Geometry

CLINOMETER

Item: A- 12 CLINOMETER

A clinometer is an instrument for measuring heights. Most clinometers give the angle of elevation, from which the height can be obtained by trigonometry or scale drawing. This model, which costs almost nothing to make, uses the principle of similar triangles and ratio.

Diagram:

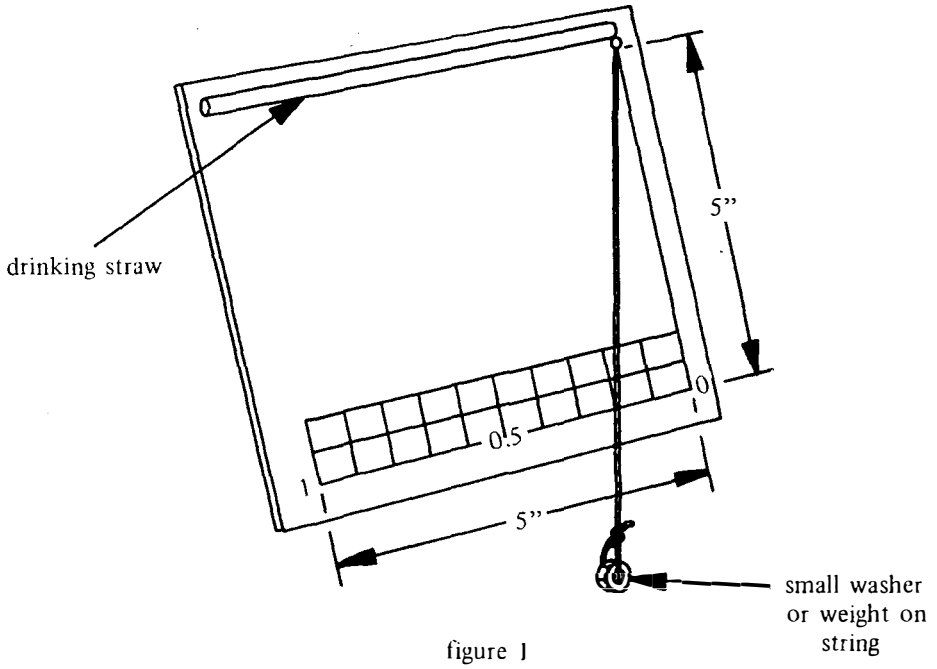


figure 1

Materials Needed:

1. Piece of square material of side 6"-7". It could be 1/2" pine or plywood, masonite, or thick cardboard.
2. Drinking straw
3. Scotch tape
4. String, 10" length

5. Small washer or weight

6. Sheet of graph paper, 1/4" or 1/10"

7. Drill, wood, with bit, 1/16" or 1/8"

Construction:

1. Drill a hole in one corner of the square about 1/2" from each edge.

2. Draw a line 5" long from this hole parallel to one edge, and another at right angles to this. This latter line will mark the position of the lower edge of the paper scale to be put on (fig. 1).

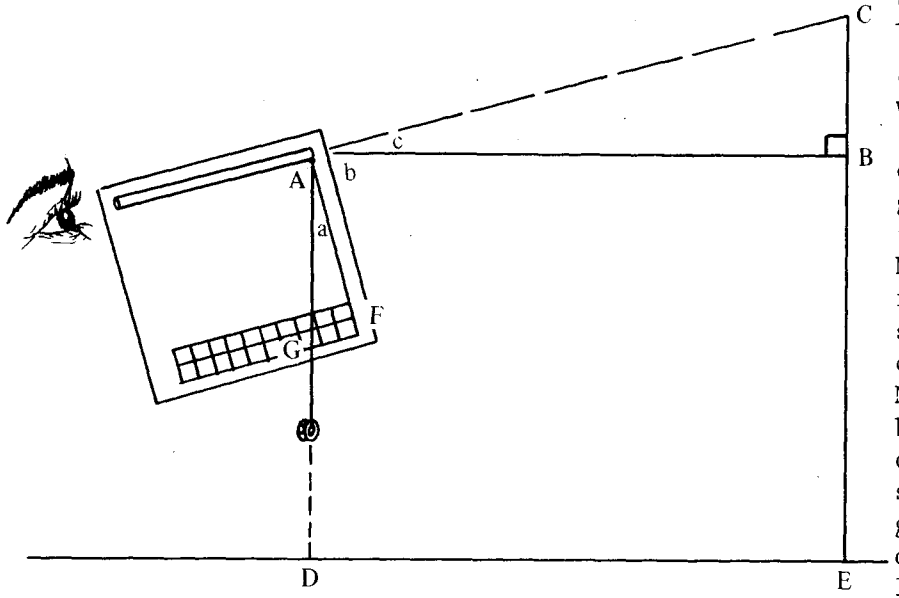
3. Cut out a 5" x 1" strip of graph paper for the scale, and graduate it from 0 to 1, starting from the right. Tape or stick it along the line so that its lower edge is 5" from the hole, which should be perpendicularly above the zero end of the scale.

4. Tie the washer to one end of the string, and attach the other end to the hole.

5. Glue or tape the drinking straw along the top edge of the clinometer as a sighting piece slightly above the hole and parallel to the lower edge of the scale (it should not protrude beyond the square in case it gets knocked out of position).

Comments:

The device is well within the ability of most middle grade children to make from household materials. The instrument will add to their experience of measurement, and will assist in the judging of heights. As soon as possible, students should learn the geometric principle used, given in fig. 2 below. (NOTE: The clinometer will give the height of the object above the user's eye. So the ground should preferably be flat.)



TO USE THE CLINOMETER

Sight on to the object whose height you want to measure. Have a companion read off the graduated scale where the string hangs. Measure the distance from where you are standing to the foot of the object (DE). Multiply this distance by the decimal fraction obtained from your scale reading. This will give the height of the object above your eye level (CB).

AB and DE (ground) are horizontal. AD is the plumbline (vertical). Line CBE is assumed to be vertical.

$a + b = 90°$

$b + c = 90°$ $\therefore a = c$

$\therefore$ triangles ABC, AFG are similar.

$\therefore \frac{GF}{AF} = \frac{CB}{AB}$ $\quad \therefore CB = \frac{GF \cdot AB}{AF} = GF \cdot AB$ (where AF was scaled to equal 1)

figure 2

Sample Activities

1. Use the clinometer to find the height of the classroom ceiling. Check by measurement.

2. Use the clinometer to find other indoor heights, or the heights of the school buildings, flagstaff, chimney, etc. Check by other means, such as the shadow method, or architect's plans.

3. What if the base of the object upon which you are sighting is inaccessible -- e.g. a heating plant chimney?

4. Would it be simpler if you could station yourself so that the string coincided with 1 on the scale? What would the angle of elevation be? (45°)

5. Could you use the clinometer to find the height of a plane above ground? If this is impracticable, could two people, each equipped with clinometers, magnetic compasses, and in touch by a telephone or radio, arrive at a plane's height by simultaneous observations, and if so, what calculations would be necessary?