF MINERALS

RICHARD H. PALMER
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My exhibit in The National Science Fair was entitled, "The Basic Points in the Classification of Minerals," and its purpose

was to show a person who had never seen a mineral before how to identify and classify it by using a series of short tests, and at the same time to show many strange and beautiful specimens that may be met. I took the seven basic points in the classification of minerals, which are streak, hardness, color, specific gravity, crystal system, cleavage, and luster, along with one lesser important but very spectacular phase, fluorescence, and using the specimens which I had collected in various parts of the United States, demonstrated and explained these phases.

I arranged my display in a staircase manner with one or two boards on each step containing minerals and cards illustrating and explaining each phase. To the right of these steps was a box arranged so as to allow no light to enter so the fluorescent minerals would be visible.

I divided my exhibit into three divisions: first, the visual section for people who know little or nothing about minerals and have no outstanding desire to learn. This section, which I tried to make as colorful as possible, included large colorful letters describing the phase along with a key sentence or phrase explaining this point if it was not self-explanatory. For example: I described cleavage simply as "The way a mineral breaks." This was fast and easy for the hurried passer-by. I used many various minerals from different localities to illustrate the various points. Also in this group I included the flourescent minerals, or as they were commonly termed, "The rocks that glow." These were very colorful and quite interesting to people who had never encountered anything like them.

Second, for the more scientific minded person who desired to know a little more about mineralogy, I included a card which explained each point well but shortly and simply. I also made a card for each mineral on the display giving all of the identifying characteristic along with the uses, occurrences, localities, and other assorted information.

Third, in addition to the above, I also included for those people interested in, or interested in starting a hobby or a profession in mineralogy a booklet entitled, "The Handbook of Mineralogy," which was written by myself in a moment of frustration from trying to understand technical references. This forty page booklet contains all of the necessary information for a person who knows nothing at all about minerals to learn about them, collect them, identify them, classify them, and display them. It has been written to make a person more interested in mineralogy as a hobby, as a leisure time activity, and as a thing that can bring him fun and self-satisfaction.

I have found that research and study are extremely important in undertaking to learn a great deal about a subject.

Although I spent about four years collecting my specimens, and about four or five months in the actual construction of my display, many long weeks and months were spent studying over books and talking to geologists.

Minerals and geology are a seed of enjoyment to me. I have found that they will not only give you pleasure, but that they will be a constructive education, training the eyes to see, and the mind to think straight. I have found that a person should show his collection to as many of his friends as possible. He should tell them of the pleasure collecting minerals has brought him, of the wonderful beauties of color and form he has seen for the first time in studying minerals, and of the interesting readings to which they have led him, of the delightful trips he has made and is planning to make, and of the high class friendships he has made, and he will grow more and more enthusiastic over collecting and studying minerals. No one ever regretted the time and effort spent with minerals.

## MY FIRST YEAR IN ASTRONOMY

NICHOLAS KENT DEMUTH
*Mabel C. Williams High School, Germantown, Tennessee*

In the fall of 1954 my science teacher mentioned something about building a telescope. Three friends and I started work on grinding a mirror for a Newtonian Reflector type telescope. After we had worked on the mirror for a while, we found out about having a science fair in Memphis. I took the telescope as a project. The mirror that we started was never finished because of the time it took for one person to grind and polish it.

After a mirror, eye piece and eye piece holder, cardboard tube, and a few other things were purchased and a few things borrowed or given to me, I started making various parts and putting others together. The mirror holder was made from two pieces of wood turned out on a lathe. The tripod was made from pipe and pipe fittings. The main tube was made from a cardboard tube. The tube saddle was made from a wood strip, two pieces of 1½ in. angle iron and two strips of 1½ in. metal. This type of telescope was brought into use by Sir Isaac Newton.

The main parts of the telescope are the eye piece, concave mirror, and the diagonal mirror. The top end of the tube is open. The light enters the open end and hits the concave mirror at the bottom of the tube. The mirror reflects the light to the diagonal mirror which is in the center of the top end of the tube. The diagonal is at a 45° angle to the tube. The light rays are then bent at right angles and are magnified by the eye piece. The eye piece is located on the tube at a right angle to the tube. My telescope is equipped with an equatorial mount.