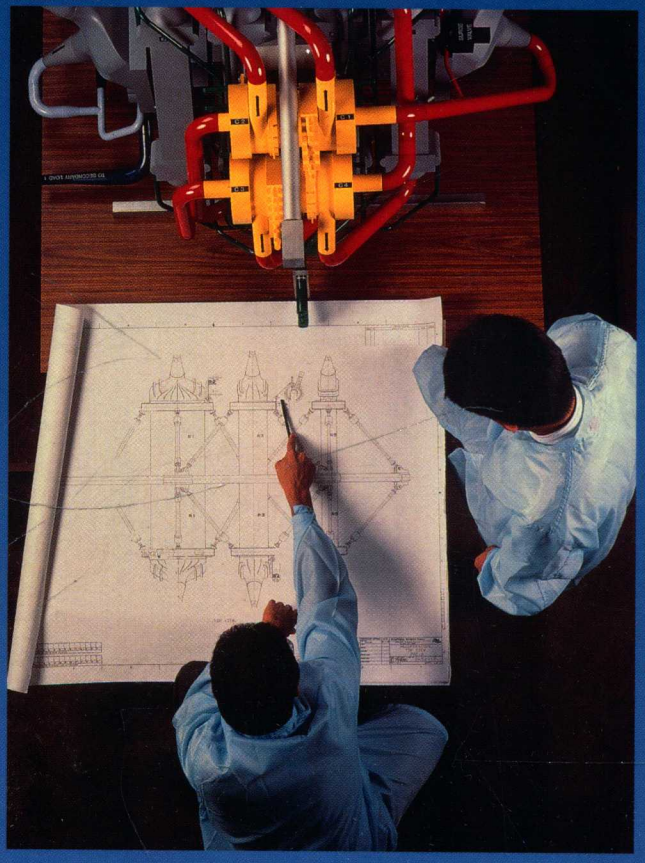
DRAWING WORKBOOK FOR

FUNDAMENTALS OF ENGINEERING DRAWING

FOURTH EDITION



CECIL JENSEN • JAY D. HELSEL

Drawing Workbook for Fundamentals of Engineering Drawing

Fourth Edition

Cecil Jensen
Former Technical Director
R. S. McLaughlin Collegiate and Vocational Institute
Oshawa, Ontario, Canada

Jay D. Helsel
Professor and Chairman
Department of Industry and Technology
California University of Pennsylvania
California, Pennsylvania

GLENCOE
McGraw-Hill
New York, New York Columbus, Ohio Mission Hills, California Peoria, Illinois

Drawing Workbook for Fundamentals of Engineering Drawing, Fourth Edition

ISBN 0–02–801871–0

Send all inquiries to:
GLENCOE/McGRAW-HILL
936 Eastwind Drive
Westerville, Ohio 43081

Printed in the United States of America

1 2 3 4 5 6 7 8 9 MAL 00 99 98 97 96

PREFACE

This *Drawing Workbook* contains worksheets that present a partially worked-out solution for assignments in each unit of *Fundamentals of Engineering Drawing, Fourth Edition.* Each worksheet has a title block and a reference number that refer to the chapter and unit number of the text. Following the table of contents are instructions that provide an overview to each assignment, and also provide references to the appropriate units. The drawing problems contain both U.S. customary (decimal inch) and metric (millimeter) units of measurement. The worksheets are printed on high-quality white paper to simulate drawings found in actual engineering practice. They are also perforated for easy removal without tearing the drawing assignment.

These worksheets have a number of benefits. First of all, they save drawing time for both the instructor and the students. For instance, the title blocks and borders are all preprinted, and some of the drawing assignments are semi-completed or have preprinted orthographic or pictorial grids. The worksheets also assist students to correctly position their drawings and focus their attention on the key concepts within the teaching unit. We estimate that these worksheets save instructors time enough to cover 30 percent more teaching material.

Students enrolled in a drafting program who are pursuing other related careers will also benefit from this workbook. For these students, this *Drawing Workbook* provides the opportunity to spend added time studying the material involving the interpretation and understanding of engineering drawing practices.

Students planning a career in drafting will also find these sheets especially useful. Supplementing CAD with these sheets will provide the student the opportunity of covering more drafting theory and application as well as developing essential sketching experience.

The positioning points on the worksheets are printed in a light gray that will not be noticeable when drawn over with a pencil. The final drawing will be the student's drawing despite the aids printed on the sheets. Finally, the drawing problem is also provided on the sheet. This means that the student can set up a workspace without the inconvenience of having to keep the textbook on the drawing board.

Another advantage of these worksheets is that they are keyed with the units in the textbook, thereby simplifying the task of selecting the correct problem for the learning material. There are sufficient drawing worksheets that permit the instructor flexibility in making assignments. Sufficient drawing assignments are included to thoroughly cover all basic elements of engineering drawings and the latest drawing practices. In addition, a variety of advanced problems are provided to accommodate individual differences in both students and programs.

The drawing assignments for these worksheets are, in most cases, taken directly from the textbook. The understanding of reading assignments is enhanced by providing worksheet assignments that are closely coordinated with the text units. Because these drawing problems were mainly designed for use on a B-size drawing paper format, changes to either the scale or some dimensions were often necessary in order to fit the drawing on the worksheet.

Although most drawing problems are on drawing paper, vellum sheets are provided at the back of this workbook so that students can gain hands-on experience for drawing on this medium. The instructor can designate appropriate times when vellum sheets are to be used.

A *Solutions Manual* for the instructor is available for the workbook. Each solution is presented on a separate page for ease in grading students' assignments. For the textbook, *Fundamentals of Engineering Drawing, Fourth Edition,* there is a comprehensive *Instructor's Management System* available from Glencoe/McGraw-Hill. It contains all of the textbook drawing solutions. These solutions are also available on the *Instructor's CD-ROM.* Please contact your local Glencoe/McGraw-Hill representative or the publisher for more details.

Although this workbook is keyed to *Fundamentals of Engineering Drawing, Fourth Edition,* it can be used with any good text that follows current ANSI and ISO drawing standards. The instructor will need to provide the text references necessary.

We are grateful to the many instructors who have used *Engineering Drawing and Design* and/or *Fundamentals of Engineering Drawing* over their very successful history. We trust that those instructors and others will find this workbook as useful as the textbooks. As always, we appreciate your comments and suggestions.

Cecil Jensen
Jay D. Helsel

CONTENTS

Preface, iii Overview, 1. Worksheets, 19.

Chapter 1 Engineering Graphics as a Language

Ref. Unit 1-4 Drafting Scales—Measuring A–1

Chapter 4 Basic Drafting Skills

Ref. Unit 4-1 Lettering—Vertical B–1
Lettering—Inclined B–2
Locating by Coordinates B–3
Relative Coordinates B–4
Absolute Coordinates B–5
Polar Coordinates B–6
Linework—Patterns B–7
Linework—Inlay Designs B–8
Linework—Shearing Blank B–9
Ref. Unit 4-2 Circles and Arcs—Designs B–10
Circles and Arcs—Pawl B–11
Circles and Arcs—Anchor Plate B–12
Circles and Arcs—Gasket No. 1 ..... B–13
Circles and Arcs—Gasket No. 2 ..... B–14
Ref. Unit 4-3 Irregular Curves—Patterns B–15
Ref. Unit 4-4 Sketching—Lines and Circles B–16
Sketching—Structural Shapes B–17
Sketching—Shaft Support and Control Arm B–18

Chapter 5 Applied Geometry

Ref. Unit 5-1 Applied Geometry—Straight Lines C–1
Ref. Unit 5-2 Applied Geometry—Arcs and Circles C–2
Ref. Unit 5-3 Applied Geometry—Polygons C–3
Applied Geometry—Template and Hook C–4
Ref. Unit 5-4 Applied Geometry—Ellipses C–5
Ref. Unit 5-5 Applied Geometry—Helix and Parabola C–6

Chapter 6 Theory of Shape Description

Ref. Unit 6-1 Orthographic Representation—Absolute Coordinates D–1
Orthographic Representation—Relative Coordinates D–2
Orthographic Representation—Two-Dimensional Coordinates D–3
Orthographic Representation—Three-Dimensional Coordinates D–4
Orthographic Representation—Corner Bracket D–5
Orthographic Representation—Location Block D–6
Ref. Unit 6-2 Orthographic Representation—Miter Lines D–7
Ref. Unit 6-3 Orthographic Representation—Surfaces Parallel and Visible D–8

Ref. Unit 6-4	Orthographic Representation—Hidden Surfaces and Edges	D–9
	Orthographic Projection—Control Block	D–10
	Orthographic Projection—Angle Stop	D–11
	Orthographic Projection—Guide Bar	D–12
Ref. Unit 6-5	Orthographic Representation—Inclined Surfaces (1)	D–13
	Orthographic Representation—Inclined Surfaces (2)	D–14
	Orthographic Representation—Inclined Surfaces (3)	D–15
	Orthographic Representation—Inclined Surfaces (4)	D–16
	Orthographic Projection—Base	D–17
	Orthographic Projection—Base Plate	D–18
	Orthographic Representation—Interpreting Drawings (1)	D–19
	Orthographic Representation—Interpreting Drawings (2)	D–20
Ref. Unit 6-6	Orthographic Representation—Circular Features (1)	D–21
	Orthographic Representation—Circular Features (2)	D–22
	Orthographic Representation—Interpreting Drawings	D–23
	Orthographic Projection—Rocker Arm	D–24
Ref. Unit 6-7	Orthographic Representation—Oblique Surfaces (1)	D–25
	Orthographic Representation—Oblique Surfaces (2)	D–26
Ref. Unit 6-8	Orthographic Representation—One- and Two-View Drawings	D–27
Ref. Unit 6-9	Special Views—Connector	D–28
Ref. Unit 6-10	Conventional Representation—Locking Plate	D–29
Ref. Unit 6-11	Conventional Breaks—Fixture Base	D–30
Ref. Unit 6-12	Lines of Intersection—Cylindrical Surfaces	D–31
Ref. Unit 6-14	Foreshortened Projection—Mounting Bracket	D–32
	Foreshortened Projection—Clutch	D–33
Ref. Unit 6-15	Intersection of Unfinished Surfaces—Cutoff Stop	D–34
	Intersection of Unfinished Surfaces—Sparker Bracket	D–35

Chapter 7 Auxiliary Views and Revolutions

Ref. Unit 7-1	Primary Auxiliary Views—Angle Bracket	E–1
	Primary Auxiliary Views—Angle Plate	E–2
	Primary Auxiliary Views—Statue Bases	E–3
Ref. Unit 7-2	Circular Features—Link	E–4
Ref. Unit 7-3	Multiple Auxiliary Views—Inclined Stop	E–5
	Multiple Auxiliary Views—Connecting Bar	E–6
	Multiple Auxiliary Views—Angle Stop	E–7
Ref. Unit 7-4	Secondary Auxiliary Views—Dovetail Bracket	E–8
	Secondary Auxiliary Views—Pivot Arm	E–9
Ref. Unit 7-5	Revolutions	E–10
Ref. Unit 7-6	Points and Lines in Space	E–11
Ref. Unit 7-7	Planes in Space	E–12
Ref. Unit 7-8	Visibility of Lines in Space	E–13
Ref. Unit 7-9	Distance Between Lines and Points	E–14
Ref. Unit 7-10	Edge and True View of Planes	E–15
Ref. Unit 7-11	Angle Between Lines and Planes	E–16

Chapter 8 Basic Dimensioning

Ref. Unit 8-1	Basic Dimensioning—Notched Block	F–1
	Basic Dimensioning—Vertical Guide	F–2
	Basic Dimensioning—Base	F–3
Ref. Unit 8-2	Dimensioning Circular Features—Adjustable Sector	F–4
	Dimensioning Circular Features—Bracket	F–5
Ref. Unit 8-3	Dimensioning Common Features—Handle	F–6
	Dimensioning Common Features—Gasket	F–7
Ref. Unit 8-4	Dimensioning Methods—Transmission Cover	F–8
	Dimensioning Methods—Adapter Plate	F–9
Ref. Unit 8-5	Limits and Tolerances	F–10
Ref. Unit 8-6	Fits and Allowances—Inch	F–11
	Fits and Allowances—Metric	F–12
	Fits—Inch	F–13
	Fits—Metric	F–14
	Fits and Allowances—Spindle	F–15
Ref. Unit 8-7	Surface Texture—Link	F–16
	Surface Texture—Column Bracket	F–17

Chapter 9 Sections

Ref. Unit 9-1	Full Sections—Shaft Base	G–1
	Full Sections—Slide Bracket	G–2
Ref. Unit 9-2	Two or More Sections—Casing	G–3
	Two or More Sections—Housing	G–4
Ref. Unit 9-3	Half-Sections—Step Pulley	G–5
	Half-Sections—Step-V Pulley	G–6
Ref. Unit 9-4	Threads in Section—Pipe Plug	G–7
	Threads in Section—End Plate	G–8
Ref. Unit 9-5	Assemblies in Section—Flanged Coupling	G–9
	Assemblies in Section—Caster	G–10
Ref. Unit 9-6	Offset Sections—Base Plate	G–11
	Offset Sections—Mounting Plate	G–12
Ref. Unit 9-7	Ribs, Holes, and Lugs—Two-Post Column Base	G–13
	Ribs, Holes, and Lugs—Shaft Support	G–14
Ref. Unit 9-8	Revolved Section—Connector	G–15
	Revolved Section—Chisel	G–16
Ref. Unit 9-9	Spokes and Arms—Offset Handwheel	G–17
Ref. Unit 9-10	Broken-Out Section—Hold-Down Bracket	G–18
Ref. Unit 9-11	Phantom Section—Bearing Housing	G–19
	Phantom Section—Housing	G–20
Ref. Unit 9-12	Section Review—Domed Cover	G–21
	Section Review—Slide Support and Drill Press Base	G–22

Chapter 10 Threaded Fasteners

Ref. Unit 10-1	Simplified Thread Representation—Guide Block	H–1
	Simplified Thread Representation—Turnbuckle Details (& Assembly)	H–2
	Simplified Thread Representation—Parallel Clamps Details (& Assembly)	H–3
	Simplified Thread Representation—Terminal Block	H–4
Ref. Unit 10-2	Detailed Thread Representation—Connector and Supports	H–5
Ref. Unit 10-3	Common Threaded Fasteners	H–6
	Common Threaded Fasteners—Shaft Intermediate Support	H–7
	Common Threaded Fasteners—Wheel Puller Details (& Assembly)	H–8
Ref. Unit 10-4	Special Fasteners—Adjustable Shaft Support Assembly (& Details)	H–9
Ref. Unit 10-5	Fasteners for Wood—Woodworking Vise Details (& Assembly)	H–10

Chapter 11 Miscellaneous Types of Fasteners

Ref. Unit 11-1	Keys, Splines, and Serrations	J–1
Ref. Unit 11-2	Pin Fasteners—Draw Bar and Cam Follower	J–2
	Pin Fasteners—Crane Hook	J–3
Ref. Unit 11-3	Retaining Rings—Power Drive Assembly (& Details)	J–4
	Retaining Rings—Roller Assembly and Viewer Case	J–5
Ref. Unit 11-4	Springs—Punch Holder Assembly	J–6
Ref. Unit 11-5	Rivets—Structural and Blind Rivets	J–7
	Rivets—Rivets for Aerospace Equipment	J–8
Ref. Unit 11-6	Welded Fasteners	J–9
Ref. Unit 11-7	Adhesive Fasteners—Joint Design	J–10
Ref. Unit 11-8	Fastener Review—Wheel Assembly (& Details)	J–11
	Fastener Review—Universal Joint	J–12

Chapter 12 Manufacturing Materials

Ref. Unit 12-1	Cast Irons—Door Closer Arm	K–1
Ref. Unit 12-2	Carbon Steel—Raising Bar	K–2
Ref. Unit 12-3	Nonferrous Metals—Outboard Motor Clamp	K–3
Ref. Unit 12-4	Plastics—Connecting Link	K–4
Ref. Unit 12-5	Rubber—Caster Assembly	K–5

Chapter 13 Forming Processes

Ref. Unit 13-1	Castings—Connector	L–1
	Castings—Swing Bracket	L–2
Ref. Unit 13-2	Forgings—Bracket	L–3
Ref. Unit 13-3	Powder Metallurgy—Bracket	L–4
Ref. Unit 13-4	Plastic Molded Parts—Pivot Arm	L–5

Chapter 14 Detail and Assembly Drawings

Ref. Unit 14-2	Functional Drafting—Cable Straps	M–1
	Functional Drafting—Cover Plate	M–2
Ref. Unit 14-3	Detail Drawings—Base Plate	M–3
	Detail Drawings—Swivel Hanger	M–4
	Detail Drawings—Locating Stand	M–5
Ref. Unit 14-4	Multiple Detail Drawings—Adjustable Pulley and Pulley Assembly	M–6
Ref. Unit 14-5	Drawing Revisions—Axle Cap	M–7
Ref. Unit 14-6	Assembly Drawings—Tool Post Holder	M–8
	Assembly Drawings—V-Block Clamp	M–9
Ref. Unit 14-7	Exploded Assembly Drawings—Coupling	M–10
Ref. Unit 14-8	Detailed Assembly Drawings—Sawhorse	M–11
Ref. Unit 14-9	Subassembly Drawings—Wheel Assembly	M–12

Chapter 15 Pictorial Drawings

Ref. Unit 15-1	Isometric Drawings—Flat Surfaces	N–1
	Isometric Drawings—Step Block and Planter Box	N–2
Ref. Unit 15-2	Isometric Drawings—Curved Surfaces	N–3
	Isometric Drawings—Base	N–4
Ref. Unit 15-3	Common Features in Isometric—Adapter	N–5
	Common Features in Isometric—Two-Post Die Set	N–6
Ref. Unit 15-4	Oblique Projection—Flat Surfaces	N–7
	Oblique Projection—Spacer Block and Dovetail Guide	N–8
Ref. Unit 15-5	Common Features in Oblique—Step Pulley and Connector	N–9
Ref. Unit 15-6	One-Point Perspective—Vise Base	N–10
Ref. Unit 15-7	Two-Point Perspective—Support Guide	N–11

OVERVIEW

Drawing A–1.

Drafting Scales—Measuring.

Reference Unit 1–4.

Use the scales specified at the top of each column and record the length of each of the lettered dimensions on the two drawings. Measure to the nearest calibration on your scale. Draw guidelines .12 in. or 3 mm apart in which to do your lettering. Keep guidelines thin and light, using a hard lead pencil. Use a softer lead for lettering.

Drawing B–1.

Lettering—Vertical.

Reference Unit 4–1.

Use a 4H or 6H lead to draw guidelines for each line of lettering as shown across the top of the sheet. Complete each line of lettering, using an HB or F lead. You may want to draw a few vertical guidelines as an aid in drawing some of the larger letters. Do not erase guidelines.

Drawing B–2.

Lettering—Inclined.

Reference Unit 4–1.

Follow instructions for Drawing B1, except slant all letters at an angle of 68° to the horizontal. You may use the 68° angle on your Ames lettering guide as an aid in drawing a few of the large letters. Keep all lines on your lettering sharp and black. Do not erase guidelines.

Drawing B–3.

Locating by Coordinates.

Reference Unit 4–1.

Measure directly on each of the drawings, or use the .25 grid to determine the exact location of each of the points. Complete the tables at the right of the drawings for both absolute and relative coordinates. Use guidelines and make all lettering .12 in. high. Letter with an HB or F lead.

Drawing B–4.

Relative Coordinates.

Reference Unit 4–1.

Work directly on the grids shown to establish and label the points given in the tables at the right. Letter neatly, using guidelines if you prefer. Connect the points either by freehand sketching on the grid lines or using a straightedge. Lines should be relatively thick, sharp, and black.

Drawing B–5.

Absolute Coordinates.

Reference Unit 4–1.

Work directly on the grids shown to establish and label the points given in the tables at the right. Connect the points either by freehand sketching on the grid lines or by using a straightedge. Keep lines thick, sharp, and black. Letter neatly.

Drawing B–6.

Polar Coordinates.

Reference Unit 4–1.

Begin at point *A* and work in a clockwise direction to make a full-size drawing of the template. Measure distances and angles as accurately as possible in order to make the figure close back at point *A*. Keep finished lines sharp and black. Corners should be sharp and clean.

Drawing B–7.

Linework—Patterns.

Reference Unit 4–1.

Follow carefully the instructions given for parts 1 through 6. Do all layout work, using light construction lines with a sharp 4H or 6H pencil. Darken all lines using an HB or H lead. Finished lines should be approximately .03 in. (0.7 mm) thick.

Drawing B–8.

Linework—Inlay Designs.

Reference Unit 4–1.

Lay out Figs. A, B, and C, using either inch or millimeter sizes. Millimeter sizes are in brackets. Use a sharp, hard lead pencil for layout. Darken all finished lines, using an HB or H lead. Finished lines should be approximately .03 in. (0.7 mm) thick. Do not dimension.

Drawing B–9.

Linework—Shearing Blank.

Reference Unit 4–1.

Use your metric scale (1:5) and follow the procedure shown at the upper right on your drawing sheet to lay out the shearing blank. Lay out all angles carefully and accurately, using triangles, drafting machine, or protractor. Draw the complete shearing blank. Begin by laying out the drawing, using light construction lines, and finish with thick (.03 in. or 0.7 mm) lines as shown in step 4. Construction lines (layout lines) need not be erased.

Drawing B–10.

Circles and Arcs—Designs.

Reference Unit 4–2.

Lay out Figs. A, B, and C on the center lines provided. First, lay out each figure, using light construction lines, and finish with thick (.03 in. or 0.7 mm) lines. The crosshatch lines in Fig. C may be drawn as thin (.016 in. or 0.35 mm), sharp, black lines.

Drawing B–11.

Circles and Arcs—Pawl.

Reference Unit 4–2.

Develop the drawing of the pawl around the intersection of the center lines in the middle of the drawing area. This center point represents the center of the 1.00 in. diameter hole. Measure accurately and lay out the entire figure, using light construction lines. Locate centers of all arcs and mark points of tangency before constructing arcs. Darken all lines (.03 in. or 0.7 mm), using an HB or H lead. Do not erase construction lines.

Drawing B–12.

Circles and Arcs—Anchor Plate.

Reference Unit 4–2.

First, locate and draw all center lines shown as light solid construction lines. Next, locate the centers of the R65 arcs and mark points of tangency. Complete the drawing by darkening all visible lines with an F or HB lead in your compass for large circles and arcs. Use the same grade of lead in a pencil along with a circle template for small circles. Lay out all circles and arcs with light construction lines before darkening them. This will ensure concentricity, especially with small circles. Darken center lines (approx. .016 in. or 0.35 mm thick), using long and short dashes (see Figures 4-1-1 through 4-1-3 in text).

Drawing B–13.

Circles and Arcs—Gasket No. 1.

Reference Unit 4–2.

Carefully measure and lay out all center lines (construction lines). Locate and mark the centers of all areas and points of tangency. Draw all circles and arcs, using light construction lines. Darken all visible lines and center lines. A circle template may be used for small circles and arcs. Do not erase construction lines or points of tangency.

Drawing B–14.

Circles and Arcs—Gasket No. 2.

Reference Unit 4–2.

Follow the four steps shown in the upper right side of the drawing sheet to draw the gasket around the center lines shown in the bottom half of the sheet. Begin by locating the centers of circles and arcs with light construction lines. Add the location of all points of tangency. Construct all circles and arcs (thin, light construction lines). Connect arcs with straight lines. Finally, darken all lines, including center lines. Do not erase construction lines.

Drawing B–15.

Irregular Curves—Patterns.

Reference Unit 4–3.

Establish points on the blank grids through which the irregular curves will pass. Do this by transferring points from the grid at the left to the grid at the right and carefully estimating points where the curved lines intersect the grid lines. Lightly sketch the curved shape through the established points. Use an irregular curve (French curve) to draw the finished lines. The French curve should be matched to as many points as possible in order to achieve a smooth finished curve. Also, on long irregular curved lines, allow the French curve to overlap somewhat from one portion of the curved line to the next.

Drawing B–16.

Sketching—Lines and Circles.

Reference Unit 4–4.

Before darkening any of your lines, carefully sketch each figure using light construction lines.

Drawing B–17.

Sketching—Structural Shapes.

Reference Unit 4-4.

The squares on the grids represent .50 in. Transfer distances from the structural steel shapes to the grid, and sketch each of the figures, using light construction lines. Darken all lines, using thick, black, visible lines. Do not add dot pattern unless instructed to do so.

Drawing B–18.

Sketching—Shaft Support and Control Arm.

Reference Unit 4–4.

Transfer points from the drawings at the top of the sheet to the grid at the bottom for each part. Carefully sketch circles and arcs followed by straight lines. Darken all visible lines and center lines.

Drawing C–1.

Applied Geometry—Straight Lines.

Reference Unit 5–1.

Follow the instructions carefully in spaces A through F. In all cases, first use light construction lines to completely solve the problem. Do not erase construction lines.

Drawing C–2.

Applied Geometry—Arcs and Circles.

Reference Unit 5–2.

Follow the instructions carefully in spaces A through F.

Space A. Locate the centers of all arcs and mark points of tangency. Use a compass with a hard, sharp lead to lay out arcs. Darken arcs with compass or circle template and pencil with soft lead.

Space B. Bisect any two sides to locate the center of the polygon. Construct the circle touching each corner.

Space C. Locate centers and points of tangency. Draw a light construction line between points *K* and *L* and divide it into three equal parts. The point of tangency between the two arcs is to fall on the mark nearest point *L* on line *LM*. Draw perpendicular bisectors of each segment of construction line *KL* to establish center points for each of the two arcs. A line perpendicular to *JK* upward from point *K* and one perpendicular to *LM* downward from point *L* will also be needed to establish centers for the arcs.

Space D. Locate the arc centers and points of tangency. Use your compass to construct the arcs. You may prefer to use a circle template as a guide when darkening the arcs. Do not erase construction lines.

Space E. Locate centers of arcs and points of tangency. Use your compass to draw the arcs. You may prefer to use a circle template as a guide in darkening the arcs. Do not erase construction lines.

Space F. Draw construction lines (straight lines) that connect *A* with *B* and *B* with *C*. Draw perpendicular bisectors of *AB* and *BC* to locate center of arc. Do not erase construction lines.

Drawing C–3.

Applied Geometry—Polygons.

Reference Unit 5–3.

Follow the instructions carefully in spaces A through F.

Space A. For the large hexagon, begin by constructing a circle whose diameter equals the distance across the corners. Establish points on the circle 60° apart. Connect the points. For the small hexagon, begin by constructing a circle whose diameter equals the distance across the flats. Establish points on the circle 60° apart. Connect the points.

Space B. Begin by constructing 30 mm and 50 mm circles around the center point given. Proceed as in Space A, except in this case divide the circles into eight equal parts rather than six.

Space C. Begin by constructing a 60 mm square and a circle within the square tangent to its sides. Complete the octagon by constructing 45° lines tangent to the circle.

Space D. Construct a 60 mm circle around the center point given. Use construction lines to establish the length of one side and step off the remaining four sides. Connect points to complete the pentagon.

Space E. Using *AB* as the radius, draw a semicircle and divide it into five equal parts. Draw radial lines from point *A* through the three division marks on the right. Using *AB* as the length of each side, locate the intersections of the remaining sides. Connect points and darken the lines representing the pentagon.

Space F. Follow the procedure given for space E, except divide the semicircle into seven spaces rather than five.

Drawing C–4.

Applied Geometry—Template and Hook.

Reference Unit 5–3.

Template: Locate points on the grid that correspond with points on the drawing. Use appropriate construction methods to develop the geometric shapes. Darken all visible lines and center lines.

Hook: Use only the dimensions given for part 4 of the table. Locate centers of circles and arcs where possible. Sketch details not given in specific dimensions.

Drawing C–5.

Applied Geometry—Ellipses.

Reference Unit 5–4.

Follow the instructions given in spaces A through C.

Space A. Begin by dividing the circles into any number of equal parts (example, 30° angles equal 12 parts.) Use radial lines to establish points through which the ellipse will be drawn. Use a French curve to draw the final ellipse.

Space B. Use construction lines to establish the centers of the small and large arcs. Use your compass to construct arcs. Give careful attention to points of tangency.

Space C. Begin by drawing a 60 mm by 120 mm rectangle about the center lines given. Use construction lines to establish points through which the ellipse will be drawn. Use a French curve to draw a smooth ellipse through the points established.

Drawing C–6.

Applied Geometry—Helix and Parabola.

Reference Unit 5–5.

Space A. Complete the front view of the cylinder on the base line given. Divide the circle into 12 equal parts. Using the length of one of the 12 dimensions, develop a stretchout of the cylinder beginning at point *A*. Use construction lines to complete the layout. Darken lines as appropriate. Do not erase construction lines.

Space B. Parallelogram method. Divide *OA* and related lines into six equal parts. Use construction lines to connect points to establish a grid. Use a French curve to connect points and complete the parabola.

Offset method. Divide line *OA* into five equal parts. Divisions on the horizontal line beginning at *A* will be established by dividing it into 5^2, or 25, equal parts. Use this method to establish a grid through which the parabolic curve will be drawn.

Drawing D–1.

Orthographic Representation—Absolute Coordinates.

Reference Unit 6–1.

Work directly on the grids shown to establish and label the points given in the tables at the right. Connect the points either by freehand sketching on the grid lines or using a straightedge.

Drawing D–2.

Orthographic Representation—Relative Coordinates.

Reference Unit 6–1.

Work directly on the grids shown to establish and label the points given in the tables at the right. Connect the points either by freehand sketching on the grid lines or using a straightedge.

Drawing D–3.

Orthographic Representation—Two-Dimensional Coordinates.

Reference Unit 6–1.

Part A is developed using the absolute coordinate method. Plot all points and label them directly on the grid. Connect the points to complete the drawing. Part B involves relative coordinates.

Drawing D–4.

Orthographic Representation—Three-Dimensional Coordinates.

Reference Unit 6–1.

Count the squares on the grids for Parts A and B to establish the *X*, *Y*, and *Z* coordinates. Label coordinates on the pictorial drawings to identify points of intersection of the various lines and surfaces.

Drawing D–5.

Orthographic Representation—Corner Bracket.

Reference Unit 6–1

Study the pictorial drawing carefully before beginning this assignment. Review Unit 6-1 in your text if you are not sure about the difference between third-angle projection and first-angle projection. Either sketch the views or use a straightedge to produce the final drawing.

Drawing D–6.

Orthographic Representation—Location Block.

Reference Unit 6–1.

Review Unit 6-1 in your text. Work from the given view in each case in developing the remaining five views. Sketch the views or use a straightedge to complete the final drawings.

Drawing D–7.

Orthographic Representation—Miter Lines.

Reference Unit 6–2.

Space A. Use light construction lines to draw the front and top views of the angle bracket. Use a 45° miter line to aid in developing the right-side view. Darken all visible lines. Do not erase construction lines.

Space B. In this case, draw the front and right-side views first. Next, add a miter line and develop the top view.

Drawing D–8.

Orthographic Representation—Surfaces Parallel and Visible.

Reference Unit 6–3.

Carefully study each of the pictorial drawings before attempting to sketch or draw the three views of each on the grids.

Drawing D–9.

Orthographic Representation—Hidden Surfaces and Edges.

Reference Unit 6–4.

Carefully study each of the pictorial drawings before attempting to sketch or draw the three views on each grid. Review Unit 6-4 on page 100 of your text before adding hidden lines.

Drawing D–10.

Orthographic Projection—Control Block.

Reference Unit 6–4.

Use construction lines to block in the three views, keeping 20 mm between views. Use a miter line if you prefer. Add hidden lines. Darken all visible and hidden lines. Remember! Visible lines are thick; hidden lines are thin.

Drawing D–11.

Orthographic Projection—Angle Stop.

Reference Unit 6–4.

Block in the front, top, and right-side views of the angle stop. Allow .50 in. between views. Use a miter line if you prefer. Darken lines as appropriate. Are there any hidden lines in the top view, front view, or right-side view? What happens when visible lines and hidden lines coincide?

Drawing D–12.

Orthographic Projection—Guide Bar.

Reference Unit 6–4.

Block in the three views required for third-angle projection. Use a miter line if you prefer. Allow .50 in. between views. Develop each view completely, using construction lines before darkening any lines. Are there hidden lines?

Drawing D–13.

Orthographic Representation—Inclined Surfaces (1).

Reference Unit 6–5.

Draw three normal views of each of the pictorials shown on sheet D13. Study the details carefully as you transfer information from the pictorial grid to the orthographic grid. Notice that inclined surfaces become foreshortened in certain views.

Drawing D–14.

Orthographic Representation—Inclined Surfaces (2).

Reference Unit 6–5.

Carefully select the front view for each of the six drawings and develop three views of each. Watch for inclined surfaces and hidden lines.

Drawing D–15.

Orthographic Representation—Inclined Surfaces (3).

Reference Unit 6–5.

Block in the three normal views for each of the six pictorials. Notice that the front view is the one that shows the most detail. Watch for inclined surfaces and hidden lines.

Drawing D–16.

Orthographic Representation—Inclined Surfaces (4).

Reference Unit 6–5.

Block in the three normal views for each of the six pictorials. Notice that the front view is the one that shows the most detail. Watch for inclined surfaces and hidden lines.

Drawing D–17.

Orthographic Projection—Base.

Reference Unit 6–5.

Block in the three views with 20 mm between views. A miter line may be useful in this case. Are there hidden lines? Notice that the front view is the one that shows the most detail.

Drawing D–18.

Orthographic Projection—Base Plate.

Reference Unit 6–5.

Lay out the three views of the base plate with 20 mm between views. Use a miter line to develop the top and right-side views. Are there hidden lines in the top view?

Drawing D–19.

Orthographic Representation—Interpreting Drawings (1).

Reference Unit 6–5.

Be sure you first understand which is the front, top, and right-side view of both the bracket and the corner bracket. Letter neatly. Use guidelines if needed.

Drawing D–20.

Orthographic Representation—Interpreting Drawings (2).

Reference Unit 6–5.

Be sure you first understand which is the front, top, and right-side view of both the angled step bracket and the angle stop. Letter neatly. Use guidelines if needed.

Drawing D–21.

Orthographic Representation—Circular Features (1).

Reference Unit 6–6.

These assignments may be freehand sketched or drawn with instruments. First, block in each view, allowing one grid space between views. Use construction lines to complete the detail in each view. Finally, darken all visible lines, center lines, and hidden lines.

Drawing D–22.

Orthographic Representation—Circular Features (2).

Reference Unit 6–6.

These assignments may be freehand sketched or drawn with instruments. First, block in each view, allowing one grid space between views. Use construction lines to complete the detail in each view. Finally, darken all visible lines, center lines, and hidden lines.

Drawing D–23.

Orthographic Representation—Interpreting Drawings.

Reference Unit 6–6.

Study the orthographic views carefully before beginning this assignment. Project visually from view to view as you establish the sizes for A through T in each case. Use guidelines for lettering your answers in the space provided.

Drawing D–24.

Orthographic Projection—Rocker Arm.

Reference Unit 6–6.

Draw the top view first and project downward to draw the front view. You may need to refer to Unit 4-2 in your text when locating the centers of the arcs connecting the large and small cylinders. Be sure to mark all points of tangency with light construction lines.

Drawing D–25.

Orthographic Representation—Oblique Surfaces (1).

Reference Unit 6–7.

Study the pictorials carefully. Block in the three views on the grids before adding details. Use a miter line if needed. Are there hidden lines in any of the views?

Drawing D–26.

Orthographic Representation—Oblique Surfaces (2).

Reference Unit 6–7.

Study the pictorials carefully. Block in the three views on the grids before adding details. Use a miter line if needed. Are there hidden lines in any of the views?

Drawing D–27.

Orthographic Representation—One- and Two-View Drawings.

Reference Unit 6–8.

Study each of the pictorials carefully. If needed, sketch the necessary views on a separate sheet of paper before working on your workbook sheet. Your solutions may be freehand sketched or drawn with instruments. Do all of the drawings need hidden lines?

Drawing D–28.

Special Views—Connector.

Reference Unit 6–9.

While a front view, right-side view, and left-side view would generally be sufficient to describe the connector, a top view or partial top view can be used to more clearly show the radii on the bent corners.

Drawing D–29.

Conventional Representation—Locking Plate.

Reference Unit 6–10.

At least three sets of features can be shown simplified on this drawing.

Drawing D–30.

Conventional Breaks—Fixture Base.

Reference Unit 6–11.

With a scale of 1:1, a great deal of foreshortening will need to occur for the views to fit the sheet. Therefore, you will need to remove (break out) some large portions between the center hole and the threaded holes on each end. Use long break lines to show where portions have been removed. Is there another way to accomplish the same objective?

Drawing D–31.

Lines of Intersection—Cylindrical Surfaces.

Reference Unit 6–12.

Grids can be developed to accurately establish the lines of intersection or you can estimate and sketch the finished lines. Your instructor will assign the method.

Drawing D–32.

Foreshortened Projection—Mounting Bracket.

Reference Unit 6–14.

Make front and top views of the mounting bracket. Rotate features into the horizontal plane in order to show all parts in their true size and shape. The front view might best be shown as a half-section. Dimension if instructed to do so. Determine limits for the keyed hole from Appendix Table 43 in your text.

Drawing D–33.

Foreshortened Projection—Clutch.

Reference Unit 6–14.

Make front and top views of the clutch. Rotate features into the horizontal plane as required. Determine limits for the keyed hole from Appendix Table 48.

Drawing D–34.

Intersection of Unfinished Surfaces—Cutoff Stop.

Reference Unit 6–15.

Review Unit 6-15 in your text for a clear understanding of intersections of unfinished surfaces before completing this assignment. Also, see Unit 8-7 for information on surface texture and how it is specified on a working drawing. This drawing should be fully dimensioned.

Drawing D–35.

Intersection of Unfinished Surfaces—Sparker Bracket.

Reference Unit 6–15.

Review Unit 6-15 in your text for a clear understanding of intersections of unfinished surfaces before completing this assignment. Also, see Unit 8-7 for information on surface texture and how it is specified on a working drawing. This drawing should be fully dimensioned.

Drawing E–1.

Primary Auxiliary Views—Angle Bracket.

Reference Unit 7–1.

The auxiliary view need only show the size and shape of the inclined surface. Be sure to allow sufficient space between views for dimensions. Review Unit 8-7 in your text for information on surface texture and how it is specified on a working drawing.

Drawing E–2.

Primary Auxiliary Views—Angle Plate.

Reference Unit 7–1.

Study the drawing setup on drawing sheet E2 before you begin to draw. Pay attention to the location of views. The auxiliary view need only show the size and shape of the inclined surface. Fully dimension the completed drawing.

Drawing E–3.

Primary Auxiliary Views—Statue Bases.

Reference Unit 7–1.

Project at right angles to the oblique surface to establish the length of the auxiliary views of the two objects. The width dimensions are taken from the top views. Do not dimension.

Drawing E–4.

Circular Features—Link.

Reference Unit 7–2.

Develop the front view and partial top and auxiliary views, using light construction lines. Establish the best location for each of the break lines on the partial views and sketch them in before darkening the remaining lines. Add dimensions and notes.

Drawing E–5.

Multiple Auxiliary Views—Inclined Stop.

Reference Unit 7–3.

Develop the required views, using light construction lines. Sketch the break lines on the three partial views before darkening the remaining lines. Add dimensions and notes. Sizes not given on the pictorial drawing can be measured directly on the front view.

Drawing E–6.

Multiple Auxiliary Views—Connecting Bar.

Reference Unit 7–3.

Develop the required views, using light construction lines. Sketch the break lines on the auxiliary views before darkening the remaining lines. Use an ellipse template to draw the ellipses that appear in the bottom view. Add dimensions and notes.

Drawing E–7.

Multiple Auxiliary Views—Angle Stop.

Reference Unit 7–3.

Draw the top view first. From the top view, project downward to develop the front view. The angular lines on the drawing sheet locate surface A on the auxiliary views. Break the auxiliary views as necessary to fit the sheet. Add dimensions and notes.

Drawing E–8.

Secondary Auxiliary Views—Dovetail Bracket.

Reference Unit 7–4.

The primary auxiliary view is developed from a partially completed top view. The top view is then completed by projecting details back to the top view. The front view is developed by projecting from the top view. Finally, develop the secondary auxiliary view by projecting from the primary auxiliary view. The hexagram hole shown in its true shape on the secondary auxiliary view is then projected to the other view. Add dimensions and notes.

Drawing E–9.

Secondary Auxiliary Views—Pivot Arm.

Reference Unit 7–4.

Complete as much of the front view as possible before projecting to the auxiliary views. The right partial primary auxiliary view should show only the inclined surface (true shape and size) of the right side. The secondary auxiliary view will show only the inclined surface containing the round hole. Add dimensions and notes.