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The Value of Outlined Worksheets in Developing Beginning Basic Mechanical Drawing Skills in Seventh Graders at Curtis Junior High School, Tacoma, Washington

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THE VALUE OF OUTLINED WORKSHEETS IN DEVELOPING BEGINNING BASIC MECHANICAL DRAWING SKILLS IN SEVENTH GRADERS AT CURTIS JUNIOR HIGH SCHOOL, TACOMA, WASHINGTON

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by

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APPROVED FOR THE GRADUATE FACULTY

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The amount of time allowed to seventh graders during one semester for exploratory experiences in mechanical drafting is very short at Curtis Junior High School. This is due to the scheduling of seventh graders in connection with art and music. Each seventh grade male student receives one semester of industrial education and one semester of either art or music. Actually the students are scheduled into woodshop and six weeks of that time is used for mechanical drawing experiences. This is not sufficient to cover the material needed to provide a good basic background for beginning mechanical drawing students. Presenting more material and more actual problem solving exercises through the use of outlined worksheets, similar to a workbook, is the prime concern of this study.

The customary method of mechanical drawing requires the student to do a certain amount of repetitious work before the problem can be solved. It is usually necessary for the student to layout and reproduce the given portions of the problem before solving can begin. This type of work is felt to be repetitious and a waste of time to the student (5:32). Outlined worksheets were developed for the purpose

of providing a workbook to be used with any beginning textbook, a workbook which is a time saver and allows the student to do problem solving without reproducing given information first. The sheets should allow the student more time for actual problem solving exercises and at the same time provide an interesting and new approach to basic mechanical drawing.

I. THE PROBLEM

Statement of the Problem

It is the purpose of this study to: (1) critically examine the value of outlined worksheets in developing beginning mechanical drawing skills in seventh grade students; (2) examine the difference, if any, between basic skills acquired by use of outlined worksheets and the conventional method; (3) examine the amount of increased problem solving experiences and the wider range of material presented to the student through the efficient use of time.

Importance of the Study

One of the prime concerns of industrial education is to impress upon the school district the importance of industrial education in the school system. Improving teaching techniques is one way of reaching this objective. Worksheets are for the purpose of presenting more material, and

providing more problem solving exercises for the student. With this as the objective, worksheets should be an important contribution to the existing curriculum.

Limitations of the Study

The study is limited to a group of approximately 120 students per year during a two year period at Curtis Junior High School, Tacoma, Washington, School District #83. Because of existing conditions and class loads, the first control group of 1966 was instructed by a teacher other than the writer, and the control group of 1967 by still another teacher. The effects of the teaching methods and objectives of the other teachers were evident in the examination of control groups I and VI. Also, for this study to be conducted with the approval of the administration it had to effectively fit into the existing curriculum.

II. DEFINITIONS OF TERMS USED

Outlined worksheets. Mechanical drawing plates that have a certain amount of the repetitious work already completed. After the first two drawings, the amount of repetitious work becomes less until the student has only to solve the problem and supply the remaining essential information.

Repetitious work. Repeating the same basic operation over and over again. This would involve placing the border and title block on the drawing and layout for placement of views. Also included in this procedure is the reproduction of the given information from the textbook before problem solving can begin.

Essential information. Information that is necessary to master basic skills in drafting. This includes the following: (1) The importance of drawing; (2) Reading a scale and making measurements; (3) Use of seven common drafting tools; (4) Clear and accurate lettering; (5) Completion of one and three view drawings; (6) Placement of dimensions; (7) Making a drawing to scale; (8) Constructing multiple views from pictorial drawings.

Recall. To be able to recall or bring to mind information already learned or presented.

Visualization. To be able to form a mental image of an object. Students should be able to visualize lines and surfaces that are hidden from view and produce these lines and surfaces in views which show the size and shape of the object clearly.

CHAPTER II

REVIEW OF LITERATURE

Little information is available in regard to the actual value of outlined worksheets, or workbooks. Only a brief summary of work closely related will be presented in this chapter.

I. LITERATURE ON THE VALUE OF WORKBOOKS

Value of Workbooks

The value of a workbook as a teaching aid is in question by some. Dr. Madden, Chairman of Graduate Studies, San Diego State College, listed the following points in defense of workbooks:

1. Workbooks are only a tool, teachers who misuse them usually do other things no better.

2. Workbook exercises are usually prepared by skilled writers, and the lessons are far better than the teacher can prepare and duplicate.

3. Time needed to write and reproduce materials takes time away from teaching tasks.

4. Various pencil-paper exercises or activities are needed to aid in the transition from concrete to abstractions.

5. A workbook accompanying a textbook compliments learning and adds variety.

6. Instruction in overcrowded classes is not efficient. No instructional material is completely adapted to individual needs.

7. Readily available materials aid in classroom management.

8. Copying the problems from the book before doing them is a waste of time to the student.

9. Workbooks help establish good work habits.

10. Workbooks encourage independence by setting tasks, a plan, a method, and time to do the task (11:94).

Opposition to Workbooks

Teachers in all aspects of education oppose workbooks. Some have what they feel are valid objections. Dr. Madden lists the following as concrete evidence against workbooks:

1. Teachers come to rely on them and cease to do developmental teaching.

2. The workbook often becomes the textbook even though it is not designed to be.

3. Pupils do not exercise, and independence is lost.

4. All pupils do the same thing regardless of individual needs.

5. Workbook activity is peacemeal and seldom does the student reach a high level of creative thinking.

6. Workbook children are often weak in writing complete sentences and lacking in written expression.

7. In a market flooded with workbooks, teachers do not select wisely.

8. Teachers and school programs lack time for workbook activity tailored to the students needs (11:94).

II. RELATED STUDIES

Some of the studies reviewed in this section are studies examining the value of programed learning. Outlined worksheets are not programed but could easily be adapted to programed instruction, and are closely related to the following studies.

A study allowing 9th grade mechanical drawing students to check their progress against a master work copy as they proceed through the assignment was conducted by Isadore Dalinsky. Dalinsky's theory was that if the student could see his mistakes immediately after he committed them he was less likely to commit the same mistake again. Dalinsky's conclusion was that instant recognition of mistakes, and the correction of mistakes before continuing with the problem allowed the student to produce better drawings with fewer mistakes and students were unlikely to commit the same mistake over again (8:24).

An experimental study into the value of models and sketching as compared to the conventional method at the 9th grade level, was conducted by Benjamin Fonseca in his Masters Thesis. Fonsecas' experimental group developed sketches and constructed the objects from the sketches. The control group was taught by the conventional method.

Fonseca concluded that the experimental groups using models and sketches were superior in ability to read drawings and produce meaningful multiple view drawings (10).

A similar study investigating the value of the construction method as compared to the workbook method at the college level was studied by N.G. Ellis, University of Missouri. The study involved a rotation group type of experiment, with the method of teaching drawing as the experimental factor. The groups were each exposed to two weeks of equal time. The difference in the mean scores attained by the students on each test administered when taught by each method was statistically analyzed to determine relative effectiveness of the two methods. Ellis found no significant difference between the mean scores in regard to information achievement. However, the mean skills developed by the students using the workbook was higher than the construction method (9).

Over 100 experiments have been conducted to investigate the value of programed learning. The findings indicate that programs do teach, and teach effectively most of the time. Dr. William Spence states that, "We can accept confidently, therefore, that programs do teach" (16:57).

The value of workbooks as a teaching aid is strengthened by Dr. Madden. He applies the four basic principles of

learning to workbooks in the following manner:

1. Basic to all learning is personal mental activity on the part of the learner.

2. Activity operates best when it is purposeful to the learner.

3. Learning is best when the understanding of the learner is high.

4. The teachers primary task is to provide experiences that continuously evolve understanding at each pupils level of development (11:95).

Dr. Madden concludes from his findings, "That the value of workbooks depends upon the system of the teacher, the subject, the class load, and the experiences involved" (11:95).

The information presented in this chapter supports the use of teaching aids, workbooks, and programed instruction which enhance learning. Dr. Spence states, "It is a fact of record that programs do teach, and even a poor program will teach" (16:57).

CHAPTER III

PROCEDURE, OBJECTIVES AND OUTLINED WORKSHEETS

All seventh grade male students at Curtis Junior High School are required to take industrial education for one semester. Because of the number of students and class scheduling, the experimental and control groups had to be arranged in the following manner; First semester, groups I and II were the experimental groups, and group III was the control group. Second semester, groups IV and V were the control groups and group VI the experimental group. Using this method, three experimental and three control groups each year totaling six in each group could be examined during the test period of two school years. Also, because of the two year time period, and class scheduling, some classes were taught by teachers other than the writer. Because of this, their method of presenting material and objectives are evident in the study.

I. PROCEDURE

Test I - Essential Information

Understanding of essential information is important to every beginning drawing student. Test I, Appendix A, was used to measure student comprehension of basic essentials

at the end of the first two weeks of each semester. The test questions consisted of true-false, multiple choice, matching, fill-in, and essay questions to provide a wide testing range.

Test I was used to examine the value of worksheets compared to the conventional textbook method of teaching. Because of scheduling and class loads it was not possible for the writer to administer all tests. However, all tests were graded by the writer.

Test II - Visualization

Test II was administered at the end of the six week period to examine the students' ability to visualize and draw objects using multiple views. Test II, Appendix A, was used to examine the students' ability to visualize. The test was constructed in such a manner that the student had to add missing lines, add missing views, or match multiple views with a pictorial drawing. The results of this test were very important to the study because the value of increased material was examined. As in Test I, because of scheduling and class loads, the writer was unable to conduct all testing, but graded all tests.

Test III - Recall

The measure of recall was also an important factor

in determining the value of worksheets. During the second semester quarter break, six students were selected at random to be retested to measure the value of worksheets after a twenty week period of time. The random selection was made by drawing numbers and testing the student who matched that number in the grade book. Test III consisted of both Tests I and II combined, and was given over a two day testing period.

Record of Material Covered

The prime aim of worksheets is to present more material to the student, and allow the student to complete more exercises in problem solving. A record was kept to log the average number of drawings completed by each group. This record was used to compare material covered by the control and experimental groups.

II. OBJECTIVES

Objectives of Outlined Worksheets

The value of outlined worksheets was based on the following objectives. As a result of worksheets the student will: (1) become aware of mechanical drawing in today's life; (2) become familiar with the use of the scale and measurement; (3) become familiar with the proper use of common drawing instruments; (4) develop proper methods of

lettering; (5) become familiar with dimensioning methods; (6) develop ability to visualize and present one, two, and three view drawings; (7) be able to draw multiple views from pictorial drawings.

III. OUTLINED WORKSHEETS

The development of worksheets was brought about when it became apparent that the existing curriculum was not satisfactory for the teaching of beginning drawing. This was mainly caused by the fact that seventh graders were only receiving from five to six weeks of drawing and there was no consistency between the material teachers were presenting. This became apparent when eighth graders showed very few signs of having any previous drawing.

The first approach was to consult with the curriculum director to see if it would be possible to allow more time for seventh grade drawing. After consultation it was decided either drop drawing or seventh grade shop, or leave it the way it existed. This decision was mainly due to over loading and scheduling problems. Worksheets then were constructed with the aim of providing the student with more material and problem solving experiences, and also fitting the expanded program into the existing curriculum.

Format of Outlined Worksheets

Appendix B contains the outlined worksheets that were constructed to fit into the existing drawing program at Curtis Junior High School. The worksheets are arranged in the following order:

1. Introduction and freehand sketching
2. Exercise in scale measurement
3. Exercise in the use of the tee square and triangles
4. Exercise in the use of the compass
5. Exercise in the use of the irregular curve
6. Introduction to simple orthographic projection
7. More complex orthographic projection

Most of the above listed exercises involved more than one drawing. The eighteen worksheets took the average student about a class period to a period and a half for each drawing. At Curtis Junior High School this is about sixty to seventy-five minutes per drawing, excluding time for calling roll and clean up.

The worksheets were printed by the District Office and a nominal fee of twenty-five cents was added to each students shop fee to cover this printing cost. This is a very low cost teaching aid, averaging less than a cent and a half per sheet.

CHAPTER IV

PRESENTATION OF DATA

The information presented in this chapter was compiled over a two year period from 1966-67 through the 1967-68 school years with assistance from fellow teachers and the administration. Without their help this study could not have been completed.

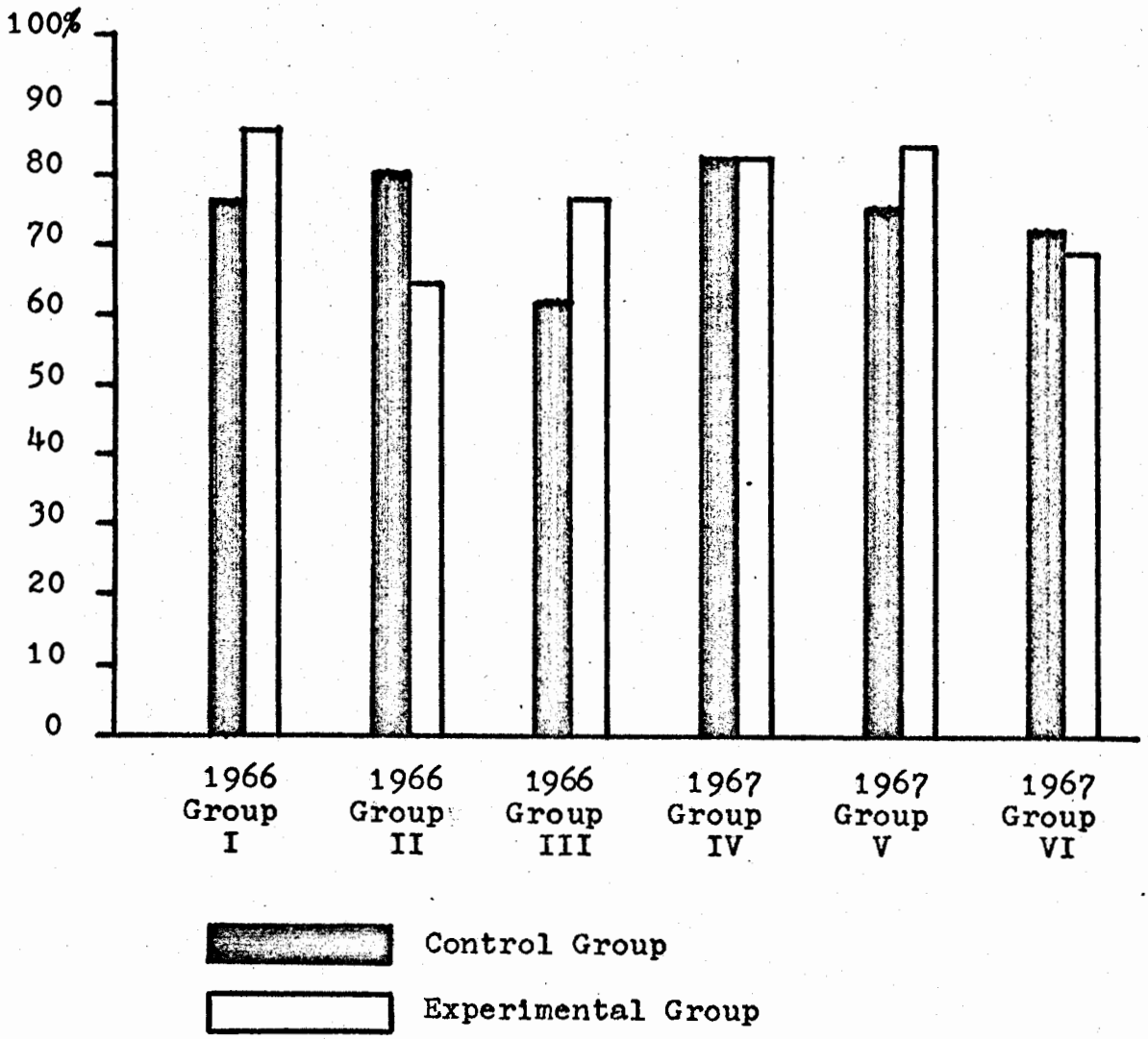
Test I - Essential Information

Both the control group and the experimental group were presented the same material from the textbook, however, the experimental group used the worksheets in conjunction with the text.

The mean scores of each group are presented in Table I, page 16. The mean score for all control groups 74.3%, and the mean score for the experimental groups 76.3% indicates very little difference in mean percentile. However, the experimental groups finished the complete section on essential information on the average of one and one half days before the end of the two week period. The difference between the experimental and the control groups is only 2% which indicates both groups measured about equally in basic understanding. The 2% difference is not enough to favor the

TABLE I

MEAN PERCENTILE SCORES - TEST I
ESSENTIAL INFORMATION



experimental method, but the amount of time saved is beneficial to the program.

Test II - Visualization

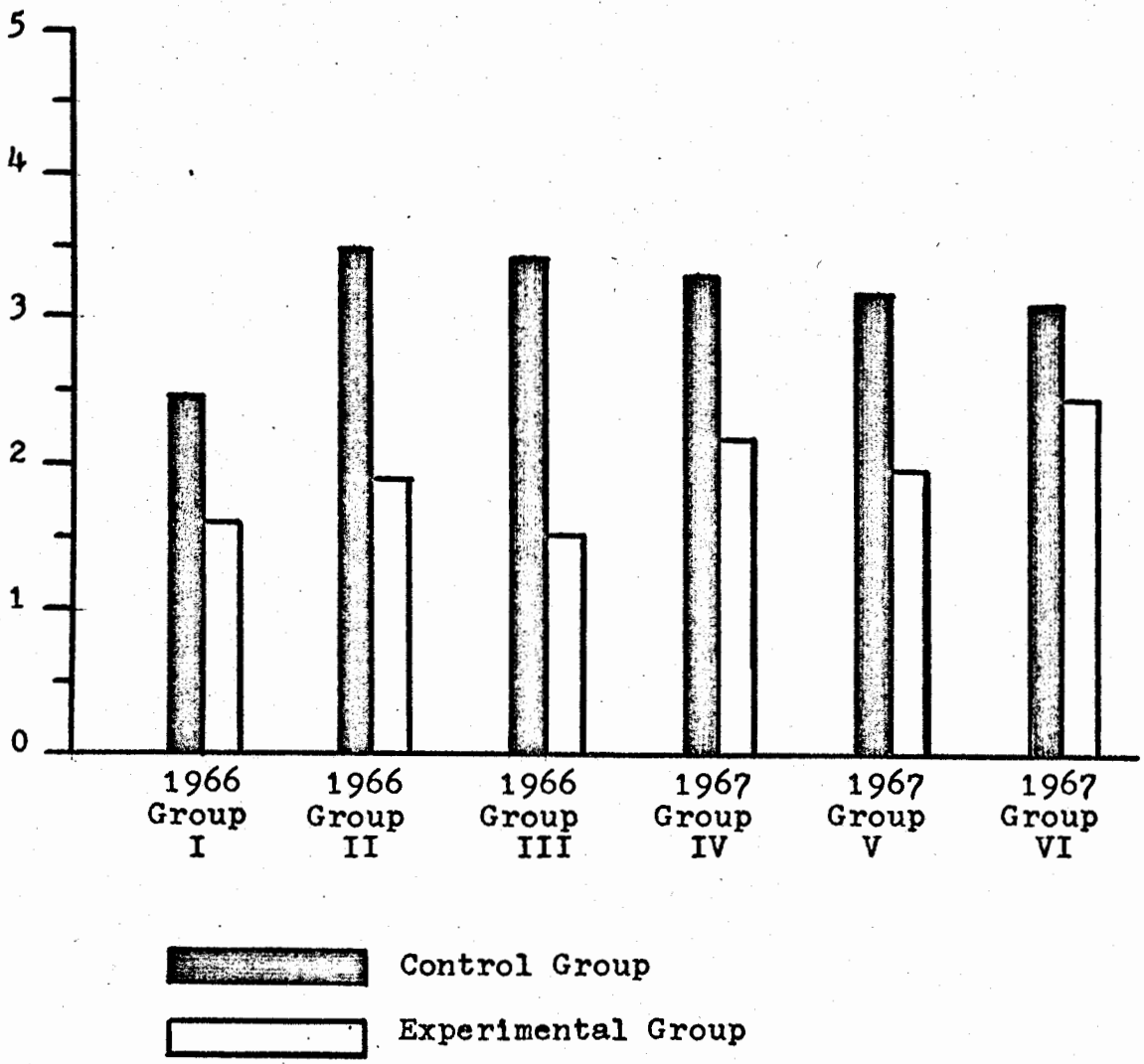
Test II was administered at the end of the six week period to measure the difference between the conventional method and the experimental method. The control group used the conventional method, and reproduced the given problems from the text before solving them. The experimental group used the worksheets with the text, and repetitious work was eliminated, allowing the student to start the exercise immediately after attaching it to the drawing board. Table II, page 18, shows the mean number of mistakes committed by each group on the visualization test. The mean number of mistakes committed by the control group was 3.18 as compared to 2.11 for the experimental group. The experimental group fared better by 1.07 less mistakes out of a possible 20, indicating that visualization of objects and lines was more thoroughly mastered by their group. An examination of Table II shows that all experimental groups scored better on visualization. The difference seems to merit the use of worksheets strongly at this point in the study.

Test III - Recall

At the quarter break in the second semester, six

TABLE II

MEAN NUMBER OF MISTAKES - TEST II
VISUALIZATION



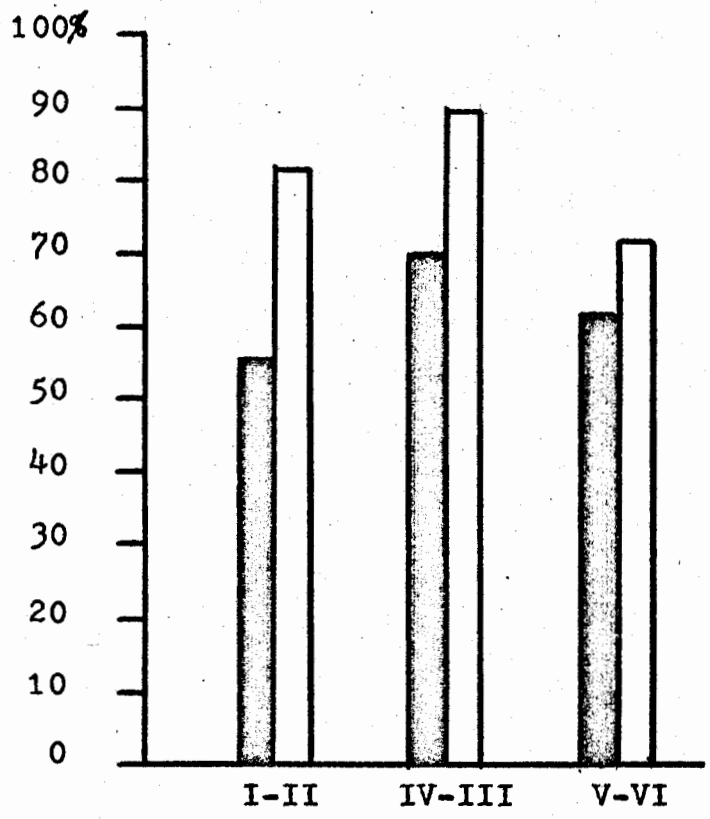
first quarter students were selected at random, to be tested for recall. Second semester students were not tested because they were not available during the summer months for testing. Table III, page 20, shows the mean results of the recall tests. The mean score of the control group is 60% as compared to the experimental groups 78.3% indicates that the experimental groups had better retention by 18.3%. Because second semester students could not be tested for recall the format of Table III is slightly different. Only six groups could be tested and groups III, 1966 and IV, 1967 had to be paired for a comparison. The difference of 18.3% seems large enough to place great value on worksheets as an aid to beginning drawing students.

Amount of Work Completed

Throughout the study a record was kept for each group to show the average number of drawings completed within the six week period. Table IV, page 22, shows the average amount of work completed by each group. The control group averaged 10.5 drawings and the experimental group averaged 17.3 drawings. It is interesting to note that the experimental group IV exceeded the required 18 drawings by completing 21 drawings on the average thus raising the average of all experimental groups to the required 18. This was due to two students completing more than 24 drawings in this group.

TABLE III

MEAN PERCENTILE SCORES - TEST III
RECALL



Group I 1966
Group II 1966
Group III 1966

Group IV 1967
Group V 1967
Group VI 1967

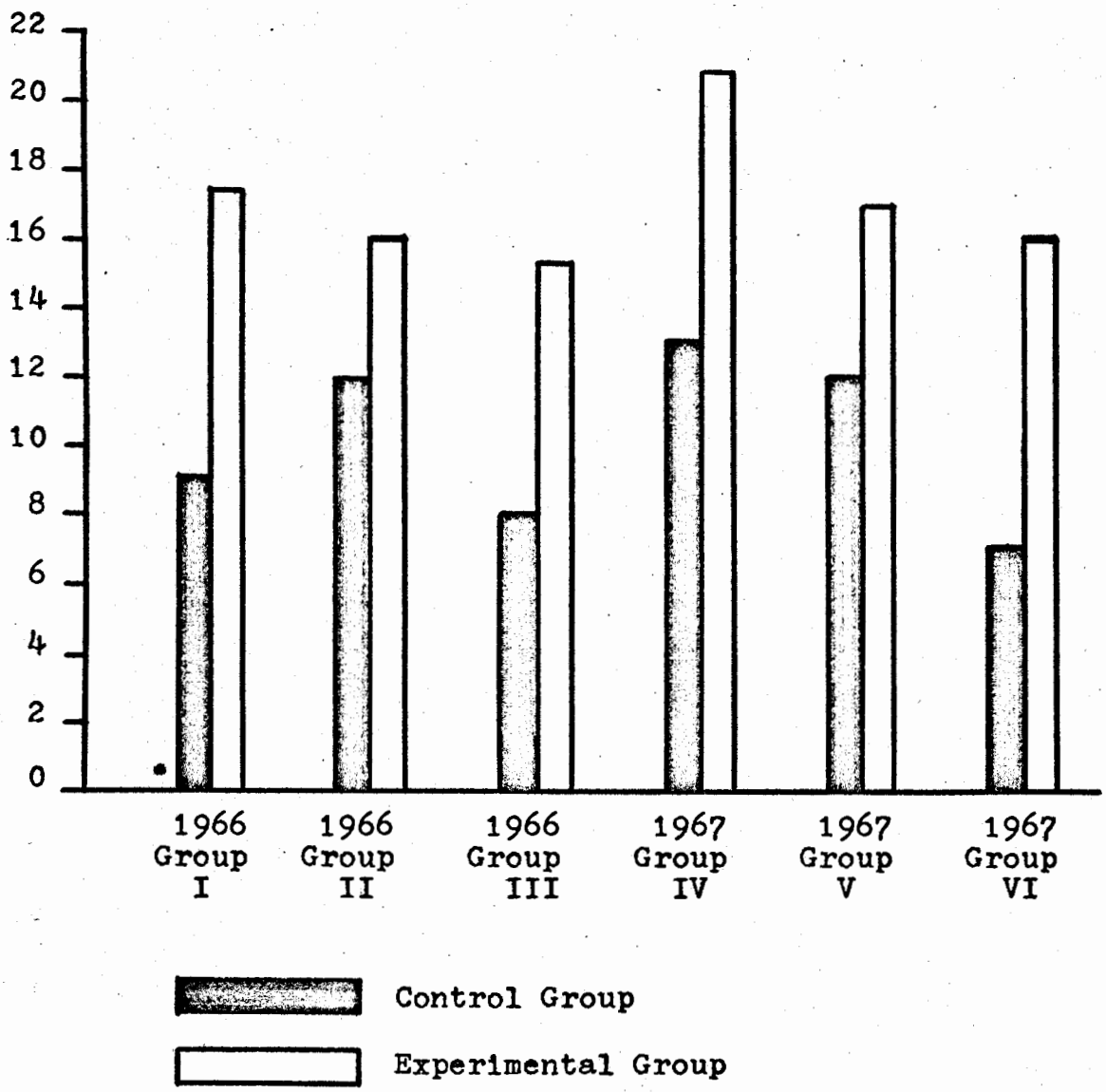
Control Group

Experimental Group

The amount of work completed by the experimental groups was 39% more than the control groups. This amount overwhelmingly indicates worksheets are of great value as a time saver, and to the amount of material that can be presented in a given length of time.

TABLE IV

AVERAGE NUMBER OF DRAWINGS
COMPLETED BY EACH GROUP



CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

I. SUMMARY

It was the purpose of this research study to develop and organize an experimental program, and to examine the value of outlined worksheets in beginning seventh grade drawing. The study was an attempt to answer the following questions:

(1) Are outlined worksheets an effective aid to the teaching of beginning mechanical drawing?

(2) Do outlined worksheets provide increased problem solving exercises in an assigned period of time with effectiveness?

(3) Do outlined worksheets provide the student with a wider range of material?

(4) Does the use of outlined worksheets effectively fit into the existing curriculum?

(5) Do outlined worksheets develop ability to visualize and draw multiple views?

The effect of this study has greatly changed the drawing program at Curtis Junior High School. The administration was impressed with the fact students accomplished more and were better organized. The program was so successful that all Curtis Junior High School drawing classes used outlined worksheets during the 1968-69 school year with plans to use worksheets again during the 1969-70 school year.

II. CONCLUSION

The experimental group did not score much higher than the control group during the first part of the study. The difference was only 2% which does not seem significant on the test of essential information. However, the experimental group finished the assignments on an average of one and one half days ahead of the control groups. The examination of ability of visualize, indicated that the experimental groups had fewer mistakes by 1.07 out of a possible 20 over the control groups. This indicates that students in the experimental groups visualized and expressed themselves better than the control group on multiple view drawings. The experimental groups scored higher by 18.3% when tested for recall. Students using outlined worksheets had better retention after twenty weeks of no exposure to drawing. The amount of work completed by the experimental groups was 39% more than the control groups. The control groups averaged 10.5 drawings and the experimental groups averaged 17.3 drawings completed during the six week period. From the data presented the following conclusions can be drawn:

(1) Outlined worksheets are effective to the teaching of beginning mechanical drawing.

(2) Outlined worksheets do provide the student with more problem solving experiences.

(3) Outlined worksheets can effectively fit into the existing curriculum.

(4) Outlined worksheets provide better organization and presentation of material to the student.

(5) Outlined worksheets are effective in the development of visualization.

III. RECOMMENDATIONS

From the data presented in this study, and the successful use of outlined worksheets at Curtis Junior High School, it is recommended that other Junior High Schools give serious consideration toward adopting the outlined worksheet method of teaching beginning mechanical drawing.

During the study some unanswered questions occured which were beyond the limits of this study. The following are recommended for further study:

(1) Are worksheets helpful to the extremely slow student?

(2) Do outlined worksheets have a tendency to lower the students ability to think creatively?

(3) Do outlined worksheets allow the teacher more time for individual instruction?

(4) Do organized materials, such as worksheets, aid in classroom management?

(5) Do outlined worksheets encourage independence by outlining set tasks?

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APPENDIX A

TEST I - ESSENTIAL INFORMATION

Name _____ Period _____

Part I - True-False (circle T or F)

T F 1. There is little use in learning about drawing unless you plan to become a draftsman.

T F 2. It is necessary to have an expensive set of drawing instruments to make a useful drawing.

T F 3. A 4H pencil is harder than a 2H pencil.

T F 4. The dividers look similar to a compass.

T F 5. The radius of a circle is one half the diameter.

T F 6. A border is always used on any type of drawing.

T F 7. Views may be placed in any order within the border lines.

T F 8. The tee square may be used to draw vertical lines by using the head against the top of the board.

T F 9. Arrowheads are usually twice as long as they are wide.

T F 10. Extension lines should touch the view being dimensioned.

Part II - Multiple Choice

___ 11. Three views commonly used in orthographic projection are; (A) front, top and bottom; (B) front, top, and left side; (C) top, front, and right side.

___ 12. The number of views needed in drawing depends on: (A) the size of the object; (B) the shape of the object; (C) the method of drawing the object.

___ 13. The shape of an object is shown by: (A) views; (B) dimensions; (C) notes.

Part II - Multiple Choice cont.

___ 14. Dimensions are put on a drawing so that: (A) you can see the size of the object; (B) you can build the object; (C) you can see the shape of the object.

___ 15. The size of a hole is shown as the: (A) cord; (B) diameter; (C) radius.

___ 16. The views of a drawing should be arranged so that there are the least number of: (A) invisable lines; (B) curved lines; (C) straight lines.

___ 17. The two dimensions shown on the front view of an object are: (A) height and width; (B) height and length; (C) width and length.

Part III - Fill in or add the missing word

18. Drawings are used as illustrations or for _____.

19. The four kinds of drawings are _____, _____, _____and_____.

20. The symbol for inches is _____ and for feet _____.

21. The measuring system of feet, yards and inches is called the _____ system.

22. The paper can be fastened to your board with thumb tacks, however, _____ is the best.

23. On most drawings letters are made about _____ high.

24. Horizontal lines are drawn with a _____.

25. Vertical lines are drawn with a _____, and a _____.

Part IV - Matching

___	26.	Radius	a.	Pictorial drawing
___	27.	Photograph	b.	For drawing irregular curves.
___	28.	Erasing Shield	c.	Points to area being explained.
___	29.	French Curve	d.	Lightest lines on drawing.
___	30.	Construction lines	e.	Used to draw arcs.
___	31.	A leader	f.	Tool used for neatness.
___	32.	Compass	g.	$\frac{1}{2}$ the diameter.

Part V - Diagram the following neatly.

33. Proper way to sharpen a drafting pencil.

34. A proper arrowhead.

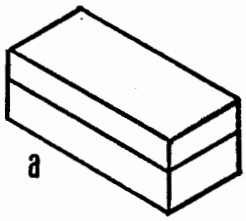
35. Proper way to sharpen a 6" bow compass.

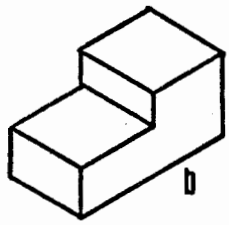
TEST 2 - VISUALIZATION

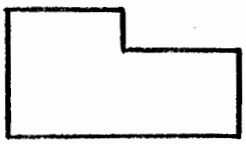
NAME _____ PERIOD _____

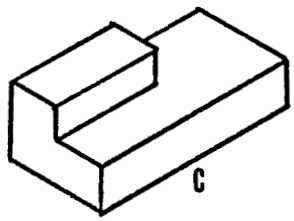
PART I Matching, (circle correct answer)

1









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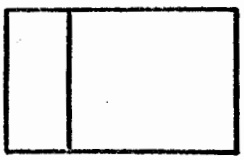

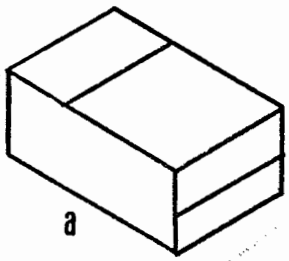

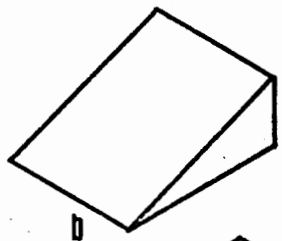

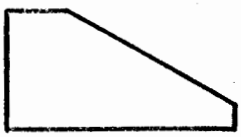

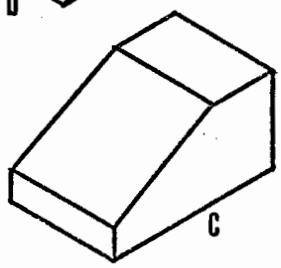

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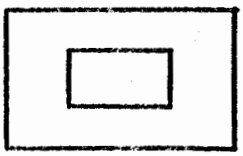
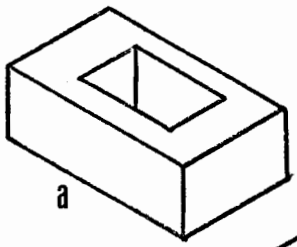
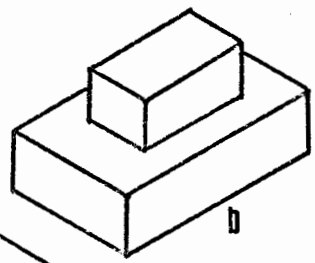
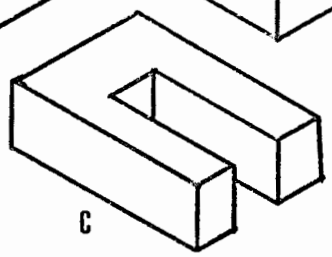


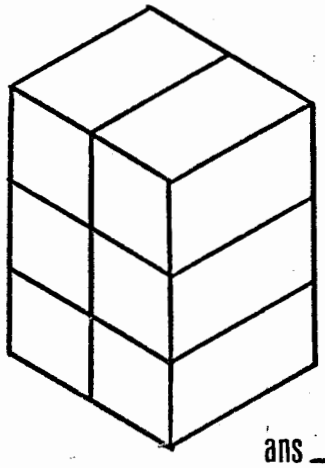






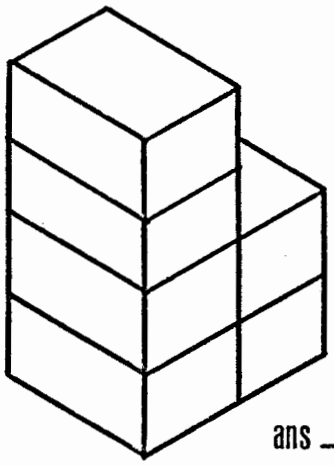
PART 2 (count the number of boxes in each stack)

4



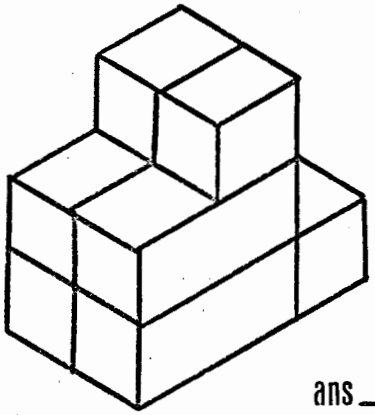
ans _____

5



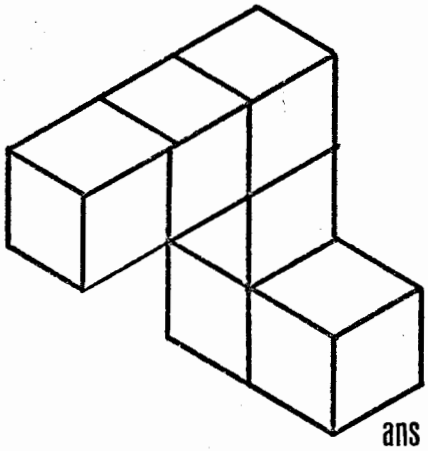
ans _____

6



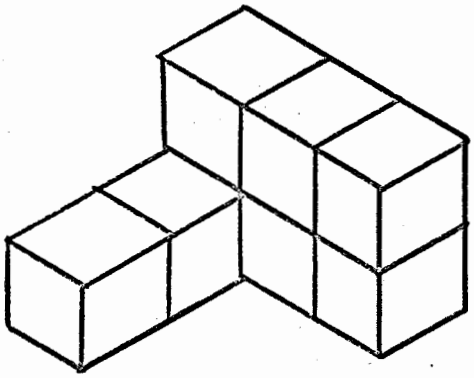
ans _____

7



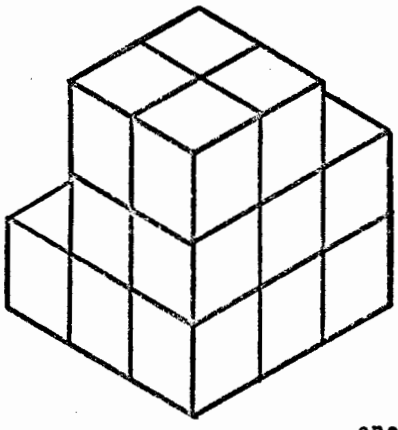
ans _____

8



ans _____

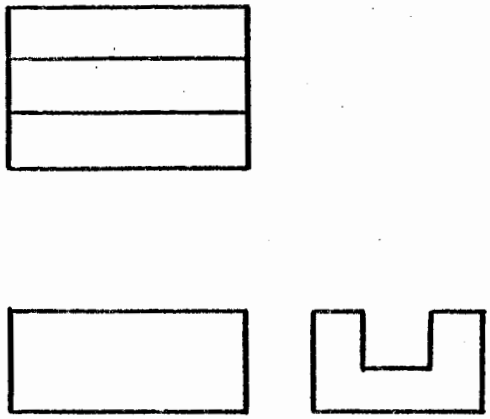
9



ans _____

PART 3 (fill in missing lines)

10



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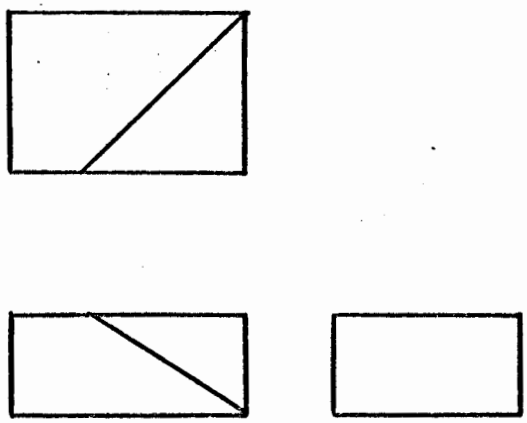

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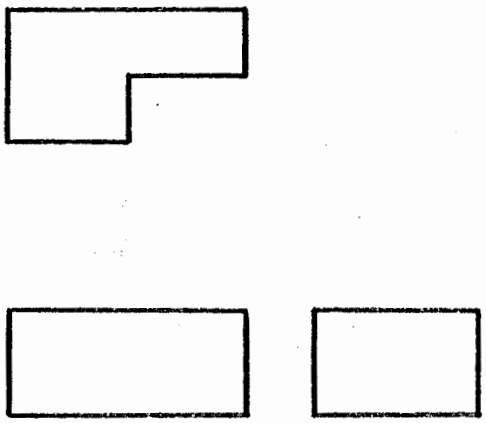

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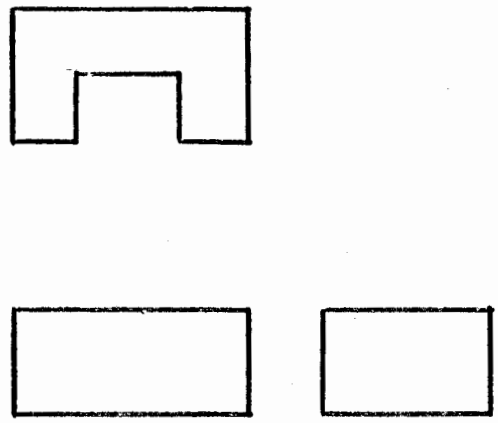

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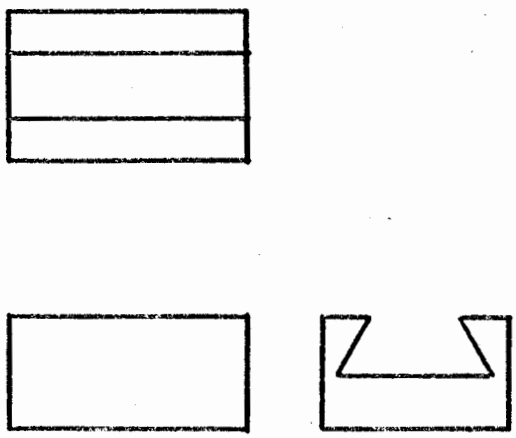

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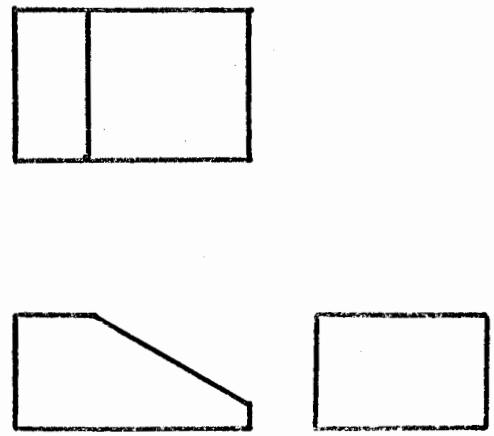
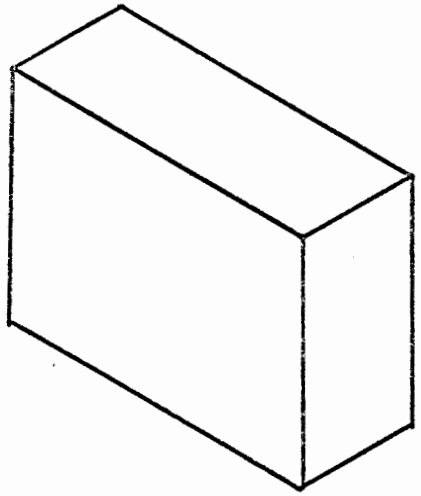


APPENDIX B

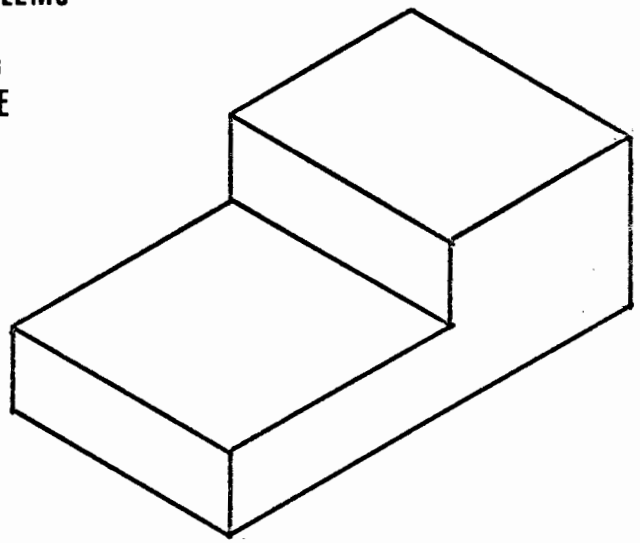
FREEHAND SKETCHING PROBLEMS

BLOCK



1

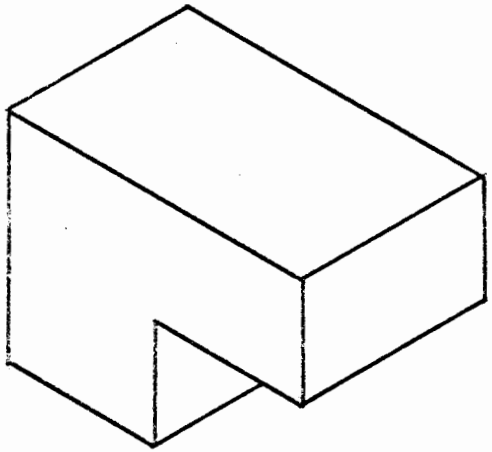
DIVIDED SURFACE



2

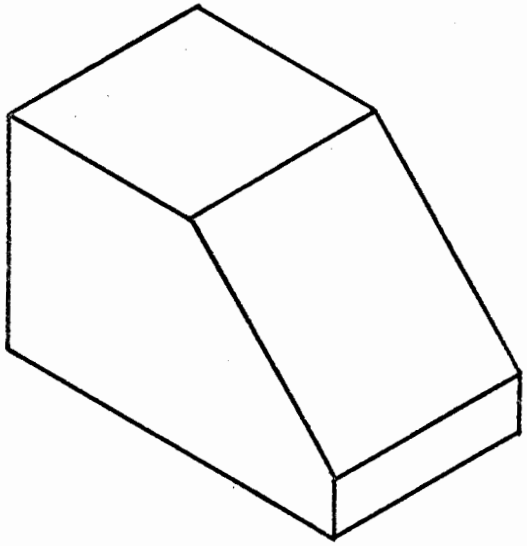
3

HIDDEN SURFACE

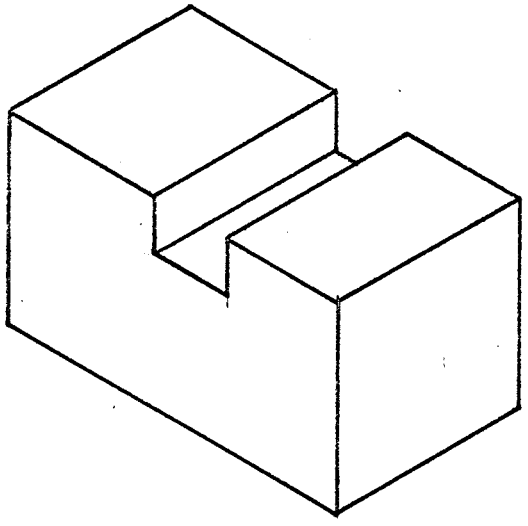


4

INCLINED SURFACE

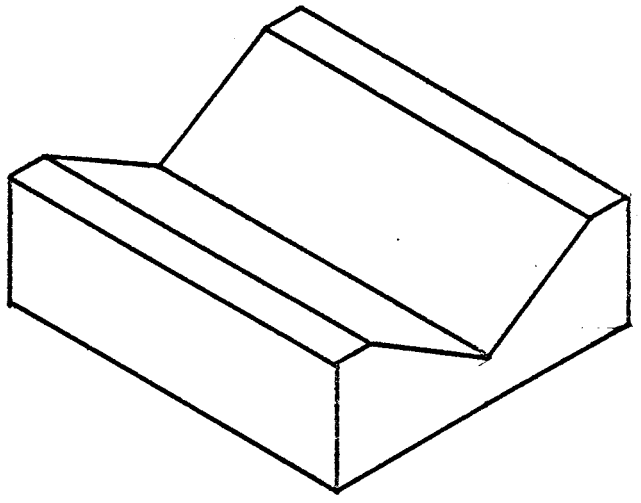


GROOVED SURFACE



5

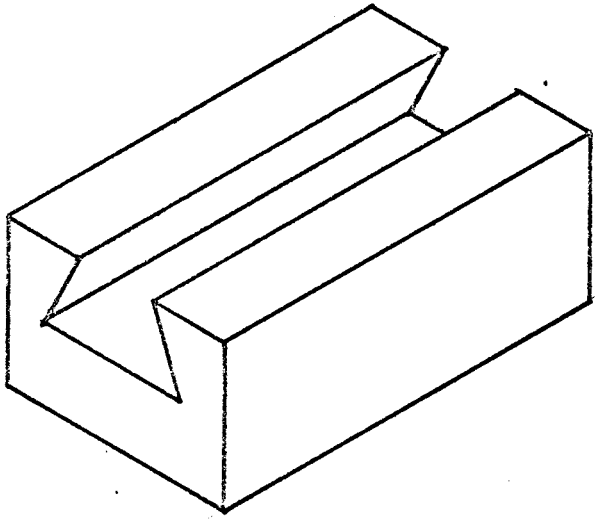
V BLOCK



6

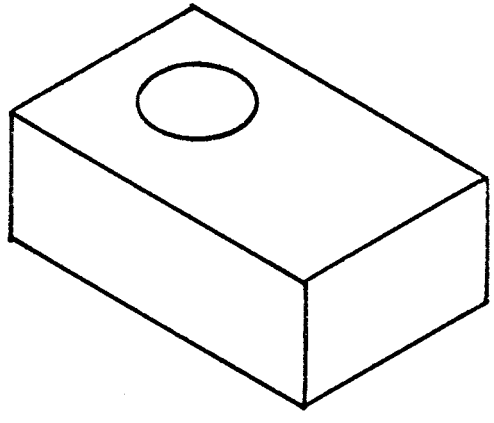
7

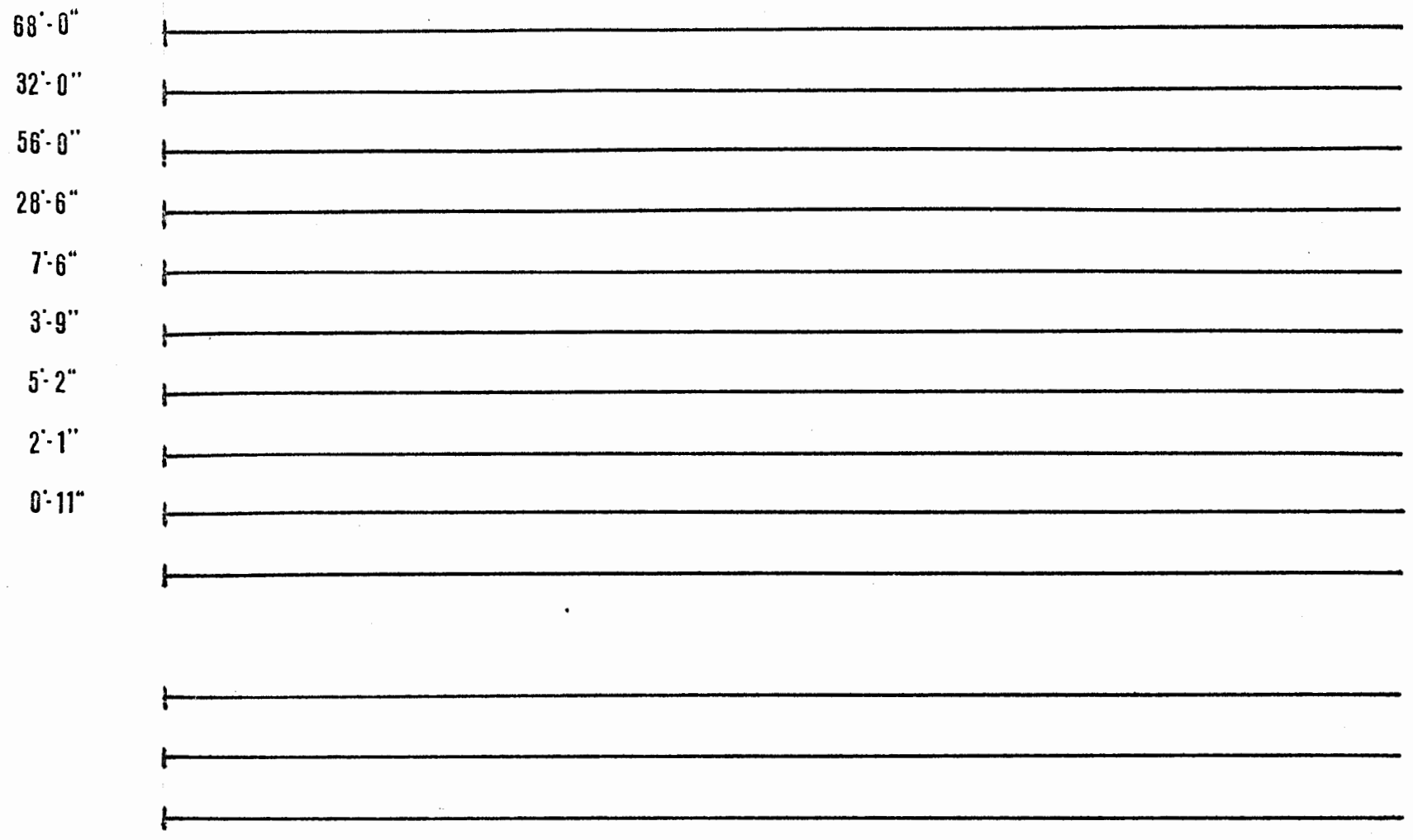
DOVETAIL



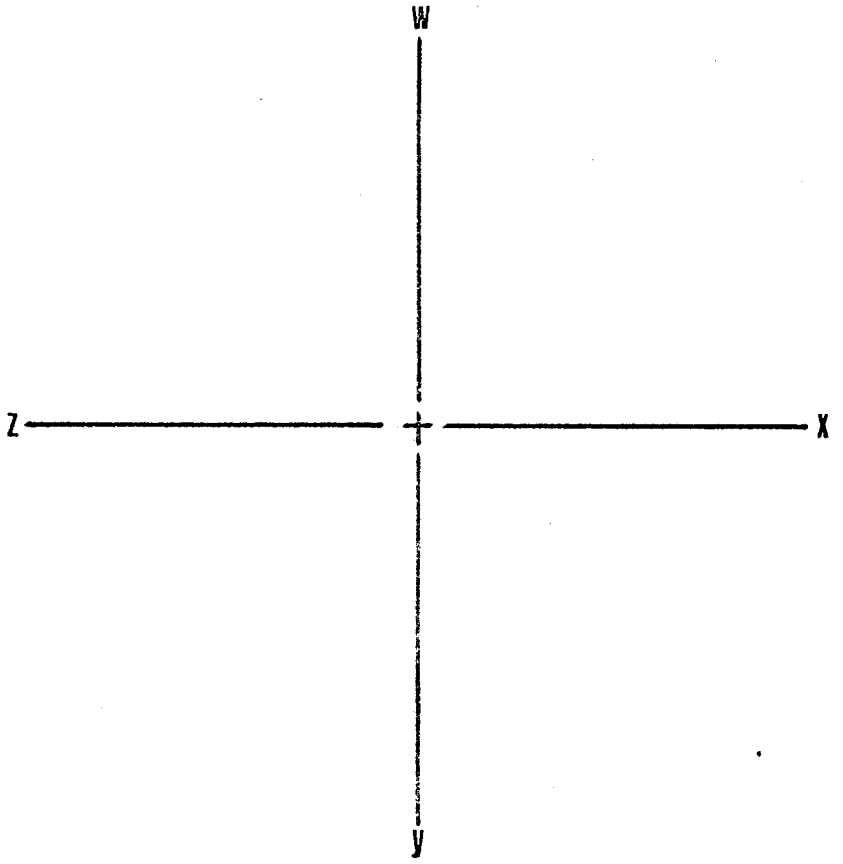
8

DRILLED SURFACE

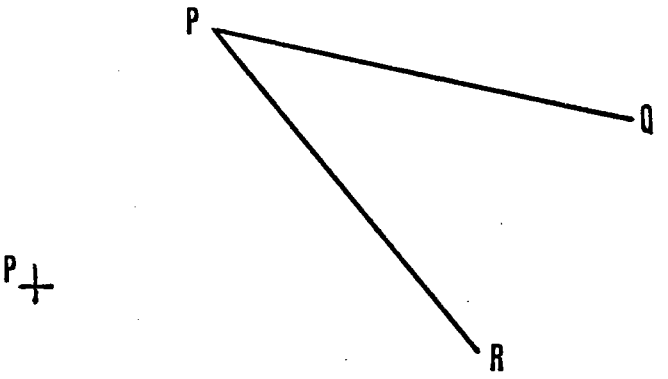




	SCALE EXERCISE			9

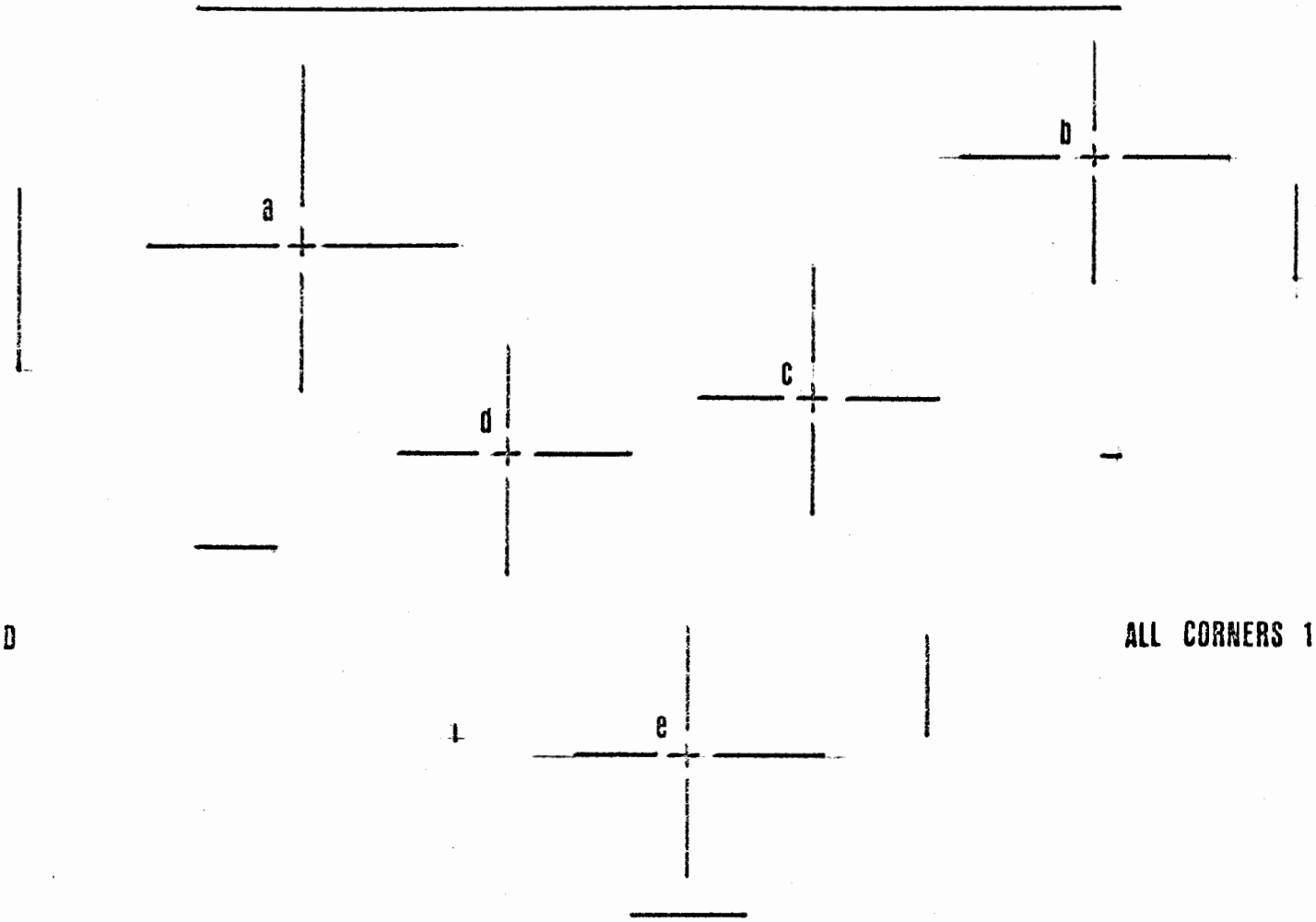


DIVIDE INTO 24
EQUAL PARTS



TRANSFER ANGLE RPQ
TO POINT "P"

	TRIANGLE EXERCISE			10



a. 1 1/4 D

b. 7/8 D

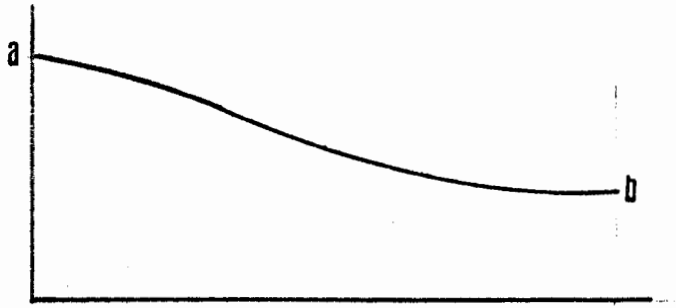
c. 3/4 D

d. 1/4 R

e. 5/8 R

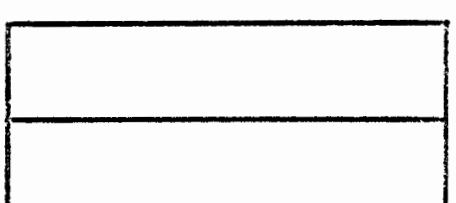
ALL CORNERS 1 INCH RADIUS

	COMPASS EXERCISE			11

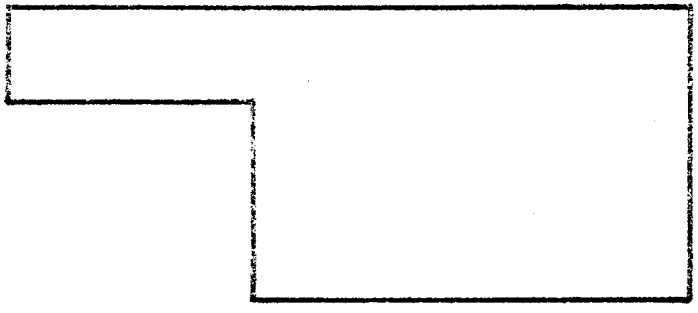


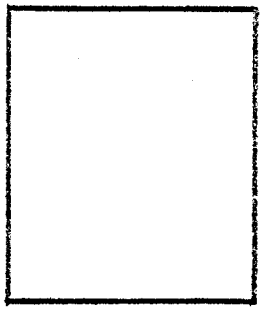
ENLARGE 3 TIMES

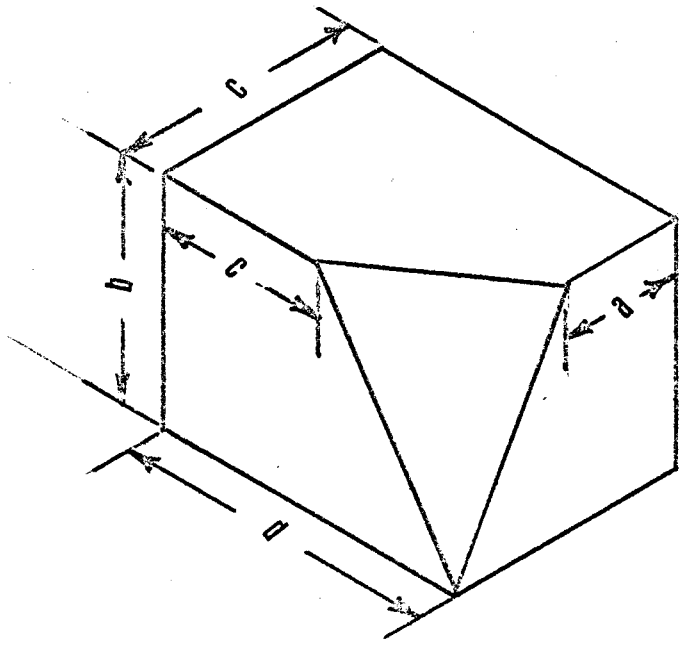
COMPLETE TOP VIEW



COMPLETE TOP & END VIEW
& DIMENSION







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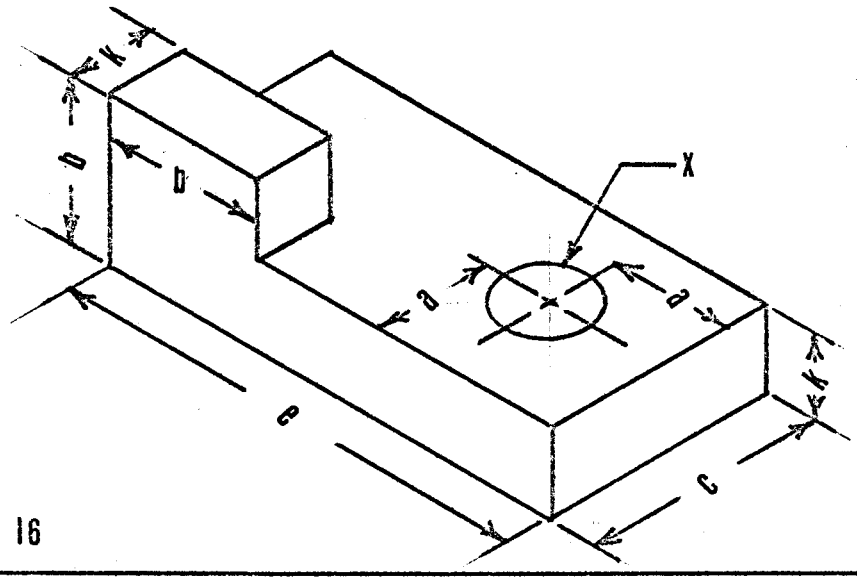
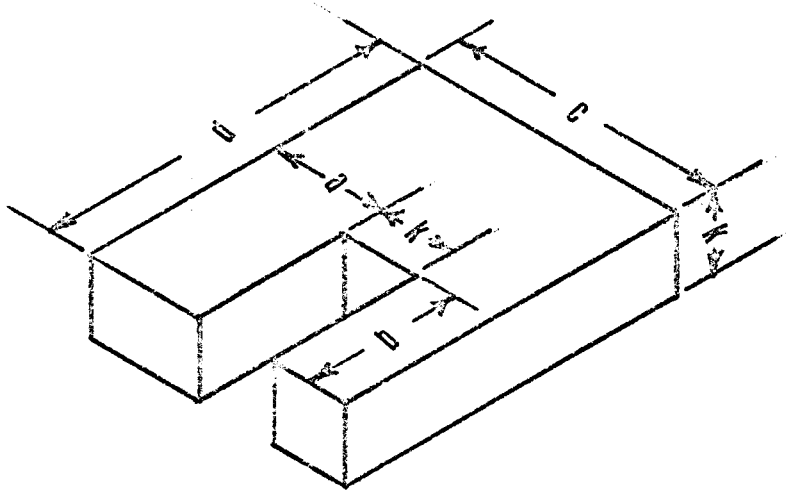


16

17



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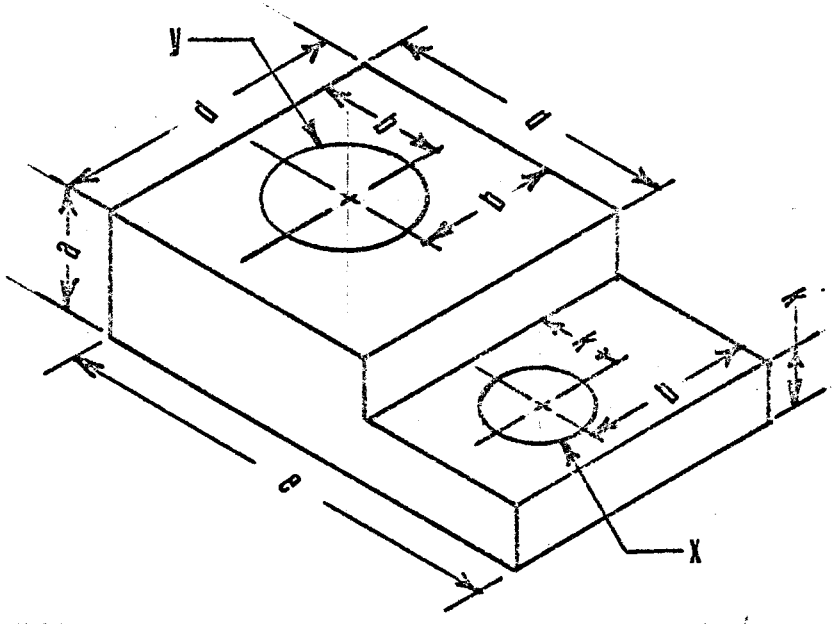
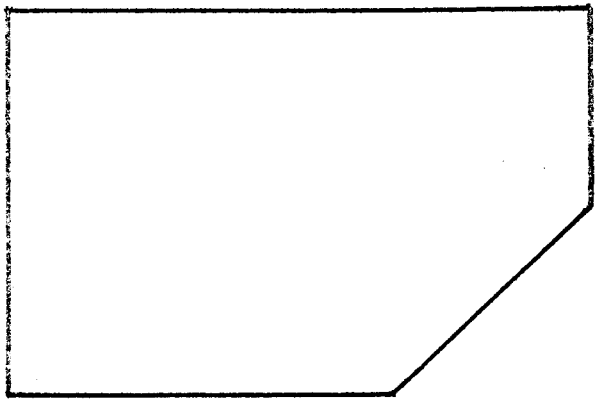
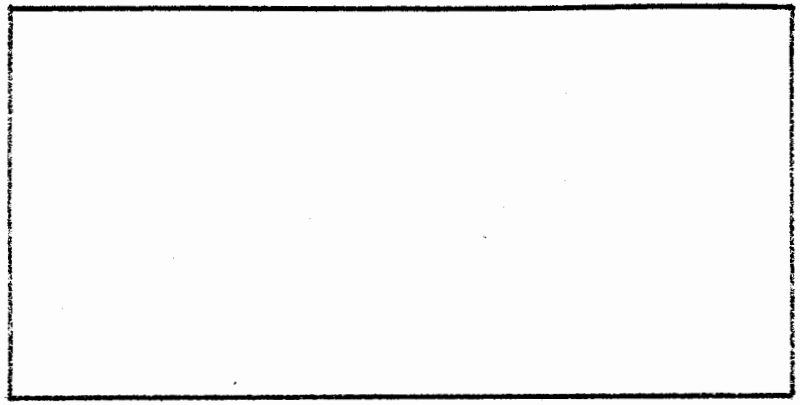


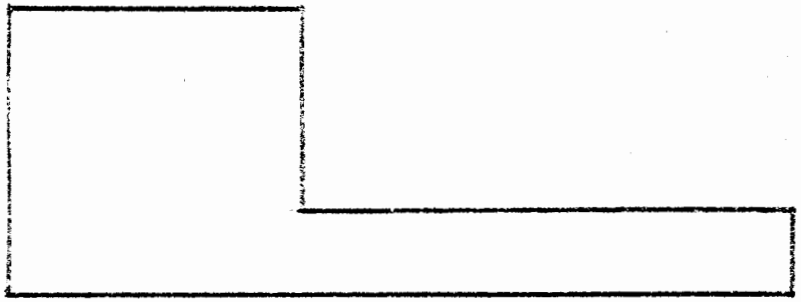
a	b	c	d	e	k	x	y				
1	1 1/2	2	3	4	1/2	3/4 D	7/8 D				



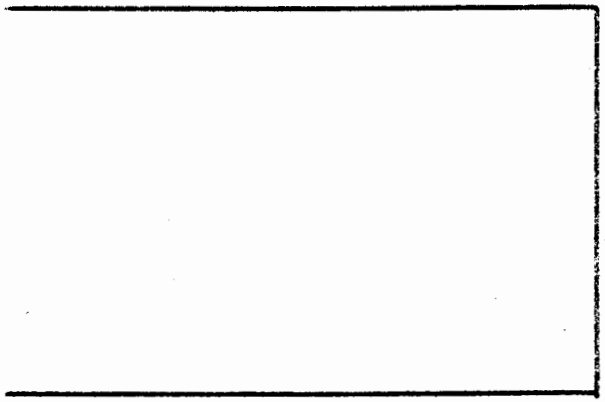
COMPLETE FRONT & END VIEW
& DIMENSION



COMPLETE ALL VIEWS
& DIMENSION



COMPLETE ALL VIEWS
& DIMENSION



COMPLETE TOP & FRONT
& DIMENSION