The students are told the grids in the workbook consist of horizontal and vertical lines. Those lines are parallel and 1/4 inch apart. They are told where the lines cross in the lower left corner is the *datum point.*

Problem 1

Point 1. Start at the datum point in the lower left hand corner of the grid area and go up1 square and to the right 2 squares

Point 2. From point 1 go to the right 4 squares.

Point 3. From point 2 go up 1 square.

Point 4. From point 3 go to the left 3 squares.

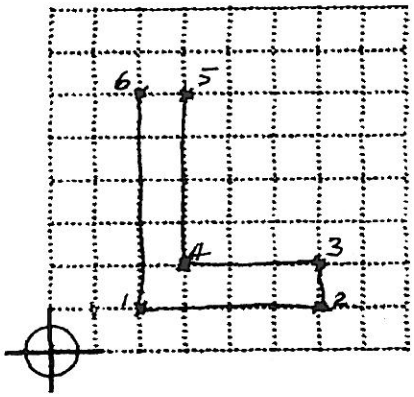
Point 5. From point 4 go up 4 squares.

Point 6. From point 5 go to the left 1 square.

Point 7. From point 6 go down 5 squares.

Now draw a straight line from points 1-2, 2-3, 3-4, 4-5, 5-6 and 6-1

What they have drawn is shown below.



It is then explained there is an easier way to write the directions. Horizontal lines are called "X" lines, vertical lines are called "Y" lines. Going to the right, or up, is "+" and to the left, or down, is "–". Since the lines are all 1/4 inch apart they can count squares to get the distance. They are shown how to measure distance counting squares and are then given problem 2 written as follows:

PROBLEM 2

Point				
1	X +	1/2	Y +	1/4
2	X +	1	Y	0
3	X	0	Y +	1/4
4	X -	3/4	Y	0
5	X	0	Y +	1
6	X -	1/4	Y	0
7	X	0	Y -	1 1/4

Problem 2 is worked in another grid but when they get done they see the solution is the same as problem 1.

They are told writing it this way is part of the Cartesian Coordinate system. If we had told them first what they were going to do some of the students would be lost before they even started. With such big sounding words it must be difficult.

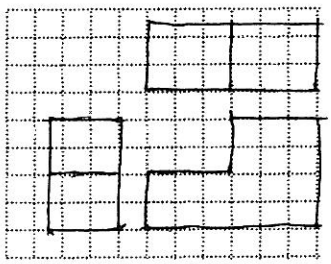
Problems 3, 4 and 5 are written the same way and all dimensions are 1/4 inch, or multiples of 1/4.

Next, it is explained that half of a 1/4 inch is 1/8 and examples of measuring in eighths are shown.

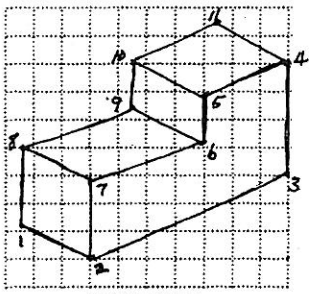
Problems 6, 7, 8 and 9 have measurements with dimensions in eighths as well as quarters.

Sixteenths are explained and examples given. Problems 10 through 23 give more practice using quarter, eighth and sixteenth inches.

Problems 20-22 are done in the same grid area. Problem 23 is in a grid area next to 20-22. The finished problems are shown below. The students do know what they are drawing, but they are drawing 3 orthographic views of the object on the left and an isometric view of the object on the right.



PROBLEMS 20 - 22



PROBLEM 23

They will see this shape often when new concepts are explained.

Orthorgraphic projection is now explained. Figures 9 and 10 shown below are some of the figures used to explain the concept. The shape of the object is the same as used in in problems 20-23.

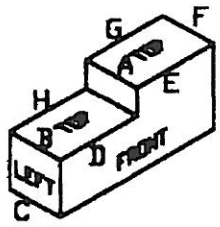


FIGURE 9

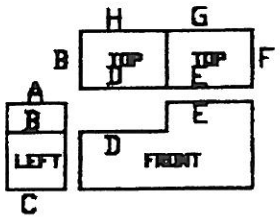
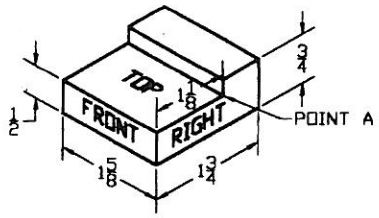


FIGURE 10

The students are now to sketch an orthographic view of an object. The first problem, number 24, is shown below. Same shape, but with different dimensions.

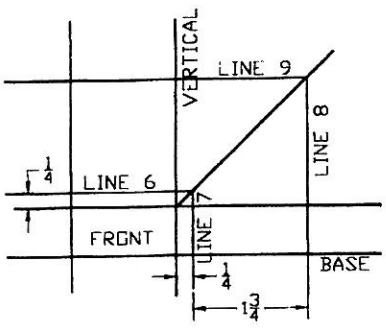


PROBLEM 24

Since problem 24 is their first orthographic drawing they are shown where to draw every line.

They are shown where to draw the 9 basic lines. Those lines are:
Line 1 the base line
Line 2: the vertical line
Line 3: the maximum height line
Line 4: the maximum width line
Line 5: the 45 degree line
Lines 6 & 7: the spacing lines
Lines 8: the maximum depth line, side view
Lines 9: the maximum depth line, top view

Figure 14 shown below shows those lines.



These 9 lines form the framework for every orhtographic problem and are very important.

In Figure 15, below, they are shown where to position the 3 views within that framework.

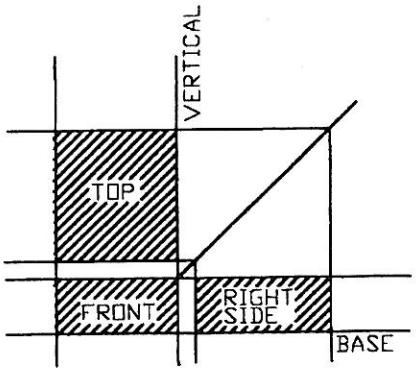


FIGURE 15

Figure 16, below, is part of the explanation used to show how to transfer points from the side view to the top.

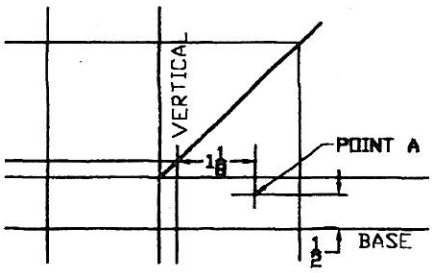


FIGURE 16

Figure 17, below, shows the last step needed to complete the three views.

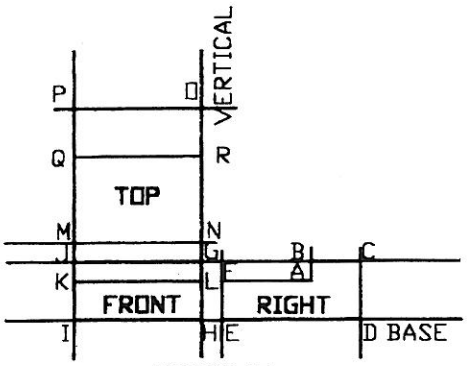


FIGURE 17

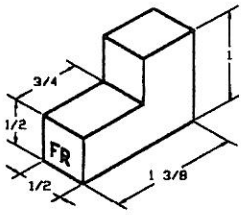
They are told to erase the construction lines and they have three orthographic views of the object. They have been told which lines to draw and where to draw them, now they are ready to do it on their own.

Problems 25 through 29 are given on the right. Notice the shape of problem 25, it is the same as 24 but with different dimensions.

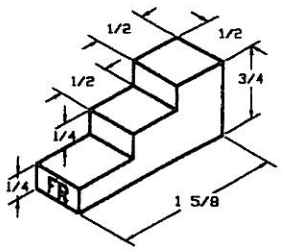
Problem 26 is the same basic shape as problem 25 except a step has been added.

Problem 27 is the same shape as figure 25 except the base is wider.

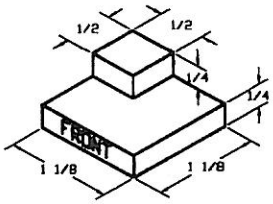
Problems 28 and 29 are similar but 29 is harder.



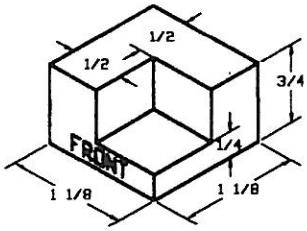
PROBLEM 25



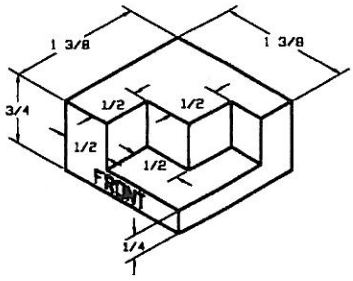
PROBLEM 26



PROBLEM 27



PROBLEM 28



PROBLEM 29

They are now ready to draw objects with hidden lines. Figure 18 shown on the right is used to explain hidden lines. Notice the shape is the basically the same as used to explain orthographics.

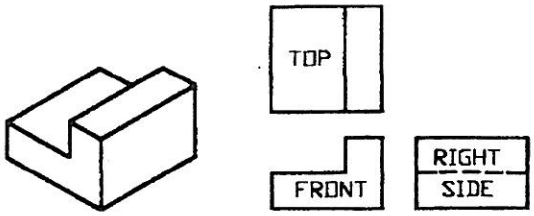
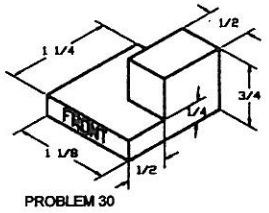
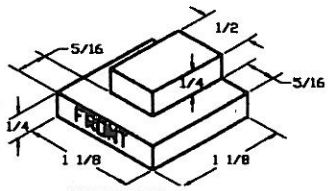


FIGURE 18

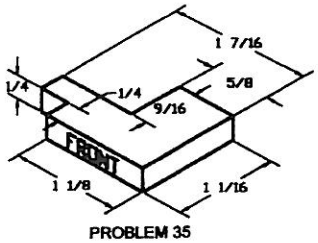
Problems 30 though 39 all have hidden lines. Some of those problems are shown on the right.



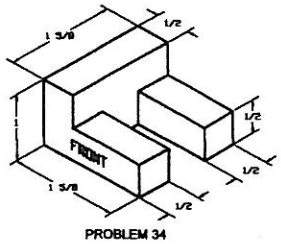
PROBLEM 30



PROBLEM 32

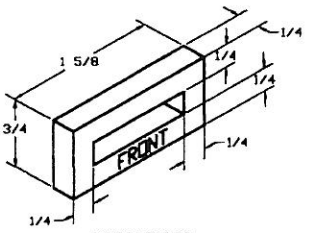


PROBLEM 35

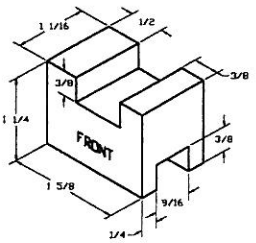


PROBLEM 34

Problems 36 though 39 have holes or slots going through them. Two of those problems are shown on the right.



PROBLEM 36



PROBLEM 38

So far all problems have surfaces with either vertical, or horizontal lines. Many objects have angled surfaces. These are explained as shown in the figures 19 and 20 below.

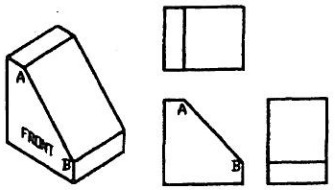


FIGURE 19

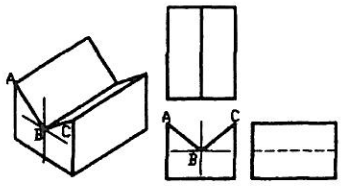
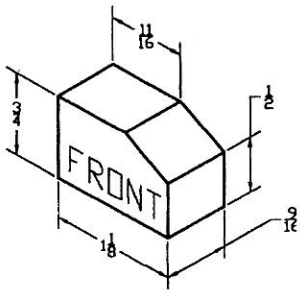
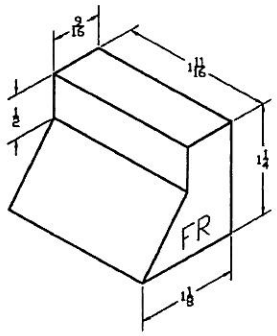


FIGURE 20

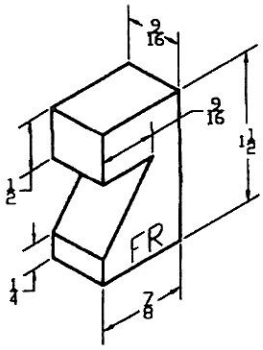
Sample problems with angled surfaces are shown below. Notice how the shape of problem 40 is much like shape used in figure 19 shown above.



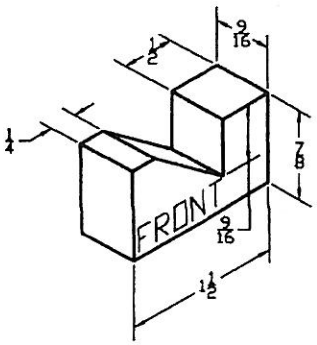
PROBLEM 40



PROBLEM 41



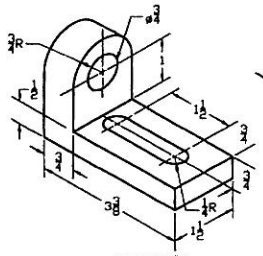
PROBLEM 42



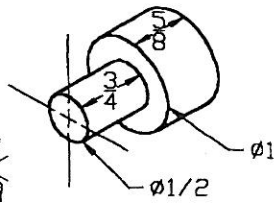
PROBLEM 43

Problems 42 and 43 above are the same shape, they are just presented from a different viewpoint. The reason is so the student draws it from a different viewpoint and they see it does look different. Students see this, you do not have to tell them.

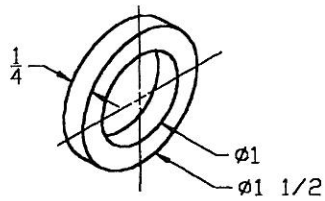
Circles and arcs are introduced next. Problems 52 through 57 involve arcs and or circles Some of the problems are shown below.



PROBLEM 54



PROBLEM 56



PROBLEM 57

Up to this point in the workbook, students have been given an isometric and they sketch 3 views of the object. They have been measuring by counting squares and parts of squares. They are now almost half way thought the workbook and have not used a rule to measure. In most traditional classes that is the first thing they have to learn. Not here.

Many students have trouble learning to read a rule. I think it is because we try to teach them 2 things at a time; the "concept of measurements" and the "markings on a stick." As they have been sketching in this workbook they have been learning the concept of measuring. Now it is time for them to learn the "markings on a stick."

Figures 25 –28, shown below, are used to explain the makings on a rule, how the length of the line indicates the inch, half, quarter, eighth and sixteenths.

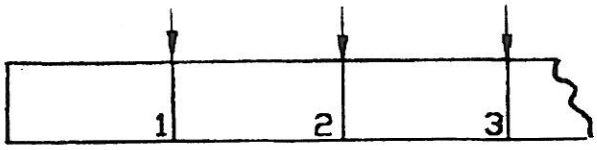


FIGURE 25

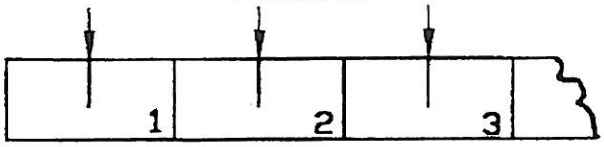


FIGURE 26

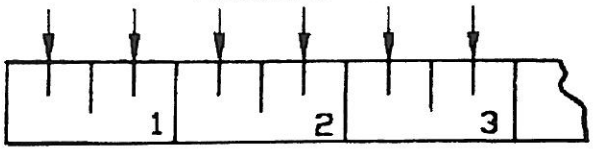


FIGURE 27

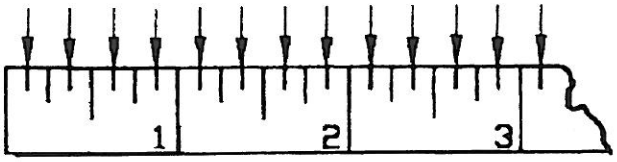


FIGURE 28

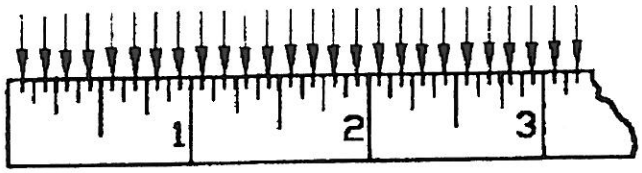
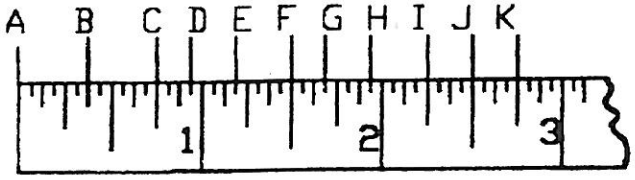


FIGURE 29

Problem 58 is shown below. The students are to give the dimensions between "A" and each of the letters.

This is easy, they understand the concept of fractions of an inch. Now it is just recognizing them on the "stick."



PROBLEM 58

Problems 47, 48 and 59 are isometric drawings with most of the lines are lettered. They are are to use a rule to measure the length of lines. Most students do not find the difficult either. The only problem we have is; some students measure outside to outside of the object while and others measure inside to inside of the lines. The thickness of the lines can result in 1/16 of an inch difference.

One of the main reasons we teach students to measure by counting squares is, it is faster than picking up a rule and making each measurement. This is a definite advantage. I had college students who had 12 hours of college credit in drafting "sketch" these problems. Those who used a rule to make the measurements took longer to do the problems than my beginning students. Simply picking up the rule and making the measurement just takes more time.

In the next section of the workbook they will be given orthographic drawings and are to make isometric drawings.

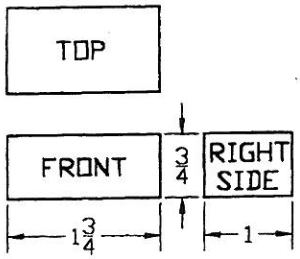
COMMENT: Many students struggle with orthographic projection, but when they start drawing isometrics the "light comes on." It happens so often one teacher said he thought we should start drawing isometrics first.

After much analysis, I think it best to stay the way it is in this book. I think if we started with isometrics then drew orthrographics the light would still come on when the change was made

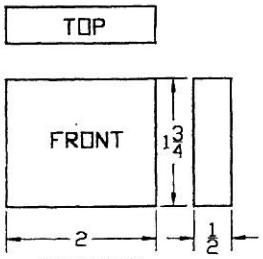
Personally I prefer to use grid paper and count squares to sketch isometrics, but it seems easier for the students to us a "T" square, triangles and a drawing board. Nothing fancy is required. "T" squares purchased at WalMart and pieces of plywood for a drawing board works fine

The first problem is an exercise drawing horizontal, vertical, and 45 degree lines using a "T" square and triangle..

There is an explanation on how to draw isometrics from orthographics. The first two problems, see 63 & 64 below, are simply rectangular boxes. Their purpose is for them to practice drawing the boxes for an isometric which is needed for all isometric drawings.



PROBLEM 63



PROBLEM 64

Figures 35 and 36, below, are used to explain how to draw isometrics which are not just boxes. Notice the familiar shape.

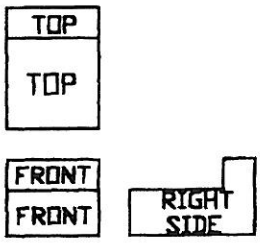


FIGURE 35

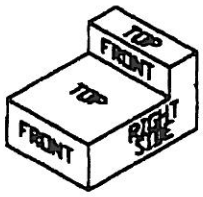
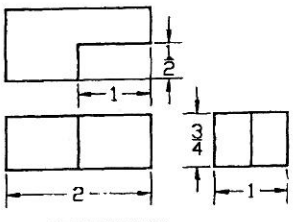
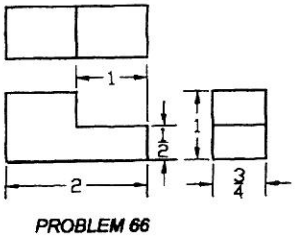


FIGURE 36

Problems 65 and 66 shown below are very much alike, the cut away notch is just in a different place.

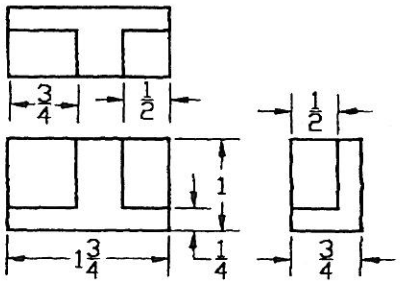


PROBLEM 65

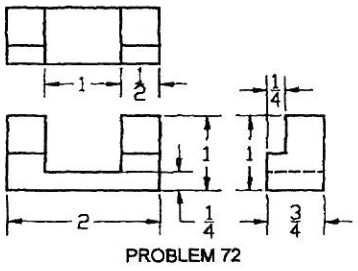


PROBLEM 66

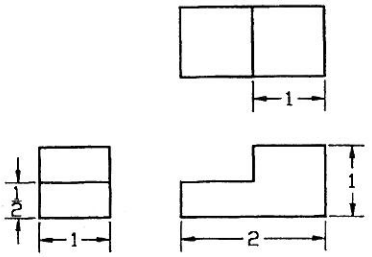
More sample problems are given below.



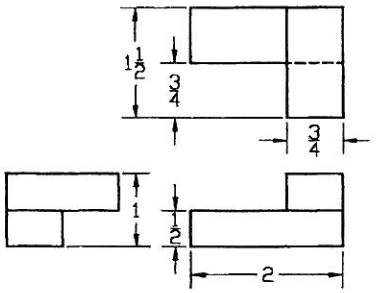
PROBLEM 70



PROBLEM 72



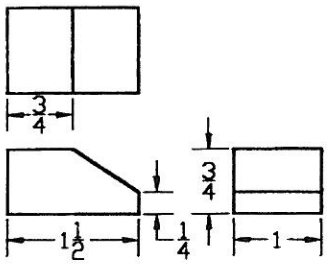
PROBLEM 76



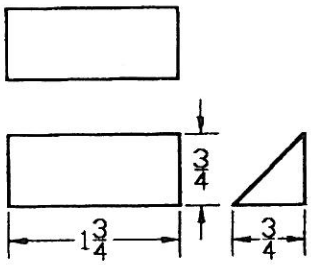
PROBLEM 77

Problems 76 is an example of adding a problem to enable the student to do the next problem. Problem 76 is simple, but it prepares them for problem 77.

Some surfaces are not parallel to one viewing plane. How to draw these in isometric are explained. Problem 78 and 79 shown below are exercises in drawing these.

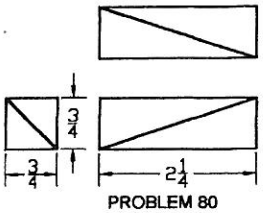


PROBLEM 78

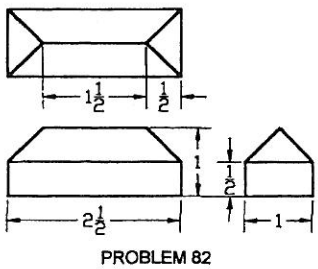


PROBLEM 79

Some surfaces are not parallel to any viewing plane. How to draw these in isometric are explained. Two problems are shown below.



PROBLEM 80



PROBLEM 82

AUXILIARY VIEWS

The next section is on auxiliary. This is the only section where they are to find the hidden view. No where in the book do we give 2 views and they draw the 3rd view, or find the missing lines. Auxiliary views are needed later when they do developments.

DEVELOPMENTS

Orthographic projections usually have only 3 views shown, but there are actually 6 possible views. See figures 50 & 51 below.

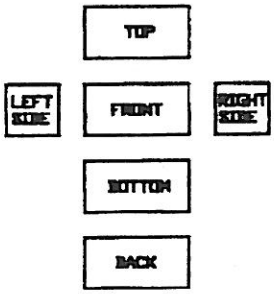


FIGURE 50

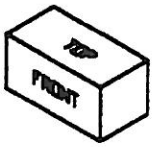


FIGURE 51

If you move the views in 50 together you have figure 52. This shape can be folded to make the actual object as shown in figure 51.

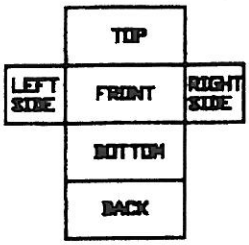


FIGURE 52

The first development is problem 91. It is nothing more than a rectangular box and is done on heavy grid sheets from the workbook..

Figures 53, 54 and 55 shows how to make a stretch out of a box with a notch in one corner.

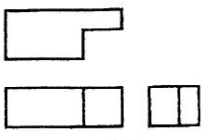


FIGURE 53

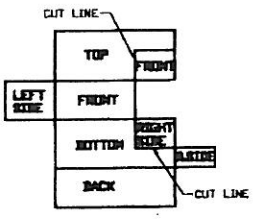


FIGURE 54

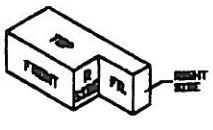
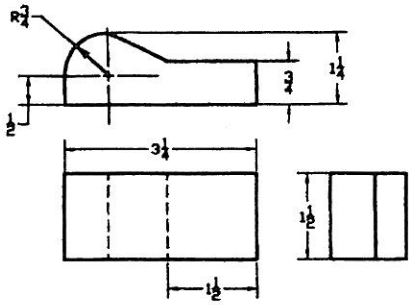


FIGURE 55

Some developments have rounded surfaces. The students are shown how to use dividers to transfer curved measurements to a straight line and then they are given problems to use that technique. Problem 97 below is one of those problems.



PROBLEM 97

The object shown in figure 60 below has a surface which is not parallel to any horizontal or vertical surface. The workbook shows how to draw such surfaces in a true size and shape.

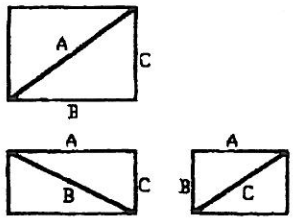
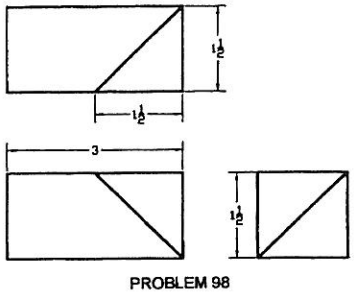
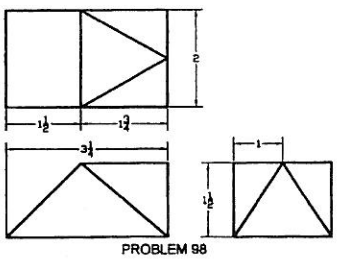


Figure 60

Problems 98 & 99 shown below, have surfaces not parallel to any horizontal surface.

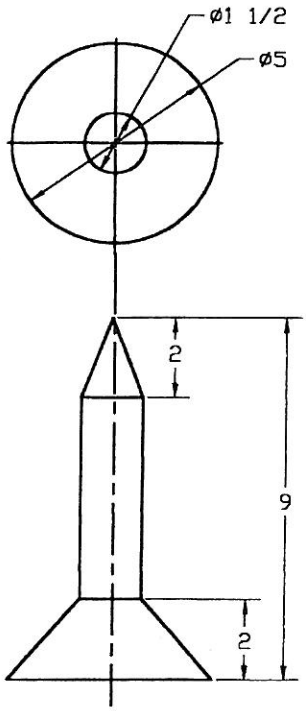


PROBLEM 98



PROBLEM 98

They are shown how to develop a cone and in problem 100 shown below, they put what they have learned to use.



PROBLEM 100

The next part of the workbook is on sectioning. Full sections, half sections, offset sections, objects with two pieces both in section, shortened sections, revolved sections, and sections with shafts, keys, pins and bolts are explained.

Problems 101 though 106 gives them practice sketching the different kinds of sections.

Problems 107 and 108 are assemblies with some parts in section.

Bolts and nuts are introduced and they are shown how to sketch them both in actual shape and using symbols. Figures 86, 87 & 88 are used for bolts. Figures 89, 90 & 89 show how to sketch a bolt head.

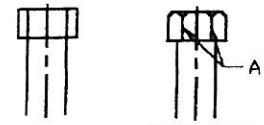


FIGURE 86

FIGURE 87

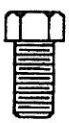


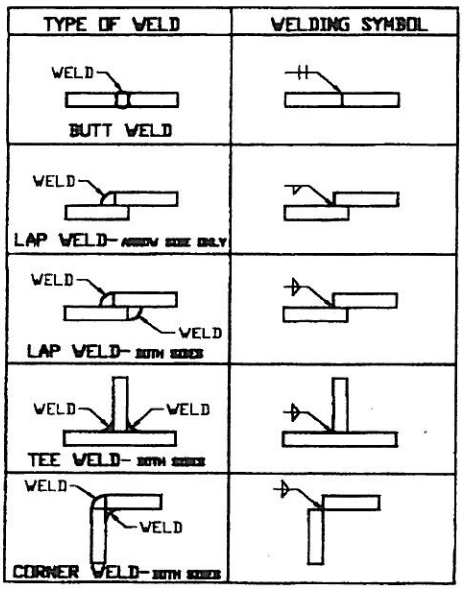
FIGURE 88

FIGURE 89

FIGURE 90

FIGURE 91

Problem 110 requires welding symbols so they are introduced to welding symbols. See drawings below . Frankly they will probably forget the meaning of each symbol., but they will remember they exist and if they are ever needed they can look them up the correct symbol



Problem 110 is to be drawn to scale. There are only 112 problems in the book and we are finally getting around to scale. Figures 92 –94 below are not in scale on this page but in the workbook they are drawn actual size in 1/4, 1/2 and full scale.

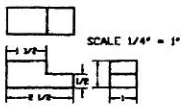


FIGURE 92

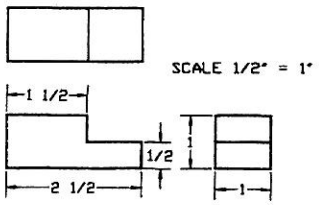


FIGURE 93

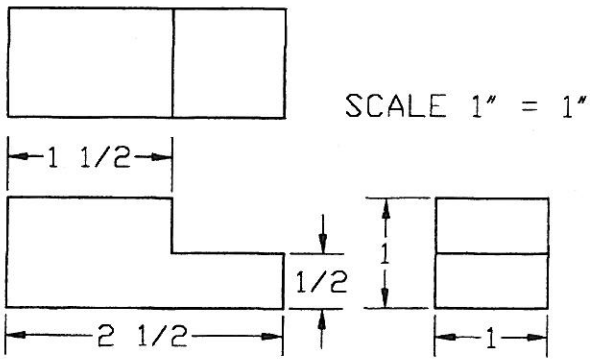


FIGURE 94