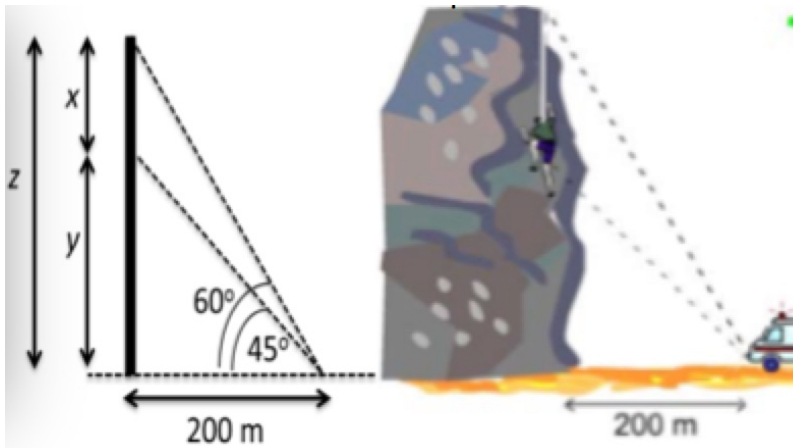


### CLIFF RESCUE



A climber is stuck at the middle of a cliff. A rescue worker on the ground is 200 m from the bottom of the cliff. The angles of elevation of the climber and of the top of the cliff as seen by the rescuer are  $45^\circ$  and  $60^\circ$  respectively.

Draw a diagram.

Another rescuer at the top of the cliff is going to lower a rope to the climber but he is not sure that his rope is long enough.

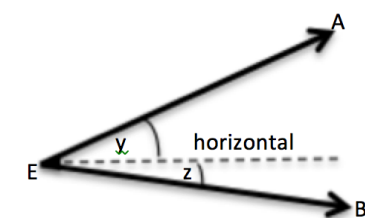
What length of rope should he use to save the climber?

### Help

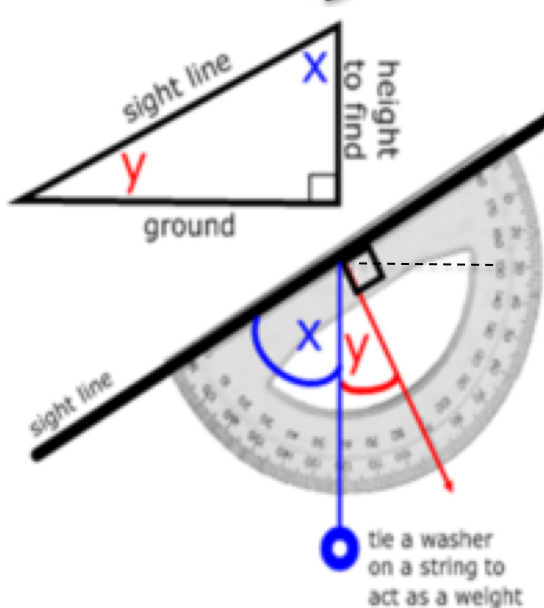
Making your own clinometer gives you a better understanding of angles of elevation and depression. In this problem you use a right angled triangle and a trig ratio to calculate the length  $z$  metres. Then you use another right angled triangle to find the length  $y$  metres.

When you know  $y$  and  $z$  you can find the length  $x$ . The rope needs to be a bit longer than  $x$  as shown in the diagram because the rescuer and the climber both need to be able to get hold of it.

### Make your own clinometer to measure angles of elevation and depression



If an observer with her eye at E looks up to a point A, then the angle between the horizontal and EA, shown in the diagram as  $\angle y$ , is called the angle of elevation. Similarly if the observer looks down to a point B then the angle between the horizontal and EB, shown as  $\angle z$ , is called the angle of depression.



The diagram shows an instrument to measure these angles.

It can be made simply and cheaply. To read the angles you need a protractor. To get an accurate vertical you need a weight (such as a heavy paperclip, a washer or a ball of plasticene) tied to a piece of string as the plumb line. To make the sight line use a drinking straw or stick.

If you hold the protractor with the  $90^\circ$  mark on the vertical the sight line is horizontal. Two people find the angle of elevation  $\angle y$ , one holds the instrument to their eye looking at the object of interest through the straw along the line of sight. The other person reads the angle between the vertical plumb line and the  $90^\circ$  mark on the protractor. This is  $\angle x$  equal to the angle of elevation.

### Extension

Make a clinometer and make up some challenges for yourself about how you could use it.